Digital Terrestrial Television
Requirements for interoperability
The D-Book 7 Part A
// Version 1

Digital TV Group

The industry association for digital television in the UK

Introduction

The first edition of the DTG D-Book was written in 1996 when DVB-T was new and untried. From the outset, the D-Book was an implementation guideline and referenced fundamental standards where possible. But many of the component parts of the document had not then achieved stable international standards and the UK implementation was therefore reproduced in full.

In subsequent editions, it has become possible to reference ETSI or other standards and the previous D-Book section simplified. However, the D-Book as an implementation guideline has become more important as non-UK based manufacturers have sought to introduce products to the UK market.

DTG Testing Ltd was established as an independent testing facility where manufacturers can bring prototype products for verification of their interoperability. Many manufacturers, both small and large, have discovered the advantage of revealing problems at this stage, rather than when they have large numbers of products in the shops or in people's homes.

As the process of switchover moves to another level next year, the importance of interoperability and test and conformance is bigger than ever. The success of Freeview continues and is largely down to the reliable products and services on the UK DTT platform which will enable a successful switchover from analogue.

D-Book 6 produced a significant step change in the UK DTT platform which introduced HDTV, DVB-T2, an MHEG return channel for transactions and streaming media and all the signalling to support this. It also introduces DVB-T2, the new modulation scheme that will be used in the UK to deliver these enhanced services.

D-Book 7 has now been split into two parts. Part A continues to specify the UK broadcast terrestrial platform and profile the receivers for Freeview. Part B introduces Connected TV, building on the European HbbTV and OIPF standards where possible to deliver enhanced hybrid services.

The DTG working groups have been working extremely hard to develop these chapters and ensure the continued success of the terrestrial platform. Much of the D-Book is now also referenced by other TV platforms such as Freesat and several international adaptations. The DTG continue to ensure European harmonisation wherever possible, while meeting the needs of the rapidly developing and highly successful UK TV market.

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March 2011

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1 UK DTT Overview

1.1 Scope of the D-Book

This document provides details of the 'Requirements for Interoperability' which have been adopted by multiplex operators in implementing digital terrestrial television services within the United Kingdom which are based on national and international technical standards that must be used by all those who have been awarded multiplex service operator licences by Ofcom.

Adherence to this specification will ensure that there is the maximum possible interoperability between multiplex operators, both in the terrestrial signals transmitted, the coverage areas reached by each service, and DTT receivers.

This document is intended to specify the minimum necessary to ensure interoperability and has been written so as to provide the maximum flexibility to operators and receiver manufacturers, allowing for the introduction and implementation of new services in the future. Wherever possible, technical detail has been kept to a minimum by referring the user to established international standards; a complete listing of the standards referred to is provided. Detailed references to all national and international technical and operational standards referred to throughout this document are provided in Annex B.

1.2 History of the D-Book

The first edition of the D-Book was published in 1996 when the infrastructure planning for digital terrestrial television (DTT) was well under way within the DTG, but before the commercial broadcast licences had been awarded and consequentially some of the significant technology contracts had not been placed. It is therefore worth noting that the regulators, the aspirant broadcasters, and existing broadcasters which were guaranteed access to DTT spectrum, referenced their system design and implementation on the DTG D-Book.

Since the first edition, the D-Book has been modified, updated and amended to reflect the continuing developments and additions to the UK DTT platform. D-Book 6 marked a significant step introducing HD support using DVB-T2. This led to the successful launch of the Freeview HD platform.

D-Book 7 is the next evolutionary step change for telelvision, embracing IP connectivity. D-Book 7 has been split into two parts. Part A builds on the broadcast specification and Part B introduces Hybrid IP support for Connected TV services.

1.3 The DTT Broadcasters

Digital terrestrial television was launched in the UK in November 1998 based on the horizontal market model. Under the prevailing UK legislation (the 1996 Broadcasting Act), the 'broadcaster' is defined as the multiplex operator - effectively a content aggregator. Multiplexes 1 (BBC) and 2 (ITV/C4) are 'gifted' in legislation to those organisations, while the other four multiplexes licences were awarded by the ITC (Independent Television Commission – now part of Ofcom). The licensees contract with programme service providers for content, and with one or other of the two UK transmission companies, National Grid Wireless and Arqiva, for distribution. Programme service providers are separately regulated by OFCOM, with the exception of the BBC, which is self-regulating under Royal Charter.

Licences for the three commercial multiplexes were awarded December 1997 with the condition that services start within one year. The commercial licence for multiplex A was granted in May 1998 and the service launched one year later.

The successful launch, in one year, of a conformant horizontal DTT platform which can be accessed by more than one independently operated transmission systems is wholly down to the process of collective agreement and collaboration across the industry – the technical results of which are recorded in the following chapters.

The BBC has made capacity available for software downloads to receivers for use by manufacturers to deliver bug-fixes and software upgrades to their products. The service is operated by DTG Testing Ltd. Other multiplexes may also be used for downloading software upgrades.

During the switchover process, the multiplexes are being renamed PSB 1, PSB 2 and PSB 3 (for the three national Public Service Broadcasting multiplexes with UK-wide coverage) and COM 4, COM 5 and COM 6 (for the three commercial multiplexes with lower coverage).

In December 2009, a DVB-T2 multiplex was launched carrying HD services. This exists as PSB 3 in the post switchover areas but is also available as a seventh multiplex in some areas to increase early HD coverage. Some local multiplexes are also being considered, with one broadcasting in Manchester and another planned in Northern Ireland in the future.

The disposition of services on the multiplexes is subject to frequent change and the latest LCN listing can be found at http://www.dmol.co.uk/. Below is a diagram of the channel line up for illustrative purposes only:

Post-DSO Multiplex Line-Up

PSB 1 (BBC) | PSB 2 (D3&4) | PSB3 HD | COM4 (SDN) | COM5 (Arqiva) | COM6 (Arqiva) | Local Mux (Manchester)

1.4 Current DTT Coverage

DTT services share the UHF frequency bands IV and V with existing analogue television services and will co-exist with these services until digital switchover.

The transmission of digital terrestrial services makes use of channels that could not be used for analogue transmissions because of mutual interference from other analogue transmissions. By using the COFDM coding and modulation system, as specified in the DVB-T standard, it has proved possible to construct national networks for six multiplexes, interleaving them with existing analogue transmissions.

The original frequency plan for DTT identified a network of 80 existing (analogue) transmitter sites, which are shown in Figure1-1.

Figure 1-1. Location of Main Stations and Relays

1.5 Digital Switchover

What is digital switchover?

By the end of 2012, television services in the UK will be completely digital. The existing analogue and low power DTT transmissions are being switched off TV region by TV region and new high power DTT transmissions are being launched from virtually every analogue transmitter site. A small number of new transmitter sites are also being built.

Who is responsible for digital switchover?

The **Government** is responsible for the policy of digital switchover, including the high-level timetable and the establishment of a Help Scheme for certain groups who may need practical assistance with switchover.

Digital UK is the not-for-profit organisation set up by the public service broadcasters and multiplex operators to lead the implementation of switchover. This involves: coordinating the technical roll-out of the high power digital terrestrial television network; communicating with the public about digital switchover to ensure everyone knows what is happening, what they need to do and when; and liaising with stakeholders to ensure understanding of and support for the switchover programme.

Ofcom is the independent regulator and competition authority for the communications industry, with an overall statutory duty to further the interests of citizens and consumers in communication matters. Ofcom is responsible for ensuring: competition between digital platforms; the optimal use of the radio spectrum; and that broadcasters and others comply with their licence obligations, in areas such as transmission coverage and reception.

What is the role of the BBC and other public broadcasters in switchover?

The BBC provides £200m to fund Digital UK's public communications campaigns and £600m to fund the Help Scheme through the licence fee. Digital UK's running costs are shared by the BBC and the other public service broadcasters. In addition, all public service broadcasters communicate with their viewers about switchover.

What other organisations are involved in digital switchover?

Digital platform operators, TV equipment manufacturers, transmission site owners, transmission providers, retailers, aerial installers, charities and consumer groups are all actively involved in the switchover to digital television.

When is switchover happening?

Switchover has been completed in a number of regions, and is rolling out to the rest of the country TV region by TV regionuntil the end of 2012. Figure 1-2 shows the TV regions.

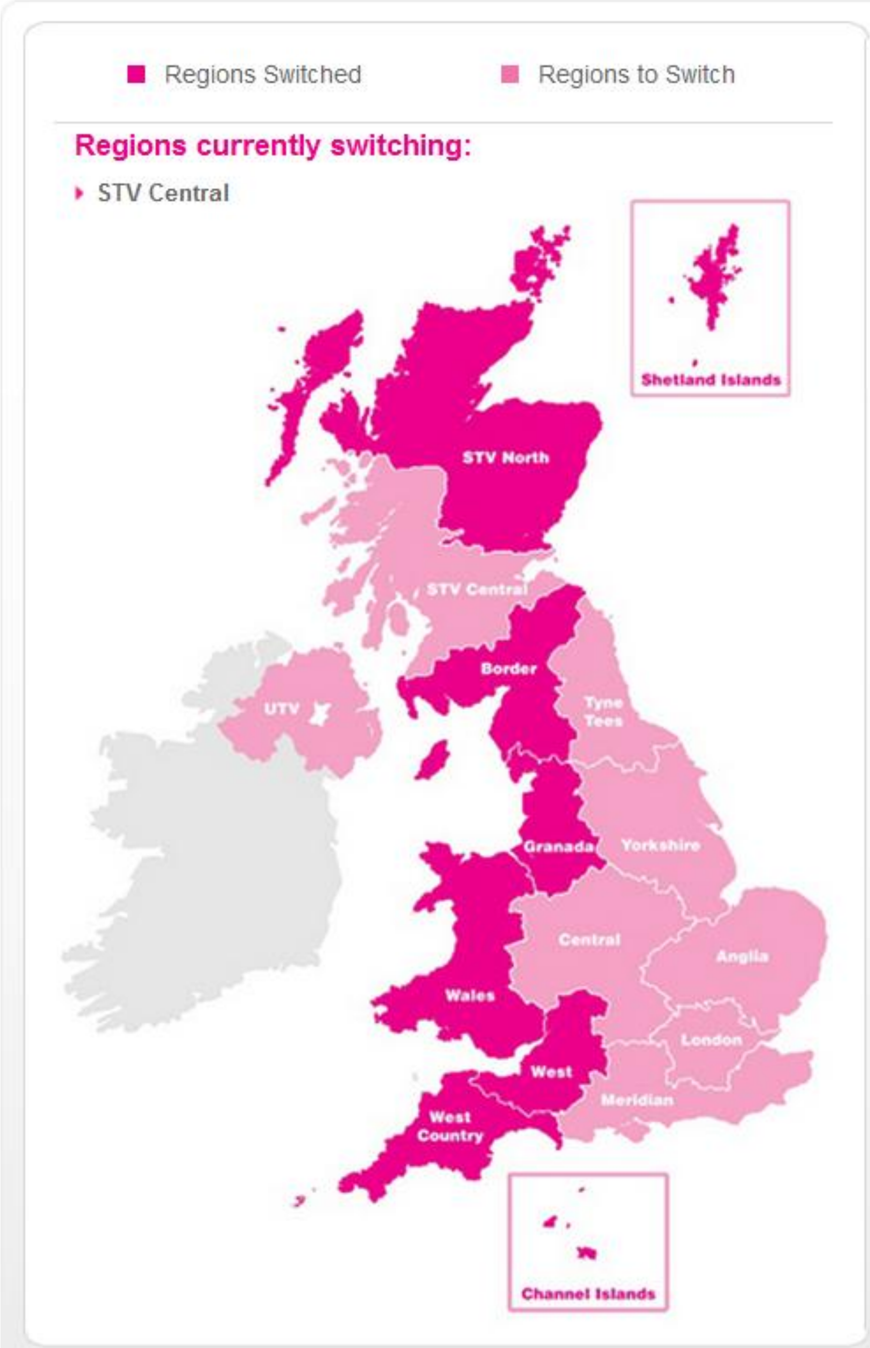


Figure 1-2. TV Regions

Within a TV region, each main transmitter and the relay stations which carry its signal will generally switch over on the same day. Most TV regions contain more than one main transmitter, and switchover for each of these might take place at different times. Further detail on the timings for each transmitter group are announced as the regional switchover date approaches. The details that have been announced to date are set in Table1-3:

TV region	Transmitter Group	Area served	Homes (000s)	Year &	Quarter DSO 1	DSO 2
Border	Selkirk	Scottish Borders	52	COMPLETED		
	Douglas	the Isle of Man	38	COMPLETED		
	Caldbeck	Cumbria, south west Scotland and the south Lakes	308	COMPLETED		
West Country	Beacon Hill	Torbay and south Devon	132	COMPLETED		
	Stockland Hill	Exeter, parts of Devon, Somerset and Dorset	206	COMPLETED		
	Huntshaw Cross	north Devon	66	COMPLETED		
	Redruth	west Cornwall and the Isles of Scilly	122	COMPLETED		
	Caradon Hill	Plymouth, parts of Devon and east Cornwall	255	COMPLETED		
Wales	Kilvey Hill	the Swansea area	132	COMPLETED		
	Preseli	south west Wales	83	COMPLETED		
	Carmel	parts of south and central Wales	110	COMPLETED		
	Llanddona	north west Wales	95	COMPLETED		
	Moel y Parc	north east Wales	179	COMPLETED		
	Long Mountain	parts of east and central Wales	24	COMPLETED		
	Blaenplwyf	parts of west and central Wales	26	COMPLETED		
	Wenvoe	Cardiff, Newport and south east Wales	649	COMPLETED		
Granada	Winter Hill	Liverpool, Manchester, Lancashire, Cheshire and north Staffordshire	3,041	COMPLETED		
West	Mendip	Bristol, parts of Somerset, Dorset, Wiltshire and Gloucestershire	913	COMPLETED		
	Ridge Hill	Herefordshire, south Shropshire and parts of Gloucestershire	100	COMPLETED		
STV North	Bressay	the Shetland Islands	9	COMPLETED		
	Keelylang Hill	the Orkney Islands	10	COMPLETED		
	Rumster Forest	Caithness and North Sutherland	23	COMPLETED		
	Eitshal	Lewis, Wester Ross, north west Sutherland and parts of Harris and Skye	12	COMPLETED		
	Skriaig	Skye, Harris, North Uist, Benbecula, South Uist and parts of Barra	8	COMPLETED		
	Angus	Angus, Dundee, Perth and parts of Fife.	210	COMPLETED		
	Durris	Aberdeen and Aberdeenshire	221	COMPLETED		
	Knockmore	Morayshire, Strathspey and parts of Easter Ross	39	COMPLETED		
	Rosemarkie	Inverness and the Great Glen	70	COMPLETED		
STV Central	Torosay	south west Highlands and Islands	17	COMPLETED		
	Darvel	parts of central Scotland, Argyll and Bute	197	2011	**11 May 11**	**25 May 11**
	Rosneath	Rosneath	44		**11 May 11**	**25 May 11**
	Craigkelly	Lothian, parts of Edinburgh and parts of Fife	455		**1 Jun 11**	**15 Jun 11**
	Black Hill	Glasgow, central Scotland and parts of Edinburgh	1,020		**8 Jun 11**	**22 Jun 11**

TV region	Transmitter Group	Area served	Homes (000s)	Year &	Quarter	
					DSO 1	DSO 2
Channel	Fremont Point	the Channel Islands	50	COMPLETED		
Central	Nottingham	the Nottingham area	74	2011	**30 Mar 11**	**13 Apr 11**
	Lark Stoke	the Stratford upon Avon area	38		**6 Apr 11**	**20 Apr 11**
	Bromsgrove	the Bromsgrove area	30		**6 Apr 11**	**20 Apr 11**
	Ridge Hill	Herefordshire, south Shropshire and parts of Gloucestershire	286		**6 Apr 11**	**20 Apr 11**
	The Wrekin	north Shropshire and south Cheshire	280		**6 Apr 11**	**20 Apr 11**
	Waltham	much of the East Midlands	815		**17 Aug 11**	**31 Aug 11**
	Sutton Coldfield	much of the West Midlands	2,123		**7 Sep 11**	**21 Sep 11**
	Fenton	Stoke-on-Trent and Newcastle-under-Lyme	128		**7 Sep 11**	**21 Sep 11**
	Oxford	Oxfordshire, parts of Berkshire and Buckinghamshire	415		**14 Sep 11**	**28 Sep 11**
Anglia	Sandy Heath	Cambridgeshire, Northamptonshire and Bedfordshire	966	2011	**30 Mar 11**	**13 Apr 11**
	Sudbury	parts of Suffolk and Essex	523		**6 Jul 11**	**20 Jul 11**
	Tacolneston	Norfolk and north Suffolk	408		**9 Nov 11**	**23 Nov 11**
Yorkshire	Oliver's Mount	the Scarborough area	31	2011	**3 Aug 11**	**17 Aug 11**
	Belmont	Lincolnshire, parts of Humberside and East Yorkshire	712		**3 Aug 11**	**17 Aug 11**
	Sheffield	the Sheffield area	119		**10 Aug 11**	**24 Aug 11**
	Chesterfield	the Chesterfield area	34		**10 Aug 11**	**24 Aug 11**
	Emley Moor	West Yorkshire and South Yorkshire	1,756		**07 Sep 11**	**21 Sep 11**
Meridian	Whitehawk Hill	the Brighton area	114	2012	**8 Feb 12**	**22 Feb 12**
	Midhurst	much of West Sussex	99	2012	**29 Feb 12**	**14 Mar 12**
	Hannington	parts of Hampshire, Berkshire and Surrey	481	2012	**7 Mar 12**	**21 Mar 12**
	Rowridge	Hampshire, the Isle of Wight, parts of Dorset and West Sussex	733	2012	**7 Mar 12**	**21 Mar 12**
	Tunbridge Wells	the Tunbridge Wells area	54	2012		
	Heathfield	East Sussex	216			
	Hastings	the Hastings area	18			
	Bluebell Hill	north and mid Kent	217			
	Dover	south and east Kent	231			
	Margate	the Margate area	9			
London	Crystal Palace	Greater London and parts of the Home Counties	4,858	2012		

TV region	Transmitter Group	Area served	Homes (000s)	Year &	Quarter	
					DSO 1	DSO 2
Tyne Tees	Bilsdale	much of North Yorkshire and Cleveland	595	2012		
	Chatton	north Northumberland	33			
	Pontop Pike	Durham and Tyneside	790			
UTV	Limavady	north west Northern Ireland	104	2012		
	Brougher Mountain	south west Northern Ireland	37			
	Divis	Belfast and the surrounding area	508			

Grey = completed transmitter groups

Table 1-3. Switchover timetable

What actually happens at switchover?
At each transmitter, switchover will happen in two stages, fourteen days apart:

Stage One
First, the terrestrial BBC TWO analogue service will be switched off overnight, along with Mux 1, where this is present. Then the new high power BBC multiplex BBC A will be switched on. This multiplex will contain digital BBC One and BBC Two, as well as some digital-only channels such as BBC Three, BBC News and CBBC.

Stage Two
Fourteen days later, the remaining analogue channels and low power digital multiplexes will be switched off overnight and replaced by the remaining high power digital multiplexes.

During the Fourteen day period between Stage One and Stage Two, viewers have the opportunity to check that their TV equipment is capable of receiving digital terrestrial TV.

Satellite, cable and broadband services are already broadcast digitally and will continue unchanged through switchover.

Coverage post digital switchover

98.5% of UK households are estimated to be capable of receiving a high quality and reliable analogue TV signal, subject to the installation of a suitable antenna system. Ofcom estimates that digital terrestrial TV coverage after switchover – for the three PSB multiplexes (two BBC multiplexes and D3&4) – will match this, so 98.5% of UK households will be capable of getting a high quality and reliable digital TV signal. In addition, Ofcom estimates that 90% of households will receive the additional 3 commercial multiplexes (two arqivamultiplexes and SDN).

1.5% – the same proportion of households who cannot get analogue TV today, but not necessarily the same households – will not be able to get what is formally classified as a fully reliable digital TV signal. However, this does not mean they won't be able to get digital terrestrial TV at all. Many will be able to receive a service which is the subject of occasional co-channel interference.

Since the effect of interference on digital TV reception is different from analogue, to be classified as high quality and reliable, the digital signal must be fully available for at least 99% of the time, as compared to only 95% time for analogue. Of the 1.5% of UK households not estimated to be capable of getting a high quality and reliable digital TV signal, most (1.2% of UK households) will still be able to get it nearly all the time (between 95% and 99% of the time). In many cases the digital interference will be experienced at particular times of the year, so even households officially designated as being outside reliable digital TV coverage areas may well get a perfectly good signal for long, uninterrupted periods.

The remaining 0.3% of households is unlikely to receive a usable digital terrestrial TV signal. Typically, these households are in the most remote parts of the UK and cannot presently get analogue TV.

1.6 System overview

Figure 1-4 shows a block diagram representing a high-level description of the complete digital broadcasting system. More detailed block diagrams of the individual parts of the system are included later in this part, and in subsequent chapters dealing with each area of the broadcasting system.

At its simplest, DTT programming originates from a number of service providers' play-out centres. It is digitally encoded either in the same broadcast centre or by a separate multiplex operator. The digital bitstream is fed to the transmitter network via a distribution network, which may be multiplexed with other traffic, on a fibre optic cable or satellite network.

At the first terrestrial transmitting station in each region, service information (S.I.) for all of the available services is injected into the bitstream, prior to channel coding and modulation, radio frequency amplification and high power filtering before being combined with other UHF signals and fed to the

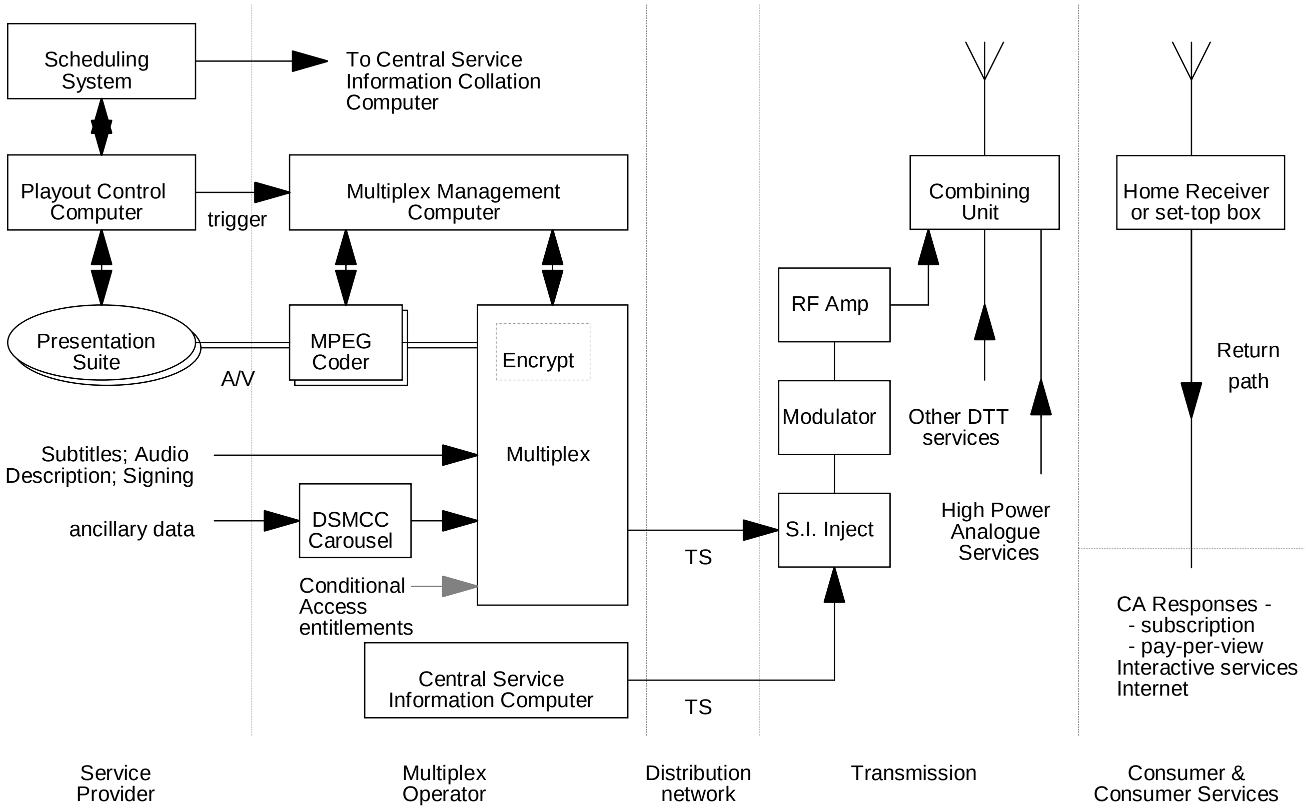


Figure 1-4. Generic - Overall Physical System Elements

transmission antenna.

At the home, the off-air signal is received on either a roof mounted outdoor or, in areas of good reception, on a set-top aerial. Provision has also been made in the UK terrestrial television broadcasting system for a return path via the public telephone network, allowing viewers to make subscription or pay-per-view requests and engage in interactive services.

The system consists of five main processes:

A broadcasting studio or transmission centre.

A source coding, compression and multiplexing system. This is the area where the audio and video signals from the studio undergo compression in order to provide signals at data rates low enough to be appropriate for carriage through the subsequent transmission path. The compression scheme universally adopted for transmission and consumer equipment has been defined by an industry standards making body called the Motion Picture Experts Group.

The individual streams of compressed audio, video associated services and data are assembled into well-defined and identifiable 'packets', which are multiplexed into a *single programme transport stream* (TS). Several different programme streams can be multiplexed within the capacity of the transport stream making a *multiple programme transport stream*. Variable "statistical" multiplexing may be applied to obtain more efficient use of the transport stream.

Programme Service Information (PSI) is also added to the transport stream, which gives details of the different programmes within the transport stream and the individual elementary streams which comprise each programme. Additionally, Conditional Access data: EMM and ECM; may be injected into the multiplex along with carrousel data for the interactive and information services.

A distribution network, which will employ further encoding and multiplexing appropriate to the physical network, and delivers the signals without distortion or losses to the transmitter sites.

The transmission system, consisting of DVB SI injection, channel coding, modulation, RF power amplification and radiation via the transmit antenna.

The SI injector selects and inserts the relevant DVB SI reflecting the Network Information and Event Schedule data pertinent to that local TV region. The channel coder processes the digital bitstream into a form suitable for it to be transmitted over the appropriate radio frequency channel, adding extra bits which the receiver can eventually use to detect and correct errors, which arise over the transmission path.

The encoded signal is then modulated onto a radio frequency carrier in an OFDM (Orthogonal Frequency Division Multiplexing) format, using a very large number of finely spaced carriers. This method of encoding is radically different to analogue broadcasts and their immunity to interfering signals allow the so-called "taboo" channels in the UHF spectrum to be used.

A receiving, decoding, and display system. This part of the system includes a radio frequency demodulator, a channel decoder to correct for errors that have occurred along the transmission path, and a source decoder which converts the compressed signals back into video, audio, and related text, which can then be displayed on a television receiver. The MHEG-5 decoder decodes and displays the information and interaction data.

Viewer responses could be delivered via a network connection to a service management or other centre.

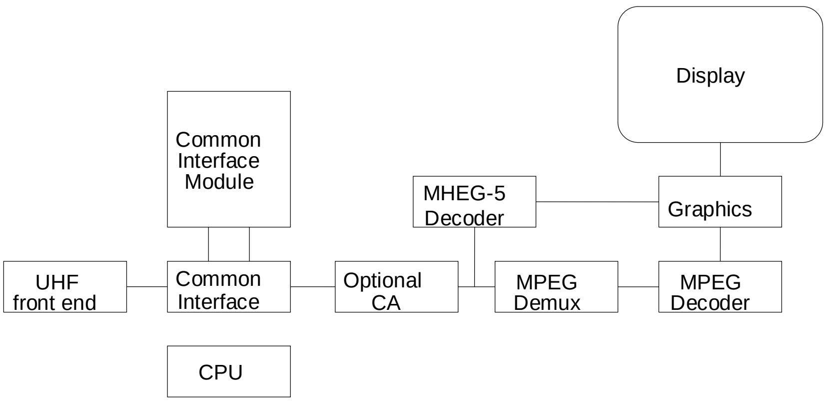


Figure 1-5. Overview of generic receiver

As mentioned above, one multiplex operator opted to distribute signals to all transmitter sites by satellite. The appropriate SI data is delivered to the injector by landline, multiplexed together with the other operator's transport streams.

1.7 The receiver

Figure 1-6 shows a high-level schematic of a generic digital receiver. The receiver profile can be found in Chapter 22.

1.8 The Role of DTG Testing Ltd.

In the summer of 2000 the DTG founded DTG Testing – an independent interoperability testing centre.

DTG Testing offers pre-launch testing of receivers and set-top boxes to D-Book requirements, software download and MHEG-5 application testing services. DTG Testing has created a set of industry-approved test suites that ensure products meet the performance required to meet the criteria for the UK 'Digital Tick' and the Freeview and Freeview Plus logos.

Manufacturers use reports generated by product conformance testing at the DTG's Test Centre as evidence to achieve the Digital Tick.

More recently, developments have delivered conformance regimes and materials for Freesat, Freeview New Zealand, Freeview Australia and several other territories.

Further information may be obtained by email from testing@dtg.org.uk.

1.9 MHEG-5 Interoperability Code of Practice

This edition of the D-Book includes a baseline specification of the UK Profile of MHEG (v1.06) and a corresponding version of the DTG MHEG Test Suite has been developed to provide a truly objective means of evaluating receiver conformance. A group of broadcasters, manufacturers and other interested parties has subsequently developed the concept of an Interoperability Code of Practice to maximise the benefits arising through application of this test tool.

The aim of the Code of Practice is to achieve a situation where deployed receivers implement all features of the UK Profile of MHEG in a conformant manner, as determined by the DTG MHEG Test Suite, and that all interactive services operate as intended on such receivers. From a viewer's perspective this will deliver a less problematic and richer experience, to the general benefit of the DTT platform.

The Code of Practice is voluntary and there are no penalties or constraints held against any of the parties in the event that shortcomings are highlighted through test procedures. However, by considering a wide range of interests and opinions in the drafting of the Code the intention was to make it easy to adopt by all relevant parties. The clearer and more objective testing regime for both applications and receivers embodied by the Code, coupled with a more co-ordinated information flow through a spirit of collaboration and engagement will provide a significant step towards a more stable and reliable experience for the viewer. Manufacturers are encouraged to sign up to the Code of Practice. Contact DTG Testing (testing@dtg.org.uk) for further details.

1.10 HD services and DVB-T2

In April 2008, the BBC Trust and Ofcom unveiled details of a major upgrade of the UK digital terrestrial television platform. The upgrade will use an advanced transmission standard known as DVB-T2, to provide viewers using new receiving equipment with up to four high definition channels by the time digital switchover is completed in the UK in 2012.

DVB-T2 uses the latest modulation and coding techniques to enable highly efficient use of spectrum for the delivery of audio, video and data services to fixed, portable and mobile devices. DVB-T2 will not replace all DVB-T transmissions in the UK and the two standards will co-exist for many years.

The DVB-T2 specification was approved by the DVB Steering Board at the end of June 2008. On approval it was released as DVB BlueBook A122 and sent to ETSI (European Telecommunications Standards Institute) for publication as a formal standard. Manufacturers are already working on the design of DVB-T2 equipment, with the first prototypes unveiled at IBC 2008.

From the end of 2009, during the switchover process, services in Mux B (PSB 3) will be re-allocated into the other multiplexes and Mux B (PSB 3) will then be converted to DVB-T2. This multiplex with then carry at least three HD services from the BBC, ITV and Channel 4/S4C.

D-Book 6.0 contains details of the DVB-T2 profiles intended for use in the UK, along with other features required to support high definition services.

1.11 Regional services

Regional services have always been present on the UK DTT platform. Due to the increase in coverage of transmitters through the process of Digital Switchover, many areas can receive signals from more than one transmitter. To aid the viewer selecting the most appropriate service, D-Book 6 introduced the Target Region Descriptor. This signalling allows a receiver to present an option to the viewer where more than one regional variant is available, as defined in 8.5.3.21.

Below is a map showing potential regional variants but is only provided for illustration purposes.

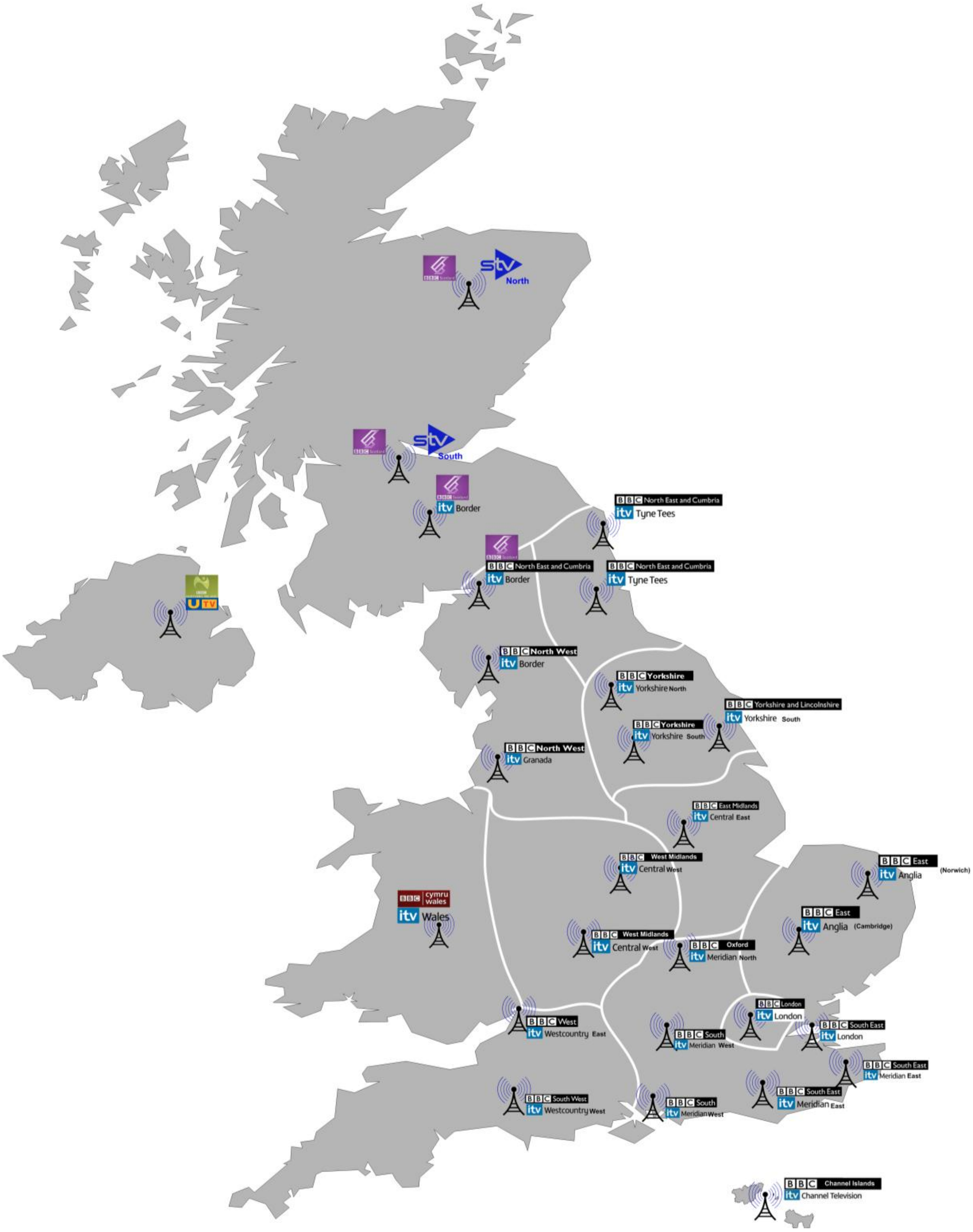


Figure 1-6. Illustration of regional variants

2 Video System Characteristics

2.1 Scope

This section defines the digital video encoding standards that shall be used in all UK UHF terrestrial Television Broadcasts and delivered using the MHEG *ICStreamingExtension* (see 13.5.4).

2.2 References

- ISO/IEC 11172-2
- ISO/IEC 13818-2
- TS 101 154
- ITU-R BT.470
- ISO/IEC 14496-10

2.3 Essential requirements

Broadcast video shall be encoded according to ISO/IEC 13818-2 constrained according to TS 101 154. All receivers shall be able to meet the minimum decoding requirements set out in TS 101 154.

Only the '25 Hz SDTV' variant described in the 'video' clause of TS 101 154 is relevant to this specification.

2.3.1 AVC SD: Essential requirements

Broadcast video shall be encoded according to ISO/IEC 14496-10 constrained according to TS 101 154. Only the '25 Hz H.264/AVC SDTV' variant described in the 'video' clause of TS 101 154 is relevant to this specification.

2.3.2 AVC HD: Essential requirements

Broadcast video shall be encoded according to ISO/IEC 14496-10 constrained according to TS 101 154. All receivers shall be able to meet the minimum decoding requirements set out in TS 101 154. Only the '25 Hz H.264/AVC HDTV' variant described in the 'video' clause of TS 101 154 is relevant to this specification.

2.4 DTG Constraints and extensions

This section sets out the additional requirements on the broadcast signals and reception equipment to be DTG compliant in addition to the DVB requirements expressed by TS 101 154.

2.4.1 Support for rapid channel acquisition

To reduce the typical time taken to start decoding a new service each video elementary stream shall contain a sequence header and associated group of pictures header. Also, each such sequence header shall be immediately preceded by a PES packet header carrying a PTS.

To achieve rapid channel acquisition the preferred practice is to include GOP headers at an interval no greater than 0.5 seconds[1] . Due to increased demands on capacity, the video stream may contain variable GOPs with a longer GOP length.

Video streams shall have a maximum GOP length of 45 frames. Video streams shall have a target or typical operating GOP length not exceeding 24 frames.

For video streams with a GOP interval greater than 0.5 seconds, the stream shall be constructed with one PES packet header per frame.

There is no requirement to set the data alignment indicator flag in the PES packet header or for the broadcast to include a data stream alignment descriptor associated with the video elementary stream in the PMT. If a data stream alignment descriptor is included for a video elementary stream then it shall indicate alignment type ‘04’.

2.4.1.1 AVC: Support for rapid channel acquisition

The frequency of the random access points (RAP) shall be equivalent to those applicable to MPEG-2 SD services.

The maximum PCR to DTS delay has an impact on channel change times and is currently being studied.

2.4.2 Picture types

Beyond the constraints applied by ISO/IEC 13818-2 and the requirement for periodic I pictures implied by Section 2.4.1 Support for rapid channel acquisition, no additional constraints are placed on the sequence of coded picture types. Specifically, no additional constraints are placed on the number of B pictures between I and P pictures. As required by the Main Profile of ISO/IEC 13818-2 broadcasts may use I, P, B and dual-prime frame types.

2.4.2.1 AVC: Picture and Slice types

There are no restrictions on picture or slice types beyond those of TS 101 154.

2.4.3 ISO/IEC 11172-2 compatibility

TS 101 154 requires that video encoding shall conform to ISO/IEC 13818-2 Main Profile at Main Level. This requires support for ISO/IEC 11172-2 ‘D’ pictures and “constrained parameters” video.

DTG conforming broadcasts shall not include ISO/IEC 11172-2 ‘D’ pictures or sequences with a horizontal_size greater than 720.

2.4.3.1 AVC: ISO/IEC 11172-2 compatibility

AVC broadcasts are not constrained by any compatibility with ISO/IEC 11172-2.

2.4.4 User data

To ensure good behaviour in current and future receiver video decoder implementations, a buffer model for user data within the video elementary stream is defined. The currently proposed use for this data is to carry the Active format decription described in Section 3.4.2. This only exploits a small

1. TS 101 154 recommends but does not mandate this.

number of the bytes that might be used. Broadcasts are not required to carry this data.

If user data is carried it shall meet the following buffer model:

- All user data bytes enter a single buffer of size at least 16 bytes (the user data start code is discarded before data is delivered to the buffer).
- All the data delivered at one time is removed from the buffer no later than 40 ms after it was delivered.

Note: This buffer is just sufficient to accommodate "Active format description" signalling. Other applications of user data are permitted but these shall not exceed the above buffer constraint when used in the same stream as "Active format description" signalling.

2.4.4.1 AVC: User data

"Active format description" signalling may be broadcast in the SEI as specified in TS 101 154 and shall meet the buffer model above.

2.4.5 Video alignment

2.4.5.1 Video with graphics

The graphics system used by applications and subtitling addresses a 720x576 pixel space. The output of the ISO/IEC 13818-2 video decoder is centred vertically and horizontally within this space after upsampling.

If the result of the upsampling process is *less* than 720 pixels wide then the output of the video decoder shall be centred within the region of 720 active digital video pixels. The offset from the start of the active digital video pixel area to the first (left most) pixel of video decoder output is the difference in their widths divided by 2 and truncated towards zero. Equivalent centring should be used to position the video decoder output vertically within the 576 active lines of the analogue display.

If the result of the upsampling process is *greater* than 720 pixels wide then the output of the video decoder shall be cropped symmetrically to fit within the region of 720 active video pixels. The number of pixels cropped from the left hand side of the video decoder output shall be the difference between its width and 720 divided by 2 and truncated towards zero. The remaining difference shall be cropped from the right hand side of the video decoder output.

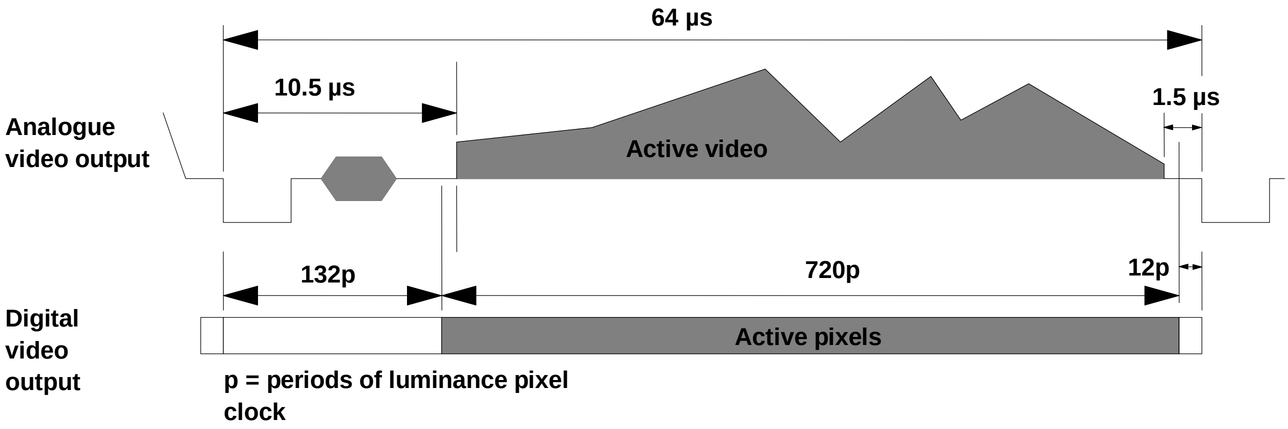


Figure 2-1. Relationship between digital video and analogue video

2.4.5.2 With analogue outputs

The digital video output of the receiver's MPEG video decoder and graphics display system domain contains 720 active pixels per line; these shall be aligned to the analogue video output signal as shown in Figure 2-1.

Note:

- At least the first 9 and the last 9 of the 720 video pixels should be replaced with blanking level to ensure compliance with System-I as defined in ITU-R BT.470.
- Optionally, additional blanking may be applied to the start and end of the active video suppressing further active pixels.
- The position of the first of the 720 active video pixels corresponds to 132 pixel periods (≈9.8 µs) after the falling edge of line sync.
- The figure is specific for PAL output signals. For receivers with SECAM output signals, similar positioning and blanking shall be done.

2.4.5.3 AVC HD: Frame Cropping

Receivers shall implement frame cropping (as defined in ISO/IEC 14496-10 section 7.4.2.1.1) when the following are true:

- the service is using one of the 1080 line formats.
- the signalling is for the purpose of selecting the relevant 1080 lines to be displayed.

2.4.5.4 AVC: Pan-Scan

There is no requirement for a receiver to support Pan-Scan.

2.4.5.5 HD video with graphics

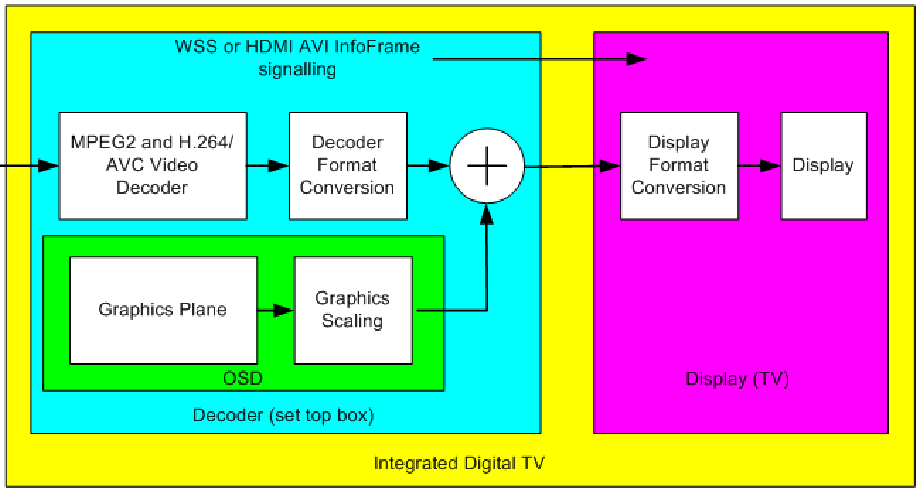


Figure 2-2. HD receiver and display format professing reference model

The On-Screen Display (OSD) comprises the Graphics Plane and Graphics Scaling. It is used for the presentation of MHEG graphics and Subtitles. The OSD should be implemented as multiple logical planes to improve the simultaneous presentation of subtitles, interactive applications and graphics. The Graphics Scaling resizes the logical graphics planes to exactly fill the Decoder output's active pixel area, regardless of the aspect ratio and format of the Decoder output. To allow interactive applications to navigate smoothly between video streams of different resolutions, the resolution of the MHEG plane used by applications shall be independent of the format of the decoded video stream. The minimum resolution of the MHEG plane shall be 1280x720 consistent with the requirement for receivers to support MHEG *HDGraphicsPlaneExtension,* but a resolution matching that of the Decoder's video output is recommended. The resolution of the Subtitle plane shall be equivalent to the display_width and display_height carried within the subtitle stream DDS.

The Decoder Format Converter (DecFC) is able to up-convert and cross-convert signals between different video formats, as well as perform aspect ratio conversion as required. The Decoder output may be 16:9 or 4:3 and shall be signalled to the Display through the HDMI AVI Infoframe or other means. The Display Format Converter (DisFC) similarly converts the signals on the Display's input to a suitable format for driving the display itself. The DisFC should therefore also perform aspect ratio conversion. Note this feature is not always supported on the HDMI inputs of "HD Ready" displays, complicating the presentation of 4:3 video with graphics.

The output of the MPEG2 and H.264/AVC video decoder is assumed to be scaled to 720x576 pixels for SD broadcasts, and either 1920x1080 or 1280x720 pixels for HD broadcasts. When no MHEG applications are running, the output from the video decoder shall be further scaled to match the Decoder output format as follows:

- For 16:9 broadcasts, the DecFC shall scale the video decoder's output to exactly fill the Decoder output's active pixel area. The output from the Decoder shall be signalled as 16:9 to the Display.

- For 4:3 broadcasts, two methods of achieving the correct presentation of video content and alignment with graphics are specified:

Decoder Aspect Ratio Conversion (set-top boxes only)

Since many "HD Ready" displays do not follow the aspect ratio signalling carried within the HDMI AVI InfoFrame, set-top box receivers shall also provide the option for the DecFC to convert 4:3 signals for presentation within a 16:9 Decoder output frame. The output from the Decoder shall be signalled as 16:9 to the Display. Note that this method may result in aspect ratio errors when video is mixed with MHEG content. Furthermore, it will also result in differences in the alignment of video and MHEG graphics dependent on the 4:3 presentation style that has been selected. For that reason, where supported by the display, Display Aspect Ratio conversion is preferred.

Display Aspect Ratio Conversion (set-top boxes and IDTVs)

To ensure the correct alignment and presentation of video and graphics on IDTVs and "HD Ready" displays, the DecFC shall additionally provide the option to "stretch" the 4:3 video signal to exactly fill the Decoder output's active pixel area. For Decoder output formats that are usually considered to be 16:9, the "stretch" process will result in an anamorphic 4:3 frame. The output from the Decoder shall be signalled as 4:3 to the display. Should the Display not respond to the aspect ratio signalling, correct alignment of video and graphics is still maintained, but the aspect ratio of both video and MHEG content may be incorrect.

When an MHEG application is running, aspect ratio conversion and signalling to the Display is specified in Section 16.6 Application Control of Aspect Ratio.

2.4.5.6 With HD analogue and digital outputs

Video timings for high definition video outputs are specified in EIA/CEA standard CEA-861-E [135] (or later), A DTV Profile for Uncompressed High Speed Digital Interfaces. Set-top boxes shall support the following Decoder Output formats:

- 1920x1080i25 - CEA Format 20
- 1280x720p50 - CEA Format 19
- 1920x1080p50 - CEA Format 31

Both video and graphics are scaled to the 1920x1080 and 1280x720 active pixel areas for these formats according to Section 2.4.5.5 HD Video with graphics.

Analogue high definition outputs are not permitted (see Section 22.3.4.4.2).

2.4.6 Colorimetry

DTG standard definition broadcasts shall use colorimetry as defined for System-I ITU-R BT.470.

MPEG-2 Video (ISO/IEC 13818-2), as amended by the corrigendum ISO/IEC JTC1/SC92/WG11 N0930, defines the interpretation of the default condition (when the sequence_display_extension is not present, or the colour_description flag is set to zero) so that the colour_primaries, transfer_characteristics and matrix_coefficients are implicitly defined by the application.

For the DTG this implicit definition is System-I as specified in ITU-R BT.470. This has colorimetry which is explicitly the same as Systems B and G specified in ITU-R BT.470. So, optionally, the use of this colorimetry can be signalled using the value 5 for each of: colour_primaries, transfer_characteristics and matrix_coefficients.

2.4.6.1 AVC: Colorimetry

Standard definition AVC broadcasts shall also use the colorimetry defined for System-I ITU-R BT.470. High Definition AVC broadcasts shall use the colorimetry defined in ITU-R BT.709. The correct colorimetry should be signalled within the AVC VUI by setting colour_description_present_flag equal to 1.

2.4.6.2 Colorimetry Management

The main difference between the standard definition and high definition colour systems are the equations used to matrix between RGB and YCbCr colour space and vice-versa. Using the wrong matrix will lead to colour distortions that are particularly visible in saturated colours. Whilst the distortions may be acceptable during normal viewing, they will become more noticeable if an MHEG application has been authored to match the colour of its graphics with graphics in the broadcast video stream. The problem may be particularly acute where an MHEG application is used to navigate between an SD video stream and an HD video stream of similar content. Unless due care is taken, the MHEG graphics will match colours in one of the broadcast streams but not the other.

One way to overcome the problem is for receivers to mix both video and graphics in RGB colour space, using the appropriate matrix coefficients for each video and graphic component. But whilst such an approach may be possible for IDTVs, it is usually preferable for set-top box receivers to keep broadcast video in component YCbCr format to minimise the number of conversion steps and rounding errors between the video decoder and the display. Set-top box receivers may mitigate the problem by signalling the correct colorimetry of video components over HDMI through the AVI InfoFrame, but presently few displays respond to the signalling.

It is therefore recommended that set-top box receivers re-matrix SD video to the BT.709 colour matrix for HD component analogue and digital outputs, provided this can be achieved without loss of video quality. Receivers that are unable to re-matrix SD video shall nonetheless ensure that the appearance of colours used by Interactive Applications does not change when applications switch between SD and HD video sources. Where necessary, this may be achieved at the expense of precise colour matching between video and graphics.

2.4.7 Encoder option constraints

It has been identified that the use of “adaptive Field/Frame” encoding can cause a large proportion of the legacy receivers to exhibit errors. This feature shall not be included for MPEG-2 video in compliant bitstreams.

2.4.8 AVC: Bar Data

There is no requirement for a receiver to support Bar Data.

2.4.9 AVC: Overscan

Receivers should apply overscan or not to an HD video signal based on the values of **overscan_info_present_flag** and **overscan_appropriate_flag**, as specified in ISO/IEC 14496-10 [104]. The behaviour of receivers when the **overscan_appropriate_flag** is not present is not defined.

2.4.10 AVC: Chrominance Sampling Structure

The chrominance sample location shall be the H.264/AVC default location, which is the same as for MPEG2 services.

3 Video Display Formatting

3.1 Scope

This section describes the video format signalling and how it may be used. The receiver response to this signalling is defined in this section.

This section:

- Provides a summary of the "Applicable standards" on page 3-1
- Introduces "Recommendations for signalling in the video stream" on page 3-2
- Defines "Video format signalling extensions" on page 3-6

3.2 Applicable standards

- ISO/IEC 13818-1
- ISO/IEC 13818-2
- EN 300 468
- TS 101 211
- TS 101 154
- ITU-R BT.1119-2
- EN 300 294

The video format shall be encoded as described in ISO/IEC 13818-1, ISO/IEC 13818-2 and EN 300 468 constrained and interpreted as described in TS 101 211 and TS 101 154 and as clarified and extended below.

Only the '25 Hz SDTV' variant described in the 'video' clause of TS 101 154 is relevant to this specification.

3.2.0 AVC: Applicable standards

- ISO/IEC 14496-10[104]

The video format shall be encoded as described in ISO/IEC 14496-10, ISO/IEC 13818-2 and EN 300 468 constrained and interpreted as described in TS 101 211 and TS 101 154 and as clarified and extended below.

Only the '25 Hz SDTV' and '25Hz HDTV' variants described in the 'video' clause of TS 101 154 are relevant to this specification.

3.2.1 Requirements for DVB compliance

3.2.1.1 Required format information

The following elements must be included for all MPEG-2 video services:

- Video sequence header (ISO/IEC 13818-2) in the video stream

  Restricted to "full screen" luminance pixel resolutions of: 720x576, 544x576, 480x576, 352x576 or 352x288 or "less than full screen" resolutions as described in TS 101 154.

3.2.1.2 AVC: Required format information

Broadcasters shall include the following elements for all video services:

- Random Access Point (RAP) in the video stream
- Video restricted to "full screen" luminance pixel resolutions of: 720x576, 544x576, 480x576, 1280x720, 960x720, 1920x1080, 1440x1080, 1280x1080 or "less than full screen" resolutions as described in TS 101 154.
- Frame cropping as defined in ISO/IEC 14496-10 section 7.4.2.1.1, but only for services using one of the 1080 line formats and to signal the relevant lines to be displayed.

3.3 Recommendations for signalling in the video stream

DTG compatible broadcasts may use any of the formats permitted by DVB (see TS 101 154). This section defines the signalling that must be used when using these formats.

3.3.1 Sequence header

The minimum video format signalling required is the video sequence header. Table 3-1 tabulates the horizontal scaling factors required to restore video to 720 pixel horizontal resolution with the correct aspect ratio. These factors complement the scaling factors employed by the broadcaster when downsampling the video before encoding.

<table>
<tr><th colspan="3"></th><th colspan="3">Source aspect ratio[a]</th></tr>
<tr><th>horizontal_size</th><th>nominal "full screen" width</th><th>effective horizontal size[b]</th><th>4:3</th><th colspan="2">16:9</th></tr>
<tr><td>545 to 720</td><td>720</td><td>720</td><td>1</td><td>4/3[c]</td><td>1</td></tr>
<tr><td>481 to 544</td><td>544</td><td>540</td><td>4/3</td><td>16/9</td><td>4/3</td></tr>
<tr><td>353 to 480</td><td>480</td><td>480</td><td>3/2</td><td>2</td><td>3/2</td></tr>
<tr><td>1 to 352</td><td>352</td><td>360</td><td>2</td><td>8/3</td><td>2</td></tr>
<tr><td colspan="3"></td><td colspan="2">4:3 display</td><td>16:9 display</td></tr>
<tr><td colspan="3"></td><td colspan="3">horizontal scaling to fill 720 wide display</td></tr>
</table>

Table 3-1. Horizontal scaling where format is signalled by the sequence header alone

a] From the aspect ratio information.

b] For example, values of horizontal_size from 481 to 544 are treated as 540 when determining the scaling factor to adapt the video for a 720 pixel wide display. I.e. 720/540 = 4/3.

c] These scaling factors apply to a centre cut-out presentation. I.e. the central 3/4 of the coded picture width is scaled by the factor indicated to fill the width of a 4:3 display.

3.3.1.1 AVC: Random Access Point

The minimum video format signalling required is the random access point.

Table 3-1-1 tabulates the horizontal scaling factors required to restore video to 1280 or 1920 pixel horizontal resolution with the correct aspect ratio. These factors complement the scaling factors employed by the broadcaster when downsampling the video before encoding.
The horizontal scaling ratios for SD signals when AVC coded are the same as for MPEG2. See Tables 3-2 and 3-3.

Coded Picture			
Luminance Resolution (horizontal x vertical)	Source Aspect Ratio	aspect_ratio_idc	16:9 Monitor up sampling
1920 x 1080	16:9	1	x 1
1440 x 1080	16:9	14	x 4/3
1280 x 1080	16:9	15	X 3/2
1280 x 720	16:9	1	x 1
960 x 720	16:9	14	x 4/3

Table 3-1-1. Horizontal scaling factors for HD resolutions

3.3.1.2 AVC: Signalling of Overscan

The Video Usability Information (VUI) parameters may include the overscan_info_present_flag and the overscan_appropriate_flag. Receivers should by default follow this signalling, for example by passing the information through via AVI InfoFrame on HDMI (in the case of STBs) or applying it directly on the display (for IDTVs). Receivers may wish to allow users to override this behaviour.

3.3.1.3 AVC: Interlaced and Progressive Scanning

The SEI Picture Timing message may include a value of pic_struct to indicate whether a coded picture should be displayed as frames or one or more fields. pic_struct values of "0" and "7" indicate that the source material is progressive and the coded picture should be displayed as one or more frames. pic_struct values of "1", "2" and "3" indicate that the source material is interlaced and should be displayed as one or more fields. The remaining values of pic_struct are intended for use in the "30 Hz" variants described in "video" clauses TS 101 154.

The pic_struct value allows receivers to correctly process the decoded video stream to ensure that progressive frames are not handled as interlaced.

Broadcasts may switch between 1080i25 and 1080p25 formats on coded video sequence boundaries only (e.g. interlaced title sequence added to a progressive programme). Receivers shall handle any such changes with no noticeable artefacts (e.g. black frame or audio click).

3.3.2 Sequence display Extension

3.3.2.1 Pan scan window

Here the sequence display extension describes a 4:3 aspect ratio window within 16:9 coded frame (the position of this window may be controlled by the picture display extension).

display_horizontal_size			effective horizontal size [a]	horizontal scaling	
Min.	Typ [b]	Max.		window fills 4:3 display	full frame fills 16:9 display
409	540	540	540	4/3	1
364	408	408	405	16/9	4/3
271	360[c]	363	360	2	3/2
1	264	270	270	8/3	2

Table 3-2.

a] Scaling to make display window fill 4:3 display is 720/effective horizontal size.

b] Recommended to broadcast. Is 3/4 of the nominal "full screen" width.

c] ETR 154 and DAVIC quote 363 as an example of 480x3/4.

3.3.2.2 Non "full screen"

Here the sequence display extension describes a window (4:3 OR 16:9) that surrounds the coded frame.

display_horizontal_size	effective horizontal size [b]	horizontal scaling to fill display of same aspect ratio[a]	note
720 704	720	1	
544 528	540	4/3	Distinguished from Table 3-2 as display_horizontal_size ≥ horizontal_size
480	480	3/2	
352	360	2	

Table 3-3.

a] Scaling to make display window fill 4:3 display is 720/effective horizontal size.

b] I.e. to fill a 4:3 display if the aspect ratio information is 0010_2 or 16:9 display if the aspect ratio information is 0011_2

3.3.3 Format switching

Receivers complying with this specification shall be able to continue outputing decoded video pictures undisturbed by changes in the video format parameters provided that these changes are constrained as follows:

- changes are implemented at a sequence boundary
- vertical_size and display_vertical_size remain unchanged
- the buffer models defined by MPEG are met
- the field parity of the first displayed field of the new sequence complements that of the last displayed field of the preceding sequence

Specifically, this allows the following parameters to be changed:

- coded picture width (horizontal_size)
- coded pixel aspect ratio (aspect_ratio_information,

display_horizontal_size)

3.3.3.1 AVC: HD to HD & SD to SD Format Switching

Receivers complying with this specification should be able to continue outputting decoded video pictures undisturbed by changes in the video format parameters provided that these changes are constrained as follows:

- changes are implemented at a random access point
- the buffer models defined by AVC are met
- the field parity of the first displayed field of the new sequence

complements that of the last displayed field of the preceding sequence

Specifically, this allows the following parameters to be changed:

- coded picture width (pic_width_in_mbs_minus1)
- interlaced or progressive picture structure (pic_struct) (restricted to 1080 line formats)

Note it is very desirable that the HD image undergo the minimum number of format conversions. See Section 3.4.2.5.2 HD AVC Receiver Processing.

3.3.3.2 AVC: SD to HD and HD to SD Format Switching

In addition to the requirements in Section 3.3.4.2, PSI and SI shall be changed to indicate the change between SD and HD.

3.4 Video format signalling extensions

DVB requires receivers to support 16:9 and 4:3 coded video (support for 2.21:1 is optional). However, additional origination formats are prevalent in the UK (such as 15:9 format Super 16 film) and invented formats (such as 14:9) may be used to accommodate the delivery of mixed formats to a heterogeneous receiver population.

This section describes how these additional formats may be carried compatibly within the standard DVB coded picture formats.

3.4.1 PSI signalling

The use of the signalling methods within the MPEG video elementary stream is unchanged from that described previously i.e. the sequence header and sequence display extension parameters describe either a 16:9 or a 4:3 aspect ratio coded frame that is either one of the full screen formats or a cropped version of one of those.

"Pan vectors" may be included in a broadcast that also uses the DTG video format signalling extensions. "Pan vectors", and the DTG extensions, provide alternative, mutually exclusive, methods of displaying widescreen material on a 4:3 display.

The EN 300 468 component descriptor in the PMT shall be appropriate for the coded frame type of the video, i.e. 4:3 or 16:9 (with or without "Pan vectors").

3.4.1.1 AVC: PSI signalling

The use of the signalling methods within the AVC video elementary stream is unchanged from that described previously, i.e. Random Access Point parameters describe either a 16:9 or a 4:3 aspect ratio coded frame that is either one of the full screen formats or a cropped version of one of those.

3.4.2 Active format description

Active format descriptions (as defined in TS 101 154) are broadcast to describe the portion of the 16:9 or 4:3 coded frame that is "of interest". The format descriptions are informative in nature and are provided to assist receivers to optimise their presentation of video. A subset of the active format descriptions is used in UK broadcasts, as tabulated in Table 3-5, "Definition of values of active_format".

Receivers conformant with the full set defined in TS 101 154 will work correctly with the UK subset.

What follows is the recommended behaviour that all receivers should follow. See also Chapter 24 "Recommended Receiverin Reaction to Apsect Ratio Signalling in Digital Video Broadcasting".

Coding

The active format description describes the aspect ratio of the "area of interest" independent of the size and aspect ratio of the coded frame. For example, active_format would be 1001_2 in both Figure. 3-1 and Figure. 3-2. This indicates that the area of interest has a 4:3 aspect ratio although in the first case the MPEG video frame carrying it has a16:9 aspect ratio and in the second case the aspect ratio of the video is 4:3.

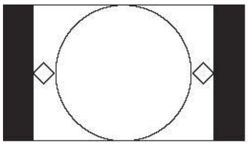


Figure 3-1.

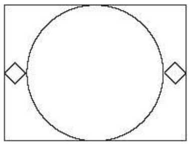


Figure 3-2.

Temporal Scope

After each sequence start (and repeat sequence start) the default aspect ratio of the area of interest is that signalled by the sequence header and sequence display extension parameters. After introduction, an active format specification persists until the next sequence start or until another active format specification is introduced.

Active Format Descriptions (AFDs) are transmitted as user data in the video elementary stream (see Section 3.4.2.1). ISO/IEC 13818-2 allows user data to be inserted in the sequence_header, the group_of_pictures_header or in the picture_header. Decoders should be capable of extracting and responding to AFD signalling inserted in any of these possible positions within the stream. Note that frame-accurate AFDs need to be signalled in the picture_header (i.e. once a picture) and the response of the decoder should be correctly timed with respect to the frame with which that AFD value is associated.

3.4.2.1 AVC: Active Format Description

The rules of operation of active format descriptions for AVC SD broadcasts are the same as those for MPEG2 SD broadcasts. AVC AFDs are carried in the SEI (Supplemental Enhancement Information) messages.

HD broadcasts shall always be in aspect ratio of 16:9. It shall be configured for optimum viewing on a 16:9 display. However, for receivers with a downconverted SD output it may be beneficial to optimise the SD output for a 4:3 display. AFDs may be used for this purpose in the same way as for 16:9 aspect ratio coded SD inputs.

3.4.2.2 Syntax

The active format definitions are carried in the user data of the video elementary stream.

Syntax	No. of bits	Identifier
`user_data_start_code`	32	bslbf
`afd_identifier (set to 44544731`$_{16}$`)`	32	bslbf
`set to 0`$_2$	1	bslbf
`active_format_flag`	1	bslbf
`reserved (set to 000001`$_2$`)`	6	bslbf
`if(active_format_flag == 1`$_2$`) {`		
`reserved (set to 1111`$_2$`)`	4	bslbf
`active_format`	4	uimsbf
`}`		

Table 3-4. DTG use of user data in video elementary streams

3.4.2.3 Semantics

afd_identifier A 32 bit value carrying the ascii string “DTG1”.

active_format_flag A 1 bit flag. A value of ‘1’ indicates that an active format is described in this data structure.

active_format A 4 bit integer describing the region of interest in terms of its aspect ratio within the coded frame as defined in ISO/IEC 13818-2, and defined in the following table:

active_format	Aspect ratio of the active region
1000_2	Active region is the same as the coded frame
1001_2	4:3
1010_2	16:9
1011_2	14:9
1100_2	reserved for future use
1101_2	4:3 (with shoot and protect 14:9 centre)
1110_2	16:9 (with shoot & protect 14:9 centre)
1111_2	Shoot & protect 4:3

Table 3-5. Definition of values of active_format

Where the aspect ratio of the active region differs from that of the coded frame, it is assumed that the active region is the largest that can be fitted within that frame, and is centred within it.

3.4.2.4 Formats illustrated

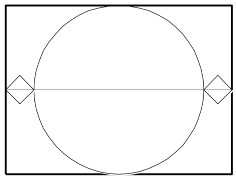
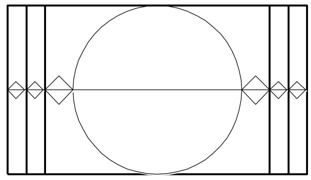
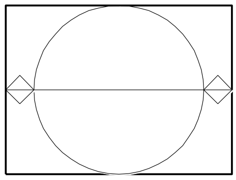
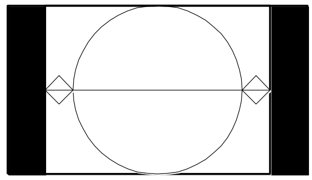
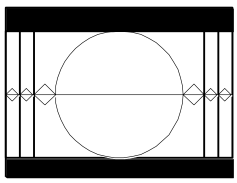
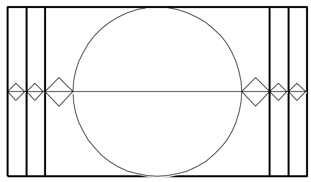
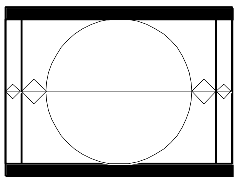
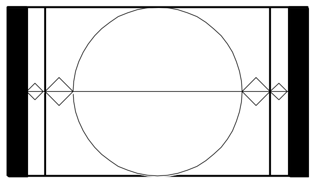
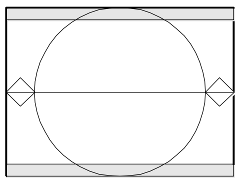
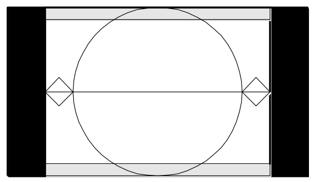
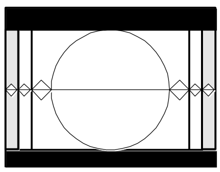
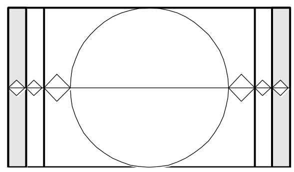
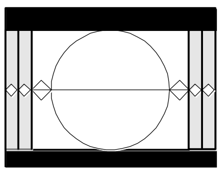
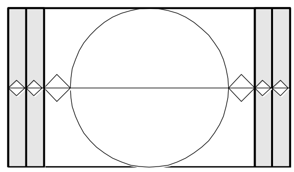
active_format		Full Frame Aspect Ratio	
value	**meaning**	**4:3**	**16:9**
1000_2	As the coded frame		
1001_2	4:3		
1010_2	16:9		
1011_2	14:9		
1100_2	reserved for future use		
1101_2	4:3 (with shoot and protect 14:9 centre)		
1110_2	16:9 (with shoot & protect 14:9 centre)		
1111_2	Shoot & protect 4:3		

Table 3-6. Formats described by the active_format description

3.4.2.5 Receiver Processing

Reference model

The reference model for the video format processing elements in the Set Top Box, TV and Integrated Digital TV are illustrated in Figure 3-3. The behaviour of the Integrated Digital TV is logically equivalent to that of a Set Top Box attached to a TV. The display format signalling between the Set Top Box and the display is Line 23 WSS (See "Wide Screen Signalling (WSS)") and/or SCART pin 8. Within an Integrated Digital TV the signalling is logically equivalent to WSS but could be conveyed by other means.

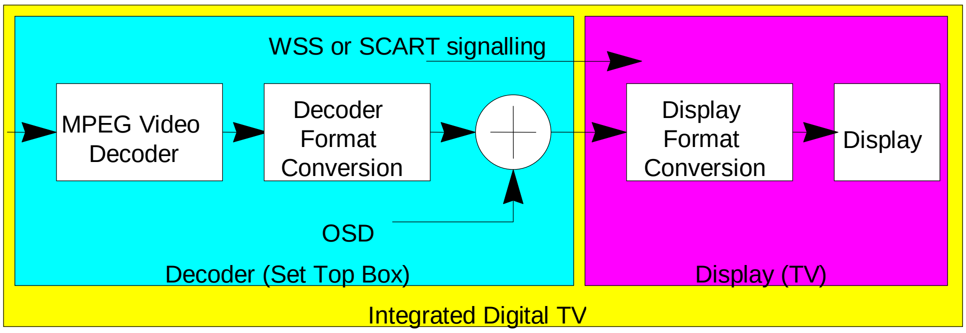


Figure 3-3. Receiver and display format processing reference model

In the reference model the output of the MPEG Video Decoder is logically 720 x 576. The processing applied to this by the Decoder Format Conversion is described in Tables 3-7 and 3-9. In many practical implementations the processes in the Decoder Format Conversion are an integral part of the MPEG Video Decoder. This does not affect the logical reference model.

The Display Format Conversion is principally concerned with the processing provided in 16:9 displays to accept 4:3 signals. This is described in Section 3.4.2.8 Format processing of a 16:9 TV connected to STB.

3.4.2.5.1 SD AVC: Receiver Processing

Reference model

The reference model for the video format processing elements in the Set Top Box, TV and Integrated Digital TV are illustrated in Figure 3-3. The behaviour of the Integrated Digital TV is logically equivalent to that of a Set Top Box attached to a TV. The display format signalling between the Set Top Box and the display is Line 23 WSS (see Section 3.4.2.10 "Wide Screen Signalling (WSS)") and/or SCART pin 8 and/or HDMI AVI InfoFrame. Within an Integrated Digital TV the signalling is logically equivalent to WSS but could be conveyed by other means.
In the reference model the output of the AVC Video Decoder is logically 720 x 576. The processing applied to this by the Decoder Format Conversion is described in Tables 3-7 and 3-9. In many practical implementations the processes in the Decoder Format Conversion are an integral part of the AVC Video Decoder. This does not affect the logical reference model.
The Display Format Conversion is principally concerned with the processing provided in 16:9 displays to accept 4:3 signals. This is described in Section 3.4.2.8 Format processing of a 16:9 TV connected to STB.

3.4.2.5.2 HD AVC: Receiver Processing

Reference model

The reference model for the video format processing elements in the Set

Top Box, TV and Integrated Digital TV are illustrated in Figures 3-4 and 3-5. The display format signalling between the Set Top Box and the display is:

1. HDMI AVI InfoFrame signalling on the main HD output. Within an Integrated Digital TV the signalling is logically equivalent to AVI InfoFrame but could be conveyed by other means
2. Line 23 WSS and/or SCART pin 8 on the secondary SD output.

Set Top Box

In the STB reference model the output of the AVC Video Decoder is logically 1920 x 1080, 1280 x 720 or 720 x 576. The Decoder Format Conversion shall ensure a compatible interface with the external display, based on the display's input format capability as described by its EDID. In many practical implementations the processes in the Decoder Format Conversion are an integral part of the AVC Video Decoder. This does not affect the logical reference model.

NOTE: It is very desirable that the HD image undergo the minimum number of format conversions. To this end EITHER:

- The Decoder Format Converter should output all video signals at a fixed format OR
- The Decoder Format Converter should limit its conversion to horizontal reconstitution of sub-sampled formats (e.g. 1440 x 1080 or 960 x 720) to 1920 x 1080, 1280 x 720 or 720 x 576, with no vertical format conversion. These three formats should be output to the display, where the display's format converter will convert them for compatibility with the display's native resolution.

There should be a method for the end user to select between the above options.

If the STB has a secondary SD output, a separate SD Output Format Conversion is required to convert the HD format signal to an SD compatible format. The SD Output Format Conversion shall also provide selectable aspect ratio conversion from 16:9 to 4:3 for use with 4:3 aspect ratio SD TV sets. It may also use broadcast AFD codes to provide the full processing provided in 16:9 SD displays to accept 4:3 signals. This is described in "Format processing of a 16:9 TV connected to STB" in Section 3.4.2.7.

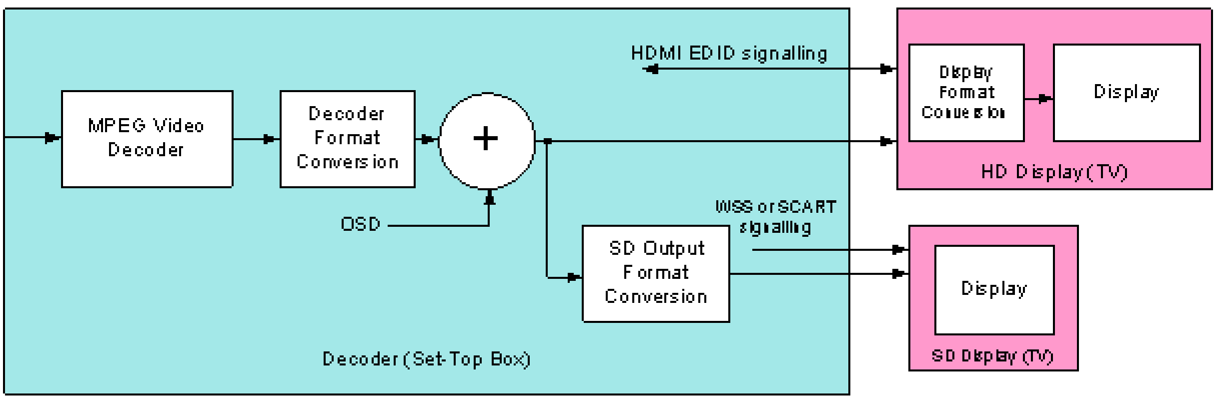


Figure 3-4. Separate STB and TV Set(s) Reference Model - HD

Integrated Digital TV In the Integrated Digital TV reference model the output of the AVC Video Decoder is logically 1920 x 1080 or 1280 x 720. The Format Conversion shall ensure a compatible interface with the internal display. In many practical implementations the processes in the Decoder Format Conversion are an integral part of the AVC Video Decoder. This does not affect the logical reference model.

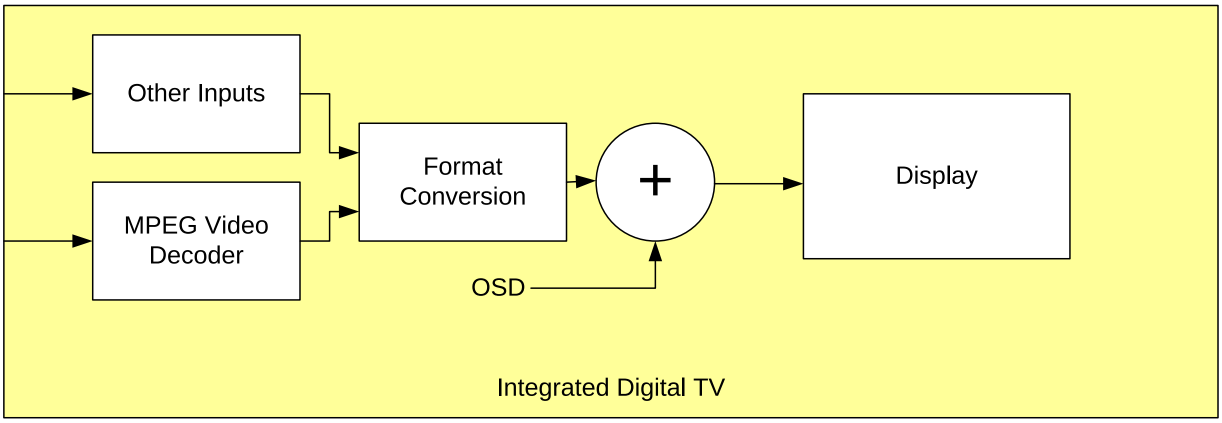


Figure 3-5. Integrated Digital TV reference model - HD

3.4.2.6 Set Top Box (STB) with 4:3 display

Table 3-7 shows the response of a Set Top Box to all broadcast formats when connected to a 4:3 aspect ratio display.

Broadcast format			STB into 4:3 display		
Description of format	On-air signalling		Decoder Format Conversion	Signalling to TV	
	MPEG	active_format		WSS codes	Scart Pin 8
4:3	4:3	1000_2	FF	0001	12 V
		1001_2			
16:9 LB		1010_2		1101	
14:9 LB		1011_2		1000	
reserved		1100_2		0001	
Full 4:3 S&P 14:9		1101_2		0111	
16:9 LB S&P 14:9		1110_2		1101	
16:9 LB S&P 4:3		1111_2		0001	

Table 3-7. Processing by STB connected to 4:3 TV (Sheet 1 of 2)

Broadcast format			STB into 4:3 display		
Description of format	**On-air signalling**		**Decoder Format Conversion**	**Signalling to TV**	
	MPEG	**active_ format**		**WSS codes**	**Scart Pin 8**
16:9		1000_2	According to user preference. See Table 3-8.		
4:3 PB		1001_2	CCO	0001	12 V
16:9		1010_2	16:9 LB	1101	12V
14:9 PB		1011_2	14:9 LB	1000	12 V
reserved	16:9	1100_2	According to user preference. See Table 3-8		
4:3 PB S&P 14:9		1101_2	CCO	0111	12 V
Full 16:9 S&P 14:9		1110_2	According to user preference. See Table 3-8		
Full 16:9 shoot & protect 4:3		1111_2	According to user preference. See Table 3-8		

Table 3-7. Processing by STB connected to 4:3 TV (Sheet 2 of 2)

a] If 14:9 letter box not available, then CCO with WSS set to 0001

Where the active_format code is a reserved value, or the active_format code is absent, the behaviour is as if the active_format code was 1000_2.

User preferences for displaying 16:9

Four user preferences for presentation of widescreen material are defined in Table 3-8. In the first three cases the STB provides processing to format 16:9 video for 4:3 display. In the 4th case the STB outputs the 16:9 format signal as if it was addressing a 16:9 display. This mode allows a 4:3 display with special features (such as letter box processing) to format the video to its aspect ratio.

Selected Mode	**Decoder Format Conversion**	**WSS codes**	**Scart Pin 8**
16:9 Letter Box	16:9 LB	1101	12 V
14: 9 Letter Box	14: 9 LB	1000	
Centre Cut-Out	CCO	0001	
Use TV's feature	FF	1110	6 V

Table 3-8. User options for displaying 16:9 on 4:3

Key

FF **Full Frame**
the output of the decoder is the full width & height of the coded frame

LB **Letter Box**
the coded frame is reduced to a 16:9 (or 14:9) letter box and presented within a 4:3 raster.

CCO **Centre Cut-Out**
the central 4:3 aspect ratio region of the 16:9 frame is extracted and output as a 4:3 raster

WSS signalling with 4:3 display

Although 4:3 displays generally are **not** expected to respond to the aspect ratio information WSS codes (see Table 3-12), this signalling is provided to ensure correct behaviour if the video is recorded and then subsequently displayed on a TV that does support WSS.

3.4.2.7 STB with 16:9 display

Table 3-9 shows the response of a Set Top Box to all broadcast format when connected to a 16:9 aspect ratio display.

<table>
<tr><th colspan="3">Broadcast format</th><th colspan="3">STB into 16:9 display</th></tr>
<tr><th rowspan="2">Description of format</th><th colspan="2">On-air signalling</th><th rowspan="2">Decoder Format Conversion</th><th colspan="2">Signalling to TV</th></tr>
<tr><th>MPEG</th><th>active_ format</th><th>WSS</th><th>Scart Pin 8</th></tr>
<tr><td rowspan="2">4:3</td><td rowspan="8">4:3</td><td>1000_2</td><td rowspan="9">FF</td><td rowspan="2">0001</td><td rowspan="8">12 V</td></tr>
<tr><td>1001_2</td></tr>
<tr><td>16:9 LB</td><td>1010_2</td><td>1101</td></tr>
<tr><td>14:9 LB</td><td>1011_2</td><td>1000</td></tr>
<tr><td>reserved</td><td>1100_2</td><td>0001</td></tr>
<tr><td>Full 4:3 S&P 14:9</td><td>1101_2</td><td>0111</td></tr>
<tr><td>16:9 LB S&P 14:9</td><td>1110_2</td><td>1101</td></tr>
<tr><td>16:9 LB S&P 4:3</td><td>1111_2</td><td>1101</td></tr>
<tr><td>16:9</td><td rowspan="8">16:9</td><td>1000_2</td><td>1110</td><td>6 V</td></tr>
<tr><td>4:3 PB</td><td>1001_2</td><td></td><td>1110</td><td>6 V</td></tr>
<tr><td>16:9</td><td>1010_2</td><td rowspan="3">FF</td><td rowspan="3">1110</td><td rowspan="3">6 V</td></tr>
<tr><td>14:9 PB</td><td>1011_2</td></tr>
<tr><td>reserved</td><td>1100_2</td></tr>
<tr><td>4:3 PB S&P 14:9</td><td>1101_2</td><td>CCO</td><td>0111</td><td>12 V</td></tr>
<tr><td>Full 16:9 S&P 14:9</td><td>1110_2</td><td rowspan="2">FF</td><td rowspan="2">1110</td><td rowspan="2">6 V</td></tr>
<tr><td>Full 16:9 shoot & protect 4:3</td><td>1111_2</td></tr>
</table>

Table 3-9. Processing by STB connected to 16:9 TV

3.4.2.8 Format processing of a 16:9 TV connected to STB

It is recommended that TVs will display the output of the Set Top Box (as described in Section 3.4.2.7 above) according to Table 3-10. 'User Preference' refers to display format options which may be supported by the TV and made available to the user.

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="5">Wide Screen Signalling</th></tr>
<tr><th>0001
4:3</th><th>0111
4:3 S&P</th><th>1000
14:9 C LB</th><th>1101
16:9 C LB</th><th>1110
Full 16:9</th></tr>
<tr><td rowspan="6">User Preference</td><td>4:3 Pillar Box</td><td colspan="2">B</td><td rowspan="2">D</td><td rowspan="6">C</td><td rowspan="6">A</td></tr>
<tr><td>14:9 Pillar Box</td><td colspan="2">D</td></tr>
<tr><td>Zoom</td><td colspan="3">C</td></tr>
<tr><td>Auto</td><td>B</td><td colspan="2">D</td></tr>
<tr><td>Wide</td><td colspan="3">A</td></tr>
<tr><td>Smart/Panorama</td><td colspan="3">Manufacturer Own</td></tr>
</table>

Table 3-10. TV Processing modes under WSS control

<table>
<tr><th rowspan="2">Mode</th><th colspan="2">Scaling</th><th rowspan="2">Description</th></tr>
<tr><th>Horizontal</th><th>Vertical</th></tr>
<tr><td>A</td><td>1</td><td>1</td><td>Makes incoming picture fill the display. Preserves geometry of 16:9, but distorts 4:3 based formats.</td></tr>
<tr><td>B</td><td>3/4</td><td>1</td><td>Makes pillar box of 4:3 signal</td></tr>
<tr><td>C</td><td>1</td><td>4/3</td><td>Expands 4:3 to fill width.
Crops top & bottom to preserve geometry</td></tr>
<tr><td>D</td><td>7/8</td><td>8/7</td><td>Expands 14:9 letter box to 14:9 pillar box with correct geometry.</td></tr>
</table>

Table 3-11. Mode Definitions

Priority of WSS and Scart Pin 8

- If Scart Pin 8 is at 6 V then the display should behave as if the WSS code is 1110 was present.
- For all other states of Scart Pin 8 the display should follow the WSS code if present.
- If no WSS code is present (and Scart Pin 8 is NOT at 6 V) then the display should behave as if the WSS code 0001 was present.

3.4.2.9 Integrated 16:9 TV

The response of an Integrated 16:9 TV to the broadcast format described in Section 3.4 Video format signalling extensions should be equivalent to the combined response of a Set Top Box ("STB with 16:9 display") and TV ("Format processing of a 16:9 TV connected to STB").

3.4.2.10 Wide Screen Signalling (WSS)

Table 3-12 reproduces the Wide Screen Signalling codes from EN 300 294 /ITU-R BT.1119-2. The shaded rows indicate codes that are not used in this context.

WSS Code[a] bits 0-3	Description
0001	full format 4: 3
1000	box 14:9 centre
0100	box 14:9 top
1101	box 16:9 centre
0010	box 16:9 top
1011	box > 16:9 centre
0111	full format 4:3 (shoot and protect 14:9 centre)
1110	full format 16: 9 anamorphic

Table 3-12. WSS codes

a] This bit ordering follows the ETS specification (i.e. bslbf). The ITU specification writes the bits d3-d0. The specifications are identical as in both cases the transmission order is d0 to d3.

Additional temporal specification for WSS outputs

- The WSS shall first be output in line 23 of the first frame to which it applies
- The same WSS status bits shall be transmitted in each subsequent frame until the video format changes

3.5 Video post processing requirements

The set of scaling factors required in a receiver to reconstruct and present full screen video are evident from the preceding parts of this chapter. The requirements for presenting video in conjunction with an interactive application are addressed in Chapter 11 MHEG 5 – Introduction to the UK Profile and specifically under in Section 16.5.4 MPEG presentation.

3.6 Recommendations for signalling

As described in TS 101 154 the target background grid descriptor and video window descriptor may be used within broadcasts to position the video output within a 720 x 576 display grid.

Further to this, the position of the video output within the display signalled in DTG broadcasts shall be restricted to even (chroma) pixel and even (field) line ordinates.

4 Audio System Characteristics

4.1 Scope

This section defines the digital encoding standards that shall be used at all UK UHF terrestrial Television Broadcasts and also those delivered using the MHEG *ICStreamingExtension* (see 13.5.4).

4.2 References

- ISO/IEC 13818-1
- ISO/IEC 13818-3
- ETSI TS 101 154.
- ITU-R BS.775
- ISO/IEC 14496-3 [106]
- ISO/IEC 14496-10 [104]
- ETSI TS 102 366

4.3 Essential requirements

Scope of requirements

These requirements on audio signals apply to applications including, but not limited to, those listed below:

- Primary and other language audio channels for television programmes
- Audio only 'radio' services
- Audio description (for the blind and partially sighted)

Synchronisation

The A/V synchronisation in radiated SD signals is such that audio is presented to the viewer no more than 20 ms before the video and no more than 40 ms after it when both components are decoded on an ideal decoder at the times indicated by their respective PTSs. Note that the A/V synchronisation for an HD service is more critical than that for an SD service.[2]

Receivers shall not introduce significant relative delay between the video and any audio component.

Where additional independent audio components are decoded from the same service (e.g. main programme audio and audio description or main programme and clean commentary) receivers should not introduce significant relative delay between the audio components.

Encoding

All audio components associated with SD MPEG2 television and MPEG1 Layer II radio services shall be encoded according to ISO/IEC 13818-3 constrained according to TS 101 154.

When the video component is not SD MPEG2, the audio component may be encoded using E-AC-3 encoding according to TS 102 366 or MPEG-4 High Efficiency AAC according to ISO/IEC 14496-3 (up to HE-AAC Level 4 excluding the use of the Parametric Stereo tool), in either case constrained

[2]. The requirements for A/V synchronisation for HD services may be revised in the future

according to TS 101 154. The use of AC-3 encoding of the audio component is not supported.

This encoding may also be used for audio-only radio services.

The encoding used for Audio Description shall use the same codec family as that used for the main audio component.

Decoding requirements	All receivers shall provide at least one audio decoder able to meet the minimum decoding requirements set out above. Preferably receivers enable decoding of both the main audio and the audio description for a television service.

4.4 Constraints and extensions

4.4.1 Set-up levels

For audio components encoded using ISO/IEC 13818-3, the level for reference tones for transmission shall be -18 dB FS, in accordance with EBU Recommendation R.68 "Alignment level in digital audio production equipment and in digital audio recorders" as recommended by TS 101 154.

The programme loudness should be -23 LUFS in accordance with EBU Recommendation R.128 "Audio loudness normalisation and permitted maximum level of audio signals".

4.4.1.1 Advanced Audio: Set-up levels

The broadcaster shall ensure that the correct signalling is used to enable receivers to output the audio encoded as MPEG4 HE-AAC or E-AC-3 at a similar level to that of an MPEG audio component (even when this component is not broadcast). Receivers are not required to modify the audio bit stream when passing it through to a digital output.

4.4.1.2 Advanced Audio: HE-AAC Metadata

Receivers shall support the use of the following metadata when decoding and transcoding HE-AAC audio:

- Dynamic Range Control according to ISO/IEC 14496-3 (dyn_rng_sgn, dyn_rng_ctl)
- Program Reference Level according to ISO/IEC 14496-3 (prog_ref_level)
- Mix Down Parameters according to ETSI TS 101 154 Annex C.5.2.4, Downmixing_levels_MPEG4 (center_mix_level, surround_mix_level).

Receivers shall ensure that HE-AAC audio levels match those of MPEG-1 audio services. This may be achieved by setting the HE-AAC decoder "target_level" to -23 dB.

When "prog_ref_level" is less than the receiver "target_level", broadcasters shall ensure that sufficient DRC is signalled to prevent excessive audio levels in the decoder. To avoid clipping, decoders shall set "ctrl1=1".

When the "prog_ref_level" is not present decoders shall assume that the program reference level equals the "target_level" and shall not apply normalisation (ISO/IEC 14496-3, Section 4.5.2.7.3).

Broadcasters shall include mix down parameters in every frame of all HE-AAC audio streams with more than two discrete channels (excluding LFE).

4.4.1.3 Ensuring Consistent Audio Levels (Informative)

The loudness of programmes coded as HE-AAC may vary to accommodate programmes with different dynamic range requirements. As an example a studio programme with a limited dynamic range could be mixed to a loudness level of -23 LUFS with little danger of clipping. But a classical music concert might be mixed to a loudness level of -31 LUFS to ensure sufficient headroom for the loudest passages of music.

There is no requirement for a receiver to measure the programme loudness. Instead the loudness is signalled to a receiver by the broadcaster using the Program Reference Level metadata (prog_ref_level)[3].

1 LU (Loudness Unit) is equivalent to 1 dB of signal level. The "LU" notation is used to indicate the EBU loudness measurement method (EBU Tech Doc 3341 "Loudness Metering: "EBU Mode" metering to supplement loudness normalisation in accordance with EBU R128"). It includes a frequency weighting, gating function and channel weighting. So a loudness level of -23 LUFS is signalled to a receiver as a prog_ref_level1 of -23 dBFS.

Receivers shall use the broadcast audio metadata to ensure that the output level of HE-AAC audio services closely matches the level of MPEG-1 audio services (section 4.4.1) on all outputs. Figure 4-0 is a logical diagram of a reference audio decoder. It shows how the audio level matching is achieved using level normalisation based on the prog_ref_level metadata, dynamic range control (DRC) and an appropriate downmix. Functional blocks that deliver the mandatory requirements of sections 4.4.1.2 and 4.4.2.1 are shown in yellow. Optional blocks, or those where a choice can be made in order to meet the audio requirements of section 22.3.4.4, are shown in blue. For clarity the audio description functionality has been omitted from this diagram.

[3] "prog_ref_level" is a 7 bit number representing 0.25 dB steps below "full scale".

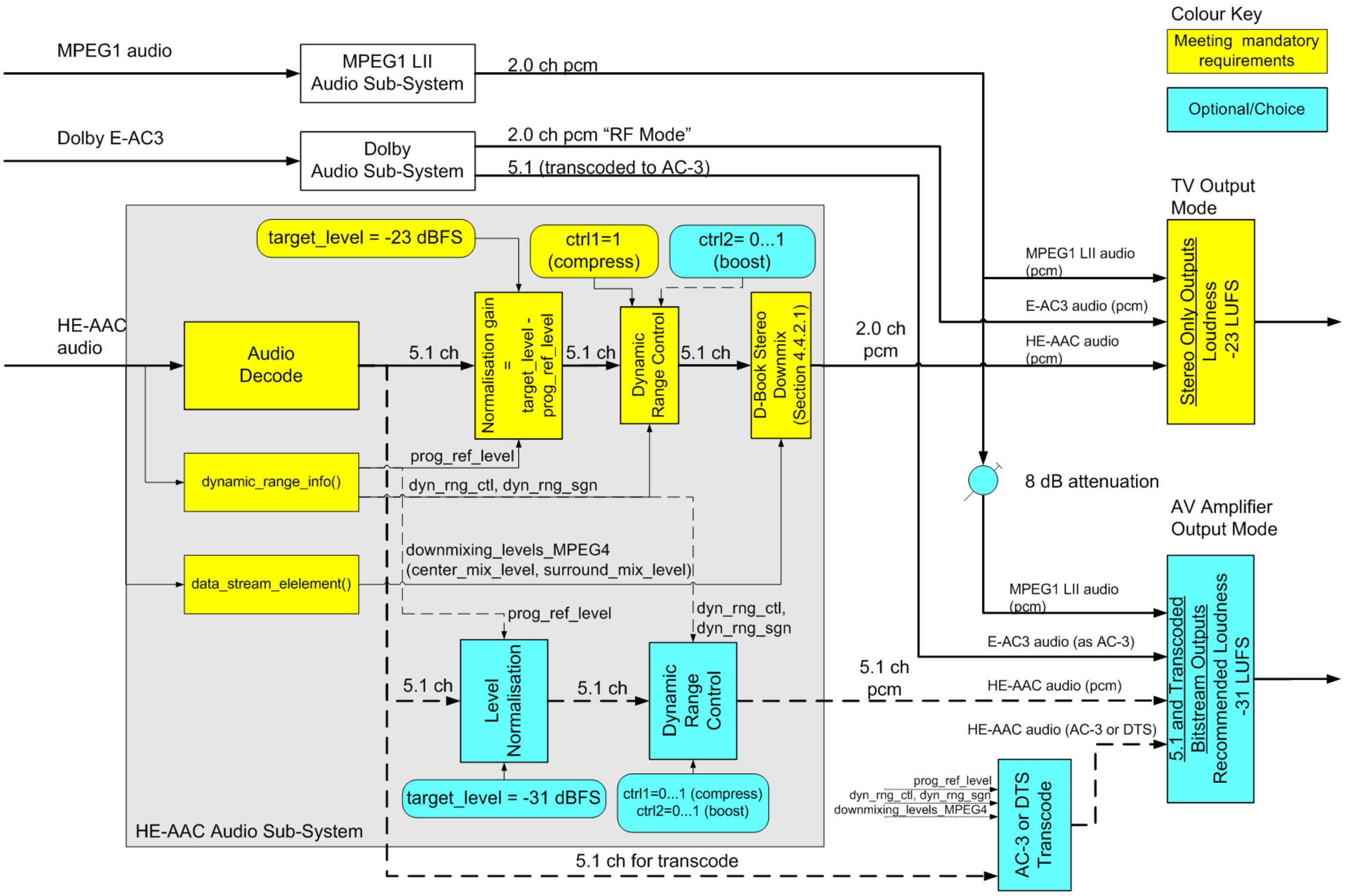


Figure 4-0. Loudness level normalisation for HE-AAC decoders

To ensure a consistent audio level between programmes and across services the reference level of the transmitted bitstream should be normalised to a "target_level" of -23 dBFS for outputs to TVs. This is achieved by applying a gain based on the difference between the "prog_ref_level" within the HE-AAC bitstream and the decoder's "target_level" (ISO/IEC 14496-3 section 4.5.2.7.2). As an example, an HE-AAC bitstream with a "prog_ref_level" parameter of -27 dBFS requires a gain of 4 dB to be applied to the decoded samples to achieve the "target_level" of -23 dBFS. Once the gain is applied the HE-AAC loudness level should closely match the loudness level of MPEG-1 audio services.

If the gain is positive there is a danger of clipping or overflow within the receiver. Broadcasters shall ensure that sufficient dynamic range compression is signalled through the "dyn_rng_sgn" and "dyn_rng_ctl" parameters to prevent excessive audio levels in the decoder when applying the normalisation gain. Section 4.4.1.2 requires receivers to apply the negative DRC "compression" words by setting the HE-AAC "ctrl1" parameter equal to "1" (i.e. compression fully enabled). The HE-AAC "ctrl2" parameter which adjusts the level of "boost" for quiet passages should either be set to "1" or made user adjustable to suit the listening environment.

When "prog_ref_level" is not present within the bitstream, "prog_ref_level" equals the decoder's "target_level" of -23 dBFS (ISO/IEC 14496-3, Section

4.5.2.7.3). So the normalisation gain would be 0 dB.

The downmix equations specified in Section 4.4.2.1 ensure that the loudness remains similar when downmixing multi-channel audio to stereo.

AV amplifiers

PCM outputs to AV amplifiers are usually normalised to a level of -31 dBFS rather than -23 dBFS used for televisions. This is to match an AV amplifier's internal AC-3 decoder and to enable the full dynamic range of nearly all content to be available without DRC[4]. In this case both "ctrl1" and "ctrl2" should be under user control to allow the dynamic range of the AV amplifier output to be adjusted to match the listening environment.

When normalising to -31 dBFS, MPEG-1 audio services should be attenuated by 8dB to match.

[4] Note that the minimum possible level for "prog_ref_level" is -31.75 dB, but -31.00 dBFS is usually the lowest level transmitted.

4.4.2 Surround sound

Surround sound

Surround sound may optionally be provided as a digital multi-channel audio service component, thereby giving freedom of artistic exploitation to the programme makers. The allocation of channels, particularly for a 5.1 channel digital audio service is given in ITU-R BS.775.

Multichannel audio signals may be optionally matrix-encoded as a stereo audio signal to generate a service which can be decoded using a matrix surround sound decoders. Provision of matrix surround sound decoders in receivers is optional.

Broadcasts will switch dynamically between stereo and multi-channel encoding, using the same codec family. Receivers shall continue to operate across any such transition.

4.4.2.1 Advanced Audio: Surround Sound

The audio decoder in all surround-sound capable receivers shall be able to downmix a digital multi-channel surround sound audio service component to stereo when this is required by the (internally or externally) connected equipment. As a minimum, receivers shall allow the user to select a Left only and Right only (Lo/Ro) downmix according to the following equations:

Lo = 1.0 x L + center_mix_level x C + surround_mix_level x Ls

Ro = 1.0 x R + center_mix_level x C + surround_mix_level x Rs

Where L is the front left channel, R the front right channel, C the centre channel and Ls and Rs are the surround left and surround right channels of a multi-channel transmission. The LFE (low frequency effects) channel does not contribute to this stereo downmix.

In the case of HE-AAC and AAC audio the centre_mix_level and surround_mix_level parameters are signalled through the downmixing_levels_MPEG4 ancillary data specified in TS 101 154 Annex C.5.2.4. In the case of E-AC-3 audio the carriage of the equivalent lorocmixlev and lorosurmixlev values (or cmixlev and surmixlev in the absence of those values) is defined in TS 102 366.

Note: The audio decoder shall not scale the downmix coefficients as described in ETSI TS 102 366 6.8.2 and ETSI TS 101 154 Annex C.5.2.4.3, since this scaling could result in loudness differentials between downmixed multichannel programmes and native stereo programmes. The broadcaster shall ensure that sufficient headroom and/or dynamic range control values are included in the transmission to prevent any overload when downmixing.

Receivers may optionally provide other downmix variants but are not required to do so.

4.5 Audio description

4.5.1 Background

Audio description (AD) is an ancillary component associated with a TV service which delivers a verbal description of the visual scene as an aid to understanding and enjoyment particularly, but not exclusively, for viewers who have visual impairments. Provision of AD for a proportion of programmes is a mandatory requirement for digital terrestrial broadcasts in the UK.

Description content is voice only and is conveyed as a separate coded mono audio stream. The AD-capable receiver decodes the main programme and the description streams and combines the decoded signals as described below.

Loud sound effects or accompanying music can make any description hard to discern. A key requirement of the AD decoder is therefore to allow the relative level of programme sound in the mix to be adjusted on a description passage-by-passage basis. The programme maker is best able to determine a suitable relative level under controlled conditions when the AD component is being authored so suitable “fade” information is transmitted with the description stream.

Individual AD users will have different aural acuity, different describers will have their own style of vocal delivery (voice pitch and timbre), several voices may be used to describe a single programme and there are, in practice, differences in audio signal level for different home receivers. Another requirement of the AD decoder is to allow the user to make minor adjustments to the volume of the description signal to suit his or her condition.

Description is typically confined to gaps in the programme narrative. Some programmes (and genres) are more suited to description than others; one programme may be effectively self-describing whilst another (e.g. a news programme or studio interview) might actually offer no opportunities for descriptive interpolation. AD receivers should therefore provide the user with a means of confirming that, in what may be extended gaps between description passages, description silence does not necessarily imply failure in delivery of the service or in the receiving equipment.

4.5.2 Signalling

This section is principally concerned with the signalling used to implement the programme provider control of programme volume. Other controls, and the method for presentation of the "described" and/or "standard" sound outputs, are addressed for information below.

4.5.2.1 Level control

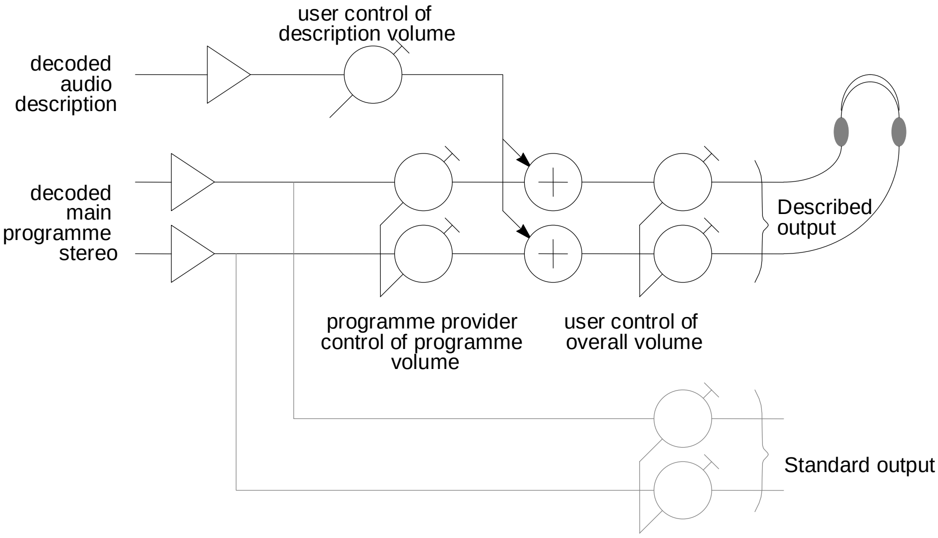


Figure 4-1. Illustration of control of audio level

Three contributions to the "described" output sound level can be identified. These are illustrated in Figure 4-1.

Providing the means for the user to adjust the relative volume of description passages is an essential receiver requirement.

4.5.2.2 Placement control

Signalling is provided to allow the broadcaster to place the "describer" at any preferred horizontal position within the sound field (speech from out-of-vision commentators is often placed to one side in the stereo image).

4.5.2.3 Syntax and semantics

Audio description fade and pan control information is coded in PES_private_data within the PES encapsulation of the coded AD component.

The structure and syntax of this field are as follows:

```
AD_descriptor(){
Reserved                1111             4 bslbf
AD_descriptor_length    1000             4 bslbf
AD_text_tag             0x4454474144     40 bslbf    (5 bytes)
AD_revision_text_tag    0x31             8 bslbf
AD_fade_byte            0xYY             8 bslbf     (FADE byte)
AD_pan_byte             0xYY             8 bslbf     (PAN byte)
reserved                0xFFFFFFFFFFFFFF 56 bslbf    (7 bytes)
}
```

The semantics are as follows:

`AD_descriptor_length:` the number of significant bytes following the length field (i.e. 8).

`AD_text_tag`: a string of 5 bytes forming a simple and unambiguous means of distinguishing this from any other PES_private_data.

A receiver which fails to recognise this tag should not interpret this audio stream as audio description.

`AD_revision_text_tag:` the AD_text_tag is extended by a single ASCII character version designator (here "1" indicates revision 1).

Descriptors with the same AD_text_tag but with a higher revision number shall be backwards compatible with this specification - the syntax and semantics of the fade and pan fields will be identical but some of the reserved bytes may be used for additional signalling.

`AD_fade_byte:` takes values between 0x00 (representing no fade of the main programme sound) and 0xFF (representing a full fade).

Over the range 0x00 to 0xFE one lsb represents a step in attenuation of the programme sound of approximately 0.3 dB giving a range of about 77 dB. The fade value of 0xFF represents no programme sound at all (i.e. mute).

The rate of signalling and the expected behaviour of a decoder to changes in fade byte are described below.

`AD_pan_byte:` takes values between 0x00 representing a central forward presentation of the audio descriptor and 0xFF, each increment representing a 360/256 degree step clockwise looking down on the listener (i.e. just over 1.4 degrees, see Figure 4-2).

The rate of signalling and the expected behaviour of a decoder are described below.

`reserved:` the remaining 7 bytes are set to 0xFF and reserved for future developments if and when required.

4.5.2.4 Example5

A PES-packet from an audio stream carrying audio description will therefore typically commence thus:

Syntax	Value	Data	Comment
Packet_start_code_prefix	0x000001	24 bslbf	
stream id	0xYY	8 uimsbf	actually
PES packet length	0xYYYY	16 uimsbf	as appropriate
'10'	10	2 bslbf	
PES scrambling control	YY	2 bslbf	
PES priority	Y	1 bslbf	
data alignment indicator	Y	1 bslbf	as appropriate
Copyright	Y	1 bslbf	
original or copy	Y	1 bslbf	
PTS DTS flags	10	2 bslbf	if PTS present
ESCR flag	0	1 bslbf	
ES rate flag	Y	1 bslbf	as appropriate
DSM trick mode flag	0	1 bslbf	
additional copy info flag	0	1 bslbf	
PES CRC flag	Y	1 bslbf	as appropriate
PES extension flag	1	1 bslbf	
PES header data length	0xYY	8 uimsbf	as appropriate
'0010'	0010	4 bslbf	
PTS[32..30]	YYY	3 bslbf	as appropriate
'1'	1	1 bslbf	
PTS[29..15]	YYYYYYYYYYYYYYY	15 bslbf	as appropriate
'1'	1	1 bslbf	
PTS[14..0]	YYYYYYYYYYYYYYY	15 bslbf	as appropriate
'1'	1	1 bslbf	
if (ES rate flag ==1'1') {etc.}			
if (PES CRC flag ==1'1') {etc.}			
PES private data flag	1	1 bslbf	
pack header field flag	0	1 bslbf	
program packet sequence counter flag	0	1 bslbf	
P-STD buffer flag	0	1 bslbf	
Reserved	111	3 bslbf	
PES extension flag 2	0	1 bslbf	
AD_descriptor(){			
Reserved	1111	4 bslbf	
AD_descriptor_length	1000	4 bslbf	in version 1
AD_text_tag	0x4454474144	40 bslbf	6 byte string
AD_revision_text_tag	0x31	8 bslbf	
AD_fade_byte	0xYY	8 bslbf	FADE byte
AD_pan_byte	0xYY	8 bslbf	PAN byte
reserved	0xFFFFFFFFFFFFFF	56 bslbf	
}			
for (i=0; i<N1; i++) {			
stuffing byte			if required
}			
// and now follows the PES data //			

Table 4-1. Illustration of PES packet header

4.5.2.5 Interpretation of pan information

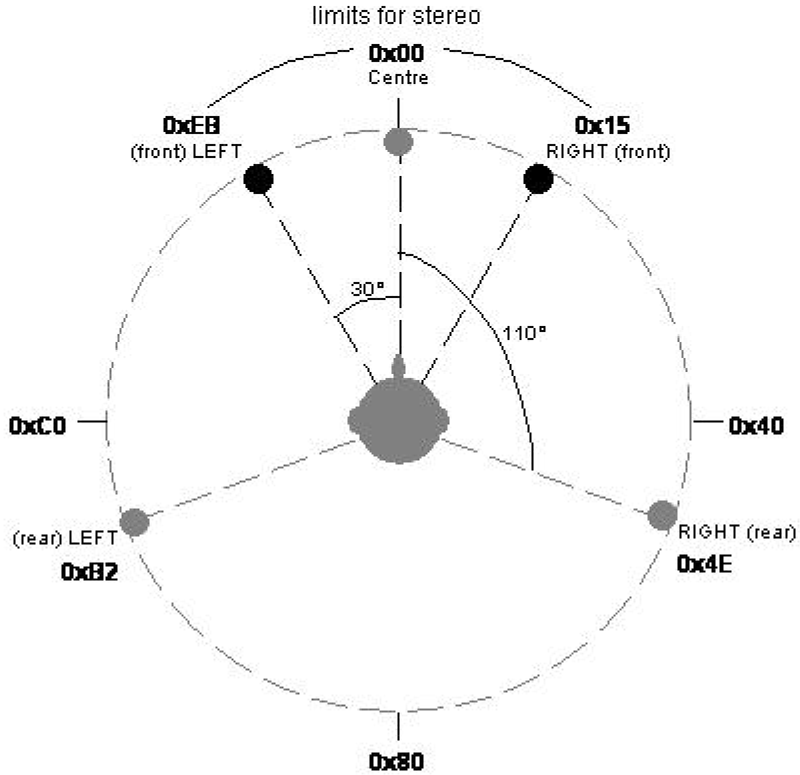


Figure 4-2. Mapping of pan byte on to sound presentation

The definition of "pan" is compatible with future systems that might employ digital multi-channel surround sound for main programme audio. Where the main programme audio is stereo the range of values for "pan" are limited to the interval 0xEB…0x00…0x15.

4.5.2.6 Signalling rate of fade and pan information

The maximum rate of signalling of fade and pan values is determined by the number of audio PES packets per second for that AD stream. For efficiency several access units of audio are typically encapsulated within one PES packet and the fade and pan values in each AD_descriptor are deemed to apply to each of the complete access units (AUs) encapsulated within, and which commence in, that PES packet.

In practice the encapsulation of several AUs within one PES packet means that fade and pan values are transmitted typically every 120 ms to 200 ms. This allows the programme provider to have some control over the attack and decay of a fade and for fades to be reasonably gentle (i.e. taking several intermediate values between no-fade and the final target) where a gap in the narrative permits.

4.5.3 Constraints on audio description stream coding

The audio description stream shall comply with TS 101 154 constrained as follows:

- The description shall have the same audio sampling frequency as the main programme sound for that service.
- The description audio shall be encoded as mono MPEG-1 layer II.

4.5.3.1 Advanced Audio: constraints on audio description stream coding

The audio description stream shall comply with TS 101 154 constrained as follows:

- The audio description shall have the same audio sampling frequency as the main programme audio for that service.
- The description audio shall be encoded as mono and shall use the same codec family as that used for the main programme audio.

4.5.4 Implementation notes

4.5.4.1 Decoder behaviour in the presence of AD

In the presence of a valid AD descriptor in the description stream of the selected service the AD decoder should present the appropriate mix of decoded programme sound and description signal to the user. The AD decoder should then attenuate the programme sound by 0.3 dB per fade value increment.

When the fade value is 0x00 (or in the absence of an AD stream) the programme sound level should be unattenuated. Care should be taken to ensure that the default levels of programme sound and description are consistent when fed with streams coding standard level signals. It is also important that the mono description is matrixed to the stereo output so as to achieve a constant perceived description volume as the description is panned from stereo left through stereo centre to stereo right (e.g. using a model based on constant power as the description is panned across the stereo sound stage).

In a stereo environment the AD decoder should interpret any pan values outside the ranges 0xEB..0xFF and 0x00..0x15 in the following manner. Pan values from 0x16 to 0x7F inclusive should be mapped to the value 0x15 (i.e. stereo hard right). Pan values from 0x80 to 0xEA should be mapped to the value 0xEB (i.e. stereo hard left).

If, whilst listening to a described programme, the user selects a new programme, the AD decoder should mute the decoded description signal and restore the programme sound to the unfaded state. This restoration should not be abrupt - it is recommended that under such conditions the value of fade and of pan are ramped to the default values (0x00) over a period of at least 1 second.

AD decoders for SD services with vision coded as MPEG2 should be capable of decoding MPEG1 layer II or MPEG2 mono signals at bit-rates between 64 kbits/s and 256 kbits/s and of supporting 32 kHz and 48 kHz audio sampling rates.

AD decoder implementations may usefully include separate hi-fi and VCR outputs and provide an output for headphones should the AD user wish to listen in the company of others who do not wish to hear the description. AD decoders should present to their VCR output a mix of programme sound and description modulated as appropriate by fade and pan but before any attenuation applied by the user control of overall volume control shown diagrammatically in Figure 4-1.

4.5.4.2 Decoder behaviour in the presence of errors

If the AD decoder detects an error in, or the absence of, the AD descriptor in the encoded AD signal, it should have a strategy which leads to muting the decoded description signal, restoring the programme sound to its default unfaded amplitude and setting the effective fade and pan values to 0x00 (e.g. the AD decoder might flywheel through isolated errors caused by occasional uncorrected transmission errors but should respond appropriately to successive instances of loss).

Whenever the AD signal is suddenly lost or regained, the AD decoder behaviour as experienced by the user should never be abrupt. It is recommended that in the event of an error or the absence of AD signal the value of fade and of pan implemented by the AD decoder be ramped from the signalled values to the default values (0x00) over a period of at least 1 second. Equally, on recovery from an error or on the re-appearance of the AD signal, the value of fade and of pan should be ramped to the signalled values from the default values (0x00) over a similar period.

4.5.4.3 Time of application

All PES packets conveying audio description audio streams shall include an audio description descriptor. As noted above, the value of fade and pan byte in any PES packet shall apply to all access units commencing within that PES packet.

Attack and decay (informative) Values for “fade” are typically transmitted 5-10 times/second. This allows the service provider to signal gradual changes of “fade”. Receivers should not implement any additional time constants.

4.5.4.4 Implementation of fade and pan (informative)

Fade

A description signal at reference level (see Section 4.4.1 Set-up levels) should appear in the mixed output also at reference level in both the left and the right-hand audio output signals when both signalled fade and pan values are zero and the user controls are at their default settings.

If the AD decoder cannot support 0.3 dB steps in implemented fade then the implemented attenuation should match the intended attenuation as closely as possible. For example if only 1 dB steps are possible then fade values of 0x00 and 0x01 should map to 0 db, 0x02, 0x03 and 0x04 should map to -1 dB, 0x05, 0x06, 0x07 & 0x08 to -2 db etc.

Pan

Panning is typically implemented by reducing the level of description in the left or the right-hand audio output signals only; description in the other signal is not attenuated.

A suitable pan characteristic can be obtained by attenuating the left or right contribution at the rate of 1 dB per pan increment. Thus a pan value of 0x08 results in an attenuation of 8 dB of the description component in the left output.

If the AD decoder cannot support 1.4 degree steps in implemented pan then the implemented pan should match the intended pan as closely as possible.

4.5.4.5 Equalisation of delays (informative)

Audio description is transmitted as PES packets with presentation time-stamps (PTS) derived from the service system clock reference as defined in ISO/IEC 13818-1 [36]. Decoders must respect this relative timing mechanism and thus ensure that the relative timing of programme audio, description audio **and** the action resulting from signalled fade/pan values are maintained at all times.

4.5.4.6 Decoder user indications

As many potential users of AD will be visually impaired, the receiver user interface should not rely solely on visual clues (e.g. LEDs or on-screen display logos) to indicate status information such as the presence or absence of description. Audible indications are essential and receiver designers should consider how to distinguish different states using, for example, contrasting synthetic tones.

The user should be able to interrogate the decoder (e.g. using a remote control) and be given an indication that all is well (e.g. a recognisable "beep" and flashing LED). This should indicate presence in the stream of decodable AD, even when the description may at that particular moment be silent and the fade value 0x00. Equally a distinguishable indication of the detected absence of the AD signal is highly desirable (e.g. a using a second style of "beep").

Other controls which would desirably have corresponding distinctive audible indications include the ability to mute the combined sound and to adjust the description and overall volumes.

Any user tones applied to the headphone or hi-fi outputs of the decoder should not be added to the decoder VCR output.

4.5.5 Advanced Audio: Audio Description

When the main audio is only provided as E-AC-3, the audio description services shall be provided as an associated service encoded with E-AC-3 as a separate stream. Mixing metadata shall be included as part of the E-AC-3 stream, as defined in ETSI TS 102 366 Annex E, and the AD_Descriptor, if present, shall be ignored.

When the main audio is only provided as MPEG-4 HE AAC, the audio description services shall be provided as an associated service encoded with MPEG-4 HE AAC. Audio Description Pan and Fade control information shall be delivered using the AD_Descriptor.

4.6 PSI/SI signalling

The streams for programme sound and for audio description are distinguished in the PSI by the use of the **ISO_639_language descriptor**. The **audio_type** field within the descriptor associated with programme sound is typically assigned the value 0x00 ("undefined") whilst the equivalent descriptor associated with audio description has its audio_type field assigned the value 0x03 ("visual impaired commentary").

This is illustrated below in a real example from a DTT PMT.

```
    .....
//main programme audio details
{
  stream_type              0x03    ; Audio MPEG1
  reserved                 111b
  elementary_PID           0x0259  ; PID for programme sound
  reserved                 1111b
  ES_info_length           0x009
  {
    descriptor_tag         0x52    ; stream identifier descriptor
    descriptor_length      0x01
    component_tag          0x02
  }
  {
    descriptor_tag         0x0A    ; ISO 639 language descriptor
    descriptor_length      0x04
    ISO_639_language_code "eng"    ; English
    audio_type             0x00    ; undefined
  }
}
.....
// audio description details
{
    stream_type            0x03    ; Audio MPEG1
    reserved               111b
    elementary_PID         0x025A  ; PID for audio description
    reserved               1111b
    ES_info_length         0x009
    {
      descriptor_tag       0x52    ; stream identifier descriptor
      descriptor_length    0x01
      component_tag        0x03
    }
    {
      descriptor_tag       0x0A    ; ISO 639 language descriptor
      descriptor_length    0x04
      ISO_639_language_code"eng"   ; English
      audio_type           0x03    ; visual impaired commentary
    }
}
```

If a service has AD in several languages the PMT reference to each stream will have the appropriate ISO_639_language_code and the AD decoder should discriminate between them on the basis of the preferred language chosen in the user settings.

The supplementary_audio_descriptor shall be used in accordance with section 7.4.2.5

4.6.1 Advanced Audio: PSI/SI Signalling

A correctly configured Enhanced_AC-3_Descriptor (as specified in ETSI EN 300 468) indicating the presence and configuration of the service shall be provided in the PMT for each E-AC-3 elementary stream, including E-AC-3 streams containing Audio Description.

The supplementary_audio_descriptor shall be used in accordance with section 7.4.2.5

5 Subtitling

5.1 Scope

This section defines the graphics standards to be used for providing subtitles that shall be used in all UK UHF terrestrial television broadcasts and also those delivered using the MHEG *ICStreamingExtension* (see 13.5.4).

This specification is based on EN 300 743 v1.3.1 but with a number of clarifications and extensions detailed here.

5.2 References

EN 300 743 v1.3.1 (2006-11)

5.3 Essential requirements

Subtitles in DTG television broadcasts shall be encoded as bitmaps according to
EN 300 743 v1.3.1 (2006-11).

All receivers shall include provision to decode and display subtitles conforming to EN 300 743 v1.3.1 (2006-11) as clarified in Section 5.4.

To accommodate the application of DVB subtitles to display sizes other than 720 pixels by 576 lines, EN 300 743 v1.3.1 (2006-11) introduces a new data structure - the **display_definition_segment** (DDS) which explicitly defines the display width and display height of the image into which the associated subtitles are to be rendered.

Absence of a DDS in a subtitle stream implies that the stream is encoded in accordance with EN 300 743 v1.2.1 and that a display size of 720 pixels by 576 lines may be assumed.

All receivers shall be capable of decoding the DDS in any subtitle stream which conforms with EN 300 743 v1.3.1 (2006-11).

Receivers designed to decode HD services *shall* make use of the DDS to position the decoded subtitles appropriately.

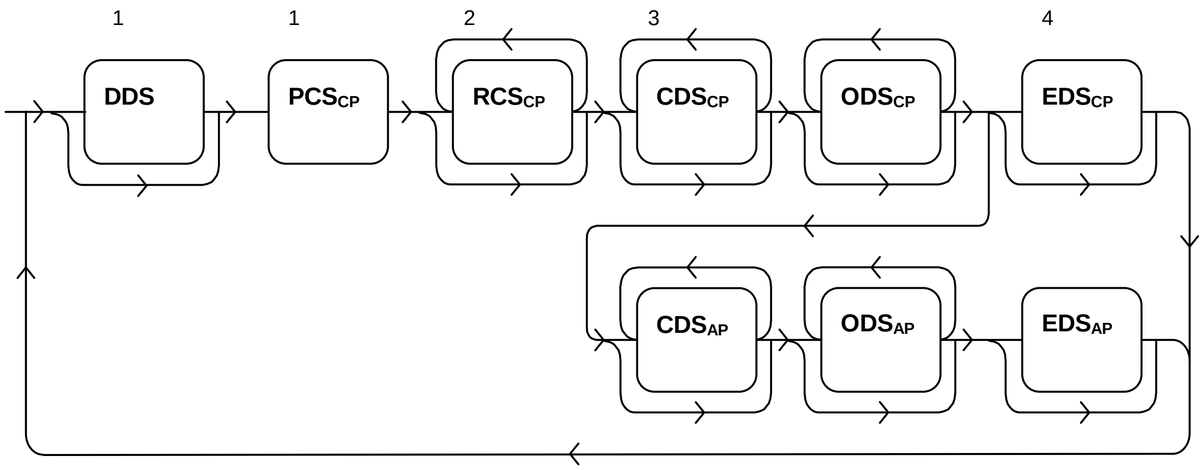
Subtitles intended for HD services shall include the DDS data structure in the subtitle stream.

Subtitles intended for SD services and targeted at SD receivers may, but need not, include the DDS data structure in the stream. However, to avoid problems with legacy receivers subtitle streams associated with SD AV services with MPEG-2 MP@ML video *shall not* include a DDS.

5.4 Clarifications to EN 300 743 v1.3.1 (2006-11)

5.4.1 Sequence of segments

Figure 5-1 illustrates the allowed sequence of segments in a subtitle stream. Each DDS (if present) or each PCS (if no DDS) indicates the start of a display set. The set of segments that follows will depend on the operation being performed in that display set.



DDS= Display Definition Segment (mandatory for HD services[5])
PCS= Page Composition Segment
RCS= Region Composition Segment
CDS= Clut Data Segment
ODS= Object Data Segment
EDS= End of Display set Segment
Cp= Composition Page
Ap= Ancillary Page

Figure 5-1. High level bitstream organisation

Note	page_state		
	Normal case	Acquisition point	Mode change
1	All display sets start with a PCS		
2	Optional unless the region is to be operated upon	All regions must be present to reserve memory for them during the remainder of the epoch.	
3	CDSs are only required if non-default colours are to be defined.		
		CDSs are **not** required at the beginning of an epoch to reserve memory, references to CLUT families from regions are sufficient to declare the memory required.	

[5] To avoid problems with legacy receivers subtitle streams associated with SD services with MPEG-2 MP@ML video shall not include a DDS.

Note	page_state		
	Normal case	Acquisition point	Mode change
4	Each display set has at most **one** EDS. This is a recommended but not mandatory segment. Receivers can take advantage of it but should not rely on it. The EDS is either the last segment of the ancillary page or the last segment of the composition page, depending on the presence or absence of ancillary data in the display set.		

Table 5-1. Notes to Figure 5-1

5.4.2 Indication of updates

The version number fields in the DDS (if present), PCS, RCS and CDS segments are significant to the decoder.

Subtitle encoders *increment* the version number (modulo 16) to indicate changes. Decoders should respond to a *change* in the version number.

Dependence on version number changes

When decoding a display set *it is sufficient* for a decoder to look for changes in page_version_number and region_version_number. If a change in region_version_number is observed for a region, the decoder shall also look for a change in the CLUT_version_number of the CLUT associated with that region.

dds_version_number

Changes to the **dds_version_number** indicate that the data in the DDS has changed. For example the display window for subtitle rendering may be moved for some creative purpose. Note however that dynamic changes to the values of **display_width** and **display_height** are not to be expected within a continuous subtitle stream.

A change to the position of the display window requires the **page_version_number** in the PCS to increment only if the data in that PCS also changes.

Changes to the DDS will only occur when the following PCS has **page_state** = ‘acquisition point’ or = ‘mode change’.

page_version_number

Changes to the **page_version_number** indicate that the data in the PCS has changed. For example, one or more regions might be repositioned or the set of visible regions might be changed.

A change in the visual appearance of regions does not require the **page_version_number** to increment. So, decoding an object into a region, or modifying a region’s CLUT does not require the **page_version_number** to increment.

region_version_number

Changes to the **region_version_number** indicate *either* that the data in the RCS has changed *or* that a graphics operation is to be performed on the region as a result of:

- The region fill flag being set
- The contents of the region’s CLUT being modified
- One or more objects being in the region’s object list

CLUT_version_number

Changes to the **CLUT_version_number** indicate that one or more locations in the CLUT family **held by the receiver** are to be modified.

So, at (or after) an acquisition point when the encoder delivers the initial state of a CLUT family the **CLUT_version_number** may remain constant if that state is consistent with the state held by receivers that have previously acquired the service.

Decoder behaviour when a CLUT is modified is only defined if ALL regions dependent on that CLUT are present with changed version numbers.

5.4.3 Colour translation during object decoding

5.4.3.1 Requested and allocated region depths

A region's **region_depth** specifies the "requested" pixel depth for that region. A region's **region_level_of_compatibility** (RLOC) indicates the minimum pixel depth that shall be "allocated" to the region.

Background (informative) EN 300 743 (previously ETS 300 743) was developed at a time when it was not practical for all receivers to deliver the "requested" pixel depth because of either memory limitations or hardware CLUT limitations. This precipitated the concept of an "allocated" pixel depth which might be less than the "requested" depth.

The UK receiver profile requires the full logical decoder memory model to be implemented by all compatible receivers. So, the "allocated" region depth shall in all cases be the "requested" depth. The descriptions provided here are provided for the benefit of other application domains that may wish to define subtitle interoperability on lower profile receivers.

Determining if a region can be displayed on reduced profile hardware

If a decoder cannot allocate a region depth compatible with the region's RLOC then the region shall be ignored.

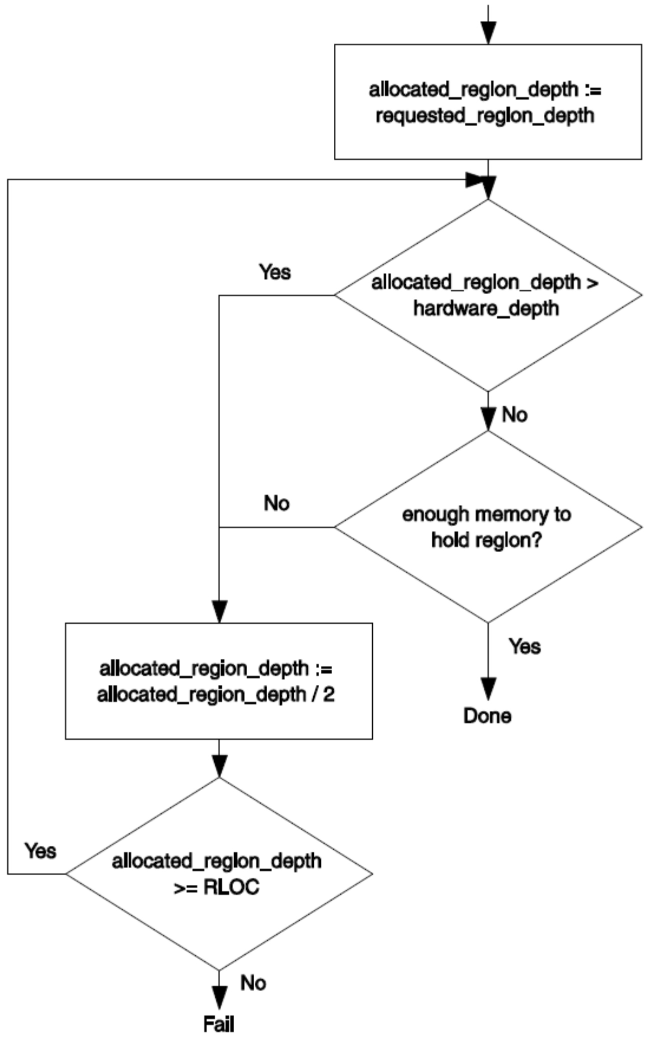


Figure 5-2. Region depth selection

5.4.3.2 Object decoding

Code string expansion

Bitmap objects are decoded with reference to the "requested" **region_depth** of the region that receives them.

The compressed data yields 2, 4 and 8 bit values which are mapped via map-tables into colour indexes appropriate for the receiving region. For example, an object destined for a region with a "requested" depth of 8 bits per pixel might contain 2-bit/pixel and 4-bit/pixel code strings. The 2_to_8 and 4_to_8 map tables (either the default tables or those embedded in the object) yield 8 bit values.

If the same object is also instanced in a region with a different depth, such as 4 bits, then the same 2-bit/pixel and 4-bit/pixel code strings are mapped through the 2_to_4 and the "unity" 4 to 4 mapping tables to yield 4 bit values.

In effect the object is decoded twice (once for each instance). This burden is already comprehended in EN 300 743 v1.3.1 (2006-11) decoder model. Manufacturers may be able to make more efficient implementations, but this is not relied upon by the encoder.

This mapping from code strings, through the map tables, to pixels in destination regions with the "requested" pixel depth is illustrated in Figure 5-3.

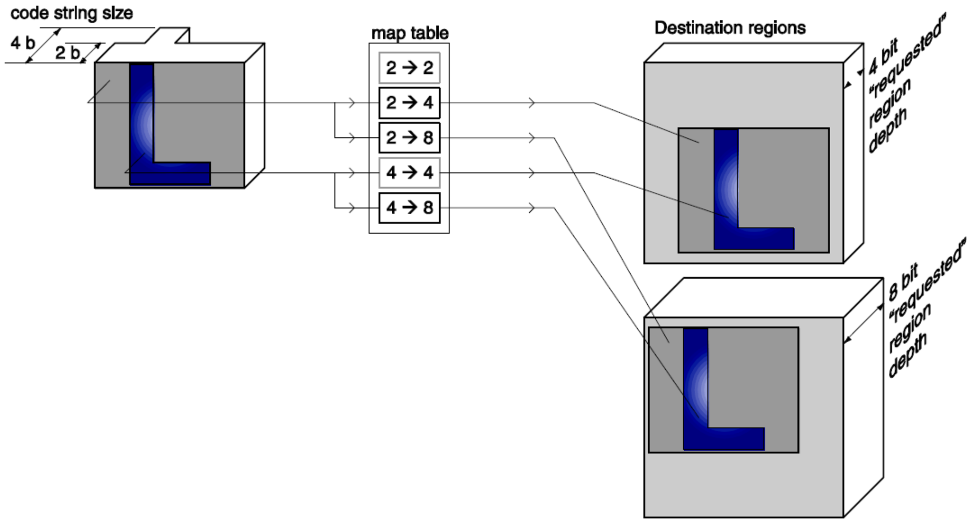


Figure 5-3. Mapping code strings to pixels in "requested" depth region

Note

See Pixel depths.

When "allocated" depth is less than "requested"

Figure 5-4 shows the complete set of code string expansions and also shows the subsequent pixel reduction that applies if the "allocated" depth of the region is less than the "requested" depth. Figure 5-4 clarifies figure 5 in section 9 of EN 300 743 v1.3.1 (2006-11).

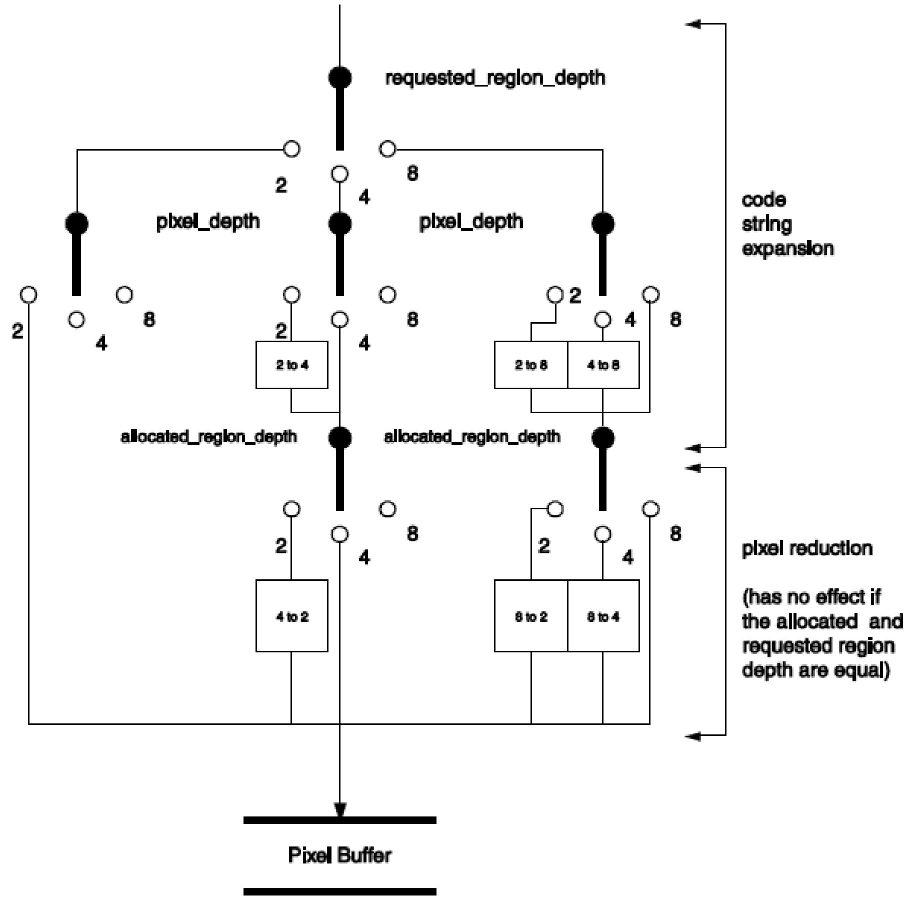


Figure 5-4. Mapping code strings to pixels

Clarifications

- Coded objects shall not have code strings with more bits per pixel than the "requested" pixel depth of any region in which the object is instanced.
- At the start of decoding an object data segment the map tables used whilst decoding are reset to the default values given in tables 11 to 13 of EN 300 743 v1.3.1. New map table definitions delivered by "n_to_n-bit map table data" pixel data sub blocks have effect until the earlier of the end of the object data segment or a further "n_to_n-bit map table data" pixel data sub block.
- The order of decoding is strictly the order in which the data is delivered by the object data segment.
- The top and bottom field data blocks in an object are relative to the top of the object (i.e. top field data block delivers pixels on the same scan line as the object_vertical_position).

  Whether the top field data block corresponds to pixels in the upper field of an interlaced display will depend on the position of the object within the region and the position of the region. The bitmap data is split into two fields as it is more convenient for some OSD implementations.

5.4.4 Page time out

5.4.4.1 When page time out matures

The behaviour of the receiver when a page time out matures is as if a PCS_{normal_case} with an empty region list was used to update the display, i.e. all regions are removed from the display but in other respects the state of the decoder remains intact. Decoders shall correctly observe page time out.

When a receiver subsequently receives a PCS with a non-empty region list the display will be updated in the normal way. If the time out is known to the decoder then it should comprehend the display update burden to re-display the regions cleared by the page time out. If the time out resulted from an error (as broadcast or in transmission) the receiver is responsible for recovering as best it can from the transient display update overload that may happen.

5.4.4.2 Time out is zero

EN 300 743 v1.3.1 defines page_time_out as:

> "*The period, expressed in seconds, after which the page is no longer valid and consequently shall be erased from the screen.*"

Accordingly, the value 0 means an immediate time out (i.e. within 0 to 5 seconds after the PTS time for the display set).

5.4.5 Other clarifications

5.4.5.1 Region instances in PCS

Each region shall be instantiated at most once in a PCS.

5.4.5.2 Temporal scope of object references

No object caching is assumed in broadcast subtitle streams. So, the scope of an object_id in an RCS is constrained to objects within the display set carrying the RCS. Also, the scope of an object_id is the composition and ancillary pages for the display set. So, an object_id used in one page cannot also be used in the other.

5.4.5.3 Repetition of segments in a display set

Decoder behaviour is not defined if segments of the same type and id value are repeated within a single display set. For example, if two ODS with the same object_id are found in a display set it is not defined if the decoder decodes the first, the second or both objects.

5.4.5.4 Segments are not fragmented between PES packets

Each PES packet carries an integer number of complete subtitle segments. Encoders may benefit from fragmenting large bitmap objects so that they are represented by more than one ODS. See Section 5.9.1 Fragmentation to improve decoding.

5.5 Revised decoder model

5.5.1 Background (informative)

The original subtitle decoder model in EN 300 743 (formerly ETS 300 743) was developed in the context of systems where the subtitle decoder was the only user of a region based, indexed colour, graphics system. In the UK environment the subtitle decoder is no longer guaranteed sole access to the display (e.g. MHEG applications may also be present concurrently) and the use of region based, indexed colour, graphics hardware can no longer be assumed. The decoder model applied here offers comparable system functionality to that in EN 300 743 v1.3.1, but additionally constrains the encoding process to ensure interoperability in the UK DTT context.

5.5.2 Decoder mode

This is a conceptual model used to define these terms precisely and to model the decoding process. The model decoder is defined only for this purpose. Neither the architecture of the model decoder nor the timing described precludes uninterrupted, synchronized play-back of streams from a variety of decoders with different architectures or timing schedules.

`

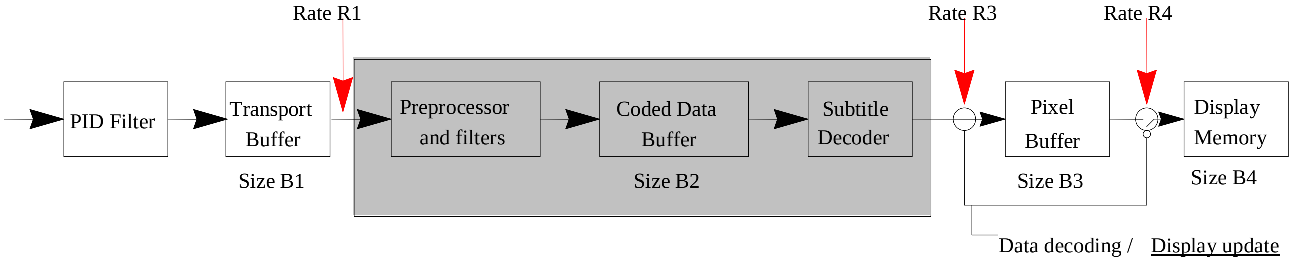


Figure 5-5. Subtitle reference decoder model

Transport buffer — As defined in EN 300 743 v1.3.1. This buffer (of size B1) is analogous to the buffers TB_n defined in ISO/IEC 13818-1. It fills at the transport stream rate and, if it contains data, empties at a rate of R1 (for values of B1 and R1 see table 5-2).

Preprocessor and filters — As defined in EN 300 743 v1.3.1.This selects appropriate PES packets and then subtitling segments on the basis of their page_id values.

Coded data buffer model — As in EN 300 743 v1.3.1 the coded data buffer is of size B2 (see table 5-2). However, buffer fullness is modelled as the coded data being removed instantaneously at the time defined by the PTS for the display set[6].

Pixel buffer — In the model decoder the output of the Subtitle Decoder is considered to be written to an off-screen “pixel buffer” of size B3 (see table 5-2) as data is decoded. The decoder is then considered to update the “display memory” starting at the time defined by the PTS for the display set.

Display memory — Compatible with EN 300 743 v1.3.1, display memory of size B4 is available for visible pixels (see Table 5-2). As broadcasts are only allowed to use regions with 4 or 8 bits per pixel (See Section 5.5.3 Encoding Constraints) the maximum number of displayed pixels is therefore 120 000 (for SD streams with no DDS) or 480 000 (for streams with a DDS).

[6] In many practical implementations decoding will start earlier than the PTS time but proceed more slowly than “instantaneously” (but no slower than the R3 pixel per second minimum). In this case the actual decoder buffer fullness will be less than predicted by this model.

Parameter	SD streams without DDS	Streams with DDS
T- buffer size B1	512 bytes	1024 bytes
T-buffer output rate R1	192 kbits/s	400 kbits/s
Code data buffer size B2	24 000 bytes	100 kbytes
Pixel buffer input rate R3	60 000 pixels/s	256 000 pixels/s
Pixel buffer size B3	80 000 bytes	320 000 bytes
Display buffer input rate R4	750 kpixels/s minimum	3 Mpixels/s minimum
Display buffer size B4	60 000 bytes	240 000 bytes

Table 5-2. Subtitle reference model parameters

5.5.2.1 Timing model

Two consecutive phases of processing are recognised:

- Data decoding (from coded data buffer to pixel buffer)
- Display updating (from pixel buffer to display memory)

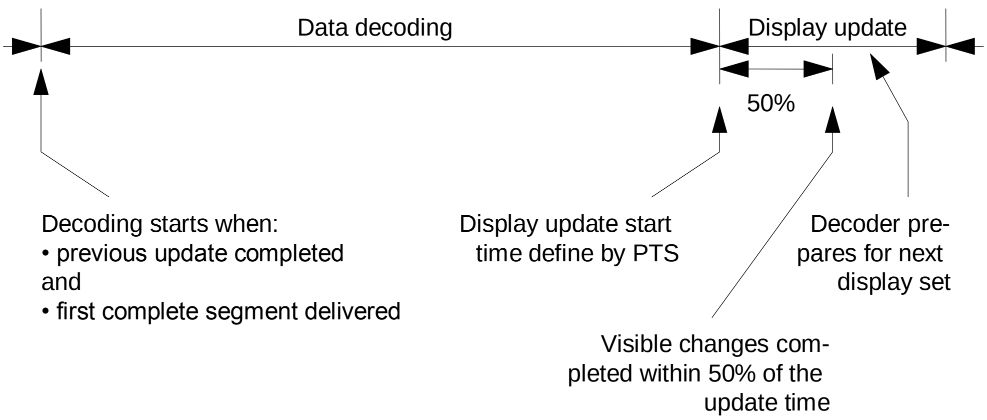


Figure 5-6. The two modelled decoding phases

The decoding process can start when the display updating process of the previous display set has completed and the first segment has been completely delivered to the decoder. The display update process starts at the time defined by the PTS of the display set.

Data decoding

The data decoding phase starts when the preceding display update phase is complete.

Epoch set-up

If the PCS has **page_state** = “mode change” or “acquisition point” then there is a maximum of 200 ms delay after complete reception of the PCS and the RCSs that define the memory use before any further segments are processed. During this time segments delivered accumulate in the coded data buffer.

This allows for the memory management tasks required by a decoder acquiring the stream at this point.

The decoding of PCSs with the **page_state** “normal case” and all segment types other than ODSs are assumed to be instantaneous.

Bitmap decoding

For each ODS the model decoder decodes data at a rate of at least R3 pixels per second independent of the pixel depth of the region. Decoding starts when previous decoding tasks have been completed and the segment has been completely delivered to the decoder (See Section 5.9.1 Fragmentation to improve decoding).

Timing

The service requirements for subtitling call for significant temporal accuracy in the presentation of subtitles. Subtitle streams are encoded with timestamps referenced to the service PCR. Decoders shall use the timestamps associated with the subtitle stream to maintain synchronism with the video such that a subtitle is presented with the next video frame at or immediately after the PTS for that subtitle display set.

Race avoidance

In addition to the above condition the last ODS of a display set is allowed at least [25] ms to decode.

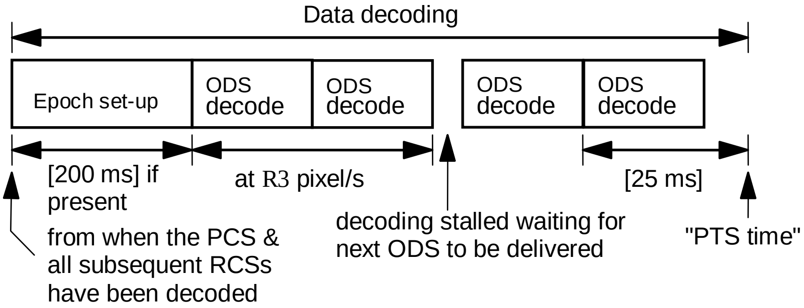


Figure 5-7. Detail of data decoding phase

Display update model

The display update process starts at the time indicated by the PTS of the display set. Except in the first display set of an epoch, no modifications are made to the display before the time indicated by the PTS.

For SD services which do not contain a DDS, the duration of the display update phase is based on an update rate of 375 000 pixels per second. However, modifications to the display shall be completed within 50% of the time available. This requirement requires an effective “display paint” rate of 750 000 pixels per second. This enables a 60 000 pixel subtitle to be transferred to the display in 80 ms. The balance of the time after display modification has been completed allows other operations that don’t modify the display.

Start of Epoch

The display update for the first display set of an epoch starts, as normal, at the PTS time for the display set, however, to allow the decoder to construct a new memory configuration, the display may be cleared an implementation dependent time before this and remain clear until the PTS time. In the limiting case, the display may be cleared as soon as the $PCS_{mode\ change}$ is decoded; in which case the preceding display set may be only displayed for a very short time.

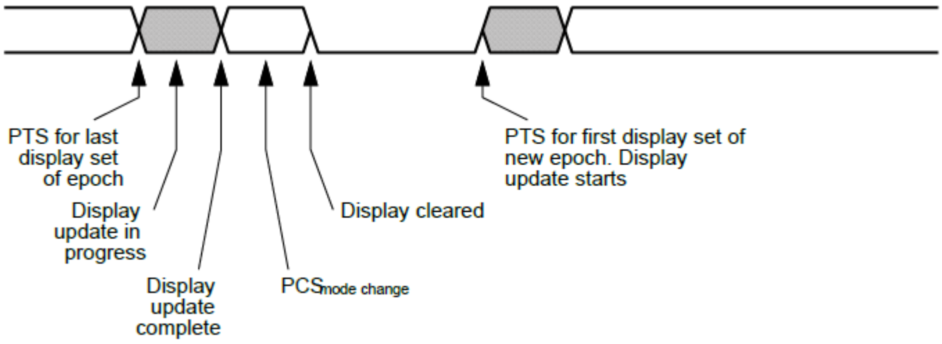


Figure 5-8. Disruption to display at start of new epoch

Updating within already visible regions

Where an object is decoded into regions that are already on-screen and are not being repositioned (i.e. the position of the region is the same in the Page Composition Segment of the Display Set that is currently being decoded as in the previous Display Set) the display update burden is the number of pixels in the smallest rectangle that will enclose the object for each instance of that object. The region depth is not considered.

Updating within off-screen regions

Here objects are considered to be decoded into an off-screen copy of the "live" region and then copied to the "live" region during the update process.

If objects are decoded into an off-screen region (i.e. a region that is not currently displayed) there is no display update burden unless the region becomes visible in this display set. In this case the display update burden is that for the entire region (as described below) and the display update for objects newly decoded into the region is not considered.

Repositioning regions

Similarly, if a currently visible region is repositioned within the page, the display update burden is that for the entire region and the burden for newly decoded objects is not considered.

Updating pages and regions

All operations that modify the display memory are comprehended in the display update budget. Table 5-3 defines the "weighting" for each pixel affected. For example, if a Page Composition Segment provides a new definition for the position of a Region then the impact on the display update budget is number of pixels in that region x2.

Operation	Weighting per pixel

Operation	Weighting per pixel
Page_state = 'mode change'[a]	1
Removing a region from the Page Composition Segment	1
Adding a region to the Page Composition Segment	1
Moving a Region within a Page	2
Redefining any of the values within the CLUT associated with Region [b]	1

Table 5-3. Additional display update budget for page/region operations

a] i.e. all previously existing regions in the display memory are re-drawn transparent before their definition is deleted.

b] This affects all the pixels in any region using a redefined CLUT.

5.5.3 Encoding constraints

All broadcasts shall be encoded as specified in EN 300 743 v1.3.1 (2006-11) but addressing the modified decoder model (described above) and observing the following constraints.

5.5.3.1 Affecting memory requirements

EN 300 743 v1.3.1 specifies a 4 kbyte "composition buffer". This was intended to comprehend the memory required to store static data structures describing the set of regions and their CLUTs used through an epoch and the transient data structures required to hold the list of objects used while decoding a display set.

This specification replaces the EN 300 743 v1.3.1 "composition buffer" with constraints on the number of regions, CLUT families and lists of objects that a decoder is required to handle. The size of this memory will be implementation dependent. This memory is in addition to the memory illustrated in Figure 5-5. Subtitle reference decoder model.

Number of regions

The maximum number of regions defined in any epoch shall be 8 for streams without a DDS or 16 for streams with a DDS.

Number of objects

The maximum number of instances of objects in a single display set shall be 128 for streams without a DDS or 256 for streams with a DDS.

Number of colours

To enable a receiver to determine the number of colours in use the following restrictions apply:

- Where a display contains one or more regions with 8 bit depth then only a single CLUT family (i.e. a single CLUT ID) shall be referenced by all of the regions concurrently displayed.
- Where a display contains only regions with 4 bit region depth then up to 4 different CLUT families (i.e. 4 different CLUT IDs) may be referenced by all of the regions concurrently displayed.

Pixel depths

Regions shall not have a **region_depth** of 2 bits per pixel.

5.5.3.2 Affecting graphics system complexity

Levels of transparency	Broadcasts should not rely on legacy receivers implementing more than one intermediate level of transparency per screen (i.e. neither 0% nor 100%). See Section 5.6.1 Limitations and approximation of transparency.
Region line exclusivity	Each region monopolizes the scan lines of which it occupies any part; no two regions can be presented horizontally next to each other.
Region width and position	The width of each region (region_width) shall be an even number of pixels. The horizontal position (region_horizontal_address) of each region shall be an even number of pixels.

5.5.3.3 Stuffing

In circumstances for which it is deemed necessary or desirable to add stuffing to a component stream (e.g. so as to maintain a minimum bit-rate for network management reasons) two mechanisms are recognised:

- transport stream stuffing including adaptation-only TS packets in the relevant elementary stream
- PES stream stuffing including PES packets with a stream_id set to padding_stream (value 0xBE) in the relevant elementary stream

The transport stream stuffing mechanism is preferred (as in many receiver implementations it presents a lower CPU burden). The PES stream stuffing mechanism although deprecated is allowed and shall be treated correctly by receivers.

The receiver behaviour in either case is the same. With reference to the "Decoder model" in Section 5.5.2 stuffing data of whatever kind is deleted from the data stream before the data stream leaves the "Preprocessor and filters" section.

5.5.3.4 Multiple languages

EN 300 743 v1.3.1 supports the use of multiple subtitle services (e.g. multiple languages) by using different **page_ids** within a single subtitle stream which is itself encapsulated within a single PID. This allows for some sharing of data between subtitling services. However it is often more convenient to convey multiple subtitle services in separate subtitle streams each conveyed in its own PID. Amongst other benefits this makes extraction of a particular subtitling service considerably easier in the decoder.

With appropriate signalling in the PSI and SI, both approaches are valid and, whilst compliant decoders must be able to accommodate both approaches, the coding of multiple languages using separate PIDs is strongly preferred.

Mixing subtitle services with and without a DDS in one PID is not allowed.

5.5.3.5 Others

Successive display sets	The value of PTS for successive display sets shall be at least 120ms apart.

5.6 UK specific features

5.6.1 Limitations and approximation of transparency

The coding provided by EN 300 743 v1.3.1 allows multiple intermediate levels of transparency per region.

Receiver requirement

Receivers are required to implement at least one intermediate level of transparency (in addition to opaque and complete transparency) per screen. Implementation of additional levels of transparency is optional.

Approximations

Where receiver hardware has limited ability to implement the number or values of semi-transparent colours encoded the following approximations shall be applied:

- Where receiver hardware implements fewer values of semi-transparency than are required by a CLUT family then the receiver shall combine two or more consecutive semi-transparent values into a single implemented transparency. When reducing the set of levels of semi-transparency lower transparency shall replace higher transparency.

  For example, if a receiver implements a single value of transparency per region and CLUT family includes the transparency levels 10%, 20%, 30% and 40% then all semi-transparent levels shall be implemented as 10%. Similarly, if the receiver can implement 2 levels of semi-transparency then the recommended mapping is 40%->30%, 30%->30%, 20%->10%, 10%->10%.
- Where the receiver cannot implement the encoded value of semi-transparency it shall replace it with the nearest value of semi-transparency it can implement.

Note

Semi-transparency shall not be approximated as either 0% or 100% transparency.

For example, if a receiver can implement 33% and 66% transparency and a CLUT family uses 15% then 33% shall be used rather than 0%.

Further example, if a CLUT family uses the following levels of transparency 25%, 50%, 75%; and a receiver only allows a single intermediate level of transparency which could be 33% or 66% then 33% shall be used in all cases.

5.7 OSD Conflicts

Spatial

Spatial conflicts between subtitles and graphics generated by other processes (e.g. MHEG-5 or User interface) shall be resolved by receivers in an implementation dependent way. Broadcasters requiring deterministic behaviour on legacy decoders should avoid possible conflicts.

Conflicts between MHEG-5 and subtitles may occur if the bounding box of any MHEG-5 visible (except those of RTGraphics, Video and Bitmaps encoded as MPEG I frames) shares the same scan line with any region in the subtitles.

Transparent colours

The transparency of the semi-transparent colours available to MHEG-5 may be affected if the subtitle stream uses levels of transparency different from the default defined for
MHEG-5.

5.8 System capabilities (informative)

Table 5-4 characterises the behaviour of the above EN 300 743 v1.3.1 based subtitling system for certain "typical" forms of subtitle for SD services without DDS. The left-most 3 columns describe the way in which new text is delivered (e.g. infrequent blocks of text or frequent individual words). The right-hand columns illustrate the decode and display times for these subtitles.

Unit of added subtitle text	Area	Repetition Rate	Decode time[a]	Display update time[b]
Three rows of text	64 kpels	One every 5 seconds	1000 ms	80 ms
One row of text	21 kpels	One every 1 second	330 ms	<50 ms
Single word (average 5 characters)	4 kpels	5 per second	75 ms	<40 ms

Table 5-4. Example subtitle system performance

a] At 60 000 pixels per second

b] Starting at the nominal time defined by the PTS this is the time until all display modification has been completed. This point is half way through the overall display update. See Figure 5-6.

5.9 Encoding guidelines (informative)

5.9.1 Fragmentation to improve decoding

Encoders should not assume that decoders can start decoding a segment any sooner than when the last byte of that segment has been delivered to the decoder. If a large bitmap is transmitted this may result in significant delay before the decoder can "start work". Encoders, by dividing large bitmaps into a number of small bitmap fragments that are then encoded as separate Object Data Segments, can overlap segment delivery with segment decode and thus allow segment decode to start earlier.

5.9.2 Definition of CLUTS at acquisition points

When CLUTs are introduced they are initialised to hold the default CLUT described in Section 10 of EN 300 743 v1.3.1. The CDS may redefine some or all of the locations in a CLUT. Display sets that are also acquisition points must contain one or more CDSs to reserve the memory for the CLUTs to be used by the regions in the epoch.

It is the encoder's responsibility to provide colour definitions in CDSs at (or shortly after) an acquisition point to ensure that decoders acquiring the stream at the current acquisition point have colour definitions consistent with those in decoders that acquired the service at an earlier acquisition point.

5.9.3 Efficient use of non_modifying_colour_flag

Decoder performance is likely to be affected if an object's non_modifying_colour_flag is set even if the object does not use any non-modifying colours. It is recommended that encoders should not set this flag for an object unless a non-modifying colour is used in the object.

5.9.4 PSI/SI signalling

Subtitling streams are signalled in the ISO/IEC 13818-1 Programme Map Table (PMT) using stream type 0x06 indicating PES packet private data and with a **subtitling_descriptor** associated with the subtitle stream component.

The subtitling descriptor defined in section 6 of the DVB SI specification EN 300 468 enables different subtitling streams to be distinguished by their **ISO-639_language_code**, **subtitling_type**, **composition_page_id** and **ancillary_page_id**.

Subtitling streams with a DDS and associated with an HD service should have a value for **subtitling_type** of 0x14 - denoting "DVB subtitles (normal) for display on a high definition monitor" - or of 0x24 - denoting "DVB subtitles (for the hard of hearing) for display on a high definition monitor".

Note that if no ancillary page is transmitted the values of **ancillary_page_id** and **composition_page_id** in the subtitling descriptor should be the same.

5.10 Decoding guidelines (informative)

5.10.1 Subtitle timing

Although accurate timing of subtitle presentation should be maintained (see Section 5.5.2.1), EN 300 743 v1.3.1 notes that there may be times when the correct time to present a subtitle (i.e. when PTS = local system clock derived from the PCR) has passed. For example, late arrival of display data can result from injudicious throttling of the bit-rate assigned to a subtitling stream at some point in the distribution network.

Given the nature of subtitles it is almost always better to display such a late subtitle than to discard it.

5.10.2 CLUT interpretation

EN 300 743 v1.3.1 Section 7.2.4 includes notes relating to interpreting CLUT values into digital luminance and colour difference signals which accord with ITU-R Recommendations ITU-R BT.601-5 and ITU-R BT.656-4. They are summarised here:

Whilst EN 300 743 v1.3.1 uses a **Y_value** of zero in any CLUT entry to signal complete transparency, implementers should note that Y=0 is disallowed in ITU-R BT.601. This condition should be recognised and mapped to a legal value (e.g. Y=16d) before conversion to RGB values in the decoder.

Note also that, whilst EN 300 743 v1.3.1 defines CLUT entries in terms of Y, Cr, Cb and T values, the standard interface definition of digital television (ITU-R BT.656-4) presents co-sited sample values in the order Cb,Y,Cr. Failure to correctly interpret the rendered bitmap image in terms of ITU-R BT.656-4 may result in incorrect colours and chrominance mistiming.

5.10.3 Decoder treatment of errors

This is a non-exhaustive list of known errors. It identifies issues that are illegal encodings.

The receiver behaviour if these conditions reach the receiver is not prescribed. However, there are likely to be a range of responses depending on the specific error, the context etc. It is an implementation issue to develop error management techniques that ensure robustness without unnecessarily disturbing the display.

Subtitles are a much-valued component of digital television services. Every decoder should use best endeavours to decode and to present the selected subtitle stream if errors at all allow.

5.10.3.1 Segment order

- Consecutive PTSs differ but by less than 120 ms.
- No PTS change preceding a PCS.
- PTS change preceding RCS, CDS or ODS.
- More than one PCS.
- DDS preceded by PCS, RCS, CDS or ODS.
- ODS or CDS precedes RCS.
- Segment type is not one of 0x10-0x13, 0x080 or 0xFF.
- Segment is not aligned with PES packets because the PES payload does start with sync byte
- Segment is not aligned with PES packets because the segment extends beyond the length of the PES packet

5.10.3.2 DDS

- **Display_width** or **display_height** > 4095.
- Changes to DDS parameters followed by PCS with **page_state** = "normal".
- Window positional parameters outside display perimeter.
- Window minimum parameters greater than values for window maximum.

5.10.3.2 PCS

- Page_time_out is zero.
- Page state is "11".
- Region_id is unknown.
- Duplicate region_id in PCS.
- Region horizontal/vertical address cause off screen or overlapping graphics.
- Region horizontal address is not even.
- Regions not listed in order of incrementing vertical address.
- Total memory for visible region exceeds 60 Kbytes.
- Segment length < 2
- Region entry incomplete (<6 bytes)

5.10.3.3 RCS

- **region_id** unknown.
- Duplicate RCS (same **region_id**) within a display set during acquisition or after a mode change.
- Duplicate RCS (same **region_id**) within a display set during normal operation.
- More than eight distinct RSCs are received during acquisition or after a mode change.
- **region_width**, **region_height**, **region_depth**, **region_level_of_compatibility** or **CLUT_id** are inconsistent with region definitions.
- **region_width** is not even during acquisition or after a mode change for streams without a DDS.
- **region_width** is zero or > 720 during acquisition or after a mode change for streams without a DDS.
- **region_height** is zero or > width of display window during acquisition or after a mode change for streams with a DDS.
- **region_level_of_compatibility** is not one of 0x01-0x03 during acquisition or after a mode_change.
- **region_depth** is not either 0x02 or 0x03 during acquisition or after a mode change.
- **region_level_of_compatibility** is greater than **region_depth**.
- **object_type** is not 0x00.
- **object_provider** is not 0x00.
- Vertical and/or horizontal position are not within the region.
- Total number of objects referenced in all RCSs exceeds 128 for streams without a DDS.
- Total number of objects referenced in all RCSs exceeds 256 for streams with a DDS.
- Total memory for declared regions exceeds B3 (see Table 5.2).
- Segment length < 10
- Incomplete Object entry

5.10.3.4 CDS

- **CLUT_id** unknown.
- Is not referenced in all required preceding RCSs.
- Duplicate CDS (same **CLUT_id**) within a display set.
- **CLUT_entry_id** > 15 _and_ **4-bit/entry_CLUT_flag** is set.
- **2-bit/entry_CLUT_flag** is set.
- Illegal colour i.e. $Y/C_r/C_b$ out of range for 601.
- Illegal $C_r/C_b/T$ values of transparent entry.
- Segment length < 2
- Incomplete CLUT entry

5.10.3.5 ODS

- **object_id** is not referenced in a preceding RCS.
- **object_coding_method** is not 0x00.
- Top field length is zero.
- Object data type is not one of 0x10-0x12, 0x20-0x22 or 0xF0.
- Object targeted at a 4-bit region contains an **8-bit/pixel_code_string()**.
- Object extends beyond region boundaries
- Segment length < 7

6 Multiplex and Transport Stream Characteristics

6.1 Scope

This section defines the transport stream standards that shall be used in all UK UHF terrestrial Television Broadcasts.

See also

Program Specific Information (PSI) is also addressed in the following areas:

- Section 5.9.4, "PSI/SI signalling"
- Section 7.4, "Use of PSI"
- Section 17.4, "Application identification and boot"

6.2 References

- ISO/IEC 13818-1, ISO/IEC 13818-2, ISO/IEC 13818-3
- TS 101 154
- ETR 289
- EN 302 755 [108]

6.3 Essential requirements

6.3.1 Multiplexing

In the case of both DVB-T and DVB-T2 systems the multiplexing of baseband signals and associated data shall conform to ISO/IEC 13818-1 constrained according to TS 101 154.

DVB-T2 systems shall carry at least one conformant MPEG-2 transport stream. Multiple transport streams in the same DVB-T2 system shall be carried on separate PLPs but may share data carried in a common PLP (or PLPs).

Other data formats defined by DVB-T2 e.g. GSE, GCS and GFPS, will not be carried on the UK DTT network but if encountered (e.g. a future test transmission) receiver operation shall not be adversely affected.

The PID and section filtering requirements for all UK DTT broadcasts shall be such that they can be received by receivers meeting the requirements set out below.

Stuffing	In circumstances for which it is deemed necessary or desirable to add stuffing to a component stream (e.g. so as to maintain a minimum bit-rate for network management reasons) two mechanisms are recognised: • transport stream stuffing including adaptation-only TS packets in the relevant elementary stream • PES stream stuffing including PES packets with a stream_id set to padding_stream (value 0xBE) in the relevant elementary stream The transport stream stuffing mechanism is preferred (as in many receiver implementations it presents a lower CPU burden). The PES stream stuffing mechanism although deprecated is allowed and shall be treated correctly by receivers.
Multiplex Flexing	UK DTT broadcasts may instantaneously alter the bit rate allocated to program components or services provided that at all times the multiplex, and the streams within it, continue to comply the with the buffer models defined for them in ISO/IEC 13818-1, ISO/IEC 13818-2, ISO/IEC 13818-3 etc. *This enables the dynamic allocation of capacity between elementary streams within the transport multiplex. This allows the broadcaster freedom to trade technical quality and quantity of programme services within a multiplex or to use instantaneous "statistical multiplexing" to allow the best use of capacity between multiple programme services by varying the bit-rate occupied by any programme elementary stream to suit instantaneous demand.*
PSI version number changes	The details and contents of a service may change during its lifetime. For example a new service component (such as audio description or a programme-related data service) may be added or a component may be dropped at the junction between one programme and the next. ISO/IEC 13818-1 provides a simple version_number mechanism which allows PSI and SI tables to be updated promptly when appropriate. Whenever the definition of a table has changed the table version_number is incremented modulo 32. Decoders should always track such changes.

6.3.2 Demultiplexing

All receivers shall be able to meet the minimum demultiplexing requirements set out in TS 101 154.

Data Rates

A receiver shall be able to demultiplex ISO/IEC 13818-1 transport streams with data rates of at least 72 Mbit/s.

While the theoretical maximum payloads supported by the DVB-T and DVB-T2 Specification are 31.67 Mbit/s and 50.35 Mbit/s respectively, receivers may include the capability to accept transport streams which have higher rates, via other means. Errors

Receivers shall implement a suitable error concealment or error recovery mechanism on receipt of transport packet errors.

PID Filters

Receivers shall be able to demultiplex at least 32 different PIDs simultaneously in order to receive any single service.

Section Filters

Receivers shall be able to implement at least 32 simultaneous section filters, each applying a filter specification to bytes 1 and 4 to 10 of the section, where each bit in the filter is individually maskable. It shall be possible to apply all 32 section filters to each section.

Burst Rate

The throughput shall be at least 5 Mbps for section filters, and at least 15 Mbps and 20Mbps for PID filters for streams associated with SD and HD services respectively (peak burst rate measured over 1 ms).

Scrambling control bits

The receiver shall respond appropriately to the DVB use of the transport scrambling control bits defined in ETR 289.

6.4 Constraints and extensions

6.4.1 Multicomponent programs

6.4.1.1 Compatible views

Where the PMT carries more than one audio or video elementary stream for a program they shall provide alternative, but compatible, “views” of a single event. For “simple” receivers this presents the viewer with a choice. However, future receivers may have the ability to decode more than one video or audio component for simultaneous presentation to the viewer.

6.4.1.2 Incompatible views

Where a broadcaster wishes to present an “incompatible” viewing alternative this shall be done as a separate program/service, NOT as alternative “views” within a single program.

6.4.1.3 Ordering the PMT

The ordering of elementary streams within the PMT is not significant. The selection of an appropriate set of components from a program is facilitated by descriptors in the PMT and the EIT.

7 Program Specific Information (PSI)

7.1 Scope

This section defines the Program Specific Information (PSI) standards that shall be used in all UK UHF terrestrial Television Broadcasts.

7.2 References

- ISO/IEC 13818-1
- ISO/IEC 14496-10
- EN 300 468 v1.10.1
- TR 101 290
- TS 101 211
- MHEG-5 UKPROFILE
- TS 102 323

7.3 Essential requirements

All PSI broadcast shall be encoded according to ISO/IEC 13818-1. All receivers shall continually monitor the PSI for change.

7.4 Use of PSI

7.4.1 PAT

The network_pid may be omitted from the programme loop, when it is present then it shall be specified on PID 0x0010 (DVB Mandatory).

7.4.2 PMT

The use of descriptors within the PMT shall be according to Table 7-1. The definition of PMT descriptors (including their tag values) required to support MHEG-5 interactive data components and services are recorded in MHEG-5 UK PROFILE.

PMT Descriptors	Tag	Extended Tag	Required
CA_descriptor	0x09		m[a]
ISO_639_language_descriptor	0x0A		m[b]
carousel_id_descriptor	0x13		b[h]
stream_identifier_descriptor	0x52		m[c]
subtitling_descriptor	0x59		m[d]
private_data_specifier_descriptor	0x5F		b[e]
service_move_descriptor	0x60		b[f]
data_broadcast_id_descriptor	0x66		b[g]
application_signalling_descriptor	0x6F		b[k]
related_content_descriptor	0x74		b[i]
supplementary audio descriptor	0x7F	0x06	b[j]

Table 7-1. Descriptors of the PMT

a] The CA_descriptor shall be included if CA is applied to any component of the program.

b] The ISO_639_language_descriptor shall be included for each audio component.

c] The stream_identifier_descriptor shall be included when required byTS 101 211.

d] The subtitling_descriptor shall be included for each DVB subtitling component.

e] The use of the private_data_specifier_descriptor is described in Section 8.5.4 Private descriptors and user-defined values.

f] The service_move_descriptor shall be included when required and shall be used in accordance with TS 101 211.

g] The use of the data_broadcast_id_descriptor is described in MHEG-5 UKPROFILE and Chapter 23 “Receiver Software Upgrading”.

h] The use of the carousel_id-descriptor is described in the MHEG-5 section.

i] The use of the related_content_descriptor is defined in ETSI TS 102 323, section 10.3.

j] The supplementary_audio_descriptor shall be included for each audio component carrying Audio Description.

k] Use of the application_signalling_descriptor is specified in D-Book Part B Section B.6.6.3.2. It shall be ignored by receivers only conforming to Part A of this specification.

7.4.2.0 Additional PMT descriptors for advanced codec services

Current standard definition (SD) services are transmitted as MPEG-2 SD video and MPEG-1 with Layer 2 audio components. Current high definition (HD) services are transmitted as H.264 HD video and AAC audio components. The AVC services shall be signalled using the service type defined in the service descriptor in the SDT as defined in Table 8-8. The use of additional descriptors for AVC service components within the PMT shall be according to Table 7-2.

The transmission of MPEG-4 (HE-AAC) audio ancillary data, will be indicated by the present of ancillary_data_descriptor (with bit b5 set) in the relevant ES_info loop of the PMT.

The transmission of H.264 DTR assistance information will be indicated by the presence of the adaptation_field_data_descriptor (with bit b2 set) in the relevant ES_info loop of the PMT.

PMT Descriptors	Tag	Required
ancillary_data_descriptor	0x6B	b
adaptation_field_data_descriptor	0x70	b
enhanced_AC-3_descriptor	0x7A	b [a]
AAC_descriptor	0x7C	b [b]

Table 7-2. Additional Advanced Codec Service Descriptors of the PMT

a] The descriptors shall be included when required by EN 300 468 Annex D

b] The descriptors shall be included when required by EN 300 468 Annex H.

7.4.2.1 PMT Component signalling

The number and type of components signalled via the PMT may change at either programme or service boundaries or may remain quasi-static - depending upon individual broadcaster's operational constraints. In the quasi-static configuration the PMT shall list a super-set of the components that may be used in the broadcast of any programme. Consequently some of these components may not be carrying useful content for all programmes.

The EIT component_descriptor signalling shall always accurately describe the valid components of a programme. Where the PMT is quasi-static then the EIT shall only describe those components that carry useful content for the consumer for that programme. Elementary streams that are not used by the programme shall not be described by the EIT, this is contrary toTS 101 211, but accurately describes the broadcast operation.

In the case of a quasi-static PMT where multiple language components are included for the same stream type and the programme content provides only a single language then the single language shall be broadcast on every corresponding component of the PMT. This shall not apply if presentation of the multiple language components is controlled by a MHEG-5 interactive application. [If all signalled components are not carrying content consumers could be forced to change their languages setting at each programme boundary. The solution assumes that at least one of the components is continuously present. This problem does not exist when the PMT is changed dynamically at programme boundaries and this should be used where-ever operationally possible].

The EIT content is informative and shall NOT be used by the receiver to enable any executive control on PSI component selection.

7.4.2.2 Dual mono audio

The use of this feature is deprecated. Broadcasters should be aware that not all receivers implement this feature and therefore its use is not recommended.

For Dual Mono Audio elementary streams then the first ISO_639_language_descriptor language code shall describe the left audio channel and any second language code shall describe the right channel. The second language code may be omitted if the right channel is not used. [Note: the language codes may be conveyed either within a single descriptor or singularly within multiple descriptors.]

7.4.2.3 Time exclusive services

Some services only broadcast for part of each day and share their multiplex capacity with other services. This may be achieved through either of the two methods below:

1. SI/PSI signalling in accordance with TS 101 211.

2. Dynamic PMT signalling to add/remove components as required for the “on” and “off” states of the service.

A receiver shall function appropriately with both methods.

The second method is useful since by exploiting features of the MHEG-5 application lifecycle it is possible to display a broadcaster defined caption when the service is in the “off” state. See MHEG-5 UKPROFILE for more details of the MHEG-5 application lifecycle.

7.4.2.4 Related content discovery

A Related Content Descriptor in the PMT indicates a component carrying one or more Related Content Tables (RCT). The RCT contains an optional service_id. A single PID may contain RCT sections relating to multiple service_ids. The service to which an RCT section without a service_id (i.e. with table_id_extension_flag set to 1) belongs to is discovered solely through association with the related content descriptor in the PMT.

7.4.2.5 Supplementary Audio

All audio streams carrying Audio Description shall have a supplementary_audio descriptor in the PMT with the mix_type set to 0b0 and editorial_classification set to 0b00001.

All audio streams carrying the main audio may have a supplementary_audio descriptor in the PMT with the mix_type set to 0b1 and editorial_classification set to 0b00000.

The other fields in the descriptor shall be coded as described in ETSI EN 300 468.

7.4.2.6 Over-Air Downloads - Object Carousel method

Each download carousel will appear as a data component within an existing service. The PMT information required to support this service and the download signalling may be static (see note below).

Although the download carousel can be carried over more than a single PID, for legacy reasons any download carousels conforming to this specification are carried on a single PID.

A data_broadcast_id descriptor in the PMT (as defined in EN 300 468 [2]) identifies the elementary stream that carries the download carousel's DSI. The data_broadcast_id value in TR 101 162 [10] is 0x0111. No extended information is included in the data_broadcast_id descriptor - so it takes the minimal form shown in EN 300 468 [2].

No information is included in the data_broadcast_id descriptor regarding the targeting of the firmware update file, that information is carried in the userInfo field of the ServiceGatewayInfo() structure within the Object Carousel described in Section 23.5.2.1.

Syntax	No. bits	Identifier	Value
`data_broadcast_id_descriptor(){`			
`descriptor_tag`	8	uimsbf	
`descriptor_length`	8	uimsbf	
`data_broadcast_id`	16	uimsbf	0x0111
`}`			

Table 7-3. Syntax of data_broadcast_id descriptor in PMT

Semantics of the data_broadcast_id descriptor:

data_broadcast_id: This 16 bit field identifies the data broadcast specification which is used to broadcast the data in the broadcast network. Allocations of values in this field are found inTR 101 162 [10].

Note if no download is currently available, the PMT may continue to signal the presence of the component but the component itself may be absent. Alternatively, a null stream can be broadcast, i.e. no download carousel is present on the signalled component.

7.4.2.7 Over-air downloads – Data Carousel method (DVB-SSU)

The PMT of the service carrying the SSU data shall contain the data_broadcast_id descriptor with the data_broadcast_id set to 0x000A, indicating an elementary stream used for the SSU service. This provides an entry point to either a standard update carousel, or a proprietary stream (not included in DTG profile), without the need for further reference from a table.

The data_broadcast_id shall be carried in the ES_info_loop of the PMT. If an SSU service is temporarily absent, this descriptor shall NOT be removed from the PMT.

The data_broadcast_ID descriptor (defined in EN 300 468 [2]) shall carry a *system_software_update_info* data structure, which is defined in TS 102 006 [17]. They are reproduced here for convenience:

Syntax	No. bits	Identifier
`data_broadcast_id_descriptor() {`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`data_broadcast_id`	16	uimsbf
`OUI_data_length`	8	uimsbf
`for (i=0;i<N;i++){`		
`OUI`	24	bslbf
`Reserved`	4	
`update_type`	4	
`reserved`	2	
`update_versioning_flag`	1	
`update_version`	5	
`selector_length`	8	uimsbf
`}`		
`}`		

Table 7-3b. Data Broadcast ID descriptor for System_Software_Update (based on EN 300 468 Sec 6.1.12 and TS 102 006 Sec 7.1 and included for information only)

descriptor_tag: shall be set to 0x66.

data_broadcast_id: shall be set to 0x000A to indicate System Software Update

OUI: This shall be set to the DVB OUI value of 0x00015a to indicate that the stream is for all OUIs.

update_type: For Simple Profile, this shall be set to 0x01; For Enhanced Profile, this shall be set to 0x02.

update_versioning_flag: shall be set to zero to indicate that there is no version information in the update_version field.

update_version: value set to zero as update_versioning_flag has fixed value.

selector_length: set to zero as there is no further data is included in this descriptor. Target receivers are identified in the Compatibility Descriptor in the DSI of the data carousel.

No private data is carried in this descriptor.

7.4.2.8 Enhanced_AC-3_Descriptor

All E-AC-3 audio components shall have a corresponding Enhanced_AC-3_descriptor in the PMT.

Component_type_flag shall be set to 0b1.

Bsid_flag shall be set to 0b1.

Mainid_flag shall be set to 0b1 for main audio, and 0b0 for audio description on a separate PID.

Asvc_flag shall be set to 0b0 for main audio, and 0b1 for audio description on a separate PID.

Mixinfoexists shall be set to 0b0 for main audio, and 0b1 for audio description on a separate PID.

substreamN_flag shall be set to 0b0. Therefore, only a dual PID solution is supported for Audio Description as the substreamN_flag is set to zero. Use of substreams (single PID) is under future consideration.

The Component_type shall be included as follows:

The AC-3 or E-AC-3 flag shall be set to 0b1 for E-AC-3 audio.

The full service flag shall be set to 0b1 for main audio, and 0b0 for audio description on a separate PID.

The service type flags shall be set to 0b000 (complete main) for main audio, and 0b010 (visually impaired) for audio description on a separate PID. This should correctly reflect the bsmod parameter (as specified in ETSI TS 102 366) of the encoded bitstream.

The number of channels flags shall be set to reflect the number of channels encoded in the bitstream. This should correctly reflect the acmod parameter (as specified in ETSI TS 102 366) of the encoded bitstream.

Example component_type values:

Description	Component_type value
Multichannel Main audio (>2 and <=5.1 channels)	0xC4
Stereo Main audio	0xC2
Stereo surround encoded Main audio	0xC3
mono Main audio	0xC0
mono Visually Impaired	0x90

Bsid shall be set to 0b00010000. This should correctly reflect the bsid parameter (as specified in ETSI TS 102 366) of the encoded bitstream

Mainid is a numerical value which uniquely identifies a main audio component within a DVB service. This shall be set to 0x00 for the first main E-AC-3 audio component of the service.

Asvc is specified as a mask, to indicate which main audio service(s) the associated audio is associated to.

Example asvc values:

to associate with mainid = 0x00, asvc shall be set to 0000 0001 (0x01)
to associate with mainid = 0x01, asvc shall be set to 0000 0010 (0x02)
to associate with mainid = 0x02, asvc shall be set to 0000 0100 (0x04)
to associate with mainid = 0x03, asvc shall be set to 0000 1000 (0x08)
to associate with mainid = 0x04, asvc shall be set to 0001 0000 (0x10)
to associate with mainid = 0x05, asvc shall be set to 0010 0000 (0x20)
to associate with mainid = 0x06, asvc shall be set to 0100 0000 (0x40)

to associate with mainid = 0x07, asvc shall be set to 1000 0000 (0x80)

Example Enhanced_AC-3_Descriptors:

The following descriptor could be used to identify an E-AC-3 5.1 full-service Complete Main Audio component, which is labelled with a mainid of zero.

DVB Enhanced AC-3 Descriptor

Descriptor tag	8 bit	0x7A (122)
Descriptor length	8 bit	0x04 (4)
Component type flag	1 bit	1
bsid flag	1 bit	1
mainid flag	1 bit	1
asvc flag	1 bit	0
mixinfoexists	1 bit	0
Substream 1 Flag	1 bit	0
Substream 2 Flag	1 bit	0
Substream 3 Flag	1 bit	0
Component type	8 bit	0xC4 (196)
bsid	8 bit	0x10 (16)
mainid	8 bit	0x00 (0)

The following descriptor could be used to identify an E-AC-3 mono visually impaired associated service which should be mixed with the main audio stream labelled with a mainid of zero.

DVB Enhanced AC-3 Descriptor

Descriptor tag	8 bit	0x7A (122)
Descriptor length	8 bit	0x04 (4)
Component type flag	1 bit	1
bsid flag	1 bit	1
mainid flag	1 bit	0
asvc flag	1 bit	1
mixinfoexists	1 bit	1
Substream 1 Flag	1 bit	0
Substream 2 Flag	1 bit	0
Substream 3 Flag	1 bit	0
Component type	8 bit	0x90 (144)
bsid	8 bit	0x10 (16)
mainid	8 bit	0x01 (1)

7.4.3 CAT

The CAT shall be broadcast if CA is applied to any service.

7.5 Guidelines

7.5.1 Repetition rates

The UK-DTT PSI guideline repetition rates are defined in Table 7-4.

Table	Maximum Time
PAT	200ms
PMT	200ms
CAT	N/A

Table 7-4. Guideline Repetition Rates

Typically multiplexes are currently using nominal repetition rates of between 80 ms and 110 ms. However these are nominal rates and short-term transient peaks up to 500 ms should be expected, see TR 101 290.

To conserve multiplex capacity nominal PSI repetition rates may increase to the figures shown in Table 7-4 but short-term transient peaks should still not exceed 500 ms.

8 UK DTT SI Rules of Operation

8.1 Scope

Chapters 8 have been written with reference to conventional remote control handsets but, in view of the developments in remote control technologies and interfaces, references to control 'buttons' or 'keys' may be to control functions or to physical buttons.

This section specifies the rules for the operation of Service Information (SI) within UK Digital Terrestrial Television (DTT) in the form of a specification for the SI present within a compliant UK DTT multiplex. The document covers:

- The use of the Service Insertion Point (SIP) to provide a framework for the transmission of multiplexes with UK DTT
- The distribution of SI within and across the multiplexes of a SIP
- The content of SI sub-tables
- Dynamic behaviour following changes to service configuration

The rules of operation specified here are in addition to the mandatory minimum set of PSI and SI defined by ISO/IEC 13818-1 [36] and TS 101 211 [13].

These rules do not prevent a receiver designed to meet the mandatory minimum set of PSI and SI defined by ISO/IEC 13818-1 [36] and TS 101 211 [13] only from receiving basic UK DTT services.

Bouquets

The use of bouquets is not covered by this specification.

8.2 References

- EN 300 468 v1.11.1 (2010-04) [2]
- TR 101 162 [10]
- TS 101 211 [13]
- ISO/IEC 13818-1 [36]
- OFCOM DTT [55]
- ISO/IEC 6937 [42]
- ISO 8859-1 [43]
- ISO 639-2 [45]
- MHEG-5 UKPROFILE [94]
- TS 102 323 [98]
- TS 102 822-4 [99]
- ISO/IEC 14496-10 [104]
- TS 102 822-3-1 [147]
- TS 102 822-3-2 [148]
- ISO 639-1 [149]
- DVB Bluebook A142 (December 2010) [150].

- DVB BlueBook A 038 [151]

8.3 Definitions and abbreviations

See "Definitions and Abbreviations".

8.4 Environment

8.4.1 Service insertion point (SIP)

UK Digital Terrestrial Television (DTT) is inherently regional as the number and composition of transmitted multiplexes differs from region to region, and the range of a terrestrial transmitter is limited. The degree of regionality differs from service to service.

This regionality is structured into Service Insertion Points (SIP), representing the next level of regionality supported for DTT. The SIP structure is derived by overlaying the different regionalities for all multiplex operators. Within a SIP, all cross-carried SI will be consistent between the multiplexes that are part of the SIP area. The cross-carried EIT may also include information on Services or Transport streams which are not broadcast within the SIP area. This is to ensure receivers have access to EIT for regional services which they may be receiving from neighbouring transmitters which are part of a different SIP area.

Each SIP may be served by a number of transmitters on different frequencies. This concept is illustrated in Figure 8-1.

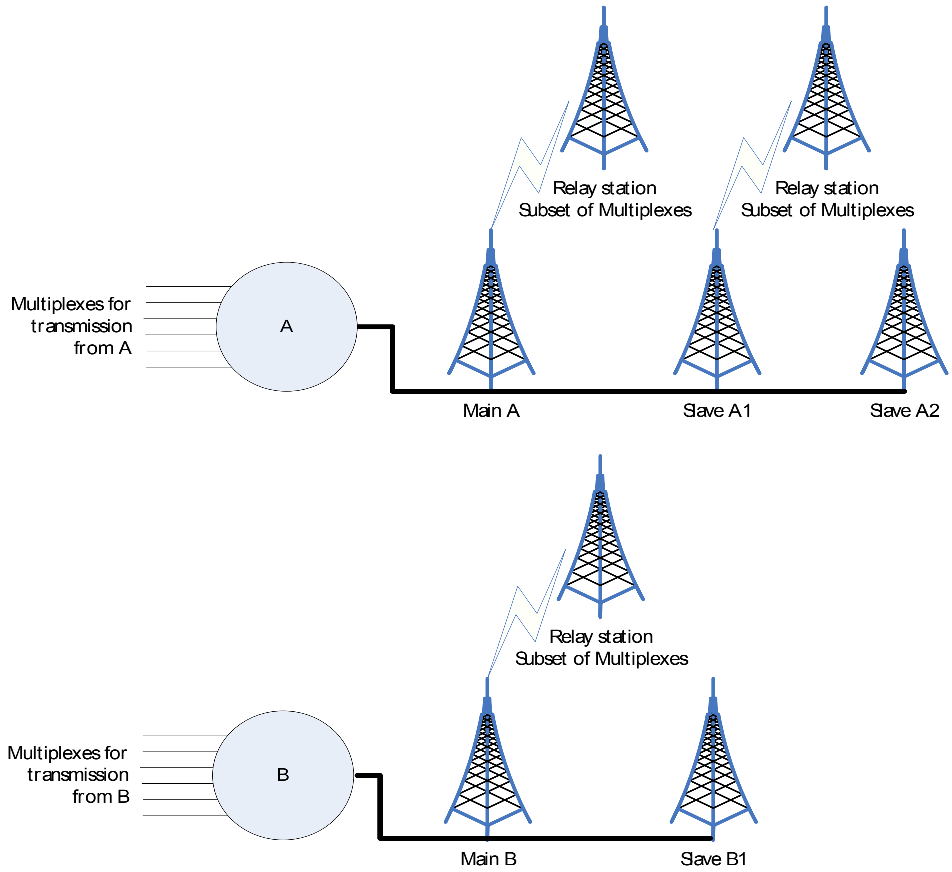


Figure 8-1. Service Insertion Point

Each SIP provides a group of co-operating multiplexes with consistent, cross-carried SI, which are then transmitted from the SIP Main transmitter and from zero or more Slave transmitters and relay stations. A multiplex transmitted from a Slave transmitter is identical to the corresponding multiplex transmitted from the Main transmitter except for the UHF channel used [7].

As part of the Digital Switchover process in the UK, the existing DTT network (called the low power DTT network) is being modified in a number of ways as the high power analogue network is switched off. In most cases the radiated power of the current low power DTT channels is being increased and frequencies are being changed.

The number of stations in the DTT network will also expand when analogue relay stations are switched over to be digital relay stations fed from other stations within the same SIP. These relay stations will only carry a subset of the Multiplexes in the SIP and it should be noted that the radiated SI from the Multiplexes from a relay stations will still contain the full SI cross carriage, including SI for Multiplexes that are not being broadcast from that relay station.

The Digital Switchover network will also employ a number of mini single frequency networks (SFNs) to allow the most efficient use of the RF spectrum.

Due to the increase in radiated power from the stations that have completed the Digital Switchover process, there is a much higher likelihood of signals being received from more than one station in a SIP and from stations that are part of different SIP regions. This may lead to issues with the number of stored services and which services are allocated the LCN value and which services are held in the 800s range. In many cases a signal from a low power relay station may be received on a lower frequency than the frequency of a much stronger signal from a line fed station so this has implications for service acquisition.

Due to the large number of relay stations it is impractical to list the frequency information for all of the relay stations in the radiated SI so not all frequencies will be listed. The alternative frequency flag will be used to indicate that other frequencies are in use for the Multiplex but without any references to all of the frequencies in use.

The new high power DTT RF signals will also include the cell id.

8.4.2 Structure of SI within multiplexes of a SIP

For the purposes of SI, a SIP is treated as a single terrestrial network, unique within UK DTT. The delivery system model is then similar to Figure 1 of EN 300 468 [2], and is illustrated in Figure 8-2.

8.4.2.1 Use of SI IDs

Within UK DTT, the use of IDs shall be as specified below:

- The value **0x233A** shall be used as the original_network_id for all UK originated DTT services.
- DVB allocates original_network_id. As DVB allows for the transfer of original_network_ids between networks at multiplexing boundaries e.g.

7 Multiplex operators may choose to provide different programme material within the same service transmitted from different transmitters within a SIP group, subject to the restriction that the SI is not affected in any way. A receiver will not be able to discriminate between such subregional services.

satellite to terrestrial or terrestrial to terrestrial the original_network_id shall not be considered as a country specific identifier.

- A single value of network_id shall be allocated to each SIP. This value shall be unique within UK DTT. These shall be allocated within the range allocated to Ofcom by DVB: block **0x3001-0x3100**.
- The transport_stream_id shall be used to uniquely identify a Transport Stream (within the UK DTT original network) comprising a specific combination of services and components. The same transport_stream_id may be used for Transport Streams transmitted from more than one SIP, provided that the differences between the Transport Streams with the same transport_stream_id is limited to the NIT (actual) and SI (other) tables only [7a].
- The service_id shall be unique to each UK DTT service that has any difference in its scheduled events, service name, service components or any other difference that requires a unique set of SI for that service.
- Each service provider is free to allocate event_ids for programmes on each of their services, provided that they are unique within the transmitted schedule for that service. From the time of first presentation in the event schedule the event_id shall be associated with a single event, even if that event is rescheduled within the currently transmitted schedule. If the event is removed from the schedule (or rescheduled to outside the transmitted schedule) then its event_id shall be removed from the schedule. Any replacement event shall be allocated a new event_id unique within the transmitted schedule.

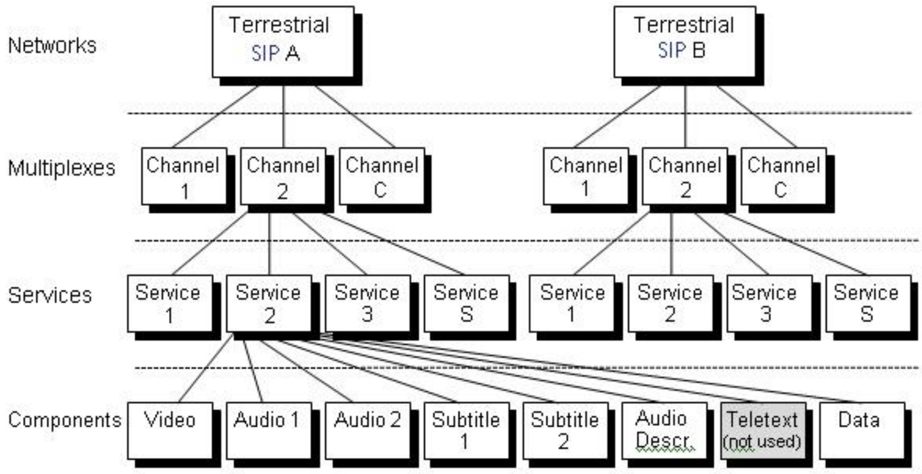


Figure 8-2. Terrestrial Service Delivery Model

7a. This ‘interpretation’ of DVB specifications is required for UK DTT to allow SI (actual) to be delivered within a Transport Stream input to a SIP where the services carried by that Transport Stream are the same for multiple SIPs. The transport_stream_id is liberally scattered throughout SI (actual) sub-tables, and descriptors such as the linkage_descriptor, and forms part of the service reference original_network_id/transport_stream_id/service_id. Automatic translation of transport_stream_id for each SIP is therefore a difficult and expensive process (and virtually impossible for service references contained within an MHEG-5 application) which would need to be duplicated for every SIP.

8.4.2.2 Cross-carriage of SI

In order to assist the receiver in providing an EPG based on SI, multiplexes within a SIP will cross-carry SI tables (as SI (other)). The cross-carried tables shall be:

- SDT_o for all Transport Streams listed in the NIT(actual).
- EIT_{pfo} for all services listed within each SDT_o and for which the EIT_present_following_flag is set to '1' (see EN 300 468 [2] section 5.2.3).
- EIT_{scho} for all services listed within each SDT_o and for which the EIT_schedule_flag is set to '1' (see EN 300 468 [2] section 5.2.3).

The information defined within this document shall be identical in actual and other variants of a sub-table. However, other information not defined by this document may differ (e.g. be present in actual but not in other variants of the same sub-table).

8.4.3 Relationship between SIPs

There is no cross-carriage of SI between SIPs with the exception of EIT other tables for adjacent regional services which maybe present.. SIPs are therefore independent networks. However, where services received from different SIPs match in their combination of original_network_id/service_id they shall be identical with regard to program content.

Note: In scenarios where services are received from different SIPs, a receiver which can't receive EIT tables for the expected "DVB triple" (transport_stream_id, original_network_id and service_id) can use as a replacement EIT tables with the same original_network_id and service_id, since the EIT data will be identical.

8.4.4 Codec Environment

Current standard definition (SD) services are transmitted as MPEG-2 SD video and MPEG-1, Layer 2 audio components. Current high definition (HD) services are transmitted as H.264 HD video and AAC audio components. The Advanced codec services shall be signalled using the service type defined in the service descriptor in the SDT as defined in Table 8-8.

8.4.5 Receiver Requirement for processing of services during scanning

Given the structure of the network as defined in 8.4.1, minimum requirements have been defined. The figures are minimum and a receiver implementation should consider handling greater numbers with consideration to the expansion of the platform.

The figures are estimated by assuming overlapping reception of 4 transmitters, increasing use of Time-Ex services, improvements in MPEG-2, launch of local multiplexes, the tranisiton to DVB-T2, the use of advanced codecs and future sale and re-use of spectrum.

Receivers shall be capable of processing 1500 services[8] through the scan process, with up to 63 services in a single multiplex.

8.4.5.1 Stored services requirement for DVB-T only receiver

A DVB-T only receiver shall be capable of storing 256 unique services.

[8]. These services are the total number of services across all the available multiplexes.

8.4.5.2 Stored services requirement for DVB-T2 receiver

A DVB-T2 receiver shall be capable of storing 800 unique services.

8.5 Use of SI

8.5.1 Country and language identification

UK DTT shall use the following identifiers for all language and country signalling.

8.5.1.1 Country code

The country code is a 24-bit field that identifies the country using a 3-character code as specified in ISO 3166 [141]. Each character is coded into 8-bits according to ISO 8859-1 [43] and inserted into a 24-bit field.

The United Kingdom has a 3-character country_code of "GBR".

The *target_region_descriptor* as defined in Section 8.5.3.21.2 shall be broadcast. The *country_code* shall be set to "GBR" and the region codes shall be used to identify the region within the network. The target*_region_name_descriptor* shall also be signalled.

Where a duplicate LCN is present in the broadcast, for example where multiple regional multiplexes exist on a common transmitter, a *target_region_descriptor* in the second loop of the NIT or in the SDT will be used to define a sub-region which will take precedence.

8.5.1.2 Language code

The language code is a 24-bit field that identifies the language, using a 3-character code as specified by ISO 639 Part 2. Each character is coded into 8-bits according to ISO 8859-1 [43] and inserted into a 24-bit field.

UK DTT shall support a number of languages which are signalled as follows in Table 8-1:

Language	3-character language code
English (default)	"eng"
Welsh	"wel" or "cym"
Gaelic	"gla"
Irish	"gle"
Undefined	"und"
Original language (of soundtrack)	"qaa"

Table 8-1. Supported language codes

Content identified as *Undefined* shall be assumed to be the default language English.

8.5.2 SI Tables

Table 8-2 below defines which SI tables shall be present within the broadcast Transport Stream to describe the service types specified in Table 8-8.

SI Table	Actual Transport Stream / Network	Other Networks or Transport Streams within the Network
NIT	✓	×
SDT	✓	✓
EIT_{pf} present/following	✓ [a]	✓ [a]
EIT_{sch} schedule	✓ [b]	✓ [b]
TDT	✓	N/A
TOT	✓	N/A
RCT	✓ [c]	N/A
AIT	✓ [d]	N/A

Table 8-2. SI Tables

a] EIT_{pf} shall be present if and only if the corresponding EIT_present_following_flag is set for the corresponding service in the corresponding SDT sub-table.

b] EIT_{sch} shall be present if and only if the corresponding EIT_schedule_flag is set for the corresponding service in the corresponding SDT sub-table

c] RCT shall only be present if the broadcaster is providing related content information.

d] Use of the AIT is specified in D-Book Part B section B.4.2.3. It shall be ignored by receivers only conforming to Part A of this specification.

Broadcasters are strongly urged not to transmit SI that has not been defined within this (or future versions of this) document in order to avoid future legacy and/or interoperability problems. Receivers should ignore tables and descriptors which are not recognised.

The details of how tables can be split into multiple sections and how this should be handled by a receiver is specified in TS 101 211 [13].

Tables

Specifically in the UK the following SI tables are not broadcast at this time but may be considered in the future:

- BAT
- NIT_{other}
- RST

Descriptors

Tables in this Chapter detail the descriptors which will be carried in the SI tables. The following key will apply:

m	mandatory, contained within all Transport Streams
b	optional, use is specified within this document
x	will not be carried within DTT tables
n/a	not applicable

Descriptors that are compliant with DVB specifications but not listed here may be included in future versions of this document and therefore may appear in future broadcasts.

The use of text strings within descriptors is given in Table 8-26.

8.5.2.1 NIT

A single, quasi-static NIT_{actual} shall be common to all multiplexes of a SIP. It shall detail the transmission parameters of the multiplexes being radiated from the SIP Main and (where present) Slave transmitters. There will normally be a new version of the NIT payload only in one of the following circumstances:

- a new multiplex is added to the SIP
- when transmission parameters are changed
- when the service make-up changes

The NIT version number may change without changes to the payload when redundancy switches take place in the transmission chain.

The use of descriptors within the NIT shall be according to the following table:

NIT Descriptors	Tag Value	Tag Extension Value	Actual	Other
network_name_descriptor	0x40		m	N/A
service_list_descriptor	0x41		m[a]	N/A
linkage_descriptor (linkage_type 0x09 only)	0x4A		b [b]	N/A
terrestrial_delivery_system_descriptor	0x5A		m[c]	N/A
multilingual_network_name_descriptor	0x5B		b[d]	N/A
private_data_specifier_descriptor	0x5F		m[e]	N/A
frequency_list_descriptor	0x62		b[f]	N/A
default_authority_descriptor	0x73		b[g]	N/A
FTA_content_management_descriptor	0x7E		b[o]	N/A
T2_delivery_system descriptor	0x7F	0x04	m[h]	N/A
network_change_notify_descriptor	0x7F	0x07	b[i]	N/A
message_descriptor	0x7F	0x08	b[j]	N/A
target_region_descriptor	0x7F	0x09	m[k]	N/A
target_region_name_descriptor	0x7F	0x0A	b[k]	N/A
logical_channel_descriptor	[0x83]		m[l]	N/A
service_attribute_descriptor	[0x86]		b[m]	N/A
HD_Simulcast_Logical_Channel_descriptor	[0x88]		b[n]	N/A

Table 8-3. Descriptors of the NIT

---

a] The use of the service_list_descriptor is mandated in OFCOM DTT [55]. It shall be present and complete for each Transport Stream loop.

b] The use of linkage descriptors is defines in Section 8.5.3.5.1.

c] The terrestrial delivery system descriptor shall be included in the NIT. The centre frequency shall correspond to the frequency of the transmission from the SIP Main transmitter.

d] Multilingual network name may be used where languages other than English are required. Languages supported shall be Welsh, Gaelic and Irish. This is an optional descriptor.

e] The use of private data is defined in Section 8.5.4.

f] The frequency_list_descriptor may be included where the SIP includes Slave transmitters. Its use is defined in Section 8.5.3.1.

g] See Section 8.5.3.13.

h] See Section 8.5.3.16.

i] See Section 8.5.3.14.

j] See Section 8.5.3.15.

k] See Section 8.5.3.21.

l] See Section 8.5.3.6.

m] See Section 8.5.3.9.

n] See Section 8.5.3.6.1

o] The use of the FTA_content_management_descriptor is defined in Section 8.5.3.19.

8.5.2.2 SDT

The SDT_{actual} shall describe all services within the multiplex. It will change when any of the services within the multiplex changes (e.g. composition or running status).

The free_CA_mode flag in the SDT shall be signalled as '1' if the service may contain events with encrypted components.
The use of descriptors within the SDT shall be according to the following table:

SDT Descriptors	Tag	Tag Extension Value	Actual	Other
service_descriptor	0x48		m	m
NVOD_reference_descriptor	0x4B		x[a]	x[a]
time_shifted_service_descriptor	0x4C		x[b]	x[b]
CA_identifier_descriptor	0x53		b[c]	b[c]
multilingual_service_name_descriptor	0x5D		b[d]	b[d]
private_data_specifier_descriptor	0x5F		b[e]	b[e]
data_broadcast_descriptor	0x64		b[f]	b[f]
default_authority_descriptor	0x73		b[g]	b[g]
FTA_content_management_descriptor	0x7E		b[h]	b[h]
target_region_descriptor	0x7F	0x09	b[i]	b[i]
service_relocated_descriptor	0x7F	0x0B	b[m]	b[m]
preferred_name_list_descriptor	[0x84]		b[j]	b[j]
short_service_name_descriptor	[0x87]		b[k]	b[k]
guidance_descriptor	[0x89]		b[l]	b[l]

Table 8-4. Descriptors of the SDT

---

a,b] NVoD reference descriptor and time shifted service descriptor are not supported. Broadcasters wishing to operate an NVoD service in the DTT environment should use SI for stand-alone services.

c] The CA identifier descriptor shall be included if CA is applied to any component of the service. The CA identifier shall be registered with DVB and listed in TR 101 162 [10].

d] The multilingual service name descriptor may be used where languages other than English are required. Languages supported shall be Welsh, Gaelic and Irish. This is an optional descriptor.

e] The use of private data is defined in Section 8.5.4.

f] The use of SI for data broadcast services is defined in Section 8.5.7.

g] The use of the default_authority_descriptor is defined in Section 8.5.3.13.

h] The use of the FTA_content_management_descriptor is defined in Section 8.5.3.19.

i] The use of the target_region_descriptor is defined in Section 8.5.3.21.

j] The use of the preferred_name_list_descriptor is defined in Section 8.5.3.7.

k] The use of the short_service_name_descriptor is defined in Section 8.5.3.10.

l] The use of the guidance_descriptor is defined in Section 8.5.3.20.

m] The use of the service_relocated_descriptor is defined in Section 8.5.3.22.

Note The use of the parental_rating descriptor has not been defined.

8.5.2.3 EIT

The EIT present/following shall be present for each service where there is a reference to that service in an NIT (actual or other) in the multiplex for which the EIT_present_following_flag is set. EIT schedule may be present for each service where there is a reference to that service in an SDT (actual or other) in the multiplex for which the EIT_schedule_flag is set. The EIT_{pf} table versions normally change on event boundaries or changes to running status flags. EIT_{sch} table versions normally change when broadcasters make changes to the schedule and at midnight UTC. All EIT events contained in EIT_{pf} and EIT_{sch} tables shall relate to transmitted content.

The free_CA_mode flag in the EIT shall be set to '1' if the event contains any encrypted components, and '0' when none of the components of the event are encrypted.

Note The use of the parental_rating descriptor has not been defined.

The use of descriptors within the EIT shall be according to the following table:

EIT Descriptors	Tag	Tag Extension Value	Actual	Other
linkage_descriptor (linkage_type 0x0d only)	0x4A		b[a]	b[a]
short_event_descriptor	0x4D		m[b]	m[b]
time_shifted_event_descriptor	0x4F		x[c]	x[c]
component_descriptor	0x50		m[d]	m[d]
CA_identifier_descriptor	0x53		b[e]	b[e]
content_descriptor	0x54		b[f]	b[f]
multilingual_component_descriptor	0x5E		b[g]	b[g]
private_data_specifier_descriptor	0x5F		m[h]	m[h]
data_broadcast_descriptor	0x64		b[i]	b[i]
content_identifier_descriptor	0x76		b[j]	b[j]
FTA_content_management_descriptor	0x7E		b[k]	b[k]
preferred_name_identifier_descriptor	[0x85]		b[l]	b[l]
guidance_descriptor	[0x89]		b[m]	b[m]

Table 8-5. Descriptors of the EIT

a] The use of the linkage_descriptor is defined in EN 300 468 [2] (section 6.2.19) and in Section 8.5.3.5.2.

b] Short event descriptor shall be included. It shall name and describe the event in a form suitable for display to the viewer. The text length, and the use of escape codes, shall be as detailed in Table 8-26. All times shown are the billed times which are suitable for display to the viewer; they may not be the actual time the event starts. Multilingual descriptions are carried within the short event descriptor, hence there is no multilingual variant.

c] Time shifted event descriptor is not supported. Broadcasters wishing to operate a NVoD service in the DTT environment should use SI for stand-alone services.

d] Component descriptor shall be included in EIT present/following and in EIT schedule tables for all elementary stream components of the event. The text length for the component description, and the use of escape codes, shall be as detailed in Table 8-26.

e] CA identifier descriptor shall be included if CA is applied to any component of the event. The CA identifier shall be registered with DVB and listed in TR 101 162 [10].

f] Content descriptor may be included. The coding shall be as defined in Section 8.5.3.2.

g] The multilingual_component_descriptor may be used where languages other than English are present. Languages supported shall be Welsh Gaelic and Irish.

h] The use of private data is defined in Section 8.5.4.

i] The use of SI for data broadcast services is defined in Section 8.5.7.

j] The use of the content_identifier_descriptor is defined in Section 8.5.3.12.

k] The use of the FTA_content_management_descriptor is defined in Section 8.5.3.19.

l] The use of the preferred_name_identifier_descriptor is defined in Section 8.5.3.8.

m] The use of the guidance_descriptor is defined in Section 8.5.3.20.

8.5.2.4 TDT and TOT

Each multiplex shall carry the TDT and TOT, from which the receiver may determine the current time (in local time). The TOT changes when the offset of local time from UTC changes (normally twice per year).

The value of time described by the TOT or TDT when it is emitted shall be within ±2 seconds of UTC.

TOT Descriptors	Tag	Actual	Other
local_time_offset_descriptor	0x58	m[a]	N/A

Table 8-6. Descriptors of the TOT

a] A valid local time offset descriptor for the UK (country code "GBR") shall be included. It shall be updated to reflect the next time offset and the time of next change as soon as practical after a change in the current time offset.

If both TOT and TDT are being transmitted they shall be within ±1 second of each other.

All times shall be displayed to the consumer in local time.

The local time offset will not necessarily be updated at the very moment of a change in daylight saving time, but broadcasters will endeavor to update the descriptor as soon as possible after the time change. The descriptor contains a field called time_of_change which contains the time and date in UTC of the next daylight saving time change. The timezone offset from UTC after this time is specified in the next_time_offset field of the descriptor. Therefore if the current time is later than the time and date specified in the time_of_change field then the time change has occurred but the broadcaster has not yet updated the descriptor. So by comparing the current time with that of the next_time_offset field a receiver can show the correct local time even if the local time offset descriptor has not yet been updated.

Receivers should be aware that when displaying an EPG across the boundary of a time change, the grid labelled in local time will have a missing hour slot where the clock moves forwards, where time will go straight from 12:59:59 to 2:00:00am. When clocks move back an EPG grid labelled in local time will have a repeated hour slot at the time of the change.

Example of using TOT in an EPG display

Receivers shall use the local time offset descriptor when presenting times of EPG events. Such times should be presented using the local time offset that will be applicable at the time of the event. Consider a current TOT containing a local time offset descriptor where the local_time_offset field is 0, the local_time_offset_polarity is 0, the time_of_change field is 25th March at 1am and the next_time_offset field is 1. Then the current time-zone is UTC and will change to UTC+1 on the 25th March. If the current date is the 23rd March, an EPG event today with a UTC start time of 9pm should be presented as having a start time of 9pm. If the viewer uses the EPG to browse events one week in the future, an EPG event on the 30th with a UTC start-time of 5pm should be presented as starting at 6pm.

8.5.2.5 RCT

The RCT provides related content information which is relevant to the content currently broadcast on a service. The syntax of the Related Content Table is described in section 10.4 of ETSI TS 102 323[98].

A RCT sub-table may be split over multiple sections.

The use of descriptors within the RCT shall be according to the following table:

RCT Descriptors	Tag	Tag Extension Value	Required
image_icon_descriptor	0x7F	0x00	b[a]
short_event_descriptor	0x4D	--	b[b]

Table 8-6a. Descriptors in the RCT

a] The image_icon_descriptor is described in EN 300 468 [2] and Section 8.5.3.17.

b] The short_event_descriptor is described in EN 300 468 [2] and Section 8.5.3.18.

8.5.3 Use of specific descriptors

8.5.3.1 Frequency list descriptor

The NIT may carry a frequency_list descriptor where there is one or more slave transmitter sites for the SIP. If present it shall be ordered according to the rules set out in TS 101 211 [13], thus defining a constant ordering of transmitters (including spaces if required).

This descriptor only relates to DVB-T multiplexes.

If there are one or more slave transmitter sites the other_frequency_flag in the terrestrial_system_delivery_desciptor shall be set to '1', indicating that other frequencies are in use.

8.5.3.2 Content (genre) coding

This coding identifies the genre of the programme (event). It is carried within the content descriptor of the EIT.

Each event shall include one content description from the UK DTT list in Table 8-7. Where multiple content descriptions are present then the first content description shall be used.

Codes are assigned in line with Table 18 in EN 300 468 [2] (content definition table), and mapped from the DVB SI table.

Content nibble level 1 only is significant. Content level 2 defines sub-genres the use of which is not defined by this document.

Drama is distinguished from Movies by being assigned a Content_nibble_level_1 of 0xF.

Content_nibble_level_1	DVB Description (for information only)	DTT Description
0x0	Unclassified	Unclassified
0x1	Movie/Drama	Movie
0x2	News/Current affairs	News and Factual
0x3	Show/ Game show	Entertainment
0x4	Sports	Sport
0x5	Children's/ Youth programmes	Children's
0x6	Music/Ballet/Dance	Entertainment
0x7	Arts/Culture (without music)	News and Factual
0x8	Social/Political Issues/ Economics	News and Factual
0x9	Education/Science/Factual Topics	Education
0xA	Leisure hobbies	Lifestyle
0xB	Special Characteristics	not supported
0xC to 0xE	Reserved for future use	not supported
[0xF]	user defined	Drama

Table 8-7. Programme Genre Coding

If there is no content coding in conformance with Table 8-7 present for an event, the default content description "unclassified" applies.

Note that content descriptors from other delivery media may use a different coding method for the content.

8.5.3.3 Parental rating coding

Parental rating coding is not defined by this document. It is considered to be a CA function.

8.5.3.4 Service descriptors

The permitted broadcast service types are listed in Table 8-8. Further service types may be used in the future.

service_type	Description
0x01	digital television service
0x02	digital radio sound service
0x0A	Advanced codec digital radio sound service
0x0C	data broadcast service
0x16	Advanced codec SD digital television service
0x19	Advanced codec HD digital television service

Table 8-8. Allowed Service Types

Service type semantics

All of the service types listed in Table 8-8 can include MHEG-5 interactive applications (or other data broadcasting) alongside video and/or audio. However, in a "data broadcast service" the principal aspect of the service is that of the data component. It is unlikely that receivers without facilities to decode the data component will be able to usefully deliver the service.

Advanced codec services shall be signalled with service types 0x0A, 0x16 or 0x19. Broadcasters may signal additional codec information in the component descriptor.

Services shall not dynamically change the codec type (e.g. MPEG-2 to MPEG-4 video).

8.5.3.5 Linkage descriptors

The CA Replacement and Parent service Linkage Descriptors are no longer defined for use within UK DTT.

The following linkage descriptor types are profiled for use within the UK DTT.

8.5.3.5.1 DVB-SSU Linkage Descriptor

A linkage descriptor shall be carried in the first loop of the NIT. The linkage descriptor carries a linkage type of 0x09 (*system software update* service) conveying the location of the transport stream carrying a system software update service within a network.

The DVB-SSU data carousel is carried as a component of a service. However, there may be multiple services carrying data carousels; in this case each will be specified by a separate SSU Linkage Descriptor. More than one data carousel may be carried on a given service, subject to the constraints of bandwidth availability and agreement of the transmission organisation.

The SSU Linkage Descriptor shall be carried in the NIT of all multiplexes.

The SSU scan_linkage_descriptor (type=0x0A) will not be transmitted in UK DTT services.

Syntax	No. bits	Identifier
`SSU Linkage Descriptor() {`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`transport_stream_id`	16	uimsbf
`original_network_id`	16	uimsbf
`service_id`	16	uimsbf
`linkage_type`	8	uimsbf
`for (i=0;i<N;i++){`		
`OUI_data_length`	8	uimsbf
`for (j=0; j<N; j++){`		
`OUI`	24	bslbf
`selector_length`	8	uimsbf
`}`		
`}`		
`}`		

Table 8-8c. Linkage Descriptor for System_Software_Update (based on EN 300 468 [2] Sec. 6.2.19 and TS 102 006 Sec 6.1, included for information only)

transport_stream_id, original_network_id, service_id:

these indicate the location of the System Software Update service.

linkage_type: shall be set to 0x09 to indicate linkage to a System Software Update service.

OUI: This shall be set to the DVB OUI value of 0x00015a to indicate that the stream is for all OUIs.

selector_length: set to zero as there is no further data included in this linkage descriptor. Target receivers are identified in the Compatibility Descriptor in the DSI of the data carousel.

No private data is carried in this descriptor.

8.5.3.5.2 SD/HD Event linkage

Linkage descriptors with linkage type 0x0d may appear in the EIT for an SD event where there is a corresponding HD event.

The target_event_id field shall contain the event_id of the HD event, which may not be resolvable at the time of broadcast of this link.

The target_listed field shall always be set to 1.

The event_simulcast field shall only be set to 1 when the SD and HD events are signalled with the same start_time in the EIT.

There may be multiple instances of this linkage type for an event.

As a consequence of the differing regionalisation of services an EIT event may contain multiple instances of a linkage descriptor of this linkage type. Receivers shall ignore any event linkage descriptors that reference services which are not receivable or are unknown, and respond appropriately to those events linkage descriptors that are applicable.

8.5.3.5.3 Extended event linkage

Linkage descriptors with linkage type 0x0e may appear in the EIT, to link events. There may be multiple instances of this linkage type for an event, and each descriptor may link to multiple events on one or more services. As a consequence of the differing regionalisation of services an EIT event may contain link to multiple services, not all of which may be receivable in all locations. Receivers shall ignore any links in extended event linkage descriptors that reference services which are not receivable or are unknown, and respond appropriately to the valid links in extended events linkage descriptors that are applicable.

8.5.3.6 Logical channel descriptor

The logical channel descriptor provides a default channel number label for services. This information is quasi-static. The logical channel descriptor may be inserted in the second descriptor loop of the NIT. Only one instance of this descriptor is allowed in each loop.

Syntax	No. of bits	Mnemonic
logical_channel_descriptor{		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0; i<N; i++){		
service_id	16	uimsbf
reserved	6	bslbf
logical_channel_number	10	uimsbf
}		
}		

Table 8-9. Logical Channel Descriptor

descriptor_tag This shall be assigned to be [0x83].

service_id This is a 16-bit field which serves as a label to identify this service from any other service within the Transport Stream. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

reserved All "reserved" bits shall be set to '1'.

logical_channel_number This is a 10-bit field which indicates the broadcaster preference for ordering services. Its use is defined in Table 8-10:

logical_channel_number	Description
0	Shall not be used
1 - 799	Broadcaster assigned logical_channel_number
800 – 999	Shall not be used
1000 - 1023	Reserved for future use

Table 8-10. Logical Channel Number

Rules for the logical channel descriptor

1. All services shall be allocated a logical channel number
2. Each logical channel number shall be used at most once within each transport stream.
3. The set of logical channel numbers may start at any value, and need not be contiguous.
4. Regional variants of a service (from different SIPs) shall be allocated the same logical channel number.

Note: The assignment of logical channel number values through time will vary as they reflect the commercial use of the broadcasts. Therefore receivers cannot rely on these values being constant.

Receiver Channel Number assignment

The receiver channel assignment is defined in Table 8-11.

Receiver Channel Number	Range Name	Description
0	Unassigned	Shall not be used.
1 – 799	Broadcast	Broadcaster defined
800 - 899	Variant	Undefined or regional variant services.
900 - 999	Manufacturer	Receiver defined logical
1000+	Unassigned	Shall not be used.

Table 8-11. Receiver Logical Channel Mapping

Broadcast range The broadcast range shall be used exclusively for broadcast services that have been assigned a valid logical channel number within the logical_channel_descriptor. Broadcast services with a valid logical_channel_number shall be placed at the corresponding Receiver Channel Number in the broadcast range such that if, during service selection, the user keys the logical channel number into the receiver then the service is selected.

Variant range A variant region contains services whose logical channel number is unassigned, duplicated or illegal. The allocation and ordering of channel numbers within this range is managed by the receiver and is not defined by this specification. A broadcast service assigned a logical channel number within this range shall be treated by the receiver as having an illegal logical channel number and placed accordingly within the variant range.

Manufacturer range The manufacturer range is reserved for use by the manufacturer to provide access to additional services e.g. analogue services, games, Internet access etc. A broadcast service assigned a logical channel number within this range shall be treated by the receiver as having an illegal logical channel number and placed accordingly within the variant range.

8.5.3.7 Preferred name list descriptor

The preferred name list descriptor provides a list of alternative names, and name identifiers, for the service. This information is quasi-static. The preferred name list descriptor may be inserted once in the SDT for each value of service_id.

Syntax	No. of bits	Mnemonic
preferred_name_list_descriptor{		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0; i<N; i++){		
ISO_639_language_code	24	bslbf
name_count	8	uimsbf
for (j=0; j<N; j++){		
name_id	8	
name_length	8	uimsbf
for (k=0; k<N; k++){		
char	8	uimsbf
}		
}		
}		
}		

Table 8-12. Preferred Name List Descriptor

descriptor_tag This shall be assigned to be [0x84].

ISO_639_language_code This 24 bit field defines the language of the of the service name.

name_count This 8 bit field specifies the number of alternative preferred names that are defined for this service.

If preferred names are provided in more than one language then the same number of names shall be provided and the set of name identifiers shall be the same in all languages.

No more than 5 preferred names per language code shall be defined for each service.

name_id This 8 bit integer provides an identifier for the preferred name.

The service name provided by the service_descriptor and the multilingual_service_name_descriptor are assigned the identifier 0 (zero). So, name_id is always greater than 0.

name_length This 8 bit integer specifies the number of bytes in the service name.

The name length limits for service names apply also to preferred names. See Table 8-26.

char This is an 8 bit integer. A string of these char specify a preferred name for the service. The text is coded as in the service_descriptor char field.

8.5.3.8 Preferred name identifier descriptor

The preferred name identifier descriptor may be used in the EIT. It identifies the preferred service name at the time of an event and so allows a schedule of service names.

If name_id is set to 0 (zero) then the service name is that defined by the service_descriptor and the multilingual_service_name_descriptor.

In the absence of the descriptor the default service name is that defined by the service_descriptor and the multilingual_service_name_descriptor.

Syntax	No. of bits	Mnemonic
`preferred_name_identifier_descriptor{`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`name_id`	8	uimsbf
`}`		

Table 8-13. Preferred Name Identifier Descriptor

descriptor_tag This shall be assigned to be [0x85].

name_id This 8 bit integer identifies a preferred service name within the list of service names defined by the preferred name list descriptor.

8.5.3.9 Service attribute descriptor

The service attribute descriptor defines the visible and selectable attributes of a service within the context of all the normal service navigation mechanisms provided by the receiver for the user. This information is quasi-static. The service attribute descriptor may be inserted in the second descriptor loop of the NIT. Only one instance of this descriptor is allowed in each loop. A service may only appear once in any instance of the descriptor. Any service that does not have an entry in the service attribute descriptor associated with its transport stream shall have the default attributes of being both visible and selectable. If no service attribute descriptor is present for a given transport stream then all services within that transport stream shall have the default attributes of being both visible and selectable.

The combination of transport_stream_id and each service_id carried within the service attribute descriptor for that transport_stream_id must be valid. Information provided in a service attribute descriptor about services that are not part of the transport stream with which the descriptor is associated shall be ignored.

Syntax	No. of bits	Mnemonic
service_attribute_descriptor{		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0; i<N; i++){		
service_id	16	uimsbf
reserved	6	bslbf
numeric_selection_flag	1	bslbf
visible_service_flag	1	bslbf
}		
}		

Table 8-14. Service attribute descriptor

descriptor_tag This shall be assigned to be [0x86].

service_id This is a 16-bit field which serves as a label to identify this service from any other service within the Transport Stream. The service_id is the same as the program_number in the corresponding program_map_section. Services need only be included if their visible and selectable attributes are to be anything other than the default.

reserved Reserved for future use, nominally set to '1', receivers shall ignore the value of this field.

numeric_selection_flag This 1-bit field further qualifies the visible_service_flag and has no meaning if the visible_service_flag is '1'. When the visible_service_flag is set to '0' this 1-bit field is used to control whether or not direct entry of the logical channel number can be used to select the service. When set to '1' this indicates that the service may be selected by direct entry of the logical channel number; this is the default state. When set to '0' this indicates that the service shall not be selectable by direct entry of the logical channel number.

visible_service_flag This 1-bit field when set to '1' indicates that the service is visible and selectable (subject to the service type being suitable etc.) via the normal service navigation mechanisms provided by the receiver for the user. When set to '0' this indicates that the receiver shall not present the service to the user in any of the normal service navigation modes. In this state access to the service by direct entry of the logical channel number is dependent on the setting of the numeric_selection_flag.

The valid combinations of these two flags is shown in Table 8-15.

visible_service _flag	numeric_selection_flag	Behaviour
1	don't care	Visible and selectable
0	1	Hidden but selectable through direct numeric entry
0	0	Hidden and non-selectable

Table 8-15. Hidden Service Behaviour

8.5.3.10 Short service name descriptor

The short service name descriptor provides an alternate short service name in text form. The information is quasi-static. The short_service_name descriptor may be inserted into the SDT. The short service name may be used where screen rendering of the full service name results in truncation of the text. This descriptor can be used to provide an alternative short name that could not be obtained by using the control codes defined in TS 101 211 [13]. For instance, the short service name (provided by this descriptor) of "BBC 1W" cannot be obtained from the service name "BBC ONE Wales" by using the control codes of TS 101 211 [13] alone. If both methods are signalled for the same service name, then the receiver can decide which string is the most appropriate for display.

Syntax	No. of bits	Mnemonic
`short_service_name_descriptor(){`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`for (i=0;i<N;i++){`		
`char`	8	uimsbf
`}`		
`}`		

Table 8-16. Short Service Name Descriptor

descriptor_tag This shall be assigned to be [0x87].

char This is an 8-bit field. A string of char fields specify the short name of the service. Text is coded using the character sets described in Annex A of EN 300 468 [2]. The control codes of Annex A are not valid in this field.

8.5.3.11 Component descriptors

Besides giving details on the basic video and audio streams, component descriptors can provide data for guide applications derived from EIT tables. These can show whether a current or future event has any additional components which may be of interest to the consumer, such as subtitles or audio description.

Any component signalled in a component descriptor must appear in the relevant PMT. The absence of a component descriptor in EIT for a particular component must not prevent user access to that component if present in the PMT.

Data components should not be signalled via this mechanism. The data broadcast descriptor provides a mechanism for indicating interactively enhanced services or events.

Receivers shall continue to function normally in the presence of any valid component descriptor as specified in EN 300468 section 6.2.8.

8.5.3.12 Content identifier descriptor

The content identifier descriptor (CID), defined in ETSI TS 102 323 [98], is used to associate a CRID with an event and is placed within the event loop of EIT. This is shown in Table 8-17 for information.

Where used, for a given combination of service_id and event_id the same CRID(s) shall be signalled across EIT schedule and p/f both actual and other.

Multiple instances of the descriptor may be present. A single descriptor may contain multiple CRIDs.

Syntax	No. of Bits	Identifier
`content_identifier_descriptor() {`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`for (i=0;i<N;i++) {`		
`crid_type`	6	uimsbf
`crid_location`	2	uimsbf
`If (crid_location == '00' ) {`		
`crid_length`	8	uimsbf
`for (j=0;j<crid_length;j++) {`		
`crid_byte`	8	uimsbf
`}`		
`}`		
`if (crid_location == '01' ) {`		
`crid_ref`	16	uimsbf
`}`		
`}`		
`}`		

Table 8-17. Content identifier descriptor

The current profile only supports the use of crid_location == '00'.

In order to safeguard against potential legacy issues that may arise if a full TV-Anytime service is deployed on UK DTT the following *user private* CRID types have been defined:

crid_type :

0x31	DTG programme CRID (equivalent to type 0x01)
0x32	DTG series CRID (a restriction of type 0x02 to be used only for series)
0x33	DTG recommendation CRID (equivalent to type 0x03)

Only these crid_types shall be supported. A receiver designed to the current specification should ignore all other CRID types.

Only a single DTG programme CRID (crid_type 0x31) shall be associated with an EIT event. Multiple DTG series CRIDs and DTG recommendation CRIDs may be associated with an EIT event (see 8.11.1 for usage)

8.5.3.13 Default authority descriptor

The default authority descriptor, defined in ETSI TS 102 323 [98], may be used to shorten the CRIDs carried within EIT by defining an appropriate CRID authority over a defined scope. This is shown in Table 8-18 for information.

Syntax	No. of Bits	Identifier
`default_authority_descriptor(){`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`for (i=0;i < descriptor_length; i++){`		
`default_authority_byte`	8	uimsbf
`}`		
`}`		

Table 8-18. Default authority descriptor

The permitted locations of the default authority descriptor within UK DTT are:

Default Authority Descriptor location	Scope of Definition	Scopes this definition overrides
First descriptor loop of NIT	Network	None
Transport stream descriptor loop of NIT	Transport stream	Network
Service descriptor loop of SDT	Service	Transport stream or network

Table 8-19. Permitted locations of the default authority descriptor

8.5.3.14 Network change notify descriptor

This descriptor allows broadcasters to notify receivers of scheduled network changes.

A network change event is a single, clearly identifiable change in the network configuration, e.g. transmission parameters and/or available services, which may require action on the part of receivers.

Network changes may be confined to a part of the network, as indicated by the use of the cell_id field (used in DVB-T and DVB-T2 systems) or may apply to the whole network, as defined by the NIT.

The network_change_notify descriptor signals at all times the current list of scheduled network change events. The absence of a network_change_notify descriptor means there are no scheduled network change events.

Zero, one or multiple network_change_notify descriptors may be present in the NIT. If a network change has been scheduled and the NIT is no longer decodable (e.g. the multiplex has changed frequency), then the invariant_tsid may be used to check SI related to date and time. Network_change_notify descriptors shall be evaluated whenever the NIT version number is updated.

Receivers shall be able to store and process multiple network changes within the same network_change_notify descriptor to allow multiple stage engineering works to be signalled in one descriptor.

Receivers shall only react to network changes signalled to occur in transmitter cells which match the cell_id in the broadcast signal relating to any service stored by the receiver.

The syntax of the descriptor is detailed in ETSI EN 300 468 [2].

Use of Network change related descriptors is discussed in section 8.9.10.

8.5.3.15 Message descriptor

This descriptor, defined in ETSI EN 300 468 [2], allows broadcasters to signal receivers a message associated with a network change (as signalled by the network_change_notify descriptor in Section 8.5.3.14) which the receiver may display to the user at appropriate times. In UK signals, the message descriptor shall always be present where the network_change_notify descriptor is used.
It resides within the first loop of the NIT.

Use of Network change related descriptors is discussed in section 8.9.10.

8.5.3.16 T2 delivery system descriptor

The T2_delivery_system descriptor is defined in ETSI EN 300 468 [2] and uses an extended tag value. All T2 multiplexes shall be described by a T2_delivery_system descriptor.

It is intended that this shall only be used with a descriptor_length of 4. However, if a longer descriptor is used, a receiver shall continue to operate.

8.5.3.17 Image Icon Descriptor

The image icon descriptor, defined in ETSI EN 300 468 [2], may be used to convey or reference an image. SD services shall use PNG type only at SD resolution. HD services shall carry PNG or JPEG types at HD resolution.

If type PNG is transmitted it shall conform to the restrictions in Section 14.7, if type JPEG is transmitted it shall conform to the restrictions in Section 14.12.

8.5.3.18 Short Event Descriptor within RCT

A short_event_descriptor shall be included in the link_info descriptor loop of each link in the RCT. The event_name is mandatory and the event description length shall be zero. The event_name shall be displayed with any promotional text at time of booking, it may also be used in the list of booked recordings.

Once a CRID carried in the RCT is resolved to an event in the EIT then the booking list shall use the short_event_descriptor in EIT in preference to the descriptor carried in the RCT.

8.5.3.19 FTA Content Management Descriptor

The Free-To-Air Content Management Descriptor, defined in DVB BlueBook A038(01/2011)[151], shall be broadcast to convey the content management policy for the delivered HD content. The expected behaviour is defined in Section 8.13.

8.5.3.20 Guidance Descriptor

The guidance descriptor is used to label events with guidance for the viewer. The descriptor contains a text field which contains the guidance text for the event e.g. “Contains strong language and scenes which some may find upsetting”. It is also used to enable access controls for programmes broadcast before the watershed. The watershed is defined by OFCOM in *The Ofcom Broadcasting Code 2008: Protecting the Under-Eighteens*. The watershed only applies to television. The watershed is at 2100 (local time). Material unsuitable for children should not, in general, be shown before 2100 or after 0530 (local time). Subscription services may have a different watershed.
Since this is a private descriptor in the user-defined range of descriptor tags, it shall be prefixed by a private data specifier descriptor.

Syntax	No. of bits	Identifier
`guidance_descriptor {`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`reserved`	6	bslbf
`guidance_type`	2	uimsbf
`if (guidance_type == 0x0) {`		
`ISO_639_language_code`	24	bslbf
`for(i=0; I<N; i++) {`		
`char`	8	uimsbf
`}`		
`}`		
`if (guidance_type==0x1) {`		
`reserved`	7	uimsbf
`guidance_mode`	1	uimsbf
`ISO_639_language_code`	24	bslbf
`for(i=0; I<N; i++) {`		
`char`	8	uimsbf
`}`		
`}`		
`if (guidance_type >= 0x2) {`		
`for(i=0; I<N; i++) {`		
`reserved_for_future_use`	8	uimsbf
`}`		
`}`		
`}`		

Table 8-20e. guidance descriptor

descriptor_tag	This shall be assigned to be [0x89].
descriptor_length	The descriptor length is an 8-bit field specifying the total number of bytes of the data portion of the descriptor following the byte defining the value of this field.
reserved	"Reserved" bits shall be set to '0'.
guidance_type	This 2-bit field specifies the guidance type defined in the descriptor. Only guidance types zero and one are currently defined, the other values are reserved for future use. The descriptor has been defined so that it can be extended in a backward compatible way at a later date.
ISO_639_language_code	This 24-bit field contains the ISO 639 Part 2 three-character language code of the language of the following guidance text field. Both ISO 639.2/B and ISO 639.2/T may be used. Each character is coded into 8-bits according to ISO 8859-1 and inserted in order into the 24-bit field. For example Gaelic has the 3-character code "gla".
char	This is an 8-bit field. A string of char fields specify the guidance information. Text information is coded using the character sets and methods described in Annex A of EN 300 468[2].
guidance_mode	This 1-bit field is used within the guidance_type '1' loop. It shall be set to '1' if guidance for content unsuitable for broadcast until after the watershed is appropriate.
reserved_for_future_use	These bytes are reserved for future use and may contain any possible value.

The descriptor can be conveyed in the descriptor loop of EIT or SDT sections. This includes EITschedule and EITpf.

The presence of the descriptor in the SDT descriptor loop indicates the default guidance information for all events in that service. Use of the descriptor in the SDT is optional.

Guidance information can be defined on an event by event basis by including this descriptor in the descriptor loop of the EIT section for the event. This overrides the guidance information in the SDT, if present. If no guidance descriptor is present in the EIT for an event, or in the SDT for the service carrying that event, then the event has no guidance information.

It is not possible to withdraw guidance at the event level if it has been enabled by the presence of the descriptor in the SDT, but the guidance text can be modified.

The guidance text carried in the char field shall be displayed as information for the viewer.

The maximum length of the guidance text shall be 75 characters. An editorially appropriate text string longer than zero characters shall always be present if the descriptor is in use.

If access control is enabled for DVRs, guidance shall be applied if, at the time of recording, the present event in EITpf contains a *guidance descriptor*, or if a *guidance descriptor* exists in the SDT for that service.

Broadcasters shall use guidance_type=0 to signal content which they deem unsuitable for broadcast until after the watershed.

guidance_type=1 can be applied at any time to signal content with guidance, such as strobe lighting. It may additionally signal content unsuitable for broadcast until after the watershed.

Multiple instances of the descriptor may be present for each event in EIT or service in the SDT with the restriction, that there shall be no more than one guidance descriptor per language code in each subtable.

8.5.3.21 Target Region signalling

Target region signalling allows receivers to offer the viewer the option of choosing a preferred region.

A target region is a geographical area containing the intended audience of a broadcast. A target region can be either an entire country, or a geographical area within a country. A country may be subdivided into a set of primary regions and each primary region may be subdivided into a set of secondary regions and, finally, each secondary region may be subdivided into a set of tertiary regions. In general, target regions subdivide a country into a hierarchy of primary, secondary and tertiary regions.

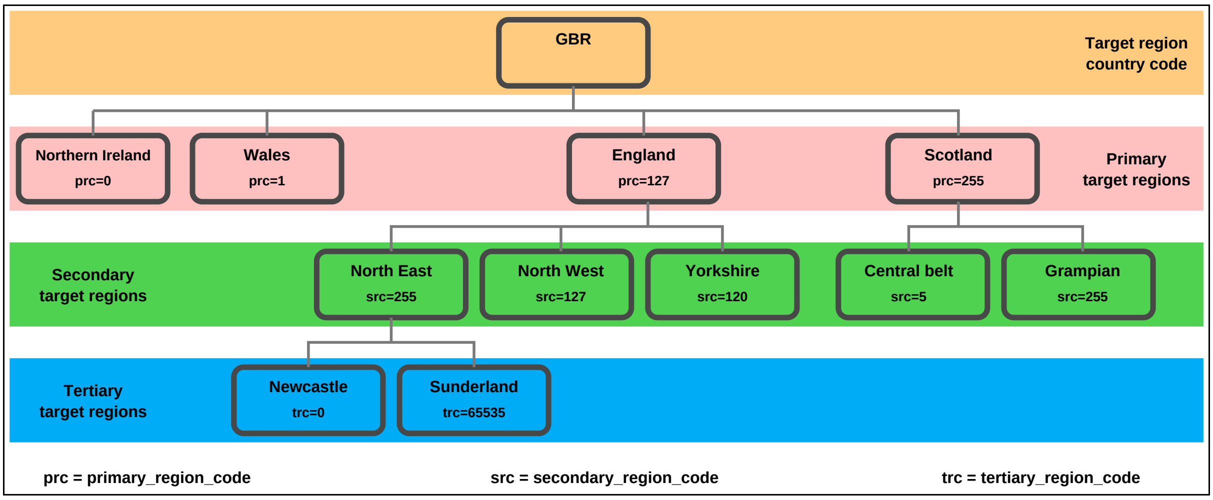


Figure 8-2a An example target region hierarchy.

Note services may be targeted at multiple target regions.

8.5.3.21.1 Target region name descriptor

The Target Region Name Descriptor is defined in EN 300 468 [2].

The UK has a regional structure. The network may be presented using the full hierarchy as defined by the descriptor. The hierarchical structure created will have variable depth. Broadcasters shall ensure an appropriate name is transmitted at each populated level for the current SIP and at all levels above them in the hierarchy. Receivers shall not assume that concatenation of individual strings from level to level will provide a sensible meaning.

The target_region_name_descriptor assigns a name to a target region. The target region name may be represented in multiple languages. For a particular target region within a country, only one name per language code shall be signalled.

This descriptor shall only be present in the first loop of the NIT. Multiple instances of this descriptor are allowed. Only a sub-set of the full name tree may be carried in each NIT, referencing only those regions targeted by services in the network defined by the NIT.

8.5.3.21.2 Target region descriptor

The target_region_descriptor identifies a set of target regions. The definition of a target region descriptor is given in EN 300 468 [2]. The set of target regions identified by the descriptor is the union of target region codes, identified by each loop in the descriptor, additionally qualified by the country_code. If the loop is empty, then this descriptor identifies a single country, by means of the country_code.

The location of a particular instance of the target_region_descriptor defines the scope of the descriptor. The target_region_descriptor is a scoping descriptor (see EN 300 468 [2]), therefore the services covered by this descriptor are determined by the descriptor's location.

The scoping property is the set of target regions it identifies. The set of target regions identified at a particular scope is the union of the sets of target regions identified by all target region descriptors present at that scope in the same table.

The target_region_descriptor may appear:

a) in the 1st loop of the NIT for all services within a network
b) in the 2nd loop of the NIT for all services within a transport stream of a network,
c) in the SDT for a single service within a transport stream.

Its use in other tables is not defined. This descriptor may appear multiple times in any descriptor loop of a table. The set of target regions defined in a descriptor loop of a table, is the union of the target regions defined by each target region descriptor. Services can be targeted at multiple target regions and therefore broadcasters shall ensure that all services are in the scope of at least one target region descriptor.

The hierarchical level of the target region identified by a single loop of the target_region_descriptor depends on the value of the region_depth field.

- If the region_depth is 0, then the target_region_descriptor loop identifies a single country.
- If the value of the region_depth is 1, then the target_region_descriptor loop identifies a single primary region within a country.
- If the value of the region_depth is 2, then the target_region_descriptor loop identifies a single secondary region, within a primary region within a country.
- If the value of the region_depth is 3, the target_region_descriptor loop identifies a single tertiary region, within a secondary region within a primary region within a country.

8.5.3.21.3 Region code allocation rules

LCN is still the primary way the service line-up is calculated. If receivers can receive a service with sufficient quality (meaning receivable SDT actual) and there are no other services assigned the same LCN, then it shall be stored in the receiver service list with that LCN even if it is not targeted at the receiver's target region.

The UK specific preference rules for the target region descriptor allow receivers to determine which of the services will be assigned the signalled LCN in the broadcast range (1-799), and which alternatives with the same LCN may be placed in the variant range (800-899).

Changes to the target region structure shall be signalled as a major change (change_type in the range 0x8 to 0xF) using the network change notify descriptor.

Where appropriate, receivers should request viewers to re-confirm their target region choice.

A receiver's chosen target region can be either:
- A country code (only)
- The combination of a country code and primary region code.
- The combination of a country code, primary region code and secondary region code.
- The combination of a country code, primary region code, secondary region code and tertiary region code.

TS 101 211 [13] provides guidance on possible methods for receivers to choose a target region

Note region codes are only unique within each hierarchy. Therefore a tertiary_region_code itself is meaningless without its parental hierarchy of country_code, primary_region_code and secondary_region_code. So with reference to Figure 8-2a it should be noted that the North East region in England, and the Grampian region in Scotland are distinct regions even though they share the same value of secondary_region_code.

Some viewers may have chosen a target region for their receiver at a higher level than some of the services they can receive. For example if the receiver's chosen region is GBR/Wales (where Wales is a primary region) the receiver might be able to see services defined at the secondary level e.g. GBR/England/Central and GBR/England/SouthWest or even services at a tertiary level.

The procedure for determining which service is assigned the signalled LCN is as follows:

- The preference rules should be tested against all services signalled with the same LCN value.
- If only a single service matches a rule that service should be assigned the signalled LCN by the receiver and no further test of precedence rules is required for the signalled LCN.
- If multiple services match a rule then the receiver can determine (by itself or preferably via user interaction) which of the matched services is assigned the signalled LCN and no further test of precedence rules is required for the signalled LCN.
- If no services match the rule, then the receiver should test the services against the next precedence rule.
- If none of the services match any of the precedence rules the receiver can determine (by itself or preferably via user interaction) which service is assigned the signalled LCN.

Therefore the rules are listed in order of decreasing precedence.

1. Service has a target region, targeting a tertiary region, whose tertiary_region_code, secondary_region_code, primary_region_code and country_code are the same as the chosen region of the receiver.
2. Service has a target region, targeting a secondary region, whose secondary_region_code, primary_region_code and country_code are the same as the chosen region of the receiver.
3. Service has a target region, targeting an entire primary region, whose primary_region_code and country_code are the same as the chosen region of the receiver.
4. Service has a target region, targeting an entire country, whose country_code is the same as the chosen region of the receiver
5. Service has a target region, targeting a tertiary region, whose secondary_region_code, primary_region_code and country_code are the same as the chosen region of the receiver (Note the tertiary_region_code of the service's target region is ignored)
6. Service has a target region, targeting a secondary or tertiary region, whose primary_region_code and country_code are the same as the chosen region of the receiver. (Note the secondary_region_code and tertiary_region_code of the service's target region is ignored)
7. Service has a target region, targeting a primary, secondary or tertiary region, whose country_code are the same as the

chosen region of the receiver. (Note the primary_region_code, secondary_region_code and tertiary_region_code of the service's target region are ignored)

Note: rule 1 can only be applied if the receiver's chosen region is at a tertiary level. Rules 2&5 can only be applied if the receiver's chosen region is at a secondary or tertiary level. Rules 3&6 can only be applied if the receiver's chosen region is at a primary, secondary, or tertiary level.

The rules assign services that broadcasters have targeted at the receiver's chosen region. This also allows efficient opt-outs for a small number of sub regions. For example, a service 'X' may be assigned an LCN and the service targeted at a country code, and a service 'Y' may be assigned the same LCN within a primary region within the same country code. This provides a far more efficient method of signalling an exception than targeting the service 'X' at multiple primary regions if there are no other services at the same LCN.

A more complex example explains the full power of the overriding feature. For example with reference to Figure 8-2a assigning a service A at the country code level, and overriding with a service B (assigned at the North East secondary region level) and by a service C (assigned at the Newcastle tertiary level). This means Service A is the target service everywhere in the UK except the North East region of England. Service B is the target service everywhere in the North East region except Newcastle. Service C is the target service only in the Newcastle target region.

A viewer may have selected the target region of their receiver at a higher level when none of the sub-regions are acceptable, for example in Figure 8-2a where the viewer has chosen the "North East" region, because they live in the North East of England but not in the Newcastle or Sunderland areas. In such cases services assigned to Newcastle and Sunderland target regions are treated like services in other branches of the target region hierarchy, since they will not match any of the precedence rules. So if service D and E are assigned the same LCN, but service D is targeted at Newcastle and service E targeted at Sunderland, the receiver can determine itself which service gets assigned the signalled LCN, and the remaining service is handled as a regional variant.

8.5.3.22 Service Relocated Descriptor

A service may be remapped by the broadcaster from one DVB triplet to another. This remapping may require a change to any of the service_id, transport_stream_id or original_network_id elements of the triplet.

A mechanism is provided which enables a receiver to track the service at its new DVB triplet by usage of the service_relocated_descriptor as defined in EN 300 468 [2]

This mechanism shall only be used when the old service has ceased broadcasting.

In the case of both services being broadcast simultaneously, the service move descriptor (defined in EN 300 468 [2]) mechanism shall be used instead.

It is recommended that the service relocated descriptor is transmitted for a minimum period of 30 days.

8.5.3.23 HD Simulcast Logical Channel descriptor

The *HD simulcast logical channel descriptor* modifies the channel mapping defined by the *logical channel descriptor* and the service attributes defined by the *service attribute descriptor* for HD capable receivers. Note all services including HD services shall be allocated a logical channel number in the *logical channel descriptor*. This information is quasi-static. The *HD simulcast logical channel descriptor* may be inserted in the second descriptor loop of the NIT. Only one instance of this descriptor is allowed in each loop; its order in relation to the *logical channel descriptor* is undefined.

Syntax	No. of bits	Mnemonic
`HD_simulcast_logical_channel_descriptor`		
`{`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`for (i=0; i<N; i++){`		
`service_id`	16	uimsbf
`visible_service_flag`	1	bslbf
`reserved`	5	bslbf
`logical_channel_number`	10	uimsbf
`}`		
`}`		

Table 8-11a HD Simulcast Logical Channel Descriptor

descriptor_tag This shall be assigned to be [0x88].

service_id This is a 16-bit field which serves as a label to identify the **replacement** service from any other service within the transport stream. The **replacement** service identified by the service_id shall be assigned the corresponding logical_channel_number on HD capable receivers. The service assigned to the same logical_channel_number (the **replaced** service) by the *logical channel descriptor*, shall be assigned the logical_channel_number assigned to this **replacement** service by the *logical channel descriptor*. Services shall be included irrespective of their running status

visible_service_flag This 1-bit field overrides the flags that may have been defined in the service_attribute descriptor for the specified service. If the value of this visible_service_flag is set to zero, then the service shall be treated as "hidden and selectable". If the value of this visible_service_flag is set to one the service shall be treated as "visible and selectable".

reserved All "reserved" bits shall be set to '1'.

logical_channel_number This is a 10-bit field which indicates the broadcaster preference for ordering services. Its use is defined in Table 8-10.

8.5.3.23.1 Rules for the HD simulcast logical channel descriptor

The logical channel descriptor [0x83] specifies all service LCN service assignments, while the HD simulcast logical channel descriptor [0x88] overrides LCN assignments for those services that change LCN and/or service visibility in an HD enabled receiver.

1. SD receivers shall not interpret the HD simulcast logical channel descriptor.
2. Each LCN appearing in the HD simulcast logical channel descriptor shall be used at most once within each transport stream.
3. Broadcasters shall ensure that the LCNs used in the HD simulcast logical channel descriptor have also been allocated by the logical channel descriptor.
4. LCNs in the HD simulcast logical channel descriptor may include the same LCN assignment in the logical channel descriptor. In such cases the HD simulcast logical channel descriptor may be used to change the service's visibility, from that defined by the service attribute descriptor.
5. The HD simulcast logical channel descriptor shall only be included in the NIT for HD services where one or more LCN assignment(s) or service attributes differ from those assigned in the logical channel descriptor and/or service attribute descriptor.
6. The logical channel descriptor and service attribute descriptors are processed before the HD simulcast logical channel descriptors. This processing may involve the use of target region descriptors and will have resolved all LCN conflicts, duplicate services and regional variant services.
7. Receivers shall only process HD simulcast logical channel descriptors for services which have been assigned an LCN in the broadcast range 1 – 799 after the processing of the logical channel number descriptor. This may involve the use of target region descriptors or other criteria to resolve cases where there are multiple HD simulcast logical channel descriptors targetting the same LCN.
8. Receivers shall assign the referenced service (the "replacement service") the LCN signalled in the HD simulcast logical channel descriptor. The "replaced service"previously assigned that LCN by the logical channel descriptor shall (where receivable) now be assigned the LCN previously assigned to the replacement service by the logical channel descriptor. The HD service shall move LCN regardless of the presence of an SD service.
9. Where an HD simulcast logical channel descriptor is in use the visibility flag shall be consistent with any service attribute descriptor (SAD) for that service. The visibility setting of the HD simulcast logical channel descriptor shall take precedence over the visibility and selection settings of the SAD. This is acceptable as the SAD state of allowing numeric selection is inappropriate for when a broadcaster is trying to move a service to a given LCN. Under these circumstances there are only two valid SAD states and these can be represented by a single bit in the HD simulcast logical channel descriptor.

8.5.4 Private descriptors and user-defined values

The private data specifier descriptor indicating the start of a scope that contains UK DTT private descriptors and/or user data shall use the private_data_specifier value 0x0000233A.

The private data specifier descriptor shall be in accordance with DVB requirements. Table 8-21 lists the private descriptors specified within this document:

Descriptor	Tag	Notes
logical_channel_descriptor	[0x83]	Associates a logical channel number with a service. Used in the NIT.
preferred_name_list_descriptor	[0x84]	Defines a list of alternative preferred names for the service. Used in the SDT.
preferred_name_identifier_descriptor	[0x85]	Identifies the current preferred name for the service. Used in the EIT.
service_attribute_descriptor	[0x86]	Defines the visibility and accessibility of the service. Used in the NIT.
short_service_name_descriptor	[0x87]	Defines an alternative shortened service name. Used in the SDT.
HD_simulcast_logical_channel_descriptor	[0x88]	Defines the logical channel swap for simulcast services. Used in the NIT.
guidance_descriptor	[0x89]	Defines a service with guidance information associated. Used in the SDT and in the EIT.

Table 8-21. Private Descriptors

Note: The definition of descriptors required to support data components and services and their tag values are recorded in the MHEG-5 specification.

Table 8-21b lists the user-defined values specified within this document:

Descriptor	Value	Notes
content_descriptor	[0xF]	Drama
linkage_descriptor	[0x80]	Reserved (Legacy value Parent Service Linkage V3.2)
content_identifier_descriptor	[0x31]	DTG programme CRID
content_identifier_descriptor	[0x32]	DTG series CRID
content_identifier_descriptor	[0x33]	DTG recommendation CRID
metadata_pointer_descriptor	[0x101]	metadata_application_format field, DTG allocated
metadata_descriptor	[0x101]	metadata_application_format field, DTG allocated

Table 8-21b. User-defined values

8.5.4a Table Segmentation

The details of how tables can be split into multiple sections and how this should be handled by a receiver has been defined in ETSI TS 101 211.

8.5.5 Registered values

Descriptor	Value(s)
original_network_id	0x233A
network_id	0x3001 … 0x3100
private_data_specifier	0x0000233A
data_broadcast_id (see MHEG-5 UKPROFILE [94])	0x0106
data_broadcast_id (Engineering Channel)	0x0111
encoding_type_id values (compressed strings)	0x01, 0x02

Table 8-22. Values registered in TR 101 162 [10] for UK DTT

8.5.6 Text strings and field sizes

8.5.6.1 Character encoding

Text strings shall be coded using the displayable character table defined in Appendix F Table F-1. Broadcasters should be aware that only characters marked as "Mandatory for SI" are guaranteed to be rendered correctly by receivers.

Control codes may be present in text strings as defined by EN 300 468 [2] Appendix A.

Characters marked as "Mandatory for SI" in Table F-1 shall be implemented by all receivers conforming to this specification. Receivers are not required to support any other character sets.

8.5.6.2 String Compression

To allow the bit-rate requirements for cross-carried data to be reduced, a mechanism to allow compression of strings in DVB SI tables will be utilised on DVB-T2 multiplexes and the cross-carried SI data for DVB-T2 services on the DVB-T multiplexes, limited to the fields defined in table 8-26.

8.5.6.2.1 Huffman compression

Individual strings shall be compressed with Huffman compression, which uses a binary tree structure to create codes for each character. Regularly occurring characters are represented with a small number of bits; rarely occurring characters are represented by a large number of bits.

The Huffman tree consists of a series of nodes. The tree has a single starting point, known as the root node. Each node has two children, known as left and the right. Each child is either another node or the decompressed character. The route taken through the tree can be described using a number of bits. A bit value of zero is used to indicate taking the left child of a node, and a bit value of one is used to indicate taking the right child of a node. The encoding of a character is the sequence of bits needed to find it in the tree, starting at the root.

The probability of a character occurring depends on the previous character. For example, the character 'h' has a far higher probability of occurring if the previous character is 't' than if the previous character is 'q'. For this reason the Huffman code used to represent a character will depend on the previous character. This is known as order-1 Huffman compression. Each character in a character set will have its own Huffman tree. To code or decode a character the tree for the previous character in the string is used. To code or decode the first character in a string the tree for character zero is used.

Some rarely occurring characters will not have Huffman codes. Such characters shall be preceded in the compressed string by an escape sequence which will indicate that the following character is not compressed.

8.5.6.2.2 Compressing strings

Strings shall be compressed using sets of static Huffman trees. The compression trees allow the encoding of any sequence of bytes except those containing the value 0x00 (0). They are optimised for English text in character sets that have byte values 0x00-0x7F (0-127) representing characters as defined in 7-bit ASCII. These include the ISO/IEC 6937 Latin alphabet defined by EN 300 468 [2] Annex A, all versions of ISO-8859 and UTF-8. All bytes in the range 0x80-0xFF (128-255) can be encoded but are not compressed.

An escape character shall be used to indicate that the following byte is not compressed. This shall have the value 0x1B (27), that corresponds to an ASCII ESC. All encoded strings with the exception of empty strings shall be terminated with the value 0x00 (0) which corresponds to ASCII NULL. Empty strings shall be encoded as uncompressed empty strings.

There shall be Huffman trees for each byte in the range 0x00-0x7F (0-127). A byte is encoded using the tree for the decoded byte preceding it. The tree for byte zero shall be used to encode the first byte. Huffman trees may contain codes for any byte in the range 0x00-0x7F (0-127). All Huffman trees shall contain an encoding for the escape character, but may contain encodings for no other bytes.

The rules for encoded strings are:

- The 8 bits following a compressed escape character contain an uncompressed byte.
- If the uncompressed byte is of value 0x80-0xFF (128-255) the 8 bits directly following it also contain an uncompressed byte. Otherwise the following bits contain a compressed Huffman code.
- If the byte sequence to be encoded contains the escape character value 0x1B (27) then this can be represented as a compressed escape character followed by an uncompressed escape character. The following character is then compressed.
- After the NULL terminating character (which may be compressed or uncompressed) the string shall be padded with bits of the value 0 so that it is byte aligned.

8.5.6.2.3 Decompressing strings

Decompression of strings uses one or more static lookup tables. These tables must be stored in the receiver. They shall not be broadcast. Different lookup tables will be optimised for strings of different types and lengths. Each individual string can be compressed with the most appropriate table.

The platform will use two lookup tables. Each will be a maximum of 10 kilobytes in size. These tables are available electronically on request from DTG.

Each byte in the table shall specify either an offset into the table or the uncompressed character. In order to decode a compressed string the receiver will first need to look at an offset in the lookup table that will depend on the previous character. An offset of zero should be used for the first character of a string. This offset will contain the root of the corresponding Huffman tree. The receiver shall then iteratively follow a chain of offsets, each one representing a node of the Huffman tree, until a decoded character is found.

The structure of the lookup tables are as shown in Table 8-24:

Syntax	No. of bits	Identifier
decode_table(){		
for (i=0;i<128;i++){		
byte_offset_of_char_i_tree_root	16	uimsbf
}		
for (i=0;i<128;i++){		
for (j=0;j<N;j++){		
left_child_is_leaf	1	bslbf
if (left_child_is_leaf==1) {		
lsbs_of_decoded_byte	7	uimsbf
} else {		
left_child_word_offset	7	uimsbf
}		
right_child_is_leaf	1	bslbf
if (right_child_is_leaf==1) {		
lsbs_of_decoded_byte	7	uimsbf
} else {		
right_child_word_offset	7	uimsbf
}		
}		
}		
}		

Table 8-24: Decode table

byte_offset_of_char_i_tree_root	This 16-bit field specifies the location in bytes from the start of the decode table where the root of the Huffman tree for previous byte of value 'i' can be found. For example the 2nd instance of this represents the byte offset to the root of the Huffman tree to use when previous byte was one.
left_child_is_leaf	This 1-bit field is set to '1' to indicate that the following 7-bits are the least significant bits of the decoded byte. If set to '0' the following seven bits specify an offset.
lsbs_of_decoded_byte	This 7-bit field specifies the least significant bits of the decoded byte The most significant bit of the decode byte is zero.
left_child_word_offset	This 7-bit field specifies the 'j' offset from the root of the current Huffman tree to the location of the left child. The offset is specified in two-byte words, so the offset in bytes is double the value of this field. The root of the current Huffman tree is at byte_offset_of_char_i_tree_root bytes from the start of the decode table.
right_child_is_leaf	This 1-bit field is set to '1' to indicate that the following 7-bits are the least significant bits of the decoded byte. If set to '0' the following seven bits specify an offset.
right_child_word_offset	This 7-bit field specifies the 'j' offset from the root of the current Huffman tree to the location of the right child. The offset is specified in two-byte words, so the offset in bytes is double the value of this field. The root of the current Huffman tree is at byte_offset_of_char_i_tree_root bytes from the start of the decode table.

The following text describes an algorithm that can be used to decode a compressed string given a decode table in the form described in Table 8-24.

- If the previous byte was a compressed escape character of value of 0x1B (27) or an uncompressed byte of value 0x80-0xFF (128-255) then the following 8 bits represent the current decoded byte.
- If the previous condition does not apply the following procedure should apply. This should only occur if the previous byte was in the ranges 0x00-0x1A (0-26) or 0x1C-0x7F (28-127), was an uncompressed escape character 0x1B (27) or was the first byte of the string.
  - The decoder shall find the value of the byte_offset_of_char_i_tree_root field for the value of 'i' where 'i' is the previously decoded byte. If there is no previous byte because the string decoding has not yet started then the value of 'i' to be used shall be zero. The value of this field is an offset in bytes from the start of the decode table, indicating the root of the decode tree.
  - If the first bit of the encoded string is zero, the decoder shall look at the offset into the decode table specified by the byte_offset_of_char_i_tree_root field. This is the value of the

root node in the tree. If the value of the first bit of the encoded string is one, the decoder shall look at offset byte_offset_of_char_i_tree_root+1 into the decode table. This is the value of the right child of the current node in the tree.

- If the first bit of the byte at the given offset is zero the value specifies a further offset into the table, specified as an offset in two byte words from the start of the current Huffman tree. If the next bit of the encoded string is zero then the decoder should move to this offset in the tree and repeat. This is the left child of the current node. The location of this byte is then (byte_offset_of_char_i_tree_root + (2 * value_of_current_leaf)) from the start of the decode table. If the next bit of the encoded string is one then the decoder should move to the byte after this offset in the tree and repeat. This is the right leaf of the current node. This location of this byte is then (byte_offset_of_char_i_tree_root + (2 * value_of_current_leaf) + 1) from the start of the decode table.
- If the first bit of the byte at the given offset is one then the remaining 7 bits contain the least significant 7 bits of the decoded byte. The most significant bit of the decoded byte shall have value zero.

- If the current decoded byte is a null character of value 0x00 (0) then the decoded string has terminated and all subsequent bits can be ignored. The decoded string does not contain the null character.

8.5.6.2.4 Signalling of compressed strings

Compressed strings shall be signalled using a method that has been standardised and is described in EN 300 468 [2]. This uses a first byte of value 0x1F to indicate that the encoding of a string is defined by an identifier called the encoding_type_id, which is the second byte of the string. The encoding_type_id is defined in Section 8.5.6. The signalling extends the mechanism used in the current version of Annex A of EN 300 468 [2] used to indicate the character code table.

If the first byte of the string does not have value 0x1F then the string is not compressed, and shall be decoded as described in the current version of Annex A of EN 300 468 [2].

8.5.6.2.5 String encoding types

If the first byte of the text field has value 0x1F then the following byte carries an 8-bit value (uimsbf) containing the encoding_type_id. This value indicates the encoding scheme of the string.

Two values of encoding_type_id have been assigned by the DVB Project Office. These are 0x01 and 0x02.

8.5.6.2.6 Decompression tables

The two values of encoding_type_id allocated to the platform shall be used to signal which of the two decompression tables shall be used to decompress the string. Either table can be used on any field in any descriptor. The decoder shall use the appropriate decompression table to decompress the string. The mappings are listed in Table 8-25:

encoding_type_id	Meaning
0x01	Decompress string using decompression table 1
0x02	Decompress string using decompression table 2

Table 8-25: mapping of encoding_type_id to decompression table

8.5.6.2.7 Character set of decompressed strings

The bytes from a decompressed string contain only the string itself. There is no signalling of the character code to be used to display the string. The byte sequence output by the string decoder is a UTF-8 encoded string.

8.5.6.3 Field sizes

Broadcasters are advised not to exceed the maximum lengths for text fields (including multilingual variants where supplied) defined inTable 8-26 as receivers may not be able to display excess characters. Note that the figures given are for the number of displayable characters (including spaces) required to represent the text field. The number of bytes required will depend on the use of control codes and whether one-byte or two-byte character representations are required.

Name Field	Maximum Name Length	Comments and examples	T Mux	T2 Mux
Network Name	24	"London"	U	C
Service Provider Name	20	"BBC"	U	C
Service Name or Preferred Name	32	"BBC ONE WALES" Full name for display on set-up menus. Note that most receivers truncate this string at 14 characters	U	U
	8	"BBC ONE" A short version for display on browse or listing display. Where implemented, this shall be shortened from the full name by use of the escape characters as defined on TS 101 211 [13],	U	U
Short Service Name	8	"BBC 1" A short version for display on browse or listing display. see Section 8.5.3.10.	U	U
Event Name	40	"Casualty" Individual broadcasters are free to add an episode title to the title within the space, e.g. "Brit Girls: Marianne"	U*	C
Short Event Description	200	"Out of Control. When Mark steps in, he faces his own past and is forced to reveal a secret." Broadcasters must ensure that the text does not overflow the maximum descriptor size.	U*	C
Component Description	0	No textual description will be given	–	–
Data Broadcast Description	200	"Test your knowledge against the rest of the nation in this year's Test the Nation" Description of interactively enhanced data services or events.	U*	C
Message Descriptor	200	"Due to Digital Switchover in your area, in order to continue to receive Freeview, this device will automatically re-tune on 30th Sept. For more information go to www.digitaluk.co.uk" Information related to the imminent Network Change	U	C
Promotional text	200	"Coming soon to BBC2 and Three: The new series of Heroes."	U*	C
Guidance Information	75	"Contains scenes of moderate violence"	U*	C
Region Name	32	"Kent and East Sussex"	U	C

U – uncompressed string C – compressed string

* compression will be applied on the DVB-T mutliplexes for "other" data tables relating to services carried on the DVB-T2 multiplex

Note: strings for which compression is not efficient will not be compressed

Table 8-26. Text Field Lengths

All name fields shall contain meaningful data. Description fields may be empty at the broadcaster's discretion.

Text string formatting in name and description fields as defined in TS101 211 [13] section 4.6 may be used by broadcasters.

8.5.7 Support for data components and services

8.5.7.1 Signalling data services and components.

Data broadcast descriptorThe EN 300 468 [2] defined data_broadcast_descriptor, with a data_broadcast_id of 0x0106 as allocated for the UK Profile of MHEG-5, may be used in the SDT and EIT.

It is used primarily to signal services or events within guide applications with interactive enhancement.

The table below reproduces the syntax of the data broadcast descriptor from EN 300 468 [2] The shaded portion shows the "selector bytes" and their definition in this profile.

	Size (bytes)	Value	
`data_broadcast_descriptor(){`			
`descriptor_tag`	1	0x64	
`descriptor_length`	1		
`data_broadcast_id`	2		
`component_tag`	1	0	for this application type
`selector_length`	1		
`for( i=0; i<selector_length; i++){`			this shaded portion shows the selector byte that apply for "Object Carousel to UK profile 1 carrying applications"
`application_type_code`	4		
`number_languages`	1		
`for( j=0; j<number_languages; j++){`			
`ISO_639_language_code`	3		
`}`			
`application_specific_data_length`	1		
`for( j=0; j<application_specific_data_length; j++){`			
`application_specific_data_byte`	1		
`}`			
`}`			
`ISO_639_language_code`	3		
`text_length`	1	0	for this application type
`for (i=0; i<text_length; i++){`			
`text_char`	1		
`}`			
`}`			

Table 8-27. Data broadcast descriptor for *UKEngineProfile1*

data_broadcast_id This carries the value of 0x0106 as allocated for the UK Profile of MHEG-5. Note: This is registered in TR 101 162 [10] under the name "The Digital Network"

component_tag The component_tag shall be set to 0 indicating that this descriptor does not provide information regarding which PID(s) carry the application. This is defined by the application_boot_descriptor in the PMT.

application_type_code This field carries the application type value for *UKEngineProfile1*.

number_languages The value in this field indicates the number of different written languages addressed by the application.

This may be zero if:

- there are no options and the application is targeted at the normal language of the service provider
- the application is language neutral (e.g. a non-verbal game)

Note: this information is informative and does not indicate the set of languages apparent to the receiver when trying to launch an application. For example, where an application provides internal selection of language preference, the data broadcast descriptor might list a set of languages while the information in the PSI and object carousel might list a single application classified with a undefined language code.

application_specific_data_length, application_specific_data_byte

There is no defined use of the application specific data in this profile but it may be used in future profiles.

Current profile receivers shall ignore and skip any application specific data.

text_length, text_char This field shall provide a description of the interactive enhancement when present. It has a maximum length of 200 characters coded as per Section 8.5.6.3 "Field sizes".

Semantics of this data broadcast descriptor

This data broadcast descriptor in the SDT indicates that an application of the type indicated is associated with the service at all times.

A data broadcast descriptor in the SDT indicates the consistent characteristics of the service that is:

EITHER:

- the properties of a non-scheduled data service or component which apply whether the service has associated EITs or not.

OR:

- the properties that are consistently available for events in a scheduled service

A data broadcast descriptor in the EIT indicates that an interactive application is provided that is specifically associated with the programme content of the event.

- Where the service is a digital television (or radio) service this implies that the programme is enhanced/augmented by an application. For example, a cookery programme with delivery of recipe and other information through an application.

- Where the service is a data broadcast service there is no implied associated video or audio (but these are possible) just that the content of the interactive applications at the time of the event has the properties described.

If a service has service type "data broadcast service" but does not have a data broadcast descriptor this indicates that service is not specified to consistently deliver any particular application formats.

The absence of a data broadcast descriptor against an event or a service must not prevent access to any interactive enhancement signalled in the PSI.

8.5.7.2 Non-scheduled services

Non-scheduled services are defined here to be those which do not have discrete events, such as a teletext-like information service. In such a service, the concept of an event is not applicable.

Non-scheduled services shall be referenced in the SDT, but shall have their EIT_present_following and EIT_schedule flags set to zero, and no EIT_{pf} or EIT_{sch} sub-tables.

8.5.8 Use of running status

The running status flag in the SDT and EIT shall have the value "running" or "not running". When a service has running status "not_running" the service shall be removed from PSI (PAT and PMT) in conformance with TS 101 211 [13] Table 3.

8.5.9 Table repetition rates

Table repetition rates shall comply with TS 101 211 [13].

8.5.10 Table cross-carriage

Where tables are cross-carried between the Transport Streams within a network, the following rules shall apply:

- Cross-carried tables (excluding EIT, TDT, TOT and RST) shall have a maximum update latency between Transport Streams of 2 cycles of the table repetition period within the other multiplex.
- The information defined within this document shall be identical in actual and other variants of a sub-table. However, other information not defined by this document may differ (e.g. be present in actual but not in other variants of the same sub-table).
- There is no requirement that actual and other tables should carry the same version number [8].
- Actual and other tables which carry the same version number may not be identical in payload.

8. Without this (severe) relaxation, it is not possible for individual broadcasters to insert their own SI (actual), while relying on a centralised SI collator to provide the SI (other). While this requirement remains, it will not be possible to synchronise version numbers between actual and other versions of the same table. It should be possible to synchronise version numbers between the same 'other' tables carried different multiplexes within the same network.

Section 8.10.1 gives a detailed model of how EITpf changes at event boundaries. This Now/Next timing model may result in EITpf actual temporarily lagging behind EITpf other. Receiver actions based on EIT processing (e.g. recording) shall still operate normally in this situation.

8.5.11 Broadcast Triggered Native Applications

This section details how broadcaster triggered native applications should behave. These are applications resident within a receiver but triggered by events in the SI. The trigger to start these applications can be disabled by a running MHEG application by calling the resident program defined in Section 13.10.8.5. Table 8-27b lists the currently defined applications:

Application	How Triggered	Resources	Comments
Promotional Linking	Active links in received RCT	Requires green remote control key and on-screen display.	See Section 8.12

Table 8-27b Broadcast Triggered Native Applications

8.6 Network evolution

Significant change in the network will be signalled using the network_change_notify descriptor defined in Section 8.5.3.14 with the expected behaviour defined in Section 8.9.

8.6.1 Change in regionalisation

Service regionality may change over time.

The service_id shall change if the service gains a unique schedule (e.g. through increased regionality). Consequent changes to transport stream ID are required if the service composition of previously identical Transport Streams become different. Increased regionality of an existing service also requires the introduction of a new SIP, and hence a new network_id.

If the Transport Streams are already regionally distinct (i.e. they already differentiated by at least one regional service and hence must have distinct Transport Stream and network IDs) then further increases in service regionalisation won't affect the Transport Stream and network IDs, just the service IDs.

Optionally, the numbering of services, Transport Streams and networks may be aligned following de-regionalisation.

8.6.1.1 Association of regional variants

When a service becomes more regional and changes its service ID associations with its previous 'incarnation' are broken unless additional signalling is provided.

The service_id associations can be signalled via the service relocated descriptor.

8.6.2 Addition to or removal of multiplexes from a network

8.6.2.1 Addition

When multiplexes are added to a network (i.e. when a SIP delivers additional Transport Streams):

1. The second loop of the NIT_{actual} shall be updated to reflect the additional Transport Streams and services.
2. Additional SDTs (actual and other) shall be carried on all of the Transport Streams from the SIP to reflect the services on the new Transport Streams.
3. Services which are moved from an existing multiplex to a new multiplex should be signalled using a service relocated descriptor for a period of at least one month.

8.6.2.2 Removal

When multiplexes are removed from a network:

1. The second loop of the NIT_{actual} shall be updated to reflect the reduction in Transport Streams and services.
2. The redundant SDTs (actual and other) shall be removed from all of the remaining Transport Streams from the SIP.

8.6.3 Addition to or removal of services from a multiplex

8.6.3.1 Permanent changes

Permanent changes in the set of services carried by a multiplex (Transport Stream) are signalled primarily in the SDT (actual and other) but is reflected in the services lists carried by the NIT etc.

8.6.3.2 Temporary changes

Temporary removal of a service is signalled by changing its running status between 'running' and 'not running'.

PSI signalling

When a service is starting the PSI description (PAT & PMT) that a service is running is established before the running status in the SI is set to 'running'.

When a service is stopping the PSI description that a service has stopped is set only after the running status in the SI is set to 'not running'.

8.6.4 RF changes

8.6.4.1 Addition of transmitters for a network

The signalling of the presence of new transmitters shall be done through the NIT and the optional addition or extension of the frequency_list descriptor within it, see Section 8.5.3.1.

8.6.4.2 Retuning of transmitters

The signalling of a change of frequency for an existing multiplex shall be done through the NIT by changing the frequency carried by the terrestrial delivery system descriptor (in the case of the main transmitter) or the appropriate entry in the frequency_list descriptor if present.

It shall also be signalled by a network change notify descriptor (see Section 8.5.3.14).

8.7 Operational behaviour

8.7.1 Regional opts

Where the programme content of a service switches periodically between a regional / local source and a national source (a 'regional opt') the service ID etc. of the service shall be permanently differentiated from other regional variations.

The only SI change likely at the time of the 'opt' will be in the EIT information (assuming that the 'opt' corresponds to an event boundary). There is no specific SI signalling to indicate the change from national to regional content.

8.7.2 Use of the Content Identifier Descriptor

Where a CRID is associated with an EIT event through the use of the content identifier descriptor it is intended to support the following functionality:

- series recording
- alternative instances (e.g. time shifted repeats)
- identification of split programmes (e.g. film split by news)
- recommendations to programmes or series

As the scope of the CRID is a CRID authority all the above uses may span multiple services.

Where a default authority descriptor is used to allow shortened CRIDs to be conveyed in EIT, full length CRIDs belonging to CRID authorities other than the default authority may also appear in EIT. It is therefore possible for different events on a service to be associated with different CRID authorities.

8.7.2.1 Series Recording

A CRID in the CID shall be a series CRID (crid type 0x32). All events having the same series CRID belong to the same series.

A receiver is expected to store and track series CRIDs for up to 13 weeks between occurrences in EIT schedule. To allow broadcasters to reuse a series CRID for a different editorial concept, receivers shall discard any series CRIDs not seen in EIT for 13 weeks.

An event may be associated with more than one series CRID.

8.7.2.2 Identification of the same programme with a CRID

The CRID in the CID shall be a programme CRID (crid type 0x31). All events having the same programme CRID, regardless of Instance Metadata Identifier (see ETSI TS 102 822-4 [99], Section 10), refer to the same programme content.

8.7.2.3 Use of Instance Metadata Identifier to manage split content

A CRID in the CID shall be a programme CRID (crid type 0x31) with an IMI extension. Where two events have the same CRID and IMI value and the gap between each event is less than 3 hours (measured from the end of the preceding event to the start of the next event) then they shall be considered to be segments of a single item of content. An item of content may be split across more than two events as long as the gap between each event remains less than 3 hours.

8.7.2.4 Broadcast signalled programme recommendations

A CRID in the CID shall be marked as crid type 0x33 (recommendation) and be a programme or series CRID.

It is not required that the recommended CRID be present in the current scope of EIT. If the event referenced by the recommendation CRID is not present in the current scope of EIT, the recommendation may be presented to the user when it appears in EIT. If a recommended CRID does not appear in EIT within 13 weeks of the referencing event it shall be discarded.

A recommendation may reference an event earlier in the EIT schedule than the linked-from event, e.g. to link to a preview programme.

A recommendation shall only be presented to the user if it can be resolved.

A recommendation CRID may resolve to a programme CRID or series CRID. Where a recommendation CRID resolves to a programme CRID then the resolved-to programme shall be presented for booking. If an event associated with the programme CRID also has an associated series CRID then the series shall also be presented for booking. Where alternative instances of the same programme CRID occur (e.g. with different A/V characteristics) then Section 8.11.2.2 applies.

Where a recommendation CRID resolves to a series CRID then only the series shall be presented for booking. It may be necessary to present the series by reference to the next resolvable event in the series.

For the same event, the broadcaster shall not insert recommendation CRIDs that resolve to a programme CRID and a series CRID which are associated with the same event within the EIT schedule.

8.7.2.5 CRID encoding

A CRID contained within a Content Identifier Descriptor shall be encoded according to the following rules:

The CRID must be a compliant URI as defined in ETSI TS 102 822-4 [99], section 8.

The CRID is further restricted to only contain characters encoded over the range from ISO 6937 0x20 to 0x7F.

The length of the CRID plus IMI (if any) shall not exceed 64 characters. The maximum lengths of the separate parts of the CRID are as follows:

authority	32 characters (excluding leading 'crid://')
data	29 characters (including leading '/')
instance metadata id	3 characters (including '#' separator)

The CRIDs are not intended to be human readable and shall not be displayed on-screen.

The use of abbreviated CRIDs shall follow the rules set out in ETSI TS 102 323 [98] section 6.3.1.

8.7.2.6 CRID Scope and Reuse

The authority part of a CRID shall be a registered internet domain name and therefore globally unique. The data part of a CRID is only unique within the scope of the associated CRID authority. An IMI is only unique within the scope of the complete CRID.

Broadcasters shall endeavour to use the same CRID whenever a programme is repeated. However, this cannot be guaranteed. A repeat of any content by a different service provider may result in a different CRID being assigned.

CRIDs and IMIs may be reused to refer to different programme concepts with the following restrictions:

Series CRIDs	shall not be re-used for 13 weeks after the scheduled end-time of the last event that referenced this CRID
Programme CRIDs	shall never be reused for different programme content
IMI	shall not be reused with the same CRID within 3 hours. Two events greater than or equal to 3 hours apart but with the same CRID & IMI shall not be considered to be split parts of the same instance.

8.8 Guidelines for the use of SI by Receivers

8.8.1 Overview of receiver guidelines

The purpose of the guidelines in the following sections is to reduce the risk of interoperability problems between multiplexes as transmitted and receiver implementations. This is particularly important in the environment of UK DTT where the lack of vertical integration makes the determinism of the end-to-end performance of the system very much more difficult.

These guidelines represent the expectations of the multiplex operators of how receivers will use the transmitted SI. Deviation from these guidelines could lead to problems for the viewer (for example, displaying an insufficient number of characters in a service name could result in the list of services presented to the viewer having apparently duplicate entries).

8.8.2 Addition of services into the service list

During the initial scan, or any subsequent network configuration changes (see section 8.9), a receiver shall only add a service to its stored service list if the multiplex in which that service is broadcast can be tuned.

The recommended method of achieving this is to add a service only when the "SDT actual" table containing the service is being received.

8.8.3 LCN assignment by Receivers

The UK DTT network contains multiple regions, within which there are services localised to a specific region providing news and other programming relevant only to that region.
In such a broadcast environment it is inevitable that some of these regions will overlap causing conflicts where regional services compete for the same LCN slot. In order to aid the receiver in setting up the channel list, the following descriptors may be broadcast:

- Target region descriptor (see section 8.5.3.21)
- Target region name descriptor (see section 8.5.3.21)
- Logical channel descriptor (see section 8.5.3.6)
- Service attribute descriptor (see section 8.5.3.9)
- HD Simulcast logical channel descriptor (see section 8.5.3.23)

Regional variants of a service have the same logical_channel_number assignment, but with different service_ids and possibly different network_ids. Where more than one regional variant of a service is received a typical implementation would be for the receiver to determine the most appropriate regional variant to place in the Broadcast Range as signalled by the logical channel number. Target region signalling is the primary method of determining the appropriate regional variant, however when this is not sufficient receivers may choose between the remaining choices using their own criteria (Note: The criteria to be used are not defined by this specification but would typically be signal strength, bit error rate or some other appropriate measure.) Any other regional variants may be placed within the variant range of the Receiver Channel Number list. However, other strategies are possible, e.g. all variants available for selection (in some receiver specific manner) from a single channel number within the broadcast range. No regional variant shall be placed within the Broadcast Range at any Receiver Channel Number other than that corresponding to the signalled logical channel number.

Two or more received services with the same service_id, (the network_ids may be the same or different) are not regional variants but identical instances of the same service. The receiver shall use target region signalling to help determine the most appropriate instance to place within the Broadcast Range and if this cannot discriminate between variants the receiver shall decide using a mechanism based on signal strength or some other criteria. Any other instances shall not be presented to the viewer and so not allocated a Receiver Channel Number..

To ensure that receivers provide a consistent result when assigning LCNs the following logical order for processing the various descriptors shall be followed.
Firstly the receiver shall perform a complete scan of all frequencies (see section 9.5) and collect information about the available services through reception of the SI data (see section 8.5.2). The receiver shall assign the available services an LCN according to the precedence rules outlined below.

8.8.3.1 Assignment of LCNs

(1) The receiver shall ensure that only UK services are assigned within the broadcaster assigned LCN range (see Table 8-11).

(2) If the receiver can receive more than one instance of a service (i.e. same service_id and original_network_id) the following should apply;

   a. If target_region_descriptors are present, the receiver shall provide a means for the user to select the preferred region. If a single instance of the service is within the receiver's selected target region preference it shall be assigned the signalled LCN. All other instances shall be discarded.

   b. In the absence of target region descriptors, or where the selected target region does not identify a single instance as being preferred, the receiver shall decide which instance of the service shall be assigned the signalled LCN. All other instances shall be discarded.

(3) If the receiver can receive more than one regional variant of a service with the same LCN then…

a. If a target_region_descriptor is present, the receiver shall provide a means of presenting the conflicting regions to the user for selection. The regions names are listed in the target_region_name_descriptor. Services not within the selected target region nor its parent target regions will be assigned LCNs in the variant range (800+).
b. In the absence of either a regional preference or information about regionality being broadcast, the receiver shall decide the preferred regional variant using an appropriate mechanism, such as the comparison of signal strength/quality. Services not within the preferred region will be assigned LCNs in the variant range (800+).

(4) Those services not identified as variants (i.e. within the chosen target region) shall be assigned an LCN within the broadcaster range as defined in the logical channel descriptor for the network on which it is broadcast.

(5) The service_attribute_descriptor shall be used to define the service visibility and availability for numerical selection.

8.8.3.2 HD simulcast logical channel descriptor processing

(6) The LCN assignment process will have eliminated duplicate services, and resolved LCN clashes. Therefore, only services placed in the broadcaster range by the LCN assignment process shall have their HD simulcast logical channel descriptors processed.

(7) If there are multiple HD simulcast logical channel descriptors targetting the same LCN, the viewer's target region preference (in combination with the receiver's criteria) can be used to determine which one to process.

(8) The receiver shall discard any HD simulcast logical channel descriptors that do not match the viewer's target region preference.

(9) The receiver shall move the HD services to the LCNs signalled in the remaining HD simulcast logical channel descriptors. After the moves are done, the SD versions of the services (where receivable) shall be placed at the LCN position of the HD services prior to the move (i.e. the HD and SD LCNs will normally be swapped but the HD service shall move regardless of the presence of an SD service).

(10) When the HD simulcast logical channel descriptor is processed, the service attributes of the HD service shall be set according to the rules set out in section 8.5.3.23.

8.8.3.3 Logical flow for LCN assignment

The flowchart in Figure 8-2b and accompanying use case examples (see Appendix H) are intended to give a representation of the process of handling LCNs and HD simulcast LCNs in a receiver. They are not intended to describe a particular implementation approach. The use case examples are intended to be read in conjunction with the flowchart.
Whilst TRD is the preferred approach, the user may decide to not express a region preference, in which case the receiver must revert to its own criteria

for resolution of service conflicts.
For simplicity, processing of services' visible/selectable attributes is not shown in the flowchart. Receivers shall correctly process the service_attribute_descriptor and/or the visible service flag in the HDS when present in the broadcast signalling.

Informative Use Case scenarios use Appendix H

Chart Key

LCN; Logical Channel Number (section 8.5.3.6)

HDS; HD Simulcast Logical Channel Descriptor (section 8.5.3.23)

TRD; Target Region Descriptor (section 8.5.3.21.1)

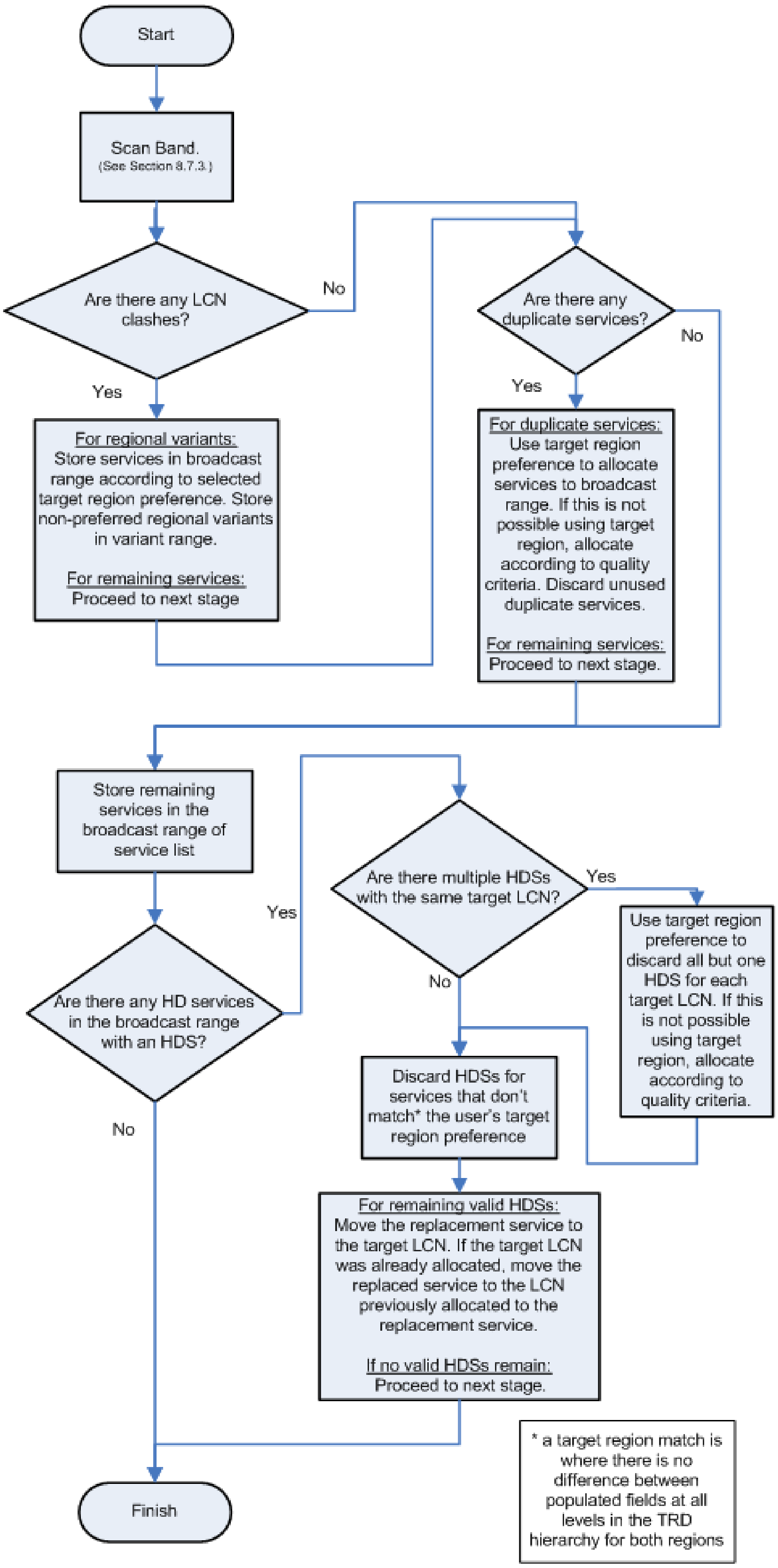


Figure 8-2b LCN Assignment

8.9 Receiver response to changes in network configuration

8.9.1 Overview

Changes to the DTT network configuration over time are inevitable. Some of these changes result from issues that are specific to a regional DTT environment. See Section 8.6.1 “Change in regionalisation”.

A possible consequence of changes to network id, Transport Stream id or service id is that viewer could ‘lose’ services if the changes to the network result in changes to favourite service lists and/or associations of services with pre-set (RCU) numbers. At worst, this could require the digital equivalent of analogue re-tuning.

This section outlines these and other issues in more detail. It should be noted that the broadcaster may assist in signalling network changes using the network change notify descriptor (Section 8.5.3.14) as described in Section 8.9.10.1.

8.9.2 Receiver SI table section acquisition

Throughout this section it is assumed that the compliant receiver will have PID and section filtering active at all times and targeted at:

- Any change in PAT and PMT version_number
- Any change in NIT(actual) version_number
- Any change in SDT(actual) and all SDT(other) version_numbers.
- Any change in EIT(actual) and all EIT(other) version_numbers.

Version numbers of cross-carried NITs(actual), SDT (others) and EIT(others) are not maintained across Transport Streams within a SIP (see Section 8.5.10 “Table cross-carriage”). Therefore, when switching to any new Transport Stream, the receiver has no means of detecting whether or not an update of SI tables has occurred in the short time since it broke away from the previous Transport Stream.

- The implication is that **all** SI **shall be re-verified when traversing multiplexes**. It is important that the execution of this process is invisible to the viewer each time a service selection brings about a change in Transport Stream.

  To reduce the receiver processing during such a traversal, a receiver may wish to hold version_numbers of SDT (actual), and EIT (actual) in non-volatile memory for each of the multiplexes it has previously visited. The receiver would then be in a position to abort table updates in the event of there being no changes to version_number.
- The receiver should have sufficient SI(other) already stored for the target multiplex, before a switch on to it is initiated, to enable the transition to be relatively seamless.
- Modification of the receiver’s service list(s) should take place only when a service has been added, removed or changed as described in the following sub-sections.

8.9.3 Change of network ID

A change in service regionality may lead to the introduction of a new SIP and hence a new network id. One or more service IDs and transport stream IDs shall also change. See Section 8.6.1 “Change in regionalisation”. These changes are comparable to the effect of moving the receiver to a new location.

So, if the receiver detects a change in network ID:

1. Obtain user consent to re-scan
2. Scan the available Transport Streams to assess the available Transport Streams and services
3. Where possible retain user preferences for previously known services
4. Consult user regarding new services

8.9.4 Addition to or removal of multiplexes from a network

During the lifetime of a receiver, it is possible that the number of multiplexes emitted from a SIP will increase or decrease. See Section 8.6.2.

A compliant receiver shall deem there to have been a change in the number of multiplexes in a network when:

- An update occurs in the NIT (actual) bringing with it a different listing inside its transport_stream_loop AND, after a re-acquisition of SI has been made, a new SDT (other) is found OR an existing SDT (other) is lost.

  (Inability to acquire a multiplex does not constitute that multiplex having been removed from the network as it could be due to the transmitter operating on reduced power or adverse propagation).

Specifically, when a multiplex is **added** to a particular network:

- The fact that a new Transport Stream has become available to the viewer should be deemed inconsequential unless they are offered more services or existing services have been moved to the new transport stream as signalled using a service relocated descriptor. Hence the behaviour of the receiver during the addition of a multiplex should be analogous to that behaviour when extra **services** are **added** to the network (see Section 8.9.5).

When a multiplex is **removed** from a network:

- A legacy set of services, which were part of that network, should be presented to the receiver user but labelled as 'unavailable' if previously available and simply not present if they were previously unavailable. The disappearance of services without this intermediate state could prove disconcerting to the viewer. The removal of deleted services from the receiver's service list should be performed after a time out period or with the permission of the viewer.

8.9.5 Addition to or removal of services from a multiplex

During the lifetime of the receiver, it is likely that the service composition within one or more multiplexes will change. See Section 8.6.3.

A compliant receiver shall deem a service to have been added to a multiplex if there is an update to the SDT (actual) for that multiplex which references the new service.

The receiver shall consider a service to have been removed if there has been no explicit reference to it in any table in any Transport Stream in which that reference was expected for a time-out period.

Note that it is not expected that a receiver should parse every single table in the network in order to search for references to a service that may have been deleted. In particular, the EIT and the SDT may contain linkage descriptors that reference services - if such references are found in the course of processing the table for some other purpose, then the service should not be considered to have been removed.

Specifically, when a new service is **added** to a multiplex:

- The user should be informed unconditionally of the service's arrival on entry to the service guide **and** if they are entitled to view the service.
- The new service should be differentiated from the existing set of services by the use of another icon or tag next to the entry when the viewer asks for a display of the services available. The length of time for which this tag is present should depend on the user accessing the service list in which the new service entry exists at least once, or after a time-out which begins from the time that the receiver is both active (switched on) and aware that there has been a multiplex re-configuration.
- Re-ordering of a service list or re-mapping of service to a number addressable from the RCU should only ever take place with the permission of the viewer.

Specifically, when a service is **removed** from a multiplex:

- The user should be informed of the deletion of the specific service (for example by the use of an icon or tag next to the service's entry when the viewer asks for a listing of available services).
- The service's name and details should be deleted from the list after a time-out period (to allow for any temporary errors in transmitted information) and with the acknowledgement of the viewer.
- While a service has been removed from the SI tables but not from the receiver's service list, the user should not be able to cause receiver malfunction by attempting to select the deleted service from the service list: If the viewer attempts to select the service, the receiver should attempt to acquire that service, and display and appropriate error/information message in the event that the service is not referenced in the PAT.
- Re-ordering of a service list or re-mapping of service to a number addressable from the RCU should only ever take place with the permission of the viewer.

Specifically, when a service is moved to another multiplex:

- Receivers should use the service relocated descriptor to track the change and migrate entries in favourite lists, reminders and booked recordings where possible.

8.9.6 Temporary removal of services from a multiplex

Temporary removal of a service from a multiplex occurs when the service moves to a non-running state (for example during the overnight closedown of that service, or in the event that two or more services share bit-rate by time division multiplexing). See Section 8.6.3.

A compliant receiver shall deem that a service is not running if an update is found in the SDT (actual or other) indicating a running_status for service of not running.

In order to prevent faults in SI blocking access to services, the receiver shall use the state of running_status in the SDT for information purposes only, and shall attempt to select the service if the viewer requests it.

The chain of events during the change of state of a service from running to not_running to which the receiver is expected to respond are [9] :

1. Removal of the service's entry in the PAT.
2. Removal of the service's PMT and components from the Transport Stream.

The receiver should respond to either event, whichever occurs first. If this happens the receiver should inform the viewer that the service is not running (for example by displaying an appropriate error/information message).

8.9.7 Replacement of services in a multiplex

The replacement of services in a multiplex is likely to occur when extra DTT regional services are launched. The replacement of a 'National' service with a 'Regional' (flavoured) service will necessarily involve changing the service_id. This procedure can be assumed to be a one-off change to the network which happens when new regional broadcasting centres are set up (see Section 8.6.1). This must not be confused with operational 'regional opts.' which occur on programme boundaries and for which no change in service_id or service name (in the SDT) takes place (see Section 8.7.1).

Broadcasters should signal the service associations between the service and its regional replacements, via the use of a service relocated descriptor in each of the regional replacement services SDT descriptor loop.

The receiver should offer a near seamless transition from the original service to the new replacement service in terms of:

- Which button on the RCU the replacement service resides - the replacement service must be accessed from the same button as the old.
- Clean and prompt replacement of any service-specific icons or graphics in the receiver's user interface environment, including favourite channel listing.

There must be a clear association between the old and new (replacement) service in order that the receiver can recognise the new service as a replacement, rather than a new, service (see Section 8.9.9.1).

8.9.8 Transmission frequency of a multiplex being changed

When new DTT transmitter sites are switched on a situation may arise in certain fringe areas in which receivers proactively take advantage of the newly provided signals to achieve more reliable digital television reception. See Section 8.6.4.

- The signalling of the presence of new transmitters will be done through the NIT and the use of the frequency_list descriptor within it if available.
- The receiver ought to be able to parameterise its next frequency band scan based on the difference(s) between the 'before' and 'after' frequency lists. e.g. the receiver may try to acquire the same multiplex on a frequency which was not previously listed in the frequency_list,

[9]. Removal of a service from *just* the PAT or *just* the PMT is a transitional state only - it is not a valid persistent state for an MPEG 2 Transport Stream.

before attempting a full UHF scan. Such a comparison will be facilitated by keeping the order of alternative frequencies in the list the same.

Specifically, a compliant DTT receiver will deem there to have been a change in multiplex frequency when:

- An update of the NIT discloses new possible frequencies for a particular network to the receiver.

  OR

- The frequency list differentiation process fails or is not supported in the receiver's software and a default full UHF band scan is performed leading to the acquisition of duplicate entries for the same multiplex

  OR

- A single multiplex is found to be no longer receivable. This should require user input to verify the state of the receiving system so as to prevent automatic re-tuning of the receiver if the antenna connection has been broken.

The advantage of an intelligent tuning approach is that the time of acquisition of a new frequency (multiplex) will be fairly small in comparison to a full UHF sweep. However, a full band scan should be used from time to time (at suitable opportunities) to ensure that physical effects on reception are accounted for (e.g. trees/buildings growing in front of the antenna or misalignment of the same).

8.9.9 Transport Stream ID of a multiplex being changed

When a broadcaster chooses to change the regionality of the services, the transport stream id (TS_ID) of the multiplex may change for some of the SIPs in the old region(s).

When the TS_ID is changed, the original_network_id is unchanged. If the service is unchanged, the service_id is unchanged, and should be considered as a direct replacement in all memory stores, configurations, and menus. If the service is changed, the service_id will change. If it is a regional replacement service, the parent_service_id will be unchanged, and the rules in Section 8.9.9.1 should be obeyed. If completely new service is added or an existing service removed, there will be no common parent_service_id, and the rules in Section 8.9.5 should be followed.

8.9.9.1 Service regionalisation

When a service becomes more regional, the existing service will be replaced by the regional service. Consequently, the service_id will be changed, the transport_stream_id and the network_id may also change. This should be signalled using service relocated descriptors in the SDT descriptor loop of the newly added replacement service(s). A receiver can replace the old service with it in all the menus and set-ups, including assignments in favourite channel lists.

Hence, if a receiver detects that a new service has appeared, it should use the service relocated descriptors to see if it can find an equivalent existing service, (or one in its memory). If it does, then it should replace the path to the old service with the path to the new service. If the receiver does not have an existing service in its memory it can be considered to be a new service, and should be added to the list, according to the logical_channel_number.

This same technique may be used for other replacement services.

8.9.9.2 Regional variant of a service

Where there are regional variants of a service from different (receivable) SIPs existing at the same time, they will have the same logical_channel_number, and hence the receiver can distinguish the offering of regional service variants of the same service from the offering of a different service.

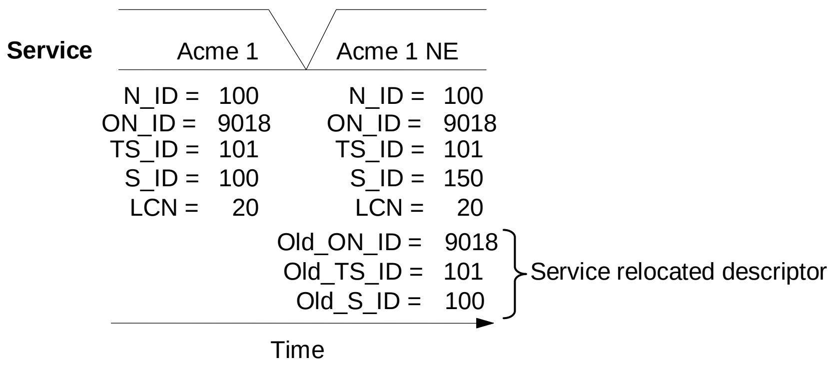


Figure 8-3. Service regionalisation

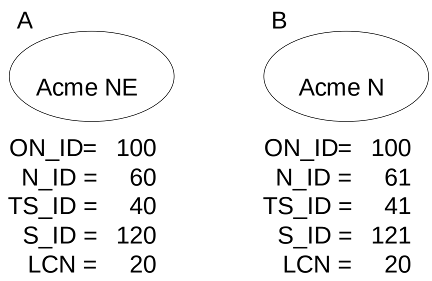


Figure 8-4. Service regionalisation

8.9.10 Use of Network change related descriptors

Network change descriptors are used to provide a receiver with additional service and network reconfiguration information, as previously described in Sections 8.9.3 to 8.9.9. Two descriptors are used, one to provide network change information to the receiver and one to provide change related textual information for the end user.

The time and duration for the change shall be signalled in the network change notify descriptor. The duration is used to signal the period over which reception or recordings may fail and may be signalled as zero or greater. The network can be considered stable at the finish time of start_time_of_change + change_duration and any receiver action should be performed at or after this time.

8.9.10.1 Use of the Network change notify descriptor

Use of this descriptor may lead to a NIT section in which zero transport stream loops reside. The total number of changes which can be signalled at any one time within the network_id shall be limited to 35.

In United Kingdom (UK) usage, a cell is used to identify a geographical transmitter location, which employs a modulator, and its associated transposer relay stations. All modulators at a single location shall have the same cell_id.

In using the change_type, the MSB is set to '1' when the signalled network change is classified as major, i.e. cannot be evaluated using SI alone. "Default" is to be used when another category does not adequately describe the current scenario, or when multiple categories would describe the current scenario. "Coverage change" is used when power and/or modulation parameter changes may change the coverage of a transmitter.

This signalling is designed to allow the receiver to select a suitable algorithm to evaluate the change_type signalled. For example, a Major network change may require a full network rescan whilst a Minor change may only require re-evaluation of the received SI.

The invariant_tsid and invariant_onid pair may be used for example when a receiver is powered on and cannot tune to the last used service. In this case, the receiver may tune to the multiplex with the invariant_tsid, using its stored tuning parameters, where it may find the current time and the latest version of the network_change_notify descriptor. Broadcasters shall endeavour to provide an invariant_tsid for each network change, however it cannot be guaranteed to be present for all changes. Receiver manufacturers should consider the situation when a receiver is not able to find the current time through invariant_tsid or other means.

Broadcasters shall endeavour to minimise the durations signalled. Each period of engineering works must be signalled separately (e.g. works on Main and Relay stations are separate events if the Relay work is not concurrent with work on the Main transmitter).

If a message_only change_type is signalled, the same mechanism for displaying the message used for other change_types shall be used. This change_type results in no changes i.e. the receiver displays the message appropriately and takes no further action.

If a change type which is reserved for future use is signalled, the MSB shall be used to evaluate whether it shall be treated as 'Major – Default' or 'Minor – Default'.

If a receiver_category unknown to the receiver is encountered, the network change event shall be ignored.

Broadcasters shall use this descriptor for all relevant service changes.

Broadcasters shall not signal change events for the same cell_id with overlapping periods defined by their start_time_of_change and change_duration.

Broadcasters shall endeavour to ensure that at the time of start_time_of_change + change_duration, the network shall be stable.

Broadcasters shall endeavour to broadcast notifications of changes at least 1 week prior to the change. A change shall continue to be signalled for 1 month after the network change event.

8.9.10.2 Use of the message descriptor

Use of this descriptor may lead to a NIT section in which zero transport stream loops reside. Due to the length of text required to accurately impart information, only one string is carried per descriptor. Zero, one or multiple descriptors may be carried concurrently.

Multiple network changes may refer to the same message_id, which implies that the message may be re-used. Multiple message descriptors may be broadcast with the same message_id provided that each carries a different ISO_639_language_code.

As the message descriptor is referenced by a message_id within the network_change_notify descriptor, all message_ids are scoped within the network_id.

If the broadcaster wishes to change the content of a message, the old message shall cease to be broadcast and the new message, with a new message_id, shall be broadcast instead. Note that this will result in a change to the message_id and network_change_version_number for the relevant network change in the network_change_notify descriptor.

8.9.10.2.1 Notes for Broadcasters

Whilst primarily designed for use in conjunction with engineering works, this descriptor may be used to provide other messages to the end user. It must not be used to impart information of an advertising nature.

Mixed case letters should be used; if not possible then lowercase should be favoured over uppercase. Where numbers are used they shall be Arabic numerals only (1, 2, 3, 4, 5,...).

Information within the message shall be phrased using terminology understood by the majority of the population.

8.9.10.2.2 Notes for Receiver manufacturers

Receivers shall store all relevant messages referenced by the network_change_notify descriptors. Manufacturers should minimise unnecessary viewer notifications e.g. where a receiver has already processed the change there may be no need to display the contents of the message descriptor.

Due to the temporal and geographical diversity of the switch-over operations it is very difficult to determine exactly the maximum number of changes a receiver has to process, store and monitor, however current modelling indicates that a receiver capable of handling 75 concurrent changes should cope in the majority of cases.

Receivers shall be capable of displaying the full length of the text field as defined in Section 8.5.6.3 without truncation.

The message should be presented using a sans-serif font designed for readability and use on television and at sizes suitable for normal viewing distances. Italic, underlined, oblique or condensed fonts should be avoided.

Text should be displayed with good contrast. Colours should be limited to an absolute maximum of 85% saturation. Pure red and white and combinations of red and green should be avoided.

Generous inter-linear spacing should be provided. Words should have a clear space around them. Flashing and scrolling text should be avoided.

Left-aligned text should be used rather than centred or right-aligned. Justified paragraphs should be avoided.

Broadcaster supplied messages shall be displayed as broadcast in the message descriptor. Any additional manufacturer message shall be clearly separated from the broadcast message.

For changes signalled as a change_type “Major” network change messages should be displayed at these times:

- On the first suitable user interaction after initial receipt of the network_change e.g. channel change, power on.
- On the first suitable user interaction 48 hours prior to the start_time_of_change.
- Either, 1 hour prior to the start_time_of_change or, on commencement of any EIT event being viewed which will finish exactly at or after the start_time_of_change.

It may also be appropriate to display the message during the network change, or if a recording is scheduled to occur during this period.

For changes signalled as a change_type “Minor”, the network change messages shall be displayed at or after the calculated finish time of the change, messages shall not be displayed before this time. Viewers should be given the choice to permanently ignore the change, instigate a receiver retune, or postpone the retune for a later time. The subsequent display of the message for postponed retunes is at the discretion of the manufacturer.

Access to the current active messages and other details (e.g. start time and date) may be displayed via the receiver's menu system.

When displaying a message, receivers shall clearly indicate on screen to the end user how the message may be removed from the display. Receivers may remove a message without user acknowledgement after an appropriate period.

When displaying a broadcast message, if the signalled change_duration in the referencing network_change_notify descriptor is greater than zero, the receiver shall display the calculated finish time, and optionally (but recommended), the start time of the network disruption.

When displaying a broadcast message, if the signalled change_duration in the referencing network_change_notify descriptor is zero, the receiver shall display the time of network change i.e. the signalled start_time_of_change.

Example Messages

Major –Default: example DSO

Due to Digital Switchover in your area, in order to continue to receive Freeview, this device will automatically re-tune.
For more information go to www.digitaluk.co.uk

Minor – Service changes: example new channel launch

Xxxx is a new and free entertainment channel launching on Freeview at channel number xx. This device will update automatically.
For more information go to www.freeview.co.uk

8.10 Profile of UK SI currently being radiated

This chapter has defined the full profile of SI that a receiver should expect to encounter and products should fully support this profile. However not all descriptors are currently supported by the transmission chain[10] . This section provides an example of the current profile of SI being radiated. It should be assumed that descriptors not listed in this section but defined in this chapter could be enabled at any time.

Table	Usage	Repetition Rate (seconds)
SDT	Actual	2
SDT	Other	10
NIT	Actual	10
EIT_{pf}	Actual	2
EIT_{pf}	Other	5
TOT	N/A	1
TDT	N/A	1
EIT_{sch}	Actual (day1)	9
EIT_{sch}	Actual (days 2-8)	27
EIT_{sch}	Other (day 1)	54
EIT_{sch}	Other (days 2-8)	270
RCT	N/A	1-30 (variable)

Table 8-28. Tables Currently in Use

Tables are fully cross-carried. The majority of services are expected to provide descriptions for each event.

10 Informative: During digital switchover a range of mixed configurations are in use across the country. Networks which have yet to switchover are generally following the above profile. Newer networks use more efficient SI transmission, particularly for EITsch, where EITsch data for the current and following 7 segments are played out at the Day1 repetition rate and segments relating to past events are played out at a slower repetition rate.

Table 8-29 lists the descriptors currently being used within the specified tables.

Table	Descriptor
NIT	service_list
	network_name
	private_data_specifier
	terrestrial_delivery_system
	frequency_list
	logical_channel
	network_change_notify
	message_descriptor
	T2_delivery_system
	target_region_descriptor
	target_region_name_descriptor
	HD_Simulcast_Logical_Channel_descriptor
	linkage_descriptor
	default_authority_descriptor
	FTA_content_management_descriptor
	service_attribute_descriptor
SDT	service
	CA_identifier
	country_availability
	data_broadcast
	private_data_specifier
	target_region_descriptor
	service_relocated_descriptor
	default_authority_descriptor
	FTA_content_management_descriptor
	guidance_descriptor
EIT	short_event
	multilingual_component
	CA_identifier
	component
	content
	data_broadcast
	content_identifier
	private_data_specifier
	linkage
	FTA_content_management_descriptor
	guidance_descriptor
TOT	local_time_offset

Table 8-29. Descriptors Currently in Use

Within the UK infrastructure some tables can only be generated by a central common source (C), others can also be generated by individual multiplex operators (M). Table 8-30 shows the possible sources for each SI table and the current configuration for each multiplex. The configuration of the network is quasi-static, but the source for a table may change without notice e.g under fault conditions.

Table	Possible Source	PSB 1	PSB 2	PSB 3	COM 4	COM 5	COM 6
NIT	C	C	C	C	C	C	C
SDT actual	C or M	C	C	C	C	C	C
SDT other	C	C	C	C	C	C	C
TOT	C	C	C	C	C	C	C
TDT	C	C	C	C	C	C	C
EIT_{pf} actual	C or M	C	C	C	C	C	C
EIT_{pf} other	C	C	C	C	C	C	C
EIT_{sch} actual	C or M	C	C	C	C	C	C
EIT_{sch} other	C	C	C	C	C	C	C

Table 8-30. Table Source within UK DTT Network

8.10.1 Now/next timing model

Broadcasters have traditionally scheduled events so that they are billed as starting at a time easily recognised by the consumer. This is often called the billed time of the event. But this isn't the time the event will actually be transmitted. This takes place at the scheduled time which may differ from the billed time by typically -1 minute to +4 minutes.

EIT tables only allow for the carriage of a single start time. Normally this will be the billed time to provide a suitable time for use in an EPG display. Using the start time carried in EIT to control now/next presentation or recording functionality will always result in mis-alignment with the content.

The scheduled time is not conveyed in any table. A receiver can determine when an event is actually starting by monitoring the transition of running status within EIT present/following. This transition is often enacted off either the scheduled start time or the broadcaster's playout automation. Consequently at times of late or extended running the transition may not be signalled until well after the start time currently being signalled for the next event. Due to processing delays in the broadcast chain there may be delays (~1 hour) before the start times in EIT tables reflect the revised programme timings.

The running status transition for a given service may well occur at different times within the actual and other representations. The actual representation is the most likely to be accurately timed.

Broadcasters should ensure that event_id is consistent between EIT present/following and schedule tables for the same broadcast event.

When the EITpfA (TableId=0x4e) changes and an event becomes the present event, this can be used by recorders as a trigger to start a recording (See section 22.2.3.9). When an event becomes the present event in an EITpfO (TableId=0x4f) this indicates that the event is starting on another multiplex. Currently EITpfA is transmitted with a repetition rate of approximately 2s, while EITpfO is transmitted with a repetition rate of approximately 5s. At first glance it would seem likely that a receiver seeing a change in EITpfO and then switching to the corresponding multiplex would find EITpfA had already changed, however this is not always the case.

Firstly the EIT sections are inserted by one of the last multiplexers in the broadcast chain, the amount of spare capacity in the multiplexer's input transport stream can vary and is non-deterministic.

Secondly different SI insertion multiplexers have different characteristics on how they insert the EIT sections, and this can result in more variation in the time between EITpf changes occuring on different multiplexes when a variety of SI insertion multiplexers are used in the same network.

Thirdly when an EIT section changes on the input of an SI insertion multiplex, some multiplexers delay updating the output section for a few seconds in order to mitigate sudden and bursty bitrate changes on the EIT pid. Such implementations generally wait until the time when they would have sent the next section for that subtable. This has the effect that sometimes the next scheduled EITpfO packet occurs on one multiplex before the next scheduled EITpfA packet on another multiplex, even though the EITpfA repeats more often than EITpfO. An example is shown in Figure 8-5a which demonstrates how a EITpf change can occur on a "Other" multiplex before it occurs on an "Actual" multiplex, even though the EITpfA sections have a much faster repetition rate.

All these effects are a side-effect of the non-deterministic nature of DVB multiplexing. While it can be easily demonstrated that EITpf changes will generally occur on all multiplexes within the time period which is a little more than the repetition time of EITpfO sections. However due to the non-deterministic nature these limits can at times be exceeded.

Therefore receivers seeing a change on EITpfO, should not assume they will immediately see the same change in the corresponding EITpfA table, but should be prepared to wait for a number of seconds if the EITpfA has yet to change.

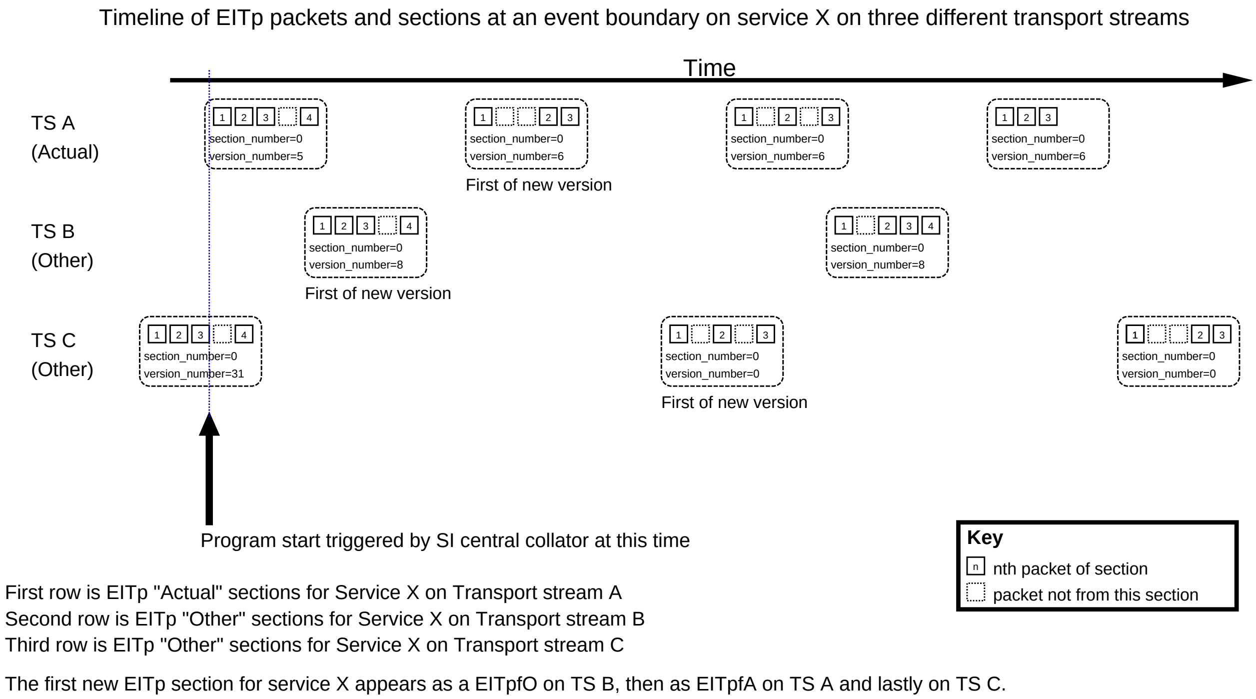


Figure 8.5a: Example EITp/f change

8.10.2 Component descriptors

The usage of component descriptors as defined in Section 8.5.3.11 "Component descriptors" is necessary as for operational reasons the signalling of a component in the PMT is generally quasi-static. Not every component will have useful content for the consumer at all times, often the component will not be populated. The mechanism defined in Section 8.5.3.11 "Component descriptors" provides a method of signalling in a guide an event which is enhanced with additional services which actually have useful content.

If the PMT is being operated in a fully dynamic mode with components only being signalled when there is useful content, Section 8.5.3.11 "Component descriptors"is backwards compatible.

Any component type defined in ETSI EN 300 468 section 6.2.8 can be signalled.

Typically the component descriptors shown in Table 8-31 are currently being signalled:

Stream_content	Component_Type	Description
0x01	0x01	Video, 4:3 aspect ratio 25Hz
0x01	0x03	Video, 16:9 aspect ratio 25Hz
0x02	0x01	Audio, single mono channel
0x02	0x03	Audio, stereo (2 channel)
0x02	0x40	Audio description for the visually impaired
0x02	0x47	MPEG-1 layer 2 audio, receiver mix audio description
0x03	0x10	DVB Subtitles (normal) with no monitor aspect ratio criticality
0x03	0x30	Open (in-vision) sign language interpretation for the deaf
0x03	0x40	Video up-sampled from standard definition source material
0x04	0x80..0xFF	Enhanced AC-3 audio
0x05	0x01..0x08	H.264/AVC Standard Definition Video
0x05	0x0B..0x10	H.264/AVC High Definition Video
0x06	0x01..0x05	HE-AAC Audio
0x06	0x47	HE-AAC receiver mix audio description for the visually impared

Table 8-31. Typical component descriptors

Once a component has been acquired, the receiver should continue to present that component irrespective of whether the component is still signalled.

It is strongly recommended that component descriptors are included in EITpf and EITsch when the video format differs from the service type signalled in the SDT or when advanced audio components are used. This additional signalling stops recorders from scheduling programme events that cannot be presented.

8.11 Use of CRID Signalling

This section gives additional information of the use and interpretation of the content identifier descriptor and default authority descriptor detailed in Sections 8.5.3.12 and 8.5.3.13 of this document.

8.11.1 CRID Types

A content identifier descriptor can indicate the type of CRID that is carried therein. TV-Anytime defines two types of CRID:

- a group CRID – to group together an arbitrary selection of content (e.g. a series)
- a programme CRID – to identify a specific piece of content (e.g. programme)

The DVB carriage of TV-Anytime data specification layers onto this a third concept of a 'recommendation CRID'. This is, in fact, a group or programme CRID but one that has special meaning to a receiver as explained below.

Each event in the EIT may be associated with multiple CRIDs through one or more Content Identifier Descriptors. Where multiple CRIDs are associated with a single event the receiver shall be able to process (and use for recording) the minimum number of CRIDs as set out below:

- DTG Programme CRID - only one programme CRID shall be signalled per event.
- DTG Series CRID - a maximum of two series CRID shall be signalled per event. The receiver shall allow both series to be booked.
- DTG Recommendation CRID - a maximum of four recommendation CRIDs shall be signalled per event. The receiver shall allow all CRIDs to be booked.

All three CRID types can be signalled, with the following interpretation:

8.11.1.1 CRID type 0x31 - DTG programme CRID

In the current context programme CRIDs are used to identify two or more EIT events as being the same programme. This prevents duplicate programmes being recorded from within the same series and also allows alternative programme instances to be recorded (or offered for recording) if a booking clash occurs.

It is not necessary for all EIT events to have programme CRIDs. In the current context they are only useful where alternative instances or split programmes are being identified.

8.11.1.2 CRID type 0x32 - DTG series CRID

Where a series CRID is conveyed in a CID according to the signalling outlined here it is to be used to only refer to an editorial concept of a series.

An event may be associated with more than one series. Where an event is associated with more than one series, an invitation to record 'programmes in the same series as this event' would book to record all events in all series associated with the selected event.

8.11.1.3 CRID type 0x33 – DTG recommendation

This identifies a looser linkage to another programme or series. A recommendation may point to a single event (programme CRID) or a series

(series CRID). While the pointed-to event(s) may also have recommendations the receiver should not follow more than the initial link (i.e. a recommendation should not to be used as part of a linked list).

The presence of recommendations can be indicated to the user (and made available for booking) at the following stages in the user interface navigation[11] :

1. In the EPG grid or schedule view (e.g. indicated as an icon)
2. When highlighting a programme in the EPG grid (e.g. indicated as an icon or through display of the recommended programmes)
3. When accessing more information on a programme (e.g. through pressing an 'i' button)
4. When booking a programme
5. When reviewing/selecting a programme in the bookings list
6. When reviewing/selecting a programme in the recorded content list

If the presence of a recommendation is indicated at stages 2, 3, 4, 5 or 6 (above) then information regarding the recommended programme(s) shall be presented to the user at an appropriate point prior to the recommendation being booked. The receiver shall present and allow the booking of recommendations at either stage 3 or stage 4. Indication of the presence of recommendations at stage 1 or stage 2 is highly recommended.

11 It is recognised that user interface designs vary, therfore the stages presented here aim to give generic stages that manufacturers can correlate to specific stages and views in their own user interface design.

8.11.2 Usage Examples

8.11.2.1 Series Recording

Where multiple events belong to an editorial concept of a series each event may have a series CRID associated with it in the CID. Figure 8-5 shows two events (1111 and 8888) that are linked through the same series CRID.

start times	17:30	18:00	19:00		20:30
Channel 1 content	Soap Episode 1	News	Drama X		Soap Episode 2
event_id	1111	2222	3333		8888
series CRID	/soap	/news	/drmX		/soap
prog CRID	/soap_ep1	---	/drmX_ep1		/soap_ep2

Figure 8-5. Series events in EIT schedule

An event may be associated with more than one series, as shown in Figure 8-6. In the current context there is no way to indicate to a user a distinction of series (as CRIDs are not human readable) therefore when an event used for series booking contains multiple series CRIDs all series referenced by the series CRIDs should be booked for recording. For example, in Figure 8-6 booking a series recording from event 1111 would record events 1111 and 2222, booking a series recording from event 2222 would record events 1111, 2222 and 3333 and booking a series recording from event 3333 would record events 2222 and 3333.

start times	19:00		20:00		23:00
Channel 1 content	Series 1 EP 12		Series 1 Catch-up		Series 2 EP 1
event_id	1111		2222		3333
series CRID	/series1		/series1		/series 2
series CRID	--		/series 2		--
prog CRID	/series1_ep12		--		/series2_ep1

Figure 8-6. Multiple series event in EIT schedule

As the lifecycle of the series CRIDs is longer than the time span of EIT schedule the event used for booking a series may be the only episode of that series currently present in EIT.

8.11.2.2 Alternate Instances

Where a programme is repeated in its entirety a broadcaster may assign the same programme CRID to both EIT events. This enables a receiver to detect an alternative instance of a programme. This can be used to assist in resolution of booking clashes. Where alternate instances belong to the same series this allows a receiver to only record a single showing of each episode, usually the first.

start times	17:30	18:00	19:00
Channel 1 content	Soap Episode 1	News	Drama X
event_id	1111	2222	3333
series CRID	/soap	/news	/dramaX
prog CRID	/soap_ep1	---	/dramaX_ep1
Channel 2 content	Football		Soap Episode 1
event_id	8888		9999
series CRID	---		/soap
prog CRID	---		/soap_ep1

Figure 8-7. Alternate instance in EIT schedule

Where the same programme content is broadcast on SD and HD services the broadcaster may assign the same programme CRID to both EIT events. Each programme instance will have different A/V characteristics which the receiver should take into consideration when choosing an alternative. Where possible the receiver should present information about each instance, e.g. picture quality and content management restrictions, and allow the viewer to be able to express a preference.

Where a receiver can receive multiple regional variations of a service it is likely that multiple alternatives may be available simultaneously. In this case a receiver should pick an alternative that reflects the user's channel preferences, i.e. record from a service in the 'broadcast' LCN range rather than an alternative in the 'variant' LCN range (see Table 8-11).

8.11.2.3 Split Programmes

The CRID supplied in the CID maybe suffixed with an instance metadata identifier (IMI). Two events with identical CRIDs (including IMI) occurring in EIT schedule within the time window specified in Section 8.7.2.3 are considered to be part of the same programme. Figure 8-8 shows an example.

start times	21:00	22:00	22:30
Channel 1 content	Film part 1	News	Film part 2
event_id	1111	2222	3333
prog CRID	/FLM1#1	/News1	/FLM1#1

Figure 8-8. Split event in EIT schedule

If the same film is repeated on another channel (using the same CRID authority) within 3 hours and is also split then a different IMI value will be used. This is shown in Figure 8-9, ‘Channel 2’. If the film is repeated as a whole event then the programme CRID will simply have the IMI part omitted, i.e. /FLM1. This is shown in Figure 8-9, ‘Channel 3’.

start times	21:00	22:00	22:30	23:00
Channel 1 content	Film part 1	News	Film part 2	
event_id	1111	2222	3333	
prog CRID	/FLM1#1	/News1	/FLM1#1	
Channel 2 content	Drama X	Film part 1	Bulletin	Film part 2
event_id	4444	5555	6666	7777
prog CRID	--	/FLM1#2	--	/FLM1#2
Channel 3 content	Soap	Film complete		
event_id	8888	9999		
prog CRID	/soap_ep1	/FLM1		

Figure 8-9. Split event in EIT schedule

Where the gap between events is equal to or greater than 3 hours then the receiver should treat them as separate programmes.

There are cases where a receiver may only see a single CRID and IMI combination. Examples include:

- When a receiver is switched on during the gap between split events.
- When a split event straddles the end of the EIT schedule.

A receiver should treat these as a single event at time of booking but should continue to monitor for additional instances of the CRID and IMI combination being broadcast.

During the lifecycle of EIT schedule broadcasters may change programmes from split to single or vice versa.

Where a broadcaster changes a single programme into a split programme (using IMIs) the broadcaster should ensure that one of the events of the new split programme maintains the event_id of the original single event. Failure to do this will result in lost or incomplete recordings.

8.11.2.4 Recommendations

A CRID supplied in the CID may be classed as a recommendation. This should be treated as a separate function to the series recording mechanism. The recommendation CRID may reference a series or programme CRID. Figure 8-10 shows a recommendation from event 1111 to event 3333 through the programme CRID '/dramaX_ep1'.

start times	21:00	22:00	22:30
Channel 1 content	Soap Episode 1	News	Drama X
event_id	1111	2222	3333
series CRID	/soap	/news	/dramaX
prog CRID	/soap_ep1	---	/dramaX_ep1
rec CRID	/dramaX_ep1	---	---

Figure 8-10. Recommendation to single event (programme CRID)

Figure 8-11 shows a recommendation from event 1111 to the whole 'Drama X' series through the series CRID '/dramaX'.

start times	21:00	22:00	22:30
Channel 1 content	Soap Episode 1	News	Drama X
event_id	1111	2222	3333
series CRID	/soap	/news	/dramaX
prog CRID	/soap_ep1	---	/dramaX_ep1
rec CRID	/dramaX	---	---

Figure 8-11. Recommendation to series (series CRID)

8.11.3 Receiver Monitoring of Series Recording Signalling

Broadcasters often need to change the schedules they publish, therefore the signalled EIT schedule is a dynamic dataset. Where a receiver uses persistent schedule information, for example to maintain a record list or reminder list it should handle changes in EIT schedule gracefully to ensure a good user experience. This includes tracking schedule time changes (start time and duration), spotting and attempting to resolve new clashes, evaluating changes to metadata and processing new or changed series information and recommendations. It is a receiver design issue as to how much user interaction is required or desired when a record list undergoes change.

The lifetime of an event or series identifier (series CRID) that is booked for recording can be viewed to follow four stages: booking, monitoring, recording and viewing, see Table 8-33.

Stage	Receiver interaction with EIT	Potential situations for receiver to handle
Booking	Event or series is booked for recording. Event id and CRIDs are added to record list. If booking a series then receiver may check EIT for other events in series.	Series CRID or programme CRID may not be present, recommendations may not be present. Published start time and duration may not be final.
Monitoring	Receiver receives EIT version number changes. Receiver re-checks EIT on each multiplex switch.	Event may change time, duration, description, etc. May have recommendations added/removed. May be added to, or removed from, a series. May be split or unsplit (event_id must remain in one of the events if programme is split). Alternative instances may be added to EIT.
Recording	EIT p/f monitored for transition of the monitored event to the 'present' event (status 'running') to control start of recording. EIT p/f monitored for absence of event to control end of recording.	The start time and duration that the event is on-air (determined by a 'running' status in EIT p/f) may be different from previously published start time and duration. Recorders need to monitor presence of the event as the 'EIT present event' to ensure a complete recording. Content Identifier Descriptors shall be present in EIT p/f where they appear in EIT schedule for the same event.
Viewing	User may wish to see event information during playback and links to series and recommendation information.	At time of viewing an event may no longer be in EIT schedule. Information may usefully be cached at time of recording to ensure consistent user experience. Information that has been added since the event was booked, e.g. series link, recommendations, may be presented to the user.

Table 8-33. The four stages of an an event or series identifier (series CRID)

When making a booking of an individual programme both the EIT event_id and programme CRID may be available to the receiver for that event. While the event_id can be used as a primary identifier (all events on a service have a unique event_id), the CRID offers an alternative way of tracking the programme which is more closely tied to the content being broadcast rather than the channel-timeslot. For example, if a programme changes channel the event_id will change whereas the CRID should remain unchanged on the new event. Also, if a programme is significantly rescheduled the event_id is likely to change whereas the CRID shall remain

consistent. Therefore, the resolution of a programme CRID to an EIT event should be deferred as long as possible, up to and including resolution through EIT present.
If an event with a changed event_id is still part of a series that is in the receiver's list of series to record then a receiver should still be expected to record the changed event. This could occur if the broadcast episode is changed. This will appear to a receiver as if a new event has been added to the series. Care should be taken in this scenario as the new event may appear to clash will the original event in the receivers record list (which will have been dropped from EIT).

8.12 Use of Related Content Signalling

This section describes the use of real-time information carried in the Related Content Table (RCT). This may be used to enact broadcast-triggered native applications. The currently defined set of broadcast-triggered native applications is listed in Section 8.5.11.

The Related Content Table, carries service specific links to other content. The presence and details of these links change dynamically. When links are available a suitably enabled receiver can display these to a viewer using its native UI: firstly through an indication that links are active (e.g. an icon to say 'press green to book') and then by displaying the list of links. If the links in the RCT table point to other broadcast content then the viewer can choose to book that content to be recorded, through the recorder's usual native booking mechanism.

There is no cross carriage of RCT information.

8.12.1 Icon activation and deactivation

The display and removal from display of an icon is actioned by the following rules:

- a new RCT table (version number change) with a **link count** greater than zero shall cause the icon to appear
- a new RCT table (version number change) with a **link count** equal to zero shall cause any currently visible green icon to be removed. This shall not cause other user interface elements currently displayed (e.g. a trailer booking dialogue) to be removed.

The display and removal of the on-screen icon shall occur within 2 seconds of the RCT table changes described above.

Note: "link count" is the number of links the receiver can understand and use, not the total links in the RCT. For example, a receiver without an IP connection may ignore all links that reference online content, hence, such a link by itself would not cause an icon to pop-up on screen.

When a link is active the green button on the remote control shall be redirected away from any running MHEG applications, see Section 13.6.1.

Promotional linking may be temporarily deactivated by a running MHEG application, see Section 13.10.8.5. For Trailer and GroupTrailer links this deactivation will be until the next RCT transition (version number change) after the MHEG application has reactivated promotional linking.

An icon maybe deactivated by pressing the receiver's usual cancel key e.g. "back up", "exit", "cancel".

8.12.2 Default Icon

The icon that is displayed on screen during an active link can be from a receiver inbuilt icon or a broadcaster signalling icon. Table 112 of ETSI TS 102 323 defines four combinations of how these icons can be used: all combinations may be used.

The presentation of the default icon and/or message shall follow usability guidelines. Manufacturers should be aware that the green button on the remote control will be used to select the promotion and take account of other on-screen objects (such as the MHEG red-button icon).

An electronic version of the default icons will be available on request from DTG Testing.

8.12.3 Image icon descriptor

A broadcast icon may be delivered in an image icon descriptor (see EN 300 468 [2]). This descriptor may be delivered in the 'link info' descriptor loops or in the outer loop of the RCT. Where the descriptor is carried in the outer loop multiple links may reference the same icon through icon_id. An icon may be split across multiple descriptors

The receiver shall use the signalled position information to position the icon if no native UI items are being displayed. If native UI items are displayed then the signalled position information should be used as a guide.

The image icon descriptor may contain inline image data or a reference to an icon carried in the MHEG carousel mounted for the current service. References to icons available through other mechanisms (e.g. IP) shall be ignored and treated as 'not acquirable' when enacting the default_icon_flag rules set out in Table 112 of ETSI TS 102 323.

8.12.3.1 Signalling of icons in multiple links

The set of links of type Trailer or GroupTrailer transmitted in an RCT concurrently shall only signal a maximum of one icon to be displayed.

As a consequence, within a single RCT, the broadcaster shall not signal links requiring both the default icon and the transmitted icon. However, the broadcaster may signal that the default icon shall be displayed if the transmitted icon has not been acquired.

If any Trailer or GroupTrailer link in the RCT has an icon_id which is non-zero, then all other Trailer or GroupTrailer links in the RCT must either indicate that same icon_id or must have both icon_id and default_icon_flag as 0 (no icon for the link).

Note that the broadcaster may transmit image_icon_descriptors in the RCT which are unreferenced by any icon_id in the link_info structures currently being transmitted. Receivers can use this to assist caching of transmitted icons.

8.12.4 Number of Links

No more than 10 links of the types *Trailer* and *GroupTrailer* shall be signalled concurrently.

8.12.5 Order of Links

Links shall be displayed on-screen in the same order they appear in the 'link info' loop of the RCT.

8.12.6 Link Stacking

The link first in the list of links shall be most relevant to the current broadcast content.

A receiver may also offer recent related content information with the current set of links.

8.12.7 Blank Section

8.12.8 Link Types

Only link_type 0x00 (URI string) shall be used. All other link types shall be ignored by the receiver. The URI string within the media_uri_byte shall be a programme or series CRID. The CRID may be resolved to an event through the EIT table.

8.12.9 CRID Resolution and Retention

The CRID may not be resolvable when signalled however a receiver should still allow a booking to be made. Any booked CRIDs shall be retained by a received for up to 13 weeks. If a CRID has not been seen in EIT after 13 weeks it shall be removed from the receiver's booking list.
Resolution of a CRID in the RCT to events in EIT shall include the complete CRID, including any IMI extension except where a conflict occurs, where a receiver may fall back to an alternate instance with or without any IMI. A CRID in the RCT without an IMI shall resolve to matching CRIDs in EIT with and without IMI extension.

Where an IMI is supplied with a CRID in the RCT the associated promotional text shall indicate the reason for targeting a preferred instance, e.g. a signed version.

i.e.

- crid://bbc.co.uk/ABC in RCT shall match either crid://bbc.co.uk/ABC or crid://bbc.co.uk/ABC#1
- crid://bbc.co.uk/ABC#1 in RCT shall as a first preference match crid://bbc.co.uk/ABC#1 however, during clash resolution, a receiver may fall back to an alternate instance with or without any IMI.

8.12.10 HowRelated Classification Scheme

Each link is described within a TVAnytime HowRelated classification scheme. The how_related_classification_scheme_id shall be 0x02 (urn:tva:metadata:HowRelatedCS:2007). All other classification schemes shall be ignored by the receiver. A receiver shall continue to operate and process links of known classification in the presence of undefined classifications in the link info loop.

8.12.11 HowRelated Types

The following TV-Anytime HowRelated types may be signalled. The value coded in column 1 of Table 8-34 'RCT term_id' shall be carried in the term_id field of the link_info structure of the RCT. This is the 'rank' of the TVA termId in the HowRelatedCS:2007 classification scheme, see TS 102 323. Other types may be signalled in the future and any HowRelated types not defined in this document shall be ignored by a receiver. A receiver shall continue to operate and process known types in the presence of undefined types in the link info loop or types that the receiver is unable to process.

RCT term_id as coded	TVA termId in HowRelatedCS:2007	Name	Definition	Receiver behaviour
0x002	1.2	IsTrailerOf	The reference points to a resource of which the currently described resource is a trailer	Receiver will offer (through a dialogue) the user the option to book the pointed to programme (programme CRID) for recording.
0x005	2.2	IsGroupTrailerOf	The reference points to a group of resources for which the currently described resource is a trailer.	Receiver will offer the user the option to book the pointed to series (series CRID) for recording.

Table 8-34. HowRelated types for Trailer Booking Service

8.12.12 Promotional Text

Promotional text shall accompany each link. The language of the text field is defined in Section 8.5.1.2. It shall describe the event being promoted in a form which is suitable for display to the viewer. There shall be sufficient information carried to allow the viewer to identify the content.

Broadcasters shall not indicate the link type in the promotional text: further assistance shall be provided by the receiver software, e.g. "Book this series".

A short event descriptor shall also be included and displayed according to the rules set out in Section 8.5.3.18.

8.12.13 RCT size

The total size of an RCT sub-table being signalled must not exceed 65535 bytes.

8.13 Content Management Signalling

This section describes the Content Management policy for content delivered by broadcast. For content delivered by IP see Section 16.5.5.

The Content Management policy for high definition content is signalled to receivers through the DVB FTA_content_management_descriptor.

The descriptor may be carried within the NIT, SDT and EIT. The order of precedence and scope is defined in EN 300 468 [2]. It is proposed that a private data specifier shall be used to precede each instance of the FTA content management descriptor, the user defined bit shall be set to "1". This ensures compliance with DVB BlueBook A 038 [151]. This will be added in a future corrigenda subject to industry approval and understanding of potential receiver impact.

There is no requirement to protect standard definition broadcasts, standard definition outputs or standard definition copies of high definition content, which it is always permissible to make. Furthermore, there is no requirement to implement Macrovision or CGMS-A on analogue standard definition receiver outputs. Note that receivers shall not provide any functional analogue high definition outputs (see Section 22.3.4.4.1).

Receivers shall respond to the Content Management signalling in accordance with the measures defined in Table 8-35. When there is no FTA_content_management_descriptor in scope, no restrictions apply to the content. When content is signalled with protection, it shall not be possible to export the content in high definition[12] without using one of the technologies specified below:

- HDCP (High-bandwidth Digital Content Protection).
- DTCP (Digital Transmission Content Protection).
- AACS (Advanced Access Content System).

12 In this context, High Definition shall mean greater than 520,000 pixels per video frame as defined by DTCP.

- AES128 or Triple DES (for encryption and binding to the receiver)

Note other technologies, in addition to HDCP, DTCP and AACS, may be added in future versions of this document.The content management system supports the copying and distribution of HD content between a range of (compatible) devices within the home, including portable devices, and the wider sharing of certain content over the Internet. Table 8-35a summarises the content management measures provided by the specification.

All HD content may be "time-shifted". This means that receivers are allowed to record the content in such a way that it is bound to it by physical or electronic means. For content signalled with content protection it shall not be possible (using reasonable methods available to a user) to access such time-shifted content on any other device at any time in a usable form (except as explicitly allowed in this section).

Note reasonable methods are deemed to include, but not be limited to, changing a user accessible setting in the receiver, changing a user accessible setting in the recording device (if separate, e.g. removable flash device) or using commonly available software on another consumer device (either software delivered as standard with the device or downloadable via the internet after discovery by a search engine).

Content may be recorded onto "removable media" (e.g. Blu-ray disc) for more general use that allows play back on any compatible device, subject to the restrictions in Table 8-35 .

Should receivers be technically or legally unable to implement a signalled state, they shall disable the export of HD content on that interface or media.

"Managed Domains", as described by DVB, are not defined in this specification. States signalled by the broadcaster as *control_remote_access_over_internet* = "01" and *control_remote_access_over_internet* = "10" shall be treated by the receiver as *control_remote_access_over_internet* = "11".

Receivers may output certain content over a network to "local" or "remote" devices, according to Table 8-35. Receivers shall determine if they are "local" to the device being output to by using the DTCP-IP "Additional Localization via RTT" protocol. At the time of writing, this protocol deems devices to be "local" if the RTT (Round Trip Time) is less than or equal to 7 ms. All other devices shall be considered "remote".

Subject to the DTCP licence conditions, any "local" high definition network copy may subsequently be moved or copied to removable media, a secondary device or a portable media player.

The states where *do not_scramble* = "1" and *control_remote_access_over_internet* ≠ "00" are not currently defined by this specification. However, Table 8-35 defines how a receiver shall behave should these states be encountered.

DVB has not yet defined the carriage of System Renewability Messages (SRMs). Once defined, support for DTCP and HDCP device revocation will be included in this specification. Until that time, the *do_not_apply_revocation* bit carried within the *FTA_content_management_descriptor* may be ignored

8.13.1 Content Management measures

	FTA Content Management Descriptor		Local environment (e.g. within a single household)						Wider sharing		
Content management state	**Do_not_ scramble**	**Control_remote_ access_ over_Internet**	**Record on DTR [1]**	**View on secondary display [2]**	**Copy to Blu-ray**	**Copy to secondary devices**	**Copy to HD PMP [3]**	**SD copy to other devices or media**	**Duplication of HD Blu-ray copies**	**Duplication of SD copies**	**Upload HD to internet**
Free Access - No Encryption	1	00	Yes	Yes	Unlimited copies - with no encryption	Unlimited copies -encryption optional	Unlimited copies - encryption optional	Unlimited copies - with no encryption	Second-generation copies possible (with no encryption)	Unrestricted and to any device	Unrestricted
Free Access - EPN	0	00	Yes	Yes	Unlimited copies - but with encryption	Unlimited copies - but with encryption[4]	Unlimited copies - but with encryption[4]	Unlimited copies - with no encryption	Second-generation copies possible - but these retain encryption	Unrestricted and to any device	Not permitted
Managed Copy (With Encryption)	0	11	Yes	Yes	One additional HD format copy permitted on one other device or to a removable media (protected by AACS) (in addition to original DTR recording)			Unlimited copies - with no encryption	Second generation copies not permitted	Unrestricted and to any device	Not permitted

1. DTR = Digital Television Recorder where the storage is bound (physically or electronically) to the receiver
2. With a suitable home network consumers are able to view any content stored on their DTR or Blu-ray recorder on secondary (network-connected) displays.
3. HD PMP = HD-capable Personal Media Player – e.g. an HD-capable 'iPod'-type device.
4. Protected by a content protection technology approved by DTCP. Other technologies may be added in the future.

Table 8-35a: Summary of Content Management Measures

8.13.2 Content Management mapping

			FTA Content Management Descriptor		Display (HDMI)	Storage Bound to Receiver (Time-shifting - e.g. internal HDD, encrypted USB HDD and Flash cards)	Removable Media (General use e.g. Blu-ray)							Networks: Local					Networks: Remote
State	**Short Name**	**Description**	**Do_not_ scramble**	**Control_remote_access_ over_Internet**	**HDCP**	**Content Encryption AES-128 or Triple DES**	**Permitted Operations**	AACS Encryption: CCI	EPN	ICT	Trusted Input	Digital Only Token	APS	**Permitted Operations**	DTCP-IP: CCI	EPN	ICT	APS	**Permitted Operations**
0	Free Access - EPN	Unrestricted Local Access **with** Encryption (Encryption Plus Non-assertion).	0	00	On	Encrypted and bound to receiver.	MOVE and COPY, Encryption On (EPN).	"00" Copy Control Not Asserted	"0" Asserted	"0" Constrained Image	"0" Not Trusted	Analogue & Digital Outputs	"000" APS off	VIEW, MOVE and COPY, Encryption On (EPN).	Copy-freely	"0" Asserted	"0" Constrained Image	"00" Copy Free	No remote access.
1	Free Access - No Encryption	Unrestricted Local and Remote Access **without** Encryption.	1	00	Off [1]	Encryption and binding recommended but not required[2].	MOVE and COPY, Encryption Off (No AACS).	AACS not required						VIEW, MOVE and COPY, Encryption Off.	DTCP not required				No restriction
2	Managed Copy (With Encryption)	Local Access between devices only, plus single removable copy.	0	01 10 11	On	Encrypted and bound to receiver.	MOVE and COPY [3] Encryption On. Once content item copied, item and the copy shall be marked "Copy No More".	"01" No More Copy	"1" Unasserted	"0" Constrained Image	"0" Not Trusted	"0" Analog & Digital Outputs Enabled	"000" APS off	VIEW, COPY, MOVE, Encryption On.	Copy One Generation [4] /No More Copies[5]	"1" Unasserted	"0" Constrained Image	"00" Copy Free	No remote access.
3	Reserved	Shall not be broadcast in the UK	1	01 10 11	Off[1]	Encryption and binding not required[2].	AACS not required							DTCP not required					No remote access.

1. By default receivers shall leave HDCP enabled at all times. See Section 22.3.4.1.1
2. Content stored unencrypted on external devices (e.g. USB drives) is not considered a "time-shift" recording as it is not bound to the receiver. Instead it is available for general use as "removable media".
3. DVB permits "transfer" (i.e. MOVE) onto removable media. A single COPY is permitted here.
4. DTCP cannot distinguish between copies on removable media and copies on "devices", so "Copy One Generation" is specified as it is the closest match to the DVB intent.
5. The export of "time-shift" recordings shall be considered equivalent to the export of the original content at the time of broadcast. Thus "time-shift" recordings shall be exported as "Copy One Generation" until either a "Removable Media" copy has been made by the receiver or a copy made over the network. Once such a copy has been made "time-shift" recordings shall be exported as "No More Copies". Notwithstanding the above, any such "time-shift recordings may be "moved" in accordance with the DTCP license.

Table 8-35: Content Management Mapping

8.14 Broadcast Record Lists

8.14.1 Introduction

Broadcast Record Lists is a method by which broadcasters may signal in the broadcast stream particular content to be acquired by an appropriately enabled receiver. Once a user has selected a record list, a receiver will acquire the content without user intervention.

This functionality will enable broadcasters to promote particular content, expose users to niche programming or expose viewers to content that is commercially attractive for example. It also allows broadcasters to use spare multiplex capacity for the pre-delivery of content.

These are lists of content where each has a consistent theme such as “the best of the last week” or “classic films”. Each list will carry metadata including a descriptive title and synopsis, along with a unique identifier in the form of a CRID. When a user selects a record list, events referenced by that list will be automatically booked and then acquired without further user intervention. The signalling will carry the metadata required for the receiver to automatically capture, store and expire recorded content.

The toolkit described in this section allows a wide range of functionality such as the creation of record lists, ability to deliver content off the schedule, the ability to deliver content in an obfuscated manner and the ability to mandate embargo and expiry times.

The metadata required to support the described record list is made available using the TV-Anytime XML model (TS 102 822-3-1 [147]).

Figure 8-12 depicts the data model for the record list functionality. Figure 8-12 (A) shows how individual TVA "push download" events hold a reference to the groups in which they reside. In most cases, the PushDownloadProgram will resolve to an event in the EIT; the start time, duration, program title and synopsis of the event may be picked up from there. Provision has also been made for recordings of content not listed in the schedule (Figure 8-12 (B). In this case, an entry in the EIT will not be present and a locator will be used to specify the service, date, time and duration for the event. In this case, the title and synopsis for the event will be delivered using a TV-Anytime ProgramInformation table.

The remainder of this section is ordered top-down, starting with the way the TV-Anytime XML shall be used, then describing how the XML is to be split in to fragments, how those fragments are packaged into containers, carriage of the containers in a DSMCC object carousel and finally profiling the descriptors used to enable the discovery of the metadata carousel.

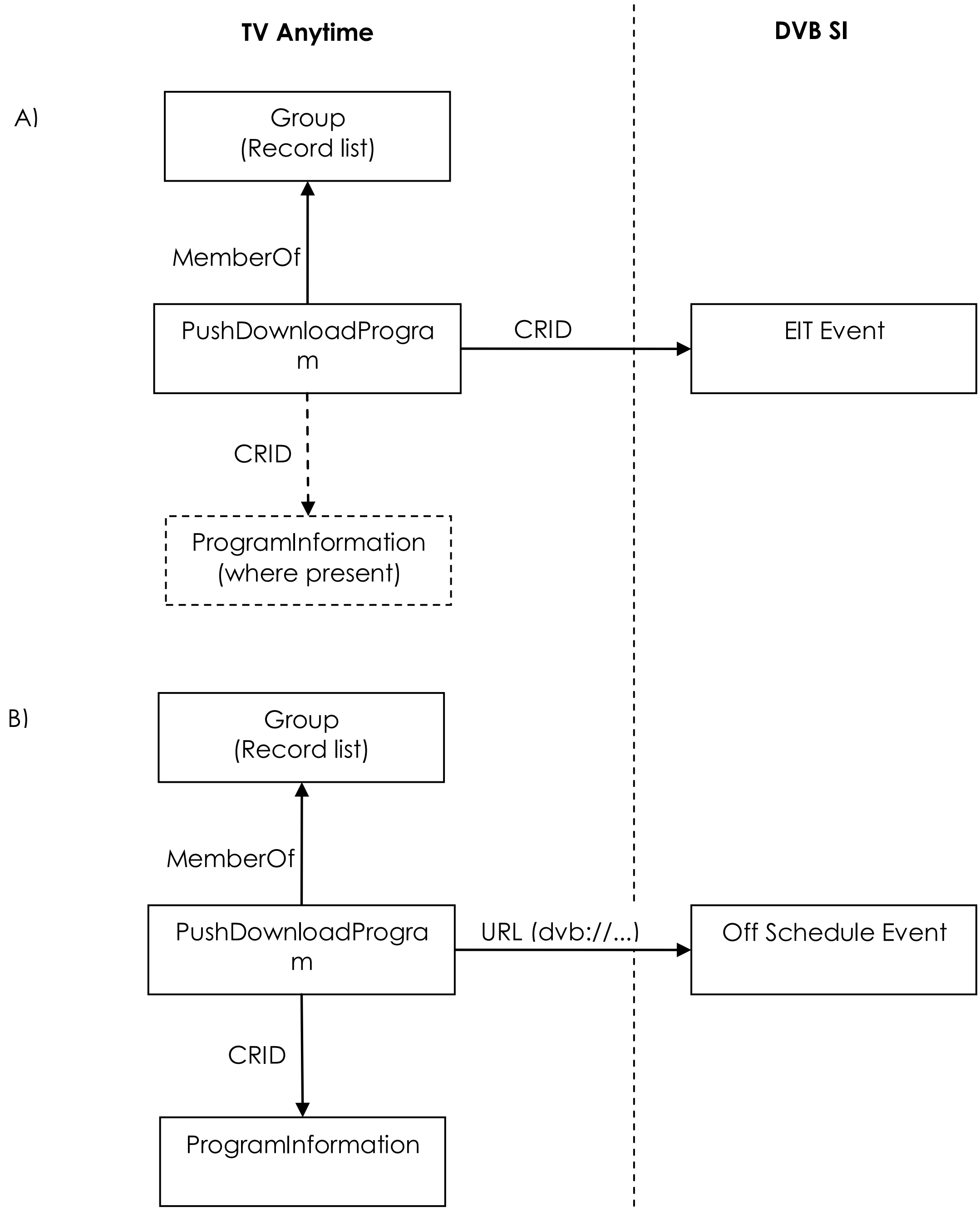


Figure 8-12. Overview of data structures required for Broadcast Record List service (informative)

8.14.2 General

Broadcast Record List functionality is enabled by the use of a subset of the TV-Anytime XML specification TS 102 822-3-1 [147].

For compatibility with future updates to this functionality and to satisfy TS 102 822-3-2 [148], receivers shall ignore unrecognised XML elements and sub-elements if the XML is otherwise well formed. XML fragments containing malformed XML may be ignored in their entirety. Receipt of unrecognised XML elements or malformed XML shall not cause the receiver to malfunction.

8.14.2.1 Content Grouping

Broadcasters shall signal groups of related content (record lists) using TV-Anytime groups with a group type of "automaticAcquisitionThemed" or "automaticAcquisitionNonThemed".

A device shall receive and manage all TV-Anytime groups that are part of the Record List metadata service.

8.14.2.2 Content Acquisition

A receiver shall automatically acquire, without user intervention, all events that correspond to PushDownloadProgram fragments which are members of Record List groups to which the user has subscribed. The resolution from PushDownloadProgram to event proceeds as follows:

Acquisition of Scheduled Events

A PushDownloadProgram CRID shall correspond to a program CRID either currently in the EIT or a program CRID that shall be broadcast at a later date.

Events requiring acquisition from the schedule shall be acquired according to the current CRID based recording acquisition rules.

Acquisition of Off-Schedule Events

An off-schedule delivery shall be identified by the presence of a ProgramURL in the PushDownloadProgram. In this case, the CRID carried by the PushDownloadProgram fragment shall not resolve to any event carried in any EIT. The contents of the URL element shall provide the means to locate an instance of a broadcast event.

The signalled URL shall take the following form and be interpreted as described in TS 102 323 [98] clause 6.4:

```
dvb://<original_network_id>.[<transport_stream_>].
<service_id>~time_duration
```

Different configurations of URL may be used in the future to signify different methods of acquisition or event. A receiver shall ignore any URL format it cannot interpret and events in any location from where they cannot be acquired.

Where an event is to be delivered off-schedule, the CRID carried by the PushDownloadProgram shall match with the CRID of a ProgramInformationFragment. This ProgramInformationFragment shall provide, at minimum, a title and synopsis for the off-schedule event.

Alternate instances of an off schedule event are indicated by multiple instances of a PushDownloadProgram with the same identification CRID but different ProgramURLs. The InstanceMetadataID element of the PushDownloadProgram shall be used to differentiate between these multiple instances. The value of InstanceMetadataID is unconnected to an IMI extension for a CRID in the EIT.

Acquisition of Obfuscated Events

Obfuscated events are, by their nature, delivered off-schedule and as such shall also be identified by the presence of a ProgramURL in the

PushDownloadProgram. Signalling and delivery of obfuscated events is described in 8.14.2.13.

8.14.2.3 Recording List Hierarchies

A recording list may contain a further reference to one or more recording lists in order to create a hierarchy.

When booking a record list, the receiver shall book all children of that record list. Broadcasters shall not signal any Broadcast Record List hierarchy with more than five levels (excluding the mandatory default record list described in 8.14.2.4)

There is no requirement for the receiver to detect loops in any group hierarchy. It is the broadcaster's responsibility to ensure no loops are created before the metadata is published.

8.14.2.4 Default Record List Group

The Record List acquisition functionality shall have a root record list that shall be identified by a well-known CRID which shall take the form:

crid://<authority>/default1.

Where <authority> is derived from the default group authority structure 8.14.7.4, found in the metadata descriptors extension 8.14.7.3.

All groups that have this group as their root are conformant to and shall be treated as defined in this document.

Groups that do not have the default group at the root of their hierarchy shall be ignored by the receiver unless specifically recognised. In this case they may be treated in a manufacturer defined manner.

8.14.2.5 Embargoed Content

The embargo date and time of an event is signalled in the ActivationTime element of the associated PushDownloadProgram. Until this date and time is reached the content shall not be playable although associated metadata (synopsis etc.) may be displayed if required.

The receiver shall use the broadcast time as the underlying timebase to determine whether the embargo time has passed.

If no embargo time is signalled for a piece of content it is assumed that content is available for viewing immediately.

8.14.2.6 Content Expiry

For obfuscated content, the ExpiresTime element, if present, shall define the date and time after which the associated instance of the content shall no longer be playable by the user. For all other content, the ExpiresTime element shall not be signalled and may be ignored by receivers.

The receiver shall use the broadcast time as the underlying timebase to determine whether the expiry time has passed.

8.14.2.7 Content Versioning

Updates to the version of a particular piece of content may be signalled using the ContentVersion element. If the version of a piece of content that has already been acquired is seen to change, the event should be re-acquired, replacing the old version in storage.

8.14.2.8 Metadata Changes Post Broadcast

A receiver may monitor the metadata for changes up to 7 days from the original broadcast of the content, or up to the event's availability to the viewer (if signalled).If a change is detected to an already acquired event, then the most recently transmitted version should be applied.

8.14.2.9 Post Watershed Material

For events with an EIT entry, the guidance rules in section 8.5.3.20 and section 22.4.3.3 shall apply.

For events delivered off schedule or obfuscated, the ParentalGuidance element of ProgramInformation shall allow receivers to replicate the behaviour of the guidance_descriptor (see section 8.5.3.20). If guidance is required for an obfuscated or off-schedule event, a term from the DTGContentWarningCS classification scheme shall be present to indicate the type of protection required. The DTGContentWarningCS classification scheme terms shall be mapped to the three states of the guidance_descriptor, as shown in Table 8-35b:

guidance_descriptor		DTGContentWarningCS term
guidance_type	guidance_mode	
0x0	-	urn:dtg:metadata:cs:DTGContentWarningCS:2011#W
0x1	0x0	urn:dtg:metadata:cs:DTGContentWarningCS:2011#G
0x1	0x1	urn:dtg:metadata:cs:DTGContentWarningCS:2011#W

Table 8-35b Mapping between DTG guidance_descriptor values and TVA DTGContentWarningCS term

Any event with the ParentalGuidance element present shall implement the relevant protection rules from section 22.4.3.3

The DTGContentWarningCS classification scheme is held under the DTG's namespace and is freely available from the DTG upon request.

8.14.2.10 Unresolvable PushDownloadPrograms

If a CRID signalled in a PushDownloadProgram cannot be resolved to an EIT event, the receiver shall continue attempts to resolve the signalled CRID according to Section 8.7.2 rules.

8.14.2.11 CRID Lifecycle Management

Fundamental CRID lifecycle management remains as per the Section 8.7.2 rules.

8.14.2.12 Blank section

Intentionally left blank..

8.14.2.13 Obfuscated Events

Off schedule events may be delivered in an obfuscated manner in order to make them inaccessible to receivers not supporting record lists. In order to hide an event, the stream types of the audio, video, subtitles and audio description (if present) shall be set to 0x06 (PES private data) in the associated PMT. The true component types shall be signalled using the event locator URI.

An obfuscated event may be recognised by the presence of a ProgramURL element in the PushDownloadProgram fragment where the contained URI has the following form

```
dvb://<original_network_id>.[<transport_stream_>].
<service_id>.fully_qualified_component *( "&" fully_qualified_component
)~timeduration
```

Where

```
fully_qualified_component = "fqc=" stream_content_and_component_type ","
component_tag *( [ "," iso639_language_code )]
```

The elements of this URI are defined in DVB Bluebook A142 (December 2010) [150]. The URI shall contain at minimum a fully_qualified_component for the video and a fully_qualified_component for the main audio. Fully_qualified_components describing audio description and subtitles may also be present. If subtitles are present, the PMT loop associated with the subtitles shall carry a subtitling descriptor which shall be interpreted in the normal way. The `stream_content_and_component_type` shall authoritively signal the component types for each stream overriding any component descriptors in any associated EIT.

The CRID carried by the PushDownloadProgram signalling an obfuscated event shall match with the CRID of a ProgramInformationFragment. This ProgramInformationFragment shall provide, at minimum, a title and synopsis for the off-schedule event. All event information shall be retrieved from the associated ProgramInformation fragment, EIT information shall be ignored.

8.14.2.14 Use of Program Information

In the case where information is available both from EIT and programme information table, the programme information table shall be used.

8.14.2.15 Version Changes (informative)

There are a number of places in the metadata where version changes can occur. The interaction of these changes can be summarised as in the table below.

Version number of module in DSM-CC object carousel	One or more of the files (containers) that this module is carrying has been updated. The container or containers transported by this module should be reacquired and the container header checked for version number changes.
Version change of referenced fragment in container header	The fragment associated with the version increment has changed in some way. Note the container itself has no associated version number.
Version change associated with TVAMain fragment	The contents of the TVAMain fragment have changed in some way. A change in a normal fragment will not trigger a version change for the TVAMain fragment, only if the TVAMain fragment itself changes will a version change be necessary.
Version change associated with XML for normal fragment	The contents of this fragment have changed in some way.

Table 8-35c Version changes in the Broadcast Record List delivery system (informative)

8.14.3 TV-Anytime XML Profile

The following section provides a profile for TV-Anytime XML for used to support Record List functionality. The symbol "@" has been used to denote an attribute.

All elements and attributes in this section are mandatory to broadcast unless specified otherwise.

The types for and definitions of all elements and attributes contained in the broadcast XML metadata shall be as set out in TS 102 822-3-1 [147] and the associated schema unless overridden or otherwise clarified by the profile in this section.

8.14.3.0 Synopsis

Where a synopsis element is present, a length attribute shall be included as detailed in TS 102 822-3-1 [147]. A synopsis with the length attribute "medium" (maximum 210 characters) shall always be provided. Additional synopses with "short" or "long" values for length may also be supplied. A maximum of one of each length type shall be present.

8.14.3.1 Language

A 2-character code as defined by ISO 639-1 [149] shall be used to signal the language where appropriate. These language codes are shown with their current equivalents in Table 8-36.

Language	XML 2-character language code	D-Book 3-character language code
English (default)	"en"	"eng"
Welsh	"cy"	"wel" or "cym"
Gaelic	"gd"	"gla"
Irish	"ga"	"gle"

Table 8-36 Language codes supported.

8.14.3.2 TVAMain Type

TVAMain	Profile
@lang	The language attribute shall be present and shall indicate the primary language for the metadata service.
@publisher	Shall be used to signal the publisher of this metadata according to TS 102 323 [98] clause 8.9.

8.14.3.3 MetadataOriginationInformation Type

MetadataOriginationInformation	Profile
@OriginID	A value used to uniquely identify this MetadataOriginationInformation instance. An OriginID shall exist for every metadataOriginIDRef in the metadata.
Publisher	A human readable name of the publisher. The maximum length of this string shall be 20 characters, aligning with the Service Provider Name field in the Service Descriptor (Table 8-26).

8.14.3.4 GroupInformation Type

GroupInformation	Profile
@lang	*Optional*. A lang attribute may be included to indicate the language used in any textual descriptions contained in this fragment and shall override a language set by the TVAMain fragment.
@groupID	A unique identifier in the form of a CRID for the Record List.
@metadataOriginIDRef	An identifier that shall resolve to the originator of this Group.
@ordered	*Optional.* Set to true if child groups shall be ordered.
GroupType	
@value	Groups associated with the Broadcast Record List service shall have the Group Types "automaticAcquisitionThemed" or "automaticAcquisitionNonThemed".
BasicDescription	-
Title	Title of the Record List. The maximum length of the title shall be 40 characters.
Synopsis	A short description of the record list's content.
Genre	*Optional*. If present shall contain a term ID from ContentCS (TS 102 822-3-1 [147] Appendix A.8). Multiple genres may be present.
MemberOf	Allows the creation of recording list hierarchies by holding a reference to a more general recording list. Mandatory for all groups apart from the default group.
@crid	A CRID referencing a more general group.
@index	*Optional.* Used to determine ordering if the parent Group indicates ordering on child Groups.

Note: the xml:lang attribute shall not be used in the Title or Synopsis elements, instead this shall be signalled as an attribute of GroupInformation and inherited accordingly.

8.14.3.5 PushDownloadProgram Type

PushDownloadProgram	Profile
Program	-
@CRID	This CRID indicates the event which should be resolved via the EIT and booked for automatic acquisition. If a ProgramURL is also present, the event is to be delivered off schedule and so this CRID will not resolve to an EIT event. Instead it shall be matched with an entry in the ProgramInformationTable
ProgramURL	*Optional*. An alternative location for the event, provided as a URL. See 8.14.2.1 and 8.14.2.13.
InstanceDescription	
MemberOf	Contains a CRID identifying the group to which this PushDownloadProgram belongs. Multiple instances of the MemberOf element may be present indicating the PushDownloadProgram belongs to multiple groups.
PublishedDuration	The duration of the event. Suitable for display to the user but a more accurate duration shall be determined using the EIT or DVB locator.
ContentVersion	*Optional*. The version of the associated content. This value shall be represented as a two character hex string. The value will increment whenever the content is updated, modulo 0xFF.
ExpiryTime	*Optional*. If present, this specific piece of pushed content will expire at the indicated time and may be removed from the receiver depending on user preferences, see section 8.14.2.6. If not present, the content is playable indefinitely.
ActivationTime	*Optional*. This value shall define the earliest time at which a user may view the associated content (embargo date/time). If this element is not present then the content is viewable immediately.

8.14.3.6 ProgramInformation Type

ProgramInformation	**Profile**
@ProgramId	A CRID identifying the content to which this ProgramInformation relates.
@lang	*Optional*. A lang attribute may be included to indicate the language used in any textual descriptions contained in this fragment and shall override a language set by the TVAMain fragment.
BasicDescription	
Title	Title of the program. The maximum length of the title shall be 40 characters.
Synopsis	A short description of the event.
ParentalGuidance	*Optional*. This element replicates the guidance_descriptor, see section 8.14.2.9. Present only if guidance is required. No more than one ParentalGuidance element may be present in any ProgramInformation fragment.
mpeg7:ParentalRating	*Mandatory if ParentalGuidance is present*. Shall contain one of the two DTGContentWarningCS terms from table X.
ExplanatoryText	*Mandatory if ParentalGuidance is present.*. This field shall replicate the functionality of the textual description found in the guidance_descriptor. The length attribute shall not be present and the maximum length of this text shall be 75 characters to align with the guidance_descriptor. Only one ExplanatoryText field shall be present per ParentalGuidance field.

8.14.4 Fragmentation of Record List Metadata

Record List metadata is conveyed as a subset of a TV-Anytime metadata description (TS 102 822-3-1 [147]), represented in XML. TV-Anytime XML files shall be fragmented as defined in TS 102 822-3-2 [148] clause 4.3.

Each fragment shall have a fragment ID which shall be a 6 digit hex string between 0x000001 and 0xFFFFFF.

The broadcaster will ensure this value is unique within the metadata service and shall not re-use a fragment ID for at least 32 days.

The value of the fragmentVersion attribute of each fragment shall be a 2 digit hex string. Each time the content of a fragment changes, the version number of that fragment shall be incremented modulo 0xFF.

8.14.4.1 New Fragments

A new XML fragment shall be inserted into an appropriate container or a new container as appropriate.

8.14.4.2 Deleted Fragments

Fragments may be removed from the metadata service. Fragments that cannot be found and are not referenced from a moved fragments structure shall be deemed to have been deleted.

8.14.4.3 XML Declaration

The XML declaration at the beginning of an XML fragment is optional and may be omitted for reasons of efficiency. If this declaration is not present, the defaults of XML version 1.0 and UTF-8 encoding shall be assumed.

8.14.4.4 Fragment Encoding and Termination

The XML text for each fragment carried in the binary repository of the container shall be encoded as UTF-8.

The text of each fragment carried in a binary repository shall be terminated with a null character 0x00 (TS 102 822-3-2 [148]).

8.14.4.5 Carriage of Fragment Version and ID

For efficiency, the version and ID shall be removed from the fragment XML as part of the containerisation process and instead these values shall only be carried in the encapsulation structure for that fragment.

8.14.4.6 TVAMain Fragment

A TVAMain fragment shall be present.

A version change for the TVAMain fragment shall force a receiver to reacquire all fragments in the metadata service. As this is a costly procedure, the version of the TVAMain fragment signalled in the encapsulation structure should be checked, even if the receiver detects file has been updated.

The TVAMain fragment shall be carried in its own container with the filename “tvamain”.

The TVAMain fragment shall be given the fragment ID 0x000000 in the tvamain encapsulation structure.

8.14.5 Carriage of XML Fragments

The specification for carriage of TV-Anytime XML in the UK is a profiling of TS 102 323 [98] clause 8 with the distinction that binary encoding is not used.

8.14.5.1 Containers

All data for the TV-Anytime metadata service shall be carried in containers as defined in TS 102 822-3-2 [148] clause 4.5.2.1.

If one or more fragments are carried in a container then an encapsulation structure and a binary data repository must both be present. A moved fragments structure may be present if required.

The maximum size of a single container shall be 64Kbytes.

8.14.5.2 Container Identification

Each container shall have an identifier which shall be a value between 0x0000 and 0xFFFF. This identifier shall be unique within the metadata service at any one time and broadcasters shall ensure container IDs are not re-used for 32 days.

8.14.5.3 Encapsulation

The encapsulation structure shall be prepared as defined in TS 102 822-3-2 [148] clause 4.6.1.1.

The value of the fragment_reference_format shall be set to 0xF0. Use of this value shall indicate an unencoded_fragment_reference structure is to be used in the loop of the encapsulation structure.

The unencoded_fragment_reference structure is defined as follows:

Syntax	No. of bits	Mnemonic
`unencoded_fragment_reference(){`		
`unencoded_fragment_pointer`	16	uimsbf
`}`		

Table. 8-37 Unencoded fragment reference

Unencoded_fragment_pointer: Offset in bytes from the start of the binary repository to the first byte of the fragment.

Fragments shall be described in the loop of the encapsulation structure in the same order with which they are placed in the binary repository (in order of ascending fragment ID). Maintaining consistency of fragment ordering between the encapsulation and binary data repository may allow the receiver to determine the length of each fragment by using adjacent unencoded_fragment_pointer values.

8.14.5.4 Binary Data Repository

Fragments are carried in the binary data repository structure as detailed in TS 102 822-3-2 [148] clause 4.6.1.4.1.

Fragments are placed in this structure in order of ascending fragment ID.

8.14.5.5 Moved Fragment Structure

The moved fragments structure shall be constructed as defined in TS 102 822-3-2 [148] clause 4.6.1.2.

If a fragment is moved from one container to another, the original container shall carry a moved fragments structure and use it to signal the new location of the fragment. The entry in the moved fragment structure shall be present for the lifetime of the moved fragment.

A container may contain only a moved fragments structure and no binary repository if necessary.

8.14.6 Carriage of Containers

Containers for a single metadata service shall be carried as file objects in an object carousel as profiled in TS 102 323 [98] Section 9.2.1. All containers shall be located in the directory signalled by the metadata descriptor relating to this metadata service. Multiple metadata services may co-exist in the same carousel, providing each is carried in a separate directory. A single metadata service cannot be spread over multiple directories.

Each file object shall contain exactly 1 container.

The container's ID shall be signalled using the filename as described in TS 102 323 [98] clause 9.2.2. Thus the name of a file carrying a container shall consist of 4 hex digits followed by the extension ".d".

8.14.7 Record List Metadata Carousel Discovery

The carousel carrying the TV-Anytime metadata shall be identified using a metadata pointer descriptor and a metadata descriptor as defined in ETSI TS 102 323 [98] clause 5.3. The metadata descriptors extension shall be present in both the metadata pointer descriptor and metadata descriptor.

8.14.7.1 Metadata Pointer descriptor

The metadata pointer descriptor (ISO/IEC 13818-1 [36]) shall be carried in the NIT or SDT, as profiled in TS 102 323 [98] Table 4. The scope implied by the location of the metadata pointer descriptor shall be respected. If the metadata pointer descriptor is delivered in the NIT, the metadata shall be valid for the network. If the metadata pointer descriptor is delivered in an SDT, then it shall be placed in the descriptor loop of all services for which the metadata service is relevant.

The value of the metadata_application_format field shall be 0x0101, signifying the metadata contained conforms to this document.

The value of the metadata_format field shall be 0x3F, signifying the receiver should use the metadata_application_format value to interpret the format of the carried metadata.

The value of the metadata_locator_record_flag field shall be 0b0.

8.14.7.2 Metadata Descriptor

The metadata descriptor (ISO/IEC 13818-1 [36]) shall be carried in the PMT entry which relates to the carousel carrying the metadata service.

The value of the metadata_application_format field shall be 0x0101, to match the metadata_application_format field in the metadata pointer descriptor.

The value of the metadata_format field shall be 0x3F, matching the metadata_format field in the metadata pointer descriptor.

The value of the metadata_service_id field shall match the metadata_service_id field in the metadata pointer descriptor.

The value of the decoder_config_flags field shall be set to 0b000 as no configuration is required.

The value of the DSM-CC flag shall be set to 0b1 as the metadata is delivered in a carousel.

The value of the service_identification_record field shall carry the path to the metadata in the carousel to which this descriptor refers. This path follows the convention set out in TS 102 323 [98] clause 5.3.4.2

8.14.7.3 Metadata Descriptors Extension

Both the metadata pointer descriptor and metadata descriptor shall contain a metadata descriptors extension to ensure the metadata is compliant to TS 102 323 [98]. However, the metadata descriptors extension found in the metadata descriptor shall have authority over the metadata descriptors extension found in the metadata pointer descriptor. The metadata descriptors extension shall be constructed as described in TS 102 323 [98] Table 10.

The value of the `DVB_carriage_format` field shall be set to 0x0, indicating delivery of containers is aligned with TS 102 323 [98] Section 9.2.1.

The value of the metadata_service_identifier_flag field shall be set to 0b0.

Use of fragment types is not specified. The fragment types list may appear in the broadcast. Receivers shall operate correctly in the presence of them.

The `metadata_service_identifier` shall be present and used to identify the Record List metadata service as profiled in TS 102 323 [98] clause 9.6.

The user_data_bytes shall carry a default group authority structure as defined in 8.14.7.4.

8.14.7.4 Default Group Authority Structure

The default group authority structure shall convey the authority for the default Record List group CRID.

Syntax	No. of bits	Mnemonic
`default_group_authority_structure(){`		
`authority_string_length`	8	uimsbf
`for (i-0;i<authority_string_length;i++){`		
`authority_byte`	8	uimsbf
`}`		
`for (i-0;i<N;i++){`		
`user_data_byte`	8	bslbf
`}`		
`}`		

Table 8-38: Default Group authority structure

authority_string_length: The number of authority_bytes in the authority_string.
authority_byte: This byte forms part of a string representing the default group authority.

9 UHF Transmission and Reception

9.1 Scope

This chapter describes the characteristics of the DVB-T and DVB-T2 signals as broadcast in the UK. It illustrates a typical transmission chain, explains how the performance may be measured, and suggests suitable performance limits. The DVB-T2 performance figures are based on simulation figures and limited evidence from early prototype receivers and will be subject to review when data from production receivers is available.

Reference is made to the spectrum masks required to avoid mutual interference and interference to other transmissions. Receiver performance issues are also discussed.

The mobile and portable standard, DVB-T/H, is not considered, except where DVB-T/H transmissions could influence the performance of DVB-T receivers.

The information presented in this chapter has been harmonised, where possible, with that given in the European E-Book, DTG RF 33 [67].

Note that the protection values given here are the values to be used for testing receivers within a conformance regime, and are not necessarily the same as values used for network planning.

9.2 References

[6] EN 300 744	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for digital terrestrial television.
[14] TR 101 290	TR 101 290 V1.2.1: Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems.
[36] ISO/IEC 13818-1	Information technology - Generic coding of moving pictures and associated audio information: Systems. ISO/IEC 13818-1:1996(E).
[54] ITC GNPQ	ITC Guidance Note on Picture Quality in Digital Television (31 Oct. 1996).
[56] WRC-95	Final Acts of the World Radiocommunication Conference (WRC-95).
[57] RADIO REG	Current UK Radio Regulations (1990, revised 1994).
[52] BS 6330	British Standard Code of Practice for Reception of sound and television broadcasting BS 6330 1983.
[53] AC106 VALIDATE	Digital TV transmitter performance specification. Submitted to DVB as TM1925.
[59] Chester 1997	The Chester 1997 Multilateral Coordination Agreement relating to Technical Criteria, Coordination Principles and Procedures for the introduction of Terrestrial Digital Video Broadcasting (DVB-T) (Chester, 25 July 1997).
[55] Ofcom DVB-T	Reference Parameters for Digital Terrestrial Television Transmissions in the United Kingdom, Ofcom, December 2006

[61] Stott J H	The effects of phase noise in COFDM - EBU Technical Review, Summer 1998.
[62] DTG RF 16	DTG RF Sub-Group Document No.16 - Digital Television Services: Calculating phase noise contributions.
[63] DTG RF 17	DTG RF Sub-Group Document No. 17 - Digital Television Services: Amplitude response errors and equivalent noise degradations.
[64] DTG RF 18	Digital Television Services: Echoes and receiver performance
[65] DTG RF 29	DTG RF Sub-Group Document No. 29 - Digital Television Services: Loss of Noise Margin within the COFDM Transmission Channel
[67] DTG RF 33	Baseline Digital Terrestrial TV Receiver Specification (the EACEM E-Book), Chapter 12.
[68] DTG RF 40	Proposal for the Long-term Echo Testing of DVB-T Receivers. Pekka Talmola. Nokia.
[69] DTG RF 42	Measurements of RF Protection Ratio Achieved by DVB-T Receivers with Multiple PAL Interferers.
[70] DTG RF 43	Analysis of echo profile measurements made on off-air DVB-T signals. Ian Pullen. BBC R&D.
[71] DTG RF 44	Echoes and DVB-T Receivers: A Further Investigation, Part 1. Ranulph Poole. BBC R&D.
[72] DTG RF 45	Echoes and DVB-T Receivers: A Further Investigation, Part 2. Ranulph Poole. BBC R&D.
[73] DTG RF 46	DVB-T Generators and Receivers: The Determination of Noise Floors.
[74] DTG RF 52	Measurements of COFDM out-of-band intermodulation and sinc-squared components.
[76] DTG RF 61	Using Channel State Information (CSI) to Characterise DVB-T Reception.
[77] DTG RF 62	DVB-T Transmission and Reception: A Technical Summary.
[78] DTG RF 68	Echoes, Doppler and DVB-T Receivers: Some Theory and Practice.
[81] DTG RF 77	Modelling Impulsive Interference in DVB-T: Statistical Analysis, Test Waveforms and Receiver Performance. José Lago-Fernandez & John Salter. BBC R&D.
[82] DTG CAI	(Draft Status) Joint CAI/DTG Aerial Benchmarking: Procedure and Benchmark Manual.
[83] R-Book 2	Installing Digital Terrestrial Television: Domestic Systems.
[84] R-Book 3	Installing Digital Terrestrial Television: MATV Systems. **Now incorporated into R-Book 5**
[85] R-Book 4	Installing Digital Terrestrial Television: Integrated Reception Systems. **Now incorporated into R-Book 5**
[86] Monograph 5	A Tutorial on Impulsive Noise in COFDM Systems. Peter Lewis. Philips Semiconductors.
[87] JPP/MB/1	DTT Frequency Planning Project — Technical Parameters and Planning Algorithms.
[88] ITC CDS DTT	ITC Community Digital Standard and Rules of Operation for DTT.
[89] 6E/TEMP/122-E	Guidelines and Techniques for the Evaluation of DTTB Systems.

[90] ITU-R BT.1368-3	Planning Criteria for Digital Terrestrial Television Services in the VHF/UHF Bands.
[109] DTG RF 112	DVB-T: Transmitter Response Errors and ENDs
[110] IEC 62002-1	Mobile and Portable DVB-T/H Radio Access — Part 1: Interface Specification
[111] IEC 62002-2	Mobile and Portable DVB-T/H Radio Access — Part 1: Interface Conformance Testing
[112] DTG RF 22	Digital television services: Specifying Permissible Emission Levels in Adjacent Digital Channels
[113] DTG RF 103	Twin 0 dB Echo Test for Diversity Receivers
[114] DTG RF 104	Channel Model for Diversity Reception using Set-Top Aerials

Table 9-1. References

9.3 Network design issues

The UK DVB-T transmitter network has been designed by the Joint Planning Project (JPP), a group made up of network operators and regulators. When work started in 1995, the requirement was to provide a network of four digital multiplexes. Where possible, these new services would be radiated from the existing analogue (PAL) transmitting sites at a power 20 dB below the analogue peak sync power. This greatly increased use of the UHF spectrum was possible because the digital (DVB-T) signals could be placed in the "taboo" channels adjacent to the PAL services. In practice, it would sometimes be necessary to restrict the radiated DVB-T powers to avoid interference problems. In other cases, where different antennas were used for transmitting PAL and DVB-T, the relative power of the received DVB-T signal could be substantially greater. In extreme cases, the relative DVB-T signal power could be as low as −35 dB or as great as −10 dB.

After the original planning exercise had been completed, the requirement was increased to six multiplexes. Finding room for the extra two was much more difficult, and it was accepted that their coverage could be less than that of the first four multiplexes.

Following launch, a programme of "equalisation" was undertaken, with the aim of maximising the "core coverage" – that is, the common service area achieved by all six multiplexes. Various techniques were employed, such as doubling the transmitter power, shuffling the channel allocations, and allowing slightly more interference to the analogue services. On top of that, the ITC specified a second modulation mode – 16 QAM, Rate 3/4 – offering about 4 dB advantage in minimum carrier-to noise requirement over the original 64 QAM, Rate 2/3. Four of the six multiplexes were changed to the new mode. As a guide, the following are the minimum field strengths needed for fixed antenna reception:

DVB-T 64 QAM, Rate 2/3		**DVB-T 16 QAM, Rate 3/4**	
Band IV	**Band V**	**Band IV**	**Band V**
47 dBμV/m	51 dBμV/m	43 dBμV/m	47 dBμV/m

Table 9-2. Minimum median field strength for fixed antenna reception

These figures are theoretical, and include a 4 dB allowance for channel impairments such as multipath distortion. Explanations of how the field strength requirements are derived are given in the "Chester" agreement Chester 1997 [59], the Joint Planning Project document JPP/MB/1 [87], and the ITU Planning Criteria ITU-R BT.1368-3 [90]; the corresponding signal powers at the receiver input may be calculated using the formula in 9.13.3.

The presence of powerful interfering signals places quite severe demands on receiver selectivity and linearity. BS 6330 [52] quotes a maximum level of 5 mV into 75 Ω
(−35 dBm) at the receiver input for PAL transmissions. "Digital Switchover", to be completed in 2012, will involve several changes with"8K", 64 QAM, rate 2/3 being adopted. In general, digital transmitter powers will be increased to –7 dB relative to the peak sync powers of the present analogue services. Allowing a safety margin, the probable signal levels under "worst case" conditions are −25 dBm for both analogue and digital signals.

The completion of the DVB-T2 Standard EN 302 755[108] and plans to use this as the preferred transmission type for high definition broadcasting in the UK has necessitated a further review. It is likely that the required field strength and C/N requirements will be very similar to those for 64 QAM DVB-T, which is already used in the UK. However, DVB-T2 offers a significant increase in channel capacity.

Transmitter performance is another important aspect. The following sections of this chapter describe how to quantify the performance in terms of equivalent noise degradation, or END. The concept is easy to understand. As an example, suppose that a receiver requires a minimum carrier-to-noise ratio (C/N) of 19 dB to provide an error-free output, when the DVB-T transmission is “perfect”. If the “real” transmitter introduces distortion such that the required C/N is now 19.5 dB, the END is said to be 0.5 dB.

END is important because it reduces the effectiveness of the transmission and hence also the service area. 0.5 dB is a realistic and acceptable target for a single transmitter. However, it is possible that some transmitters will make use of rebroadcast links. If the signal is not regenerated before being rebroadcast, the ENDs will accumulate. Thus, if there is a long chain of rebroadcast transmitters, the overall END could be much greater than 0.5 dB. Unfortunately simple linear addition rules do not apply if the characteristics of the modulation mode have been weakened by ENDs greater than about 0.5 dB. Resilience to interference and multipath is disproportionately degraded.

Network performance limits are increasingly important as DVB T coverage spreads, and will become even more so with the advent of Switchover. Hence this chapter provides recommendations for the performance of relay chains. Note that any figures given here should be regarded as “guidance”; the actual figures form part of the contract between broadcaster and transmission provider.

9.4 Modulation parameters

9.4.1 DVB-T

The following modes or “options” from the DVB-T specification EN 300 744 [6] have been specified by Ofcom (formally ITC) for all current UK DVB-T broadcasts ITC CDS DTT [88]. Receivers should be able to switch between these automatically:

OFDM Parameters	Values (Option 1)	Values (Option 2)	Values (Option 3)
Number of carriers	1705 (2K)	1705 (2K)	6817 (8K)
Modulation	64 QAM	16 QAM	64 QAM
Inner coding R_C	2/3	3/4	2/3
Guard interval (Δ/T_U)	1/32	1/32	1/32
TS data rate (Mbit/s)	24.1283422	18.0962567	24.1283422

Table 9-3. Specified modulation modes

The receiver should be capable of demodulating all non-hierarchical modes specified in the DVB-T Specification EN 300 744 [6]. It is not necessary for the receiver to demodulate the hierarchical modes, but the presence of such a mode should not cause the receiver to malfunction. Note that the E-Book DTG RF 33 [67] requires the demodulation of both hierarchical and non-hierarchical modes.

As digital switchover (DSO) progresses it is intended that Options 1 & 2 will be phased out in preference to Option 3. During or post DSO, spectrum will become available for new applications and services such as HDTV / SDTV from high / low power transmitters. It is intended that HDTV will be transmitted using DVB-T2 (see 9.4.2). The following DVB-T modes are currently under consideration for future SDTV applications.

OFDM Parameters	Values (Option 7)	Values (Option 8)
Number of carriers	6817 (8K)	6817 (8K)
Modulation	QPSK	64 QAM
Inner coding R_C	1/2	3/4
Guard interval (Δ/T_U)	1/32	1/32
TS data rate (Mbit/s)	6.0320856	27.1443850

Table 9-3a. Modulation modes under consideration for future use.

For the Option 7 mode, commercial requirements are being considered. For the Option 8 mode, transmission trials have started. It is too early to say whether the above modes under consideration will be specified for future use. It is felt prudent that performance parameters for Option 8 should be specified in this version of the D-Book[13] . However at this time, receivers need only be tested (see Chapter 10) with a small sub-set of the Option 8 performance parameters.

For DVB-T the inner coding is ‘Viterbi’ and the outer coding is ‘Reed Solomon’.

The error in the clock frequency of any transmitted OFDM ensemble should not exceed ±3 ppm.

13 Performance parameters for Option 7 are not specified at this time and therefore Option 7 is not included in all the performance tables.

9.4.2 DVB-T2

Ofcom have specified the following modes (options 4, 5 & 6) from the DVB-T2 specification EN 302 755 [108] for UK DVB-T2 broadcasts. Additionally, a new mode, option 11, is being planned for a multiplex in Northern Ireland. Receivers should be able to switch between these automatically.

OFDM Parameters	Values (Option 4) DTG104	Values (Option 5) DTG106	Values (Option 6) DTG109	Values (Option 11) DTGnnn
Number of carriers	6913 (8KE)	27841 (32KE)	27841 (32KE)	[TBD]
Modulation	64QAM	256 QAM	256 QAM	[TBD]
Inner coding R_c	4/5	3/5	2/3	[TBD]
Guard interval (Δ/T_U)	1/32	1/128	1/128	[TBD]
Pilot Pattern	PP7	PP7	PP7	[TBD]
Frame Length (data symbols)	242	59	59	[TBD]
Transport stream data rate	34.6880914	36.1407594	40.2146452	[TBD]

Table 9-3b. Specified DVB-T2 modulation modes[14]

Options 4, 5 & 6 of the above modes utilise the 'extended carrier' feature within the DVB-T2 specification (as signified by an "E" suffix). However, it may not be possible to use this feature for some UHF channels as DVB-T2 is introduced, especially if frequency offsets are also required.

The receiver should be capable of demodulating all single profile modes specified in the DVB-T2 Specification EN 302 755 [108].

The number of options means this is impractical to verify. Therefore a verifiable sub-set of modes is specified in Annex G. Any additional modes of operation that are planned to be used in the future will need to have RF performance tests carried out and interoperability verified with Freeview accredited products in the market, prior to being implemented within the UK network.

HDTV services using the Option 6 mode above have started. As digital switchover (DSO) progresses these will be rolled out across the whole UK transmitter network It is not clear whether 'extended carrier' modes will be allowed in the long-term. It is therefore felt prudent that performance parameters for the following 'non-extended carrier' modes (as signified by an "N" suffix) should be specified in this version of the D-Book[15].

OFDM Parameters	Values (Option 9)	Values (Option 10)
Number of carriers	27265 (32KN)	27265 (32KN)
Modulation	256 QAM	256 QAM
Inner coding R_c	3/5	2/3

[14]. Full technical parameters are detailed in Annex G

[15]. At this time, the performance parameters for non-extended carrier modes have been kept the same as those of extended carrier modes because the most stringent requirements are required for planning purposes. However, for receiver testing (see Chapter 10) only a small sub-set of the performance parameters for Options 9 & 10 need be tested.

Guard interval (Δ/T_U)	1/128	1/128
Pilot Pattern	PP7	PP7
Frame Length (data symbols)	59	59
Transport stream data rate	35.2461861	39.2192332

Table 9-3c. Modulation modes under consideration for future use.

If FEFs are to be used, it is recommended that the power level of the FEF is the same average power as the T2-frame (within 0.5dB). If the power of the FEF is lower than that of the T2-frame, the FEF should be kept as short as possible (i.e. short relative to the typical AGC time constant of a receiver front-end) and less than or equal to the preceding T2 Frame.

For DVB-T2 the inner coding is 'LDPC' and the outer coding is 'BCH'.

The error in the clock frequency of any transmitted OFDM ensemble should not exceed ±3 ppm.

9.5 Channel frequencies

The channels are identified in the same way as they were for the PAL analogue services, the nominal centre frequency of each channel being given by

$$f_C = 474 \text{ MHz} + (i-21) \times 8 \text{ MHz}.$$

i is an integer between 21 and 68, corresponding to the channel number.

The centre frequency of the digital transmission may be offset by ±1/6 MHz (approximately 166.67 kHz) to ease adjacent channel operation.

It should be noted that UHF channels >60 (i.e. channels 61 to 68) are likely to be re-assigned in the future.

The error in the centre frequency of the transmitted OFDM ensemble should not exceed ± 500 Hz.

9.6 Transmission chains

The purpose of the transmission system is to deliver ISO/IEC 13818-1 [36] Transport Stream packets from the transmitter input to the receiver output in a quasi-error-free manner. "Quasi-error-free", or QEF, is defined as a bit error ratio (BER) of below 10^{-11} at the output of the outer decoder (a BER of 10^{-11} approximately equivalent to a single error per hour).

A transmission chain can comprise a single transmitter and receiver, or a more complicated system involving relay stations. It is convenient to consider these two possibilities separately.

9.6.1 Reference transmission chain

A "reference" transmission chain, involving a single transmitter and receiver, is illustrated below, with the purpose of identifying interfaces that might be useful or essential for testing. Although Figure 9-1 is representative of current implementations, advancing technology could result in significant changes. For instance, direct conversion techniques are becoming popular for receiver design.

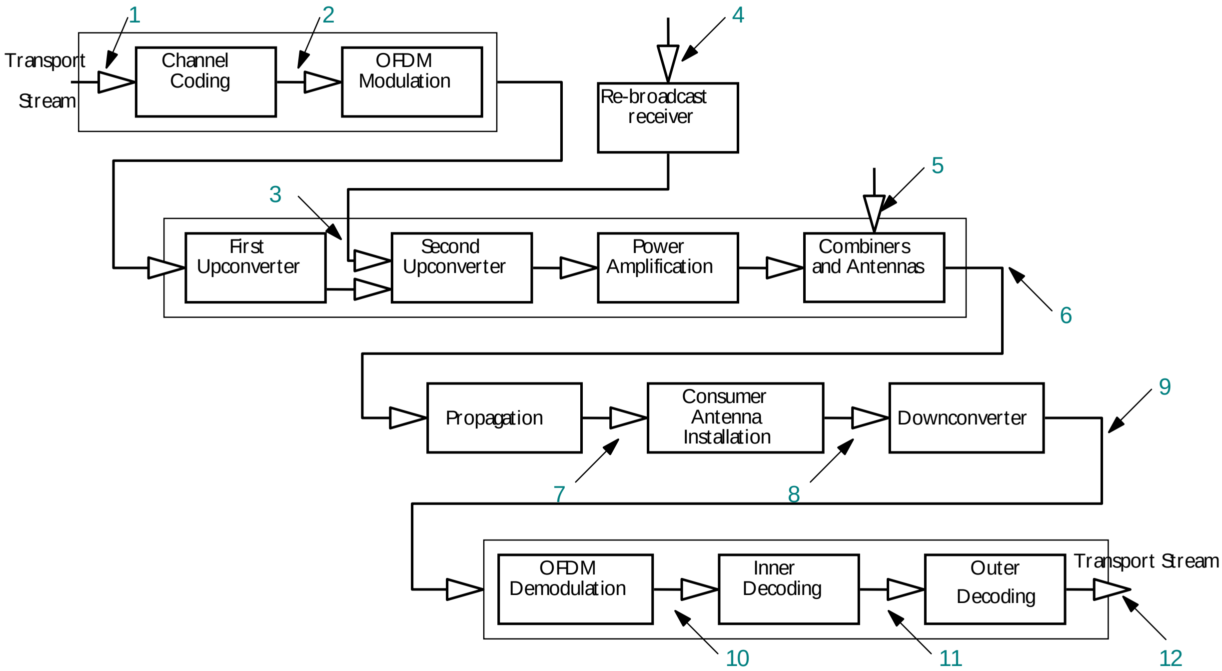


Figure 9-1. Reference Transmission Model

1. Transport Stream input
2. Input to OFDM modulator
3. Analogue OFDM modulated signal at IF
   From either first upconverter OR re-broadcast receiver
4. Off-air signal at re-broadcast receiver
5. Interface between power RF stages of different operators
6. Input to antenna feeder
7. Received signal at consumer's antenna
8. Input to consumer's DVB-T receiver
9. Output from second down converter, input to OFDM demodulator
10. Uncorrected symbols
11. Output of inner decoder
12. Transport Stream output

9.6.2 Multiple Transmission Chain

A more complicated transmission system, involving relay stations, is shown below. This "multiple transmission chain" contains all likely types of equipment, but should not be regarded as typical. The possible signal impairments are discussed in Section 9.7.5.

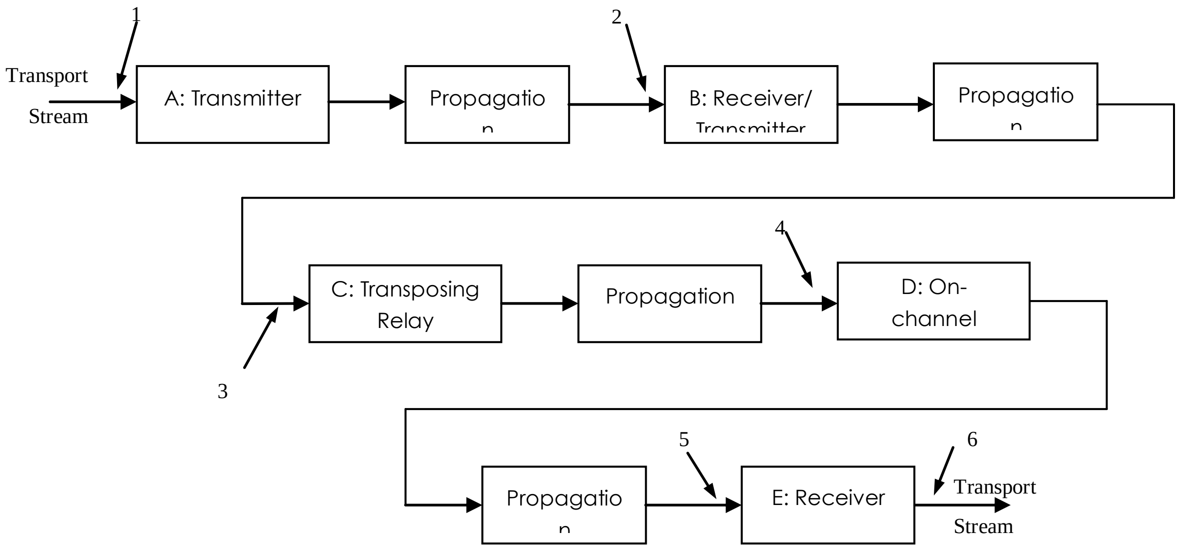


Figure 9-2. Multiple Transmission Chain Model

Equipment Types

A. A transmitter of the type illustrated in 9.6.1 for the "reference transmission chain", fed directly with the transport stream.
B. A transmitter of the same type, but fed from the transport stream output of a rebroadcast receiver.
C. A transmitter, generally of lower power, not fed from the transport stream output of a rebroadcast receiver. Generally, the incoming signal is converted to an intermediate frequency, and then converted again to the final frequency. The input and output frequencies are different.
D. An installation that amplifies the off-air signal and transmits it on the same frequency. Sophisticated techniques are included to prevent "howl-around".
E. A receiver of the type illustrated in 9.6.1 for the "reference transmission chain".

Interfaces

1. Transport Stream input of transmitter
2. RF input of rebroadcast receiver
3. RF input of transposer
4. RF input of on-channel repeater
5. RF input of consumer's receiver
6. Transport Stream output of consumer's receiver

9.7 Transmitter noise-like impairments

9.7.1 Noise-like processes

Many of the impairments introduced by transmitters are said to be "noise-like", because their effect is equivalent to the presence of additive white Gaussian noise (AWGN) on an otherwise perfect OFDM signal. The total impairment is expressed as an equivalent noise floor (ENF) or a modulation error ratio (MER). When measured in dB for an AWGN channel, ENF and MER are numerically identical but of opposite sign. ENF equals the ratio of noise power to OFDM carrier power, whilst MER is effectively the ratio of carrier power to noise power.

The impairments considered to be noise-like are:

- Finite precision in the OFDM modulator and other digital processing stages.
- High-frequency phase noise introduced by local oscillator and timing references; that is, those phase noise components occurring at offset frequencies greater than half the OFDM carrier spacing.
- Thermal noise.
- Intermodulation products resulting from non-linearity in the transmitter chain[16].
- Amplitude response errors resulting from an imperfect transmitter response or multipath propagation. Because a greater C/N ratio is then required at the receiver input, response errors can also be considered as a 'noise-like' impairment.

Impairments that cannot be considered as being equivalent to the addition of white Gaussian noise are:

- Group delay errors
- Low-frequency phase noise

These "Further transmitter impairments" are considered in Section 9.8.

[16]. DVB-T2 has a feature called peak to average power ratio reduction (PAPR). The effect of this is to reduce the intermodulation products compared to DVB-T for the same transmitter output power when the same transmitter is used. In practice, this will improve transmitter efficiency because lower peak power transmitters can be used for DVB-T2 whilst maintaining similar output power and intermodulation performance compared to that of a DVB-T transmitter.

9.7.2 Transmitter response errors

Amplitude response errors caused by imperfect transmitter amplification, filtering or combining do not affect the transmitter MER because the OFDM signal and its noise-like impairment are equally affected. However, the response errors make the signal more difficult to demodulate and there is thus a slight increase in the C/N requirement at the receiver input. This increase in C/N or equivalent noise degradation (END) can be estimated. This impairment can be considered as a small amount of multipath within the propagation path between transmitter and receiver.

Generalised calculators for "Option 1 and 3" are available, allowing any reasonable transmitter response to be entered. See DTG RF 112 to obtain an estimate of END. The principle behind this estimate is as follows. The C/N and hence BER are calculated for each carrier within the OFDM ensemble. When this is done, the overall (or average) BER is found to be worse than the ideal case where all carriers have C/N. If the C/N is then increased to restore the BER to its ideal value, the increase equals the END. This can only give an approximate answer because it is dependent upon receiver implementation — in particular channel estimation and decoding metrics. Most practical transmitter response errors do not significantly increase the difficulty of the channel, and the END is usually very small. Propagation channels normally have a much greater effect than transmitter errors.

It is convenient to model this END as an additional 'virtual' ENF component at the transmitter.

9.7.3 Measurement of noise-like impairments

The measurement of noise-like impairments is much simpler now that dedicated test equipment is readily available. One of the 'magic' features of an OFDM signal is that its own pilot carriers (which are dispersed within the channel in both frequency and time) can be filtered and used to obtain the errors associated with data-carrying carriers. The MER of each of these carriers can be measured and a mean value of MER for the whole signal then derived. Sometimes the noise-like impairments introduce by the test equipment itself can be taken into account, so improving accuracy at the limit of measurement (typically 40 dB).

A sample of the transmitter's output is passed to the input of the test equipment in the usual way. A MER display of individual carriers may be available to show any spurious interference or other problem. The mean or average MER for the whole signal is normally given as a single dB value.

The same test equipment may also be able to provide a plot of the frequency response across the OFDM ensemble. Alternatively, a normal spectrum analyser used with relatively low resolution and video bandwidth can provide the frequency response of the transmitted signal. Modern spectrum analysers may also provide an electronic output file of amplitude and frequency values. This is particularly useful for any automated calculation of END associated with a poor transmitter frequency response.

9.7.4 The effect of transmitter noise-like impairments

Both 'noise-like' and 'virtual' noise impairments described above can be expressed as an equivalent noise floors (ENF_1 and ENF_2 respectively). Alternatively they can be expressed as equivalent noise degradations (END_1 and END_2 respectively) of an otherwise perfect channel. The total degradation associated with a transmission can be calculated and identified as END_T. The required carrier-to-noise ratio (C/N) at the receiver input is calculated (in dB) from

$$(C/N) = (C/N_{ref}) + END_T.$$

(C/N_{ref}) is the carrier-to-additive white Gaussian noise (AWGN) ratio at the receiver input which gives the Reference BER. For the "Option 1 & 3" modes, this is given in Table 9-12 and is 18.9 dB. It is only under laboratory test conditions that END_T can be assumed to be zero. Practical transmitters and propagation conditions will always result in a finite value.

The following formulas are applicable:

- $ENF_1 = 1/ MER$
- $1/END_2 = 1 - \{ENF_2 \times (C/N_{ref})\}$
- $ENF_T = ENF_1 + ENF_2$
- $1/END_T = 1 - \{ENF_T \times (C/N_{ref})\}$
- $ENF_2 = (END_2 - 1) / \{END_2 \times (C/N_{ref})\}$

The quantities in italics in the above formulas in are all expressed in linear terms.

Typically END_2 associated with any transmitter response error is less than 0.2 dB and has little additional effect even for quite poor values of MER. Propagation channels other than the perfect channel (END_2 = 0) will increase the (C/N) requirement at the receiver input. Generally, we can model both transmitter response errors and the propagation channel as the impairment END_2.

It is informative to tabulate overall END_T values for different values of MER and END_2. This is done in Table 9-5 below for the "Option 1 & 3" modes.

A MER of 50 dB is the value chosen to represent a 'perfect' source and the reference for calculation of ENDs.

END_2 values up to 0.2 dB account for typical transmitter response errors and / or small amounts of multipath within the propagation channel.

END_2 values greater than 0.2 dB are associated with increasingly 'difficult' propagation channels (here any transmitter response errors are likely to be swamped by the propagation channel).

		END_2 values associated with:								
		Transmitter response errors and 'easy' channels			More 'difficult' channels					
MER (dB) ↓	END_1	0.05	0.1	0.2	0.5	1	2	3	4	5
23	2.14	2.22	2.30	2.47	2.99	3.92	6.16	9.50	20.43	∞
24	1.61	1.68	1.75	1.90	2.35	3.14	4.92	7.16	10.50	21.43
25	1.22	1.29	1.36	1.49	1.90	2.61	4.14	5.92	8.16	11.50
26	0.94	1.00	1.07	1.19	1.57	2.22	3.61	5.14	6.92	9.16
27	0.73	0.79	0.85	0.97	1.33	1.94	3.22	4.61	6.14	7.92
28	0.57	0.63	0.68	0.80	1.15	1.73	2.94	4.22	5.61	7.14
29	0.45	0.50	0.56	0.67	1.00	1.57	2.73	3.94	5.22	6.61
30	0.35	0.41	0.46	0.57	0.90	1.45	2.57	3.73	4.94	6.22
31	0.28	0.33	0.38	0.49	0.81	1.35	2.45	3.57	4.73	5.94
32	0.22	0.27	0.32	0.43	0.75	1.28	2.35	3.45	4.57	5.73
33	0.17	0.22	0.28	0.38	0.69	1.22	2.28	3.35	4.45	5.57
34	0.14	0.19	0.24	0.34	0.65	1.17	2.22	3.28	4.35	5.45
35	0.11	0.16	0.21	0.31	0.62	1.14	2.17	3.22	4.28	5.35
36	0.09	0.14	0.19	0.29	0.60	1.11	2.14	3.17	4.22	5.28
37	0.07	0.12	0.17	0.27	0.58	1.09	2.11	3.14	4.17	5.22
38	0.05	0.10	0.16	0.26	0.56	1.07	2.09	3.11	4.14	5.17
39	0.04	0.09	0.14	0.24	0.55	1.05	2.07	3.09	4.11	5.14
40	0.03	0.08	0.13	0.24	0.54	1.04	2.05	3.07	4.09	5.11
50	0.00	0.05	0.10	0.20	0.50	1.00	2.01	3.01	4.01	5.01

Table 9-5. The effect of MER and END_2 to END_T

Key

Blue value: Laboratory reference condition.
Green values: END_T is less than 0.5 dB.
Orange values: END_T is between 0.5 & 2 dB.
Pink values: END_T is between 2 & 3 dB.
Red values: END_T is greater than 3 dB.

The above table gives the END_1 values associated with a range of MER values for modulation modes "Options 1 & 3".
For most practical values of END associated with transmitters (< 0.5 dB), then an approximation (in dB) is

$$END_T = END_1 + END_2.$$

The table however does include example high values of END_1 and END_2 to illustrate the disproportionate effect of these — resulting ultimately in an infinite value for END_T!

9.7.5 Rebroadcast relays and multiple transmitter chains

The use of relay equipment in multiple transmitter chains is illustrated in Figure 9.2. END measurement is then more difficult, because the broadcaster must take into account the impairments introduced by the propagation path. Measurements on the various equipment types are discussed below.

Receiver/Transmitter ("B" in Figure 9.2).

The receiver demodulates and decodes the off-air signal to provide a regenerated transport stream. This transport stream then feeds the transmitter. Provided that the off-air signal is of sufficient quality for the transport stream to be regenerated, the propagation path has no effect on the transmitted signal. The performance of the transmitter is measured in the manner just described, and the END would normally be kept within 0.5 dB.

Serious disturbances to the propagation path cause loss of transport stream and consequent programme outages. Acceptable limits would normally be included in the service level agreement between the broadcasting company and the transmission provider.

Transposing Relay ("C" in Figure 9.2).

The receiver does not demodulate the off-air signal, but (usually) converts it to an intermediate frequency (IF). The transmitter takes this IF and converts it to the final frequency for re-transmission. Both receiver and transmitter are included within the same item of equipment — an arrangement that is economical in terms of both cost and space. The quality of the propagation path directly affects the transmitted signal.

The method of END measurement is much as described in Section 9.7.3. Note the following:

- The END of the relay alone can be checked in the laboratory. However, this test does not indicate how the equipment will perform in real life.
- The real life END figure will include contributions from the parent transmitter and propagation path, as well as from the transposing equipment itself. Normally this overall END is the required parameter.
- The propagation path is likely to vary, so logging the END over an extended period is desirable. It may be possible to equalise a response error associated with a static short delay echo.

An overall END of 0.5 dB is unlikely to be realistic. Acceptable ENDs would normally feature in the service level agreement between the broadcasting company and the transmission provider. It might be possible to overcome any loss of coverage associated with a poor END by increasing the output power of the relay.

On-Channel Repeater ("D" in Figure 9.2).

An on-channel repeater receives the off-air signal, amplifies it, and transmits it on the same frequency. Sophisticated techniques may be included to cancel any output signal accidentally arriving at the input, and which would otherwise cause "howl-around". END measurements are made in the way just described for the transposing relay. Note the following:

- The real life END figure is likely to include contributions from the parent transmitter, any subsequent relay stations and the propagation path. However, it is also possible that a sophisticated on-channel repeater could dynamically reduce some of the impairments associated with the propagation path.

Unless regeneration of the transport stream takes place, the END will increase along the transmitter chain. The maximum allowable END should be quoted in the service level agreement between the broadcasting company and the transmission provider. As stated under "Transposing Relay", it might be acceptable to overcome any loss of coverage associated with a poor END by increasing the output power of the equipment.

9.8 Further transmitter impairments

9.8.1 Group delay errors

Single Transmitter.

At interface 6 (in Figure 9-1), the delay of any COFDM carrier relative to that of any other should not exceed the following:

2K Modulation Modes	500 ns
8K Modulation Modes	2.8 µs
32K Extended Carrier Modulation Modes	2.8 µs

It is sufficient to measure the group delay between the input to the first analogue upconverter (interface 3) and the combiner output (interface 6). A network analyser is suitable, provided that it can be programmed to allow for the frequency change. Note that most of the group delay errors are likely to be introduced by any high-power filters and combiners.

Multiple Transmitter Chain.

The cumulative delay of any COFDM carrier relative to that of any other should not exceed the following:

2K Modulation Modes	1.5 µs
8K Modulation Modes	2.8 µs
32K Modulation Modes	2.8 µs

Measuring the cumulative delay directly is likely to prove difficult. If so, the figure will need to deduced by adding the contributions of the individual items of equipment. Of course, regeneration of the transport stream removes any previous cumulative delay.

9.8.2 Phase noise in COFDM systems

Phase noise is introduced by local oscillators and timing references within the transmission chain. If a noisy oscillator signal is viewed on a spectrum analyser, the phase noise appears as sidebands symmetrically disposed about the oscillator centre frequency. Away from the centre frequency, the sideband density generally falls off rapidly. Oscillator phase noise degrades the transmission chain transmitted signal because, in the frequency conversion process, the noise is transferred from the oscillator to each of the carriers within the OFDM ensemble.

Phase noise is specified by quoting L(f), the single sideband phase noise power in a 1 Hz bandwidth, at a frequency f from the centre frequency. The unit of L(f) is dBc per Hz, the "c" signifying that the reference is the total power of the oscillator. Oscillator manufacturers normally provide plots of L(f) *versus* f.

At the receiver demodulator, the phase noise has two different effects. Low-frequency noise gives rise to common phase error (CPE) – "common" because each of the OFDM carriers suffers the same phase error. In principle this error can be measured and removed by the demodulator. High-frequency noise introduces *intercarrier interference* (ICI). The noise from one carrier becomes superimposed upon the neighbouring carriers within the ensemble, and cannot be removed by the demodulator. Because CPE and ICI are different in their effect, they must be specified differently.

ICI may be calculated approximately by integrating L(f) for all values of f above half the OFDM carrier spacing and for all carriers within the ensemble (an accurate calculation makes use of *weighting functions*; see, for instance, Stott J H [61]). The result is a contribution to the system noise floor or ENF, which may be measured in the way described in Section 9.7.3.

An approximate value of CPE is given by integrating L(f) for all values of f below half the OFDM carrier spacing and for a *single* carrier within the ensemble. (Again an accurate calculation makes use of weighting functions.) The result is expressed in dB relative to 1 radian^2, or dB(rad^2). The actual effect of CPE depends strongly on the receiver design. Modern receivers can remove all CPE within reason. However, in order for a transmission to be compliant with all possible receiver designs, it is recommended that the total CPE for all values of f greater than 10 Hz should not exceed -40 dB(rad^2).

DTG RF 16 [62] provides a calculator for determining ICI and CPE from the phase noise spectrum. Note that there is little difference between the phase noise requirements for 2K and 8K modulation modes.

9.8.3 Centre carrier breakthrough

Some types of modulator, especially those using direct I/Q upconversion, are prone to the generation of a spurious component at or about the COFDM centre carrier frequency. This is called "centre carrier breakthrough".

Centre carrier breakthrough is troublesome because any information on the true centre carrier is corrupted, and this corruption may be extended to nearby carriers during the demodulation process.

For the END to remain within 0.1 dB, the centre carrier breakthrough should not exceed the following values:

Option	Modulation	Code Rate	dBc
1	64-QAM	2/3	-32.5
2	16-QAM	3/4	-35.0
3	64 -QAM	2/3	-32 5
4	64-QAM	4/5	-33 TBC
8	64-QAM	3/4	-35 TBC
5 & 9	256-QAM	3/5	-34 TBC

Option	Modulation	Code Rate	dBc
6 & 10	256-QAM	2/3	-35 TBC
11	[TBD]	[TBD]	[TBD]

Table 9-6. Limits for centre carrier breakthrough (dBc)

To measure centre carrier breakthrough the output is examined with a narrow resolution bandwidth spectrum analyser. It may be helpful if a COFDM test signal with a spectral "hole" is used. If the output is examined with a spectrum analyser, any breakthrough is easily seen in the hole. Note that the loss in power caused by the hole needs to be taken into account.

9.9 Single frequency networks

Single frequency networks are not used at present within the UK. However, they will be introduced during "Switchover".

The following section is based upon previous experience of operating single frequency networks and is intended to provide an indication of typical network operating parameters. It should be regarded as informative as it does not represent any issue of interoperability. It is based upon typical performance that can be achieved with commercially available DVB-T/H and GPS equipment. It is recognised that, whilst being the widely available, GPS is not the only available option for synchronisation of SFNs and that other solutions could be implemented using other systems and/or signal types.

Parameter	Tolerance	Comment
Network Time Synchronisation	± 100ns	Any station with respect to any other within the network. Measurement can be made with respect to a common reference e.g. GPS or by off-air reception of a station(s). In the latter case correction must be made for propagation time.
Centre Frequency (long term accuracy)	≤ 1 part in 10^{10}	Usually derived from a disciplined oscillator[a].
Peak Timing Jitter	≤ 20ns	Timing jitter can be produced by a disciplined oscillator[a] that is affected by interference.
Maximum rate of Timing Jitter	≤1Hz	As above

Table 9-7. Limits for centre carrier breakthrough (dBc)

a] An oscillator whose accuracy is controlled by comparison with an external reference such as GPS or other frequency standard.

9.10 Spectrum masks

Ofcom have specified, in the UK Radio Interface requirement 2022, the minimum requirements for broadcast transmitters administered by them. The spectrum masks are designed to prevent interference between digital terrestrial TV transmissions, analogue terrestrial TV transmissions (until Switchover) and other transmissions. There are different requirements dependent upon:

- Channel frequency and associated adjacent channel services
- Transmitter power (for low power transmissions it can be more relevant to express out-of-band and spurious emissions in absolute units)

Transmissions conforming to these masks will not necessarily be acceptable in other respects. For example, the implied END could be excessive (see Section 9.7). Receiver manufacturers should note that transmissions outside Bands IV and V could cause interference if the receivers are not suitably designed; GSM (900 MHz) and Tetra (380 to 470 MHz) are such transmissions. It should be noted that UHF channels >60 (i.e. channels 61 to 68) are likely to be re-assigned in the future and the interference potential of any new transmissions will require study.

9.11 Receiver RF interconnections

9.11.1 Receiver input

A receiver will be designed to receive transmissions according to the modulation parameters given in Section 9.4.1 and /or Section 9.4.2 at the frequencies given in Section 9.5. The receiver RF input is taken as the reference point for all the receiver performance measurements described in this chapter. Domestic television equipment almost always possesses a nominal input impedance of 75 Ω, but 50 Ω is sometimes used for professional or monitoring receivers.

Note that diversity receivers will be equipped with two or more inputs.

9.11.2 DC power from receiver antenna socket

A DC output on the antenna socket may be provided. This supply would be used for powering external equipment such as masthead amplifiers, distribution amplifiers and active indoor antennas. It must be switchable, and must be able to recover from the large inrush currents taken by high value capacitors within the external equipment. A specification for such a supply is given in the table below:

Parameter	Value	See Note
Voltage in ON state	+5.0 V	1
Voltage tolerance	±0.2 V	1, 2
Maximum load current	30 mA	3
Maximum load capacitance	100 μF	4
Resistance in OFF state	47 kΩ – 1 MΩ	5
Protection: externally applied voltages	±15 V DC	6
Default state (new receiver)	OFF	
State following receiver power-up	Last known	7

Table 9-8. Specification for optional antenna supply

Notes

1. The specified voltage and tolerance apply at the centre pin of the antenna connector (relative to the outer conductor ground) at any load current between zero and the specified maximum.
2. The power supply, when enabled by the user, shall remain present when the receiver is in the STANDBY state.
3. Continuous short-circuit protection shall be provided. This must operate when a resistance of 10 Ω or below is connected to the antenna socket. Recovery from a short-circuit condition should be automatic, without a user "reset" being required.
4. The devices to be powered may incorporate decoupling and filtering capacitors. The supply should be able to start up into any load capacitance up to the specified maximum without tripping any protection circuit. In addition, the supply should handle the connection of the load when the output voltage is already present ("hot-plugging").
5. In the OFF state the DC resistance measured at the antenna input shall be in the specified range. The upper limit is intended to prevent the accumulation of atmospheric "static" charge from an antenna.
6. In either the ON or OFF state, the receiver shall be undamaged by connection of an external DC voltage in the specified range.
7. When not in use, the receiver shall remember the state of the power supply and restore it promptly after repowering.

Compliance testing

A test load comprising a 150 ohm resistor in parallel with a suitable low-ESR electrolytic capacitor may be used to verify compliance with Note 4 of this specification.

9.11.3 RF loop-through

RF loop-throughs are the means by which several items of domestic television equipment may be "daisy-chained": the signal from the receiving antenna passes through each item in turn, without being seriously degraded in the process.

The RF loop-through comprises an RF input which is used by the receiver equipment itself and a split, coupled or tapped RF output to provide RF to another (external) item of receiving equipment. Like the input, the output should possess a nominal impedance of 75 Ω.

The loop-through and the following receiver may be thought of as a "system". A well designed loop-through will not cause the noise figure of the system to be more than 1 dB worse than that of the receiver alone. There are a number of factors that contribute to this figure. These include the loss introduced by the interconnection, the noise figure of the second receiver, and the gain and noise figure of the loop-through.

The gain between the RF input and RF output should be no greater than that necessary to achieve the noise performance. An excessive gain could result in the second receiver being overloaded when strong signals are present. Note that if the frequency range is to include the VHF broadcast bands, it may be necessary to exclude non-broadcast transmissions such as Tetra.

The linearity of the loop-through should be sufficient to avoid intermodulation products and cross modulation being troublesome at any likely signal level.

9.11.4 Modulator output

The receiver may provide a re-modulated output for use with a PAL receiver. If so, the output must be tuneable to any of UHF channels 21 to 68. The peak signal level should be 3 mV nominal across 75 Ω (-39 dBm).

It is desirable but not essential that the user should be able to switch off the remodulated output.

Notes

The accuracy of a load impedance in an RF system is specified in terms of the return loss ratio. This is defined as the incident power divided by the reflected power; hence the larger the ratio, the better the quality of the load. Very poor values give rise to frequency response errors and loss of receiver sensitivity.7

9.12 Minimum carrier-to-noise ratios

Reference BER

A certain minimum carrier-to-noise ratio (C/N) is required to achieve quasi-error-free (QEF) reception of the signal. (QEF is defined as a transport stream bit error ratio (BER) of less than 10^{-11}, equivalent to about one error per hour). The actual value of C/N depends on both the modulation scheme and the propagation conditions between transmitter and receiver. Because such BERs are difficult to measure during practical tests, it is usual to measure the much higher BER at the output of the inner decoder. For DVB-T a value of 2×10^{-4} at this point is called the “reference BER” in this document. For DVB-T2 a value of 1×10^{-7} at this point is called the “reference BER”. Generally, it is slightly more difficult for a receiver to achieve the reference BER (BER_{Ref}) than it is to achieve QEF. However, the difference is sufficiently small that it can be ignored. All the figures in this chapter are based upon the BER_{Ref} degradation criterion, except Table 9-20. The BER_{Ref} criterion is not generally recommended for test and measurement of receivers — a degradation criterion based on ‘failure’ is preferable (see Chapter 10).

The C/N difference or delta value in dB between BER_{Ref} and ‘failure’ is given in Table 9-19 and a summary of performance targets for ‘failure’ criterion, as described in Chapter 10, is given in Table 9-20.

9.12.1 DVB-T

Minimum C/N

A table of the minimum usable C/N values for various channels is given in EN 300 744 [6]. Simulation results for the Gaussian channel are reproduced below.

		Required C/N for Reference BER	Approximate bitrate (Mbit/s)			
Modulation	Code Rate	Gaussian Channel	$\Delta/T_U = 1/4$	$\Delta/T_U = 1/8$	$\Delta/T_U = 1/16$	$\Delta/T_U = 1/32$
QPSK	1/2	3.5	4.98	5.53	5.85	6.03
	2/3	5.3	6.64	7.37	7.81	8.04

Modulation	Code Rate	Required C/N for Reference BER Gaussian Channel	Approximate bitrate (Mbit/s) Δ/T_U = 1/4	Δ/T_U = 1/8	Δ/T_U = 1/16	Δ/T_U = 1/32
	3/4	6.3	7.46	8.29	8.78	9.05
	5/6	7.3	8.29	9.22	9.76	10.05
	7/8	7.9	8.71	9.68	10.25	10.56
16-QAM	1/2	9.3	9.95	11.06	11.71	12.06
	2/3	11.4	13.27	14.75	15.61	16.09
	3/4	12.6	14.93	16.59	17.56	18.10
	5/6	13.8	16.59	18.43	19.52	20.11
	7/8	14.4	17.42	19.35	20.49	21.11
64-QAM	1/2	13.8	14.93	16.59	17.56	18.10
	2/3	16.7	19.91	22.12	23.42	24.13
	3/4	18.2	22.39	24.88	26.35	27.14
	5/6	19.5	24.88	27.65	29.27	30.16
	7/8	20.2	26.13	29.03	30.74	31.67

Table 9-11. Required C/N for Reference BER

The figures quoted from [6] are based on simulations which assume perfect channel estimation.

A practical demodulator could possess a significant implementation margin; see the "DVB-T noise model" discussed in Section 9.13.1.

The figures appearing in the table assume that the receiver does not possess diversity capability. Diversity reception is considered in Section 9.14.5.

9.12.2 DVB-T2

Minimum C/N

A table of the minimum usable C/N values for various channels is given in ETSI TR 102 831. Simulation results for the Gaussian channel with the correction applied assuming the use of 32K FFT and pilot pattern PP7 are given below. For different pilot patterns, a different correction factor should be applied.

Modulation	Code Rate	Required C/N Gaussian Channel	Approximate Bitrate (Mbit/s) Δ/T_U = 1/128
QPSK	1/2	[1.4]	7.4
	3/5	[2.7]	8.9
	2/3	[3.5]	10
	3/4	[4.5]	11.2
	4/5	[5.1]	11.9
	5/6	5.5	12.5
16-QAM	1/2	6.2	15
	3/5	7.9	18.1
	2/3	[9.2]	20.1

		Required C/N	Approximate Bitrate (Mbit/s)
Modulation	**Code Rate**	**Gaussian Channel**	**Δ / T_U = 1/128**
	3/4	10.3	22.6
	4/5	11.1	24.1
	5/6	11.7	25.2
64-QAM	1/2	10.1	22.5
	3/5	12.3	27
	2/3	13.7	30.1
	3/4	15.4	33.8
	4/5	16.4	36.1
	5/6	17	37.6
256-QAM	1/2	13.4	30.1
	3/5	16.3	36.1
	2/3	[18.1]	40.2
	3/4	20.2	45.2
	4/5	21.5	48.3
	5/6	22.3	50.3

Table 9-11b. Required C/N for Reference BER

Notes

The figures quoted from ETSI TR 102 831 are based on simulations which assume perfect channel estimation and perfect synchronisation. The values in square brackets [ ] are estimated from simulations at an error rate of 1 x 10^{-4}.

A practical demodulator could possess a significant implementation margin; see the "Noise Model" discussed in Section 9.13.1.

The figures appearing in the table assume that the receiver does not possess diversity capability. Diversity reception is considered in Section 9.14.5.

9.13 Receiver noise performance

9.13.1 DVB-T / T2 noise model

A useful model for calculating noise performance is illustrated below. The terminology used is as follows:

C = signal input power (W)

k = Boltzmann's constant (1.38×10^{-23} J/K).

T = Reference temperature (290 K)

B = system noise bandwidth[17] (7.61, 7.71 & 7.77 MHz).

The model comprises the following representative components:

- A front-end stage with noise factor F [no dB] and "perfect" automatic gain control (AGC). The action of the AGC is to provide a power gain of 1/C, and so the tuner output is unity as a consequence.
- An excess noise source of power P_X at the tuner output. Note that, by normalising the carrier power to unity at the output, the relative value P_X can be added directly at this point.
- A practical but unimpaired demodulator; that is, a demodulator with a fast channel equaliser and a consequent implementation margin (IM).
- For DVB-T, it is sufficient to use a single IM value of 2dB for all constellations and code rates.

  For DVB-T2, the following constellation dependent IM values are used for Gaussian channels:

Constellation	Implementation margin (IM) (dB)
256 QAM	2.4
64 QAM	2.3
16 QAM	2.1
QPSK	1.8

For non-Gaussian channels, the above IM values for DVB-T2 are increased by an amount which is code rate dependent:

Code rate	Increase in IM for non-Gaussian channels (dB).
1/2	0.5
3/5	0.5
2/3	0.6
3/4	0.8
4/5	1.2
5/6	2.0

[17]. DVB-T and DVB-T2 normal carrier mode = 7.61MHz, DVB-T2 8k extended carrier mode = 7.71MHz, DVB-T2 32k extended carrier mode = 7.77MHz

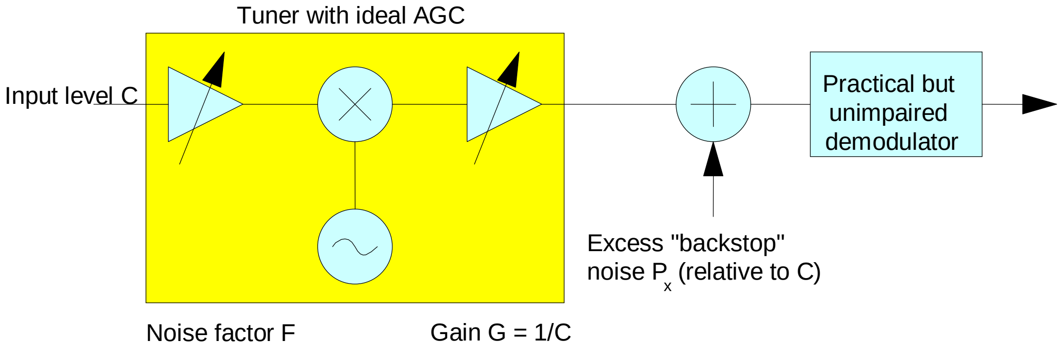


Figure 9-8. Tuner noise model

Note that the relative excess noise P_x is the sum of contributions from all stages in the signal chain. Significant contributions could include:

- Local oscillator phase noise.
- Quantisation noise introduced by the demodulator analogue-to-digital converter.
- "Backstop" thermal noise introduced after the gain-controlled stages in the receiver.
- Transmitter intermodulation products.

The carrier-to-noise ratio is C / kT_0B at the tuner input, and CG / kT_0BFG at the tuner output. Hence the carrier-to-noise ratio at the input to the "practical" demodulator is given by

$$C/N = CG / (kT_0BFG + P_x)$$

$$= C / (kT_0BF + CP_x) \text{ , since } G = 1/C.$$

The C/N ratio at the demodulator for a minimum required level of performance (R_{DQEF} say) will depend upon the theoretical performance for a particular modulation mode and an implementation margin (IM) as specified above. A practical formula for R_{DQEF} in dB is given below:

$$R_{DQEF} \text{ (dB)} = \text{Theoretical C/N (dB)} + \text{IM (dB)}$$

Note this not the C/N ratio at the receiver input.

The value of C for this level of performance is the sensitivity (Pin). Re-arranging the above equation gives this:

$$P_{in}(sensitivity) = \frac{KT_0BFsys}{({}^{1}\!/\!_{R_{DQEF}} - Px)}$$

Note that the C/N ratio at the receiver input for this performance level (A_{RQEF} say) is then:

$$\frac{P_{in}(sensitivity)}{KT_0BFsys} = \frac{1}{({}^{1}\!/\!_{R_{DQEF}} - Px)}$$

All the above parameters are taken to be linear quantities. In practice, it is more usual to express C/N, Pin, G, F, Px, R_{DQEF} and A_{RQEF} in dB.

A practical formula for the sensitivity (Pin) in dBm is given below:

$$Pin\ (dBm) = A_{RQEF}\ (dB) + Noise\ floor\ (dBm)$$

where A_{RQEF} is the C/N ratio in dB at the receiver input that provides the minimum performance level. Note this will be slightly greater than R_{DQEF}, especially so for high capacity modes.

9.13.2 DVB-T carrier-to-noise examples

The noise model referred to in Section 9.13.1 shows that any practical system will require a C/N ratio greater than that given in Table 9-11. The actual C/N value, which is called A_{RQEF} in the noise model, will depend upon the minimum C/N ratio, the demodulator implementation margin (IM) and the amount of excess noise contribution P_x.

For example, if the minimum C/N ratio is that in Table 9-11, IM is 2.0 dB and P_x is -33 dBc[18], the overall C/N for the most commonly used modes can be calculated. These are shown in the table below:

Modulation	Code Rate	Gaussian channel C/N (dB)
QPSK	1/2	5.5
	2/3	7.3
	3/4	8.3
16-QAM	1/2	11.3
	2/3	13.4
	3/4	14.7
64-QAM	1/2	15.9
	2/3	18.9
	3/4	20.4

Table 9-12. Example calculation of C/N for Reference BER

Note The effect of P_x is greater for the higher transport stream bit-rates. A P_x value of –33 dBc is typical of laboratory test conditions, whereas values of –30 dBc and –27dBc could be encountered with high power transmitters and relay chains respectively. Planners should note that the C/N requirement for 64 QAM, code rate 2/3 (option 1 transmission mode) would then be 19.0 dB and 19.4 dB respectively.

[18]. This figure is achievable by a "good" domestic receiver.

9.13.2.1 DVB-T2 carrier-to-noise examples

The noise model referred to in Section 9.13.1 shows that any practical system will require a C/N ratio greater than that given in Table 9-11b. The actual C/N requirement will depend upon the choice of FFT size, pilot pattern, demodulator implementation margin (IM) and the amount of excess noise contribution P_x. If P_x is taken as–33 dBc[19], and with the IM figures given in section 9.13.1, the overall C/N requirements for 32K FFT size and Pilot Pattern PP7 will be as shown in the table below.

Modulation	CodeRate	Gaussian Channel C/N (dB) for 32K, PP7
QPSK	1/2	3.2
	3/5	4.5
	2/3	5.3
	3/4	6.3
	4/5	6.9
	5/6	7.3
16-QAM	1/2	8.3
	3/5	10.0
	2/3	11.3
	3/4	12.4
	4/5	13.2
	5/6	13.9
64-QAM	1/2	12.4
	3/5	14.7
	2/3	16.1
	3/4	17.8
	4/5	18.9
	5/6	19.5
256-QAM	1/2	15.9
	3/5	18.9
	2/3	20.8
	3/4	23.0
	4/5	24.5
`	5/6	25.4

Table 9-12b. Required C/N for Reference BER

Note The effect of P_x is greater for the higher transport stream bit-rates. A P_x value of –33 dBc is typical of laboratory test conditions, whereas values of –30 dBc and –27dBc could be encountered with high power transmitters and relay chains respectively. Planners should note that the C/N requirement for 256 QAM, code rate 2/3 (option 6 transmission mode) would then be 21.0 dB and 21.6 dB respectively.

[19]. This figure is achievable by a "good" domestic receiver.

9.13.3 DVB-T sensitivity examples

The signal level at the receiver input which gives Reference BER performance is called the receiver sensitivity. Section 9.13.1 shows that the actual value depends upon the front-end stage noise figure, the minimum C/N ratio, the demodulator implementation margin and the excess noise contribution P_x.

Implementations might vary, but if the minimum C/N ratio is that in Table 9-11, F is taken as 8 dB and IM is taken as 2.0 dB, example receiver sensitivities for the most commonly used modes can be calculated. These are shown in the table below:

Modulation	Code Rate	Gaussian channel sensitivity (dBm)
QPSK	1/2	-91.7
	2/3	-89.9
	3/4	-88.9
16-QAM	1/2	-85.9
	2/3	-83.8
	3/4	-82.5
64-QAM	1/2	-81.3
	2/3	-78.3
	3/4	-76.8

Table 9.13. Example calculation of receiver sensitivity

Note

The effect of P_x is greater for the higher transport stream bit-rates. A P_x value of –33 dBc is typical of laboratory test conditions, whereas values of –30 dBc and –27dBc could be encountered with high power transmitters and relay chains respectively. Planners should note that the sensitivity requirement for 64 QAM, code rate 2/3 (option 1 transmission mode) would then be -78.2 dB and -77.8 dB respectively.

9.13.3.1 DVB-T2 sensitivity examples

The signal level at the receiver input which gives Reference BER performance is called the receiver sensitivity. Section 9.13.1 shows that the actual value depends upon the front-end stage noise figure, the choice of FFT size, pilot pattern, demodulator implementation margin and the excess noise contribution P_x.

Implementations might vary, but if the minimum C/N ratio is that in Table 9.12b, the IM figures are as given in section 9.13.1and F is taken as 8 dB, the receiver sensitivities for 32K FFT size and Pilot Pattern PP7 are shown below in Table 9-13b.

Modulation	CodeRate	Gaussian channel sensitivity (dBm)
QPSK	1/2	-93.9
	3/5	-92.6
	2/3	-91.8
	3/4	-90.8
	4/5	-90.2
	5/6	-89.8
16-QAM	1/2	-88.8
	3/5	-87.1
	2/3	-85.7
	3/4	-84.6
	4/5	-83.8
	5/6	-83.2
64-QAM	1/2	-84.6
	3/5	-82.4
	2/3	-81.0
	3/4	-79.2
	4/5	-78.2
	5/6	-77.6
256-QAM	1/2	-81.2
	3/5	-78.2
	2/3	-76.3
	3/4	-74.0
	4/5	-72.6
	5/6	-71.7

Table 9.13b. Receiver sensitivity requirements

Note The effect of P_x is greater for the higher transport stream bit-rates. A P_x value of –33 dBc is typical of laboratory test conditions, whereas values of –30 dBc and –27dBc could be encountered with high power transmitters and relay chains respectively. Planners should note that the C/N requirement for 256 QAM, code rate 2/3 (option 6 transmission mode) would then be -76.1 dB and -75.5 dB respectively.

9.13.4 Field strength and receiver input level

The power levels quoted in Table 9-14, for example, are in units of dBm, where 0 dBm is equivalent to 1 mW. The receiver manufacturing industry commonly uses the unit of dBμV instead, where 0 dBμV is equivalent to 1 μV. Converting between the two quantities is straightforward:

0 dBm is equivalent to 0.274 VRMS across 75 Ω ;

therefore 0 dBm is equivalent to 108.75 dBμV.

Fundamental theory shows that the signal power available at the input of a receiver is given by:

$$P = \frac{E^2 (1.64)\, GL\lambda^2}{480\, \pi^2} ,$$

whereE = field strength (V/m),
G = antenna gain relative to that of a dipole,
L = feeder factor,
λ = wavelength (m).

Typically, the product GL equals 5 (7 dB).

If P is to be expressed in dBm,

$$P_{(dBm)} = 10 \log_{10} P + 30 .$$

If the field strength is to be expressed in dBμV/m,

$$E_{(dB\mu V/m)} = 20 \log_{10} E + 120 .$$

9.14 Receiver Interference and Echo Immunity

This section includes some information on diversity reception, since the main purpose of a diversity receiver is to provide better performance in a multipath (echo) environment. However, performance can also be better in an "ideal" (Gaussian) channel.

9.14.1 Co-channel and adjacent channel performance

The immunity of the receiver to interference from other transmissions is an important issue for the following reasons:

- There will be at least four, and possibly five, existing analogue transmissions from the same site.
- The analogue signal levels received could be 35 dB greater than the wanted digital signal level.
- Approximately 65% of the digital transmissions are adjacent channel to analogue transmissions.
- Co-channel Interference could be present from distant analogue and digital transmitters.
- Adjacent or non-adjacent channel Interference could be present from nearby digital transmitters.

Note that the risk of interference from any of the above sources will change as Digital Switchover progresses.

Following the completion of switchover, in line with the rest of Europe, Ofcom is considering the introduction of wireless broadband services using LTE in the 800MHz range (i.e. former UHF TV channels 61-69). As LTE transmissions will be from different sites to the broadcast transmitters, there will be many places where the received levels of the wanted DTT transmission will be significantly less than the unwanted LTE signal. It is therefore especially important that DTT receivers are designed to ensure the maximum possible tolerance to LTE signals. This issue is discussed in more detail in section 9.14.2.1.

Table 9-14 provides a summary of the recommended tolerance of the receiver[20] to various sources of interference. The "level of interfering signal" is relative to the wanted signal. For modulation modes options 1 and 2 these requirements are the same as the previous version of the D-Book. No work has been done in updating these requirements as they will not be used post Switchover. With any one interferer scenario present at the given level, the BER_{Ref} should not be exceeded.

20.The term "protection ratio" is sometimes used. When expressed in dB, protection ratio is numerically equal to the maximum tolerable level of interference but of opposite sign. See also 9.14.4, "Summary of performance targets".

Channel of interfering signal	Type of interfering signal	Level of interfering signal(s) (dB) unless otherwise stated for each modulation Option.							
		1	**2**	**3**	**8**	**4**	**5 & 9**	**6 & 10**	**11**
Co-channel (N)	Additive white Gaussian noise	-19.2	-15.1	–18.9	–20.4	-19.0	-18.9	-20.8	[TBD]
	PAL-I / I1	–4	0	-4	-3	-6.4	-6.3	-8.2	[TBD]
	DVB-T / T2 / H[21]	-19.2	–15.1	–18.9	–20.4	-19.0	-18.9	-20.8	[TBD]
Adjacent channel (N±1)	PAL-I1 (–25 dBm max.)	+35	+37	+35	+35	+35	+34	+32	[TBD]
	DVB-T (–35 dBm max.)	+27	+29	N/A	N/A	N/A	N/A	N/A	N/A
	DVB-T / H (–25 dBm max.)	N/A	N/A	+27	+26	+27	+26	+24	[TBD]
	DVB-T2E (–25 dBm max.)	N/A	N/A	+25	+24	+27	+26	+24	[TBD]
Non-adjacent channel (N±2)	DVB-T / T2E / H (–25 dBm max.)	N/A	N/A	+38	+36	+38	+37	+35	[TBD]
Non-adjacent channel (N±3)	DVB-T / T2E / H (–25 dBm max.)	N/A	N/A	+43	+41	+43	+42	+40	[TBD]
Non-adjacent channel (N±M) (M ≥ 4, and M ≠ +9)	DVB-T / T2E / H (–25 dBm max.)	N/A	N/A	+47	+44	+47	+46	+44	[TBD]
Non-adjacent channel (N+9) (Possible image channel)	PAL-I / I1 (-25 dBm max)	+46	+50	+46	N/A	+46	+45	+43	[TBD]
	DVB-T / T2E / H (–35 dBm max.)	+31	+35	N/A	N/A	N/A	N/A	N/A	N/A
	DVB-T / T2E / H (–25 dBm max.)	N/A	N/A	+31	+29	+31	+30	+28	[TBD]
Simultaneous non-adjacent channels (N+2) and (N+4)	DVB-T / T2E / H (each signal at –25 dBm max.)	N/A	N/A	+28	+27	+28	+27	+25	[TBD]

Table 9-14. Recommended tolerance of receiver to interference

a] For full details of interfering signals see Chapter 10, "RF Test Procedures for DVB-T and DVB-T2 receivers"

21. Note, these signals (8 MHz channel) have the same effect as AWGN and separate testing is not required.

9.14.2 Adjacent and non-adjacent channel interference

There are two main mechanisms within the receiver by which a signal can cause interference:

- inadequate filtering within the receiver, both in the front end (RF) and IF stages
- inadequate dynamic range within the receiver, giving rise to inter-modulation and other effects

The diagram below shows an example of how the sensitivity of a receiver is degraded by the presence of interfering signals and shows the test points used to assess performance:

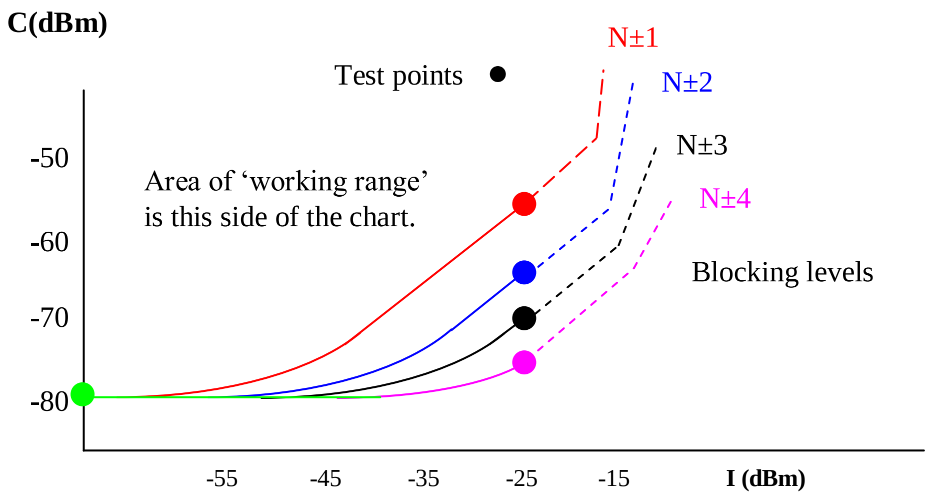


Figure 9-9: Example plots of adjacent and non-adjacent channel performance

9.14.2.1 Interference from LTE signals

As mentioned in section 9.14.1, the introduction of LTE signals in the former UHF TV channels 61-69 introduces a new dimension to the interference environment – the introduction of a high level signals from non-co-sited transmitters, where the interfering source is potentially a much smaller distance from the receiver than the wanted DTT source. Hence it is likely the level of interfering LTE signals will be much higher than the wanted DTT signals.

Initial tests of LTE interference assumed that the LTE signals would be of constant power envelope, and relatively good protection ratios were obtained. However further work has shown that there are other LTE signals, such as when a basestation (BS) has no data to transmit (the 'idle' condition) or a handset (UE) is transmitting at a relatively low data rate, where the time-varying nature of the interfering signals has the potential to cause degraded C/I performance. The exact mechanism for this is not yet understood, but it is thought that it may be caused by disturbances to the receiver's automatic gain control (AGC) circuitry resulting from the time-varying LTE signal. Equally, it has been seen that some well-designed receivers are virtually immune to the differences between the constant power signals and the time-varying signals.

To minimise the risk of disturbance to television reception, it is very important therefore that receiver designers ensure that their implementations are unaffected by such time-varying LTE signals. The rest of this section first describes the interference environment, and then some preliminary tests.

Note that these tests are considered preliminary at this stage, so it may be considered necessary to change them in the near future. For the avoidance of doubt, these LTE protection ratios are the values that will be used for testing new receivers, but it should be remembered that some older receivers already deployed may have significantly worse performance in this respect.

LTE Interference scenarios

There are two different types of LTE interference to consider – the first from basestations (BS) and the second from handsets – or 'user equipment' (UE). BS interference is usually considered the more challenging, mostly because the transmission frequencies are much closer to the retained TV channels, and also because of the much higher transmission powers. However it should be remembered that the UE may be operated just outside the house of someone trying to watch TV, and so the propagation loss could be considerably less than for the BS case.
It is likely that the BS will operate from up to three 10 MHz channels, usually referred to as Licensee A, B and C. Similarly, the UE is likely to operate on one of three 10 MHz channels, and this is shown below.

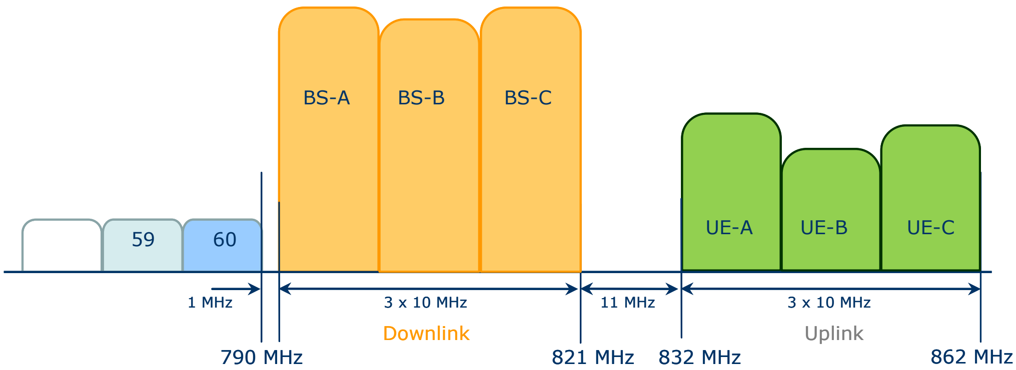


Figure 9-9b: LTE Interference scenarios

LTE BS Interference

The worst case BS interference scenario is for Licensee A interfering with TV reception in channel 60. However, tests have shown that for some receivers an equally demanding test is Licensee B interfering with channel 60, and so receivers are tested under both these conditions. As indicated above, ideally a range of traffic conditions should be checked, e.g. 0% (idle), 50% and 100%. However, as a minimum, the worst case condition, based on an assessment of existing receivers, should be used – 0%. Ideally, both a high level signal and a low level signal should be checked, but for simplicity, a moderately high level signal is proposed, with the active portions of the LTE signal at a fixed level of –15dBm (since this is an 'idle' signal, the mean power of the LTE signal level will be lower at approximately –23.5dBm).

LTE UE Interference

The worst case for interference from UE depends upon the architecture of the DTT receiver's front-end. For a conventional can tuner with a super-heterodyne architecture, the worst case may occur for Licensee C interfering into TV channel 60, whereas for a silicon tuner design, Licensee A may be the more demanding case.

Therefore receivers are tested with UE signals corresponding to both of these cases. As with the BS, the traffic loading of the UE can affect the protection achieved, with low data rates potentially being more problematic than high rates. Therefore, for this preliminary test a data rate of 1MB/s is used. Again, a high level should be used, and for simplicity the same value of –15dBm is proposed for the active part of the UE signal (since this is a time varying signal, the mean power of the UE signal level will be lower at approximately –24.7dBm)

All of these tests are summarised in the table below, and the required tolerances are given in Table 9-14c.

Test	Wanted signal (DVB-T/T2) Channel	Interferer signal	Traffic condition	Interferer level of active portion of signal (dBm)
1	60	LTE BS-A	0%	–15
2	60	LTE BS-B	0%	–15
3	60	LTE UE-C	1 Mb/s	–15
4	60	LTE UE-A	1 Mb/s	–15

Table 9-14b. LTE interference test conditions

Test	Minimum Level of interfering signal(s) (dB) relative to wanted signal for each modulation Option.									
	DVB-T					DVB-T2				
	1	2	3	8	4	5	9	6	10	11
1			+30	+30	+30	+30	+30	+30	+30	[+30]
2			+30	+30	+30	+30	+30	+30	+30	[+30]
3			+30	+30	+30	+30	+30	+30	+30	[+30]
4			+30	+30	+30	+30	+30	+30	+30	[+30]

Table 9-14c. Preliminary LTE interference test tolerances

9.14.3 Multipath performance

Because of reflections or echoes, the transmitted signal will often reach the receiving antenna via a number of paths — hence the term multipath. For modes suited to SFN working there may be more than one transmitted signal and the signal timing of one relative to any other may be positive or negative. As the delays associated with the various paths are likely to be different, the result is an uneven channel response. A further problem occurs if a path delay is changing or if a relative path delay exceeds the guard interval. For this latter case, some of the signal then appears as a noise-like interferer (see DTG RF 18 [64]). Note that most fixed receiving antennas are directional, and therefore offer some discrimination against echoes.

The multipath performance of DVB-T/T2 is such that "perfect" picture quality is possible in circumstances where echoes would render a PAL signal unusable. However, the picture will fail completely if the echo levels are excessive, and it is therefore essential to quantify the failure point of a receiver. Three different echo profiles have been defined for this purpose. The paths making up the profiles are given in terms of delay and phase at the centre frequency of the channel. This ensures that the channel response is independent of centre frequency.

Echo within the Guard Interval

All competently designed receivers should cope with a single static echo (no Doppler) when the relative path delay is within the guard interval (GI) providing there is sufficient resultant signal power. For the case of a single 0 dB static echo with the following delays relative to the GI and 90° phase at the channel centre, a recommended maximum "C/N for Reference BER" is given.

	C/N for Reference BER (dB)							
	Option:							
Echo delay	1	2	3	8	4	5 & 9	6 & 10	11
0.5 × GI	25.0	24.0	24.8	N/A	N/A	N/A	N/A	N/A
0.95 × GI	N/A	N/A	24.8	28.3	23.5	22.1	24.1	[TBD]

Table 9-15. Tolerance to a single 0 dB echo within the GI

Echo with Doppler

In the previous version of the D-Book Doppler parameters were not agreed. However, all competently designed receivers should cope with expected time variations in connection with paths to fixed roof-top reception. Such variation is caused by the swaying of masts, antennas and the branches of trees etc.

For modulation Options 3 & 4 and the case of a single 20 µs, 0 dB echo with 0° phase at the channel centre, the recommended variation in "C/N for Reference BER" is less than 3 dB for frequency differences between the main path and echo, of 1 to 20 Hz (corresponding to pure Doppler shifts of ±0.5 to ±10 Hz after receiver AFC).

For modulation Options 5, 6, 8, 9 & 10 and the case of a single 20 µs, 0 dB echo with 0° phase at the channel centre, the recommended variation in "C/N for Reference BER" is less than 3 dB for frequency differences between the main path and echo, of 1 to 10 Hz (corresponding to pure Doppler shifts of ±0.5 to ±5 Hz after receiver AFC).

Typically the value of "C/N for Reference BER" increases with frequency difference as shown below.

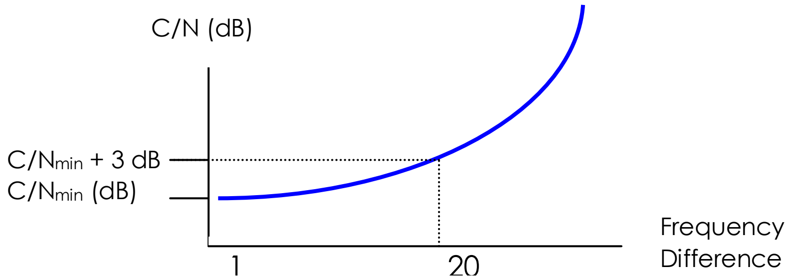


Figure 9-10. Example tolerance to a single echo with Doppler

Further details are given in Chapter 10. For a typical channel simulator, 1 to 20 Hz "pure Doppler" would be selected for the echo path, with a frequency ratio of 1.0. At 666 MHz, 20Hz pure Doppler corresponds to a speed of 9 m/s.

Echo outside the Guard Interval

All competently designed receivers should cope with some degree of multipath when the relative path delays are outside the guard interval (GI) providing there is sufficient main path signal power. For the case of a single static echo with the following delays and 90º phase at the channel centre, the recommended maximum "Echo amplitude for Reference BER" is given in the following table. Note that for modes suited to SFN working, negative relative delay is just as important as positive relative delay. Ultimately, with sufficient relative delay, a single echo becomes equivalent to uncorrelated co-channel interference.

	Test reference:	A	B	C	D	E
Option 1	Delay (μs)	7	15	30	50	60
	Amplitude (dB)	-4.3	-10.3	-14	-16.3	-20.6
Option 2	Delay (μs)	7	15	30	50	60
	Amplitude (dB)	n/a	n/a	n/a	n/a	n/a
Option 3	Delay (μs)	± 28	± 60	± 120	± 200	± 260
	Amplitude (dB)	-4.3	-10.3	-14	-16.3	-20.6
Option 8	Delay (μs)	± 28	± 60	± 120	± 200	± 260
	Amplitude (dB)	-4.3	-11.8	-15.4	-17.7	-22.0
Option 4	Delay (μs)	± 28	± 30	± 33	n/a	n/a
	Amplitude (dB)	-2.0	-2.0	-22.5	n/a	n/a
Option 5 & 9	Delay (μs)	± 28	± 60	± 119	± 135	n/a
	Amplitude (dB)	-2.0	-3.5	-8.0	-23.0	n/a
Option 6 & 10	Delay (μs)	± 28	± 60	± 119	± 135	n/a
	Amplitude (dB)	-2.0	-5.5	-10.0	-25.0	n/a
Option 11	Delay (μs)	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
	Amplitude (dB)	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]

Table 9-15b. Tolerance to a single echo outside the GI

Echo profiles

The echo profiles are as follows:

- A short delay combination of echoes with 0° phase at the channel centre. All six echoes are within the guard interval, and none is dominant: there is no "direct" path. This profile provides a stringent test of the receiver's channel equaliser.
- A medium delay combination of echoes with 0° phase at the channel centre. There is a dominant direct path and five echoes. The test signal is based on the most probable echoes encountered during UK field measurements.
- A long delay combination of echoes with 0° phase at the channel centre. There is a dominant direct path and five echoes. The test signal is based on the "worst" echoes encountered during UK field measurements.

Details of the echo profiles are listed in the table below. In each case, a recommended maximum "C/N for Reference BER" is given. Note that the carrier power is defined as the *total* signal power, not that of the direct path alone.

Multipath Profile	**Path Delay and Att^{n}**		**C/N for Reference BER (dB)**							
	(µs)	**(dB)**	**Option:**							
			1	**2**	**3**	**8**	**4**	**5 & 9**	**6 & 10**	**11**
Short delay multipath profile	0 0.0 5 0.4 1.4 5 2.3 2.8	2.8 0 3.8 0.1 2.6 1.3	24.2	21.5	24.2	25.7	23.1	21.6	23.6	[TBD]
Medium delay multipath profile	0 1 5 8 12 21	0 8.6 12.6 18 20.7 22.2	N/A	N/A	N/A	N/A	21.3	N/A	N/A	[TBD]
Long delay multipath profile	0 5 14 35 54 75	0 9 22 25 27 28	24.2	20	23	24	N/A	19.7	21.8	[TBD]

Table 9-15c. Tolerance of receiver to multipath profiles

9.14.4 Impulse interference

Impulse interference is different from other forms of interference, in that it is generated in short bursts. Sources include car ignition systems and domestic appliances such as switches and electric motors. Car ignition noise reaches the receiver through the antenna, whereas interference from domestic sources mostly enters the system through poorly screened cables and connectors. The damage is potentially serious because a DVB-T single "glitch" can destroy a complete symbol's worth of data. For DVB-T2, data is spread or time interleaved over several symbols and is therefore considerably more resilient.

Many of the early problems encountered with DVB-T can be resolved by improving the quality of installation – see R-Book 2 [83], R-Book 3 [84] and R-Book 4 [85]. However, there is a need for test signals to assess receiver performance, for the following reasons:

- "Standard" demodulators should possess a certain minimum resilience to interference.
- Some demodulators could include sophisticated techniques for improving their resilience, and it is important to know how effective these are.

The test method developed by the DTG comprises bursts of Gaussian noise. In that case, the theoretical tolerance of the receiver can be calculated as follows. The interference power is integrated over a symbol period, to obtain the interference energy; then the energy of the wanted signal within that symbol period is divided by this figure. Should the result fall below the minimum C/N requirement for the particular modulation mode, the system will fail. Note that because the majority of symbols are unaffected by this type of impairment, measurement of BER is meaningless and performance can only be assessed in terms of "picture failure" or onset of uncorrectable errors (the DTG test method uses picture failure – see table 9-20).

A number of test signals have been designed, all based on the above idea. Figure 9-11 illustrates the terminology:

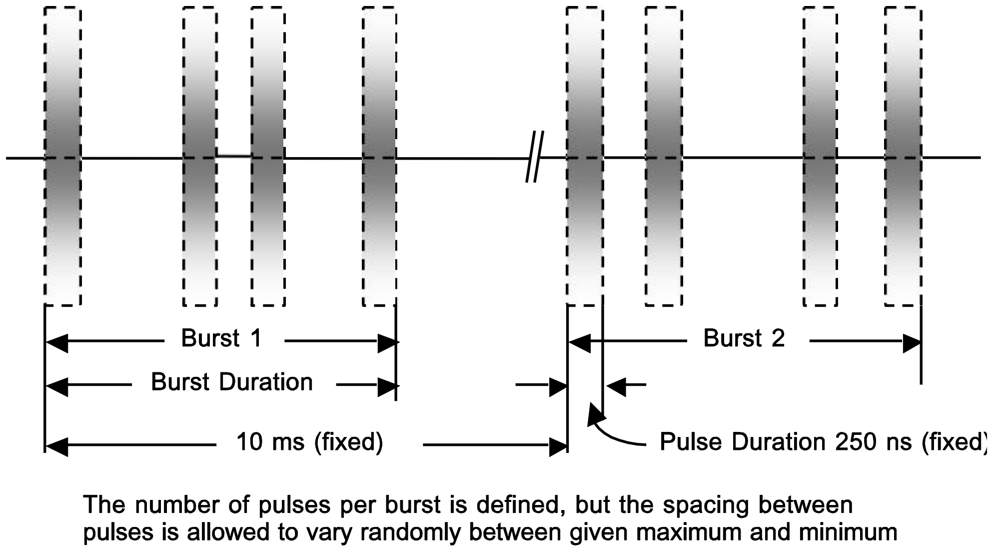


Figure 9-11. The impulse noise test signal

Each burst is relatively short compared with the symbol period, so that most bursts only affect a single symbol. The separation between bursts is sufficiently great for them to behave as isolated events: any errors resulting from the first burst will have been flushed from the system by the time the second burst is received.

All pulses are generated by gating a Gaussian noise source of power P. Hence the noise energy in a burst is the product of P and the total duration of the gating pulses, Te, within the burst. Since the total signal energy is the product of the carrier power, C, and the active symbol duration, Tu, the ratio of wanted signal energy to interference energy is:

$$(C \times T_U) / (P \times T_e)$$

The DVB-T theoretical failure point corresponds to this quantity equalling the minimum carrier-to-noise requirement, (C/N)ref , for the system. In other words, the tolerance of the receiver to the test signal should exceed its tolerance to ungated Gaussian noise by a factor (T_U / T_e). This so-called "tolerance factor" is generally expressed in dB. Note that it is independent of modulation mode, receiver implementation margin and degradation criterion.

For DVB-T, six tests have been defined, as detailed in the table below. The tolerance factors are presented in the final column.

Test No.	Pulses per burst	Minimum/maximum pulse spacing (µs)		Burst duration (µs)		Tolerance factor (dB)
				Maximum	Effective	
1	1	N/A	N/A	0.25	0.25	29.5
2	2	1.5	45	45.25	0.50	26.5
3	4	15.0	35	105.25	1.00	23.5
4	12	10.0	15	165.25	3.00	18.7
5	20	1.0	2	38.25	5.00	16.5
6	40	0.5	1	39.25	10.00	13.5

Table 9-16. Impulse noise tests and theoretical receiver tolerance

As an example, suppose that a receiver reaches "picture failure" when C/N = 17.6 dB — a typical figure for "Option 1". The anticipated picture failure point for Test 2 then corresponds to a theoretical burst power of –17.6 dBc + 26.5 dB, or +8.9 dBc. Of course, during tests, P is easily measured by switching off the gating so that the noise is present continuously. There are three additional factors which have to be considered concerning the practical aspects of these tests.

- Having only a relatively small number of pulses per burst means that there is a statistical uncertainty concerning the actual power of a burst. As a consequence, degraded performance can occur. This is accounted for by allowing an additional uncertainty margin.
- The receiver is expected to 'cleanly' clip[22] impulsive interference when the burst power exceeds about +10 to +12 dBc. As a consequence, enhanced performance is expected.

[22]. This means there are no secondary effects such as AM to PM conversion,

- Burst power levels greater than +30 dBc are difficult to produce and this represents a practical limit.

The first two above effects become more relevant as the test number is reduced.

However, they do not necessarily cancel each other out as mode dependencies are different. The maximum C/I values for different tests and options for DVB-T are detailed in the following table.

	C/I (dB) for "picture failure"			
Test no.	**Option 1**	**Option 2**	**Option 3**	**Option 8**
1	-10.1	-15.7	-30	-30
2	-7.1	-12.7	-26.4	-18.9
3	-4.1	-9.7	-11.4	-9.9
4	-0.8	-4.9	-6.7	-5.2
5	1.4	-2.7	-4.4	-2.9
6	4.4	0.3	-1.4	0.1

Table 9-17. DVB-T maximum C/I values for impulse noise tests

A DVB-T receiver that employs countermeasures against impulse interference should tolerance factors in excess of those given in Table 9-17 for one or more tests. The higher the test number, the greater the difficulty in designing effective countermeasures.

The subject of impulse interference is treated in the Monograph 5 [86].

9.14.4.1Impulse Interference DVB-T2

DVB-T2 is different to DVB-T in that data is spread or time interleaved across several symbols. As a consequence DVB-T2 is considerably more resilient to impulsive interference.

Using the same principles as for the tests with DVB-T, some new tests have been designed for DVB-T2, and the parameters for these are given in Table 9-17b. Tests 7 & 8 duplicate the parameters of tests 3 & 6, but with a longer burst repetition period (see below). These tests are intended to be representative of the full range of impulsive interference captures analysed in BBC White Paper WHP080 [81].

Due to the extended duration of these tests and the time interleaving in DVB-T2, the original burst repetition period of 10ms is no longer relevant, and so for these new tests, the burst repetition period is extended to 1000ms.

Note that initially maximum C/I values are not yet available for the new tests. As an interim measure, DVB-T2 receivers will therefore be tested with the original tests 3 & 6 (using the 10ms burst repetition period) as well as the new tests 7-12.

oscillator pulling or rail bounce.

The maximum C/I values acceptable for each of these tests with different DVB-T2 options is given in Table 9-17c.

Test No.	Pulses per burst	Minimum/maximum pulse spacing (µs)		Burst duration (µs)		Tolerance factor (dB)
				Maximum	Effective	
7	4	15.0	35	105.25	1.00	[TBC]
8	40	0.5	1	39.25	10.00	[TBC]
9	80	0.5	3	237.25	20	[TBC]
10	400	1	30	11,970.25	100	[TBC]
11	4,000	0.5	3	11,997.25	1,000	[TBC]
12	40,000	0.5	1	39,999.25	10,000	[TBC]

Table 9-17b. Impulse noise tests for DVB-T2

Test no.	Burst repetition period (ms)	C/I (dB) for "picture failure"			
		Option 4	Option 5 & 9	Option 6 & 10	Option 11
3	**10**	-30	-30	-30	N/A
6	**10**	-8	-8	-6	N/A
7	**1000**	[TBD]	[TBD]	[TBD]	[TBD]
8	**1000**	[TBD]	[TBD]	[TBD]	[TBD]
9	**1000**	[TBD]	[TBD]	[TBD]	[TBD]
10	**1000**	[TBD]	[TBD]	[TBD]	[TBD]
11	**1000**	[TBD]	[TBD]	[TBD]	[TBD]
12	**1000**	[TBD]	[TBD]	[TBD]	[TBD]

Table 9-17c. DVB-T2 maximum C/I values for impulse noise tests

9.14.5 Diversity reception

Unlike 'standard' receivers, a diversity receiver has two or more RF inputs. Implementations may vary, but the general principle is that the signals obtained from two or more antennas are selected or combined in some way prior to decoding (only two-way diversity is considered here).

Compared to 'standard' reception, diversity reception can offer a significant advantage when the channel response is changing fast because of multipath — the so called 'diversity gain'. This gain is expressed in dB, and equals the reduction in transmitter power that would give the same coverage as for a standard receiver. Typical values are 6 to 8 dB. In addition, Doppler performance is also improved.

For fixed rooftop and indoor portable reception, the channel conditions change much more slowly than for mobile reception, yet diversity reception can still offer a considerable benefit in reception reliability. A single antenna may suffer a deep or flat-fade condition that is both position and frequency dependent. A second antenna is unlikely to suffer such conditions simultaneously.

The most powerful form of diversity reception with signals from two antennas is the use of two front-ends and associated demodulators working together to achieve maximum ratio combining (MRC). This, in essence, combines corresponding COFDM carriers using quality weighting, and results in the greatest overall C/N ratio. Compared to 'standard' reception, there is a potential 3 dB noise advantage in a Gaussian channel.

Simple Diversity Test

A diversity receiver will be expected to have the same performance as that of a 'standard' receiver when only one RF input is used (specified as input A or 'main') and the other RF input (B) terminated. A simple test to ensure that MRC diversity is effective is as follows:

1. The Gaussian sensitivity for input A only (input B terminated) is measured.
   The Gaussian sensitivity for input B only (input A terminated) is measured.
   These two sensitivities should be equal; if not, an average can be noted.

2. A 0 dB, 0° phase, 2.5 μs echo profile is applied to input A.
   A 0dB, 180° phase, 2.5 μs echo profile is applied to input B, with equal power.
   The sensitivity is measured.

   The improvement in sensitivity in (2) compared to (1) above should be at least 2.5 dB for any mode.

Note The echo profile at each receiver input introduces regular nulls in the channel response. However, the nulls at one input correspond to peaks at the other input. Combining the two input signals should be nearly equivalent to presenting a non-diversity receiver with a single, flat signal of the same total power. Hence the theoretical improvement in sensitivity noted in the second step should be 3 dB.

Further details of the above diversity test are given in DTG RF 103 [113].

Multi-Channel Diversity Tests

There are two multi-channel diversity tests. These are designed to represent likely situations when a portable receiver is used inside a room. The first profile assumes that two equal signals of relative delay 0.5 μs enter the room. Each of these signals is then reflected twice around the room. The two receiver antennas (A and B) are taken to be relatively close, say a half-wavelength apart. Profile 1 is as follows:

Path Delay (μs)	**Channel A**		**Channel B**	
	Path Loss (dB)	Phase (deg)	Path Loss (dB)	Phase (deg)
0.00	6	340	5.3	119
0.05	9	30	8.3	93
0.10	12	129	11.3	329
0.50	7.5	175	6.8	138
0.55	10.5	231	9.8	146
0.60	13.5	297	12.8	307

Table 9-18. Profile 1 for Multi-Channel Diversity Tests

The paths indicated by shading are the two incoming signals. Although these are nominally equal, slight adjustments have been made to ensure 0 dB total power.

Profile 2, shown below, is based on Profile 1, but assumes 3 dB further loss per reflection. It has been introduced as a check that the performance of the receiver does not depend excessively on the echo profile.

Path Delay (us)	**Channel A**		**Channel B**	
	Path Loss (dB)	Phase (deg)	Path Loss (dB)	Phase (deg)
0.00	6	340	5.7	119
0.05	12	30	11.7	93
0.10	18	129	17.7	329
0.50	7.5	175	7.2	138
0.55	13.5	231	13.2	146
0.60	19.5	297	19.2	307

Table 9-18b. Profile 2 for Multi-Channel Diversity Tests

Whatever profile is chosen, the test is carried out as follows:

1. The sensitivity (C/N) for input A only (input B terminated) is measured. The sensitivity for input B only (input A terminated) is measured. These two sensitivities will not be equal, since Channels A and B possess different powers.
2. Both inputs (Channels A and B) are now applied. The sensitivity is measured again.

The improvement in sensitivity noted in 2 should be at least 6 dB for either input and any mode.

Further details of the above diversity tests are given in DTG RF 104 [114].

9.14.6 Summary of DVB-T/T2 performance targets

It is common to express performance in terms of C/N or C/I "protection ratios". Although the "Reference BER" impairment criterion has been used so far in this chapter, the "picture failure" (PF) criterion is often favoured during measurements. This is because not all domestic equipment provides a display of BER from the output of the inner decoder. The difference or delta values associated with these criteria are:

Impairment	Options 1, 2, 3 & 8	Options 4, 5, 6, 9, & 10, 11.
Thermal noise, AWGN & Echo outside the GI.	1.3 dB	0 dB
All other impairments except II.	2.0 dB	0 dB
Impulsive interference (II).	N/A	N/A

Table 9-19: Delta values (dB) between BER_{Ref} and PF

The following table on the next page is a summary of protection ratio 'failure' targets for the different impairments described in this chapter. Note that for receiver tests (see Chapter 10) and for the modulation Options that are under consideration for future use, only a sub-set of these performance parameters need be tested at this time.

In general, three levels of testing are required:

1) Functional tests for DVB-T & T2 modes according to 9.4.

2) Performance tests for Options 1,2,3 & 6 according to table 9.20.

3) A sub-set of performance tests for Options 4,5, 8, 9 &10, comprising:

C/N with AWGN

DVB-T2E ACI (N±1) protection.

LTE Interference

Note that at this time only a functional test is required for Option 7.

			DVB-T Options			
Impairment / Test	**Wanted signal level (dBm)**	**Interferer(s) level (dBm)**	**1**	**2**	**3**	**8**
Basic RF Tests						
Sensitivity (dBm)	Variable	-	–79.2	–83.4	–79.6	-78.1
C/N with AWGN (dB)	–50	Variable	17.9	13.8	17.6	19.1
PAL CCI (N) protection (dB)	–50	Variable	2.0	–2.0	2.0	5.0
PAL ACI (N±1) protection (dB)	Variable	–25	–37.0	–39.0	–37.0	-37
DVB-T ACI (N±1) protection (dB)	Variable	–25	–29.0	–31.0	–29.0	-28
DVB-T2E ACI (N±1) protection (dB)	Variable	–25			-27	-26
DTT Non-ACI (N±2) protection (dB)	Variable	–25			–40.0	-38
DTT Non-ACI (N±3) protection (dB)	Variable	–25			–45.0	-43
DTT Non-ACI (N±M) protection (dB), M≥4, M≠9	Variable	–25			–49.0	-46
PAL (N+9) Protection (dB)	Variable	–25	–48.0	–52.0	–48.0	-45
DTT (N+9) Protection (dB)	Variable	–25			–33.0	-31
LTE (BS-A) Protection (dB)	Variable	–15			–30.0	–30.0
LTE (BS-B) Protection (dB)	Variable	–15			–30.0	–30.0
LTE (UE-C) Protection (dB)	Variable	–15			–30.0	–30.0
LTE (UE-A) Protection (dB)	Variable	–15			–30.0	–30.0
Linearity Test						
DTT Simultaneous non-ACI (N+2) & (N+4) protection (dB)	Variable	–25 (Each)			–30.0	-29
Multipath Tests						
C/N (dB) with 0 dB, 0.5 GI echo	–50 (path 1)	Variable C/N	23.0	22.0	22.8	N/A
C/N (dB) with 0 dB, 0.95 GI echo	–50 (path 1)	Variable C/N			22.8	26.3
ΔC/N (dB) with 0 dB, 20µs echo and 20 Hz Doppler (±10 Hz after AFC)	–50 (path 1)	Variable C/N for each Doppler freq.			3.0	N/A
ΔC/N (dB) with 0 dB, 20µs echo and 10 Hz Doppler (±5 Hz after AFC)	–50 (path 1)	Variable C/N for each Doppler freq.	N/A	N/A	N/A	3.0
Level (dB) for test A	–50 (path 1)	Variable path 2	–3.0		–3.0	-3
Level (dB) for test B	–50 (path 1)	Variable path 2	–9.0		–9.0	-10.5
Level (dB) for test C	–50 (path 1)	Variable path 2	–12.7		–12.7	-14.1
Level (dB) for test D	–50 (path 1)	Variable path 2	–15.0		–15.0	-16.4
Level (dB) for test E	–50 (path 1)	Variable path 2	–19.3		–19.3	-20.7
Short delay echo profile	–50 (path 1)	Variable C/N (dB)	22.2	19.5	22.2	23.7
Medium delay echo profile	–50 (path 1)	Variable C/N (dB)	N/A	N/A	N/A	N/A
Long delay echoes profile	–50 (path 1)	Variable C/N (dB)	22.2	18.0	21.0	22.0
Impulsive Interference Tests						

II Test 1 (dB)	–60	Variable	–10.1	–15.7	–30.0	-30.0
II Test 2 (dB)	–60	Variable	–7.1	–12.7	–26.4	-18.9
II Test 3 (dB)	–60	Variable	–4.1	–9.7	–11.4	-9.9
II Test 4 (dB)	–60	Variable	–0.8	–4.9	–6.7	-5.2
II Test 5 (dB)	–60	Variable	1.4	–2.7	–4.4	-2.9
II Test 6 (dB)	–60	Variable	4.4	0.3	–1.4	0.1
Diversity Tests (where applicable)						
Twin 0 dB echo, Diversity gain (dB)	Variable		2.5	2.5	2.5	2.5
Profile 1: Diversity gain (dB)			6.0	6.0	6.0	6.0
Profile 2: Diversity gain (dB)			6.0	6.0	6.0	6.0

Table 9-20a. Performance target PF values for various impairments (DVB-T)

			DVB-T2 Options					
Impairment / Test	**Wanted signal level (dBm)**	**Interferer(s) level (dBm)**	**4**	**5**	**9**	**6**	**10**	**11**
Basic RF Tests								
Sensitivity (dBm)	Variable	-	-78.1	-78.2	-78.2	-76.3	-76.3	[TBD]
C/N with AWGN (dB)	–50	Variable	19.0	18.9	18.9	20.8	20.8	[TBD]
PAL CCI (N) protection (dB)	–50	Variable	6.4	6.3	6.3	8.2	8.2	[TBD]
PAL ACI (N±1) protection (dB)	Variable	–25	-35.0	-34.0	-34.0	-32.0	-32.0	[TBD]
DVB-T ACI (N±1) protection (dB)	Variable	–25						
DVB-T2E ACI (N±1) protection (dB)	Variable	–25	-27.0	-26.0	-26.0	-24.0	-24.0	[TBD]
DTT Non-ACI (N±2) protection (dB)	Variable	–25	-38	-37	-37	-35	-35	[TBD]
DTT Non-ACI (N±3) protection (dB)	Variable	–25	-43	-42	-42	-40	-40	[TBD]
DTT Non-ACI (N±M) protection (dB), M≥4, M≠9	Variable	–25	-47	-46	-46	-44	-44	[TBD]
PAL (N+9) Protection (dB)	Variable	–25	-46	-45	-45	-43	-43	[TBD]
DTT (N+9) Protection (dB)	Variable	–25	-31	-30	-30	-28	-28	[TBD]
LTE (BS-A) Protection (dB)	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (BS-A) Protection (dB)	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (UE-C) Protection (dB)	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (UE-A) Protection (dB)	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
Linearity Test								
DTT Simultaneous non-ACI (N+2) & (N+4) protection (dB)	Variable	–25 (Each)	-28	-27	-27	-25	-25	[TBD]
Multipath Tests								
C/N (dB) with 0 dB, 0.5 GI echo	–50 (path 1)	Variable C/N	N/A	N/A	N/A	N/A	N/A	N/A
C/N (dB) with 0 dB, 0.95 GI	–50 (path	Variable C/N	23.5	22.1	22.1	24.1	24.1	[TBD]

echo	1)							
ΔC/N (dB) with 0 dB, 20μs echo and 20 Hz Doppler (±10 Hz after AFC)	–50 (path 1)	Variable C/N for each Doppler freq.	3.0	N/A	N/A	N/A	N/A	[TBD]
ΔC/N (dB) with 0 dB, 20μs echo and 10 Hz Doppler (±5 Hz after AFC)	–50 (path 1)	Variable C/N for each Doppler freq.	N/A	3.0	3.0	3.0	3.0	[TBD]
Level (dB) for test A	–50 (path 1)	Variable path 2	-2.0	-2.0	-2.0	-2.0	-2.0	[TBD]
Level (dB) for test B	–50 (path 1)	Variable path 2	-2.0	-3.5	-3.5	-5.5	-5.5	[TBD]
Level (dB) for test C	–50 (path 1)	Variable path 2	-22.5	-8.0	-8.0	-10.0	-10.0	[TBD]
Level (dB) for test D	–50 (path 1)	Variable path 2	-	-23.0	-23.0	-25.0	-25.0	[TBD]
Level (dB) for test E	–50 (path 1)	Variable path 2	-	-	-	-	-	[TBD]
Short delay echo profile	–50 (path 1)	Variable C/N (dB)	23.1	21.6	21.6	23.6	23.6	[TBD]
Medium delay echo profile	–50 (path 1)	Variable C/N (dB)	21.3	N/A	N/A	N/A	N/A	[TBD]
Long delay echoes profile	–50 (path 1)	Variable C/N (dB)	N/A	19.7	19.7	21.8	21.8	[TBD]
Impulsive Interference Tests								
II Test 3 (dB) (BRP=10ms)	–60	Variable	–30.0	–30.0	–30.0	–30.0	–30.0	N/A
II Test 6 (dB) (BRP=10ms)	–60	Variable	–8.0	–8.0	–8.0	–6.0	–6.0	N/A
II Test 7 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 8 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 9 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 10 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 11 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 12 (dB) (BRP=1000ms)	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
Diversity Tests (where applicable)								
Twin 0 dB echo, Diversity gain (dB)	Variable		2.5	2.5	2.5	2.5	2.5	[TBD]
Profile 1: Diversity gain (dB)			6.0	6.0	6.0	6.0	6.0	[TBD]
Profile 2: Diversity gain (dB)			6.0	6.0	6.0	6.0	6.0	[TBD]

Table 9-20b. Performance target PF values for various impairments (DVB-T2)

10 RF Test Procedures for DVB-T and DVB-T2 receivers

10.1 Introduction and scope

This chapter gives defined test conditions and example procedures for the testing of receivers intended for use with DVB-T and DVB-T2. Reference should also be made to chapter 9 where appropriate. The performance tests can be split into three different categories: basic RF tests, multipath tests and impulsive interference tests. The methods and procedures described are not meant to serve as rigid algorithms for testing; they merely suggest test regimes that have already proved useful for the assessment of receivers intended to be part of the UK transmission chain in Section 9.6, "Example transmission chain".

The target performance figures are intended as a guide to both receiver manufacturers and network planners.

10.2 References

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[86] Monograph 5	A Tutorial on Impulsive Noise in COFDM Systems. Peter Lewis. Philips Semiconductors.

Table 10-1. References

10.3 Summary of tests and performance targets

Section 9.4, "Modulation parameters", details DVB-T and DVB-T2 modes and the status of modulation parameter Options 1 to 10.

In general, three levels of testing are required:

1) Functional tests for DVB-T & T2 modes according to Section 9.4.

2) Performance tests for Options 1, 2, 3 & 6 according to table 10-2.

3) A sub-set of performance tests for Options 4, 5, 8, 9 &10, comprising:

Test 10.7.2 (C/N with AWGN)

Test 10.7.6 (DVB-T2E ACI (N±1) protection).

LTE Interference

Note that a full set of performance parameters for Options 4, 5, 8, 9, & 10 are given in table 10-2 but only the sub-set above need be tested at this time. Performance parameters for Option 7 are not specified at this time and therefore Option 7 is not included in all the performance tables.

A summary of the tests and performance targets covered by this chapter is given below in Table 10-2. The figures in this table are for the picture failure (PF) degradation criterion (see Section10.6, "Degradation criteria"). This table is the same as tables 9.20 a & b except that a reference is given to the test as detailed in this chapter.Some performance targets are expressed as 'protection ratios' (PR). This is a measure of the capability of a receiver to receive or acquire a wanted signal in the presence of an unwanted (interfering) signal at a specified frequency offset. It is defined as the ratio in dB between the wanted and interfering signal levels (C/I) at the point where a degradation criterion is reached.

In addition to these performance tests, functional tests of relevant DVB-T2 modulation parameters should also be made. These are detailed in Annex G.

The "level of interfering signal" is relative to the wanted signal. For modulation modes options 1 and 2 these requirements are the same as the previous version of the D-Book except for II tests 1,2 & 3 for option 1 where an additional margin has been included. No further work has been done in updating these requirements as they will not be used post Switchover. For modulation mode option 3 new requirements have been introduced. The table also serves to indicate which tests are applicable to each mode.

Impairment / Test	Test	Wanted signal level (dBm)	Interferer(s) level (dBm)	DVB-T Options			
				1 (2K, 64Q, r2/3)	2 (2K, 16Q, r3/4)	3 (8K, 64Q, r2/3)	8 (8K, 64Q, r3/4)
Basic RF Tests							
Sensitivity (dBm)	10.7.1	Variable	-	–79.2	–83.4	–79.6	-78.1
C/N with AWGN (dB)	10.7.2	–50	Variable	17.9	13.8	17.6	19.1
PAL CCI (N) protection (dB)	10.7.3	–50	Variable	2.0	–2.0	2.0	5.0
PAL ACI (N±1) protection (dB)	10.7.4	Variable	–25	–37.0	–39.0	–37.0	-37
DVB-T ACI (N±1) protection (dB)	10.7.6	Variable	–25	–29.0	–31.0	–29.0	-28
DVB-T2E ACI (N±1) protection (dB)	10.7.6	Variable	–25			-27	-26
DTT Non-ACI (N±2) protection (dB)	10.7.7	Variable	–25			–40.0	-38
DTT Non-ACI (N±3) protection (dB)	10.7.7	Variable	–25			–45.0	-43
DTT Non-ACI (N±M) protection (dB), M≥4, M≠9	10.7.7	Variable	–25			–49.0	-46
PAL (N+9) Protection (dB)	10.7.5	Variable	–25	–48.0	–52.0	–48.0	-45
DTT (N+9) Protection (dB)	10.7.8	Variable	–25			–33.0	-31
LTE (BS-A) Protection (dB)	10.7.10	Variable	–15			–30.0	–30.0
LTE (BS-B) Protection (dB)	10.7.10	Variable	–15			–30.0	–30.0
LTE (UE-C) Protection (dB)	10.7.11	Variable	–15			–30.0	–30.0
LTE (UE-A) Protection (dB)	10.7.11	Variable	–15			–30.0	–30.0
Linearity Test							
DTT Simultaneous non-ACI (N+2) & (N+4) protection (dB)	10.7.9	Variable	–25 (Each)			–30.0	-29
Multipath Tests							
C/N (dB) with 0 dB, 0.5 GI echo	10.8.7	–50 (path 1)	Variable C/N	23.0	22.0	22.8	N/A
C/N (dB) with 0 dB, 0.95 GI echo	10.8.7	–50 (path 1)	Variable C/N			22.8	26.3
ΔC/N (dB) with 0 dB, 20μs echo 20Hz Doppler (±10 Hz after AFC)	10.8.8	–50 (path 1)	Variable C/N for each Doppler freq.			3.0	N/A
ΔC/N (dB) with 0 dB, 20μs echo. 10 Hz Doppler (±5 Hz after AFC)	10.8.8	–50 (path 1)	Variable C/N for each Doppler freq.	N/A	N/A	N/A	3.0
Level (dB) for test A	10.8.9	–50 (path 1)	Variable path 2	–3.0		–3.0	-3
Level (dB) for test B	10.8.9	–50 (path 1)	Variable path 2	–9.0		–9.0	-10.5
Level (dB) for test C	10.8.9	–50 (path 1)	Variable path 2	–12.7		–12.7	-14.1
Level (dB) for test D	10.8.9	–50 (path 1)	Variable path 2	–15.0		–15.0	-16.4
Level (dB) for test E	10.8.9	–50 (path 1)	Variable path 2	–19.3		–19.3	-20.7
Short delay echo profile	10.8.4	–50 (path 1)	Variable C/N (dB)	22.2	19.5	22.2	23.7
Medium delay echo profile	10.8.5	–50 (path 1)	Variable C/N	N/A	N/A	N/A	N/A
Long delay echo profile	10.8.6	–50 (path 1)	Variable C/N (dB)	22.2	18.0	21.0	22.0
Impulsive Interference Tests							
II Test 1 (dB)	10.9	–60	Variable	–10.1	–15.7	–30.0	-30.0
II Test 2 (dB)	10.9	–60	Variable	–7.1	–12.7	–26.4	-18.9
II Test 3 (dB)	10.9	–60	Variable	–4.1	–9.7	–11.4	-9.9
II Test 4 (dB)	10.9	–60	Variable	–0.8	–4.9	–6.7	-5.2

II Test 5 (dB)	10.9	–60	Variable	1.4	–2.7	–4.4	-2.9
II Test 6 (dB)	10.9	–60	Variable	4.4	0.3	–1.4	0.1
Diversity Tests (where applicable)							
Twin 0 dB echo, Diversity gain (dB)	10.10.1	Variable		2.5	2.5	2.5	2.5
Profile 1: Diversity gain (dB)	10.10.2			6.0	6.0	6.0	6.0
Profile 2: Diversity gain (dB)	10.10.2			6.0	6.0	6.0	6.0

Table 10-2a. C/N and C/I Target values (picture failure) for DVB-T with various impairments

				DVB-T2 Options					
Impairment / Test	**Test**	**Wanted signal level (dBm)**	**Interferer(s) level (dBm)**	**4 (8KE, 64Q, r4/5)**	**5 (32KE, 256Q, r3/5)**	**9 (32KN, 256Q, r3/5)**	**6 (32KE, 256Q, r2/3)**	**10 (32KN, 256Q, r2/3**	**11 [TBD]**
Basic RF Tests									
Sensitivity (dBm)	10.7.1	Variable	-	–78.1	–78.2	–78.2	–76.3	–76.3	[TBD]
C/N with AWGN (dB)	10.7.2	–50	Variable	19.0	18.9	18.9	20.8	20.8	[TBD]
PAL CCI (N) protection (dB)	10.7.3	–50	Variable	6.4	6.3	6.3	8.2	8.2	[TBD]
PAL ACI (N±1) protection (dB)	10.7.4	Variable	–25	–35.0	–34.0	–34.0	–32.0	–32.0	[TBD]
DVB-T ACI (N±1) protection (dB)	10.7.6	Variable	–25	N/A	N/A	N/A	N/A	N/A	N/A
DVB-T2E ACI (N±1) protection (dB)	10.7.6	Variable	–25	–27.0	–26.0	–26.0	–24.0	–24.0	[TBD]
DTT Non-ACI (N±2) protection (dB)	10.7.7	Variable	–25	–38	–37	–37	–35	–35	[TBD]
DTT Non-ACI (N±3) protection (dB)	10.7.7	Variable	–25	–43	–42	–42	–40	–40	[TBD]
DTT Non-ACI (N±M) protection (dB), M≥4, M≠9	10.7.7	Variable	–25	–47	–46	–46	–44	–44	[TBD]
PAL (N+9) Protection (dB)	10.7.5	Variable	–25	–46	–45	–45	–43	–43	[TBD]
DTT (N+9) Protection (dB)	10.7.8	Variable	–25	–31	–30	–30	–28	–28	[TBD]
LTE (BS-A) Protection (dB)	10.7.10	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (BS-B) Protection (dB)	10.7.10	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (UE-C) Protection (dB)	10.7.11	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
LTE (UE-A) Protection (dB)	10.7.11	Variable	–15	–30.0	–30.0	–30.0	–30.0	–30.0	–30.0
Linearity Test									
DTT Simultaneous non-ACI (N+2) & (N+4) protection (dB)	10.7.9	Variable	–25 (Each)	–28	–27	–27	–25	–25	[TBD]
Multipath Tests									
C/N (dB) with 0 dB, 0.5 GI echo	10.8.7	–50 (path 1)	Variable C/N	N/A	N/A	N/A	N/A	N/A	N/A
C/N (dB) with 0 dB, 0.95 GI echo	10.8.7	–50 (path 1)	Variable C/N	23.5	22.1	22.1	24.1	24.1	[TBD]
ΔC/N (dB) with 0 dB, 20µs echo 20Hz Doppler (±10 Hz after AFC)	10.8.8	–50 (path 1)	Variable C/N for each Doppler freq.	3.0	N/A	N/A	N/A	N/A	[TBD]
ΔC/N (dB) with 0 dB, 20µs echo. 10 Hz Doppler (±5 Hz after AFC)	10.8.8	–50 (path 1)	Variable C/N for each Doppler freq.	N/A	3.0	3.0	3.0	3.0	[TBD]
Level (dB) for test A	10.8.9	–50 (path 1)	Variable path 2	–2.0	–2.0	–2.0	–2.0	–2.0	[TBD]
Level (dB) for test B	10.8.9	–50 (path 1)	Variable path 2	–2.0	–3.5	–3.5	–5.5	–5.5	[TBD]
Level (dB) for test C	10.8.9	–50 (path 1)	Variable path 2	–22.5	–8.0	–8.0	–10.0	–10.0	[TBD]
Level (dB) for test D	10.8.9	–50 (path 1)	Variable path 2	N/A	–23.0	–23.0	–25.0	–25.0	[TBD]
Level (dB) for test E	10.8.9	–50 (path 1)	Variable path 2	N/A	N/A	N/A	N/A	N/A	[TBD]
Short delay echo profile	10.8.4	–50 (path 1)	Variable C/N (dB)	23.1	21.6	21.6	23.6	23.6	[TBD]

Medium delay echo profile	10.8.5	–50 (path 1)	Variable C/N	21.3	N/A	N/A	N/A	N/A	[TBD]
Long delay echo profile	10.8.6	–50 (path 1)	Variable C/N (dB)	N/A	19.7	19.7	21.8	21.8	[TBD]
Impulsive Interference Tests									
II Test 3 (dB) (BRP = 10ms)	10.9	–60	Variable	–30.0	–30.0	–30.0	–30.0	–30.0	N/A
II Test 6 (dB) (BRP = 10ms)	10.9	–60	Variable	–8.0	–8.0	–8.0	–6.0	–6.0	N/A
II Test 7 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 8 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 9 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 10 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 11 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
II Test 12 (dB) (BRP = 1000ms)	10.9	–60	Variable	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]	[TBD]
Diversity Tests (where applicable)									
Twin 0 dB echo, Diversity gain (dB)	10.10.1	Variable		2.5	2.5	2.5	2.5	2.5	[TBD]
Profile 1: Diversity gain (dB)	10.10.2			6.0	6.0	6.0	6.0	6.0	[TBD]
Profile 2: Diversity gain (dB)	10.10.2			6.0	6.0	6.0	6.0	6.0	[TBD]

Table 10-2b. C/N and C/I Target values (picture failure) for DVB-T2 with various impairments

10.4 General test arrangement

A block diagram of the basic test arrangement is shown in Figure 10-1 below.

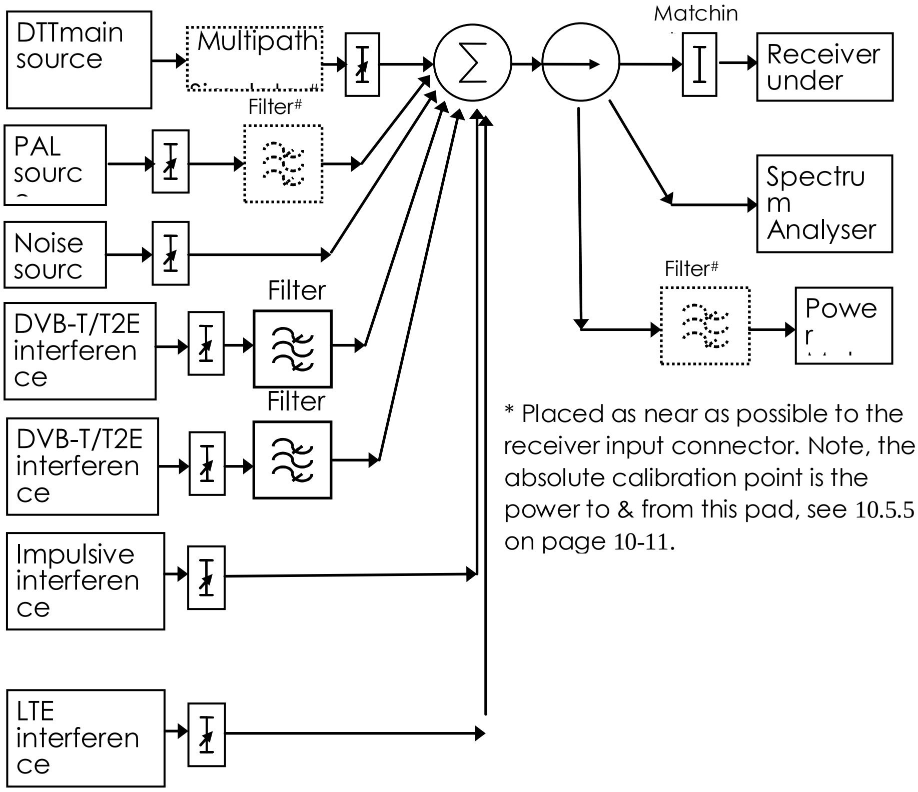


Figure 10-1. Basic test arrangement

10.4.1 DTT main source

Details of modulation options 1 to 11 are given in sections 9.4.1 and 9.4.2.

Note that for DVB-T2 the suffix "E" signifies extended carrier modes and the suffix "N" signifies non-extended carrier modes. If no suffix is use then either is applicable. If the term DTT is used then either DVB-T or DVB-T2 is applicable.

The signal from this laboratory generator is assumed ideal and it should be verified that noise and intermodulation products from the generator are as low as can be achieved. It is expected that the equivalent noise floor (ENF) is significantly better than -34 dBc. This is the typical value that is assumed for a high power transmitter in chapter 9. The value of ENF assumed for an 'ideal' source and the 'base-line' value for calculation of END is -50 dBc. However, this value would be difficult to verify.

The transport stream composition for DVB-T is not too critical but it is recommended that a single test program with the following minimum data rates is used:

Standard	Minimum test program data rates
DVB-T	4.5 to 5 Mbit/s (MPEG2)
DVB-T2	X to Y Mbit/s (MPEG4) - TBD

The transport stream composition for DVB-T2 is under study. However, testing with DVB-T2 signals should be carried out using a single PLP.

10.4.2 PAL source

PAL-I1 signal source: 75% colour bars vision modulation, FM sound carrier (-13 dB) with ±50 kHz deviation at 1 kHz rate, and modulated NICAM sound carrier (-20 dB). For upper channel protection ratio tests, it is essential that this signal source complies with the spectrum mask requirement for PAL-I1 as given in D-Book 5, Section 9.10.4, “PAL-I signals”. (The original PAL-I mask allows much higher vestigial sideband levels that would interfere with the lower adjacent channel.)

The power of the modulated analogue PAL-I1 signal is conventionally referenced to the power of the vision carrier during the line synchronising pulse. This is the peak sync power (PSP) and care is required to measure this accurately. Some sources can be switched to a single tone at PSP in order to make this measurement easier. Because the above modulation of this test source is line repetitive, the average power of the PAL-I1 signal source (including FM and NICAM sound) can be measured with a power meter.

With the correct modulation depth [23], there is a fixed relationship between the average power and PSP. For example, for this modulation, PAL-I1 PSP level = PAL-I1 average level +3.3 dB[24].

10.4.3 Noise source

This is a broadband additive white Gaussian noise (AWGN) generator. The output can be restricted to cover the UHF bands of interest (400 to 900 MHz approximately).

10.4.4 DVB-T/T2E interfering sources

The signals from these generators are used as interfering sources. The symbol rate frequency should be locked to a different frequency standard from that of the wanted COFDM signal source. There should be a deliberate frequency offset between frequency standards such that the symbol phase of the interfering source relative to the wanted source rotates by at least one cycle whilst each measurement is made. The ENF of these sources is not as critical as that of the main source; however spectrum purity is very important. Most wideband laboratory signal sources will require additional channel filtering to remove any and out-of-band emission (including broadband noise) when performing tests 10.7.6 10.7.7 and 10.7.8. Otherwise these measurements may not be valid.

10.4.5 Impulsive interference source

This is described in detail in Section10.9, “Impulsive interference tests”.

10.4.5a LTE interference source

The LTE interference source consists of a replay from an Arbitrary Signal Generator (ARB) of an IQ file corresponding to the condition to be tested. The required IQ files can be downloaded from DTG Testing ftp site and correspond to the following conditions:

23.For PAL-I and PAL-I1: white = 20% carrier.

24.The corresponding relationship for the old PAL-I standard is: PAL-I PSP level = PAL-I average level +3.0 dB.

- LTE BS Idle (0% traffic), centred on 796MHz (BS-A) and 806 MHz (BS-B)
- LTE UE (1 Mb/s traffic), centred on 857MHz (UE-C) and 837 MHz (UE-A)

The LTE source is always switched off, except where indicated otherwise.

10.4.6 Spectrum analyser

For general monitoring or power / power ratio measurement.

For noise measurements it is recommended that the spectrum analyser should set as follows.

Centre Frequency:	Centre of channel under test
Span:	10 MHz
Detector:	Sample[a]
Resolution BW:	500 kHz
Video BW:	1 kHz
Video / trace averaging:	OFF during adjustment ON (~8 sweeps) during confirmation
Amplitude units:	2 dB/div (after trace is found)

a] This is good practice but not crucial if only comparative measurements are being made; 'peak' can be used. However, it is important to use the same detector type for each measurement.

10.4.7 RF power meter

Ideally, this should be capable of sensing powers down to -60 dBm. Note if a bandpass filter is used to achieve selectivity, then the noise bandwidth should be taken into account when measuring broadband white noise. A useful technique for Gaussian channel measurement is to use a filter with a noise bandwidth less than the DVB-T signal bandwidth, such as 4 MHz. Relative measurements of C (carrier) & N (noise) are then easy.

10.4.8 Step attenuators

Calibrated step attenuators with a range of 70 dB and incremental in steps of 0.1 dB. Note the characteristic for data failure in DVB-T is known to be very steep and a 0.1 dB increase in C/N can yield significant results. The test methods within this document rely upon accurate attenuation values, so it is essential that attenuators are calibrated and that any calibration factors are applied.

10.4.9 Couplers etc.

A selection of couplers, combiners, terminations and matching pads etc., to achieve the functions illustrated in the test arrangement block diagram given in Figure 10-1 Basic Test arrangement. The coupler(s) used to combine sources should have good isolation in order to ensure there is no interaction between sources. Note that for impulsive interference tests the test source has a spectrum centred on the test frequency, and with a bandwidth around 80-100MHz.

10.5 General test conditions

10.5.1 Environment

No environmental parameters are specified. DTG tests would normally be performed with the receiver 'free standing' on a bench in the environmental conditions present in the laboratory at the time of test. Manufacturers should note that the actual conditions of use could be more stringent

10.5.2 Frequency offsets

All tests are performed with sources on specified UHF channels with nominally zero frequency offset except for the sensitivity test detailed in 10.7.1.

10.5.3 DTT signal level

For co-channel tests with PAL and AWGN, the wanted signal level should be -50 dBm. This should be more than sufficient for the receiver to achieve its 'backstop' noise performance. In other words, thermal noise at the receiver input is insignificant compared to the level of the wanted signal.

For adjacent and image channel tests, the level of the wanted signal is variable. The intention is to keep the interfering signal constant at its maximum expected level. This is a quite different approach from that traditionally adopted, but it does guarantee that the receiver will be tested at a realistic 'worst case' signal level. Further information is given in Section 9.14.1, "Co-channel and adjacent channel performance".

For impulsive interference tests, the recommended DVB-T signal level is reduced from -50 to -60 dBm. This is because of the need to produce noise that has a very much higher power density than the signal. Since the noise must be wideband, the total power must be quite high. Working with a -60 dBm DVB-T signal eases this problem, and the signal power is still sufficiently higher than the level of thermal noise at the receiver input.

10.5.4 Impedance matching

Usually the components of the test signal generating system will possess 50 Ω characteristic impedance. The input impedance of the device under test is likely to be a nominal 75 Ω. So usually a matching pad must be inserted between the test system and the device under test. A minimum loss pad (5.7 dB) is preferable to a transformer because the additional loss reduces mismatch uncertainty. Even if the generating system is of 75 Ω characteristic impedance, it would still be good practice to use a 6 dB attenuator pad here.

The input impedance of many commercial tuners is only approximately 75 Ω (≤6 dB return loss), and may vary with frequency. The pad will increase the return loss seen by the test sources by the forward and return loss of the pad, so the total return loss of the 'load' will be about 18 dB (minimum). However, there may still be a residual absolute mismatch uncertainty error (±0.1 dB) if the return loss of the source is no better than 20 dB.

If the source impedance of the test system is truly close to 50 Ω the exact position of the matching pad may be unimportant. But this cannot always be safely assumed and the consequence of different loads on the test system is not always predicable. Therefore the location of the matching pad should, at least, be consistent and it is good practice to place it at close to the tuner as possible.

Inserting additional attenuator pads can make further reductions in the effect of impedance uncertainties, (e.g. 3 dB or 6 dB) at the tuner input (75 Ω) or source output (50 Ω). While this is usually excellent practice, it may not be appropriate for some tests because of the additional loss of precious power.

10.5.5 Reference measurement and calibration points

The reference measurement point is the receiver input. It is good practice to calibrate the test system at this point with a power meter. This point is likely to be 75 Ω impedance. If the power meter is 50 Ω impedance, then the test system can be calibrated at the end of the 50 Ω cable connected to the impedance matching pad that is placed close to the receiver input. The attenuation of the matching pad (5.7 dB for a minimum loss 50 / 75 Ω pad) has to be taken into account when considering signal powers at the receiver input. This is especially important when measuring receiver sensitivity because this is an absolute measurement of signal power.

10.6 Degradation criteria

Digital systems employ powerful error protection, so in the presence of an impairment the failure characteristic is relatively abrupt in comparison to analogue systems - the so-called ‘digital cliff-edge’ effect. The onset of un-correctable errors (UCE) or ‘failure’ of a digital system is one criterion for establishing the performance of a receiver’s immunity to interference. However, failure of the system is no basis for network planning purposes.

The reference BER (BER_{REF}) is an important measure of the transmission chain, see Section 9.6, “Example transmission chain” and is defined in Section 9.12 Minimium carrier-to-noise ratios. However, the BER_{REF} criterion is not generally recommended for test and measurement of receivers (even if available) and a degradation criterion based on ‘failure’ or UCE is now favoured. Different DVB-T receiver degradation criteria (which fall into three main groups) are compared in Table 10-3 below.

Criterion	Description	Comments
BER_{REF}	DVB-T Post inner decoder BER=$2x10^{-4}$ DVB-T2 Post inner decoder BER=$1x10^{-7}$	BER can be very erratic with some types of impairment (e.g. impulsive inference), so an accurate measure can be hard to achieve. A measure of BER is often not available (e.g. in a commercial receiver).
UCE	No un-correctable TS errors in a defined period.	Probably the most useful measure, but unfortunately this is often not available (e.g. in a commercial receiver).
UCE Rate	A measure of the number of UCE in a defined period.	Sometimes normalised to ‘Errored Seconds’ (Used for ‘mobile’ applications)
PF	“Picture Failure”. No observed (or detected) picture artefacts in a defined period.	This is what the consumer sees and cares about. There is always access to a ‘picture’ in a commercial receiver. However, when testing demodulators alone, MPEG decoding and picture display is not always available.[a]
SFP	“Subjective failure point”	Essentially the same as PF

Table 10-3. Comparison of degradation criteria

a] Even when available, different MPEG decoders may behave in different ways to TS errors.

BER measurements are relatively stable with Gaussian noise and noise-like impairments, but can be erratic with other types of impairment, especially if the demodulator synchronisation is being affected. With impulsive noise, BER is meaningless. If un-correctable errors (UCE) in the transport stream can be clearly identified, for example through access to a packet-error flag, then this is usually the best method of assessing performance when impulsive interference is present. (the DTG test method uses picture failure - see Table 10-2)

Quite often there is no direct way of identifying BER or transport stream errors. Then picture failures (PFs) are the only means of assessing the limits to immunity. PFs may be identified by **manual** observation (subjective) or, perhaps better still, by means of a monitoring instrument.

In Table10-2 C/N and C/I Target values for various impairments, two degradation criteria are specified: BER_{REF} and 'failure'. If we use the analogy of the 'digital cliff-edge' to illustrate these criteria, then BER_{REF} is analogous to the top of the cliff and 'failure' is analogous to halfway down the cliff. The gradient of the cliff is very steep and the best estimates of the increment (Δ) in dB from BER_{REF} to 'failure' with different impairments are given below in Table 10-4.

Impairment	DVB-T Δ (BER_{REF} to 'failure')	DVB-T2 Δ (BER_{REF} to 'failure')
Thermal noise, AWGN, DTT CCI and Echo out side the GI	1.3 dB	0 dB
All other impairments except II	2.0 dB	0 dB
Impulsive interference	N/A	N/A

Table 10-4. Impairment increment Δ for different criteria

10.6.1 Measurement of failure point

Whether UCEs or PFs are used, the point of failure or onset of un-correctable errors may be assessed using the methods described below. Note: Theoretical assumptions concerning the statistics of impulsive interference are supported in a separate publication (DTG RF 74n [79]). Any subjective assessment of failure point must satisfy the conflicting requirements of being both reliable and quick. After application or change in level of an impairment, a settling time is allowed and the picture is observed for a specified period of time or intervals of time. Looking for picture artefacts usually results in a reasonably accurate subjective assessment. However, experience has shown that with some types of impairment such as impulsive interference, there is an inherent uncertainty in the boundary position. A single ten-second observation, for example, can give a misleading and variable indication of the failure point.

For impulsive interference tests (see Section 10-9 Impulsive interference tests) the boundary marking the failure point is far less definite than it is for continuous Gaussian noise tests and this effect increases dramatically when there are just a few pulses of gated noise per burst. One reason for this is that the actual energy in such individual bursts will vary as a result of the statistical nature of the noise.

If no countermeasures are employed and as C/I is varied, the rate of increase of errors is, indeed, fairly fast once the failure point boundary is passed. However, because of the statistical spread of the actual burst energy value, there is a spread of error rate about the 'true' failure point boundary.

The measurement method should try to handle this uncertainty.

Extremely long test periods are not the solution; they merely increase the opportunity for misleading events to take place. This shifts the results towards slightly lower power values, but has a negligible effect on repeatability.

An improvement in repeatability could be achieved by having a failure criterion such that a specified, larger, number of symbols must be damaged during the test period. But there is no simple relationship between observed picture artefacts and the number of symbols damaged, so this technique is not practicable.

A good alternative is to require that a specified proportion of test periods must be damaged. A useful reduction in uncertainty is achieved if the failure criterion is such that:

2 out of 3 ten-second periods must be 'good', (i.e. 1 out of 3 can be 'bad').

Furthermore, this technique does not increase the measurement time by very much. Regions of 'undisputed badness' will usually be identified immediately in the second ten-second period, i.e. within 11 seconds. Regions of 'undisputed goodness' will usually be identified by the end of the second ten-second period, i.e. within 20 seconds. Only in borderline regions will the full 30 seconds be required. Note that the failure characteristic of DVB-T2 is even more abrupt than that of DVB-T. Small changes in impairment level can result in going from 0 out of 3 to 3 out of 3 'good' periods.

More complex 'M out of N periods of T seconds' can lead to more accurate results in theory but tend to be very cumbersome to implement without an automated test system. They also tend to take longer. So the '2 out of 3 ten-second periods' technique is recommended.

10.6.2 Signal acquisition

One aspect that should also be considered is whether the receiver demodulation, synchronisation and decoding circuitry exhibits any hysteresis in the presence of a variable level of impairment. A receiver should be able to acquire a degraded signal even at 'failure'. If that is not the case, then the only degradation criterion that can be used for receiver measurement has to be based upon successful signal acquisition.

10.7 Basic RF tests

A list of basic RF tests is included in Table 10-2. For all tests, reference should be made to the block diagram showing the basic test arrangement. This is given in Figure 10-1. This diagram shows a switch as a means of selecting other devices for monitoring and calibration. This 'switching' concept will be used to describe the procedures. However, the actual means of selection and calibration will depend upon individual arrangements.

10.7.1 RF sensitivity

The RF sensitivity is a measure of the ability of the receiver to successfully acquire and decode the DTT signal at low power levels including when the signal has a frequency offset. Note that when changing the signal source to include or remove a frequency offset the receiver should be re-scanned each time. Additional theoretical information is given in Section 9.13, "Receiver noise performance".

10.7.1.1 Procedure

Step	Procedure
	Test Arrangement DVB-T/T2E Interference Source - off PAL Source - off AWGN Source - off DTT Main Source - on channels 21 with –'ve offset, 21 zero offset, 21 +'ve offset, 45 with –'ve offset, 45 zero offset, 45 with +'ve offset, 68 with –'ve offset, 68 zero offset, and 68 with +'ve offset (minimum, ideally all other channels but only zero offset is required)
1	Changeover switch to power meter. (See note [a]).
2	Note power meter and step attenuator reading
3	Changeover switch to demodulator
4	Increase step attenuator until the degradation criterion is achieved
5	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the condition in (4) can be acquired.
6	Subtract attenuator reading from initial power meter reading to give RF sensitivity. (The effect of any matching device used at the receiver input must be taken into account.)
7	Repeat above for other UHF channels and offsets.

Table 10-5.

a] For greatest accuracy, measure the power at the receiver input (see Section 10.5.5 Reference measurement and calibration points).

10.7.1.2 Output

Lowest value of RF signal power necessary for performance at the specified degradation criterion (RF Sensitivity). RF sensitivity may be plotted as a function of UHF channel. Alternatively, if only one value of RF sensitivity is to be quoted, then this should be the highest (worst) value.

10.7.2 Performance with Additive White Gaussian Noise (AWGN)

This test measures the carrier to noise ratio required to achieve the degradation criterion in an ideal Gaussian channel. There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable. Additional theoretical information is given in Section 9.13.2, "Receiver input carrier-to-noise requirements".

10.7.2.1 Procedure

Test Arrangement	
DVB-T/T2E Interference Source - off PAL Source - off AWGN Source - on DTT Main Source - on channel 45 (as a minimum, ideally 21, 45 & 68)	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn noise source off; adjust DTT level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn DTToff, turn noise on
4	Adjust noise to be the same power level as the DTTsignal (when measured in the same noise bandwidth e.g. 4 MHz).
5	Turn DTTon, confirm total power is now +3 dB relative to power in Step 4.
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved
8	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the condition in (7) can be acquired.
9	Noise attenuator increase (step 7) gives C/N at the degradation criterion. Alternatively independently measure (in the same noise bandwidth) the relative difference (dB) of C & N values
10	Repeat above for other UHF channels ..

Table 10-6.

10.7.2.2 Output

Value of C/N to give the specified degradation criterion.

10.7.3 Performance with co-channel PAL interference

The ability of DVB-T/T2 receivers to operate with co-channel PAL is tested in this procedure. The receiver performance is, in this case, largely determined by the demodulator implementation and not the front-end characteristics. Thus, only one UHF channel is specified.

10.7.3.1 Procedure

Test Arrangement
DVB-T/T2E Interference Source - off
PAL Source - on channel N
AWGN Source - off
DTT Main Source - on channel 45.

Step	Procedure
1	Changeover switch to power meter
2	Turn PAL source off, adjust DTT level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn DTT off, turn PAL on
4	Adjust PAL PSP level (see 10.4.2) to -50 dBm + A dB.
5	Changeover switch to demodulator
6	Turn DTTon and adjust step attenuator in PAL channel until the degradation criterion is achieved
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the condition in (6) can be acquired.
8	Attenuator change (step 6) gives the protection ratio magnitude (see note [a]).

Table 10-7.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal (C/I) when the system is degraded by the specified amount. Particular care should be taken with the 'sign' of this protection ratio because the levels of wanted and unwanted signals are likely to be similar. Thus if the attenuator increased in Step 6 by 2 dB the protection ratio would be +2 dB. If the attenuator decreased in Step 6 by 2 dB the protection ratio would be -2 dB.

10.7.3.2 Output

Protection ratio for a co-channel PAL interferer.

10.7.4 Performance with adjacent channel PAL interference

The effect of an adjacent channel PAL interferer is tested here. The effect of the interferer in both the upper (N+1) and lower (N-1) adjacent channels is tested. For upper adjacent channel (N+1) protection ratio tests, it is essential that this signal source complies with the spectrum mask requirement for PAL-I1 as given in Figure 9-7, "PAL-I1 sideband response mask".

10.7.4.1 Procedure

Test Arrangement	
DVB-T/T2E Interference Source - off PAL Source - on, channel (N±1) Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 22, 45 & 67).	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn DTT source off, adjust PAL PSP level (see 10.4.2) to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn PAL off, turn DVB-T/T2 on
4	Adjust DTT to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn PAL on and increase step attenuator in DTT channel until the degradation criterion is achieved
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the condition in (6) can be acquired.
8	Attenuator increase (Step 6) gives the protection ratio magnitude (see note [a]).
9	Repeat above to include (N±1) for channel 45. Also 22 and 67 if required.

Table 10-8.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal (C/I) when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 35 dB, the protection ratio would be -35 dB.

10.7.4.2 Output

Protection ratio for an upper (N+1) adjacent channel PAL interferer.
Protection ratio for a lower (N-1) adjacent channel PAL interferer.

10.7.5 Performance with (N+9) PAL interference (image)

The ability of a DTT receiver to operate with an interfering PAL signal on a channel other than an adjacent or co-channel, and where the receiver may be particularly susceptible to interference, is tested in this procedure. Typically this would be the receiver image channel at N+9 if the receiver first IF is approximately 36 MHz.

10.7.5.1 Procedure

The test procedure is similar to that given for adjacent channel protection ratio (see Section 10.7.4).

Step	Procedure
Test Arrangement DVB-T/T2E Interference Source - off PAL Source - on channel (N+9) Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 21, 45 & 59). Repeat for DVB-T2	
1	Changeover switch to power meter
2	Turn DTT source off, adjust PAL PSP level (see 10.4.2) to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn PAL off, turn DTT on
4	Adjust DVB-T to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn PAL on and increase step attenuator in DTT channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (Step 6) gives the protection ratio magnitude (see note [a]).
9	Repeat above to include UHF channels 21 and 59 if required

Table 10-9.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded to the degradation criterion. Thus if the attenuator increase in Step 6 above is 45 dB, the protection ratio would be -45 dB

10.7.5.2 Output

Protection ratio for an image channel (N+9) PAL interferer into DVB-T.

Protection ratio for an image channel (N+9) PAL interferer into DVB-T2.

10.7.6 Performance with adjacent channel DVB-T/T2E interference

The effect of an adjacent channel DVB-T/T2E interferer is tested here. The effect of the interferer in both the upper (N+1) and lower (N-1) adjacent channels is tested.

10.7.6.1 Procedure

Test Arrangement DVB-T/T2E Interference Source - on, channel (N±1) PAL Source - off Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 22, 45 & 67)	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn DTT source off, adjust DVB-T/T2E Interferer level to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn DVB-T/T2E Interferer off, turn DTT main source on
4	Adjust main source to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferer on and increase step attenuator in main source channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (step 6) gives the protection ratio magnitude (see note[a])
9	Repeat above to include (N±1) for channel 45. Also 22 and 67 if required.

Table 10-10.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 30 dB, the protection ratio would be -30 dB.

10.7.6.2 Output

Protection ratio for an upper (N+1) adjacent channel DVB-T interferer into DVB-T.
Protection ratio for a lower (N-1) adjacent channel DVB-T interferer into DVB-T.

Protection ratio for an upper (N+1) adjacent channel DVB-T2E interferer into DVB-T.
Protection ratio for a lower (N-1) adjacent channel DVB-T2E interferer into DVB-T.

Protection ratio for an upper (N+1) adjacent channel DVB-T2E interferer into DVB-T2.
Protection ratio for a lower (N-1) adjacent channel DVB-T2E interferer into DVB-T2.

10.7.7 Performance with non-adjacent channel DTT interference

The effect of a non-adjacent channel DTT interferer is tested here. The effect of the interferer in the following non-adjacent channels is tested: (N±2), (N±3) and (N±4).

10.7.7.1 Procedure

Test Arrangement DTT Interference Source - on, channel (N±2), (N±3) and (N±4) PAL Source - off Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 25, 45 & 64)	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn main source off, adjust Interferer level to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn Interferer off, turn main source on
4	Adjust main source to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferer on and increase step attenuator in main channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (step 6) gives the protection ratio magnitude (see note[a])
9	Repeat above to include (N±2), (N±3), (N±4) for DVB-T and T2 in channel 45. Also channels 25 and 64 if required.

Table 10-11.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 30 dB, the protection ratio would be -30 dB.

10.7.7.2 Output

Protection ratio for (N+2) non-adjacent channel DTT interferer into DVB-T.
Protection ratio for (N-2) adjacent channel DTT interferer into DVB-T.

Protection ratio for (N+3) non-adjacent channel DTT interferer into DVB-T.
Protection ratio for (N-3) adjacent channel DTT interferer into DVB-T.

Protection ratio for (N+4) non-adjacent channel DTT interferer into DVB-T.
Protection ratio for (N-4) adjacent channel DTT interferer into DVB-T.

Protection ratio for (N+2) non-adjacent channel DTT interferer into DVB-T2.
Protection ratio for (N-2) adjacent channel DTT interferer into DVB-T2.

Protection ratio for (N+3) non-adjacent channel DTT interferer into DVB-T2.
Protection ratio for (N-3) adjacent channel DTT interferer into DVB-T2.

Protection ratio for (N+4) non-adjacent channel DTT interferer into DVB-T2.
Protection ratio for (N-4) adjacent channel DTT interferer into DVB-T2.

10.7.8 Performance with (N+9) DTT interference (image)

The ability of a DTT receiver to operate with an interfering DTT signal on a channel where the receiver may be particularly susceptible to interference is tested in this procedure. Typically this would be the receiver image channel at N+9 if the receiver first IF is approximately 36 MHz.

10.7.8.1 Procedure

The test procedure is similar to that given for adjacent channel protection ratio (see Section 10.7.6, "Performance with adjacent channel DVB-T/T2 interference".

Test Arrangement	
DTT Interference Source - on channel (N+9) PAL Source - off Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 21, 45 & 59)	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn main source off, adjust interferer level to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn interferer off, turn main source on
4	Adjust main source to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferer on and increase step attenuator in main channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (Step 6) gives the protection ratio magnitude (see note [a]).
9	Repeat above to include DVB-T & T2. Also UHF channels 21 and 59 if required

Table 10-12.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded to the degradation criterion. Thus if the attenuator increase in Step 6 above is 35 dB, the protection ratio would be -35 dB

10.7.8.2 Output

Protection ratio for an image channel (N+9) DTT interferer into DVB-T.

Protection ratio for an image channel (N+9) DTT interferer into DVB-T2.

10.7.9 Performance with two DTT interfering signals

The effect of two DTT interfering signals is tested here. The interfering signals are in the following non-adjacent channels: (N+2) and (N+4). This is a test of the receiver front end third order non-linearity.

10.7.9.1 Procedure

Test Arrangement DTT Interference Sources - on, channel (N+2) and (N+4) PAL Source - off Noise Source - off DTT Main Source - on channel 45 (as a minimum, ideally 21, 45 & 64)	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn main source off, adjust each Interferer level to -25 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Turn Interferers off, turn main source on
4	Adjust main source to -25 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferers on and increase step attenuator in main channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (step 6) gives the protection ratio magnitude (see note[a])
9	Repeat above to include DVB-T & T2. Also UHF channel 21 and 64 if required.

Table 10-13.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 30 dB, the protection ratio would be -30 dB.

10.7.9.2 Output

Protection ratio for (N+2) and (N+4) DTT interferers into DVB-T.

Protection ratio for (N+2) and (N+4) DTT interferers into DVB-T2.

10.7.10 Performance with adjacent and non-adjacent LTE BS interference

The effect of an LTE interferer is tested here. The effect of a basestation (BS) interferer to DTT in channel 60 is tested.

10.7.10.1 Procedure

Step	Procedure
Test Arrangement DVB-T/T2E Interference Source - off PAL Source - off Noise Source - off DTT Main Source - on channel 60 LTE BS-A & BS-B 0% - on	
1	Changeover switch to power meter
2	Turn DTT source off. Select LTE BS-A 0%, and adjust LTE Interferer level to -15 dBm – 8.5dB + A dB. Where A dB is the power loss of any matching device used at the receiver input. (This interferer level is the mean level measured by the power meter, corresponding to a level of -15dBm during the active portions of the signal).
3	Turn LTE Interferer off, turn DTT main source on (channel 60)
4	Adjust main source to -15 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferer on and increase step attenuator in main source channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (step 6) gives the protection ratio magnitude (see note[a])
9	Repeat above with LTE BS-B 0%

Table 10-13a.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 30 dB, the protection ratio would be -30 dB.

10.7.10.2 Output

Protection ratio for LTE BS-A interferer into DVB-T and DVB-T2 (channel 60).
Protection ratio for LTE BS-B interferer into DVB-T and DVB-T2 (channel 60).

10.7.11 Performance with non-adjacent LTE UE interference

The effect of an LTE interferer is tested here. The effect of a handset (UE-C & UE-A) interferer to DTT in channels 60 is tested.

10.7.11.1 Procedure

Step	Procedure
	Test Arrangement DVB-T/T2E Interference Source - off PAL Source - off Noise Source - off DTT Main Source - on channel 60 LTE source UE (1 Mb/s; centre frequency 857MHz, UE-C and 837MHz, UE-A) - on
1	Changeover switch to power meter
2	Turn DTT source off. Select LTE UE-C, and adjust LTE Interferer level to -15 dBm – 9.7dB + A dB. Where A dB is the power loss of any matching device used at the receiver input. (This interferer level is the mean level measured by the power meter, corresponding to a level of -15dBm during the active portions of the signal).
3	Turn LTE Interferer off, turn DTT main source on (channel 60)
4	Adjust main source to -15 dBm +A dB
5	Changeover switch to demodulator
6	Turn interferer on and increase step attenuator in main source channel until the degradation criterion is achieved.
7	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
8	Attenuator increase (step 6) gives the protection ratio magnitude (see note[a])
9	Repeat above with LTE UE-A.

Table 10-13b.

a] Protection ratio is defined as the ratio of the wanted signal to unwanted signal when the system is degraded by the specified amount. Thus if the attenuator increase in Step 6 above is 30 dB, the protection ratio would be -30 dB.

10.7.11.2 Output

Protection ratio for LTE UE-C interferer into DVB-T and DVB-T2 (channel 60).
Protection ratio for LTE UE-A interferer into DVB-T and DVB-T2 (channel 60).

10.8 Multipath tests

This section gives deals with the performance of DTT receivers when echoes are present. The rationale and derivation of these tests are given in DTG RF 32 [66]. Further information is also given in Section 9.14.3, which points to additional references concerning the effect of echoes on receiver performance.

The tests comprise the assessment of the receiver performance with a single static echo both inside and outside the guard interval and with three static multipath profiles. The long echo test profile is based upon worst case measurements made in the UK (see DTG RF 43 [70], DTG RF 40 [68]). The medium echo test profile is also based upon these measurement but is weighted according to probability of occurrence and is therefore less stringent. A list of these multipath tests is included in Table 10-2.

There are now targets for the performance of the receiver with a single echo outside the guard interval. For further information about multiple echo performance (see DTG RF 44 [71], DTG RF 45 [72]).

10.8.1 Specifying echoes

The obvious parameters to specify are the echo delay and echo attenuation, both relative to those of a main path. A problem now arises in that the relative phase will be frequency dependent. This is not very helpful, so the convention is to normalise the channel centre frequency to zero, and specify the echo phase at this frequency. By specifying the parameters in this way, the channel frequency response becomes independent of centre frequency.

If an echo delay is changing due to a moving reflector then this results in a Doppler shift of frequency (Fd) relative to that of the direct or main path.

$$Fd = \pm V \times F/c$$

Where: Fd = Doppler shift (Hz)

V = Speed of reflector (m/s)

F = Carrier frequency (Hz)

c = Speed of light = 3×10^8 (m/s)

At 666 MHz, a 20Hz Doppler shift corresponds to a speed of 9 m/s.

10.8.2 Multipath channel power considerations

Particular care is required to ensure that the power of the multipath channel and the relative level of AWGN are known.

With only one or main path (no echoes) the system can be readily calibrated and there is little doubt about absolute and relative power levels. When echoes are added to the channel, the power in the channel will increase. The actual power increase may be dependent upon how the multipath simulator deals with this situation and whether any different options are available. There are at least two known ways that multipath simulators behave, and as an example we shall consider the echo profile for the short delay echo test as detailed in Table 10-14, "Short delay echo profile". Let us assume that Path 1 (main path) has been set to give an output of 0 dBm. When Paths 2 to 6 are enabled, the following may happen depending upon instrument type or settings:

1. The main path reference is maintained and the total output power is determined by the vector summation of all paths [25] . For our example, this would be +7.4 dBm. A disadvantage of this is that sufficient headroom has to be allowed to handle this additional power. The theoretical worst-case situation of 6 identical paths, although unlikely in practice, implies an additional headroom requirement of $20 \times \log_{10} 6 = 15.6$ dB.
2. The instrument may try to maintain a 0 dBm output signal by calculating the total channel power and adjusting the output level accordingly. This has the advantage of easing headroom requirements; however, if the calculation is based upon RMS addition of path amplitudes (as distinct from vector addition) there will be an error if the path delays are short (the so called 'flat fade' region). This is the case for our example of the short delay echo test as detailed in Table 10-14, "Short delay echo profile". The calculated power is +6.2 dBm, which is 1.2 dB less than the true power obtained by vector addition.

An additional complication arises in determining the reference for the application of AWGN, especially if the noise source is part of the multipath simulator. There may be an option of referencing the AWGN source to either the output signal or to the main path only. Again, particular care is required to ensure the noise power is as expected.

The convention used for the tests described in this chapter will be to reference all levels to the main path and the behaviour will be assumed to be as (1) above. The 'carrier' power is the total channel power, which includes any echoes. The channel power may be calculated by vector summation of all signal paths, using the spreadsheet in DTG RF 59 [75].

25. A spreadsheet ([75] DTG RF 59) is available to calculate multipath channel profiles, powers etc.

10.8.3 Channel profiles

The multipath channel simulator should be capable of producing the following channel profiles:

Delay (µs)	Relative Attenuation (dB)	Phase (degree)
0	2.8	0
0.05	0	0
0.4	3.8	0
1.45	0.1	0
2.3	2.6	0
2.8	1.3	0

Table 10-14. Short delay echo profile

Delay (µs)	Relative Attenuation (dB)	Phase (degree)
0	0	0
1	8.6	0
5	12.6	0
8	18	0
12	20.7	0
21	22.2	0

Table 10-15a. Medium delay echo profile

Delay (µs)	Relative Attenuation (dB)	Phase (degree)
0	0	0
5	9	0
14	22	0
35	25	0
54	27	0
75	28	0

Table 10-15b. Long delay echo profile

10.8.4 Performance with short delay echoes

This test measures the carrier to noise ratio required to achieve the degradation criterion in a channel which includes short delay echoes as detailed in Table 10-14, "Short delay echo profile". There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

10.8.4.1 Procedure

The test procedure is similar to that given for performance with AWGN (see Section 10.7.2, "Performance with Additive White Gaussian Noise (AWGN)") and this Gaussian C/N value is used as a reference. However, the total power of the DTT signal within the channel is increased by 7.4 dB by the echoes. This amount has to be taken into account when calculating the final C/N value.

Test Arrangement DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on. DTT Main Source - on channel 45 via multipath generator.	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn noise source off, adjust DTT (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input. (See note[a]).
3	Turn DTT off, turn noise on
4	Adjust noise to be the same power level as the DTT (no echo) signal when measured in the same bandwidth (e.g. 4 MHz filter used with power meter).
5	Turn DTT on, confirm total power is now +3 dB relative to power in Step 4
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved. Noise attenuator increase gives the required C/N for a Gaussian channel (no echoes). Note this value (see note[b]).
8	Change DTT source from no echo to the short delay echo profile given in Table 10-14, "Short delay echo profile,".
9	Change step attenuator in noise channel until the degradation criterion is achieved. Note this change of attenuator value = δA dB. (Decreasing the attenuator means δA is -'ve)
10	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
11	Calculate the required C/N to achieve the degradation criterion with this short delay echo profile using the expression: (Gaussian C/N value dB) + (δA dB) + 7.4 dB (see note[c]).

Table 10-16.

a] If the output from the multipath simulator includes local oscillator and image channel signals then an unfiltered power meter could give misleading readings. It may be easier to use the spectrum analyser to make this measurement. The setting of the absolute input level is not critical.

b] This value of C/N should be the same as that for a standard AWGN test as detailed in 10.7.2 Performance with Additive White Gaussian Noise (AWGN) on page 12. However, the multipath generator may introduce some further noise, which may result in a slight increase (0.1 dB) in the C/N value to that from 10.7.2 on page 12. This should be ignored because δA in Step 9 is a relative measurement.

c] The total power of the DTT signal within the channel is increased by 7.4 dB by the echoes. Take great care with the sign of δA dB, as its likely value may be near zero. For example if the attenuator in Step 9 is decreased in value by 0.5 dB then δA = -0.5 dB.

10.8.4.2 Output

C/N for DVB-T to achieve the degradation criterion with this short delay echo profile.

C/N for DVB-T2 to achieve the degradation criterion with this short delay echo profile.

10.8.4a Performance with medium delay echoes (DVB-T2, option 4 only)

This test measures the carrier to noise ratio required to achieve the degradation criterion in a channel which includes medium delay echoes as detailed in Table 10-15a, "Medium delay echo profile". There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

10.8.4a.1 Procedure

The test procedure is similar to that given for performance with AWGN in Section10.7.2, "Performance with Additive White Gaussian Noise (AWGN)" and with short delay echoes in Section 10.8.3, "Channel profiles". The Gaussian C/N value from Section 10.7.2 is used as a reference. The total power of the DVB-T2 signal within the channel is increased by 0.8 dB by the echoes. This amount has to be taken into account when calculating the final C/N value.

Test Arrangement DVB-T/T2 Interference Source - off. PAL Source - off. Noise Source - on. DVB-T?T2 Main Source - on channel 45 via multipath generator.(modulation option 4 only).	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn noise source off, adjust DVB-T2 (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input. (See note[a]).
3	Turn DVB-T2 off, turn noise on
4	Adjust noise to be the same power level as the DVB-T2 (no echo) signal when measured in the same bandwidth (e.g. 4 MHz filter used with power meter).
5	Turn DVB-T2 on, confirm total power is now +3dB relative to power in Step 4
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved. Noise attenuator increase gives the required C/N for a Gaussian channel (no echoes) Note this value (see note[b]).
8	Change DVB-T2 source from no echo to medium delay echo profile given in Table 10-15a, "Medium delay echo profile," .
9	Change step attenuator in noise channel until the degradation criterion is achieved. Note this change of attenuator value = δA dB. (Increasing the attenuator means δA is +'ve)
10	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
11	Calculate the required C/N to achieve the degradation criterion with this medium delay echo profile using the expression: (Gaussian C/N dB) + (δA dB) + 0.6 dB (see note[c]).

Table 10-17.

a] If the output from the multipath simulator includes local oscillator and image channel signals then an unfiltered power meter could give misleading readings. It may be easier to use the spectrum analyser to make this measurement. The setting of the absolute input level is not critical.

b] This value of C/N should be the same as that for a standard AWGN test as detailed in 10.7.2 Performance with Additive

White Gaussian Noise (AWGN**)** on page 12. However, the multipath generator may introduce some further noise, which may result in a slight increase (0.1 dB) in the C/N value to that from 10.7.2. This should be ignored because δA in Step 9 is a relative measurement.

c] The total power of the DVB-T2 signal within the channel is increased by 0.8 dB by the echoes. Take great care with the sign of δA dB, as its likely value may be near zero. For example if the attenuator in Step 9 is increased in value by 0.5 dB then δA = +0.5 dB.

10.8.5.2 Output

C/N for DVB-T2 Option 4, to achieve the degradation criterion with this medium delay echo profile.

10.8.5 Performance with long delay echoes (excludes DVB-T2 option 4)

This test measures the carrier to noise ratio required to achieve the degradation criterion in a channel which includes long delay echoes as detailed in Table 10-15, "Long delay echo profile". There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

10.8.5.1 Procedure

The test procedure is similar to that given for performance with AWGN in Section10.7.2, "Performance with Additive White Gaussian Noise (AWGN)" and with short delay echoes in Section 10.8.3, "Channel profiles". The Gaussian C/N value from Section 10.7.2 is used as a reference. The total power of the DTT signal within the channel is increased by 0.6 dB by the echoes. This amount has to be taken into account when calculating the final C/N value.

Test Arrangement DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on. DTT Main Source - on channel 45 via multipath generator.	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn noise source off, adjust DTT (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input. (See note[a]).
3	Turn DTT off, turn noise on
4	Adjust noise to be the same power level as the DTT (no echo) signal when measured in the same bandwidth (e.g. 4 MHz filter used with power meter).
5	Turn DTT on, confirm total power is now +3dB relative to power in Step 4
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved. Noise attenuator increase gives the required C/N for a Gaussian channel (no echoes) Note this value (see note[b]).
8	Change DTT source from no echo to long delay echo profile given in Table 10-15, "Long delay echo profile," .
9	Change step attenuator in noise channel until the degradation criterion is achieved. Note this change of attenuator value = δA dB. (Increasing the attenuator means δA is +'ve)
10	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
11	Calculate the required C/N to achieve the degradation criterion with this long delay echo profile using the expression: (Gaussian C/N dB) + (δA dB) + 0.6 dB (see note[c]).

Table 10-17.

a] If the output from the multipath simulator includes local oscillator and image channel signals then an unfiltered power meter could give misleading readings. It may be easier to use the spectrum analyser to make this measurement. The setting of the absolute input level is not critical.

b] This value of C/N should be the same as that for a standard AWGN test as detailed in 10.7.2 Performance with Additive White Gaussian Noise (AWGN) on page 12. However, the multipath generator may introduce some further noise, which may result in a slight increase (0.1 dB) in the C/N value to that from 10.7.2. This should be ignored because δA in Step 9 is a relative measurement.

c] The total power of the DTT signal within the channel is increased by 0.6 dB by the echoes. Take great care with the sign of δA dB, as its likely value may be near zero. For example if the attenuator in Step 9 is increased in value by 0.5 dB then δA = +0.5 dB.

10.8.5.2 Output

C/N for DVB-T to achieve the degradation criterion with this long delay echo profile.

C/N for DVB-T2 to achieve the degradation criterion with this long delay echo profile.

10.8.6 Performance with a single 0 dB echo within the guard interval

This test measures the carrier to noise ratio required to achieve the degradation criterion in a channel which includes a single 0 dB echo within the guard interval (GI). Two echo delays are defined: 0.5 × GI and 0.95 × GI, both with 90° phase at the channel centre. There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

10.8.6.1 Procedure

The test procedure is similar to that given for performance with AWGN in 10.7.2, "Performance with Additive White Gaussian Noise (AWGN)" and with short delay echoes in Section 10.8.3, "Channel profiles". The Gaussian C/N value from Section 10.7.2 is used as a reference. The total power of the DTT signal within the channel is increased by 3.0 dB by the echo. This amount has to be taken into account when calculating the final C/N value.

Test Arrangement

DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on.
DTT Main Source - on channel 45 via multipath generator. 0 dB echo of 0.95 × GI or 0.5 × GI as required. Both with 90° phase.

Step	Procedure
1	Changeover switch to power meter
2	Turn noise source off, adjust DTT (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input. (See note[a]).
3	Turn DTT off, turn noise on
4	Adjust noise to be the same power level as the DTT (no echo) signal when measured in the same bandwidth (e.g. 4 MHz filter used with power meter).
5	Turn DVB-T/T2 on, confirm total power is now +3dB relative to power in Step 4
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved. Noise attenuator increase gives the required C/N for a Gaussian channel (no echo) Note this value (see note[b]).
8	Change DTT source from no echo to include the required 0 dB echo..
9	Change step attenuator in noise channel until the degradation criterion is achieved. Note this change of attenuator value = δA dB. (Increasing the attenuator means δA is +'ve)

Test Arrangement DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on. DTT Main Source - on channel 45 via multipath generator. 0 dB echo of 0.95 × GI or 0.5 × GI as required. Both with 90° phase.	
Step	**Procedure**
10	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
11	Calculate the required C/N to achieve the degradation criterion with this 0 dB echo using the expression: (Gaussian C/N dB) + (δA dB) + 3.0 dB (see note[c]). Repeat steps 8 to 11 for other echo delays as required.

Table 10-18.

a] If the output from the multipath simulator includes local oscillator and image channel signals then an unfiltered power meter could give misleading readings. It may be easier to use the spectrum analyser to make this measurement. The setting of the absolute input level is not critical.

b] This value of C/N should be the same as that for a standard AWGN test as detailed in **Section 10.7.2 Performance with Additive White Gaussian Noise (AWGN)**. However, the multipath generator may introduce some further noise, which may result in a slight increase (0.1 dB) in the C/N value to that from Section 10.7.2. This should be ignored because δA in Step 9 is a relative measurement.

c] The total power of the DTT signal within the channel is increased by 3 dB by the echo. Take great care with the sign of δA dB, as its likely value may be near zero. For example if the attenuator in Step 9 is increased in value by 0.5 dB then δA = +0.5 dB.

10.8.6.2 Output

C/N to achieve the degradation criterion with a 0 dB echo within the guard interval for the required delay tested.

10.8.7 Performance with a single 0 dB echo with Doppler

This test measures the carrier to noise ratio required to achieve the degradation criterion in a channel which includes a single 0 dB echo with Doppler. There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

10.8.7.1 Procedure

The test procedure is similar to that given for performance with AWGN in Section 10.7.2, "Performance with Additive White Gaussian Noise (AWGN)" and with short delay echoes in Section 10.8.3, "Channel profiles". The Gaussian C/N value from Section 10.7.2 is used as a reference. The total power of the DVB-T signal within the channel is increased by 3.0 dB by the echo. This amount has to be taken into account when calculating the final C/N value.

Test Arrangement DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on. DTT Main Source - on channel 45 via multipath generator. 0 dB, 20μs echo with Doppler shift.	
Step	**Procedure**
1	Changeover switch to power meter
2	Turn noise source off and adjust DTT (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input. (See note[a]).
3	Turn DVB-T/T2 off, turn noise on
4	Adjust noise to be the same power level as the DTT (no echo) signal when measured in the same bandwidth (e.g. 4 MHz filter used with power meter).

Test Arrangement DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - on. DTT Main Source - on channel 45 via multipath generator. 0 dB, 20μs echo with Doppler shift.	
Step	**Procedure**
5	Turn DTT on, confirm total power is now +3dB relative to power in Step 4
6	Changeover switch to demodulator
7	Increase step attenuator in noise channel until the degradation criterion is achieved. Noise attenuator increase gives the required C/N for a Gaussian channel (no echo) Note this value (see note[b]).
8	Change DTT source from no echo to include a 0 dB echo of 20 μs delay with a Doppler shift.
9	Change step attenuator in noise channel until the degradation criterion is achieved. Note this change of attenuator value = δA dB. (Increasing the attenuator means δA is +'ve)
10	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired.
11	Calculate the required C/N to achieve the degradation criterion with this 0 dB echo using the expression: (Gaussian C/N dB) + (δA dB) + 3.0 dB (see note[c]). Repeat steps 8 to 11 for Doppler shifts: 1, 5, 10, 20 Hz (corresponding to ±0.5, ±2.5, ±5 and ± 10 Hz after receiver AFC).

Table 10-19.

a] If the output from the multipath simulator includes local oscillator and image channel signals then an unfiltered power meter could give misleading readings. It may be easier to use the spectrum analyser to make this measurement. The setting of the absolute input level is not critical.

b] This value of C/N should be the same as that for a standard AWGN test as detailed in **10.7.2 Performance with Additive White Gaussian Noise (AWGN)** on page 12. However, the multipath generator may introduce some further noise, which may result in a slight increase (0.1 dB) in the C/N value to that from 10.7.2. This should be ignored because δA in Step 9 is a relative measurement.

c] The total power of the DTT signal within the channel is increased by 3 dB by the echo. Take great care with the sign of δA dB, as its likely value may be near zero. For example if the attenuator in Step 9 is increased in value by 0.5 dB then δA = +0.5 dB.

10.8.7.2 Output

Value of C/N to achieve the degradation criterion with a 0 dB echo within the guard interval for each Doppler shift tested. Typically the C/N value will increase with increasing Doppler shift; however the variation over the range 1 to 10 Hz (for Options 5, 6, 8, 9 &10) and 1 to 20 Hz (for Options 3 &4) should be less than 3 dB.

10.8.8 Performance with a single echo outside the guard interval

10.8.8.1 Procedure

The characteristic of a DTT receiver to echoes outside the guard interval is obtained with this procedure. For modes suited to SFN working both positive and negative delays are tested. There should not be a significant variation in performance for different UHF channels, provided that the front-end phase noise contribution is acceptable.

Test Arrangement
DVB-T/T2E Interference Source - off. PAL Source - off. Noise Source - off.
DTT Main Source - on channel 45 via multipath generator.

Step	Procedure
1	Changeover switch to power meter
2	Adjust DTT (no echo) level to -50 dBm + A dB. Where A dB is the power loss of any matching device used at the receiver input.
3	Change DTT source from no echo to include a single echo at 90° phase.
4	Adjust echo delay to be at the edge of the guard interval.
5	Adjust echo amplitude (relative to main path) until the degradation criterion is achieved.
6	Switch receiver off /on, toggle receiver channel tuning, or toggle changeover switch to ensure the degradation criterion condition can be acquired. Note the echo amplitude and delay.
7	Repeat from Step 5 for other echo delays (both positive and negative if required).
8	Tabulate results of echo power versus delay as shown below in Table 10-20b.

Table 10-20.

10.8.8.2 Output

Value of single echo amplitude (relative to main path) to achieve the degradation criterion for each delay tested. Results may be tabulated as shown below where the values already entered are the target values.

	Test reference:	**A**	**B**	**C**	**D**	**E**
Option 1	**Delay (µs)**	7	15	30	50	60
	Amplitude (dB)	-4.3	-10.3	-14	-16.3	-20.6
Option 2	**Delay (µs)**	7	15	30	50	60
	Amplitude (dB)	n/a	n/a	n/a	n/a	n/a
Option 3	**Delay (µs)**	± 28	± 60	± 120	± 200	± 260
	Amplitude (dB)	-4.3	-10.3	-14	-16.3	-20.6
Option 8	**Delay (µs)**	± 28	± 60	± 120	± 200	± 260
	Amplitude (dB)	-4.3	-11.8	-15.4	-17.7	-22.0
Option 4	**Delay (µs)**	± 28	± 30	± 33	n/a	n/a
	Amplitude (dB)	-2.0	-2.0	-22.5	n/a	n/a
Option 5 &9	**Delay (µs)**	± 28	± 60	± 119	± 135	n/a
	Amplitude (dB)	-2.0	-3.5	-8.0	-23.0	n/a
Option 6 & 10	**Delay (µs)**	± 28	± 60	± 119	± 135	n/a
	Amplitude (dB)	-2.0	-5.5	-10.0	-25.0	n/a
Option 11	**Delay (µs)**	± 28	± 60	± 119	± 135	n/a
	Amplitude (dB)	-2.0	-5.5	-10.0	-25.0	n/a

Table 10-20b. Example table of results for test 10.8.8

10.9 Impulsive interference tests

This section deals with testing the immunity of DTT receivers to impulsive interference. An overview of impulsive interference issues is given in Monograph 5 [86] and a brief overview of the recommended noise test signals can be found in Section 9.14.4, "Impulse interference".

The test waveforms proposed are sufficiently representative of impulsive interference to permit meaningful estimates of likely performance in real situations. But they are also highly repeatable so that accurate performance comparisons can be made in a relatively short time. All tests are based on gated Gaussian noise (GGN). This is relatively easy to generate, and has been shown to be a good approximation to impulsive interference. The gating waveforms have been devised to represent typical scenarios and are derived from extensive captures of real impulsive interference (see DTG RF 77 [81]).

A main reason for developing these tests is to help the development, and comparative testing, of countermeasures against impulsive interference. Six different test waveforms are proposed. For each test the theoretical immunity of a receiver without countermeasures has been calculated. Against this figure the actual immunity of a receiver can be compared. The tests range from 'easy', where simple countermeasures can easily bring improvements, to 'very difficult', where improvement will be extremely difficult to achieve

10.9.1 Basic test system

In addition to a standard DVB-T/T2 test signal generation system, the test requires a means of adding Gaussian noise gated by the waveforms described in Section 10.9.2. The basic system is shown in Figure 10-4 below.

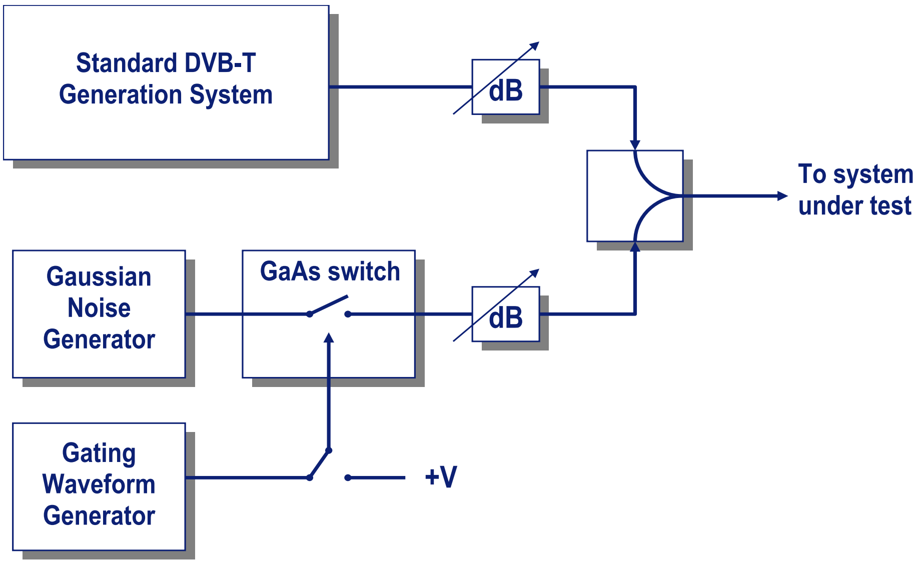


Figure 10-4.Basis of system for assessing immunity to impulsive interference.

The GaAs switch has a very high on-off ratio and prevents any breakthrough of continuous noise. So only short bursts of noise, under the control of the Gating Waveform Generator, are applied to the system under test.

10.9.2 Test waveforms – DVB-T

There are six gating waveforms specified for DVB-T. They produce impulsive interference that increases in severity from 'Test 1', the least severe, to 'Test 6', the most severe. Each test characterizes one or more types of real impulsive interference that have been observed and analysed (see DTG RF 77 [81]).

All the gating waveforms consist of a sequence of 250 ns pulses. This pulse length is used because it approximates to the observed duration of the elemental impulses that make up bursts of real impulsive interference experienced by the demodulator.

Each of the six tests has a different number of 250 ns pulses in its sequence. The separation between the pulses is randomised with uniform distribution, but constrained to accord with the analyses of real impulsive interference (see DTG RF 77 [81]).

The specification of the gating waveforms is given in Section 9.14.4, "Impulse interference" and also in Table 10-22, "Gating waveform pulse sequences for the six tests" below.

Test No	Pulses per burst	Effective Burst Duration (µsec)	Min. Pulse Spacing (µsec)	Max. Pulse Spacing (µsec)	Range of actual burst durations (µsec)
1	1	0.25	N/A	N/A	0.25
2	2	0.50	1.5	45	1.75 - 45.25
3	4	1.00	15	35	45.25 - 105.25
4	12	3.00	10	15	110.25 - 165.25
5	20	5.00	1	2	19.25 - 38.25
6	40	10.00	0.5	1	19.75 - 39.25

Table 10-22. Gating waveform pulse sequences for the six tests.

The nominal separation between the bursts is 10 msec, i.e. from the leading edge of the 1st pulse in burst N to the leading edge of the first pulse in burst N ± 1. This is very long compared with the duration of a symbol, and so the disruptive effect of each burst will dissipate before the next arrives. As an example, impulsive bursts that might result from Test 3 are represented in Figure 10-5.

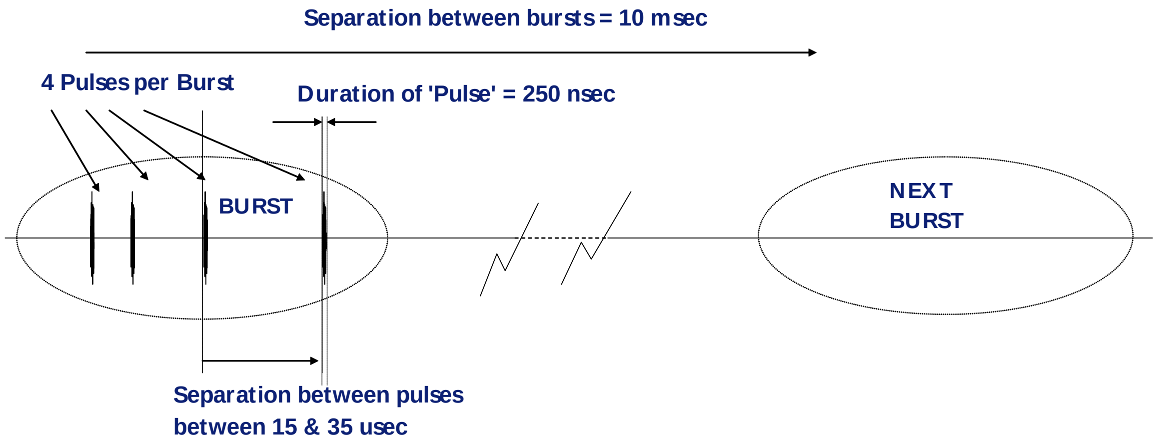


Figure 10-5. Example of possible 'Test 3' waveform.

The full symbol period for the UK 2K modes is 231 µsec. So if the bursts are separated by 10 msec they will occur on about every 43rd symbol, and there will be a 'slip' in the nominal position of the burst between symbols of: 10000 - (43 x 231) µsec = 67 µsec = 29% symbol. This ensures that during a typical test there will be a wide, and rapid, spread of burst positions.

For most of the tests the maximum burst duration is significantly shorter than a 2K symbol, so most bursts will apply all their energy to one symbol. Some tests, notably Test 4, can produce bursts up to about half the length of a 2K symbol, so some bursts will 'straddle' symbols and their effect may be diluted. However, the 'slip' in the burst position between symbols ensures that if one burst straddles a symbol it is very unlikely that the next will. So there will be a large number of bursts that exhibit their maximum disruptive effect by applying all their energy to one symbol.

A method of generating the gating waveforms described here is given in DTG RF 74m [80].

10.9.2.1 Test Waveforms – DVB-T2

For DVB-T2, six new tests have been added (see section 9.14.4.1 "Impulsive Interference DVB-T2"). The parameters for these tests are given in Table 10-22b.

Due to the extended duration of these tests, the original burst repetition period of 10ms is no longer relevant, and so for all of these tests, the burst repetition period is extended to 1000ms.

Test No.	Pulses per burst	Minimum/maximum pulse spacing (µs)	Burst duration (µs)		Tolerance factor (dB)
			Maximum	Effective	

Test No.	Pulses per burst	Minimum/maximum pulse spacing (µs)		Burst duration (µs)		Tolerance factor (dB)
				Maximum	Effective	
7	4	15.0	35	105.25	1.00	[TBC]
8	40	0.5	1	39.25	10.00	[TBC]
9	80	0.5	3	237.25	20	[TBC]
10	400	1	30	11,970.25	100	[TBC]
11	4,000	0.5	3	11,997.25	1,000	[TBC]
12	40,000	0.5	1	39,999.25	10,000	[TBC]

Table 10-22b. Impulse noise tests for DVB-T2

10.9.3 Guassian noise generator

Real impulsive interference normally has a noise density that is inversely proportional to frequency; however the spectral density of the interference signal that is coupled into a UHF antenna, downlead or unscreened outlet plate is less predictable. In these tests, a flat noise spectrum is used. This is easy to generate and provides a valuable measure of a device’s immunity to impulsive interference because most of the damage is normally done by the noise that falls within the channel bandwidth at the demodulator input. Nevertheless, the noise bandwidth should be greater than the channel bandwidth, so that a significant noise voltage is applied to the tuner input (this may have an effect). It is recommended that the noise spectrum should be flat and have a bandwidth of around 80-100MHz centred approximately on the channel under test.

Previously a wideband noise source was recommended, but tests have indicated that a narrower bandwidth source provides a more demanding test than a signal with the full 1GHz bandwidth, and so this narrower bandwidth source is now specified.

10.9.4 Noise gating switch

The noise-gating switch should have a high on-off ratio to prevent any breakthrough of continuous ‘Gaussian’ noise. Double GaAs switches with a guaranteed 75 dB on-off ratio are commercially available at reasonable cost and these or better should be used.

10.9.5 Complete impulsive interference test system

An appropriate complete test system is shown in Figure 10-7 below.

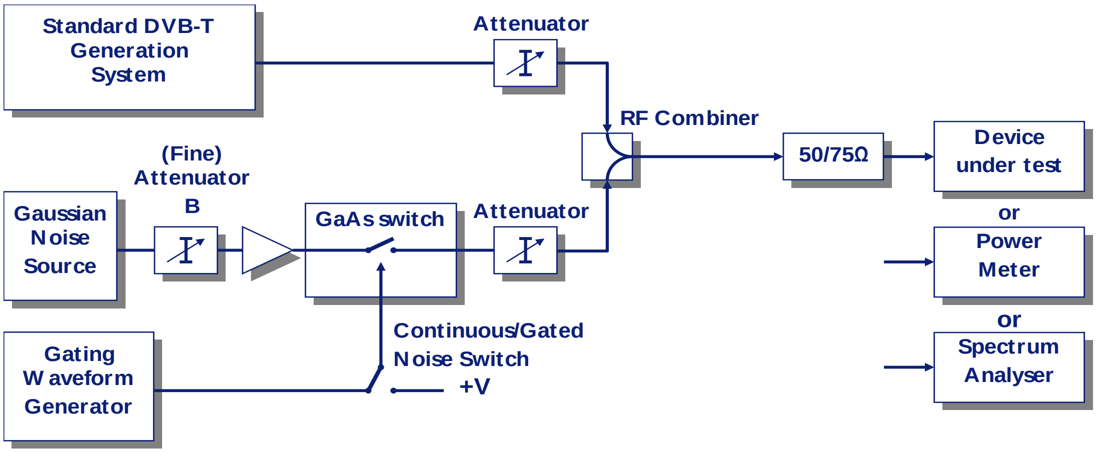


Figure 10-7. Complete test system

The test system described above will generally allow a full characterisation of the receiver performance and assist with identifying any deficiencies in receiver design. It is now considered that a practical C/I limit of -30 dBc should be set to ease test requirements and allow simpler test systems. Determining actual C/I 'failure' values less than -30 dBc is quite onerous and not considered to be of any practical benefit. It is sufficient for those tests specified which have a C/I 'failure' performance target value of <-30 dBc for the test to be performed with a C/I value of -30 dBc and non-failure condition observed.

10.9.6 Recommended measurement procedure

Step	Procedure
	Continuous/Gated switch set to +V position (continuous) Replace device-under-test with power meter (initially), and spectrum analyser (afterwards),.
1	After warming up and self-calibrating, set DTT generator in required mode, and at the required frequency.
2	Connect the power meter to output of system
3	Set Attenuator A to minimum, and attenuator C to maximum
4	Carefully adjust the power level from DTT Generator to display on the power meter a suitable reference level near to the maximum noise available.
5	Replace the power meter with the spectrum analyser and display the DTT signal. Store the trace.
6	Set Attenuator A to maximum, and attenuator C to minimum
7	Using fine attenuator B, carefully adjust the noise level to match the previously stored DTT signal. (Switch off video averaging during adjustment, and switch it on again to confirm the setting is accurate.)
8	Calibration is now complete, and the ratio between the wanted signal and the interference will be given by the difference between the settings of attenuators A and C.

Table 10-24. Calibration procedure

Step	Procedure
	Continuous/Gated switch set to +V position (continuous) Connect the device under test to the output of the test system
1	Set DTT generator in required mode, and at the required frequency.
2	Set Attenuator A to the value that will produce a -60 dBm at the input of the device under test.
3	Adjust attenuator C until the required degradation criterion is met. (If necessary fine adjustment can be provided using facilities elsewhere in the system, provided they are restored afterwards.)
4	The Gaussian C/N limiting value is the difference between the settings of attenuators A & C, (plus the effect of any fine adjust provided elsewhere.)

Table 10-24b. Measurement of Gaussian C/N reference

Continuous/Gated switch set to the Gating Waveform Generator position Connect the device under test to the output of the test system	
Step	**Procedure**
1	Set DTT generator in required mode, and at the required frequency.
2	Set Attenuator A to the value that will produce a -60 dBm at the input of the device under test.
3	Set the Gating Waveform Generator to produce the required test waveform.
4	Adjust attenuator C until the required degradation criterion is met. (If necessary fine adjustment can be provided using facilities elsewhere in the system, provided they are restored afterwards.) If a C/I value (see step 5) of -30dBc is reached then stop and record a C/I value of <-30 dBc.
5	The Impulsive noise C/I limiting value is the difference between the settings of attenuators A & C, (plus the effect of any fine adjust provided elsewhere.)
6	The measured C/N limit is the absolute measure of tolerance to impulsive noise, and may be compared with the value given in Table 10-23.
7	The difference between this and the Gaussian C/N value obtained previously is the measure of 'tolerance factor', and may be compared with the theoretical value given in Table 10-23.

Table 10-24c. Measurement of C/I performance

10.9.7 Behaviour of receivers

The theoretical behaviour of a DVB-T receiver without any specific countermeasures is derived below:

For a particular impulsive interference test signal, the 'tolerance factor' of a receiver can be defined as:

$$\frac{P_n}{P_g}$$

where P_n is the maximum impulsive noise power that can be applied without failure,
and P_g is the power level of continuous Gaussian noise with equivalent disruptive effect.

Extensive bench measurements support the theory that, on average, the disruptive effect of an impulsive noise burst during a symbol is similar to that of continuous 'Gaussian' noise that contributes the same noise energy within one 'main' symbol period, (i.e. excluding the guard interval).

So, if T_e is the effective impulsive noise burst duration, i.e. the sum of the durations of the elements of the noise burst, and T_u is the 'main' symbol period, i.e. the period during which continuous Gaussian noise is contaminating a symbol,

Then, in theory, $\frac{P_n}{P_g} = \frac{T_u}{T_e}$

So, the theoretical tolerance factor of any receiver is inversely proportional to the effective burst duration.

The tolerance factor has the important property that its expected value is independent of constellation, guard-interval, code rate, failure criteria, and actual Gaussian C/N. Note however that the theoretical tolerance factor is dependent on the 'main' symbol period T_U which is determined by FFT size. So the tolerance factor for 8K is 6dB higher than for 2K because T_U is four times longer.

There are three additional factors which have to be considered concerning the practical aspects of these tests.

- Having only a relatively small number of pulses per burst means that there is a statistical uncertainty concerning the actual power of a burst. As a consequence, degraded performance can occur. This is accounted for by allowing an additional uncertainty margin.
- The receiver is expected to 'cleanly' clip[27] impulsive interference when the burst power exceeds about +10 to +12 dBc. As a consequence, enhanced performance is expected.
- Burst power levels greater than +30 dBc are difficult to produce and this represents a practical limit.

The first two above effects become more relevant as the Test Number is reduced. However, they do not necessarily cancel each other out as mode dependencies are different. The maximum C/I values for different tests and options for DVB-T are detailed in the following table.

	C/I (dB) for "picture failure"		
Test no.	**Option 1**	**Option 2**	**Option 3**
1	-10.1	-15.7	<-30
2	-7.1	-12.7	–26.4
3	-4.1	-9.7	–11.4
4	-0.8	-4.9	–6.7
5	1.4	-2.7	–4.4
6	4.4	0.3	–1.4

Table 10-25. DVB-T maximum C/I values for impulse noise tests

[27]. This means there are no secondary effects such as AM to PM conversion, oscillator pulling or rail bounce.

DVB-T2 is different to DVB-T in that data is spread or time interleaved across several symbols. As a consequence DVB-T2 is considerably more resilient to impulsive interference. The limiting values of C/I have still to be determined for the new tests (7-12) – until targets are set, results of measurements will be recorded to assist with the definition of the targets. As an interim measure, tests 3 & 6 will continue to be used (with the burst repetition period of 10ms). Targets for these are given in the table below.

Test no.	Burst repetition period (ms)	C/I (dB) for "picture failure"			
		Option 4	Option 5	Option 6	Option 11
3	10	-30	-30	-30	N/A
6	10	-8	-8	-6	N/A
7	1000	[TBD]	[TBD]	[TBD]	[TBD]
8	1000	[TBD]	[TBD]	[TBD]	[TBD]
9	1000	[TBD]	[TBD]	[TBD]	[TBD]
10	1000	[TBD]	[TBD]	[TBD]	[TBD]
11	1000	[TBD]	[TBD]	[TBD]	[TBD]
12	1000	[TBD]	[TBD]	[TBD]	[TBD]

Table 10.25b. DVB-T2 maximum C/I values for impulse noise tests

10.10 Diversity receiver tests

A diversity receiver will be expected to have the same performance as that of a 'standard' receiver when only one RF input is used (specified as input A or 'main') and the other RF input (B) terminated. In addition to all the preceding tests listed above the following tests give a measure of the effectiveness of diversity functionality.

10.10.1 Simple Diversity Test

A simple test to ensure that MRC diversity is effective is as follows:

1. The Gaussian sensitivity for input A only (input B terminated) is measured. The Gaussian sensitivity for input B only (input A terminated) is measured. These two sensitivities should be equal; if not, an average can be noted.

2. A 0 dB, 0° phase, 2.5 µs echo profile is applied to input A.
   A 0dB, 180° phase, 2.5 µs echo profile is applied to input B, with equal power.
   The sensitivity is measured.

   The improvement in sensitivity in (2) compared to (1) above should be at least 2.5 dB for any mode.

Note The echo profile at each receiver input introduces regular nulls in the channel response. However, the nulls at one input correspond to peaks at the other input. Combining the two input signals should be nearly equivalent to presenting a non-diversity receiver with a single, flat signal of the same total power. Hence the theoretical improvement in sensitivity noted in the second step should be 3 dB.

Further details of the above diversity test are given in DTG RF 103 [113].

10.10.2 Multi-Channel Diversity Tests

There are two multi-channel diversity tests. These are designed to represent likely situations when a portable receiver is used inside a room. The first profile assumes that two equal signals of relative delay 0.5 µs enter the room. Each of these signals is then reflected twice around the room. The two receiver antennas (A and B) are taken to be relatively close, say a half-wavelength apart. Profile 1 is as follows:

Path Delay (µs)	**Channel A**		**Channel B**	
	Path Loss (dB)	Phase (deg)	Path Loss (dB)	Phase (deg)
0.00	6	340	5.3	119
0.05	9	30	8.3	93
0.10	12	129	11.3	329
0.50	7.5	175	6.8	138
0.55	10.5	231	9.8	146
0.60	13.5	297	12.8	307

Table 10-26. Profile 1 for Multi-Channel Diversity Tests

The paths indicated by shading are the two incoming signals. Although these are nominally equal, slight adjustments have been made to ensure 0 dB total power.

Profile 2, shown below, is based on Profile 1, but assumes 3 dB further loss per reflection. It has been introduced as a check that the performance of the receiver does not depend excessively on the echo profile.

Path Delay (us)	**Channel A**		**Channel B**	
	Path Loss (dB)	Phase (deg)	Path Loss (dB)	Phase (deg)
0.00	6	340	5.7	119
0.05	12	30	11.7	93
0.10	18	129	17.7	329
0.50	7.5	175	7.2	138
0.55	13.5	231	13.2	146
0.60	19.5	297	19.2	307

Table 10-26b. Profile 2 for Multi-Channel Diversity Tests

Whatever profile is chosen, the test is carried out as follows:

1. The sensitivity (C/N) for input A only (input B terminated) is measured.
   The sensitivity for input B only (input A terminated) is measured.
   These two sensitivities will not be equal, since Channels A and B possess different powers.
2. Both inputs (Channels A and B) are now applied.
   The sensitivity is measured again.

The improvement in sensitivity noted in (2) should be at least 6 dB for either input and any mode.

Further details of the above diversity tests are given in DTG RF 104 [114].

11 MHEG-5 Introduction to the UK Profile

11.1 Scope

Chapters 12-19 of this document embody version 1.06 of the UK Profile of MHEG-5. This is the specification of a broadcast profile of MHEG-5 to be implemented in Digital Terrestrial TV receivers for deployment in the UK. It identifies the minimum functionality that the receiver will need to support.

The chapters also contain details of MHEG extensions to cover both the Interaction Channel and HD MHEG.

Any corrigenda or interoperability issues that need to be considered in conjunction with this specification will be logged by DTG Testing Limited. Any implementer of this specification is advised to contact the Test Centre Manager at DTG Testing Limited. Annex E "Corrigenda to Version 1.06 of the UK Profile of MHEG-5" contains details of corrigenda already agreed by the time of the publication of this version of this document. This Annex shall be considered to be a normative part of this specification. It will be republished from time to time to incorporate any new corrigenda items.

11.2 The Code of Practice

Collaboration between relevant industry experts representing both manufacturers and broadcasters has led to the completion of the baseline specification of the UK Profile of MHEG (v1.06) and a corresponding version of the DTG MHEG Test Suite, the latter providing a truly objective means of evaluating receiver conformance. A group of broadcasters, manufacturers and other interested parties has subsequently developed the concept of an Interoperability Code of Practice (see Annex D "DTT MHEG Interoperability Code of Practice") to maximise the benefits arising through application of this test tool.

The aim of this Code of Practice is to achieve a situation where deployed receivers implement all features of the UK Profile of MHEG in a conformant manner, as determined by the DTG MHEG Test Suite, and that all interactive services operate as intended on such receivers. From a viewer's perspective this will deliver a less problematic and richer experience, to the general benefit of the DTT platform.

This Code of Practice is voluntary and there are no penalties or constraints held against any of the parties in the event that shortcomings are highlighted through test procedures. However, by considering a wide range of interests and opinions in the drafting of this Code the intention was to make it easy to adopt by all relevant parties. The clearer and more objective testing regime for both applications and receivers embodied by this Code, coupled with a more co-ordinated information flow through a spirit of collaboration and engagement, will provide a significant step towards a more stable and reliable experience for the viewer.

Any questions or enquiries regarding this Code should be directed to the Test Centre Manager at DTG Testing Ltd. (+44 (0)207 501 4350, testing@dtg.org.uk) or by visiting http://www.dtg.org.uk.

12 The User Experience

12.1 Introduction

This section looks at the behaviour seen by the user. It is provided to give context to the receiver specifications. However, much of the behaviour shown here results from functionality coded into the broadcast application, rather than the receiver.

This broadcaster controlled behaviour should be seen as a concept model for how services may appear. As broadcasters develop services, and gain experience from user feed-back, the detail of the behaviour they implement is likely to evolve.

12.1.1 Visual appearance

Balance of AV and MHEG-5Table 12-1 illustrates the range of different visual appearances the viewer might experience. Each “screen” shows a different balance between “conventional TV” AV content and information delivered via MHEG-5.

Visual Appearance	Description
	1. Conventional TV
	2. TV with visual prompt of available information
	3. TV with information overlaid

Table 12-1. Typical range of programme types perceived by viewers

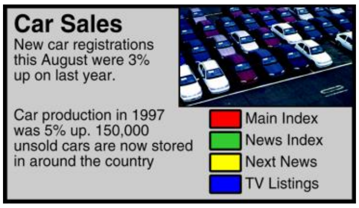
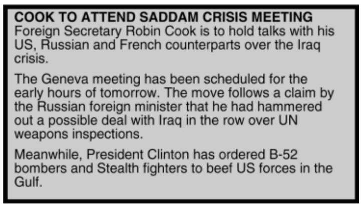
Visual Appearance	Description
	4. Information with video or picture inset
	5. Just information

Table 12-1. Typical range of programme types perceived by viewers

Time and Space

The user may see a change in appearance either when they change channel or as a service changes through time.

Figure 12-1. What might be seen across channels and through

12.2 User Navigation

Channel Change

The user can use any of the navigation methods to change channel:

- "Surfing" using "Programme up" & "Programme down"
- Direct selection by pressing a favourite channel button
- Selection from options within the "Info" or "Guide" screens

These apply equally to TV and Information services. There may also be cases where the user changes channel from within an information service. When a service has been selected, regardless of the service type, the user can again change channel in the usual way.

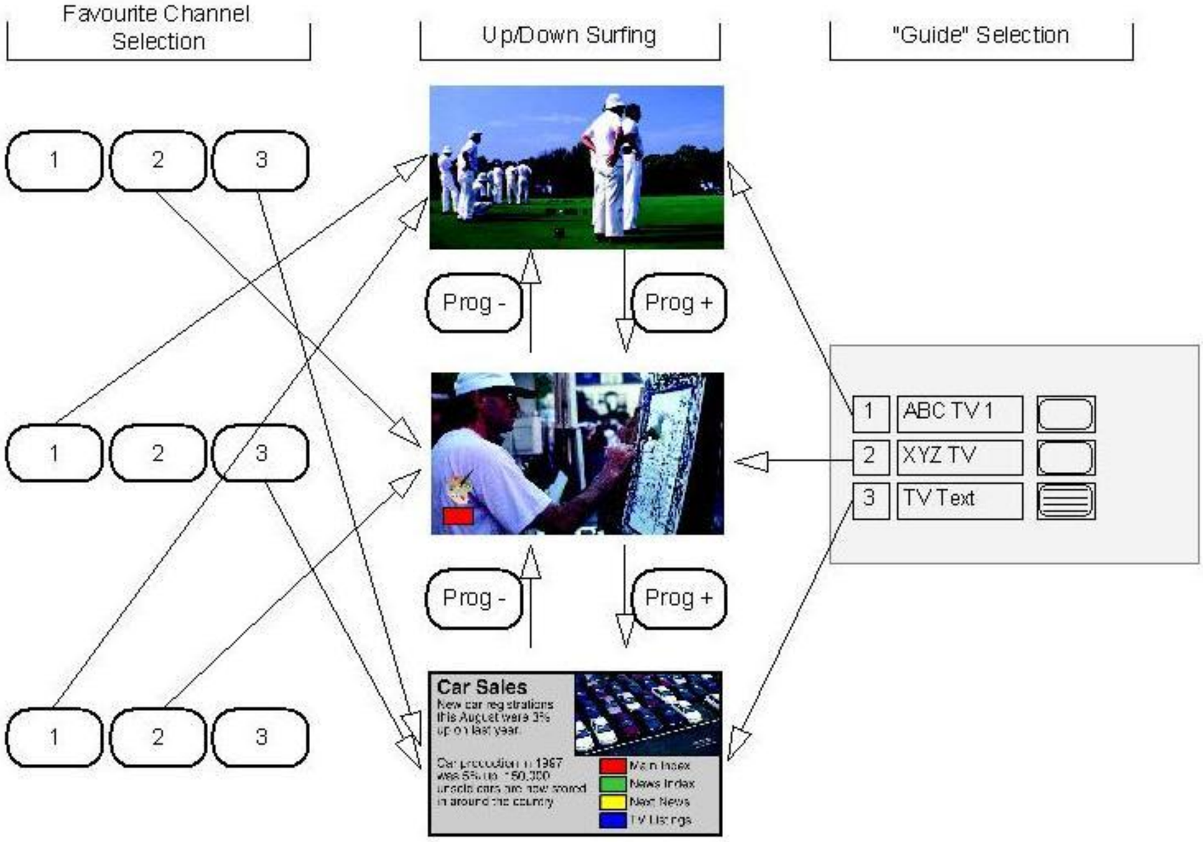


Figure 12-2. Changing channels

The "Text" Button — The effect of the "Text" button may vary slightly from programme to programme.

See 19.3.1 "The traditional "teletext" key"

See 19.3.2 "Accessing additional programme information"

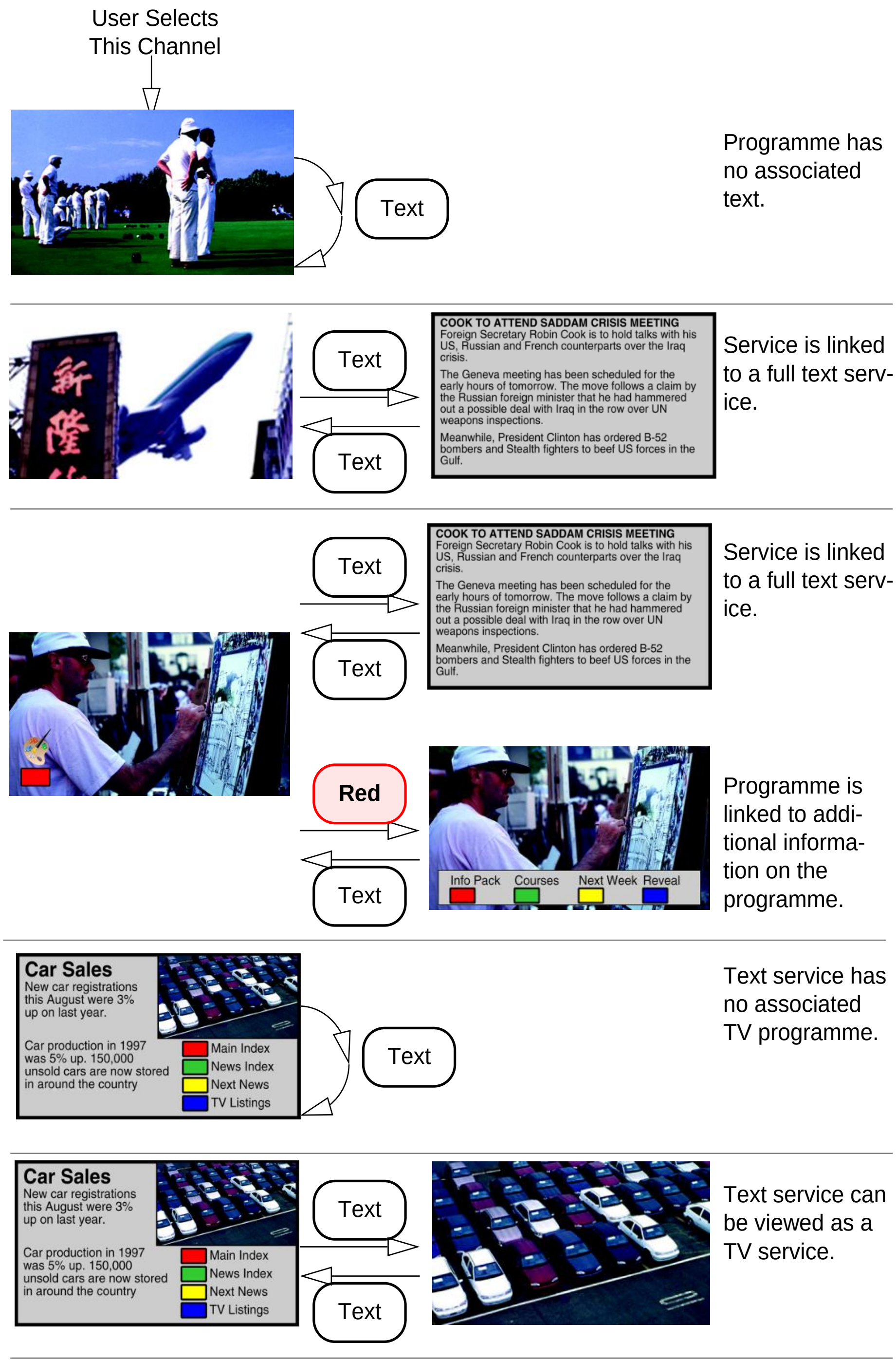


Figure 12-3. Using the text button

12.3 Channel selections within an Information Service

MHEG-5 services can provide facilities to change channel. For example, they may provide listings of current programmes and the ability to select a programme.

The effect of changing channel from an MHEG-5 application is exactly the same as if the user selected a channel from the receiver's "Guide".

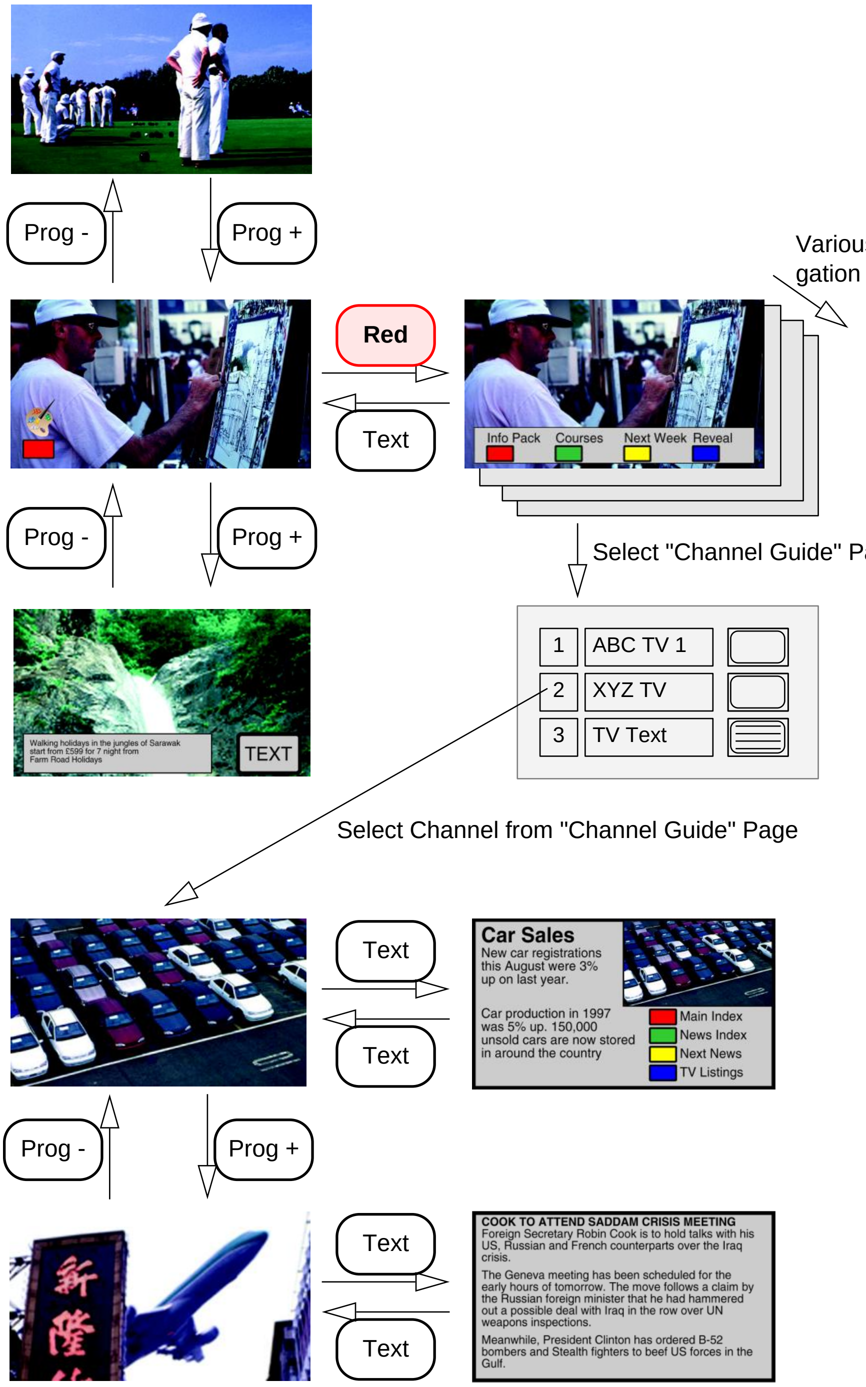


Figure 12-4. Using a TV listings page to change channel

12.4 Use of video within an Information Service

MHEG-5 services can use video inset into pages. For example, this could provide a video "preview" of the services on a multiplex. This might result in a channel change, but if the viewer "backs out" they will return to the service they started from.

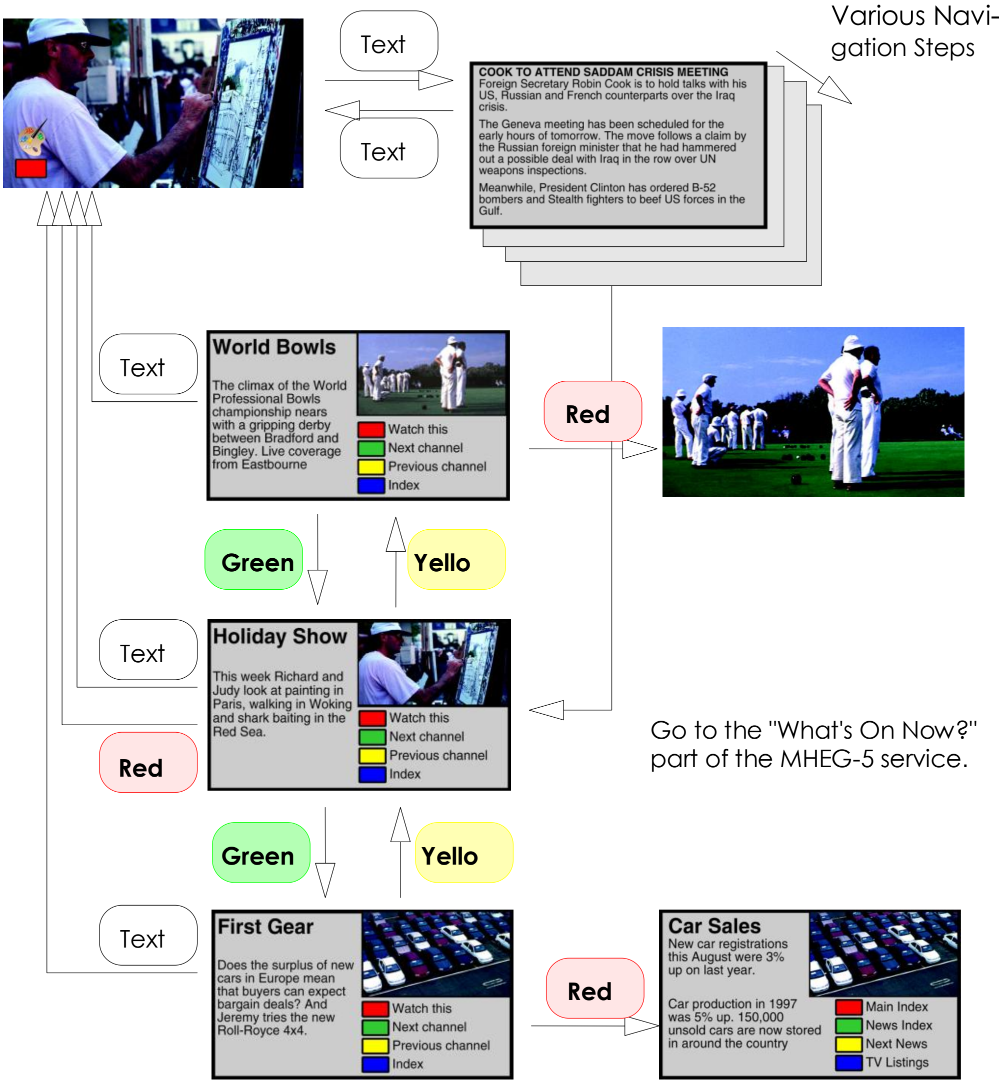


Figure 12-5. A possible "What's on now?" TV browser

13 MHEG-5 Engine Profile

Chapters 13 to 19 have been written with reference to conventional remote control handsets but, in view of the developments in remote control technologies and interfaces, references to control 'buttons' or 'keys' may be to control functions or to physical buttons.

This section provides the detailed specification of the MHEG-5 engine required in compliant digital TV receivers. This specification is an "application domain" in the terms set out in Annex D of ISO/IEC 13522-5.

This "application domain" is referred to as "*UKEngineProfile1*"

13.1 Basic specification

The engine shall be compliant with the ISO/IEC 13522-5 (MHEG-5) specification for a Hypermedia presentation engine using the "application domain" definition provided by this document. The following are also considered to be in force:

- The corrigenda to ISO/IEC 13522-5 published as ISO/IEC 13522-5:1997/Cor.1:1999(E)
- The additional language specifications described in Section13.12 "Extensions to the MHEG-5 language specification"

See also:

- Section13.13 "Clarifications, restrictions and amendments"
- Section17.5 "Caching"

13.2 Object interchange format

The ASN.1 notation defined in Annex A of ISO/IEC 13522-5 shall be used as the
application interchange format. The encoding of the MHEG-5 objects from this ASN.1 syntax shall make use of the *Distinguished Encoding Rules* (DER) defined in ITU-T X.690.
In line with the recommended error handling behaviour in the MHEG-5 specification:

- The engine shall ignore each element of a Group's Items sequence that it does not recognise, as well as valid MHEG-5 objects that are not supported by this Profile
- The engine shall ignore unrecognised fields
- The engine shall ignore unrecognised elementary actions
- The engine may ignore Ingredients that include an unrecognised ContentHook
- The engine shall ignore the ObjectInformation exchanged attributes where encoded

In all such cases, there shall be no effect on the rest of the Application or Scene, which shall be interpreted normally.

13.3 Set of classes

Table 13-1 identifies the classes that a receiver implementing the *UKEngineProfile1* shall implement.

Class	Abstract/ Concrete[a]	Required (Y/N[b])	Notes
Root	A	Y	
Group	A	Y	
Application	C	Y	
Scene	C	Y	
Ingredient	A	Y	
Link	C	Y	
Program	A	Y	
ResidentProgram	C	Y	See Section 13.10 "ResidentPrograms"
RemoteProgram	C	N	
InterchangedProgram	C	N	
Palette	C	N	
Font	C	Y/N[d]	See Chapter 15 "Text and Interactibles"
CursorShape	C	N	
Variable	A	Y	See Section 13.11 "Limitations on standard data-types"
BooleanVariable	C	Y	
IntegerVariable	C	Y	
OctetStringVariable	C	Y	
ObjectRefVariable	C	Y	
ContentRefVariable	C	Y	
Presentable	A	Y	
TokenManager	A	Y	
TokenGroup	C	Y	
ListGroup	C	Y	
Visible	A	Y	
Bitmap	C	Y	See Section 13.5.2 "Bitmap objects" and Section 14.8 "MPEG stills".
LineArt	C	N	See Section 14.5 "LineArt & DynamicLineArt. See footnote.[c]
Rectangle	C	Y	
DynamicLineArt	C	Y	See Section 14.5 "LineArt & DynamicLineArt"
Text	C	Y	See Section 15.6 "Text mark-up"
Stream	C	Y	
Audio	C	Y	See Section 13.4.1.4 "Audio stream decoders" and Section 13.5.3 "Stream 'memory' formats".
Video	C	Y	
RTGraphics	C	N	
Interactible	A	Y	
Slider	C	Y	See Section 15.9 "Slider"
EntryField	C	Y	See Section 15.7, "EntryFields"
HyperText	C	Y	See Section 15.8, "HyperText"
Button	A	N	
HotSpot	C	N	
PushButton	C	N	

Table 13-1. Classes supported by this engine profile (Sheet 1 of 2)

Class	Abstract/ Concrete[a]	Required (Y/N[b])	Notes
SwitchButton	C	N	
Action	C	Y	

Table 13-1. Classes supported by this engine profile (Sheet 2 of 2)

a] Abstract classes are not "interchanged" (i.e. not directly used) in *UKEngineProfile1* MHEG-5 applications

b] 'Y' = yes, i.e. receivers implementing *UKEngineProfile1* shall support these classes. 'N' = no, i.e. receivers implementing *UKEngineProfile1* are not required to support these classes. Also, classes marked 'N' may not be completely defined in the UK context at this time.

c] The LineArt class shall not be instantiated, i.e. no MHEG-5 applications conforming to this profile shall include LineArt objects. No content encoding is defined for this class in this profile. However, engine implementations may include the LineArt class effectively as an abstract class supporting instantiable classes based on LineArt such as Rectangle and DynamicLineArt.

d] Receivers supporting *DownloadableFontExtension* shall support the Font class. Receivers not supporting *DownloadableFontExtension* are not required to support the Font class.

13.4 Set of features

All receivers shall implement all of the effects of MHEG-5 actions and the internal behaviours of MHEG-5 classes required under Section 13.3 "Set of classes". Table 13-2 identifies the *UKEngineProfile1* requirement with regard to features defined as "optional" within ISO/IEC 13522-5.

Feature	Required (Y/N[a])	Notes
Caching	Y	See Section 17.5, "Caching".
Ancillary connections	N	See Section 13.4.2 "Not required features".
Cloning	Y	The receiver shall support cloning at least of the following classes: Text, Bitmap & Rectangle.
Free-moving cursor	N	See 13.4.2 "Not required features".
Bitmap scaling	N	Limited scaling is required for I-frame bitmaps, but not for PNGs. See "Scaling" section.
Video scaling	Y	See Section 16.5.4, "MPEG presentation".
Stacking of Applications	Y	See Section 16.9, "Application stacking".
Trick Mode	N	Not applicable for any currently defined stream-items' content type. See Section 13.4.2 "Not required features" and see Section 16.5.3 "Trick modes".

Table 13-2. Requirements for MHEG-5 “Optional” Features

a] ‘Y’ = yes, i.e. receivers implementing *UKEngineProfile1* shall support these features.

13.4.1 GetEngineSupport ‘feature’ strings

Table 13-3 identifies the GetEngineSupport feature strings that receivers implementing *UKEngineProfile1* shall support:

String		Constraint
Standard	Short	

<table>
<tr><th colspan="2">String</th><th>Constraint</th></tr>
<tr><th>Standard</th><th>Short</th><th></th></tr>
<tr><td>AncillaryConnections</td><td>ACo</td><td>Shall return “false”. See Section 13.4.2.</td></tr>
<tr><td>ApplicationStacking</td><td>ASt</td><td>Shall return “true”. See Section 16.9, “Application stacking”.</td></tr>
<tr><td>Cloning</td><td>Clo</td><td>Shall return “true”.</td></tr>
<tr><td>FreeMovingCursor</td><td>FMC</td><td>Shall return “false”. See Section 13.4.2.</td></tr>
<tr><td>MultipleAudioStreams(N)</td><td>MAS(N)</td><td>Shall return “true” for N≤1. See Section 13.4.1.4 “Audio stream decoders”.</td></tr>
<tr><td>MultipleVideoStreams(N)</td><td>MVS(N)</td><td>Shall return “true” for N≤1.</td></tr>
<tr><td>OverlappingVisibles(N)</td><td>OvV(N)</td><td>Shall return “true” for all values of N.
See Section 16.5.2, “Video decoder performance” and Section 14.4 “Overlapping Visibles”.</td></tr>
<tr><td>Scaling</td><td>Sca</td><td>Shall return “false”.
See Section 16.5.4, “MPEG presentation”.</td></tr>
<tr><td>SceneAspectRatio(W,H)</td><td>SAR(W,H)</td><td>Shall return “true” for (W, H) is (4,3) or (16,9).</td></tr>
<tr><td>SceneCoordinateSystem(X,Y)</td><td>SCS(X,Y)</td><td>Shall return “true” for (X,Y) is (720,576).
See Section 14.1 “The graphics plane”.</td></tr>
<tr><td>TrickModes</td><td>TrM</td><td>Shall return “false”. See Section 13.4.2.</td></tr>
<tr><td>VideoScaling(CHook,X,Y)[a]</td><td>VSc(CHook,X,Y)[a]</td><td>Shall return “true” for the combinations of CHook, X & Y that are supported by the implementation. The minimum set of combinations that shall be supported is tabulated below. See “MPEG presentation”.
<table>
<tr><th>Parameter</th><th>Values</th></tr>
<tr><td>CHook</td><td>10, 15</td></tr>
<tr><td>X</td><td>1440, 1080, 720, 540, 360</td></tr>
<tr><td>Y</td><td>1152, 576, 288</td></tr>
</table></td></tr>
<tr><td>BitmapScaling(CHook,X,Y)[b]</td><td>BSc(CHook,X,Y)[b]</td><td>Shall return “true” for the combinations of CHook, X & Y that are supported by the implementation. The minimum set of combinations that shall be supported is tabulated below. See “MPEG presentation”.
<table>
<tr><th>Parameter</th><th>Values</th></tr>
<tr><td>CHook</td><td>2, 7</td></tr>
<tr><td>X</td><td>1440, 1080, 720, 540, 360</td></tr>
<tr><td>Y</td><td>1152, 576, 288</td></tr>
</table></td></tr>
<tr><td>VideoDecodeOffset(CHook,Level)[a]</td><td>VDO(CHook,Level)[a]</td><td>Shall return “true” for the combinations of CHook & Level tabulated below that are supported by the implementation.
See Table 13-4 “VideoDecodeOffset parameters”.</td></tr>
</table>

String		Constraint
Standard	Short	

Table 13-3. *UKEngineProfile1* GetEngineSupport behaviour (Sheet 1 of 2)

String		Constraint
Standard	**Short**	
BitmapDecodeOffset(CHook,Level)[b]	BDO(CHook,Level)[b]	Shall return "true" for the combinations of CHook & Level tabulated below that are supported by the implementation. See Table 13-5 "BitmapDecodeOffset parameters".
UniversalEngineProfile(N)	UEP(N)	Receivers fully conformant with this specification shall return true when N corresponds to the values defined in Annex C.2. Shall also return true when N is a manufacturer specific string identifying an element of the receiver software or hardware. Receivers may respond to a number of such strings, each representing, for example, a module of code. See Section 13.4.1.3 "Engine identification strings". See also Section 19.20.1 "UKEngineProfile".
ICProfile(N)	ICP(N)	Shall return "true" for N=0 if the receiver supports the *InteractionChannelExtension*. Shall return "true" for N=1 if the receiver supports *ICStreamingExtension* but may not implement the stream buffering as described in Section 16.3.8 "IC Stream buffer". Shall return "true" for N=2 if the receiver supports *ICStreamingExtension* including the buffer restrictions as described in Section 16.3.8.3 "Restrictions". Shall return "true" for N=3 if the receiver supports *ICStreamingExtension* as described in Section 16.3.8 "IC Stream buffer". Note: a receiver which returns "true" to ICP(3) must also return "true" to ICP(2) and ICP(1). Shall return "true" for N=4 if the receiver supports *ICEncryptedStreamExtension*. Note: a receiver which returns "true" to ICP(4) does not mean that ICP(2) or ICP(3) is supported. Shall return "true" for N=5 if the receiver supports ICStreamingExtension including bit rates up to and including 4096 Kbps and H.264 HD AVC video as described in Section 13.5.4 Non-linear stream formats Shall return "false" for all other values of N.
DownloadableFont(CHook)	DLF(CHook)	Shall return "true" for the values of CHook that are supported by the Font class. Shall return "false" for all other values of CHook. See 15.3.1, "Downloading".
NonLinearPlaybackKeys	NLK	Shall return "true" if the receiver supports *ICStreamingExtension* and supports all of the following keys as defined in 13.6.2: •Stop key •Play and Pause keys, or a combined

String		Constraint
Standard	**Short**	
		Play/Pause key •Either Skip Forward or Fast Forward or both •Either Skip Backwards or Rewind or both.
HDExtension(N)	HDE(N)	Shall return "true" for N=0 if the receiver supports *HDVideoExtension* as described in Section 14.11. Shall return "true" for N=1 if the receiver supports the *HDGraphicsPlaneExtension* as described in Section 14.11.1.1. Note: receivers supporting both the *HDVideoExtension* and *HDGraphicsPlaneExtension* should respond "true" to tests for HDE(0) and for HDE(1). Shall return "false" for all other values of N.
BitmapFormat(CHook)	BFo(CHook)	Shall return "true" where CHook is one of the defined values of Bitmap content hook listed in Table 13-7 and supported by the receiver. This string is mandatory if the receiver supports *HDVideoExtension* (see Section 14.11) or *HDGraphicsPlaneExtension* (see Section 14.11.1.1) otherwise optional.

Table 13-3. *UKEngineProfile1* GetEngineSupport behaviour (Sheet 2 of 2)

a] This CHook is that for a Stream. See Table 13-7.

b] These CHooks are those for Bitmaps. See Table 13-7.

Unspecified requests will always result in GetEngineSupport returning false. This implies that future MHEG-5 engine implementations supporting more than these minimum features will recognise additional strings.

Receivers shall truthfully reflect their capability when interrogated with GetEngineSupport.

13.4.1.1 VideoDecodeOffset

CHook	Level	Description
10,15	0	The receiver can present Video for which the Position and VideoDecodeOffset attributes are constrained so that the decoded and scaled video is fully on screen, i.e. the resulting top left and bottom right corner coordinates are both in the range (0, 0) to (720, 576).
	1	The Position and VideoDecodeOffset attribute for Video can be such that the decoded and scaled video can be partially off screen. At least half of the decoded image height must remain within the display raster. For horizontal scaling factors of full size and above, at least one quarter of the decoded image width must remain within the display raster. For horizontal scaling factors below full size, at least half the decoded image width must remain within the display raster.

Table 13-4. VideoDecodeOffset parameters

See the examples under Section 13.12.10.2 "Changes to "Effect of MHEG-5 actions".

13.4.1.2 BitmapDecodeOffset

CHook	Level	Description
2,7	0	The receiver can present I-frame Bitmaps for which the Position and BitmapDecodeOffset attributes are constrained so that the decoded and scaled bitmap is fully on screen, i.e. the resulting top left and bottom right corner coordinates are both in the range (0, 0) to (720, 576).
	1	The Position and BitmapDecodeOffset attributes for I-frame Bitmaps can be such that the decoded and scaled bitmap can be partially off screen. At least half of the decoded image height must remain within the display raster. For horizontal scaling factors of full size and above, at least one quarter of the decoded image width must remain within the display raster. For horizontal scaling factors below full size, at least half the decoded image width must remain within the display raster.

Table 13-5. BitmapDecodeOffset parameters

See Section 13.12.7 "Changes to the Bitmap class" and the examples under Section 13.12.10.2 "Changes to "Effect of MHEG-5 actions".

13.4.1.3 Engine identification strings

All receivers shall return true to at least:

- One string that uniquely identifies the receiver via its make, model and version number. This shall be of the form "mmmcccvvv", where "mmm" uniquely identifies the manufacturer, "ccc" is a unique model code and "vvv" is the principal version of the complete receiver software build.
- One string that identifies the MHEG engine provider and version number. This shall be of the form "MHGmmmvvv", where "mmm" uniquely identifies the manufacturer of the MHEG engine and "vvv" is the version number of the currently embedded build.
- One string that identifies the DSM-CC stack provider and version number. This shall be of the form "DSMmmmvvv", where "mmm" uniquely identifies the manufacturer of the DSM-CC stack and "vvv" is the version number of the currently embedded build.

The subfields "mmm", "ccc" and "vvv" shall be encoded as 3 octets with values in the range 0x21 to 0x7E inclusive.

So for example, a particular receiver might recognise the following strings:

UEP(FEG001103)

UEP(MHGFEG056)

UEP(DSMFEG017)

Whilst another receiver might recognise the following:

UEP(AST003213)

UEP(MHGBUP122)

UEP(DSMCDU008)

Other strings may also return true.

13.4.1.4 Audio stream decoders

Two sources of audio are considered in the context of the *UKEngineProfile1* MHEG-5 engine:

1. MPEG audio [38] data "live" from a stream as it is broadcast (e.g. the sound track for a TV programme) or is delivered via the Interaction Channel.
2. MPEG audio [38] data from memory (see Section 13.5.3 "Stream 'memory' formats").

UKEngineProfile1 receivers shall provide one MPEG audio [38] decoder which can decode data either from a stream OR from an object in memory.

The meaning of MultipleAudioStreams(N) and MAS(N) for N>1 has not yet been defined in the UK context.

13.4.2 Not required features

Features identified as not required in this profile SHALL NOT be implemented by receivers conforming to this profile. This constraint is to ensure that, when implemented, these features are correctly specified for the UK.

13.4.3 MHEG-5 Extensions

This document defines the following extensions to the UK Profile Specification v1.06:

- *HDGraphicsPlaneExtension* (see Section 14.11.1 "Resolution")

This extends the MHEG-5 engine to allow support for an HD graphics plane.

- *HDVideoExtension* (see Section 14.11, "High definition graphics model")

  This extends the MHEG-5 engine to allow support for HD video and audio coding and presentation

- *InteractionChannelExtension*

  This extends the MHEG-5 engine to allow support for static content retrieval over an always-on IP connection

- *ICStreamingExtension*

  This extends the MHEG-5 engine to allow support for static and streaming content retrieval over an always-on IP connection. Receivers that implement *ICStreamingExtension* shall also implement *InteractionChannelExtension*.

- *ICEncryptedStreamExtension*

  This extends the MHEG-5 engine to allow support for decoding and presenting streaming content that has been encrypted before delivery to the receiver. Receivers that implement *ICEncryptedStreamExtension* shall also implement *InteractionChannelExtension* and *ICStreamingExtension*

- *LifecycleExtension* (see Section 16.2.9 "Keeping an application running across service tunes")

  This extends the MHEG-5 engine to allow MHEG-5 applications to continue running across service tunes.

- *NativeApplicationExtension* (see Section 8.5.11 "Broadcast Triggered Native Applications") This extends the MHEG-5 engine to allow the co-existence of MHEG-5 applications and broadcast-triggered native applications.

- *DowloadableFontExtension* (see Section 15.3.1, "Downloading") This extends the MHEG-5 engine to allow support for a range of typefaces, styles and sizes for text presentation.

13.5 Content data encoding

Table 13-6 identifies the minimum set of coding of attributes that shall be supported by the engine.

Attribute	Permissible values
FontAttributes	See Section 15.4.1 "FontAttributes"
FontName	See Section15.3.3 "Invoking the font"
AbsoluteColour	See Section 14.3.3 "Direct/Absolute colours"
CharacterSet	See Table 15-3
TransitionEffect	Not required feature

Table 13-6. Content table

Table 13-7 identifies the minimum set of data types that shall be supported by the engine for each type of content. It also identifies the content hook values for each data type.

Type of content	Specification (Data Types)	Hook values
Font	See Section 15.3.1 "Downloading"	10[a]
Palette	(None specified)	
Bitmap	Reserved	1
	MPEG-2 Intra frame [37]. See Section14.8 "MPEG stills"	2
	Reserved	3
	PNG bitmap. See Section 14.7 "PNG bitmaps"	4
	Reserved	5
	JPEG bitmap. See Section14.12 "JPEG bitmaps"	6
	H.264 Intra Frame. See Section14.13. Support for H.264 Intra Frames is mandatory for a receiver that supports *HDVideoExtension*, otherwise optional.	7
	Reserved	8
Text	See Section 15.6, "Text mark-up"	10
EntryField	See Section 15.2 "Character encoding" See Section 15.7 "EntryFields"	10
HyperText	See Section 15.8 "HyperText"	10
Stream	A broadcast MPEG program with construction and components that conform to the present document.	10
	A "file" containing a single elementary stream that can be decoded from memory. Data formats are described in Section 13.5.3 "Stream 'memory' formats". In this profile Audio is the only stream component that can be decoded from memory.	11
	An MPEG-2 Single Program Transport Stream, containing a combination of audio, video and DVB subtitle components that conform to the present document, restricted as described in Section 13.5.4 "Non-linear stream formats", and which may be accessed in a non-linear method, see Section 16.5.3 "Trick Modes" In this profile "http:" or "https" are the only sources that are supported for this content hook. Support for this content hook is required for receivers that implement *ICStreamingExtension*.	15
LineArt	(None specified)	
CursorShape	(None specified)	
InterchangedProgram	(None specified)	

Table 13-7. Encoding Table

[a] For the Font class, content hook 10 shall be supported by receivers that implement *DownloadableFontExtension*. For receivers that do not implement *DownloadableFontExtension*, there is no content hook value defined for the Font class.

13.5.1 Use of negative hook values

Negative hook values are reserved for use by receiver manufacturers to signal manufacturer specific encoding formats. These shall never be signalled by a broadcaster and may only be used by the manufacturer for local applications.

13.5.2 Bitmap objects

Scaling — Scaling (the ScaleBitmap action) shall be supported for bitmap objects with MPEG I-frame content. See Section14.8 "MPEG stills". Scaling shall not be supported for Bitmap objects using PNG or JPEG bitmaps.

Tiling — Support for tiling is only required for PNG bitmaps, and for JPEG bitmaps where supported.

Transparency — Transparency can be encoded within the PNG bitmaps. Support for object level transparency (i.e. the Transparency internal attribute of the Bitmap class) is not required for any bitmap type. See Section 14.4.1 "Transparency & overlapping Visibles".

13.5.3 Stream 'memory' formats

In this profile the only StreamComponent that accepts a Storage specification of memory is Audio. Video can only be played from stream.

Audio — Each "file" of audio content is an OctetString carrying audio elementary stream data. Each "file" delivers an integer number of audio access units and the first byte of each file is the first byte of an audio access unit.

The MPEG Audio data in all other respects conforms to the specifications provided in the present document with the constraint that only MPEG-2 audio data is required to be supported.

13.5.4 Non-linear stream formats

Receivers that implement *ICStreamingExtension* shall be able to present a Transport Stream delivered by IP at bit rates up to and including 2048kbps. Receivers returning true for ICP (5) shall be able to present a Transport Stream delivered by IP at bit rates up to and including 4096kbps and H.264 HD AVC. Higher bit rates may be supported.

The audio, video and subtitle components will be encapsulated in a single program MPEG-2 Transport Stream.

The transport stream will contain minimal PSI necessary to enable correct interpretation of the stream:

- PAT. There will be only one programme identified in the PAT.
- PMT. This will identify the video, audio and subtitle components of the programme, where present.

SI/PSI tables shall remain unchanged throughout the Transport Stream.

No additional SI/PSI tables are guaranteed to be included; if they are then they should be ignored.

In this profile components of a Stream with a content hook of 15 shall be subject to the following restrictions.

Video	Where the Transport Stream includes a video component it shall be encoded as H.264 AVC as defined in Section 2.3. Receivers returning true for ICP(5) shall support H.264 HD AVC as defined in section 2.3.2.
Audio	Where the Transport Stream includes audio components they shall be encoded as MPEG-4 High Efficiency AAC as defined in Section 4.3. Support for multi-channel audio is not required.
Subtitles	No additional restrictions

13.5.4.1 Encrypted non-linear streams

Receivers that implement *ICEncryptedStreamExtension* shall be able to decrypt non-linear streams delivered by IP.

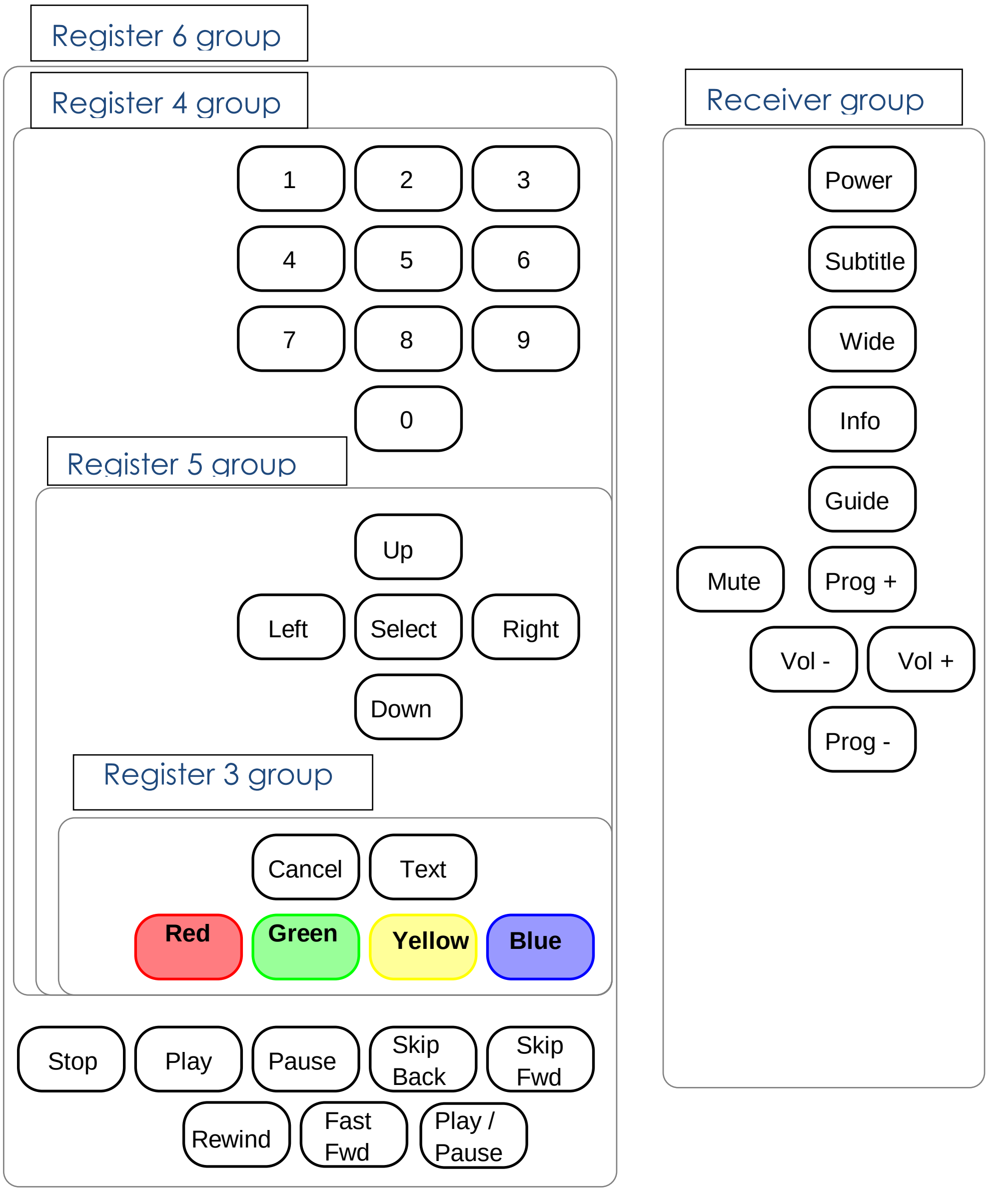
When the content payload of Transport Stream packets is encrypted it shall use the AES-128 encryption algorithm defined in FIPS PUB 197 [145]. This is used in the variant of Cipher-Block-Chaining (CBC) mode as defined in ANSI_SCTE 52 [146].

Note that SCTE52 was originally defined for use with DES, which has a 64-bit block size. However the extension of the principle to the 128-bit block size of AES is obvious.

13.6 User input

13.6.1 Remote control functions

Figure 13-1 illustrates the functions of the receiver remote control. This is provided to help explain the "function groups". The physical appearance (including possible labelling) of the remote control and the methods of interaction delivering the required functions may be quite different from the one illustrated. Recommended labelling can be found in Section 25.3 "Recommendations for remote control button labelling".



Receiver group

The input provided by this group **is never available to a running MHEG-5 application**.

This group provides the most frequently used receiver control functions. They have the same effect whether the viewer is watching a TV service, an

	MHEG-5 service or using other receiver screens. For example, the "Program up" & "Program down" always have the effect of changing channel. All other receiver specific functions (e.g. to invoke the receiver set-up screens) are also within this group.
Register 3 group	The input provided by this group is **always available to a running MHEG-5 application**. However, see Section 13.6.4, "Interaction with broadcast-triggered native applications". In some receiver implementations this group may also be used for interacting with receiver applications such as the "Info" & "Guide" screens when there is either no running MHEG-5 application or the current MHEG-5 application has been "paused" (see Section 16.10 "Receiver process priority"). This group shall not be used for receiver "channel surfing".
Register 4 group	The input provided by this group **is sometimes available to a running MHEG-5 application**. MHEG-5 applications have exclusive use **only after** the viewer has *entered* the broadcast application. This is to avoid confusion with "channel surfing" for which these groups may also be used.
Register 5 group	As Register 4 group.
Register 6 group	As Register 4 group. Receivers that support *ICStreamingExtension* shall support this register group. However, only those keys that exist on the receiver's remote control shall actually generate events. If no DVR keys are present, this input register is equivalent to register 4. Receivers shall indicate the availability of the optional keys to the MHEG application through the "NonLinearPlaybackKeys" engine feature string (see Section 13.4.1 "GetEngineSupport feature strings"). Receivers may implement either separate Play and Pause keys or a combined Play/Pause key.

13.6.2 UserInput registers

Receivers shall implement input event registers 3, 4 and 5 defined in Table 13-8. The DAVIC defined registers 1 & 2 are shown for information only. Keys marked as 'O' are optional. Where they are supported by the receiver the values defined shall be generated.

UserInput EventData	Function Name	Register Number					
		1	2	3	4	5	6[28]
1	Up	✓	✓		✓	✓	✓
2	Down	✓	✓		✓	✓	✓
3	Left	✓	✓		✓	✓	✓
4	Right	✓	✓		✓	✓	✓
5-14	0, 1, 2, 3, 4, 5, 6, 7, 8, 9 respectively	✓			✓		✓
15	Select	✓	✓		✓	✓	✓
16	Cancel	✓	✓	✓	✓	✓	✓
17	Help	✓	✓				
18-99	Reserved by DAVIC						
100	Red			✓	✓	✓	✓
101	Green			✓	✓	✓	✓
102	Yellow			✓	✓	✓	✓
103	Blue			✓	✓	✓	✓
104	Text			✓	✓	✓	✓
105-119	Reserved for future UK specification						
120	Stop						O
121	Play						O
122	Pause						O
123	Skip Forward						O
124	Skip back						O
125	Fast Forward						O
126	Rewind						O
127	Play/Pause						O
128-256	Reserved for future UK specification						
≥257	Vendor specific						

Table 13-8. InputEvent Registers

Note: Applications may switch between InputEvent registers dynamically as they progress. Selection of an InputEvent register shall not have side effects on other aspects of the receiver behaviour such as video presentation.

[28]. Input register 6 shall only be supported by receivers that implement *ICStreamingExtension*.

13.6.3 Implementation of this interaction model

The receiver is responsible for implementing the set of input functions defined for the input event registers (see Section 13.6 "User input"). How applications use the different InputEvent registers and the resultant user experience is addressed through authoring guidelines (see Section 19.2 "Avoiding confusion with navigator functions").

13.6.4 Interaction with broadcast-triggered native applications

For receivers supporting *NativeApplicationExtension*, it shall be possible for keys in the Register 3 group (i.e. Cancel, Text, Red, Green, Yellow, Blue) to be available to a broadcast-triggered native application (see Section 8.5.11) instead of an MHEG-5 application, irrespective of the input event register, even when Section 13.6.1 would otherwise grant exclusive use of those keys to an MHEG-5 application.

The currently defined native applications require access to the Green key.

13.7 Semantic constraints on MHEG-5 applications

As implied by the capabilities of the engine in Section 13.4.1 "GetEngineSupport 'feature' strings".

13.8 EngineEvents

Table 13-9 lists the minimum set of engine events that the engine is required to support.

EventData Name	EventData Value	Notes
	< 0	Manufacturer specific
Reserved	0 1	Reserved
GroupIDRefError	2	This event shall be raised if a Launch, Spawn or TransitionTo ElementaryAction attempts to access a file that cannot be provided by the file system as a file. See Section 13.8.1."Object retrieval errors".
ContentRefError	3	This event shall be raised if an application attempts to access referenced content that cannot be provided by the file system. See Section 13.8.1."Object retrieval errors".
TextKeyFunction	4	Generated when the user activates the "Text" function and there is an active scene object. This event is raised independently of the InputEvent register selected at the current moment or whether any interactible has the InteractionStatus of True. If "Text" function causes both the EngineEvent and the UserInput event then the EngineEvent shall be raised first. See Section 13.6.1 "Remote control functions".
Reserved	5	Reserved
VideoPrefChanged	6	Generated when the user preferences for video aspect ratio handling change in a way that would alter the return values for the VideoToGraphics resident program, see 13.10.8.1, "VideoToGraphics" . Note that this event is *not* generated when the broadcast video changes aspect ratio, nor when a change affects only *display* format conversion.
PauseResume	7	Generated after the MHEG-5 engine process resumes processing after a period where it is descheduled. See Section 16.10 "Receiver process priority".
SubtitlePrefChange d	8	Generated when the user preferences for the presentation of DVB Subtitles changes. This event is raised when the condition of "Control E3" as illustrated in Figure 16-3, section 16.4.3 changes.

Table 13-9. Required Engine Events (Sheet 1 of 3)

EventData		Notes
Name	**Value**	
NetworkBootInfo	9	Generated in response to changes in the relevant data_broadcast_id_descriptor when: • The network_boot_sub-descriptor either appears or changes (as indicated by the NB_version), and the NB_action is set to 0x02 • The network_boot_info sub-descriptor either appears or changes (as indicated by the NB_version), the NB_action is set to 0x01, and the current application is being executed from the CI file system. The application can access the value of the NB_info field at any time via the resident program GetBootInfo.
NonDestructiveTune OK	10	If the receiver implements *LifecycleExtension*, generated when the receiver successfully attaches to the requested carousel in a target service after a non-destructive tune (see Section 13.10.6.4 "SI_TuneIndexInfo" 13.10.6.4, "SI_TuneIndexInfo" and Section 16.2.9, "Keeping an application alive across service tunes"). If the receiver does not implement *LifecycleExtension*, reserved.
Reserved	11…15	Reserved
CancelKeyFunction	16	Generated when the user activates the "cancel" function from the appropriately mapped key. This event is raised independently of the InputEvent register selected at the current moment or whether any interactible has the InteractionStatus of True. If a key press causes both the EngineEvent and the UserInput event then the EngineEvent shall be raised first. See Section 13.6.1 "Remote control functions".
Reserved	17...99	Reserved
RedKeyFunction	100	Generated when the user activates the appropriate colour key and there is an active scene object. This event is raised independently of the InputEvent register selected at the current moment or whether any interactible has the InteractionStatus of True. If a key press causes both the EngineEvent and the UserInput event then the EngineEvent shall be raised first. See Section 13.6.1 "Remote control functions".
GreenKeyFunction	101	
YellowKeyFunction	102	
BlueKeyFunction	103	

Table 13-9. Required Engine Events (Sheet 2 of 3)

EventData		Notes
Name	**Value**	
Reserved	104 - 199	Reserved
The following engine events shall be implemented only in receivers that implement *InteractionChannelExtension*. Otherwise these values are reserved		
ICStatusChanged	200	Generated when the state of the receiver's interaction channel connection changes in a way that would alter the return value of the GetICStatus resident program. (See Get ICStatus in Section 13.10.9a.1)
ICLocalError	201	Generated if an application attempts to access referenced content, an application object or a scene object that cannot be provided by the file system because no interaction channel connection is available.
ICNetwork Error	202	Generated if an application attempts to access referenced content an application object or a scene object that cannot be provided by the file system because a remote server did not respond
ICRemoteError	203	Generated if an application attempts to access referenced content, an application object or a scene object that cannot be provided by the file system because a remote server indicates that the requested file is unavailable.
The following engine events shall be implemented only in receivers that implement *ICStreamingExtension*. Otherwise these values are reserved.		
StreamRefError	204	This event is raised if an application fails to access a media stream that it is attempting to play. The event shall not be raised for broadcast services.
StreamUnderflow	205	This event is raised when a media stream stops being presented due to buffer underflow. This event shall not be raised when playback reaches the end of the stream. The event shall not be raised for broadcast services.
Reserved	206	Reserved
AudioDescPrefChanged	207	Generated when the viewer preference for the presentation of Audio Description changes.
StreamUnderflowResume	208	This event is raised when a media stream resumes being presented following buffer underflow. The event shall not be raised for broadcast services.
Reserved	209	Reserved
KeyFileError	210	This event is raised when a key file associated with a media stream cannot be obtained, or is not valid.
Reserved	All other values	Reserved

Table 13-9. Required Engine Events (Sheet 3 of 3)

13.8.1 Object retrieval errors

The engine event GroupIDRefError shall be raised if an Action directly attempts to access an object that cannot be provided by the file system as a file. Similarly, the engine event ContentRefError shall be raised if an Action directly attempts to access some content that cannot be provided by the file system as a file, Stream or StreamEvent. The events shall not be generated if the content of the file is otherwise invalid. For clarification a retrieved empty file shall not generate either of these events. Neither event is raised when a URL reference to a broadcast service cannot be resolved. See also Section 16.3.7 "Stream presentation errors".

The above does not define the behaviour of file access errors that are the consequence of file accesses from resident programs. In this profile the only ResidentPrograms that attempt to access files are CheckContentRef and CheckGroupIDRef. These don't raise any engine events (the return parameters from the program include an indication of file availability).

13.8.2 Object retrieval errors – Interaction Channel

This clause applies only to receivers that implement *InteractionChannelExtension*.

If an Action results in one of ICLocalError, ICNetworkError or ICRemoteError being raised in addition to one of the GroupIDRefError or ContentRefError, the engine event relating to the interaction channel shall be raised first.

13.9 Protocol mapping and external interaction

<table>
<tr><th>MHEG-5 entity</th><th>Mapping needed</th><th>Semantics</th></tr>
<tr><td>OpenConnection, CloseConnection</td><td>Mapping to connection management</td><td rowspan="3">Not required in UKEngineProfile1.

See Section 13.4.2 "Not required features" .</td></tr>
<tr><td>RemoteProgram objects</td><td>Mapping to RemoteProgram call protocol in the application domain</td></tr>
<tr><td>Application name space in case a TransitionTo action uses the ConnectionTag parameter</td><td>Mapping to the name space of the application domain</td></tr>
<tr><td>Persistent storage name space</td><td>Mapping to the name space of the persistent storage</td><td>See Section 16.7 "Persistent storage" .</td></tr>
<tr><td>Stream actions</td><td>Mapping to the stream interface of the application domain</td><td rowspan="2">See Section 18.3 "Namespace mapping".</td></tr>
<tr><td>Stream events</td><td>Mapping to stream states and stream events in the application domain</td></tr>
</table>

Table 13-10. Protocol Mapping

13.10 ResidentPrograms

Table 13-11 lists the ResidentPrograms that a *UKEngineProfile1* receiver shall implement.

Table 13-12 lists further optional ResidentPrograms

Table 13-12a lists the ResidentPrograms that receivers implementing *InteractionChannelExtension* shall implement.

Table 13-12b lists the ResidentPrograms that receivers implementing *ICStreamingExtension* shall implement.

Table 13-12c lists the ResidentPrograms that receivers implementing *NativeApplicationExtension* shall implement.

Resident program			Invocation			Reference
			Typical Use		Never Fork	
Description		**Name**	**Call**	**Fork**		
GetCurrentDate		GCD	✓			Section 13.10.2.2, “GetCurrentDate”
FormatDate		FDa	✓			Section 13.10.2.3, “FormatDate”
GetDayOfWeek		GDW	✓			Section 13.10.2.4, “GetDayOfWeek”
Random		Rnd	✓			Section 13.10.3.1, “Random”
CastToContentRef	[a]	CTC	✓			Section 13.10.4.1, “CastToContentRef”
CastToObjectRef	[a]	CTO	✓			Section 13.10.4.2, “CastToObjectRef”
CastToStringInt	[a]	CSI	✓			Section 13.10.4.3, “CastToStringInt”
GetStringLength		GSL	✓			Section 13.10.5.1, “GetStringLength”
GetSubString		GSS	✓			Section 13.10.5.2, “GetSubString”
SearchSubString		SSS	✓			Section 13.10.5.3, “SearchSubString”
SearchAndExtractSubString		SES	✓			Section 13.10.5.4, “SearchAndExtractSubString”
SI_GetServiceIndex		GSI	✓			Section 13.10.6.1, “SI_GetServiceIndex”
SI_TuneIndex		Tin	✓		✓[b]	Section 13.10.6.2, “SI_TuneIndex”
SI_TuneIndexInfo		TII	✓			Section 13.10.6.4, “SI_TuneIndexInfo”
SI_GetBasicSI		BSI	✓			Section 13.10.6.3, “SI_GetBasicSI”
GetBootInfo		GBI	✓			Section 13.10.11.1, “GetBootInfo”
CheckContentRef		CCR		✓		Section 13.10.7.1, “CheckContentRef”
CheckGroupIDRef		CGR		✓		Section 13.10.7.2, “CheckGroupIDRef”
VideoToGraphics		VTG	✓			Section 13.10.8.1, “VideoToGraphics”
SetWidescreenAlignment		SWA	✓			Section 13.10.8.2, “SetWidescreenAlignment”
GetDisplayAspectRatio		GDA	✓			Section 13.10.8.3, “GetDisplayAspectRatio”
CI_SendMessage		CIS	✓		✓	Section 13.10.9.1, “CI_SendMessage”
SetSubtitleMode		SSM	✓			Section 13.10.8.4, “SetSubtitleMode”
WhoAmI		WAI	✓			Section 13.10.10.1, “WhoAmI”

Table 13-11. *UKEngineProfile1* mandatory Resident Programs

a] See “Type conversion”.

b] Applications shall not invoke this resident program using Fork.

Resident program		Invocation			Reference
		Typical Use		Never Fork	
Description	Name	Call	Fork		
Debug	DBG	✓			13.10.10.2, "Debug"

Table 13-12. Optional Resident Programs

Resident program		Invocation			Reference
		Typical Use		Never Fork	
Description	Name	Call	Fork		
GetICStatus	GIS	✓			Section 13.10.9a.1 "GetICStatus"
ReturnData	RDa	✓			Section 13.10.9a.2, "ReturnData"
SetHybridFileSystem	SHF	✓		✓	Section 13.10.9b.1, "SetHybridFileSystem"
PersistentStorageInfo	PST	✓			13.10.9a.5, "PersistentStorageInfo"
SetCookie	SCk	✓			13.10.9a.6, "SetCookie"
GetCookie	GCk	✓			13.10.9a.7, "GetCookie"

Table 13-12a. Mandatory Resident Programs for receivers that implement *InteractionChannelExtension*.

Resident program		Invocation			Reference
		Typical Use		Never Fork	
Description	Name	Call	Fork		
MeasureStreamPerformance	MSP		✓		Section 13.10.9a.3, "MeasureStreamPerformance"
PromptForGuidance	PFG	✓		✓	Section 13.10.9a.4, "PromptForGuidance"
GetAudioDescPref	GAP	✓			Section 13.10.8.6, "GetAudioDescPref"
GetSubtitlePref	GSP	✓			Section 13.10.8.7, "GetSubtitlePref"
GetPINSupport	GPS	✓			Section 13.10.9a.8, "GetPINSupport"

Table 13-12b. Mandatory Resident Programs for receivers that implement *ICStreamingExtension*.

Resident program		Invocation			Reference
		Typical Use		Never Fork	
Description	Name	Call	Fork		
SetBroadcasterInterruptions	SBI	✓			Section 13.10.8.5 "SetBroadcasterInterruptions"

Table 13-12c. Mandatory Resident Programs for receivers that implement *NativeApplicationExtension*

Typical Use — Tables 13-11, 13-12, 13-12a, 13-12b and 13-12c provide an indication of the method by which the resident program is typically invoked (Call or Fork). This indication is informative. **The function of the resident program shall be identical whether invoked by Call or Fork.**
See also Section 19.15 "Use of Call and Fork with ResidentPrograms".

Program names — Earlier editions of this specification supported a long form of the resident program name. This long form is no longer supported. The three character "Name" indicated in Tables 13-11, 13-12, 13-12a, 13-12b and 13-12c shall be used to invoke the ResidentProgram.

13.10.1 Encoding of resident program names

The names of resident programs are conveyed in OctetStrings. The character encoding for names of resident programs uses ISO 8859-1. All of the characters used in Table 13-11 lie in the code range 0x00…0x7E.

Case sensitive names — The names of resident programs are case sensitive.

13.10.2 Date and time functions

13.10.2.1 Day, date & time functions

Some of these functions return textual information. In all cases this shall use the UTF-8 representation of character codes selected from the character repertoire in Table 15-18 "Set of characters supported by the engine".

13.10.2.2 GetCurrentDate

Synopsis — Retrieves the current local date and time.
Arguments — GCD(date, time)

in/ out/ in-out	type	name	comment
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	date	The Modified Julian date. Encoded as the number of days since Midnight on November 17, 1858.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	time	The current time encoded as the number of seconds since midnight.

13.10.2.3 FormatDate

Synopsis Format a string representing a date according to a specifiable format.

Arguments FDa(dateFormat, date, time, datestring)

in/ out/ in-out	Type	name	comment
input	GenericOctetString	dateFormat	A string specifying the format for presenting the date and time in the output string. See below.
input	GenericInteger	date	The Modified Julian date. Encoded as the number of days since Midnight on November 17, 1858.
input	GenericInteger	time	Values in the range 0 to 86399 describe the time encoded as the number of seconds since midnight. The meaning of other values are not defined.
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	dateString	The resultant formatted date and time.

Description

dateFormat The dateString is formed taking the input dateFormat string and expanding the fields prefixed with '%' as described below:

```
'%Y' Year, 4 digits
'%y' Year, last 2 digits
'%X' Month, with padding zero (01-12)
'%x' Month, without padding zero (1-12)
'%D' Day, with padding zero (01-31)
'%d' Day, without padding zero (1-31)
'%H' Hour, with padding zero (00-23)
'%h' Hour, without padding zero (0-23)
'%I' Hour, with padding zero (01-12)
'%i' Hour, without padding zero (1-12)
'%M' Minutes, with padding zero (00-59)
'%m' Minutes, without padding zero (0-59)
'%S' Seconds, with padding zero (00-59)
'%s' Seconds, without padding zero (0-59)
'%A' AM/PM indication
'%a' am/pm indication
'%%' single"%" character
```

For example, on June 4, 1995, at 16:56, with dateFormat "%Y-%x-%d %I:%M %a" the result in dateString is "1995-6-4 4:56 pm".

13.10.2.4 GetDayOfWeek

Synopsis Returns the day of the week.
Arguments GDW(date, dayOfWeek)

in/ out/ in-out	type	name	comment
Input	GenericInteger	Date	The Modified Julian date. Encoded as the number of days since Midnight on November 17, 1858.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	dayOfWeek	An integer representing the day of the week. 0 represents Sunday, 1 Monday etc.

13.10.3 Random number function

13.10.3.1 Random

Synopsis Returns a random number.
Arguments Rnd(num, random)

in/ out/ in-out	type	name	comment
input	GenericInteger	Num	Specifies the upper limit to the range of random numbers returned.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	Random	A random number in the range 1…num inclusive. The returned value is undefined if num < 1.

13.10.4 Type conversion functions

13.10.4.1 CastToContentRef

Synopsis Casts an OctetString to a ContentReference.

Arguments CTC(string, contentRef)

in/ out/ in-out	type	name	comment
input	GenericOctetString	string	
output	GenericContentReference (Shall provide an IndirectReference to a ContentRefVariable)	contentRef	

Description Casts the OctetString variable string to the ContentReference variable contentRef.

13.10.4.2 CastToObjectRef

Synopsis Casts an OctetString and Object Identifier to an ObjectReference.

Arguments CTO(string, objectId, objectRef)

in/ out/ in-out	type	name	comment
input	GenericOctetString	string	String to be cast to group identifier.
input	GenericInteger	objectId	Integer to be cast to object number.
output	GenericObjectReference (Shall provide an IndirectReference to an ObjectRefVariable)	objectRef	

Description Casts the combination of the OctetString string and the Integer objectId to the ObjectReference variable objectRef.
This ResidentProgram can only yield the long form of object reference (where the group identifier is explicit).

13.10.4.3 CastToStringInt

Synopsis Casts an ObjectReference to its GroupIdentifier and ObjectNumber.

Arguments CSI(objectRef, groupId, objectNumber)

in/ out/ in-out	type	name	comment
input	GenericObjectReference	objectRef	Object Reference to be cast.
ouput	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	groupId	String to store the groupId.
output	GenericInteger (Shall provide an IndirectReference to an IntegerVariable)	objectNumber	Integer to store the object number.

Description Casts the ObjectReference to an OctetString variable and an Integer variable. The OctetString variable shall contain the object reference's GroupIdentifier, and the Integer variable shall contain the object reference's ObjectNumber. If the ObjectReference does not have an encoded GroupIdentifier then the resident program shall return the default value of GroupIdentifier. The format of the GroupIdentifier returned (i.e. if it uses a fully resolved or shorthand notation) is not defined.

13.10.5 String manipulation functions

These resident programs are for the manipulation of OctetStrings, and octet values in the range 0x00…0xFF are valid and particular values have no special meaning. In particular the value zero does not indicate a string termination. Furthermore, neither mark-up codes nor multi-byte UTF-8 characters are given special treatment; they are just considered as octets within the string.

Range of string index valuesThe first octet of any string is referenced by an index of 1.

For the input indices beginExtract, endExtract and startIndex the following bounds checking shall be performed as the first step of executing the resident program:

- If the index is less than 1 it shall be treated as 1.
- If the index is greater than the string length then it shall be treated as the string length.

13.10.5.1 GetStringLength

Synopsis Returns the number of octets within the string.

Arguments GSL(string, length)

in/ out/ in-out	type	name	Example	comment
input	GenericOctetString	string	"Foo##Bar"	
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	length	8	

Description Returns in the output *length* the number of octets within the input *string*.

13.10.5.2 GetSubString

Synopsis Extracts a sub-string from a string

Arguments GSS(string, beginExtract, endExtract, stringResult)

in/ out/ in-out	type	name	Example	comment
input	GenericOctetString	string	"Foo##Bar"	
input	GenericInteger	beginExtract	2	Index of the first octet to be extracted.
input	GenericInteger	endExtract	4	Index of the last octet of the string to be extracted.
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	stringResult	"oo#"	

Description Extracts the part of *string* from the octet specified by *beginExtract* up to, and including, the octet specified by *endExtract*.

13.10.5.3 SearchSubString

Synopsis Searches for a sub-string within a string

Arguments SSS(string, startIndex, searchString, stringPosition)

in/ out/ in-out	type	name	example	comment
input	GenericOctetString	string	"Foo##Bar"	
input	GenericInteger	startIndex	1	Index of the first octet to be considered in the search.
input	GenericOctetString	searchString	"##"	The target string.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	stringPosition	4	The index of the target within *string* or -1 if not found.

Description Searches for a sub-string within a string from a specified starting index. The string is specified by *string*. The octet to start the search from is specified by *startIndex* and the target sub-string is specified by *searchString*. *stringPosition* returns the index within the string of the first octet of the target sub-string, -1 is returned if the string is not found or if *string* is empty. If *searchString* is empty, the search succeeds at *startIndex*. If both *string* and *searchString* are empty, -1 is returned.

13.10.5.4 SearchAndExtractSubString

Synopsis Searches and extracts a sub-string within a string

Arguments SES(string, startIndex, searchString, stringResult, stringPosition)

in/ out/ in-out	type	name	example	comment
input	GenericOctetString	string	"Foo##Bar"	
input	GenericInteger	startIndex	1	Index of the first octet to be considered in the search.
input	GenericOctetString	searchString	"##"	The target string.
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	stringResult	"Foo"	The string between the startIndex and the target. An empty string is returned if the target is not found.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	stringPosition	6	The index just after the target or -1 if not found.

Description Searches and extracts a sub-string within a string from a specified starting index. The string is specified by *string*. The octet to start from is specified by *startIndex* and the target sub-string is specified by *searchString*. *stringPosition* returns the index of the octet **immediately after** the *searchString* within the string or -1 if the string is not found or if *string* is empty. If *searchString* is empty, the search succeeds at *startIndex*. If both *string* and *searchString* are empty, -1 is returned. The first index of the string is 1.

stringPosition may, if the sub-string is the last element within *string,* have an index beyond its end. *stringResult* returns the string from *startIndex* up to, but not including, *searchString*. For example, if "Bar" is sought in "Foo##Bar" then the returned values are "Foo##" and 9.

13.10.6 Service selection

These resident programs provide a means to select (i.e. tune to) a given service. They also include the SI_GetBasicSI resident program, which assists in dealing with the regional variants of a service.

The "DBook" defines the service_attribute_descriptor, which can be used to control the
presentation of a given service within any service navigation mechanisms provided by the
receiver for the viewer. The behaviour of these resident programs shall be unaffected by
any use of this descriptor.

13.10.6.1 SI_GetServiceIndex

Synopsis Returns an index providing an engine specific reference to a service.

Arguments GSI(serviceReference, serviceIndex)

in/ out/ in-out	type	name	comment
input	GenericOctetString	serviceReference	serviceReference defines a Stream using one of the locator formats defined in Chapter 18 "Name Mapping"
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	serviceIndex	This variable returns an integer greater than or equal to zero referencing a service which can be used as the input to SI_TuneIndex. -1 is returned if the service is not available.

Description The resident program returns the index of the Service in the Service list described by serviceReference. serviceReference is the string used to define a Service in a URL format. This resident program shall accept both explicit (see Section 18.3.3 "URL formats for access to broadcast services") and inheritance (see Table 18-1 "Names within the receiver") formats.

Service availability is determined by the description of currently running services provided by the SI in the TS currently selected at the time the resident program is called. Services with a running status of "running" or "undefined" shall be considered available. However, this doesn't guarantee that the service is running!

13.10.6.2 SI_TuneIndex

Synopsis Tunes to the given service. **This shall not be invoked with Fork.**

Arguments TIn(serviceIndex)

in/ out/ in-out	type	name	comment
input	GenericInteger	serviceIndex	This integer describes the service to which the receiver shall attempt to tune.

Description The receiver attempts to tune to the specified service. Calls to this resident program may or may not return before the tune has completed in an implementation dependent way. The behaviour is undefined if an invalid serviceIndex is used.

13.10.6.3 SI_GetBasicSI

Synopsis Returns basic SI information about the service identified in the input serviceIndex.

Arguments BSI(serviceIndex, networkId, origNetworkId, transportStreamId, serviceId)

in/ out/ in-out	type	name	comment
input	GenericInteger	serviceIndex	This integer is a receiver-specific identifier for the service about which basic SI is required (see Section 13.10.6.1, "SI_GetServiceIndex").
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	networkId	Returns the appropriate DVB SI value.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	origNetworkId	
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	transportStreamId	
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	serviceId	

Description

The resident program returns a series of integers representing basic Service Information (SI) about a service. The service is identified by means of a receiver specific "ServiceIndex". This integer can be determined by means of the SI_GetServiceIndex resident program (see Section 13.10.6.1, "SI_GetServiceIndex"). The output values are undefined if an invalid serviceIndex is used.

13.10.6.4 SI_TuneIndexInfo

Synopsis

Provides a means to define how a receiver shall execute a subsequent application initiated service tune.

Arguments

TII(tuneinfo)

in/ out/ in-out	type	name	comment
input	GenericInteger	tuneinfo	This input parameter specifies how the receiver shall execute any subsequent application initiated service tune.

Description

The resident program can be used to define how the receiver shall execute any subsequent application initiated service tune. It may be called at any time prior to the call of the SI_TuneIndex resident program. The resident program effectively writes a system variable (tuneinfo) accessible by the receiver. The scope of this variable is that of the calling application.

The default receiver behaviour, until explicitly changed by the application, shall be as if tuneinfo has been set to 0, resulting in a destructive service tune, executed "normally"- (see below).

The 4-byte tuneinfo argument shall be treated as a 32-bit bit-field encoded as follows.

The value of bit 0 (the least significant bit of tuneinfo) represents the tune_quietly_flag, which shall be interpreted as follows:

0 (unset)	Perform any subsequent application initiated service tune *normally*.
1 (set)	Perform any subsequent application initiated service tune *quietly*.

If the receiver does not support *LifecycleExtension*, bits 1, 2 and 3 of tuneinfo shall be ignored and the receiver shall behave as if they were unset i.e. indicating a destructive service tune, as described below.

The value of bit 1 of tuneinfo represents the app_keeprunning_flag, which shall be interpreted as follows:

0 (unset)	Perform any subsequent application initiated service tune *destructively* by terminating the current application.
1 (set)	Perform any subsequent application initiated service tune *non-destructively* by attempting to keep the current application running both during and afterwards.

The value of bit 2 of tuneinfo represents the explicit_carousel_id_flag, which shall be interpreted as follows:

0 (unset)	Value of carousel_id to be used in a non-destructive tune not encoded but instead shall be obtained based on the setting of the carousel_id_mapping_flag (see below). Bits 8-15 of tuneinfo are reserved in this case and shall be ignored.
1 (set)	Value of carousel_id to be used in a non-destructive tune encoded by bits 8-15 of tuneinfo, where bit 8 is the lsb of the carousel_id. NOTE: These 8 bits contain the complete encoding of the carousel_id, not just the first 8 bits. Carousels that need to be referenced in this way must have their carousel_id set to be in the range 0-255.

The value of bit 3 of tuneinfo represents the carousel_id_mapping_flag, which shall be interpreted as follows:

0 (unset)	Value of carousel_id to be used in a non-destructive tune shall be that for the Current Carousel (see 16.2.7, “Application context”).
1 (set)	Value of carousel_id to be used in a non-destructive tune shall effectively be that of the Initial Carousel for the target service to be tuned to (see 16.2.7, “Application context”).

If the receiver does not support *NativeApplicationExtension*, bit 4 of tuneinfo shall be ignored and the receiver shall behave as if it were unset.

The value of bit 4 of tuneinfo represents the broadcaster_interrupt_flag, which shall be interpreted as follows:

0 (unset)	Broadcaster interruption status flag shall follow the normal rules specified in 13.10.13, “Duration of effect of ResidentPrograms”.

	1 (set)	Set broadcaster interruption status flag to disabled following the service tune (see 13.10.8.5, "SetBroadcasterInterruptions").

Summary of extensions

Bit 0 of tuneinfo shall be interpreted by all receivers.

Bits 1-3 of tuneinfo shall be interpreted by receivers that support *LifecycleExtension* and shall otherwise be ignored.

Bit 4 of tuneinfo shall be interpreted by receivers that support *NativeApplicationExtension* and shall otherwise be ignored.

Bits 5-7 and all other bits of tuneinfo are reserved and shall be ignored.

Destructive Service tune

If the app_keeprunning_flag is unset, or if the receiver does not support *LifecycleExtension*, then any subsequent application initiated service tune shall be executed destructively. This means that the current application will be terminated as part of the service tune. In this scenario:

If the tune_quietly_flag is unset then the receiver shall execute the service tune normally. This means that the viewer experience shall be exactly as if they had initiated a standard service tune through selection of the new service using any of the receiver's inherent service navigation mechanisms, e.g. using the Ch+/- keys or numeric entry. This shall be reflected in (but not restricted to):

- Presentation of any front panel channel number,
- Presentation of any now/next information,
- The point from which any relative navigation, such as Ch+/, shall be performed.

If the tune_quietly_flag is set then the receiver shall execute the service tune quietly. This means that the receiver shall suppress the presentation of all information, e.g. channel number, service name, and now/next etc., usually presented during a standard service tune. The effect should be such that it is not possible to tell the difference between a quiet tune to another service and previewing the components of that same service using an application. In addition the viewer service context shall not be changed by a quiet tune, i.e. it shall remain that of the last normal tune whether initiated by an application or by the viewer. This means that a number of quiet tunes may be cascaded without changing the viewer service context. Whatever the actual service currently tuned to, the viewer service context shall be used for all relevant receiver interaction, including (but not restricted to):

- Presentation of any front panel channel number,
- Presentation of any now/next information,
- The point from which any relative navigation, such as Ch+/-, shall be performed.

The explicit_carousel_id_flag, carousel_id_mapping_flag and any encoded value of carousel_id shall be ignored.

Non-destructive service tune

If the app_keeprunning_flag is set and the receiver supports

LifecycleExtension then any subsequent application initiated service tune shall be attempted non-destructively. This means that the receiver shall attempt to keep the current (calling) application running both during and after the service tune.

The first step of a non-destructive service tune is the "tune" itself. In this scenario:

If the tune_quietly_flag is unset (i.e. a normal tune) then the receiver shall nonetheless execute the *transitional* part of the service tune as if the tune_quietly_flag *were* set, suppressing the presentation of all information, e.g. channel number, service name, and now/next etc., usually presented during a standard service tune. However, the receiver state *at the end of the service tune* shall be exactly as if the viewer had initiated a standard service tune through selection of the new service using any of the receiver's inherent service navigation mechanisms, e.g. using the Ch+/- keys or numeric entry. This should be reflected in (but not restricted to):

- Presentation of any front panel channel number,
- Presentation of any now/next information,
- The point from which any relative navigation, such as Ch+/-, shall be performed.

If the tune_quietly_flag is set then the receiver shall execute the service tune quietly exactly as defined for the scenario when the app_keeprunning_flag is unset, as described previously.

The receiver shall keep the application running during the tune, although some functions, such as the servicing of carousel file requests, will be suspended during this period (see 16.2.9, "Keeping an application alive across service tunes").

The second step of a non-destructive tune occurs after the actual "tune" has been successfully completed. This involves re-evaluating the presentation of broadcast streams by any active MHEG-5 Stream objects and attempting to attach to a carousel in the new service. In this scenario:

If the explicit_carousel_id_flag is unset then the receiver shall use the carousel_id_mapping_flag to determine the carousel to attempt to attach to.

> If the carousel_id_mapping_flag is unset then the receiver shall attempt to attach to a carousel in the new service that has the same carousel_id as that of the Current Carousel (in the previous service) at the point that the application initiated the non-destructive tune.
>
> If the carousel_id_mapping_flag is set then the receiver shall attempt to attach to the Initial Carousel for the new service (see 16.2.7, "Application context").

If the explicit_carousel_id_flag is set then the receiver shall attempt to attach to a carousel in the new service that has the value of carousel_id identified by bits 8-15 of tuneinfo, i.e. in the range 0-255.

The carousel_id_mapping_flag shall be ignored.

If the identified method for attempting to attach to a carousel in the new service fails, e.g. no carousel is present in the new service with the required value of carousel_id, then the receiver shall not attempt to employ an alternative method as a fallback. Instead the receiver shall terminate the running application and attempt to launch the auto-boot application for the new service (see 16.2.5, "Auto boot broadcast application")..

13.10.7 Checking references

This set of Resident Programs can be used by applications to determine if objects (from a file system) are available before embarking on a course of action that requires the objects.

The tests serve two functions, first they confirm that the "file" implied by the reference is available in the file system, secondly the test confirms that, where practical, the file has been brought into the receiver's memory. References to be checked using these Resident Programs may be to any file system supported by the receiver, including any optional file systems that are implemented.

When the object being referenced is to be retrieved from a DSM-CC object carousel then, for the purposes of these Resident Programs the minimum condition under which a "file" may be considered as available is when the IOR of the corresponding File object has been extracted from the relevant parent Directory (or ServiceGateway) object.

If the receiver implements *InteractionChannelExtension* then when the object being referenced is to be retrieved over HTTP, receivers shall make a HEAD request to discover whether the object is available. Object availability shall be determined by the reception of an HTTP response code indicating success (see Section 17.8.3 "Response status codes").

If the receiver implements a cache for the IC file system then depending on the server's response to the HEAD request, the receiver may subsequently make a GET request so that the object can be loaded into the receiver's memory as a side effect of the Resident Program.

The access controls as defined in section 17.15 shall be considered when determining the availability of a file. A HEAD request must be validated against the server list file but needs no further authentication. However if a GET request is optionally performed then this must follow the requirements of the authentication rules. An object referenced in CheckGroupIDRef shall be treated as a file containing code for the purposes of availability. Therefore the availability of an object may be different when requested with CheckContentRef than with CheckGroupIDRef.

An authoring example is provided under Section 19.10 which illustrates the expected use of these Resident Programs.

13.10.7.1 CheckContentRef

Synopsis Allows an application to check if an item of content is available.

Arguments CCR(ref-to-check, ref-valid-var, ref-checked-var)

in/ out/ in-out	type	name	comment
input	GenericContentReference	ref-to-check	This input parameter specifies the target object whose availability is to be checked.
output	GenericBoolean (Shall provide an IndirectReference to a BooleanVariable)	ref-valid-var	This output parameter signals whether the target object is "available".
output	GenericContentReference (Shall provide an IndirectReference to a ContentRefVariable)	ref-checked-var	This output parameter delivers the content reference input to the resident program when it was invoked.

Description The intended use of CheckContentRef is "non blocking", i.e. it will normally be invoked using the Fork action. This allows the scene to continue operating while the check is performed.

The ref-valid-var result is true if the referenced object exists in the file system, and if receiver resources permit, has been retrieved from the file system to receiver memory. The engine is NOT required to start decoding the content.

The application author is responsible for ensuring the type of the file. For example, if the referenced object is a scene or application object then the resident program will still return true if the file is found to be available.

13.10.7.2 CheckGroupIDRef

Synopsis Allows an application to check if an application or scene object is available.

Arguments CGR(ref-to-check, ref-valid-var, ref-checked-var)

in/ out/ in-out	type	name	comment
input	GenericObjectReference (The object number shall be 0, i.e. the object shall be an application or a scene)	ref-to-check	This input parameter specifies the target object whose availability is to be checked.
output	GenericBoolean (Shall provide an IndirectReference to a BooleanVariable)	ref-valid-var	This output parameter signals whether the target object is "available".
output	GenericObjectReference (Shall provide an IndirectReference to an ObjectRefVariable)	ref-checked-var	This output parameter delivers the object reference input to the resident program when it was invoked.

Description	The intended use of CheckGroupIDRef is "non blocking", i.e. it will normally be invoked using the Fork action. This allows the scene to continue operating while the check is performed. The ref-valid-var result is true if the referenced object exists in the file system, and if receiver resources permit, has been retrieved from the file system to receiver memory. The engine is NOT required to start decoding the content. The application author is responsible for ensuring the type of the file. For example, if the referenced object is a PNG graphics file the resident program will still return true if the file is found to be available.

13.10.8 Presentation information

13.10.8.1 VideoToGraphics

Synopsis: Transforms a point in the logical 720x576 video co-ordinate space to the corresponding point in the co-ordinate system of the current Scene.

Arguments: VTG(videoX, videoY, graphicsX, graphicsY)

in/ out/ in-out	type	name	comment
Input	GenericInteger	videoX	Specifies the input point for the transformation. The point (in the MPEG coded frame) is specified in a logical 720x576 co-ordinate space (see also Section 16.5.4.2 "Transparency of MPEG encoding").
Input	GenericInteger	videoY	
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	graphicsX	Returns a point where an object could be positioned so as to appear on top of the specified input point in the video frame, taking into account any Decoder Format Conversion currently being applied (see also Section 16.6 "Application control of aspect ratio").
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	graphicsY	

Note: if no video is being presented, the return values of this resident program are undefined.

Informative Note: An implementation might perform this calculation in matrix form as follows:

$$\begin{bmatrix} graphicsX \\ graphicsY \\ 1 \end{bmatrix} = \begin{bmatrix} scaleX & 0 & (posX + offsetX) \\ 0 & scaleY & (posY + offsetY) \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} DecFC \end{bmatrix} \times \begin{bmatrix} videoX \\ videoY \\ 1 \end{bmatrix}$$

where

videoX and *videoY* are the input co-ordinates in the 720x576 video co-ordinate system,
DecFC is a matrix describing the current Decoder Format Conversion,
scaleX and *scaleY* are the current Video scale factors (e.g. 0.5, 1.0 etc),
posX and *posY* are the current video position from the Position attribute of the MHEG-5 Video object,

offsetX and *offsetY* are the current values of the VideoDecodeOffset attribute of the MHEG-5 Video object,
graphicsX and *graphicsY* are the output co-ordinates in the 720x576 Scene co-ordinate system.

A few common DecFCs might be:

$$DecFC_{none} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad DecFC_{CCO} = \begin{bmatrix} 16/1 & 0 & -120 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$DecFC_{pillarbox} = \begin{bmatrix} 12\ 1 & 0\ 9 \\ /\ 0 & 1\ 0 \\ 0 & 0\ 1 \end{bmatrix} \qquad DecFC_{letterbox} = \begin{bmatrix} 1 & 0 & 0 \\ 0\ 12\ 1 & 7 \\ 0\ /\ 0 & 1 \end{bmatrix}$$

$$DecFC_{14by9letttterbox} = \begin{bmatrix} 16/1 & 0 & -720/1 \\ 0 & 12/1 & 576\ 1 \\ 0 & 0 & /\ 1 \end{bmatrix}$$

Of course, the resident program must in practice use the true transformation in use rather than any theoretical one if the two differ.

Examples

Scenario	Input Points	Output Points
Broadcast is a 16:9 coded frame of size 720x576. The display is 16:9 and no DecFC is being applied	(40,60) (-500,-500)	(40,60) (-500,-500)
Broadcast is a 16:9 coded frame of size 720x576. The display is 4:3 and the DecFC is centre-cut-out	(0,0) (360,100)	(-120,0) (360,100)
Broadcast is a 16:9 coded frame of size 352x288. The display is 4:3 and the video is being shown in a 16:9 letterbox	(0,0) (720,576)	(0,72) (720,504)
Broadcast is a 4:3 coded frame of size 720x576. The display is 4:3 and the video has been scaled to 360x288 and positioned at (200,200)	(0,0) (720,576)	(200,200) (560,488)
Broadcast is a 16:9 coded frame of size 1920x1080. The Scene co-ordinate system is 720x576. The display is 16:9 and no DecFC is being applied.	(40,60) (-500,-500)	(40,60) (-500,-500)

13.10.8.2 SetWidescreenAlignment

Synopsis: Sets the current mode for aligned presentation of graphics and 16:9 video for 4:3 displays.

Arguments: SWA(mode)

in/ out/ in-out	type	name	comment
Input	GenericInteger	mode	Specifies a new WidescreenAlignment Mode: 1 = Centre-Cut-Out 2 = Letterbox

Description: This resident program sets the Widescreen Alignment Mode for forced alignment of 16:9 video and 4:3 graphics (typically to support 4:3 displays). The value is only relevant when the active Scene has an explicit 4:3 AspectRatio attribute defined and the video is broadcast with a 16:9 coded frame. See Section 16.6 "Application control of aspect ratio".

The default mode is "1" (Centre-Cut-Out). See Section 13.10.13 "Duration of effect of ResidentPrograms".

13.10.8.3 GetDisplayAspectRatio

Synopsis: Returns the aspect ratio of the display.

Arguments: GDA(aspectratio)

in/ out/ in-out	type	name	comment
output	GenericInteger (Shall provide an IndirectReference to an IntegerVariable)	aspectratio	Indicates the display: 1 = 4:3 2 = 16:9

13.10.8.4 SetSubtitleMode

Synopsis

Enables or disables subtitle presentation simultaneous to MHEG-5 presentation.

Arguments

SSM(on)

in/ out/ in-out	type	name	comment
input	GenericBoolean	on	Enables or disables subtitle presentation on receivers that support simultaneous display of subtitles and MHEG-5 applications. True = enable.

Description

If a receiver is able to simultaneously display subtitles and MHEG-5 applications then this resident program provides a means for the application author to explicitly disable or enable subtitle presentation. See Section 13.10.13 "Duration of effect of ResidentPrograms" and Section16.4.3 "Subtitle decoder".

On receivers which do not display subtitles and MHEG-5 applications simultaneously this resident program shall have no effect.

The default mode is enabled.

13.10.8.5 SetBroadcasterInterruptions

This resident program shall be implemented only in receivers that support *NativeApplicationExtension*.

Synopsis

Provides a means to define whether the MHEG application can be interrupted by a broadcast-triggered native application.

Arguments

SBI(status)

in/ out/ in-out	type	name	comment
input	GenericBoolean	status	Enables or disables the receiver's ability to respond to other broadcaster signalling, e.g. promotional linking (see D-Book Section 8.5.11) which may interrupt or overlay the current application. True = Enabled False = Disabled

Description

This resident program defines how broadcast- triggered native applications shall co-exist with a running MHEG-5 application. It enables a running MHEG-5 application to permit interruption from other broadcast-triggered native applications at certain times, e.g. when running in the background, and prohibit interruption when that would create an undesirable user experience, e.g. while the user is interacting with the running MHEG-5 application.

If the status is enabled, the receiver is permitted to interrupt or suspend the current MHEG-5 application e.g. to display a broadcast-signalled message.

The MHEG-5 application runs until a broadcast-triggered native application is signalled by SI and the receiver is not capable of simultaneous presentation of the broadcast application and the MHEG-5 application.

If the receiver is capable of simultaneous presentation of the broadcast application and the MHEG-5 application, the MHEG-5 application may continue to run but may not receive some UserInput events. See Section 13.6.4, "Interaction with broadcast triggered native applications" and Section 8.5.11 . This resident program shall not affect the receiver's response to keys other than those in the Register 3 group.

If the status is disabled, broadcast-triggered native application (e.g. promotional link events) shall not interrupt (or overlay) the current MHEG-5 application.

User-initiated actions can always pause, suspend or kill the MHEG-5 application. See Section 16.10, "Receiver process priority".

The effect of changing the status is immediate irrespective of whether a broadcast-triggered native application has already been signalled. If the receiver is currently showing a broadcast-triggered native application with which the user has not interacted when the status is set to disabled, that broadcast-triggered native application shall immediately be removed and any keys in use by the application shall be available to the MHEG-5 application.

The default status is enabled, unless following a service tune where modified by bit 4 of a call to SI_TuneIndexInfo (see Section 13.10.6.4).

The status is a receiver global value shared by an auto-boot Application and any subsequent Applications invoked by a Launch or Spawn. The status is reset to the default value when the last Application in the Application stack is terminated.

13.10.8.6 GetAudioDescPref

Synopsis Returns the viewer preference for audio description.

Arguments GAP(viewerPref)

in/ out/ in-out	type	name	comment
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	viewerPref	Returns true if the current viewer preference is for the receiver to use the audio description soundtrack.

Description This resident program allows an MHEG application to determine whether audio description is currently enabled. This may be used to allow a content provider to make available streams with and without audio description to avoid streaming unused data.

13.10.8.7 GetSubtitlePref

Synopsis Returns the viewer preference for subtitles.

Arguments GSP(viewerPref)

in/ out/ in-out	type	name	comment
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	viewerPref	Returns true if the current viewer preference is for the receiver to display DVB subtitles.

Description This resident program allows an MHEG application to determine whether subtitles are currently enabled. This may be used to allow a content provider to make available streams with and without subtitles to avoid streaming unused data.

13.10.9 Common Interface

13.10.9.1 CI_SendMessage

Synopsis: Sends a message via an open DVB CI Application MMI session related to the current application. **This shall not be invoked with Fork.**

Arguments: CIS(Message, Response)

in/ out/ in-out	type	name
input	GenericOctetString	Message
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	Response

Description: Sends the OctetString bytes in Message to the open DVB CI Application MMI session related to the current application. The bytes are sent using the FileRequest message (see Section 16.11.3.4). The FileRequest RequestType will be set to 'data'. On receiving the FileAcknowledge message the resident program returns the DataByte field of the FileAcknowledge message in the OctetString Response (see Section 16.11.3.5).
If no DVB CI Application MMI session exists then the resident program shall have no effect.

13.10.9a Interaction channel

The resident programs defined in this section shall be implemented only in receivers that implement *InteractionChannelExtension* and optionally *ICStreamingExtension*.

13.10.9a.1 GetICStatus

Synopsis: Returns the availability of the interaction channel

Arguments: GIS(ICStatus)

in/ out/ in-out	type	name	comment
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	ICStatus	0 = Active 1 = Inactive 2 = Disabled

Description: The return value of this resident program provides dynamic information to indicate the status of the interaction channel connection available to the receiver.
"Active" means that the interaction channel has not been disabled by the viewer and that the network interface is physically connected and fully configured[29].

[29]. The network interface is considered to be fully configured if the necessary parameters have either been provided by the viewer or have been obtained automatically.

"Inactive" indicates that the interaction channel has not been disabled by the viewer but that the network interface is not physically connected or is not fully configured.

"Disabled" means that the interaction channel has been disabled through the action of the viewer.

If the receiver has more than one connection, it should respond with the status of the "best connection". A reasonable interpretation of "best" would be the connection that would retrieve content in the shortest time.

13.10.9a.2 ReturnData

Synopsis: Sends data to a remote server using the HTTP POST method.

Arguments: RDa(url, [name, value]…, responseCode, responseData)

in/ out/ in-out	type	name	comment
input	GenericOctetString	url	This input parameter specifies the URL to which data will be sent. See Section 18.3.2.5, "Reserved characters in HTTP URIs"
input	GenericOctetString	name	A list of name/value pairs to be sent to the server.
input	GenericBoolean or GenericInteger or GenericOctetString or GenericObjectReference or GenericContentReference	value	
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	response Code	The response code from the server. Zero if no response code was returned.
output	GenericOctetString (shall provide an IndirectReference to an OctetStringVariable)	response Data	The data returned by the server, if any.

Description: This resident program takes a variable number of arguments. One or more name and value pairs may be present. The name and value arguments are used to construct a data set of content type *application/x-www-form-urlencoded* as specified by section 17.13.4 of HTML 4.01 except that references to IETF RFC 1738 shall be taken as references to IETF RFC 3986, which updates it. This produces a data set of the form *name1=value1&name2=value2*, where each of the names and values has been percent-encoded after replacing any space characters with "+".

The data set may contain characters that are not represented in the US-ASCII character set; consequently the percent-encoding shall be carried out as specified for characters from the Universal Character Set in section 2.5 of IETF RFC 3986. Characters are assumed to be encoded as UTF-8. For example, the character Latin Capital Letter '*A With Grave*' is represented in

UTF-8 by the octets 0xC380. In the text representation of MHEG, this character would be written as '=C3=80'; after percent-encoding this would become "%C3%80".

This data set forms the Entity-Body of an HTTP POST request. The server's response code and any data returned by the server are returned to the MHEG application. The response code shall be interpreted in accordance with Section 17.8.3 "Response status codes". If no valid response code is returned by the server, the responseCode parameter shall be set to zero.

GenericOctetString and GenericContentReference arguments are treated directly as strings. GenericInteger arguments are converted to strings as decimal integers with no leading zeros. GenericBoolean arguments are converted to the string "true" if true and to the string "false" if false. GenericObjectReference arguments are converted to a string consisting of the GroupIdentifier (if any) followed by "," (0x2C) followed by the ObjectNumber as a decimal integer with no leading zeros.

In any case where an invalid set of arguments is supplied (such as a missing value argument) the resident program call shall fail in accordance with Section 13.10.12 "Data exchange with ResidentPrograms".

See also Section 19.24.2, "Example of ReturnData resident program".

13.10.9a.3 MeasureStreamPerformance

Synopsis Measures the IP-sourced stream presentation performance.

Arguments MSP (url, maxBytes, speed)

in/ out/ in-out	type	name	comment
input	GenericOctetString	url	This input parameter specifies an optional URL that can be retrieved for the purposes of determining the throughput. See Section 18.3.2.5 "Reserved characters in HTTP URIs"
input	GenericInteger	maxBytes	The maximum number of bytes to retrieve. If set to 0 or a negative value the entire file may be retrieved.
outpu t	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	speed	The average speed capability, in bytes/second or -1 if speed cannot be determined.

Description This resident program allows an MHEG application to determine the maximum rate of stream delivery from its IP connection that can be expected to be successfully presented. The speed returned should consider all limitations on the stream presentation in addition to the performance of the IP connection, e.g. throughput of the HTTP stack.

The receiver shall use the URL provided to determine the time taken to retrieve and decode a representative item of content. The content shall not be made available to the MHEG application. The receiver shall not source the data from any internal cache. From the size of the content and the time taken to load it completely to memory, along with adjustment for any known internal restrictions, the receiver shall calculate the speed as bytes per second.

If maxBytes is a positive number then the receiver shall make a partial request from the server, using the following header:

Range: 0-<maxBytes>

If the HTTP server does not support the Range header, the receiver shall close the connection after a maximum of maxBytes bytes have been transferred.

If for any reason the speed cannot be determined the program shall return a speed value of -1.

Range: 0- (i.e. no upper bound in the range request)

If this form of Range Request is used, then the reciever shall close the connection after a maximum of maxBytes bytes have been transferred.

13.10.9a.4 PromptForGuidance

Synopsis Allows the receiver to verify that content is acceptable for presentation.

Arguments PFG(restriction, result)

in/ out/ in-out	type	name	comment
input	GenericOctetString	restriction	This input parameter provides a string that can be presented to the user to indicate why verification is required
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	result	Indicates if the restricted content may be presented.

Description This resident program allows an application to confirm that an item of content can be presented to the viewer, based on the restriction advice provided. The method of confirming that the content may be presented is not defined but shall not cause the MHEG application to be terminated. As an example if the receiver implements a “parental control” PIN it could display a dialogue to indicate that the content is restricted, using the restriction string to indicate why it is restricted, and ask the viewer to enter the PIN to allow presentation. If the PIN is not provided then the resident program returns “false”. For a receiver that does not implement any parental control mechanism the resident program will always set the presentable return flag to “true”.

The restriction parameter contains a string that may be presented to the viewer. The string shall use the UTF-8 representation of character codes selected from the "Mandatory for SI" character set in Table F-1.", and shall not contain any of the non-printing characters described in 15.6.3 “Non-printing characters” or the carriage return character. Any unrecognised character codes in the string may be ignored and the string shall be limited to 50 characters.

13.10.9a.5 PersistentStorageInfo

Synopsis Returns the status of true persistent storage.

Arguments PST (enabled)

in/ out/ in-out	type	name	comment
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	enabled	True = enabled False = disabled

Description The resident program returns whether the user has enabled access to true persistent storage (see 16.7a, "True persistent storage").

13.10.9a.6 SetCookie

Synopsis Sets a cookie for use by the receiver when making HTTP requests.

Arguments SCk(identity, expiryDate, value, secure)

in/ out/ in-out	Type	name	comment
input	GenericOctetString	identity	The name of the cookie to write. The string is formatted in the form: name,domain/path
input	GenericInteger	expiry Date	The expiry date of the cookie, expressed as a Modified Julian date or zero if the cookie is transient.
input	GenericOctetString	value	The value to set for the cookie.
input	GenericBoolean	secure	Specifies the secure attribute (see 17.8.5, "Cookie support")

Description The resident program sets a cookie that may be used when making HTTP requests.

The identity parameter defines the name of the cookie and the domain and path for which it applies. For example, the identity

userid,serverdomain.com/mheg

creates a cookie named userid which is to be sent with requests to servers in the .serverdomain.com domain for resources within the /mheg directory.

13.10.9a.7 GetCookie

Synopsis

Retrieves a cookie set by the SetCookie resident program or previously received in an HTTP response.

Arguments

GCk(identity, found, expiryDate, value, secure)

in/ out/ in-out	Type	Name	Comment
input	GenericOctetString	identit y	The name of the cookie to read. The string is formatted in the form: name,domain/path
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	found	True if the requested cookie was found.
output	GenericInteger (shall provide an IndirectReference to an IntegerVariable)	expiry Date	The expiry date of the cookie, expressed as a Modified Julian date or zero if the cookie is transient
output	GenericOctetString (shall provide an IndirectReference to an OctetStringVariable)	value	The value of the cookie.
output	GenericBoolean (shall provide an IndirectReference to a BooleanVariable)	secur e	True if the secure attribute was specified (see 17.8.5, "Cookie support")

Description

The resident program reads a cookie set by the SetCookie resident program or previously received in an HTTP response.

The identity parameter defines the name of the cookie and the domain and path for which it applies. For example, the identity

userid,serverdomain.com/mheg

reads a cookie named userid which is to be sent with requests to servers in the .serverdomain.com domain for resources within the /mheg directory.

13.10.9a.8 GetPINSupport

Synopsis

Returns the PIN support in the receiver

Arguments

GPS(support)

in/ out/ in-out	type	name	comment
output	GenericInteger (shall provide an IndirectReference toa IntegerVariable)	support	Indicates the PIN support in the receiver -1 = PIN is not supported 0 = PIN is supported and disabled 1 = PIN is supported and enabled

Description

This resident program allows an MHEG application to determine whether a parental control mechanism using a PIN is supported in the receiver and whether it is currently enabled or not.

13.10.9b Hybrid file system

The resident programs defined in this section shall be implemented only in receivers that implement *InteractionChannelExtension*.

13.10.9b.1 SetHybridFileSystem

Synopsis: Defines or modifies the mappings used by the hybrid file system

Arguments: SHF(pathName, mappingList)

in/ out/ in-out	type	name	comment
input	GenericOctetString	pathName	This input parameter specifies a pathname which is to be mapped to a list of locations.
input	GenericOctetString	mappingList	This input parameter specifies a list of locations to which the pathname is to be mapped.

Description

This sets up a mapping from a pathname within the hybrid file space to a list of locations.

A pathname is composed of the following terms in sequence:

- Path Origin
- zero or more instances of a Path
- zero or one instances of a Filename

where those terms have the meanings defined in Table 18-2.

A location is composed of the following terms in sequence:

- Source
- Path Origin
- zero or more instances of a Path
- zero or one instances of a Filename

where those terms have the meanings defined in Table 18-2, save that the

Source shall be that of any file system available to the receiver other than the hybrid file system and persistent storage (including true persistent storage).

Considering the hybrid and other file systems as tree structures, each pathname or location shall therefore be a reference to a node of such a tree. A pathname or location shall end with "/" (0x2F) unless it refers to a terminal node (a file as opposed to a directory).

The mappingList argument shall consist of one or more locations; if there is more than one location, each shall be separated by a space character (0x20).

If the pathName argument ends with "/", each location within the mappingList argument shall end with "/", otherwise each location shall not end with "/".

The only permitted exceptions are as follows:

- If mappingList is an empty string (and pathName is not an empty string), the mapping for that pathName (if any) shall be removed. Receivers shall ignore any request to remove the default mapping in this way.
- If pathName is an empty string, all mappings shall be removed and the default mapping restored.

If the arguments to the resident program are not in accordance with the requirements stated above, the resident program shall not alter the mapping table.

If a mapping is made for a pathname for which there is an existing mapping, the new mapping shall replace the existing one. Note: the default mapping cannot be deleted but can be replaced by this mechanism.

Changes made to the state of the mapping table shall not affect any requests for content that are in progress. Requests for content made through the hybrid file system shall proceed according to the state of the mapping table at the time the request was made.

13.10.10 Developer utilities

13.10.10.1 WhoAmI

Synopsis Returns all engine identification strings recognised by the engine.

Arguments WAI(ident)

in/ out/ in-out	type	name	comment
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	Ident	This string contains a list of all identification strings recognised by the receiver, separated by spaces.

Description This resident program returns a list of the engine identification strings recognised by the receiver and which would generate a "true" response in the UEP(N) GetEngineSupport request (see Section 13.4.1 "GetEngineSupport 'feature' strings"). For example, a receiver might return the string "FEG001103 MHGFEG056 DSMFEG017".

13.10.10.2 Debug

Synopsis

Allows output of debug messages.
Support for this resident program is optional. If implemented, it provides a mechanism for application authors to obtain debug output. Exactly where the debug message appears will depend on the hardware configuration: a set top box may use a serial port, or a PC TV card may open a text window.

Arguments

DBG([argument] …)

in/ out/ in-out	type	name	comment
input	GenericBoolean or GenericInteger or GenericOctetString or GenericObjectReference or GenericContentReference	argument	The first of the optional list of arguments

Description

This resident program outputs a list of zero or more input arguments. The exact output representation for each variable-type is implementation dependent. Table 13-13 provides examples of suitable output.

type	output
GenericBoolean	False
GenericInteger	180999
GenericOctetString	it’s evolving
GenericObjectReference	(DSM://debug.mhg, 20)
GenericContentReference	/a/logo.png

Table 13-13. Example output representations

The debug output is not implicitly terminated by a newline, allowing a sequence of calls to concatenate output on the same line. If newlines and tabs are required in the output, these shall be passed to the Debug resident program using octet string arguments containing the hexadecimal values 0x0D and 0x09 respectively.

13.10.11 Access to application lifecycle signalling

13.10.11.1 GetBootInfo

Synopsis — Allows an application to access the value of the NB_info field at any time.

Arguments — GBI(infoResult, bootInfo)

in/ out/ in-out	type	name	comment
output	GenericBoolean (Shall provide an IndirectReference to a BooleanVariable)	infoResult	Set to true if a network_boot_info sub-descriptor is present in the data_broadcast_id descriptor on the component from which the initial carousel was mounted. Otherwise false is returned
output	GenericOctetString (Shall provide an IndirectReference to an OctetStringVariable)	bootInfo	Return value is NB_Info field if found. An empty string is returned if infoResult is false.

Description — The resident program returns a GenericBoolean in the infoResult output variable indicating whether or not a network_boot_info sub-descriptor has been found and received; if it has, the bootInfo output variable shall be set to the value of the NB_info field of the network_boot_info sub-descriptor (see Section 17.4.2.1 "data_broadcast_id_descriptor").

13.10.12 Data exchange with ResidentPrograms

This section is intended to clarify the behaviour of information passed between MHEG-5 applications and resident programs.

Memory spaces

There are two distinct memory spaces to consider:

- MHEG-5 application memory
- Procedural code memory

On invocation

When a ResidentProgram is invoked (with Call or Fork) the behaviour is as if a snap shot of the input and in-out parameters were passed from the application memory space to the memory space of the procedural code.

CallSucceeded/ForkSucceeded Values

In section 14.4 of ISO/IEC 13522-5 it states that the value of the BooleanVariable CallSucceeded / ForkSucceeded is set to false if the Program "finishes abnormally".

CallSucceeded and ForkSucceeded shall return false only if the ResidentProgram could not be called, for example if the parameters were of the incorrect type or the Program did not exist. In all other cases, the call is deemed to have succeeded even if, for example, the input parameters are formatted with incorrect values such as null strings or negative integers.

During execution

While the procedural code executes there is no connection between its memory space and that of the MHEG-5 application.
In principle the MHEG-5 application could modify variables passed by reference to the procedural code with no effect on the procedural code's version. However, this is probably not a useful thing to do.

On completion

If the procedural code completes normally then its results (any in-out, output parameters and the succeeded parameter) are transferred back to the MHEG-5 application memory. The timing here is significant; from the MHEG-5 application's point of view all of the results of the ResidentProgram are delivered atomically between the processing of asynchronous events.

Note: The processing of an asynchronous event includes the processing of all consequent synchronous events. The behaviour is as if an Action object with a series of SetVariable actions is performed.

13.10.13 Duration of effect of ResidentPrograms

Except for receivers implementing *InteractionChannelExtension* the following clause applies:
Certain ResidentPrograms affect the state of the receiver. In all cases the scope of such state changes is that of the running MHEG-5 Application. Default state shall be restored whenever an Application terminates or a new Application starts (see Section 16.2.2 "Launching and terminating MHEG-5 applications"). The state shall be reset before any links in the new Application can fire.

Receivers that implement *InteractionChannelExtension* vary the above clause solely for the state of the hybrid mapping table (see Section 17.13 "Hybrid file system"). This persists until the auto-boot process begins (see Section17.4.4.2 "Locating the initial object") such that Applications inherit the state of the mapping table from previously running Applications. When an Application is spawned, the state of the hybrid mapping table is saved; when a spawned Application quits, the state of the hybrid mapping table is restored before the previous Application is restarted.

13.11 Limitations on standard data-types

BooleanVariable

The BooleanVariable size is undefined as the implementation of its representation is not significant provided that all possible Boolean values can be represented. However, when modelling storage (e.g. when written to persistent storage) Booleans occupy 1 byte.

type of value	size	min. value	max. value
true or false	Unspecified	n/a	n/a

IntegerVariable

type of value	size	min. value	max. value
signed integer	32 bits	-2147483648	2147483647

OctetString

The OctetString data type is restricted to be not longer than 2147483647 octets long, thus the only practical restriction is that of available memory (see Section 16.8 "Receiver resource model").

A null OctetString value shall be encoded as "".

ObjectNumber

The ObjectNumber data type is restricted in the following way:

type of value	size	min. value	max. value
signed integer	32 bits	0[a]	2147483647

a] 0 for Group objects and 1 for Ingredient objects

GroupIdentifier & ContentReference

GroupIdentifiers shall be at least 1 byte in length. ContentReferences may be 0 bytes length. In both cases the maximum length has the same restrictions as an OctetString.

See Section 18.3.2 "Mapping rules for GroupIdentifier and ContentReference".

13.12 Extensions to the MHEG-5 language specification

13.12.1 Preamble

This profile specifies a number of changes to the MHEG-5 language that must be supported by receivers. The changes have been made to improve the performance of the language, whilst maintaining compatibility with the original specification.

Where there is a definition of ASN.1 notation, this shall be used in conjunction with Annex A of the language specification.

13.12.2 Changes to the Group class

Timer functionality has been moved to the Group class from the Scene class.

13.12.2.1 Changes to "Own internal attributes"

The following internal attribute is added:

The internal attribute Timers (as defined in the Scene class of ISO/IEC 13522-5) is added. All references in the text to Scene shall be replaced by Group.

13.12.2.2 Changes to "Events"

The following event is added:

TimerFired

This event is generated when a timer has fired.

- Associated data: TimerIdentifier - Integer.

13.12.2.3 Changes to "Effect of MHEG-5 actions"

The following actions are added:

SetTimer(TimerId, TimerValue, AbsoluteTime)

The SetTimer action (as defined in the Scene class of ISO/IEC 13522-5) is added. All references in the text to Scene shall be replaced by Group. The text form of the syntax description shall be modified as follows:

Text form

```
SetTimer ::= ":SetTimer" "(" Target TimerID [NewTimer] ")".
NewTimer ::= TimerValue [AbsoluteTime].
```

13.12.3 Changes to the Application class

13.12.3.1 Changes to "Own exchanged attributes"

The following changes are made:

BackgroundColour	The BackgroundColour attribute is renamed to OriginalBackgroundColour.
TextColour	The TextColour attribute is renamed to OriginalTextColour.
FontAttributes	The FontAttributes attribute is renamed to OriginalFontAttributes.

Note: the above changes have no impact on the textual notation and the ASN.1 tags.

OriginalDesktopColour

Colour to be used for the Desktop (i.e. the bottom of the display stack).

- Optional Integer or OctetString. An Integer will be interpreted as an index in a Palette; an OctetString will be interpreted as a direct colour value.
- Default value: Opaque black.

ASN.1 form

```
A.3 Application Class

ApplicationClass ::= SET
{
  COMPONENTS OF GroupClass,
  on-spawn-close-down [35] ActionClass OPTIONAL,
  on-restart [36] ActionClass OPTIONAL,
  default-attributes [37] SEQUENCE SIZE (1..MAX) OF DefaultAttribute
OPTIONAL,
  original-desktop-colour [249] Colour OPTIONAL
}
```

Text form

```
ApplicationClass ::= "{:Application" Group [OnSpawnCloseDown]
[OnRestart] [DefaultAttributes] [OriginalDesktopColour] "}".
OriginalDesktopColour ::= ":OrigDesktopColour" Colour.
```

13.12.3.1a Changes to "Own internal attributes"

DesktopColour

Colour to be used for the Desktop (i.e. the bottom of the display stack).

- Integer or OctetString value. An Integer will be interpreted as an index in a Palette; an OctetString will be interpreted as a direct colour value.
- Initial value: Value of the OriginalDesktopColour attribute.

13.12.3.2 Changes to "Effect of MHEG-5 actions"

The wording of the :Launch and :Quit elementary actions of the Application class appear to render the :OnCloseDown attribute useless. The wording is modified so as to resolve this problem and bring the behaviour for the Application class in line with that of the Scene class and its :TransitionTo elementary action.

Launch

Steps 1 and 2 of the sequence of actions are modified to read:

1. Apply the *Deactivation* and *Destruction* behaviours of the currently active Scene object, if any.
2. Apply the *Deactivation* and *Destruction* behaviours of the currently active Application object, if any.

Quit

Steps 1 and 2 of the sequence of actions are modified to read:

1. Apply the *Deactivation* and *Destruction* behaviours of the currently active Scene object, if any.
2. Apply the *Deactivation* and *Destruction* behaviours of the target Application object.

SetDesktopColour(NewDesktopColour)

Set the DesktopColour attribute of the target Application object.

ASN.1 form

```
set-desktop-colour [250] SetDesktopColour
SetDesktopColour ::= SEQUENCE
{
  Target GenericObjectReference
  New-desktop-colour NewColour
}
```

Text form

```
":SetDesktopColour" "(" Target NewColour ")"
```

13.12.4 Changes to the Scene class

To support the concept of a Scene with no aspect ratio, the AspectRatio attribute is made optional.

Timer functionality has been moved to the Group class.

13.12.4.1 Changes to "Own exchanged attributes"

The following exchanged attribute is changed:

AspectRatio

Original aspect ratio of the Scene. This attribute is expressed by a width / height ratio.

- Optional rational number.
- If no AspectRatio is specified, the Scene has no aspect ratio.

ASN.1 form

```
A.4 Scene Class

SceneClass ::= SET
{
  COMPONENTS OF GroupClass,
  input-event-register [51] INTEGER,
  scene-coordinate-system [52] SceneCoordinateSystem,
  aspect-ratio [53] AspectRatio OPTIONAL,
  moving-cursor [54] BOOLEAN DEFAULT FALSE,
  next-scenes [55] SEQUENCE SIZE (1..MAX) OF NextScene OPTIONAL
```

```
}
```

13.12.4.2 Changes to “Own internal attributes”

The following internal attribute is removed:

Timers — The internal attribute Timers is removed from the Scene class.

13.12.4.3 Changes to “Events”

The TimerFired event is removed.

13.12.4.4 Changes to “Effect of MHEG-5 actions”

The following action is removed:

SetTimer(TimerId, TimerValue, AbsoluteTime)

The SetTimer action is removed from the Scene class.

The following action is added:

SetInputRegister(NewInputRegister)

Change the InputEventRegister attribute of the target Scene object. Changing the register will affect how subsequent key presses are handled by the Scene. Note that key events generated before the ElementaryAction are unchanged.

Provisions of use:

- The target object shall be an available Scene object

ASN.1 form

```
set-input-register [239] SetInputRegister

SetInputRegister ::= SEQUENCE
{
   target GenericObjectReference,
   new-input-register GenericInteger
}
```

Text form

```
":SetInputReg" "(" Target GenericInteger ")" .
```

13.12.5 Changes to the TokenGroup class

13.12.5.1 Changes to "Effect of MHEG-5 actions"

CallActionSlot(Index) The second provision of use is changed to read:
Index shall be set in the range [1, number of ActionSlots associated with the item that currently has the token].

13.12.6 Changes to the ListGroup class

13.12.6.1 Changes to "Own exchanged attributes"

The ListGroup class exchanged attribute Positions is renamed to OriginalPositions. The ASN.1 value and text representation remains the same.

13.12.6.2 Changes to "Own internal attributes"

The ListGroup class is extended with a new Internal Attribute Positions. The default value for this is that of attribute OriginalPositions.

13.12.6.3 Changes to "Effect of MHEG-5 actions"

The following action is added:

SetCellPosition(CellIndex, NewXPosition, NewYPosition)

Change the display position of a ListGroup object display cell. A cell is identified by its (one based) index. The Positions attribute for this cell is changed and the object is redrawn. If the CellIndex specifies an index smaller than or equal to 1 then the position of the first cell is changed. If the CellIndex specifies an index greater than or equal to the number of cells then the position of the last cell is changed.

Provisions of use:

- The target object shall be an available ListGroup object

ASN.1 form

```
set-cell-position [238] SetCellPosition

SetCellPosition ::= SEQUENCE
{
   target GenericObjectReference,
   index GenericInteger,
   new-x-position GenericInteger,
   new-y-position GenericInteger
}
```

Text form

```
":SetCellPosition" "(" Target Index XPosition YPosition ")" .
```

13.12.7 Changes to the Bitmap class

13.12.7.1 Changes to "Own internal attributes"

The following internal attribute is added:

BitmapDecodeOffset

Position of the top left corner of the decoded and scaled bitmap with respect to the top left corner of the Bitmap object.

- Pair of Integers (XOffset, YOffset).
- Initial value: (0,0).

BitmapScale

Value of the bitmap scaling in pixels to be used when presenting the Bitmap object.

- Pair of Integers (XBitmapScale, YBitmapScale).
- Initial value: this part of ISO/IEC 13522 does not define the initial values for the BitmapScale attribute; these values may be specified in the application domain.

13.12.7.2 Changes to "Effect of MHEG-5 actions"

The following actions are added:

SetBitmapDecodeOffset(NewXOffset,NewYOffset)

Change the location of the decoded and scaled bitmap with respect to the target Bitmap object. The offset parameters may be negative.

Execute the following sequence of actions:

1. Set the BitmapDecodeOffset attribute according to NewXOffset and NewYOffset.

2. If the Bitmap object is active, redraw the graphic widget representing the object on the screen in the bounding box defined by the BoxSize and Position attributes and according to its position in the DisplayStack of the active Application object.

Provisions of use:

- The Target object shall be an available Bitmap object.
- NewXOffset and NewYOffset shall correspond to an offset interpreted in the Scene coordinate system defined by the SceneCoordinateSystem attribute of the currently active Scene.

ASN.1 form

```
set-bitmap-decode-offset [246] SetBitmapDecodeOffset
SetBitmapDecodeOffset ::= SEQUENCE
{
  target GenericObjectReference,
  new-x-offset GenericInteger,
  new-y-offset GenericInteger
}
```

Text form

```
":SetBitmapDecodeOffset" "(" Target NewXOffset NewYOffset ")" .
NewXOffset::= GenericInteger .
NewYOffset::= GenericInteger .
```

Examples

See examples under SetVideoDecodeOffset in Section 13.12.10 "Changes to the Video class".

GetBitmapDecodeOffset(XOffsetVar,YOffsetVar)

Return the location of the decoded and scaled bitmap with respect to the target Bitmap object. The offset values may be negative.

Set the Variables referenced by XPositionVar and YPositionVar to the value of the X and Y decode offset of the target Bitmap object respectively.

Provisions of use:

- The Target object shall be an available Bitmap object.
- XOffsetVar and YOffsetVar shall refer to active IntegerVariable objects.

ASN.1 form

```
get-bitmap-decode-offset [247] GetBitmapDecodeOffset
GetBitmapDecodeOffset ::= SEQUENCE
{
  target GenericObjectReference,
  x-offset-var ObjectReference,
  y-offset-var ObjectReference
}
```

Text form

```
":GetBitmapDecodeOffset" "(" Target XOffsetVar YOffsetVar ")" .
XOffsetVar::= ObjectReference .
YOffsetVar::= ObjectReference .
```

The following action is changed to the following description to replace that in clause 39.4:

ScaleBitmap(NewXScale, NewYScale)

If the MHEG-5 engine implements the Scaling option, the effect of this action is described below. Engines that do not support the Scaling option shall ignore this action.

Note that this action does not affect the BoxSize internal attribute of the Bitmap object; in other words, the Bitmap is scaled, but its bounding box remains the same.

Execute the following sequence of actions:

1. Set the BitmapScale attribute according to the values of NewXScale and NewYScale.
2. Adapt the rendering of the Bitmap so that it fits to the XBitmapScale and YBitmapScale dimensions. The XBitmapScale and YBitmapScale attributes represent the final dimensions of the Bitmap in pixel numbers. Thus, the graphical representation of the Bitmap may not keep its original aspect ratio.

Provisions of use:

- The Target object shall be an available Bitmap object.
- NewXScale and NewYScale shall be positive Integers.

13.12.8 Changes to the Text class

13.12.8.1 Changes to "Own exchanged attributes"

The following changes are made:

FontAttributes

The FontAttributes attribute is renamed to OriginalFontAttributes.
Change the first sentence of the description to "This attribute is used to set initial specific Font attributes such as style, character size, text colour and background colour".

Change all references to FontAttributes in the description to OriginalFontAttributes.

TextColour

The TextColour attribute is renamed to OriginalTextColour.
Change the first sentence of the description to "Indicate which colour should initially be used…"

BackgroundColour

The BackgroundColour attribute is renamed to OriginalBackgroundColour.
Change the first sentence of the description to "Indicate which colour should initially be used…"

Note The above changes have no impact on the textual notation and the ASN.1 tags.

13.12.8.2 Changes to "Own internal attributes"

The following internal attributes are added:

TextColour

Colour to use for the text characters when representing the Text object. This attribute is interpreted as a zero-based index in the look-up table defined in the PaletteRef attribute or as a direct colour value, depending on the attribute type.

- Integer or OctetString. An Integer will be interpreted as an index in a Palette; an OctetString will be interpreted as a direct colour value.

Initial value: OriginalTextColour.

BackgroundColour

Colour to use for the background area when representing the Text object. This attribute is interpreted as a zero-based index in the look-up table defined in the PaletteRef attribute or as a direct colour value, depending on the attribute type.

- Integer or OctetString. An Integer will be interpreted as an index in a Palette; an OctetString will be interpreted as a direct colour value.
- Initial value: OriginalBackgroundColour.

FontAttributes

This attribute is used to set the specific Font attributes such as style, character size, text colour and background colour.
The exact encoding format of the FontAttribute attribute is related to the value of the type of Font object mentioned by the Font attribute.

- OctetString.
- Initial value: OriginalFontAttributes

13.12.8.3 Changes to "Effect of MHEG-5 actions"

The following actions are added:

SetBackgroundColour(NewBackgroundColour)

Change the BackgroundColour attribute of the target Text (or derived class) object to NewBackgroundColour. The object is redrawn.

Provisions of use:

- The target object shall be an available Text object.

ASN.1 form

```
set-background-colour [237] SetBackgroundColour

SetBackgroundColour ::= SEQUENCE
{
   target GenericObjectReference,
   new-background-colour NewColour
}
```

Text form

```
":SetBackgroundColour" "(" Target NewColour ")" .
```

SetTextColour(NewTextColour)

Change the TextColour attribute of the target Text (or derived class) object to NewTextColour. The object is redrawn.

Provisions of use:

- The target object shall be an available Text object.

ASN.1 form

```
set-text-colour [240] SetTextColour

SetTextColour ::= SEQUENCE
{
   target GenericObjectReference,
   new-text-colour NewColour
}
```

Text form

```
":SetTextColour" "(" Target NewColour ")" .
```

SetFontAttributes(NewFontAttributes)

Change the FontAttributes attribute of the target Text (or derived class) object to NewFontAttributes. The object is redrawn.

Provisions of use:

- The target object shall be an available Text object.

ASN.1 form

```
set-font-attributes [241] SetFontAttributes

SetFontAttributes ::= SEQUENCE
{
   target GenericObjectReference,
   new-font-attribute GenericOctetString
}
```

Text form

```
":SetFontAttributes" "(" Target GenericOctetString ")" .
```

13.12.9 Changes to the Stream class

To support Stream objects as a source of events without Video, Audio or RTGraphics objects the multiplex component is made optional.

13.12.9.1 Changes to "Own exchanged attributes"

The following exchanged attribute is changed:

Multiplex

Change the bulleted list to read:

- Optional attribute
- Sequence of inclusions of Video, Audio and RTGraphics objects…

ASN.1 form

A.30 Stream Class

```
StreamClass ::= SET
{
   COMPONENTS OF PresentableClass
    (WITH COMPONENTS {…, original-content PRESENT}),
   multiplex [92] SEQUENCE SIZE(1..MAX) OF StreamComponent OPTIONAL,
   storage [93] Storage DEFAULT stream,
   looping [94] INTEGER {infinity(0)} DEFAULT 1
}
```

Text Form

```
StreamClass ::= "{:Stream" Presentable [Multiplex][Storage][Looping]
"}" .
```

13.12.9.1a Changes to "Own internal attributes"

The following internal attribute is added:

CounterMaxPosition

Position of the last frame of the Stream.

This attribute is expressed in StreamCounterUnits

- Integer
- Initial value: -1, meaning EndOfStream.

13.12.9.1b Changes to "Internal behaviours"

The following internal behaviour is changed:

ContentPreparation

[Existing behaviour]

6. Attempt to set the CounterMaxPosition internal attribute to the position of the last frame of the Stream, expressed in StreamCounterUnits.

13.12.9.2 Changes to "Effect of MHEG-5 actions"

The following actions are added:

GetCounterPosition(CounterPositionVar)

Get the current position within a stream.

Execute the following sequence of actions:

1. Set the value of CounterPositionVar to the value of the CounterPosition attribute of the target Stream.

Provisions of use:

- The Target object shall be an available Stream object
- CounterPositionVar shall refer to an active IntegerVariable object

ASN.1 form

```
get-counter-position [251] GetCounterPosition
GetCounterPosition ::= SEQUENCE
{
 target GenericObjectReference,
 counter-position-var ObjectReference
}
```

Text Form

```
":GetCounterPosition" "(" Target CounterPositionVar ")"
CounterPositionVar ::= ObjectReference
```

GetCounterMaxPosition(CounterMaxPositionVar)

Gets the total size of a stream.

Execute the following sequence of actions:

1. Set the value of CounterMaxPositionVar to the value of the CounterMaxPosition attribute of the target Stream.

Provisions of use:

- The Target object shall be an available Stream object
- CounterMaxPositionVar shall refer to an active IntegerVariable object

ASN.1 form

```
get-counter-max-position [252] GetCounterMaxPosition
GetCounterMaxPosition ::= SEQUENCE
{
 target GenericObjectReference,
 counter-position-var ObjectReference
}
```

Text Form

```
":GetCounterMaxPosition" "(" Target CounterPositionVar ")"
CounterPositionVar ::= ObjectReference
```

13.12.10 Changes to the Video class

13.12.10.1 Changes to "Own internal attributes"

The following internal attribute is added:

VideoDecodeOffset

Position of the top left corner of the decoded and scaled video with respect to the top left corner of the Video object.

- Pair of Integers (XOffset, YOffset).
- Initial value: (0,0).

VideoScale

Value of the video scaling in pixels to be used when presenting the Video object.

- Pair of Integers (XVideoScale, YVideoScale).

- Initial value: this part of ISO/IEC 13522 does not define the initial values for the VideoScale attribute; these values may be specified in the application domain.

13.12.10.2 Changes to "Effect of MHEG-5 actions"

The following actions are added:

SetVideoDecodeOffset(NewXOffset, NewYOffset)

Change the location of the decoded and scaled video with respect to the target Video object. The offset parameters may be negative.

Execute the following sequence of actions:

1. Set the VideoDecodeOffset attribute according to NewXOffset and NewYOffset.

2. If the Video object is active, redraw the graphic widget representing the object on the screen in the bounding box defined by the BoxSize and Position attributes and according to its position in the DisplayStack of the active Application object.

Provisions of use:

- The Target object shall be an available Video object.
- NewXOffset and NewYOffset shall correspond to an offset interpreted in the Scene coordinate system defined by the SceneCoordinateSystem attribute of the currently active Scene.

ASN.1 form

```
set-video-decode-offset [242] SetVideoDecodeOffset
SetVideoDecodeOffset ::= SEQUENCE
{
  target GenericObjectReference,
  new-x-offset GenericInteger,
  new-y-offset GenericInteger
}
```

Text form

```
":SetVideoDecodeOffset" "(" Target NewXOffset NewYOffset ")" .
NewXOffset::= GenericInteger .
NewYOffset::= GenericInteger .
```

Example 1

Quarter-screen video with masking to prevent display of pixels normally hidden at fullscreen size due to overscan.

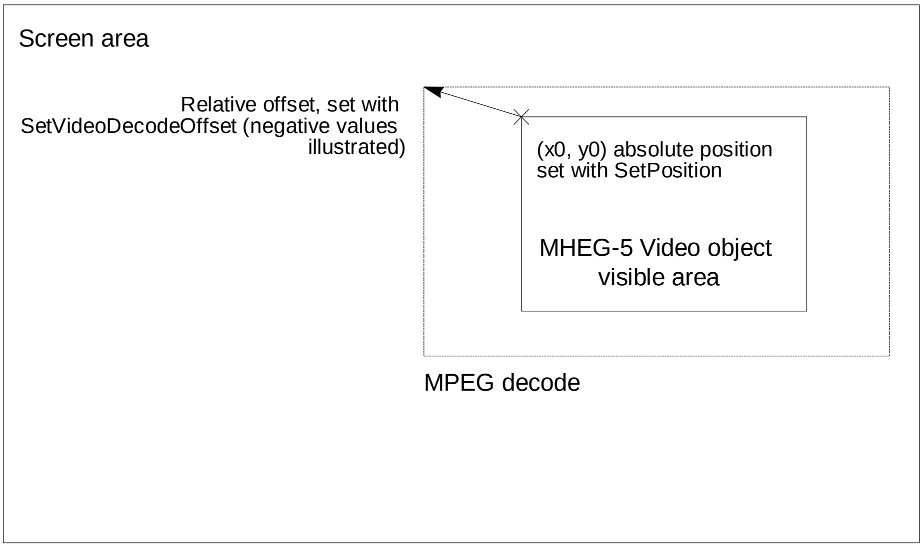


Figure 13-2.

Example code:

```
:SetBoxSize (10 0 0)
:ScaleVideo (10 360 288)
:SetVideoDecodeOffset (10 -8 -2)
:SetPosition (10 368 102)
:SetBoxSize (10 344 284
```

Example 2

Full-screen video with masking to display one quarter of the image. This allows a quarterscreen presentation of four separate pictures under application control.

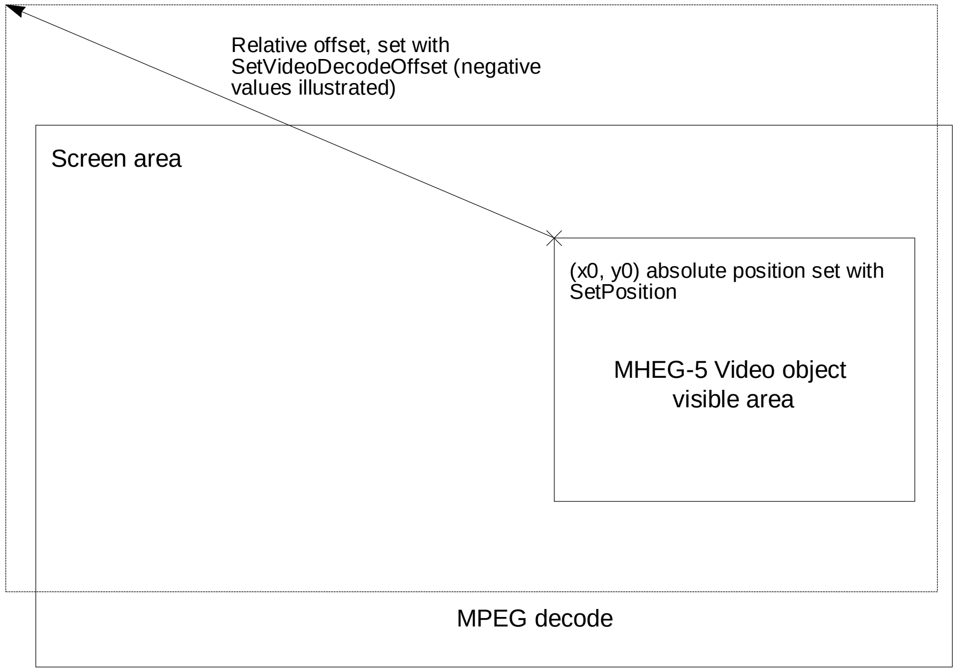


Figure 13-3.

Example code:

```
:SetBoxSize (10 344 284)
:SetPosition (10 360 100)
:SetVideoDecodeOffset (10 -368 -290)
```

Example 3 Double size video masked to show a quarter of the video image full-screen.

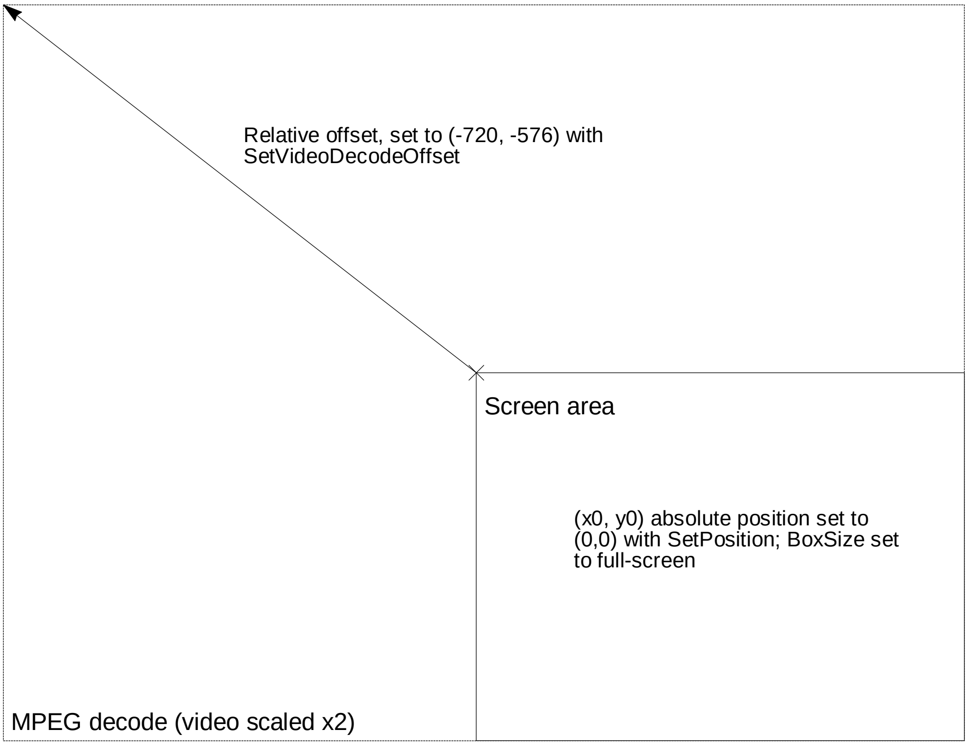


Figure 13-4.

Example code:

```
:SetBoxSize (10 0 0)
:ScaleVideo (10 1440 1152)
:SetVideoDecodeOffset (10 -720 -576)
:SetPosition (10 0 0)
:SetBoxSize (10 720 576)
```

GetVideoDecodeOffset(XOffsetVar,YOffsetVar)

Returns the location of the decoded and scaled video with respect to the target Video object. The offset values may be negative.

Set the Variables referenced by XPositionVar and YPositionVar to the value of the X and Y decode offset of the target Video object respectively.

Provisions of use:

- The Target object shall be an available Video object.
- XOffsetVar and YOffsetVar shall refer to active IntegerVariable objects.

ASN.1 form

```
get-video-decode-offset [243] GetVideoDecodeOffset
GetVideoDecodeOffset ::= SEQUENCE
{
  target GenericObjectReference,
  x-offset-var ObjectReference,
  y-offset-var ObjectReference
}
```

Text form

```
":GetVideoDecodeOffset" "(" Target XOffsetVar YOffsetVar ")" .
XOffsetVar::= ObjectReference .
YOffsetVar::= ObjectReference .
```

The following action is changed to the following description to replace that in clause 39.4:

ScaleVideo (NewXScale, NewYScale)

If the MHEG-5 engine implements the Scaling option, the effect of this action is described below. Engines that do not support the Scaling option shall ignore this action.

Note that this action does not affect the BoxSize internal attribute of the Video object.

Execute the following sequence of actions:

1. Set the VideoScale attribute according to the values of NewXScale and NewYScale.
2. Adapt the rendering of the Video so that it fits to the XVideoScale and YVideoScale dimensions. The XVideoScale and YVideoScale attributes represent the final dimensions of the Video in pixel numbers. Thus, the graphical representation of the Video may not keep its original aspect ratio.

Provisions of use:

- The Target object shall be an available Video object
- NewXScale and NewYScale shall be positive Integers

13.12.11 Changes to the Slider class

13.12.11.1 Changes to "Own exchanged attributes"

The following changes are made:

MinValue	The MinValue exchanged attribute is renamed OriginalMinValue.
MaxValue	The MaxValue exchanged attribute is renamed OriginalMaxValue.
StepSize	The StepSize exchanged attribute is renamed OriginalStepSize.

Note: the above changes have no impact on the textual notation and the ASN.1 tags.

13.12.11.2 Changes to "Own internal attributes"

The following internal attributes are added:

MinValue

Lowest value that the SliderValue attribute may be set to.

- Integer value
- Initial value: Value of the OriginalMinValue attribute.

MaxValue

Greatest value that the SliderValue attribute may be set to.

- Integer value
- Initial value: Value of the OriginalMaxValue attribute.

StepSize

The smallest value by which the value of the SliderValue internal attribute may be increased or decreased.

- Integer value
- Initial value: Value of the OriginalStepSize attribute.

13.12.11.3 Changes to "Events"

The following event is added:

SliderValueChanged

This event is generated when the SliderValue attribute of the Slider changes due to user interaction, or if any of the Step, SetSliderValue, SetPortion or SetSliderParameters actions are invoked.

- Associated data: SliderValueTag - Integer. The value of the associated data shall be set to the SliderValue attribute.
- Event type: Asynchronous

ASN.1 form

Add the following to the EventType enumeration in section A.6 before the final closing brace:

```
slider-value-changed(33)
```

Text form

Add the following to the EventTypeEnum in section B.4.6 before the final full stop:

```
|"SliderValueChanged"
```

13.12.11.4 Changes to "Internal behaviour"

The following internal behaviour is changed:

Interaction

Execute the following sequence of actions:

1. Apply the Interaction behaviour as defined in the Interactible class.
2. Allow the user to interact with the Slider object by moving the marker along the main axis. Exactly how this user interaction takes place is not specified by this part of ISO/IEC 13522-5 [40]. However, the smallest marker displacement shall be proportional to the value of the StepSize attribute. Each time the marker is moved,

   a) set the SliderValue attribute to a value that corresponds to the new marker position,

   and

   b) generate a SliderValueChanged event.
3. When interaction has completed, either because the user terminates the interaction or because the application terminates it using the SetInteractionStatus action,

   a) set the InteractionStatus attribute to False, and

   b) generate an InteractionCompleted event.

13.12.11.5 Changes to "Effect of MHEG-5 actions"

The following actions are changed:

Step

Change point 4 of the sequence of actions to read:
4. Generate a SliderValueChanged event.

SetSliderValue

Change point 3 of the sequence of actions to read:
3. Generate a SliderValueChanged event.

SetPortion

Change point 3 of the sequence of actions to read:
3. Generate a SliderValueChanged event.

The following action is added:

SetSliderParameters(NewMinValue,NewMaxValue,NewStepSize)

Change the Slider's lowest and greatest values, and the smallest value by which the value of the SliderValue attribute may be increased or decreased.

Execute the following sequence of actions:

1. Set the MinValue, MaxValue and StepSize attributes according to NewMinValue, NewMaxValue and NewStepSize respectively.
2. Set the SliderValue attribute to MinValue.
3. If the Slider is active, redraw the Slider taking into account the new values, and according to its position in the DisplayStack of the active Application object.
4. Generate a SliderValueChanged event.

Provisions of use:

- the Target shall be an available Slider object
- NewMinValue, NewMaxValue, NewStepSize shall conform to the following criteria:

  NewMinValue < NewMaxValue

  N × NewStepSize = (NewMaxValue - NewMinValue), where N is some positive
  integer

  NewMaxValue - NewMinValue >= Portion

ASN.1 form

```
set-slider-parameters [248] SetSliderParameters
SetSliderParameters ::= SEQUENCE
{
  target GenericObjectReference,
  new-min-value GenericInteger,
  new-max-value GenericInteger,
  new-step-size GenericInteger
}
```

Text form

```
":SetSliderParameters" "(" Target NewMinValue NewMaxValue
NewStepSize ")" .
NewMinValue ::= GenericInteger .
NewMaxValue ::= GenericInteger .
NewStepSize ::= GenericInteger .
```

13.12.12 Changes to the HyperText class

13.12.12.1 Changes to "Own internal attributes"

The following internal attribute is added:

FocusPosition	Index of the currently highlighted anchor where an index of 1 represents the first anchor in the content. A value of 0 means that there is no anchor to highlight. When content with at least 1 anchor is available this attribute will be in the range [1,N] where N is the number of anchors in the content. In all other situations (content is not available or there are no anchors within the content) this attribute will have the value 0. • Integer • Initial value: 0 (no anchor to highlight).

13.12.12.2 Changes to "Events"

The following event is added:

FocusMoved	Signals that the value of the FocusPosition attribute has been updated. This event will be generated when either the user moves the anchor highlight, or the SetFocusPosition ElementaryAction is invoked. • Associated data: the new value of FocusPosition - Integer. • Event type: Asynchronous.
ASN.1 form	Add the following to the EventType enumeration in section A.6 before the final closing brace: `focus-moved(32)`
Text form	Add the following to the EventTypeEnum in section B.4.6 before the final full stop: `|"FocusMoved"`

13.12.12.3 Changes to "Internal behaviours"

Interaction step 2

The following text replaces the definition of the HyperText Interaction behaviour step 2 in ISO/IEC 13522-5:
"Allow the user to move the focus through the set of anchors in the Hypertext object and to select the focused anchor. Each time the focus moves a FocusMoved event is generated."

Each time an anchor is selected an AnchorFired event is generated.

ContentPreparation

The ContentPreparation internal behaviour semantics have changed from this object's base class as follows:
Apply steps 1 to 3 of the ContentPreparation behaviour of the base class *synchronously*.

The following steps are *asynchronous* and occur when the content of the object has been fully retrieved:

Apply steps 4 and 5 of the ContentPreparation behaviour of the base class.

6. If there are no anchors then set the FocusPosition internal attribute to zero otherwise set it to one. If the FocusPosition internal attribute changes then generate a FocusMoved event.

7. Generate a ContentAvailable event.

13.12.12.4 Changes to "Effect of MHEG-5 actions"

The following actions are added:

GetFocusPosition(FocusPositionVar)

Set the variable referenced by FocusPositionVar to the value of the FocusPosition attribute.

Provisions of use:

- The target object shall be an available HyperText object.
- FocusPositionVar shall refer to an active IntegerVariable object.

ASN.1 form

```
get-focus-position[244] GetFocusPosition
GetFocusPosition ::= SEQUENCE
{
  target GenericObjectReference,
  focus-position-var ObjectReference
}
```

Text form

```
GetFocusPosition  := ":GetFocusPosition" "(" Target FocusPositionVar
")" .
FocusPositionVar ::= ObjectReference .
```

SetFocusPosition(NewFocusPosition)

Set the FocusPosition attribute to the value of NewFocusPosition. This change is to be reflected in the visual representation of the object. If NewFocusPosition is greater than N, where N is the number of anchors available in the content for the target object then it shall be treated as N.

A FocusMoved event will be generated if the value of the FocusPosition is altered by this elementary action.

Provisions of use:

- The target object shall be an available HyperText object

ASN.1 form

```
set-focus-position[245] SetFocusPosition

SetFocusPosition ::= SEQUENCE
{
 target GenericObjectReference,
 new-focus-position GenericInteger
}
```

Text form

```
SetFocusPosition ::= ":SetFocusPosition" "(" Target NewFocusPosition
")" .
NewFocusPosition ::= GenericInteger .
```

13.12.13 Changes to the LineArt class

To remove the inconsistency in the requirements of OriginalLineWidth and NewLineWidth, zero values are to be permitted in both cases.

13.12.13.1 Changes to "Own exchanged attributes"

The following exchanged attribute is changed:

OriginalLineWidth

The second paragraph of definition for this attribute is modified to read:
The OriginalLineWidth attribute is expressed in pixels in the scene coordinate space. It is specified in pixel height for horizontal lines and in pixel width for vertical lines. It shall not be negative.

13.12.13.2 Changes to "Effect of MHEG-5 actions"

The following action is changed:

SetLineWidth(NewLineWidth)

The second provision of use is modified to read:

NewLineWidth shall be set or refer to a non-negative integer value.

13.13 Clarifications, restrictions and amendments

13.13.1 Additional semantics for the SetTimer action

If the TimerValue attribute of the SetTimer action is negative then the engine shall ignore the action regardless of the setting of the AbsoluteTime flag.

Note: the ISO corrigenda [41] contains the following text which shall **also** be observed:

"*If the time indicated in TimerValue has already passed and the AbsoluteTime is set to True, the TimerFired event shall not be raised.*"

13.13.2 CounterPosition attribute

In this specification there is no support for managing NPT so there is no mapping between the MHEG-5 internal attribute CounterPosition of the Stream class and NPT.

In the case where the Stream class references a broadcast stream, the Stream class CounterPosition attribute will always remain in an undefined state, and any MHEG-5 actions which depend on this attribute (i.e. Stream class SetCounterTrigger, SetCounterPosition, GetCounterPosition, SetCounterEndPosition and GetCounterMaxPosition) shall be ignored. The associated internal attributes CounterEndPosition, CounterMaxPosition and CounterTriggers are also undefined.

In the case where the Stream class references a stream obtained from the IP connection the CounterPosition shall indicate an offset in the stream playback in units of 188 bytes. Where the CounterPosition represents an offset greater than the size of the stream content it shall indicate the end of stream. Note that the CounterMaxPosition attribute has a value of -1 until the size of the stream can be determined. For broadcast streams and IP-delivered streams that do not terminate, the value will remain equal to -1.

For IP-delivered streams the size of the stream should be calculated from the Content-Length header provided by a server. If a Content-Range header is present, this should be used in preference to the Content-Length header so that CounterMaxPosition will represent the size of the stream rather than the amount of data transferred over HTTP.

13.13.3 Synchronous event processing

The behaviour of MHEG-5 Engines while processing synchronous events has been the source of some confusion in the past, with many engine implementations differing in how multiple synchronous events are handled in large elementary actions. e.g. Launch, Spawn etc. Two interpretations of ISO/IEC 13522-5 are allowed in this profile to cater for the ambiguity. Each interpretation is described below as pseudo-code for the engine's event processing loop, and for the 'Send Event' primitive as it appears in the Elementary Actions in ISO/IEC 13522-5. Implementations need not use the example code and data structures below, but shall behave as if they do. Engine implementations may use either interpretation but shall not introduce new interpretations.

Preferred interpretation

Send Synchronous Event (as a result of Executing ElementaryAction):

```
  Examine Links.
  Append ElementaryActions to 'Temporary Action Queue'

Processing Loop:
  FOREACH AsyncEvent DO
    Create 'Main Action Queue' from resulting ElementaryActions.
    FOREACH ElementaryAction in 'Main Action Queue' DO
      Create 'Temporary Action Queue'
      Execute ElementaryAction
      Prepend 'Temporary Action Queue' to 'Main Action Queue'
    ENDFOR
  ENDFOR
```

Alternative interpretation

Send Synchronous Event (as a result of Executing ElementaryAction):

```
  Append Event to 'Synchronous Event Queue'

Processing Loop:
  FOREACH Asynchronous Event DO
    Create 'Main Action Queue' from resulting ElementaryActions.
    FOREACH ElementaryAction in 'Main Action Queue' DO
      Execute ElementaryAction
      Create 'Temporary Action Queue'
      FOREACH Event in 'Synchronous Event Queue' DO
        Examine Links
        Append ElementaryActions to 'Temporary Action Queue'
      ENDFOR
      Prepend 'Temporary Action Queue' to 'Main Action Queue'
    ENDFOR
  ENDFOR
```

Explanation

The two models satisfy the requirements set out in ISO/IEC 13522-5 and differ in exactly when a synchronous event is handled. In the preferred interpretation, synchronous events are handled as they are raised and the resulting Actions are made ready to run. In the alternative interpretation, synchronous events are queued and handled after the ElementaryAction that raised them has completed.

The main difference in observed behaviour is found during large Actions such as Launch. In the alternative interpretation, each "IsRunning" event is handled after the Launch Actions has completed. At this point, all 'InitiallyActive' Link objects in the Application are active and will fire if set to source from the 'IsRunning' event. If the preferred interpretation is used then the event is handled at the point it is raised, and a Link can only fire if it appears before the source Ingredient in the Items attribute of the Application. See also Section 19.14.1 "Synchronous event processing".

13.13.4 Actions that generate more than one synchronous event

Some actions lead to the generation of more than one synchronous event. For example, the Move or MoveTo actions on a TokenGroup lead to both TokenMovedFrom and TokenMovedTo events.

MHEG-5 describes the order in which the events are generated (in this case TokenMovedFrom followed by TokenMovedTo).

The effect of each of these events is equivalent to the following:

```
For each synchronous event
  Place any elementary actions that result in a queue
For each elementary action in the queue
  Apply the action
```

So, for example, if the one of the actions resulting from the TokenMovedFrom event is to deactivate the link responding to the TokenMovedTo event the actions of the TokenMovedTo event will still be applied as they will have been queued before the actions from the TokenMovedFrom event start executing.

13.13.5 TransitionTo deactivation of shared=FALSE ingredients

The Shared attribute of the Ingredient class indicates whether the Ingredient object is intended for continuous presentation across a Scene transition. Whenever a TransitionTo action is executed, the Deactivation behaviour is applied to all active Ingredient objects of the currently active Application object that have the Shared parameter set to False. This happens regardless of whether there is a Scene active before the TransitionTo action is executed.

13.13.6 Interactibles

In accordance with ISO/IEC 13522-5, MHEG-5 objects that belong to the class Interactible may be in a certain state, called "interacting", which is signalled by the InteractionStatus attribute of the object being True. When an object is in this state, no UserInput events shall be generated by the MHEG-5 engine.

A restriction on the receiver implementation of interaction methods for any Interactible is that the Text, Red, Green, Yellow and Blue key functions shall not be used. Further, even when the InteractionStatus is true, the EngineEvents corresponding to all key functions shall still be generated even if UserInput events are not - as described above.

The engine behaviour is undefined if SetData is targeted at an EntryField or a HyperText object while its InteractionStatus attribute is set to True.

13.13.7 Clarification of StreamPlaying and StreamStopped events

In this profile, Stream objects generate StreamPlaying and StreamStopped events in accordance with ISO/IEC 13522-5 and ISO/IEC 13522-5:1997/Cor.1:1999(E). Events shall be generated for all Stream objects whether of storage type stream or memory.

A StreamPlaying event shall only be generated when a Stream successfully starts playing.

A StreamStopped event shall only be generated when a previously-playing Stream stops, for example following deactivation of the Stream object. Streams with storage type Memory will additionally generate a StreamStopped event if they cease on reaching the end of their last loop.

A SetData action invoked on a running Stream object shall not of itself cause StreamStopped and StreamPlaying events to be generated. However, the appropriate event shall be raised if a SetData action causes a change in the validity of the referenced content, for example if an invalid ContentReference is used. A valid ContentReference is one that can be resolved to a stream, which may not necessarily include presentable audio or video components.See also Section 16.3.7 "Stream presentation errors".

A Stop action on a Stream that failed to start playing shall not raise a StreamStopped event.

See also Section 16.3.4 "Stream continuance on Application object deactivation".

A StreamPlaying event shall be generated when an IP Stream is activated from an arbitrary position as defined by the CounterPosition internal attribute. More specifically, it is generated simultaneously with the first piece of content data (video frame, audio sample) being presented to the user. A StreamStopped event shall be generated when an IP Stream presentation reaches the counter position as defined by the CounterEndPosition internal attribute. See also Section 16.3.8 "IC stream buffering".

13.13.8 Use of NextScenes to preload content

In this profile the GroupIdentifiers within the NextScenes attribute of the Scene class shall be regarded as context-free file names, and the files referenced can contain either MHEG-5 code or content.

13.13.9 Application defaults

<table>
<tr><th>Attribute</th><th>Default value</th></tr>
<tr><td>Font</td><td>rec://font/uk1</td></tr>
<tr><td>FontAttribute</td><td><table><tr><td>Attribute</td><td>Value</td></tr><tr><td>Size</td><td>24 pt</td></tr><tr><td>Line spacing</td><td>28 pt</td></tr><tr><td>Letterspace</td><td>0</td></tr><tr><td>Style</td><td>plain</td></tr></table></td></tr>
<tr><td>TextColour</td><td>'=FF=FF=FF=00'</td></tr>
<tr><td>HighlightRefColour</td><td>'=FF=FF=FF=00'</td></tr>
<tr><td>SliderRefColour</td><td>'=FF=FF=FF=00'</td></tr>
<tr><td>CharacterSet</td><td>10</td></tr>
<tr><td>TextContentHook[b]</td><td>10</td></tr>
<tr><td>BitmapContentHook</td><td>4</td></tr>
<tr><td>StreamContentHook</td><td>10</td></tr>
<tr><td>DesktopColour[a]</td><td>'=00=00=00=00'</td></tr>
</table>

Table 13-14. MHEG-5 Application defaults

a] i.e. the colour of the bottom of the display stack
b] applies also to subclasses of Text

13.13.10 Effect of SetData on Internal Attributes

In this profile, SetData actions targeted to Stream and Bitmap objects do not reset any scaling factors set using ScaleBitmap or ScaleVideo. This overrides sections 16.1 and 20.8 of ISO/IEC 13522-5:1997/Cor.1:1999(E) [41].

Additionally, the SetData action targeted to a Stream object does not reset the Speed attribute. Triggers are not reset when SetData action is applied

13.13.11 Clarification of TransitionTo, Launch and Spawn behaviour

ISO/IEC 13522-5 [40] defines the sequences of actions that take place in response to TransitionTo, Launch and Spawn ElementaryActions. In this profile receivers shall ensure that the file containing the new Group is loaded and, where possible, is syntactically valid before beginning step one of these sequences. Such ElementaryActions that fail at this point are ignored. See also Section 19.16.

13.13.12 References to shared=FALSE ingredients

In this profile, item I.B. of clause 51 of ISO/IEC 13522-5 [40] shall be read as if the word "shared" were omitted, i.e. "Reference to an Ingredient of the active Application:"

13.13.13 Restrictions on Link EventSource

Clause 51 of ISO/IEC 13522-5 [40] places restrictions on the types of ObjectReference that can be dereferenced within the context of an Application. In this Profile, the use of ObjectReferences within Application objects is further restricted for the specific case of the LinkCondition attribute of Links contained within an Application. Such Links shall not specify an EventSource that references other Applications or Scenes. Receiver behaviour is not defined if such references are made.

13.13.14 Video Termination attribute

All broadcast streams containing video are considered to be continuous and so do not come to an end. The Termination attribute of the Video class shall therefore be ignored for broadcast streams.

Streams obtained from the Interaction Channel can come to an end; receivers shall observe the semantics of the Termination attribute when presenting such streams.

When a stream obtained from the Interaction Channel comes to an end and the Stream object has its Termination attribute set to Freeze, the video decoder output shall freeze showing the final complete frame of the stream. If the SetData action is targeted to such a Stream that has ended in this way, the presentation shall remain frozen until new content becomes available.

If the MHEG engine is de-prioritised when the stream is terminated then the state of video presentation when it is reprioritised is undefined.

13.13.15 Clarification of Root object destruction behaviour

When an object dynamically created using Clone is destroyed, the MHEG-5 engine shall free all resources (including internal resources) allocated to the object. This means that a destroyed object created with Clone can not be re-prepared. In this case, the Root class Destruction behaviour shall be carried out as if the GroupCachePriority of the group containing the object were 0, regardless of the assigned value. This means that applications should be able repeatedly to Clone an object and Unload the clone without leaking memory.

13.13.16 Illegal parameter handling in :SetVariable

If the parameter passed to the :SetVariable ElementaryAction cannot be parsed because it is incorrectly formed (for instance it cannot be parsed as an Integer) then the effect on the target variable is implementation specific.

14 MHEG-5 Engine Graphics Model

14.1 The graphics plane

The “graphics plane” is used to represent all visibles except video streams and MPEG I-frame bitmap objects [30] .

The Desktop defined by MHEG-5 is visible at the bottom of the display stack wherever there is no graphics plane object or other visible overlapping it. It can be set to any single RGB colour, where the colourformat has at least the same colour depth as the graphics plane. Its default setting is black (i.e. opaque, with the red, blue and green components all zero).

Drawing Area — The drawing area available for applications has pixel dimensions of 720x576.

Visible Area — See Section 19.4.2 “Visible area”.

Graphics/Video Alignment — See Section 16.5.4 “MPEG presentation”.

Colour Range — The graphics plane shall be able to support colours at least subjectively equivalent to the 256 colours in “The colour palette”.

14.2 The colour palette

The graphics plane shall support at least 256 colours[31] .

To accommodate receivers with an 8 bit indexed graphics system a single 256 colour CLUT is defined. This can be shared between the possibly concurrent demands of the MHEG-5 engine, subtitle decoding and manufacturer specific receiver applications.

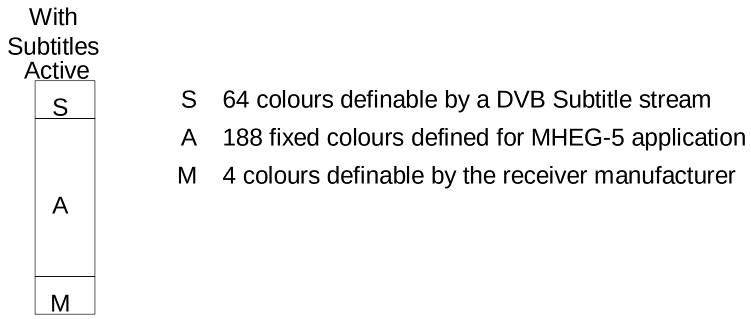


Figure 14-1. Colour Palette division between concurrent processes

Reservation for MHEG-5 applications

188 locations (the ‘A’ palette in Figure 14-1) are reserved for use when displaying MHEG-5 applications. Receivers may support more than the minimum 188 colours in the ‘A’ palette.

Fidelity of reproduction — When an application invokes a colour in the ‘A’ palette it shall be reproduced exactly. If applications invoke colours that are not in the

---

30. MPEG I-frames and video are assumed to reside in a separate truecolour display buffer.

31. This specification allows the graphics plane to be implemented as either an 8 bit indexed store or a truecolour store.

currently active palette they shall be reproduced in an implementation dependent way.

Palette definition

Table 14-1 defines the colour combinations in the ‘A’ palette. Figure 14-2 illustrates the opaque colours in the palette.

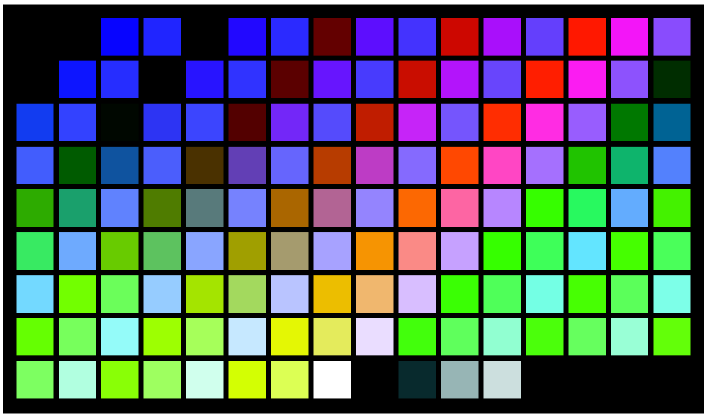


Figure 14-2. ‘A’ palette (showing opaque colours only)

Transparency		Additional Grey Levels (R=G=B)	Red	Green	Blue	Number of colours
0%	0x00	42, 85, 170, 212	0, 63, 127, 191, 255	0, 31, 63, 95, 127, 159, 191, 223, 255	0, 127, 255	139
30%	0x4C[a]	--	0, 85, 170, 255	0, 51, 102, 153, 204, 255	0, 255	48
100%	0xFF	--	--	--	--	1
					Total	188

Table 14-1. ‘A’ Palette construction rules

a] Where the receiver cannot implement this ‘ideal’ value of semi-transparency it shall replace it with the nearest value of semi-transparency it can implement. Note: the 30% transparency level shall not be approximated as either 0% or 100% transparency.

Reservation for DVB Subtitles

64 locations (the ‘S’ palette in Figure 14-1) are reserved for use when displaying DVB Subtitles. UK DVB Subtitle encoding constraints restrict broadcasts to use colour indices in the range 0…63. The ‘S’ palette may be dynamically loaded during subtitle decoding.

Subtitle priority for transparency

Where the ‘S’ palette contains values of semi-transparency different from those in the ‘M’ and ‘A’ palettes and subtitles are enabled for presentation (see Section16.4.3 “Subtitle decoder”) then the subtitle decoding shall have priority if the receiver is not able to meet both sets of requirements.

Reservation for manufacturer use

4 locations (‘M’ in Figure 14-1) are reserved for receiver manufacturer use.

14.3 Colour representation

14.3.1 Colour space

The engine is responsible for converting between colour spaces as is required.

Depending on the content type the MHEG-5 engine handles colours in both RGB (colour for buttons, text etc. and PNG graphics) and YC_rC_b (MPEG stills and DVB subtitles) colour spaces.

Broadcasts shall use colorimetry as defined by ITU-R BT.470-4 System I (which is explicitly the same as ITU-R BT.470-2 System B,G). This defines the relationship between RGB and YC_rC_b, which shall be used wherever a transformation from one representation to the other is required.

The RGB components defining the receiver colour palette are in the range 0 to 255. This range shall map linearly into the range 0 to 1 used for the ITU specified transformation.

This specification does not comment on the colour representation used by the receiver as long as the relationship between colours in the graphics and video planes is maintained.

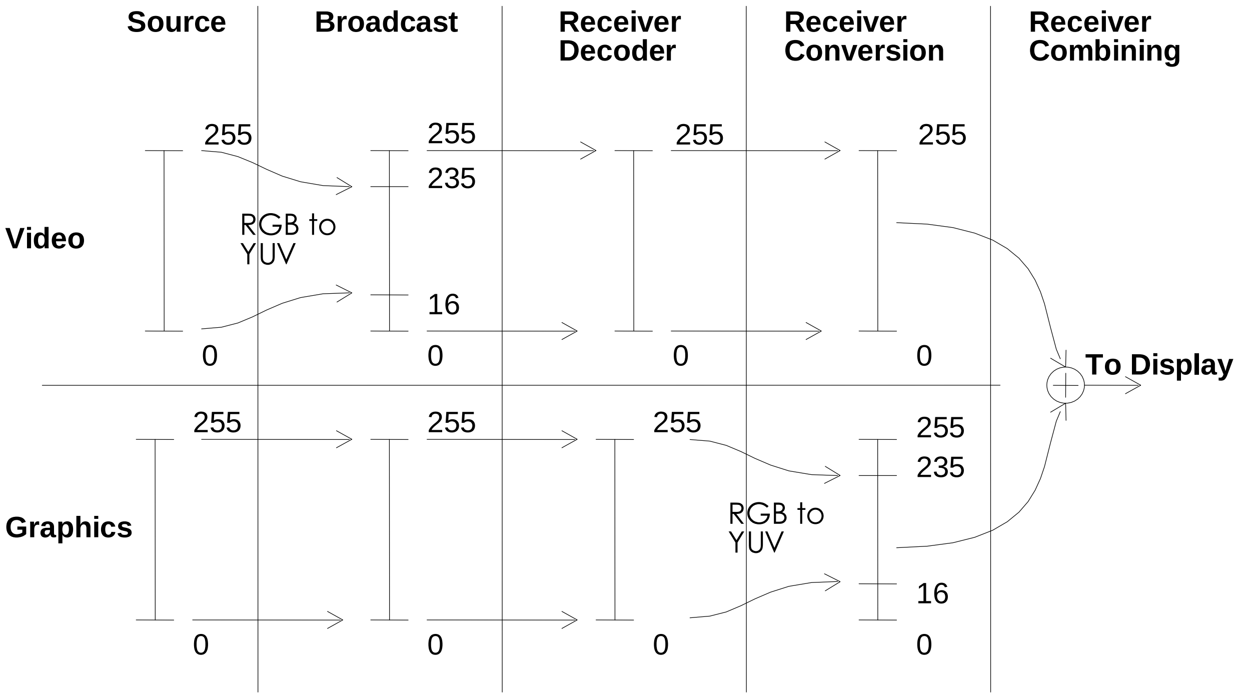


Figure 14-3. A receiver with video and graphics combined in YUV form

14.3.2 Gamma

MPEG video and DVB Subtitles deliver YC_rC_b data in accordance with ITU-R BT.601. These signals are gamma pre-corrected. **Receivers shall assume that ALL RGB values invoked by MHEG-5 applications are comparably gamma pre-corrected.**

Application authors are advised to pre-correct RGB values (such as those in PNG graphics) to be consistent with the pre-correction applied to the MPEG video.

14.3.3 Direct/Absolute colours

Direct/Absolute colour values in MHEG-5 applications shall be expressed as a 4 byte OctetString constructed as shown in Figure 14-4.

First			Last
Red	Green	Blue	Transparency
7 0	7 0	7 0	7 0

Figure 14-4. Absolute colour format

The Red, Green and Blue code values in the range 0 to 255.

The Transparency byte codes are values in the range 0 to 255 representing transparency. 0 is opaque.

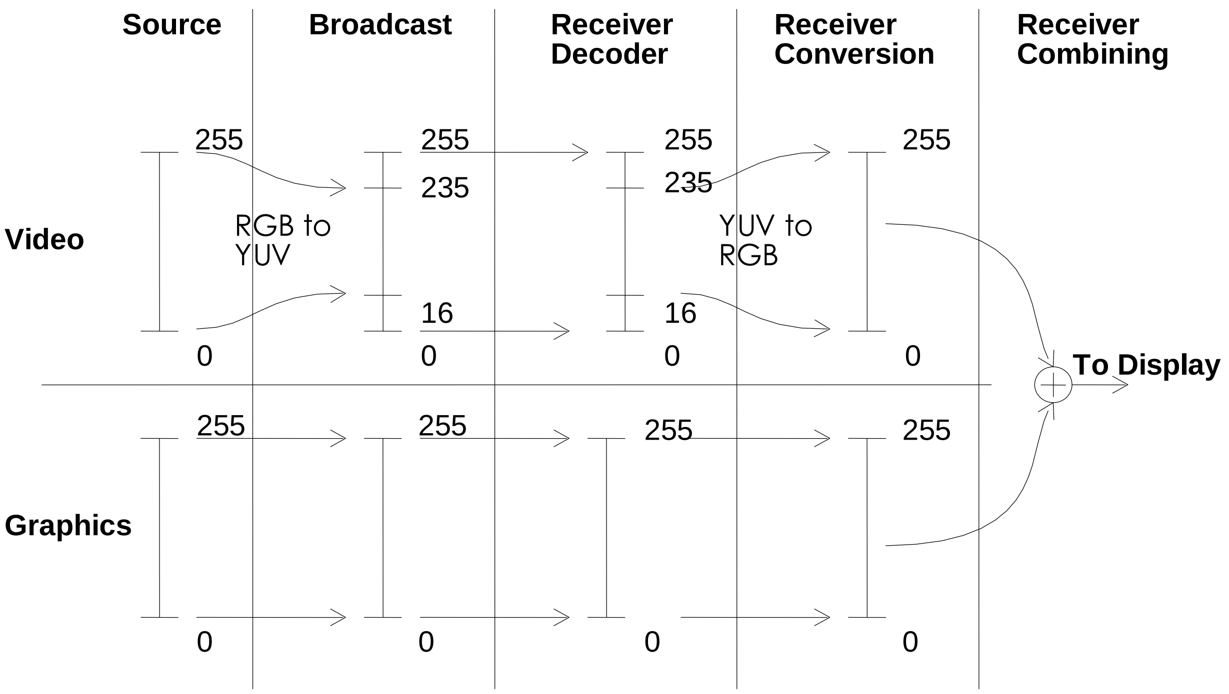


Figure 14-5. A receiver with video and graphics combined in RGB form

14.3.4 Approximation of transparency

Receivers are required to implement 3 levels of transparency 0% (opaque), 30% and 100% (completely transparent). Implementation of additional intermediate levels of transparency is optional. The MHEG-5 encoding of colours within PNG bitmaps can convey a wider range of transparency.

Where the receiver cannot implement an encoded value of semi-transparency it shall replace it with the nearest value of transparency it can implement.However, if the encoded value of transparency is in the range 10%-90% / 0x19-0xE6 it shall not be approximated as either 0% or 100% transparency.

So, 9% may be approximated as 0% but 10% shall be represented with a value in the range 10% to 90% such as 30%. Similarly, 91% may be approximated as 100%.

14.3.5 PNG modes

See Section 14.7.2 "Colour encoding".

14.4 Overlapping Visibles

14.4.1 Transparency & overlapping Visibles

Overlaying visibles

When visibles overlap the MHEG-5 rules for rendering Visibles shall be observed where transparency is 0% or 100% or where semi-transparent pixels are the only visible[32] pixels above MPEG video or an MPEG I-frame. Where intermediate levels of transparency overlay other forms of Visible certain approximations are permitted. If semi-transparent pixels overlay one or more layers of semi-transparent pixels the top most semi-transparent pixel may "punch through" to the video or be treated as opaque. However, semi-transparent pixels may not "punch through" opaque pixels.

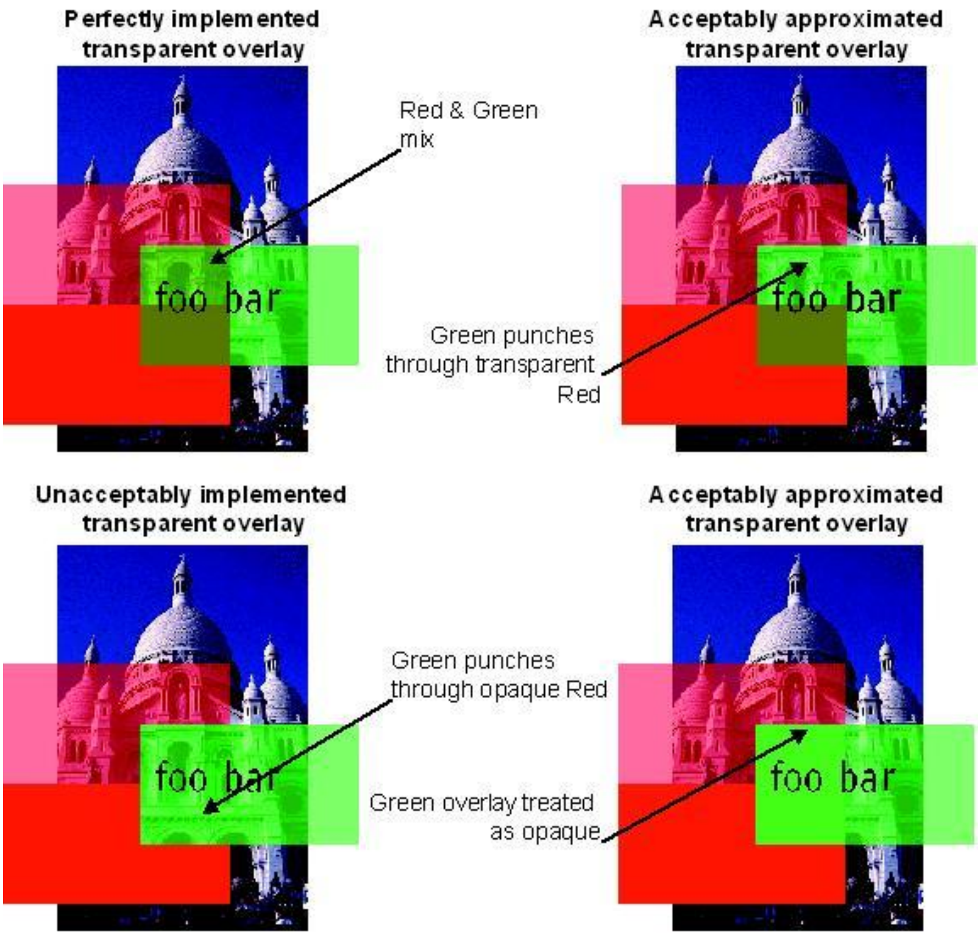


Figure 14-6. Approximation of transparency

Rendering performance

Authors should be aware that the graphics drawing speed may decrease where visibles with an intermediate level of transparency are placed directly over objects other than MPEG video or MPEG I-frames.

32. I.e. with transparency < 100%.

14.5 LineArt & DynamicLineArt

14.5.1 Clarifications

14.5.1.1 Lineart borders

The fill colour of Rectangle and DynamicLineArt objects shall not extend into any border area. Transparent or semi-transparent borders shall be rendered directly on top of underlying objects.

14.5.1.2 'Fat' lines

'Fat' lines are centred

Draw actions targeted at a DynamicLineArt object describe the course of a nominal zero width line. On top of this nominal line, a line with width LineWidth is painted. Ideally, the painted line is centred on the nominal line. Engines approximate this centring in an implementation dependent way. This behaviour applies to all draw actions.

Note

The behaviour of the DrawRectangle action is different from the behaviour of the Rectangle class.

Clipping at box edge

'Fat' lines running overlapping the edge of the DynamicLineArt object or near its border will be cropped. The exact behaviour of this cropping depends on the implementation dependent way in which the 'fat' line is aligned to the nominal line.

14.5.1.3 Line ends

The appearance of the ends of lines and the junctions in polygons and polylines is implementation dependent.

14.5.1.4 Bordered bounding box

The border area, LineWidth pixels wide, of a DynamicLineArt object with BorderedBoundingBox set True, clips draw actions to the DynamicLineArt object. The origin of the co-ordinate system for draw actions remains the Position of the object.

DynamicLineArt objects with BorderedBoundingBox set False have no border and drawing operations on such objects clip only at the edges of the object.

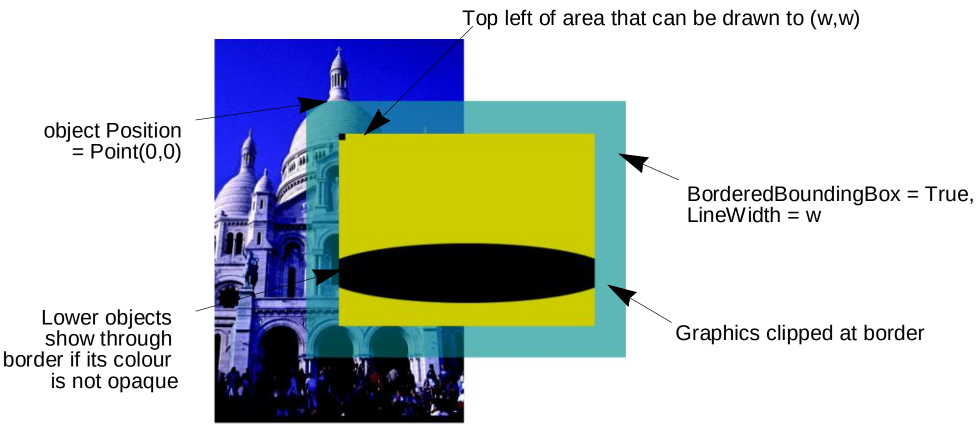


Figure 14-7. Graphics clipped at borderf

14.5.1.5 DrawSector

Figure 14-8 illustrates the results of a DrawSector action where RefLineColour is green and RefFillColour is yellow:

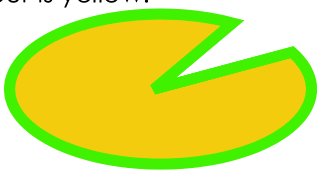


Figure 14-8. DrawSector illustrated

14.5.1.6 Effect of pixel transparency

DynamicLineArt (DLA) objects are regarded as 2 dimensional drawing surfaces. Drawing actions targeted to a DLA object cause pixels to be simply replaced with the current LineColour attribute.

Note that this means that no alpha mixing is performed at an intra-object level (i.e. between the pixels caused by successive actions on the same DLA), but that when the DLA object is rendered there is inter-object alpha mixing with the objects below the DLA in the display stack. For this model the transparent colour is regarded as a valid pixel colour (and not the lack of a colour).

14.5.1.7 Co-ordinate system

The co-ordinates used in DynamicLineArt drawing operations address the corners of display pixels such that the point (0,0) represents the top left-hand corner of the object and not the centre of the first pixel. A filled rectangle drawn from the point (0,0) to the point (4,4) with no line width is therefore four pixels square.

14.5.2 Limitations

The following allowances are made to assist receiver implementation. Authors should take account of the implied authoring constraints.

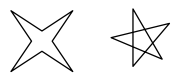
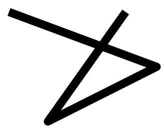
Topic	Receiver allowance	Authoring guideline
LineStyle attribute	Implement ALL line styles as solid	Avoid using dashed or dotted line styles (other line attributes such as width or colour should be used to differentiate line styles)
Filled closed shapes	The receiver behaviour when filling certain shapes is not defined. These shapes are: • concave polygons • self-crossing polygons All other shapes shall be completely filled with the colour defined by the RefFillColour attribute.	Avoid using filled concave polygons and filled self crossing polygons. I.e. avoid filling shapes like:  If these shapes such as these are required filled they may be constructed from primitive elements such as triangles which are guaranteed to fill in a predictable way.
Self crossing polygons and polylines.	The appearance of pixels at the junction of self crossing lines is not defined.	Avoid self crossing lines such as: 

Table 14-2. Limitations on LineArt and DynamicLineArt

14.6 Text, EntryFields and HyperText

Text objects (and the text areas in EntryField and HyperText objects) are treated as 2 inseparable layers in the display stack. The lower layer is the "paper" and immediately above this the "ink". The display stack rendering rules used in this profile apply to these layers (see Section 14.4.1 "Transparency & overlapping Visibles").

So, the "paper" colour (the BackgroundColour of the Text) (if any) is painted over the objects below it in the display stack applying whatever blending is appropriate. Then over this the "ink" colour (the TextColour of the Text) is painted, again applying whatever blending is appropriate.

14.7 PNG bitmaps

14.7.1 Specification conformance

PNG bitmaps shall be encoded in conformance with version 1.0 of PNG. The treatment of the chunks described by version 1.0 are described below. *UKEngineProfile1* decoders shall ignore any additional chunks.

Chunk	Comment
IHDR	Shall be used in the decoding process as described by the PNG specification.
PLTE	
IDAT	
IEND	
cHRM	Receiver shall skip
gAMA	Receiver shall skip
sBIT	Receiver can skip
bKGD	Receiver shall skip
hIST	Receiver can skip
tRNS	**Receiver shall consider**
pHYs	This field shall be ignored by receivers that do not support *HDGraphicsPlaneExtension*. Such receivers shall render all images pixel for pixel into the graphics plane. Receivers supporting *HDGraphicsPlaneExtension* (see Section14.11.1.1) shall consider all images to be of SD resolution unless they contain a pHYs chunk with a unit specifier of '1' and one of the following pixel resolutions: 1280x720 images: 3543 pixels per metre (90 dpi) 1920x1080 images: 5315 pixels per metre (135 dpi)
tIME	Receiver shall skip
tEXt	Receiver shall skip
zTXt	Receiver shall skip

Table 14-3. Treatment of PNG chunks by *UKEngineProfile1*

See also:

- Section 13.5.2 "Bitmap objects"

14.7.2 Colour encoding

Engines are required to support ALL of the PNG colour types defined in PNG Specification Version 1.0 (see Table 14-4). Engines are responsible for mapping these colours to those used by the engine's OSD.

Colour Type	Allowed Bit Depths	Interpretation
0	1,2,4,8,16	Each pixel is a grayscale sample.
2	8,16	Each pixel is an R,G,B triple.
3	1,2,4,8	Each pixel is a palette index; PLTE chunk must appear.
4	8,16	Each pixel is a grayscale sample, followed by an alpha sample.
6	8,16	Each pixel is an R,G,B triple, followed by an alpha sample.

Table 14-4. PNG Formats 8

Any combination of PNGs with different colour types may be active at any one time. Similarly, engines are responsible for mapping RGB16 direct colour specifications to colours that the OSD can support.

Where PNG graphics use colours defined in the minimum application palette (A) these colours shall be reproduced correctly. Other colours shall be reproduced in an implementation dependent way.

14.7.3 Aspect ratio signalling

Receivers that do not support *HDGraphicsPlaneExtension* shall ignore the aspect ratio and size of pixels (whether implicitly or explicitly defined) and pixels shall be mapped 1-to-1 into the SceneCoordinateSystem.

Receivers supporting *HDGraphicsPlaneExtension* shall use the pHYs chunk of the PNG image data to determine how to render the image, as specified in Sections 14.7.1 and 14.11.3.3.

14.8 MPEG-2 stills

14.8.1 File format

The payload of a file delivering an MPEG-2 I-frame shall:

- be a valid video_sequence() including a sequence_extension()
- contain one I frame, i.e. one picture_header(), one picture_coding_extension(), and one picture_data() encoded as an intra coded frame, with picture structure = "frame"

The structure is:

```
sequence_header()
sequence_extension()
extension_and_user_data(0)
optional group_of_pictures_header() and extension_and_user_data(2)
picture_header( picture_coding_type = "I frame")
picture_coding_extension( picture_structure = "frame picture")
picture_data()
sequence_end_code()
```

14.8.2 Semantics

An MPEG-2 video decoder conforming to the same behaviour as the main video decoder is used to decode the fragment of data containing the I-frame. See Section 2.3.

14.8.3 Presentation

See Section16.5.4 “MPEG presentation” for description of the presentation of MPEG stills.

14.9 MPEG video

See Section16.5.4, “MPEG presentation”.

14.10 Appearance of Visible objects during content retrieval

Whilst content is being retrieved, Visible objects shall be displayed in the following way:

- for Bitmap objects: completely transparent
- for Video objects: opaque black
- for Text objects: as an empty Text object

Text objects shall also be displayed as an empty Text object while any referenced Font data is being retrieved.

14.11 High definition graphics model

High definition receivers (i.e. ones that are capable of decoding and presenting HD resolution video) shall observe the standard Graphics Model described in Sections 14.1-14.10 of the present document with the exceptions specified in the following sections. Support for decoding and presenting HD resolution video is hereafter referred to as HDVideoExtension.

14.11.1 Resolution

Support for an HD resolution graphics plane as described in Section 14.11.1.1 is hereafter referred to as *HDGraphicsPlaneExtension*.

Receivers claiming support for *HDGraphicsPlaneExtension* must also have all of the following:

- an HD output (e.g. HDMI)
- support for SD and HD resolution JPEG and PNG images
- support for the square text style and 20 and 22 point text

The resolution of the physical graphics plane for MHEG applications shall be independent of the resolution of any video being presented and shall be fixed for at least the lifetime of the running MHEG application.

Note In practice this resolution is likely to be dependent on the configuration of the HDMI output.

14.11.1.1 HD resolution graphics plane

For a receiver to support *HDGraphicsPlaneExtension* (an HD resolution graphics plane compliant with this profile) the following shall be observed:

Resolution The graphics plane resolution shall be at least 1280x720 pixels, with the recommended resolution being 1920x1080 pixels. Other resolutions between these two limits are also permitted but it must be noted that applications can only provide HD images in one of those two resolutions and so image rendering would need to support additional scaling factors and picture quality could be adversely affected.

Note If the SCART output (as opposed to the HDMI output) is configured by the viewer for use as the primary output (where such a feature is provided) the graphics plane resolution may be reduced to 720x576 pixels if this provides a superior visual output compared to down-conversion of an HD resolution graphics plane.

Colour range The graphics plane shall provide an RGB colour space with at least 16 bits per pixel. At least 4 bits shall be used for each of the red, green, blue and transparency components. The graphics plane shall provide at least 16 evenly spaced levels of transparency.

Direct/absolute colours Colour definitions within MHEG-5 Visibles are encoded with 8 bits per component. Bitmap content may use a variety of different bit depths. Where the graphics plane supports fewer bits per channel, colours and transparency values shall be mapped by dropping the least significant bits. Where this contradicts anything stated in Section 14.3.4, the present clause shall take priority.

Text rendering Text shall be rendered in the manner described in Section 15.5.1.

Bitmap format and resolutionBitmap images encoded using the PNG format as described in Section 14.7 and the JPEG images as described in Section 14.12 shall be supported at both SD and HD resolutions.

14.11.2 Mapping the MHEG application co-ordinate system to the graphics plane

MHEG applications use a 720x576 co-ordinate system for describing all graphics presentation, video scaling and positioning. This logical co-ordinate system is used to describe services for presentation on both SD and HD capable receivers.

The 720x576 MHEG co-ordinate system shall describe an area that maps to the entirety of the supported graphics plane, even when the resolution of the graphics plane is different. Further, the entirety of the supported graphics plane shall map to the entirety of the video plane, even when the resolutions of the two are different.

Note A consequence of this is that an existing MHEG application authored using the 720x576 co-ordinate system for presentation as part of an existing SD resolution service can also be used for presentation as part of a HD resolution service.

Where the resolution of the MHEG application co-ordinate system differs from that of the supported graphics plane the act of mapping the application description into a rendered graphics output shall involve a process of "intelligent rendering" (see Section 14.11.3).

The mapping from MHEG application co-ordinate system to supported graphics plane shall be fixed for at least the lifetime of the running MHEG application such that the visual presentation of graphics aspects of an MHEG application does not vary. This shall be the case even when the resolution of any video being presented changes, e.g. from SD to HD or vice-versa, as a result of an application-initiated change of video source.

14.11.3 Intelligent rendering

This section applies only to receivers supporting *HDGraphicsPlaneExtension*.

14.11.3.1 Introduction

The process of intelligent rendering involves:

- Transforming the bounding box of each MHEG Visible object within the 720x576 co-ordinate system used to describe an MHEG application into an HD co-ordinate system that maps one-to-one with the resolution of the supported graphics plane.
- Rendering the visual appearance of each MHEG Visible object directly into the supported graphics plane reflecting the transformed bounding box.

Co-ordinate transformation The transformation from SD co-ordinates to HD co-ordinates shall be performed by multiplying the original SD co-ordinate with the ratio of HD to SD dimensions, and then rounding down the result.

The transformation from an SD horizontal co-ordinate x_{SD} to an HD horizontal co-ordinate x_{HD} shall be:

$$x_{HD} = \left\lfloor x_{SD} \cdot \frac{xres_{HD}}{xres_{SD}} \right\rfloor$$

The transformation from an SD vertical co-ordinate y_{SD} to an HD vertical co-ordinate y_{HD} shall be:

$$y_{HD} = \left\lfloor y_{SD} \cdot \frac{yres_{HD}}{yres_{SD}} \right\rfloor$$

These transformations ensure that the extreme values of the SD co-ordinate system (e.g. 0,0 and 720,576) map to the extreme values of the HD co-ordinate system (e.g. 0,0, and 1920,1080 for a 1920x1080 graphics plane).

Where objects "touch" in the MHEG-5 application, then platforms must ensure that the objects "touch" when displayed, i.e. no gaps are allowed between adjacent objects. If such objects are the same colour, no unspecified "invented" colours are allowed at the boundary between the objects. The mechanism by which these constraints are achieved is by transformation of the Bounding box as described in Section 14.11.3.2 "Bounding box transformation".

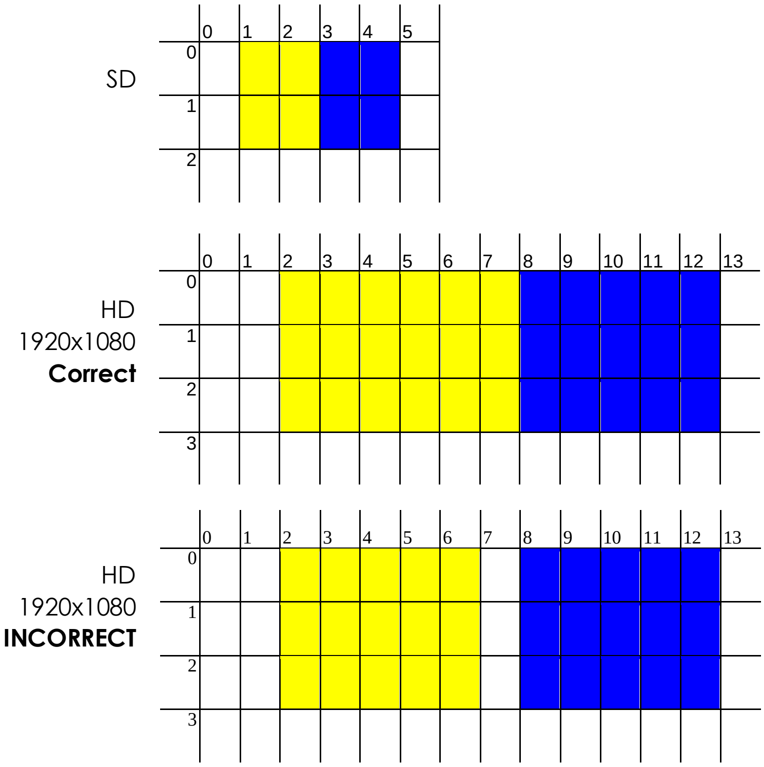
14.11.3.2 Bounding box transformation

The rectangular nature of the bounding box for MHEG Visibles makes the transformation relatively straightforward. However, since the mapping from the MHEG application co-ordinate system and any HD resolution graphics plane does not involve convenient multiples, the mapping is not linear.

The transformation of a Visible object's bounding box shall be based on separate transformations of the top-left and bottom-right co-ordinates. This method of transformation preserves the author's intention that touching objects in the SD co-ordinate system should touch in the HD co-ordinate system. Receivers shall ensure that where objects of the same colour touch, no other colour is visible at the boundary.

Example

In the figure below, the yellow object has an SD position of (1,0) and a box size of (2x2). The transformation is applied to the top left and bottom right co-ordinates, (1,0) and (3,2) so that the resulting object on a 1920x1080 graphics plane has a top-left co-ordinate of (2,0) and a box size of (6x3). The blue object is mapped in the same way and has an HD position of (8,0)



and a box size of (5x3).

The two objects touch in the HD graphics plane, just as they did in the SD co-ordinate space but they have different sizes in the HD graphics plane.

The correct rendering of these objects on a 1920x1080 graphics plane is shown in the second figure. The third figure shows the effect of separately mapping the position and the box size, resulting in incorrect behaviour with a gap between the objects.

14.11.3.3 Visual appearance

Text

Each line of text shall be rendered directly into the HD resolution graphics plane. Constraints on the renderer used are defined in Section 15.5.1.

In order that each line of text occupies the same proportion of the screen, the font size as described in the MHEG application must be scaled before being passed to the text renderer. This scaling will vary depending on the resolution of the graphics plane as described below.

Receivers supporting *HDGraphicsPlaneExtension* shall support an additional two font sizes smaller than those required for an SD receiver. The complete list of font sizes required and the corresponding vertical point sizes for rendering on HD resolution graphics planes are as follows:

Informative name	**Font size at 720x576**	**Point size equivalent at 1280x720**	**Point size equivalent at 1920x1080**
Heading / Large subtitle	36	45	67.5
Subtitle	31	38.75	58.125
Body	26	32.5	48.75
Footnote	24	30	45
HD22	22	27.5	41.25
HD20	20	25	37.5

Note 1: If the precise point sizes specified cannot be realised, receivers may round down to the nearest integer point size.

Note 2: For other resolutions, the HD font size can be calculated as:

$$size_{HD} = \frac{yres_{HD}}{yres_{SD}} size_{SD}$$

Text rendered on SD displays is scaled to give a compromise 14:9 presentation that gives acceptable results on both 4:3 and 16:9 displays. For backwards compatibility, this scaling is also performed by default when rendering onto HD resolution graphics planes. However, the square pixel nature of the HD resolution graphics planes means that the required conversion from points to pixels in the horizontal dimension differs from that used when rendering into the SD graphics plane. Whereas receivers assume that SD pixels have a width of 56/45 points (see Section 15.5.3), receivers shall assume that HD pixels have a width of 7/8 points. The consequence of this is that the text rendered on a 16:9 HD display will, by default, have the same aspect ratio as text rendered onto a 16:9 SD display.

Receivers supporting *HDGraphicsPlaneExtension* shall also support rendering of text without 14:9 scaling. This option is invoked by the use of the 'square' style in the FontAttributes string (see Section 15.4.1).

Images

Images encoded at SD resolution shall be scaled during rendering to an HD graphics plane using appropriate scale factors such that an image that is the same size as its SD bounding box fills the transformed HD bounding box.

If an image is encoded at an HD resolution it may still need to be scaled up or down depending on the resolution of the HD graphics plane provided by the receiver.

Bitmap objects with the Tiling attribute set to 'true' shall be scaled and rendered such that there are no gaps or disturbances in the rendering at the boundaries of the tiles.

LineArt

The SD-specified line width needs to be transformed. This shall be performed using the rounded down mean of the vertical and horizontal scaling factors.

DynamicLineArt

A receiver may render dynamic line art at the SD resolution and rescale as if it were an SD image being upscaled to a HD resolution.

However, for a better quality of presentation, a receiver may render dynamic line art directly into the HD resolution graphics plane. This option is preferred.

If the receiver renders dynamic line art at the HD resolution, the co-ordinates of each vertex in the SD co-ordinate system shall be separately transformed into HD co-ordinates using the equations in Section 14.11.3.1. For shapes based on ellipses, the start and end angles must also be transformed as follows:

$$\theta_{HD} = \arctan\left\{ \frac{xres_{SD} \cdot yres_{HD}}{xres_{HD} \cdot yres_{SD}} \tan\theta_{SD} \right\}$$

Note that the transformation must be applied separately to the start and end angles and not to the arc angle. Also note that the value of θ_{HD} will become - θ_{HD} in the second and fourth quadrants.

Note there are no special "touching" requirements for the rendering of DynamicLineArt objects since all touching elements described necessarily touch after the transformation.

14.12 JPEG bitmaps

JPEG images shall be encoded in conformance with ISO/IEC 10918-1 [131] using the JFIF file exchange format.

Images shall only be coded using the sequential DCT-based mode and Huffman coding. Progressive DCT-based, lossless and hierarchical modes, and images using arithmetic coding need not be supported and shall not be broadcast. Any thumbnail images present shall be ignored.

Receivers that do not support *HDGraphicsPlaneExtension* shall ignore pixel aspect ratio and resolution information in the JFIF APP0 marker. Such receivers shall render all images pixel for pixel into the graphics plane.

Receivers supporting *HDGraphicsPlaneExtension* (see Section14.11.1.1) shall consider all images to be of SD resolution unless they contain an APP0 marker with a units specifier of '1' or '2' and one of the following pixel resolutions encoded in the Xdensity and Ydensity fields:

1280x720 images: 35 dots per cm or 90 dots per inch

1920x1080 images: 53 dots per cm or 135 dots per inch

14.13 H.264/AVC stills

14.13.1 File format

The payload of a file delivering an H.264/AVC I frame shall:

- be a valid video sequence
- contain one I frame,
- be formatted as a raw byte stream.
- be flagged as a full_frame_snapshot (receivers shall ignore the snapshot_id).

i.e. an IDR access unit, with intra coded slice data and a sequence end.

The structure is:

- IDR access unit delimiter
- Sequence Parameter Set (SPS)
- Picture Parameter Set (PPS)
- Supplemental enhancement information (SEI)
- Coded slice of IDR picture
- End of Sequence

The file shall contain neither SEI pic_timing messages nor SEI buffering_period messages.

14.13.2 Semantics

An H.264/AVC video decoder conforming to the same behaviour as the main video decoder is used to decode the fragment of data containing the I-frame. See Section 2.3.

14.13.3 Presentation

See Section 16.5.4, "MPEG presentation" for description of the presentation of H.264/AVC stills.

15 Text and Interactibles

15.1 Text rendering overview

This section addresses the encoding of text and how its presentation is controlled and behaves. The application of these rules to classes that *present* text is summarised in Table 15-1:

	Character encoding	FontAttributes	Text rendering	Text mark-up	HyperText mark-up
Text	✓	✓	✓	✓	
EntryFields[a]	✓	✓	✓		
HyperText[b]	✓	✓	✓	✓	✓

Table 15-1. Application of rules to classes

a] Section **15.7 EntryFields**"

b] Section **15.8 HyperText**"

15.1.1 Non-presented text

No restrictions are placed on the byte values in OctetStrings that are **not** for presentation except as listed below:

GroupIdentifiers — See Section 18.3.2 "Mapping rules for GroupIdentifier and ContentReference".

Type conversion — Where OctetStrings are converted by the "CastToContentRef" and "CastToObjectRef" resident programs **NO** processing is applied to the byte values (i.e. it is just a type conversion).
It is the author's responsibility to ensure that the byte values in the resultant string are suitable for the context in which they are next used.

15.2 Character encoding

Table 15-18 "Set of characters supported by the engine" lists the minimum set of characters supported by the built in font. Characters shall be encoded according to ISO 10646 [44] and the Universal Character Set Transformation Format, 8-bit format (UTF-8) which is standardised as amendment 1 to ISO 10646 [44].

UTF-8

Table 15-2 reproduces the UTF-8 coding scheme. The character repertoire in Table 15-18 will only require 1, 2 or 3 byte codes. Where text is in English, Welsh or Gaelic, the majority of characters will be coded on 1 byte.

ISO 10646 [44] value	1st byte	2nd byte	3rd byte	4th byte
0000 0000 0xxx xxxx	0xxx xxxx			
0000 0yyy yyxx xxxx	110y yyyy	10xx xxxx		
zzzz yyyy yyxx xxxx	1110 zzzz	10yy yyyy	10xx xxxx	
1101 10ww wwzz zzyy+ 1101 11yy yyxx xxxx	1111 0uuu[a]	10uu zzzz	10yy yyyy	10xx xxxx

Table 15-2. UTF-8 Bit Distribution

a] Where uuuuu = wwww + 1

Null characters

The treatment of code zero (null) differs between the ISO specification of UTF-8 and that used in Java systems. However, this is transparent to the MHEG-5 environment as null terminated strings are not used.

CharacterSet attribute

Table 15-3 identifies the minimum set of values of CharacterSet attribute (as used in the Application and Text classes) that the engine shall support.

Attribute	Character Set
<10	Reserved for future use or other application domains
10	ISO 10646 [44]
>10	Reserved for future use

Table 15-3. Engine CharacterSet Attributes

15.3 Fonts

15.3.1 Downloading

Receivers implementing *DownloadableFontExtension* shall support downloadable fonts using the MHEG-5 Font class; other receivers shall not support downloadable fonts or the Font class.

Application references to non-downloadable fonts shall be direct (i.e. an OctetString representing the name of the font). Text objects referencing downloadable fonts shall do so using a reference to an MHEG-5 Font object. Downloadable fonts cannot be referenced by name.

15.3.1.1 OpenType fonts

Receivers implementing *DownloadableFontExtension* shall support OpenType® fonts with TrueType™ outlines as defined by the OpenType specification version 1.4. [143]

OpenType fonts are identified using a CHook value of 10.

Profile of OpenType

Receivers implementing *DownloadableFontExtension* are required to support the 'required' tables, the 'tables related to TrueType outlines' and the 'kern' table (format '0' horizontal kerning only). Support for other tables is optional. Application authors are advised to avoid using fonts that make use of optional tables as these may be rendered differently by different receivers.

Receivers may support TrueType Collections. Application authors shall not use TrueType Collections; in this Profile, one MHEG-5 Font object provides a single font.

Font parameters

For OpenType fonts, the following table defines the values to be used for the font metrics parameters referenced in section 15.5 "Text Rendering".

Parameter name	Obtained from
metricsResolution	unitsPerEm field, defined in the Font Header ('head') table
outlineResolution	
advanceWidth, charSetWidth	advanceWidth values, defined in the Horizontal Metrics ('htmx') table. Note: for monospaced fonts, only a single advance width may be defined
xMin, yMin, yMax	xMin, yMin, yMax, defined in the Font Header ('head') table
kern	value, defined in the Kerning ('kern') table

Table 15-3a OpenType font parameters

Text styles

When referencing a downloaded font, the 'plain' text style (see 15.4.1, "FontAttributes") shall refer to the single text style present in the referenced font file, whatever that may be. If the receiver supports *HDGraphicsPlaneExtension*, the 'square' text style shall also refer to the single text style present in the referenced font, but without 14:9 aspect ratio correction, as described in Table 15-5.

15.3.1.2 Presentation

If the receiver implements *DownloadableFontExtension*, Text, EntryField and HyperText objects referencing a downloaded font shall not be rendered until the receiver has downloaded the required font data. Until then, the object shall be presented as defined in section 14.10, "Appearance of Visible objects during content retrieval".

Where an attempt to download content for an MHEG-5 Font object fails, any Text objects dependant on it shall be rendered in the receiver's in-built font.

15.3.1.3 Defensive response

All receivers shall implement the following measures to ensure robust behaviour with any applications that attempt to use in-built or downloadable fonts that are not available, or font characteristics that the receiver doesn't recognise:

If the font requested by a Font object is not available, the receiver shall use its in-built font.

If any of the attributes of the Font object are invalid, e.g. an unsupported content hook, the receiver shall use its in-built font.

If the font style of a Text object is recognised then it shall be used; if not, the style referenced by 'plain' shall be used.

Where a font contains a limited range of available sizes or the receiver can only display a limited range of sizes, if the requested font size of a Text object does not match one of those available, the receiver shall substitute the next smaller size available. If the required font is smaller than the smallest available, then the smallest available size shall be used.

Any character not supported by the engine shall not be considered as part of the input.

15.3.1.4 Font resource model

Receivers shall be able to support the simultaneous presentation of at least 4 downloaded fonts which are comparable (in terms of both number and graphical complexity of characters) to the in-built font, together with the in-built font.

15.3.2 Embedded font

15.3.2.1 The DTG/RNIB font design project (informative)

The Project	A font design and testing program conducted by the DTG and the RNIB with technical support from Bitstream has delivered a font with good legibility for use in TV applications.
Font Characteristics	The font is a kerned sans-serif (like Helvetica or Arial) designed to look good on both 4:3 and 16:9 displays. See "Text on a 4:3 display".
IPR	This font, "rec://font/uk1" is provided by the RNIB, on a royalty free basis (depending on format) for use in digital TV products sold in the UK. Licensing of this font is managed for the RNIB by Bitstream. Manufacturers should contact Bitstream regarding licence arrangements.

15.3.2.2 Font version

All receivers shall use the metrics defined in v7.51 of the Tiresias Screen font[33] . It is recommended that any receiver implementing 1-bit/pixel rendering use the bitmaps also contained in this release.

The bitmaps contained in v7.51 ensure that the 1-bit/pixel representation is suitable for use with a typical TV display. This takes into account:

- interlace and limited resolution of typical TV displays - particularly for small font sizes
- the need to minimise the risk that the physical rendering might exceed the logically available width (see Section 15.5.1 "Philosophy").

15.3.2.3 Required sizes and styles

Receivers shall implement at least the DTG/RNIB font in at least the sizes identified in Table 15-4. This shall be the default font implemented by the engine.

Size (points)	TV lines[a] over 'Cap-V'	Informative Name	Styles	
			Plain	Square
36	24	Heading / Large subtitle	✓	✓[c]
31	21	Subtitle	✓	✓[c]
26	18	Body	✓	✓[c]
24	16	Footnote	✓[b]	✓[c]
22	15	HD22	✓[c]	✓[c]
20	14	HD20	✓[c]	✓[c]

Table 15-4. "UK1" sizes and styles

a]The primary definition of the character size is the font size in points, the height of a capital letter 'V' in TV lines is provided for information only.

b] The default size and style. See also Section13.13.9, "Application defaults".

c] Required only in receivers supporting *HDGraphicsPlaneExtension*

15.3.3 Invoking the font

The DTG/RNIB font is invoked by using "rec://font/uk1" as the FontName for an Application object Font attribute or the OriginalFont attribute of the Text class.

The default font for engines conforming to *UKEngineProfile1* is "rec://font/uk1".

33. It has been established that v8.03 of the Tiresias Screenfont (produced at the request of the DVB MHP project) is, at the level of individual character metrics, a superset of v7.51. However, it must be pointed out that the metrics of the font itself (xMin, xMax, yMin and yMax) are different and if used will not result in text rendering compliant with this specification. Hence, even if the individual character metrics are taken from v8.03 the metrics of the font need to be taken from v7.51.
Other versions of the font are not automatically guaranteed to have compatible metrics.

15.4 Text object attributes

15.4.1 FontAttributes

Receivers shall support two font attribute formats, one is textual (but verbose), the second is terser. The short and long forms shall not be mixed within an attribute string.

15.4.1.1 Textual form

This string format <style>.<size>.<linespace>.<letterspace> is carried in an OctetString.

For example, “plain.26.32.0” means plain 26 point text on 32 point line spacing with default letterspace.

Field	Set of allowed values	Meaning
style	‘plain’ ‘square’	plain text Text to be rendered without correction for a 14:9 aspect ratio (required only in receivers supporting *HDGraphicsPlaneExtension*).
size	‘20’ ‘22’ ‘24’ ‘26’ ‘31’ ‘36’	font size in points as decimal integer strings
linespace	‘0’ ... ‘255’[a]	space between the baselines of adjacent lines of text in points as decimal integer strings
letterspace	‘-32767’ … ‘32767’[a]	increase in spacing in 1/256 points between consecutive characters expressed as a signed decimal integer string

Table 15-5. Long form text format parameters

a] Values outside this allowed range shall be limited to the nearest allowed value.

15.4.1.2 Short form

The font attributes are a 5 byte OctetString.

syntax	bits	type	allowed values
`style`	8	bslbf	See Table 15-7
`size`	8	uimsbf	0x14, 0x16, 0x18, 0x1A, 0x1F or 0x24
`linespace`	8	uimsbf	0...255
`letterspace`	16	tcimsbf	-32767...32767

Table 15-6. Short form text format parameters

style: An 8 bit string coded as shown in Table 15-7.

size: An 8 bit unsigned integer giving the height of the font face in points.

linespace: An 8 bit unsigned integer giving the spacing between the baselines of adjacent lines of text in points.

letterspace: A 16 bit signed integer specifying in units of 1/256th point the required increase in the spacing between consecutive characters.

Style bit field								Style	Illustrative plain text characters possibly convenient to authors when entering "style" in textual notation
7	6	5	4	3	2	1	0		
don't care			square[a]	outline[b]	Underline[b]	bold[b]	italic[b]		
x	x	x	0	0	0	0	.0	plain	' ' '@'
x	x	x	0	0	0	0	1	italic	'!' 'A'
x	x	x	0	0	0	1	0	bold	'"' 'B'
x	x	x	0	0	0	1	1	bold-italic	'#' 'C'
x	x	x	1	0	0	0	0	square	'0' 'P'
x	x	x	1	0	0	0	1	square-italic	'1' 'Q'
x	x	x	1	0	0	1	0	square-bold	'2' 'R'
x	x	x	1	0	0	1	1	square-bold-italic	'3' 'S'

Table 15-7. Coding of 'style' (includes future coding use)

a] Only receivers implementing *HDGraphicsPlaneExtension* are required to support the 'square'style

b] Italic, bold, underline and outline are not supported in this profile

15.4.2 Control of text flow

Required flow modes

Receivers shall implement at least the required set of text flow modes identified in Table 15-8.

Attribute	Required Values	Optional Flow Modes		Notes
		Optional Value[a]	Replacement Alternative[b]	
HorizontalJustification	start, end, centre	justified	start	See Section 15.5.4 "Rendering within the limits of the Text object"
VerticalJustification	start, end, centre	justified	start	
LineOrientation	horizontal	vertical	horizontal	
StartCorner	upper-left	upper-right, lower-left, lower-right	upper-left	
TextWrapping	true, false			See Section 15.5.6 "Line breaking"

Table 15-8. Required set of text flow modes

a] Implementation of the attribute values in this column is optional and their appearance, if implemented, is not defined by this Profile. See also Section 19.14 "Undefined behaviour".

b] This column defines the flow mode that shall be implemented by an engine when requested to implement an optional flow mode that it does not support.

See also Section 19.9.2 "Text flow control".

15.5 Text rendering

15.5.1 Philosophy

This section describes "logical" rules that ensure text flows identically on all receivers and defines some rendering requirements to ensure that a minimum acceptable level of text legibility is achieved even when using very simple bitmap rendering.

For a receiver that does not support the *HDGraphicsPlaneExtension,* no restriction is placed on the rendering technology used in a receiver provided that it achieves the deterministic text flow characteristics and the minimum rendering requirements described in this section.

For a receiver supporting *HDGraphicsPlaneExtension* it is recommended that text be rendered using anti-aliasing with at least 8 levels to be mapped to colours between the relevant Text object's TextColour and BackgroundColour. This recommendation shall apply at all times, i.e. regardless of the resolution of any video being presented.

Note: If the Text object's BackgroundColour is transparent or partially transparent, the intermediate colours for anti-aliasing will also be partially transparent.

The conceptual rendering process can be described as follows:

1. Based on the size of the Text object to render into and characteristics of the font, calculate:

   • The maximum number of lines of text that may be rendered.

   • The width available for rendering on each line.

See Section 15.5.4 "Rendering within the limits of the Text object".

2. Determine how the text to render flows, effectively defining a series of lines to render using:

   • The "logical" rules for calculating the width of rendered text (see Section 15.5.5 "'logical' text width rules").

   • The available width for rendering (from step 1).

   • The rules for breaking text (see Section15.5.6, "Line breaking").

3. Determine where each line of text to render is placed vertically within the Text object (see Section15.5.7 "Positioning lines of text vertically within the Text object"). This needs to consider that:

   • If the number of lines of text to render (from step b) exceeds the maximum number of lines of text that may be rendered (from step a) "vertical truncation" may be required, i.e. discard some of the lines to render.

   The positioning of lines to render is affected by the vertical justification of the Text object.

4. Determine the placement of individual characters in a line to render (see Section15.5.8, "Rendering lines of text horizontally"). This needs to consider that:

   • Even having correctly applied the rules relating to the flow of text, in some extreme circumstances the length of the line of text to render can be wider than the available width for rendering (from step 1). To handle this, "horizontal truncation" may be required, i.e. discard some of the characters from the line to render.

• The placement of characters in the line to render is affected by the horizontal justification of the Text object.

• The placement of characters in the line to render should ensure sensible and consistent spacing between adjacent characters (see Section15.5.10 "Placing runs of characters & words").

It is also worth pointing out that special rules exist for handling tabulation (see Section 15.5.9 "Tabulation") which need to be taken into account in the implementation of many of these steps.

Note the order of these steps is illustrative and may vary between implementations for reasons of convenience or efficiency.

15.5.2 Font definition

The characteristics of the fonts used by the engine shall be defined in terms of the Portable Font Resource (PFR). This font format was selected since it is a "public" data structure due to its inclusion in relevant DAVIC specifications [50]. The PFR specification is available from Bitstream's website (www.bitstream.com).

There is no requirement for receivers to embed font data using this format and it should be considered simply as a convenient "container" for publishing.

15.5.2.1 Font bounds

The PFR font definition includes a set of parameters xMin, xMax, yMin and yMax that are **properties of the font**. These define the maximum extent of the outline representation of characters within the physical font, and as such are defined in terms of outline resolution units (outlineResolution).

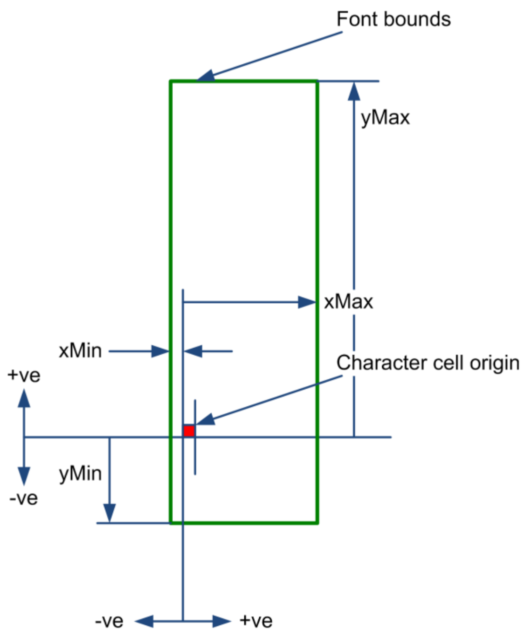


Figure 15-1. Font bounds

(xMin, yMin) and (xMax, yMax) are the bottom-left and top-right corners of an imaginary bounding rectangle within which all characters in the font can be completely enclosed.

In this profile these parameters are used to position the text within a Text object to guarantee that the extremities of all characters are completely within the Text object. See Section 15.5.4 "Rendering within the limits of the Text object".

15.5.2.2 "Physical" font data

"Physical" font data such as horizontal escapement and kerning is defined in the PFR in terms of metrics resolution units (metricsResolution). This is a high resolution representation, abstracted from any actual rendering system.

Note the outlineResolution and metricsResolution are not necessarily the same.

15.5.3 Converting font metrics to display pixels

Many of the calculations in this section are in a high resolution physical coordinate system, either metrics or outline resolutions. These values need to be converted into the pixel resolution of the display device to allow characters to be rendered.

Values in terms of these high level resolutions can be simply converted to values in terms of points by multiplying by the font size (in points) and dividing by the resolution, i.e. metricsResolution or outlineResolution as appropriate. However, this value in points still needs to be converted into a value in pixels.

Computer display systems typically assume a 72 pixel per inch display. So, as each point is 1/72 inch, the horizontal and vertical size of each pixel is 1 point.

Vertical resolution

The computer convention is preserved for the vertical dimension of the SD MHEG-5 display (i.e. each of 576 SD OSD lines is considered to be 1 point high). When rendering on HD resolution graphics planes, one line is again considered to be 1 point but text sizes are scaled up as described in Section 14.11.3.3.

Horizontal resolution

Due to the non-square pixel nature of SD broadcast displays, the 1 pixel = 1 point conversion cannot be preserved.

To simplify the *UKEngineProfile1* all receivers shall assume that each of the 720 SD pixels has a uniform width of 56/45 points regardless of the scene aspect ratio and display aspect ratio. This approximates the pixel aspect ratio for a 14:9 aspect ratio display. So, all text will be subject to moderate aspect ratio distortion. However, broadcasters will be able to predict text flow without having to author specifically for each display type. Also, this allows receivers to be implemented with font bitmaps in a single aspect ratio.

For compatibility with SD receivers, receivers supporting *HDGraphicsPlaneExtension* shall also render text in the 'plain' style with the appropriate correction required for 14:9 text rendering. However, due to the square pixel nature of HD graphics planes, the correction required is a factor of 7/8.

Receivers supporting *HDGraphicsPlaneExtension* shall render text in the 'square' style without applying any correction for 14:9 text rendering.

The following table summarises the pixel aspect ratio values to be used when rendering text:

Text style	Co-ordinate system	Pixel aspect ratio for text rendering (parX/parY)
'plain'	SD (non-square-pixel)	56/45
	HD (square-pixel)	7/8
'square'	SD (non-square-pixel)	64/45
	HD (square-pixel)	1/1

All text flow calculations (see Sections 15.5.4, 15.5.5, 15.5.6 and 15.5.9) and positioning calculations (see Sections 15.5.7 and 15.5.8) shall be performed at SD resolution. The final rendering of text shall be performed at HD resolution.

The 'square' style is required only in receivers supporting *HDGraphicsPlaneExtension* but to ensure consistency in rendering between receivers using different HD graphics plane resolutions, text flow calculations shall nonetheless be performed at SD using the specified pixel aspect ratio.

Section 15.11 shows an example of the text rendering process when using an HD graphics plane.

15.5.4 Rendering within the limits of the Text object

When typesetting for print, character extremities may extend beyond the nominal text flow area. However, print has margins so the edge of the text flow is not the technical limit to the area that can be printed. In this profile the bounds of the Text object are treated as the technical limit to the area that can be printed. Taking this into account a "virtual margin" shall be defined using properties of the font (xMin, yMin, xMax and yMax) to ensure that all presented characters are completely rendered within the bounds of the Text object.

As stated previously, these parameters are defined in outline resolution units and so need to be converted to TV pixels. Based on the principles described previously (see Section 15.5.3 "Converting font metrics to display pixels") this can be achieved by using the following:

yOffsetTop

$$yOffsetTop_{pixels} = \begin{cases} div(yMax_{outlineResolution} \times fontSize, outlineResolution) & yMax > 0 \\ 0 & yMax \le 0 \end{cases}$$

yOffsetBottom

$$yOffsetBottom_{pixels} = \begin{cases} div(-yMin_{outlineResolution} \times fontSize, outlineResolution) & yMin < 0 \\ 0 & yMin \ge 0 \end{cases}$$

xOffsetLeft

$$xOffsetLeft_{pixels} = \begin{cases} div(-xMin_{outlineResolution} \times fontSize \times parY_{SD}, outlineResolution \times parX_{SD}) & xMin < 0 \\ 0 & xMin \ge 0 \end{cases}$$

where: $parX_{SD}$ and $parY_{SD}$ are values from the table in section 15.5.3.

outlineResolution is extracted from the PFR, div (A, B) = ceil (A / B), '/' is a rational divide and ceil(A) is the first integral number greater than or equal to A.

yOffsetTop, *yOffsetBottom* and *xOffsetLeft* are all greater than or equal to zero and represent the number of available pixels required above, below and to the left of the character origin to prevent clipping of any character in the font. A value *xOffsetRight* could be defined along similar lines but is not relevant to this profile.

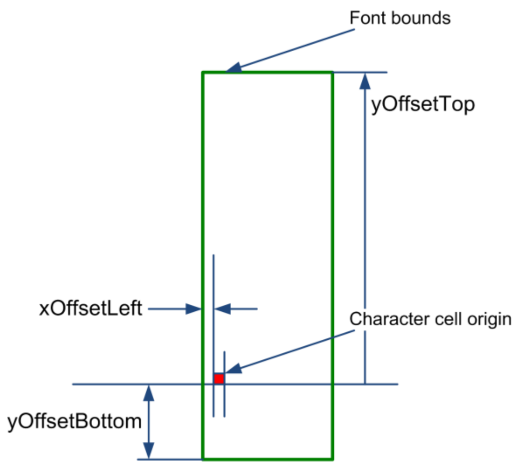


Figure 15-2. Font Bounds

15.5.4.1 Vertical limits

The origin of any character shall be at least yOffsetTop inside the top edge of the Text object and at least yOffsetBottom inside its bottom edge. Assuming that all characters in a line of text share a common baseline then, **regardless of VerticalJustification** the number of lines of text that may be presented within a text object is

num_lines = floor((height_Text_object - (yOffsetBottom + yOffsetTop)) / linespace) + 1

All values are in pixels. The variable linespace is an attribute of the Text object that defines the space between the baselines of consecutive lines of text. The function floor(A) rounds A to the first integral number less than or equal to A.

Note: Linespace is defined in units of points but as described previously (see Section 15.5.3 "Converting font metrics to display pixels") these map one-to-one with pixels in the vertical direction.

15.5.4.2 Horizontal limits

The number of characters that may be rendered on a line is not simply dependent upon the width of the Text box and the horizontal escapement for each character, but also needs to consider that the rendering of the first character in a line may extend to the left of its origin. Thus, **regardless of HorizontalJustification** the space available for rendering a line of text within a Text object is

available_width = width_Text_object – xOffsetLeft

All values are in pixels. available_width may then be used with the "logical" text width rules to determine text flow.

15.5.5 'logical' text width rules

To ensure that text will flow identically[34] on different receivers and authoring stations, regardless of the quality of the character rendering a set of "logical" text width rules are defined here.

These rules are a simplification of the rules that might be applied in a typographic rendering system. The objective of these simplifications is to reduce the receiver complexity required to ensure exact correlation of text flow behaviour.

The "logical" text width shall be used in the following cases:

- to determine when to wrap lines of text within a Text object
- to determine which tab stops text has passed when implementing tab characters

The calculation of "logical" text width is based on "physical" font data. This data provides a description of the font at a very high resolution, abstracted from any actual rendering system. Consequently, the calculation of the "logical" width of a string of characters involves, computing their width at this high resolution and then converting to units appropriate to the rendering system, e.g. TV pixels, before making decisions about text flow (see Section15.5.3 "Converting font metrics to display pixels")

34.I.e. lines and words will break at the same character position.

15.5.5.1 Computing "logical" text width

The key parameters when calculating the width of a string of N characters are:

- Text font size (one of the values in Table 15-4 "'UK1' sizes and styles")
- charSetWidth (carried by the "Character Record")
- The metricsResolution (carried by the "Physical font record")
- Any kerning adjustment (see "Pair kerning Data")

Font sizes

Font sizes are expressed as the size of an "Em"[35] in units of "points"[36] .

Character widths

The physical font record carries a character record for each character code. This gives the width of each character relative to the size of an Em in metricsResolution units[37] .

Kerning

For certain character combinations (a "kerning pair") a kerning adjustment may also be provided. Typically kerning reduces character spacing for pairs such as AV instead of AV

The pair kerning data within the pairKernData extra data items in the physical font record defines this adjustment. This defines a baseAdjustment (shared by several character pairs) and an adjustment (for a particular character pair). These provide a signed adjustment to the nominal charSetWidth of the first character.

Like charSetWidth kerning adjustments are in terms of metricsResolution units.

Kerning adjustments only apply between characters, not between the start of a line of text and the edge of the text object.

Letter spacing

Letterspace (defined in the font attribute of the text object, see Section 15.4.1 "FontAttributes") allows for an expansion/condensation of the character spacing for all of the characters in a text object.
In printing, this is sometimes referred to as tracking.

35.Broadly speaking this is the minimum distance between the baselines of consecutive lines of text in the given font. If text is 48 point then the Em at that size is 48 points.

36.An archaic typographical unit. Traditionally there were 72.27 points to an inch. Computerised systems now use 72 points per inch for simplicity.

37.So, if metrics are specified in 1/1000ths of an Em a character with a width of 0.6 Em will have a set width of 600.

15.5.5.2 Logical text width

The equation below shows how the width of a string of N characters is computed.

$$\text{logical width of N character}_{\text{points}} =$$

$$\text{div}((N-1)\times\text{letter space},256)+\text{div}\left(\text{fontsize}\times\left(\sum_{1}^{N}\text{charSetWidth}[i]+\sum_{1}^{N-1}\text{kern}[i,i+1]\right),\text{metricsResolution}\right)$$

$$\text{logical width of N character}_{\text{pixels}} = \text{div}(\text{logical width of N character}_{\text{points}}\times parY_{SD}, \text{parX}_{SD})$$

Where in div(A, B):

- B is unsigned and A is signed

  and

- div(A, B) = ceil(A / B)

Where '/' is a rational divide and ceil(A) is the first integral number greater than or equal to A. So, the calculations round up when reducing precision and tend to over estimate the width of text.

The width of pixels is $parX_{SD}$ *and* $parY_{SD}$ points, see Section15.5.3 "Converting font metrics to display pixels".

15.5.6 Line breaking

15.5.6.1 TextWrapping false

Where the TextWrapping attribute of a Text object is set False, text shall break onto a new line only where a Carriage Return character is present in the text. The number of lines to render shall be equal to the number of Carriage Returns present, plus one.

15.5.6.2 Text Wrapping true

Where the TextWrapping attribute is set to True, the text flow may additionally be broken onto a new line according to the following wrapping rules. The text wrapping behaviour is independent of the Text object's justification settings and is considered to take place before any truncation (see Section15.5.7 "Positioning lines of text vertically within the Text object").

The effect of the text wrapping rules is to remove breaking characters and insert additional Carriage Returns. (This happens only as far as rendering is concerned; the GetTextData action on a Text object shall return the *actual* text content.)

Firstly, based on the "logical" width of the text, receivers shall determine for each line, the first contiguous sequence of non-breaking characters that:

1. would not completely fit within the available width; and
2. that follows one or more breaking characters

If such a sequence exists, the breaking character preceding it shall be replaced with a Carriage Return character.

Secondly, *all trailing* breaking characters shall be discarded from all lines of text. Preceding breaking characters are not affected.

F

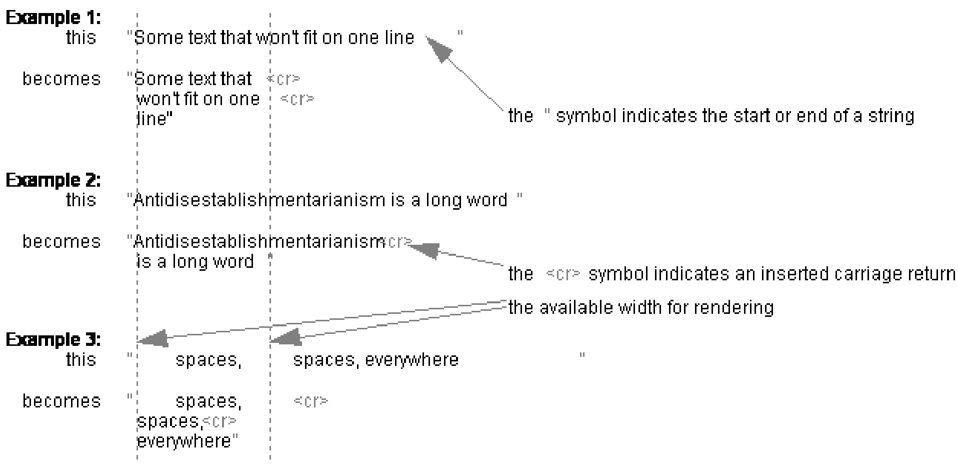


Figure 15-3. Text wrapping examples

After the text wrapping pre-processing is performed, the text truncation rules in Section 15.5.7 "Positioning lines of text vertically within the Text object" still apply. This profile does not support hyphenation and sequences of non-breaking characters that exceed the available width are not wrapped (see Example 2 above) but will subsequently be truncated according to Section15.5.7.

15.5.7 Positioning lines of text vertically within the Text object

15.5.7.1 Truncation

When the number of lines of text to be rendered exceeds the available height within the text box, lines shall be dropped from the end of the text for "start" and "centre" VJustification settings and from the beginning for "end" VJustification.

The truncation operation will result in a number of lines that can be displayed within the box and these shall be presented according to Section 15.5.7.2 "Positioning". No partial lines shall be displayed.

15.5.7.2 Positioning

- When VerticalJustification = start (top aligned text) the baseline of the first (top most) line shall be yOffset Top inside the top edge of the Text object and each following line shall be spaced according to the value of linespace.

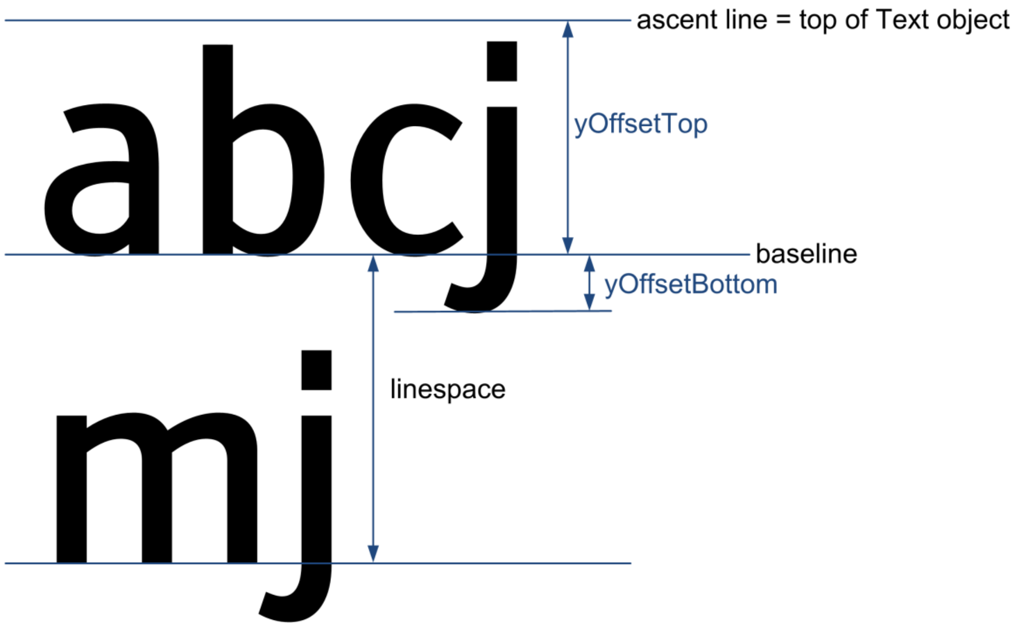


Figure 15.4: Vertical measures

- When VerticalJustification = end (bottom aligned text) the origin of the last (bottom most) line shall be yOffsetBottom inside the bottom edge of the Text object and each previous line shall be spaced according to the value of linespace.

- When VerticalJustification = centre (vertically centred text), the positioning of the lines shall be such that the space above the first line of text equals the space below the last line of text (to within one SD pixel) as shown:

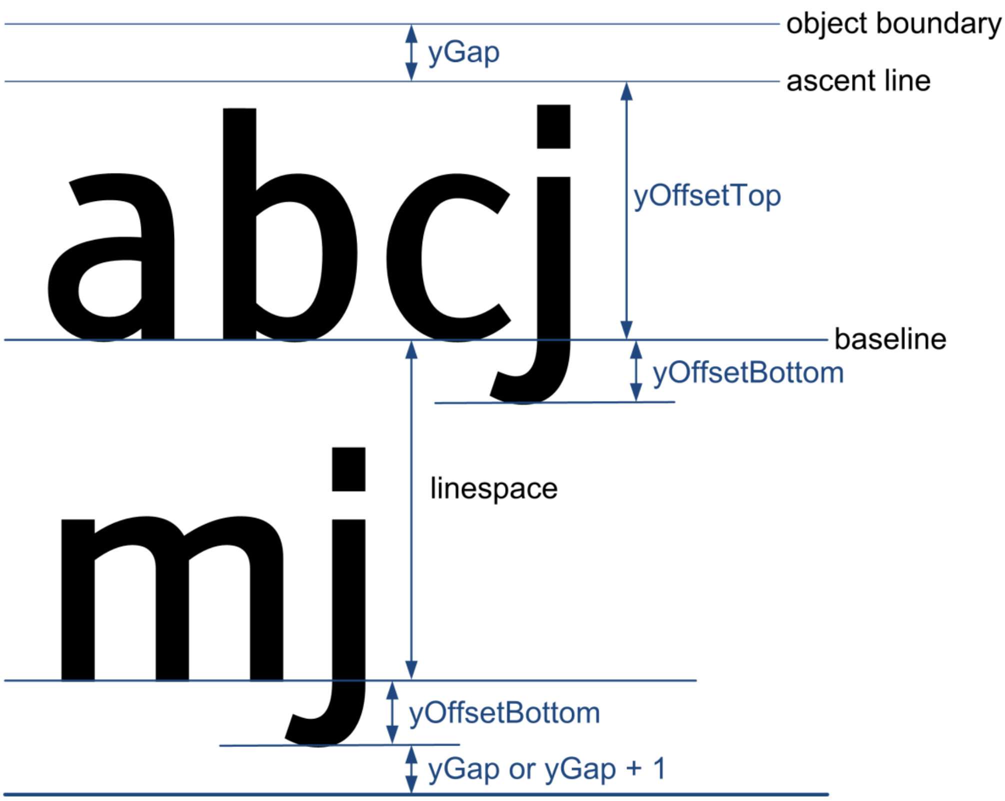


Figure 15.5: Vertical measures

15.5.7.3 Examples

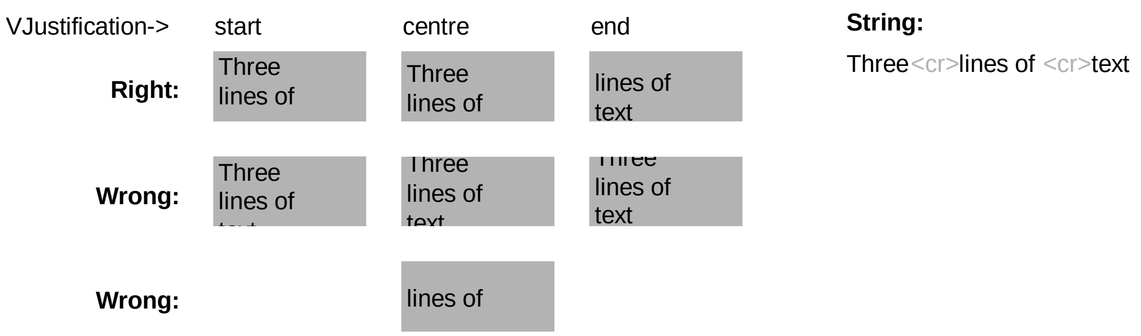


Figure 15-6. Vertical positioning example 1

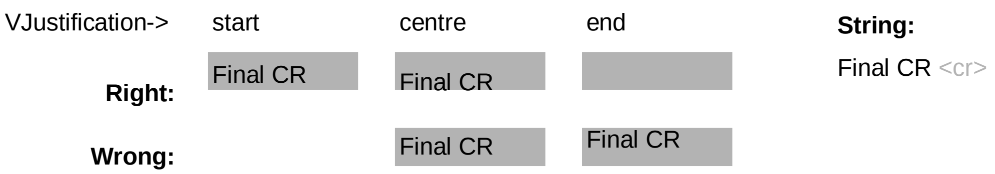


Figure 15-7. Vertical positioning example 2

15.5.8 Rendering lines of text horizontally

15.5.8.1 Truncation

Where a line of text is too long to fit within the **available_width** of the **Text** object (see section Section15.5.4.2 "Horizontal limits"), the line shall be truncated based on the text's logical width. The result shall be as if the complete line were aligned appropriately on the text box (taking into account its **HJustification** setting) with only those characters whose origin falls to the right of xOffsetLeft and whose right hand edge falls inside the right hand edge of the box, being rendered. Thus, in the "end" **HJustification** case, a portion of text from the end of the string will be rendered with its right hand edge aligned to the text box. In the "centre" case the centre of the string will appear at the centre of the box with excess characters being dropped from each end.

15.5.8.2 Placement

- When HorizontalJustification = **start** (left aligned text) the origin of the first (left most) character shall be xOffsetLeft inside the left edge of the Text object.
- When HorizontalJustification = **end** (right aligned text) the origin of the last (right most) character shall be as necessary to ensure that it is completely visible when rendered.
- When HorizontalJustification = centre (horizontally centred text), the positioning of the characters shall be such that the gap to the left of the text equals the gap to the right (to within one SD pixel). Note that this may place the first character's origin to the left of xOffsetLeft.

15.5.8.3 Examples

HJustification->	start	centre	end	**String:**
Right:	This text is too lo	his text is too lon	is text is too long	This text is too long
Wrong:	This text is too lor	This text is too lor	his text is too long	
Wrong:		This text is too lo	This text is too lo	

Figure 15-8. Horizontal positioning

15.5.8.4 Scaling for HD resolution graphics planes

Receivers that support *HDGraphicsPlaneExtension* shall perform the final rendering process at the HD graphics plane resolution, using the scaled text sizes described in Section 14.11.3.3.

15.5.9 Tabulation

In left aligned text (HorizontalJustification = start) tab stops are defined horizontally every 45 SD pixels from the left edge of the text box. 'Horizontal Tabulation' advances the origin of the next character to be rendered to the next tab stop in the direction that the text is currently flowing (the character repertoire in Table 15-18 only requires left to right text).

- Tab characters only have meaning in left aligned text. If the text is right aligned or centred then tab character shall be treated as a space character.
- A tab logically advances the rendering of the text by at least the width xOffsetLeft. If the normal origin of the next character to be rendered after the tab character is after a tab stop, a tab character will advance the rendering to the subsequent tab stop.
- The tab stops are at regular intervals from the left edge of the Text object and are not affected by the xOffsetLeft offset to the origin of the first character.

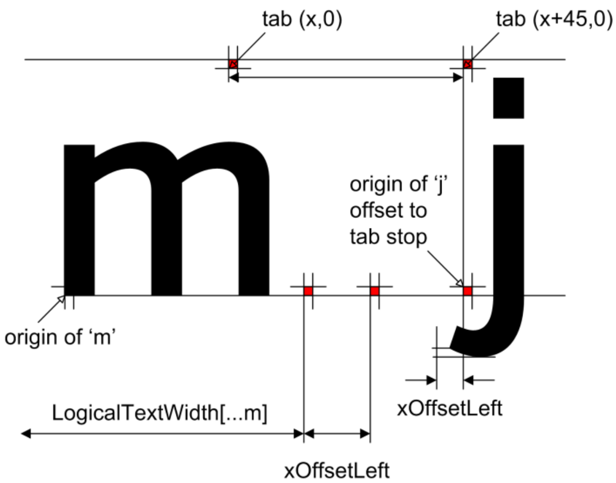


Figure 15-9. Effect of horizontal tabulation

15.5.10 Placing runs of characters & words

A run of characters starts from a well defined point:

- The start edge of the text object (see Section 15.5.4 "Rendering within the limits of the Text object)
- A tab stop

After this origin the fine positioning of character cells and the gaps between words is not fully specified.

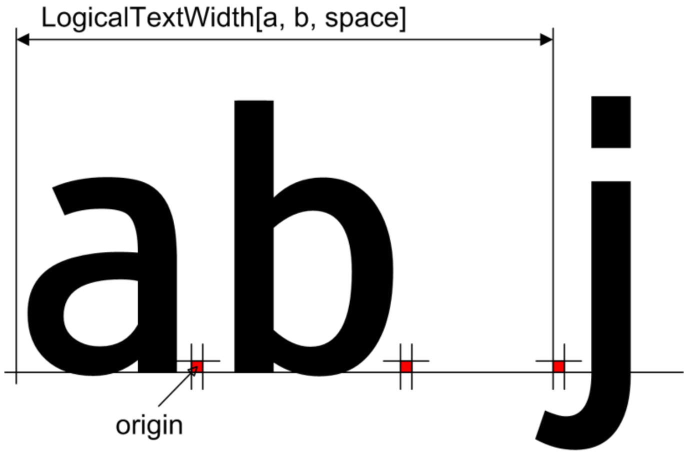


Figure 15-10. Calculation of character placement

However, the following rendering requirements shall be observed to ensure that a minimum acceptable level of text legibility is achieved:

- The spacing between any pair of characters shall "appear" to be consistent wherever that pair of characters is displayed.
- At the default character spacing no two non-whitespace characters shall "appear" to touch.
- The physical rendering of a run of text as determined by the "logical" rules shall be achieved completely within the space used for the "logical" calculation.
- No partially rendered characters shall be presented.

It is worth pointing out that the "logical" position of each character as determined by the "logical" rules is likely to be a non-integer. For renderers unable to support suitable sub-pixel positioning, e.g. a 1-bit/pixel bitmap renderer, this is impossible to implement. Thus whilst the "logical" rules must be used to determine the flow of text, they need not be observed for individual character placement within this flow and other strategies may be employed as long as the requirements above are satisfied.

15.6 Text mark-up

15.6.1 White space characters

Certain non-printing characters have special meaning. These are identified in Table 15-9.

This table also indicates those characters that may be considered as candidates for line breaking when **TextWrapping** is enabled.

UTF-8 Value(s)	Character	Name	Breaking/ Non-breaking	Meaning
0x09	0x0009	Tab	Breaking	See Section 15.5.9 "Tabulation"
0x0D	0x000D	Carriage Return	N/A	Causes the text flow to break. The origin for the next character to be rendered moves to a new baseline "linespace" below that just rendered. The horizontal position of the next line will depend on the horizontal alignment setting.
0x20	0x0020	Space	Breaking	Spaces text by the width defined for the space character. When an object has **TextWrapping** set to "true" lines may be broken at a space. See Section15.5.6 "Line breaking" .
0xC2A0	0x00A0	Non-breaking Space	Non-breaking	Identical spacing characteristics to 0x20 but is not seen as word boundary for deciding a position to break a line of text. (0xC2A0 is the UTF-8 representation of 0x00A0)
0xE28087	0x2007	Figure Space	Non-breaking	Can be used in a string of numerals as an alternative to using comma to denote "thousands". This character is not treated as a word boundary when deciding a position to break a line of text.

Table 15-9. Special characters

15.6.2 Marker characters

The codes 0x1C to 0x1F are zero width, non-spacing, non-printing characters available for use by MHEG-5 authors as markers in text objects, i.e. when using string handling RPs.

15.6.3 Non-printing characters

Certain characters (or character sequences) have no immediate visual representation. These include:

- 0x0A Line Feed (LF) (see Note)
- 0x1C to 0x1F marker characters (see Section15.6.2)
- Format control and hypertext mark-up (see Section15.6.4 and Section15.8)
- Other characters not recognised by the receiver

When presenting text that includes these characters the character placement shall be as if the non-printing characters were eliminated from the text before rendering. In particular, the character spacing and inter character kerning shall be computed as if the non-printing characters were not present.

Note the character sequence CRLF shall be rendered identically to a single Carriage Return line breaking character i.e. the Line Feed is ignored.

15.6.4 Format control mark-up

Within text objects mark-up codes can be used to control the presentation of text. The sequence in Table 15-10 marks the start of some marked-up text. For each "start of mark-up" a corresponding "end of mark-up" is defined. The byte sequence for the "end of mark-up" is illustrated in Table 15-11. The minimum number of supported mark-up instances, where each instance is a start and end mark-up pair, is 256.

Engines shall ignore start and end mark-up sequences that do not conform to this specification by skipping past the N + 3 byte start sequence or 2 byte end sequence. This includes mark-up sequences in which the parameters_length field (N) does not match that expected for the markup_start_identifier.

	bits	value	note
`start_of_markup`	8	0x1B	Escape
`markup_start_identifier`	8	0x40-0x5E	'@' to '^'
`parameters_length`	8	N	
`for( i=0; i<N; i++ ) {`			
`  parameter_byte`	8	0x00…0xFF	
`}`			

Table 15-10. General format for start of text mark-up

	bits	value	note
`end_of_markup`	8	0x1B	Escape
`markup_end_identifier`	8	0x60-0x7E	'`' to '~'

Table 15-11. General format for end of text mark-up

Min. Nesting	start mark-up	end mark-up	description
	0x1B 0x42 0x00	0x1B 0x62	Applies 'bold' style to the text enclosed[a]
16	0x1B 0x43 0x04 0xrr 0xgg 0xbb 0xtt	0x1B 0x63	Applies colour to the text enclosed. 0xrr specifies the red intensity, 0xgg the green, 0xbb the blue and 0xtt the transparency.

Table 15-12. Text object mark-up codes

a] Not supported in this profile

15.6.5 Future compatibility

Compatible extensions to the set of mark-up codes may be defined in future profiles. For each pair the markup_end_identifier will be 32 (0x20) greater than its corresponding markup_start_identifier. Engines shall ignore unrecognised mark-up and display any text enclosed within it.

15.7 EntryFields

15.7.1 Supported characters

All receivers shall provide entry field input for the following character repertoires:

InputType	Set of characters	Comment
numeric	0 - 9 (UTF-8 coded Unicode 0x30 to 0x39)	The UTF encoding for each of these characters is one byte long.
alpha		not supported
any		
listed		

Table15-13. Characters supported by EntryFields

If the receiver implements *InteractionChannelExtension* then it shall provide the augmented entry field input specified below.

InputType	Set of characters	Comment
numeric	0 - 9 (UTF-8 coded Unicode 0x30 to 0x39).	
alpha	A - Z (UTF-8 coded Unicode 0x41 to 0x5A) and a - z (UTF-8 coded Unicode 0x61 to 0x7A).	See Section 15.7.4 "Non-numeric input".
any	All printable characters in the character repertoire. Note that input methods may not support all of these characters – see 15.7.4.2 (Minimum requirements).	See Section 15.7.4 "Non-numeric input".
listed	Any application-defined subset of the set of characters required by the 'any' InputType.	See Section 15.7.4 "Non-numeric input".

Table 15-13a. Characters supported by EntryFields when *InteractionChannelExtension* implemented

15.7.2 Appearance

15.7.2.1 Receivers that do not implement *InteractionChannelExtension*

The EntryField is to be presented as a simple single line Text object with the size and position specified. If the text is too big to fit in the EntryField the appearance of any text that overlaps the edge is not defined, the engine shall not provide scrolling or line wrapping. Similarly, the appearance of any EntryField that contains new line characters is undefined.

Since the EntryField inherits from the Text class, its background colour and text colour are defined by the BackgroundColour and TextColour attributes. The usable text area of an EntryField behaves as a Text object inset by 4 SD pixels on all sides from the BoundingBox.

The 4 SD pixel area between the BoundingBox and the usable text area shall be filled with the HighlightRefColour when both the HighlightStatus and EngineResp attributes are True and shall be filled with the BackgroundColour otherwise.

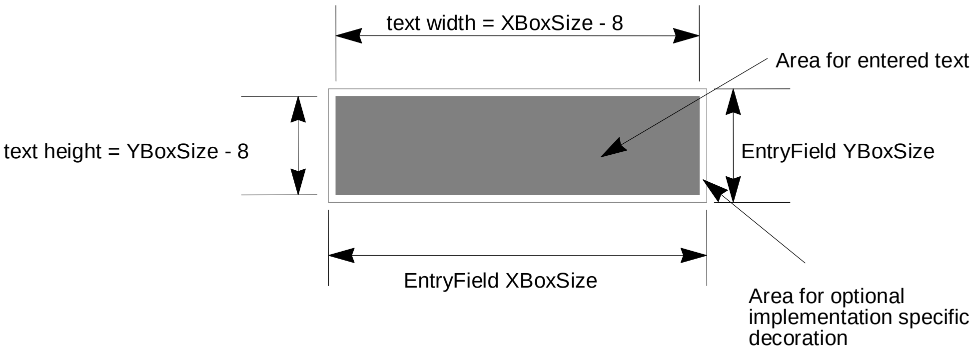


Figure 15-11. Area for text in an EntryField

The shape of the caret is implementation specific but shall be clearly visible and its colour shall be the EntryField's TextColour. The caret shall not affect the flow of text within the entry field.

If the ObscuredInput attribute is set to True each character (including any OriginalContent) shall be represented by the asterisk character (0x002A).

15.7.2.2 Receivers that implement *InteractionChannelExtension*

Receivers that implement the *InteractionChannelExtension* modify the behaviour specified above as described in this clause.

The restriction to a single line of text is removed. This removes the specifications imposed by the first paragraph in Section 15.7.2.1 "Receivers that do not implement *InteractionChannelExtension*".

The TextWrapping attribute shall be supported for EntryFields. If at any time the content is too big to fit in the EntryField, the appearance of the content shall be as for a Text object with the same HJustification and VJustification attributes. The engine shall not provide scrolling.

If the ObscuredInput attribute is set to True each character (including any OriginalContent) shall be represented by the asterisk character (0x002A). However if the InputType is alpha, any or listed and a multi-press entry mechanism is implemented the character being selected shall be unobscured and shall only be obscured once it has been added to the text of the EntryField.

15.7.3 Behaviour

Character encoding The content of an EntryField shall not include any of the non-printing characters described in 15.6.3 "Non-printing characters" or the carriage return character. Receiver behaviour is undefined if such characters are used. However, the content may contain characters not permitted for the InputType of the EntryField, for example "#".

Values used for EntryField attributes, such as EntryPoint and MaxLength, and associated elementary actions, refer to numbers of characters and not bytes. Also, TextData and all associated elementary actions are to use UTF-8 encoding. In this profile, except where *InteractionChannelExtension* is implemented, the set of characters supported all encode to one byte and so the two are usually equivalent. Where this may not be true is if the OriginalContent contains characters outside of the InputType character set, which may encode into more than one byte.

Semantics of EntryFieldFull & MaxLength

This profile defines the following additional semantics for the EntryFieldFull event and the MaxLength attribute:

- The EntryFieldFull event will only be triggered when the number of characters in an EntryField goes from less-than MaxLength to MaxLength. If the number of characters is already MaxLength and the viewer attempts to insert additional characters then the event is not triggered.
- The EntryFieldFull event is only triggered as the result of viewer interaction and is never triggered as the result of a SetData action or if OriginalData is greater than MaxLength.
- MaxLength defines the absolute limit to the number of characters that the EntryField will allow in its TextData attribute.
- A MaxLength value less than 0 shall be treated the same as a value of 0.
- The MHEG-5 engine shall not provide feedback to the user to indicate that the field is full, this is the responsibility of the application.
- SetData on an EntryField will truncate the new string if it has more than MaxLength characters.

EntryPoint In addition to the semantics of EntryPoint laid out in ISO/IEC 13522-5, setting the value of EntryPoint to less than 0 has the same effect as setting it to 0.

Successive character entryWhen an EntryField accepts input characters they are added to the TextData in the normal order for the LineOrientation and StartCorner of the object.

In this profile the only required LineOrientation and StartCorner are *horizontal* and *upper-left* (i.e. normal Latin script left to right text). So, if the characters '1', '2', '3', & '4' are pressed in that order the string "1234" shall be added to the TextData.

Only SetData when inactiveAs specified in Section13.13.6 "Interactibles" the engine behaviour is undefined if SetData is targeted at an interactible while its InteractionStatus attribute is set to True.

User input When an EntryField object is being interacted with it shall observe the generic behaviour for Interactibles as described in Section13.13.6

"Interactibles" In addition the following key presses have special meaning (see Table 13-8 "InputEventRegisters"):

- Select simply terminates interaction
- Cancel terminates interaction and also sets the TextData attribute to an empty string
- Left results in the character to the left of the insertion point (if any) being deleted regardless of the state of OverwriteMode

Numerics of the EntryField The following interpretation of the EntryField class Interaction behaviour and EntryPoint and OverwriteMode attributes shall be used:

- The insertion point is just before the character referenced by EntryPoint
- The EntryPoint is the zero-based index of a character
- After a new character is entered the EntryPoint shall be incremented
- If the OverwriteMode attribute is set to True any new character replaces the character most recently referenced by the EntryPoint

  (i.e. the character just after the insertion point is replaced and then the insertion point moves one character space so that it is just after the character just entered).
- If the OverwriteMode attribute is set to False any new character is inserted before the character originally referenced by the EntryPoint.
- During interaction the behaviour is as if there is a non-printing, zero-width, end-of-text character after the last character in the TextData. This character can have the insertion point (i.e. be referenced by the EntryPoint) but cannot be overwritten. In this way the insertion point can be positioned after the last character in the TextData. This conceptual character is never to be considered part of the TextData attribute.

Examples

In the examples below the initial string is "abc" and the entered string is "123".

OverwriteMode	Initial EntryPoint	Resulting String	Resulting EntryPoint
False	0	123abc	3
False	1	a123bc	4
False	3	abc123	6
True	0	123	3
True	1	a123	4
True	3	abc123	6

Table 15-14. EntryField Interaction examples

15.7.4 Non-numeric input

This clause is specific to receivers that implement *InteractionChannelExtension*.

15.7.4.1 Introduction

EntryField objects allow for the input of non-numeric characters. The behaviour described in Section 15.7.4 applies where an EntryField has an InputType of 'alpha' or 'any', or where the InputType is 'listed' and the list of characters includes any character other than the numbers '0' to '9' (Unicode 0x30 to 0x39) (see Table 15-13b, "Characters supported by EntryFields when *InteractionChannelExtension* implemented").

15.7.4.2 Minimum requirements

The implementation of the entry field shall meet at least the following requirements:

- Receivers shall support at least one method of non-numeric input
- Shall be capable of returning both lower-case and upper-case characters
- All input methods shall be able to return at least the characters listed in Table 15-14a
- The default input method shall not make the MHEG presentation unreadable
- Any optionally implemented input method that substantially obscures the MHEG presentation shall only be activated following informed deliberate user action other than an entry field gaining focus (e.g. an implementation dependent method such as pressing a dedicated button, opening a pull-out keyboard, picking up a specialised input device).
- Where the InputType is other than 'any' then the input method should filter any feedback to the viewer so that only acceptable characters can be entered.

15.7.4.3 SMS entry method

This clause defines a recommended non-obscuring method that meets the minimum requirements above and can be implemented using a remote control without alphabetic keys.

Receivers implementing this method shall use a 'multi-press with timeout' method for entry of non-numeric input into an EntryField, as follows:

Basic method

Each numeric key shall have a set of non-numeric symbols associated with it. The first time that a particular numeric key is pressed, the first non-numeric symbol shall be added to the content of the EntryField. For each subsequent press of the same key within a timeout period, the most recently entered character shall be replaced with the next non-numeric symbol for that key (or the first non-numeric symbol if there are no more) and a new timeout period shall begin.

After a timeout period has expired, any key press shall cause a new character to be entered.

Timeout period

The recommended key press timeout is 1.5 seconds unless the key repeat rate achievable with the receiver's remote control dictates a longer timeout period.

Appearance during input

The receiver shall represent the caret of the EntryField in a different form during the timeout period, returning to the standard form once the timeout expires.

Character to key mappings

Receivers shall use the basic mappings of alphabetic characters to keys defined by ISO/IEC 9995-8:1994 with the addition of the key's own numeric character to the end of each list. In addition, certain symbol characters shall be assigned to the keys 1 and 0. The complete list of key assignments shall be as follows:

Key	Characters (Unicode value in parentheses)
1 (or 0)[1]	Space (0x20), Full stop (0x2E), Comma (0x2C), Hyphen-minus (0x2D), Question mark (0x3F), Exclamation mark (0x21), Apostrophe (0x27), Colon (0x3A), Semicolon (0x3B), Solidus (0x2F), 1 (0x31)
2	a (0x61), b(0x62), c (0x63), A (0x41), B (0x42), C (0x43), 2 (0x32)
3	d (0x64), e (0x65), f (0x66), D (0x44), E (0x45), F (0x46), 3 (0x33)
4	g (0x67), h (0x68), i (0x69), G(0x47), H(0x48), I (0x49), 4 (0x34)
5	j (0x6A), k (0x6B), l (0x6C), J (0x4A), K(0x4B), L (0x4C), 5 (0x35)
6	m (0x6D), n (0x6E), o (0x6F), M(0x4D), N(0x4E), O(0x4F), 6 (0x36)
7	p (0x70), q(0x71), r (0x72), s (0x73), P (0x50), Q(0x51), R (0x52), S (0x53), 7 (0x37)
8	t (0x74), u (0x75), v (0x76), T (0x54), U(0x55), V(0x56), 8 (0x38)
9	w(0x77), x (0x78), y (0x79), z (0x7A), W(0x57), X(0x58), Y(0x59), Z (0x5A), 9 (0x39)
0 (or 1)[1]	Ampersand (0x26), Commercial at (0x40), Low line (0x5F), 0 (0x30)

Table 15-14a. Mappings of non-numeric characters to the numeric keys

Note the order of values is left to right, then top to bottom, i.e. Space, Full stop … Solidus, 1 for Key 1 and Ampersand, Commercial at, Low line, 0 for Key 0.

Note[1] the mapping of the 1 and 0 key may be interchanged and is implementation specific.

The UTF-8 encoding for each of these characters is one byte long.

Character subsets

Applications may restrict the range of characters to be permitted in an EntryField using the 'listed' InputType. Where the range of characters is limited, any character that is not present in the application-supplied character list shall be skipped when the key associated with that character is pressed.

15.8 HyperText

In addition to the mark-up codes identified for **Text** objects in Section15.6 "Text mark-up" **HyperText** objects can also include the mark-up in Table 15-15. See Section19.9 "Text encoding".

start mark-up	end mark-up	description
0x1B 0x41 0xnn tag_bytes	0x1B 0x61	Associates the OctetString tag_bytes with the **Anchor** text enclosed between the start mark-up and the end mark-up. 0xnn is the length of the tag_bytes OctetString.
0x1B 0x44 0xnn body_attr_bytes	0x1B 0x64	This mark-up is only interpreted if it is the first mark-up in the text. It conveys attributes of the "body" of the hypertext. The coding of these attributes is in Table 15-16. 0xnn is the length of the body_attr_bytes OctetString.

Table 15-15. Additional HyperText mark-up codes

Markup sequences defined in Table 15-15 shall not be nested. Receiver behaviour is undefined if such nested markup is encountered.

	bits	type
'0'	1	bslbf
anchor_colour_flag	1	bslbf
active_anchor_colour_flag	1	bslbf
visited_anchor_colour_flag	1	bslbf
anchor_wrapping_flag	1	bslbf
Reserved	3	bslbf
if(anchor_colour_flag == '1') {		
anchor_colour	32	bslbf
}		
if(active_anchor_colour_flag == '1') {		
active_anchor_colour	32	bslbf
}		
if(visited_anchor_colour_flag == '1') {		
visited_anchor_colour	32	bslbf
}		
for(i=0; i<N; i++){		
reserved_byte	8	
}		

Table 15-16. Body attribute encoding

anchor_wrapping_flag When set to True this flag indicates that the input focus wraps to the opposite end of the list of anchors when the user attempts to navigate past the boundaries of the object. The top and bottom events shall not be fired. When this flag is set to False the focus remains on the limiting visible anchor and the top event or bottom event (as appropriate) shall be fired.

	Where there is no body attributes markup present, anchor wrapping shall be disabled.
anchor_colour	The 32 bit integer in this field, if present, specifies the colour for unvisited hypertext anchors. If this field is not present then the colour for unvisited hypertext anchors is the default given in "Default anchor colours". The colour encoding is shown in Figure 14-4 "Absolute colour format".
active_anchor_colour	The 32 bit integer in this field, if present, specifies the suggested colour for hypertext anchors when they have the user focus. Support for this field is optional since the receiver may have an alternative means of representing active anchors. However, if text colour is used to represent that an anchor has the focus then the colour in this field shall be used if present. If this field is not present then the colour for unvisited hypertext anchors is the default given in Section 15.8.2.2 "Default anchor colours". The colour encoding is shown in Figure 14-4 "Absolute colour format".
visited_anchor_colour	The 32 bit integer in this field, if present, specifies the suggested colour for previously visited hypertext anchors. This field shall be ignored even if present and visited anchors shall appear the same colour as unvisited ones (see anchor_colour above).
reserved_byte	Bytes reserved for future use.

15.8.1 HyperText anchors

After the application transfers the focus of user interaction to a HyperText object (by using the SetInteractionStatus action) the engine is responsible for managing interaction with the HyperText object.

The OctetString tag_bytes is the "tag" of the anchor as defined by MHEG-5. When the anchor "fires" the tag_bytes are returned as the associated data of the AnchorFired event and are placed in the LastAnchorFired internal attribute.

The engine is responsible for:

- the movement of the user focus amongst the anchors in the HyperText in response to user input
- providing feedback to the user as their focus moves
- allowing the user to select an anchor

15.8.2 Appearance

15.8.2.1 Visual appearance of anchors

Anchor markup shall have a higher priority than any other visual markup. That is to say that the visual representation for an anchor shall override any other visual parameters which may be in force at that point in the text. For example if an anchor appeared in a section of text which had its colour changed with the colour change mark-up the anchor would still appear in the colours defined for an anchor.

15.8.2.2 Default anchor colours

anchor_colour	0x0000FF00 (saturated blue)
active_anchor_colour	0xFF000000 (saturated red)

Table 15-17.

15.8.2.3 Highlight

The HighlightStatus attribute shall not affect the visible appearance of HyperText objects in this profile.

15.8.3 Behaviour

The exact behaviour during interaction is dependent upon the input device being used. Principally the user *identifies* and *selects* anchors. This document specifies behaviour for an input device offering up, down, left, right and select actions. Behaviour for input devices not conforming to this pattern will be considered as the need arises.

Anchor identification

The user identifies an anchor by moving the "focus" between anchors by means of a sequence of direction key navigational steps. The "up" or "left" user interface functions will move the focus to the previous anchor. The "down" or "right" user interface functions will move the focus to the next anchor. The focus can move to anchors that are not currently visible on screen in this way.

Behaviour

When a **Hypertext** object is being interacted with it shall observe the generic behaviour for Interactibles as described in Section13.13.6 "Interactibles". In addition:

- Each time focus is moved it generates a FocusMoved event. In the case where the focus is at a boundary, the user attempts to move across that boundary and focus wrapping is switched off this event is not generated.
- Anchors shall be fired by the user activating the "Select" user interface function
- Interaction with the **HyperText** object shall be terminated if the user activates the "Cancel" user interface function

Special behaviour at boundaries

NOTE: This section addresses the case when the anchor_wrapping_flag is set to False.

In addition to generating anchor fired events when the user selects an anchor in the hypertext, the engine shall also generate these events if the user tries to navigate past the first or last anchors when the anchor_wrapping_flag is set to '0'.

top event

- When the user focus is on the first (i.e. "top") anchor in the HyperText, and the user navigation direction is "up" (up or left arrow key) then an AnchorFired event shall be generated by the HyperText object with EventData "rec://htext/top"

bottom event

- When the user focus is on the last (i.e. "bottom") anchor in the Hypertext, and the user navigation direction is "down" (down or right arrow key) then an AnchorFired event shall be generated by the HyperText object with EventData "rec://htext/bot".

common behaviour

- The visual feedback of the location of the user focus, and the logical position of the user focus, shall remain on the anchor just inside the boundary after a user navigation that tries to cross the boundary. The top event or bottom event (as appropriate) shall be fired instead of the FocusMoved event.
- The application author is responsible for appropriately "using" the "boundary" event.

  For example, a Link might be provided to set the interaction status of the HyperText object to False and to then highlight some other Interactible.
- If the interaction status of the HyperText object is still true after the "boundary" event has fired (i.e. no Link was active for the event, or its effect did not set the InteractionStatus of the HyperText object to False) the HyperText object continues to operate with the user focus remaining on its last position.
- These events shall be generated even if there are no anchors in the text. In this case pressing up/left while the HyperText object has InteractionStatus set to True shall generate the top event and pressing down/right shall generate the bottom event.

So, if the user navigation direction is "up" (up or left arrow key) when the focus is on the top most anchor there is no visual feedback unless specifically authored into the application. A subsequent "down" (down or right arrow key) user input will cause the user focus to move to the next anchor within the HyperText object unless the application has used the "boundary" event to stop interaction with the HyperText.

Where the navigation method of the engine does not use 2D navigation of the focus between anchors, and hence does not use navigation concepts such as "up" and "down" an alternative method shall be provided to ensure that the "rec://htext/top" (or "rec://htext/bot" as appropriate) event is generated as the result of user navigation away from the object.

For example, an engine using cursor/mouse based interaction might generate an AnchorFired event with EventData "rec://htext/top" when the cursor leaves the upper half of the bounding box of the HyperText object and "rec://htext/top" when the cursor leaves the lower half of the bounding box.

15.9 Slider

15.9.1 Appearance

Visually the Slider shall be implemented as a rectangular "Thumb" within an invisible "Guide", i.e. there shall be no background to the Slider. This allows application developers to implement a slider function with an application-specific background.

The Thumb shall be a rectangular area, the colour of which is defined by the SliderRefColour attribute.

The "width" of the Thumb shall be the size of the Slider object in the dimension perpendicular to the axis defined by the Orientation attribute.

The "length" of the Thumb is its dimension along the axis defined by the Orientation attribute. The Thumb's position and length will vary depending upon the SliderStyle attribute as follows:

- If the SliderStyle is set to normal, the Thumb is rendered as a 9 SD pixel long «marker» which is centred on the position on the «main axis» corresponding to the SliderValue attribute. At the extremes of SliderValue the Thumb shall remain within the bounding box of the Slider and still be rendered completely. Positions for intermediate values of SliderValue shall be evenly spaced within these limits (to within one SD pixel).
- If the SliderStyle is set to thermometer, the Thumb's position and length are as defined in the SliderStyle attribute in ISO/IEC 13522-5 [40].
- If the SliderStyle is set to proportional, the Thumb's position and length are as defined in the SliderStyle attribute in ISO/IEC 13522-5 [40].

The Slider shall be highlighted if both the HighlightStatus and EngineResp attributes are True. The appearance of this highlight shall be to change the colour of the rectangular area representing the Thumb to be that defined by the HighlightRefColour.

15.9.2 Behaviour

When a Slider object is being interacted with it shall observe the generic behaviour for Interactibles as described in Section13.13.6 "Interactibles". In addition:

- The SliderValue attribute can be modified using user input functions as follows:

  If the Orientation attribute is set to "left" then the "left" and "right" user input functions shall respectively increase and decrease the SliderValue by the value of the StepSize attribute.

  If the Orientation attribute is set to "right" then the "right" and "left" user input functions shall respectively increase and decrease the SliderValue by the value of the StepSize attribute.

  If the Orientation attribute is set to "up" then the "up" and "down" user input functions shall respectively increase and decrease the SliderValue by the value of the StepSize attribute.

  If the Orientation attribute is set to "down" then the "down" and "up" user input functions shall respectively increase and decrease the SliderValue by the value of the StepSize attribute.

- Interaction with the Slider object shall be terminated if the user activates either the "Select" or "Cancel" user interface function.

15.10 Character repertoire

Table 15-18 lists the control characters. See Section 15.6.3 "Non-printing characters".

Characters marked as "Mandatory for MHEG" in Appendix F Table F-1 shall be implemented by all decoders conforming to this specification for font "rec://font/uk1".

UCS-2	UTF-8	Glyph	Unicode Name For Character
0000	00		
to			Non printing control codes
0008	08		
0009	09		Horizontal Tabulation
000A	0A		
to			Non printing control codes
000C	0C		
000D	0D		Carriage Return
000E	0E		
to			Non printing control codes
001B	1B		
001C	1C		Zero width, non-spacing, non-printing characters available for use as markers.
to			
001F	1F		

Table 15-18 Set of control characters supported by the engine.

15.11 Text rendering example (informative)

This example illustrates the steps involved in rendering the following MHEG-5 Text object onto a 1920x1080 high definition graphics plane. Note the example text does not include any tab characters or any words that require truncation; the steps shown therefore omit calculations for those eventualities.

```
{:Text 1
      :OrigContent 'This is a test of high definition text
     rendering'
      :OrigBoxSize 300 60
      :OrigPosition 100 100
      :FontAttributes 'plain.24.24.0'
      :Hjustification start
      :Vjustification start
      :TextWrapping true
     }
```

The sequence of steps is as follows:

1. Using SD resolution calculations, determine the number of lines that can be rendered and the width available for rendering. See Section15.5.4.
   Result: num_lines = 2; available_width = 296 (xOffsetLeft = 4)
2. Using SD resolution calculations and a horizontal conversion factor of 45/56, determine the lines of text to be rendered. See Section15.5.5 and 15.5.6.
   Result:line1 = "This is a test of high definition text", width = 290
   (metrics width = 30697, points width = 360)
   line2 = "rendering", width = 79
   (metrics width = 8314, points width = 98)
3. Using SD resolution calculations, determine the vertical position of each line of text. See Section 15.5.7.
   Result:line1 baseline y = 122 (yOffsetTop = 22)
   line2 baseline y = 146 (linespace = 24)
4. Using SD resolution calculations, determine the horizontal position for the start of each run of text. See Section 15.5.8.2.
   Result:line1 run 1 x = 104 (xOffsetLeft = 4)
   line2 run 1 x = 104
5. Map the positions of the runs of text to the HD co-ordinate system. See Section 14.11.3.1.
   Result:line1 baseline start position = (277, 228)
   line2 baseline start position = (277, 273)
6. Map the text size to the HD co-ordinate system. See Sections 14.11.3.3 and 15.5.3.
   Result:text size = 45pt with an 8/7 horizontal stretch factor
7. Render the text using the values calculated in steps 5 and 6.

For the same text object but with FontAttributes 'square.24.24.0', the calculations are as follows:

1. num_lines = 2; available_width = 297 (horizontal factor now 45/64, xOffsetLeft = 3)

2. line1 = “This is a test of high definition text”, width = 254 (factor 45/64)
   line2 = “rendering”, width = 69 (factor 45/64)
3. line1 baseline y = 122
   line2 baseline y = 146
4. line1 run 1 x = 103 (xOffsetLeft = 3)
   line2 run 1 x = 103
5. line1 baseline start position = (274, 228)
   line2 baseline start position = (274, 273)
6. text size = 45pt with no horizontal stretch factor

If the text had included tab characters, there would have been additional runs of text to consider from step 4 onwards. If text wrapping had not been used or if there had been a single word longer than the available_width, truncation would have been performed, either after step 4 or at step 7.

16 MHEG Receiver Requirements

16.1 Introduction

This section describes the measures that shall be taken by the receiver to ensure good application behaviour.

16.2 Application lifecycle

16.2.1 Introduction to application lifecycle signalling

Applications may be broadcast for a number of purposes and for varying lengths of time. For example, a digital text service may be required to be available 24 hours a day, 7 days a week. An enhanced interactive service based on a particular broadcast "program" may only be required to be active for a period of hours or days. At the other end of the scale interactive adverts may only be available for a matter of seconds. As a result it can be seen that a broadcaster needs complete control of how, and when, interactive applications are launched, executed and terminated. This is what is meant by application lifecycle.

Application lifecycle signalling - that is the method by which applications are signalled to launch or terminate - can be categorised to three different types.

Application level signalling Application level lifecycle signalling is the method by which application authors can control the lifecycle of the application. This could be by authoring the application to quit at a particular time, by using stream events or other application signalling mechanisms. There is no reliance on the network or service configuration and thus it is not considered further in this section.

Service-level signalling Service level signalling is the way of passing application lifecycle information to the receiver in the broadcast stream that is independent of any currently running applications, i.e. no target code is required in any application.

Network-level signalling Network level application level signalling is the method by which network operators may control from which component applications are launched and when they are terminated. This enables network operators control over if, when and how applications are launched and terminated, regardless of the content passed to the network via broadcasters and/or carousel generators.

Scope The following application lifecycle specification is designed for operation with broadcast DSM-CC carousels and CI file systems and addresses the interaction channel for receivers that implement *InteractionChannelExtension*. Future profiles that support additional connectivity or storage mechanisms may require an extended application lifecycle specification.

16.2.2 Launching and terminating MHEG-5 applications

Applications may be activated in a number of different ways:

- An auto-boot application starts after a broadcast service is selected (see Section16.2.5)

- An application is introduced by a CI module (see Section16.11.3.2)
- An application is launched or spawned by an already running application (see Section16.9)
- An application restarts after an application that it spawned quits (see Section16.9)
- An auto-boot application starts after all other applications have quit (see Section16.2.5)
- An auto-boot application starts following a change of NB_version (see Section16.2.4)
- An auto-boot application starts following the reception of a DsmccDescriptorList section with a table_id extension of 0xFFFF (see Section16.2.3).

Applications may terminate for a number of different reasons:

- They execute a Quit action
- They are killed by the receiver following a channel change (see Section16.2.6)
- They are killed because a CI module generates a RequestStart or AppAbortRequest message (see Section16.11.3.2)
- They are killed because of a change of NB_version in the network_boot_info sub-descriptor, and the NB_action field is set to 0x01 (see Section16.2.4)
- They are killed following the reception of a DsmccDescriptorList section with a table_id extension of 0xFFFF (see Section16.2.3)

Several different file systems are potentially available to an application:

- The broadcast file system delivered by the DSM-CC Object Carousel (see Chapter 17)
- The file system provided by a CI module
- For receivers that implement *InteractionChannelExtension* both the IC file system and the hybrid file system

The conditions that lead to these file systems being available are specified in Section16.2.8 "Accessible file systems".

16.2.2.1 Preparing for launch

Before implementing step 1 of the behaviour of the Launch action described in ISO/IEC 13522-5 the receiver should make its best efforts to retrieve the application object to be launched into its memory. I.e. where possible, the engine should not start tearing down the current Scene/Application until a rapid build-up of the next application can be assured.

16.2.3 Service-level application lifecycle signalling

Application lifecycle signalling at the service level is a way to signal actions to the receiver via the broadcast stream that are completely independent of any currently running applications.

These actions are signalled using DsmccDescriptorList sections (i.e. DSMCC_sections with table_id of 0x3D) with particular defined table_id_extensions. The location of these sections is specified by the assocTag field value contained in the service_boot_info sub-descriptor (see Section 17.4.2.1 "data_broadcast_id_descriptor").

The following table_id_extensions are supported in this profile. Note that there is no requirement for a receiver to parse the contents of the section; the table_id_extension on its own is enough to signal which action the receiver should perform.

table_id_extension	Action
0xFFFF	All applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running) or removed from the application stack. The boot process shall then be restarted. No CI mounted applications are terminated.

Table 16-1. Reserved extensions for DsmccDescriptorList sections

The action is performed only once for a particular table_id_extension and table version: the receiver shall not perform the action again until the table version changes.

16.2.4 Network-level application lifecycle signalling

Auto mount broadcast file system

If a PMT of a service has a data_broadcast_id descriptor for a component then this indicates that the component carries a DSI of an Object Carousel to be mounted and searched for an auto-boot application.

If no auto-boot application is found then the Object Carousel remains mounted. A broadcast auto-boot application may be introduced subsequently and/or an application may be introduced by a CI module using a RequestStart message (see Section16.11.3.2 "RequestStart").

network_boot_info

All applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running), or removed from the application stack, when a network_boot_info sub-descriptor (contained in a data_broadcast_id descriptor) either appears or changes (as indicated by the NB_version), and the NB_action is set to 0x01 (see Section17.4.2.1 "data_broadcast_id_descriptor"). The boot process shall then be restarted. A CI mounted application shall receive a NetworkBootInfo EngineEvent if a network_boot_info sub-descriptor either appears or changes and the NB_action is set to 0x01 (see Section17.4.2.1 "data_broadcast_id_descriptor").

An application can access the value of the NB_info field at any time via the resident program GetBootInfo (see Sections17.4.2.1 and 13.10.11.1 "GetBootInfo").

data_broadcast_id

If a data_broadcast_id descriptor is removed from a service then all applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running) or removed from the application stack. The boot process shall then be restarted.

carousel_id

If the carousel_id descriptor identifying the mounted carousel is removed from a service then all applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running) or removed from the application stack. The boot process shall then be restarted.

If the carousel id changes on a non-mounted carousel (i.e. a carousel which does not contain the auto-boot application as indicated by the data_broadcast_id descriptor) then no action is taken.

Carousels moving components

If a mounted carousel, indicated by a valid carousel_id descriptor and data_broadcast_id descriptor, moves between components or pids no action is to be taken unless the carousel id has been changed. In this case all applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running) or removed from the application stack. The boot process shall then be restarted. This allows receivers to ignore which components or pids carousels are provided on, and to only act upon changes in the carousel id in the currently mounted carousel.

Removal of service

Time-exclusive services may be achieved by altering SI/PSI signalling in accordance with TS 101 211 [13].

Table 3 of TS 101 211 [13] defines the set of states that a service may be in. If a service enters any non-transition state other than "service is running and broadcasting" then all applications that originated from the mounted DSM-CC carousel shall be terminated (if the application is currently running) or removed from the application stack. The carousel is then unmounted.

Action when the service is in a transition state as defined by TS 101 211 [13] is not defined by this specification.

16.2.5 Auto boot broadcast application

Whenever a service that includes an auto-boot MHEG-5 application as a component is selected the MHEG-5 application shall be launched.

If an auto-boot MHEG-5 application component is added to a service (e.g. a new event starts that has an associated MHEG-5 application) the MHEG-5 application shall be launched.

How's this done?

The receiver looks continuously for the availability of an MHEG-5 application as part of a service. So:

- when a service is selected, the receiver shall follow the rules in Section 17.4 "Application identification and boot" to identify an MHEG-5 application to launch.
- if an MHEG-5 application appears in a service that previously didn't have an application, the application will be launched.
- if an MHEG-5 application Quits the receiver shall attempt to launch a new application. See Section16.9 "Application stacking" and Section17.4 "Application identification and boot".

16.2.6 Auto kill application

Whenever the receiver changes channel, except as a result of a non-destructive tune, any executing MHEG-5 application is killed, the application stack is cleared and all file systems are unmounted.

I.e. if the user interacts with the receivers navigator functions to change channel the current application will be killed. If the new channel has an application this one will be launched. If the application invokes a destructive channel change (via a resident program), and the channel change is successful, the current application will be killed then replaced by any application associated with the new channel.

Invocation of different video and audio stream objects by an application is not considered a channel change. So, an application can "preview" a service before selecting it.

16.2.7 Application context

The first part of a file reference is the "source" (see Section 18.3.2). This section defines what this source is at any given time.

Initial Carousel

The initial carousel, if present, is the auto-mount file system (see "Auto mount broadcast file system") of the selected service. If there is no auto-mount file system then no initial carousel is defined.

Current Carousel

At first the "Current Carousel" is the same as the "Initial Carousel". Application execution can cause the "Current Carousel" to change by launching or spawning applications in a different carousel.

This uses "LiteOptionsProfileBody" references between object carousels.

The "Current Carousel" defines where file references with source of "DSM:" are found.

The receiver shall perform a full autoboot as defined in section 17.4 in the following cases:

- If the current application quits and the application stack is empty
- Following a RequestStart with an non-empty initial object or AppAbortRequest message from a CI module

Current Source

The "Current Source" is the file system from which the currently executing application object was delivered. The "Current Source" is used to resolve file references that do not explicitly include a source.

For example, if the currently executing application object is delivered by the CI file system then a source of "CI:" is assumed when resolving file references that do not explicitly specify the source. If the currently executing application object is delivered by a broadcast Object Carousel then the "Current Source" is the "Current Carousel" and a source of "DSM:" is assumed when resolving file references that do not explicitly specify the source.

If the receiver implements the *InteractionChannelExtension* then the "Current Source" can be the IC file system or the hybrid file system if the currently executing application object is delivered by these mechanisms. A source of "http:", "https:' or "hybrid:" is assumed as appropriate. During the auto-boot process the "Current Source" is initialised to "hybrid:".

16.2.8 Accessible file systems

The following file systems are potentially available to an application:

- The broadcast file system delivered by the DSM-CC Object Carousel (see chapter 17). This, if present, is mounted as a consequence of selecting a broadcast service (see "Auto mount broadcast file system" under 16.2.4, "Network-level application lifecycle signalling").
- The file system provided by a CI module. This, if present, is mounted because of activity by a CI module (see 16.11, "Interaction with DVB Common Interface module system").

Additionally, if the receiver implements *InteractionChannelExtension* the following file systems are potentially available to an application:

- The IC file system. This is available as a consequence of an IP connection being available to the receiver (see See 17.7, "IC file system").
- The hybrid file system, which manages access to other file systems and is always available to applications (see Section 17.13 "Hybrid file system").

Any of these file systems may be mounted simultaneously.

Broadcast applications

All auto-boot broadcast applications, and applications descended from them, have access to files in the "Current Carousel".

A broadcast application will also have access to files provided by the CI module if a CI module has previously sent a RequestStart message and the session from the module is still open.

CI introduced applications

All applications introduced by a CI module, and applications descended from them, have access to files provided by the CI module.

Applications from a CI module may also have access to broadcast files if the current service has an auto-mount file system (see "Auto mount broadcast file system" on page 16-3). The broadcast file system available initially will be the "Initial Carousel" of the service (a side effect of a RequestStart that introduces the new initial application from the CI module). However, application action can cause the "Current Carousel" to change.

Interaction Channel

If the receiver implements *InteractionChannelExtension*additional file systems become available as specified in this clause.

All applications running on a receiver which has an available IP connection have access to files in the IC file system. To do this, references which are valid http or https URIs are required.

All applications have access to the hybrid file system. Depending on the configuration of the hybrid file system mapping table references may resolve to references to the broadcast, CI or IC file systems.

16.2.9 Keeping an application running across service tunes

It is possible to attempt to keep an application running across a service tune (referred to as a "non-destructive tune") by setting the app_keeprunning_flag within the tuneinfo argument of the SI_TuneIndexInfo Resident Program. The steps involved in this are defined in Section 13.10.6.4 "SI_TuneIndexInfo" . Support for this feature is referred to as *LifecycleExtension*. This section describes behaviour required for receivers that implement *LifecycleExtension*.

The new service may be the same as the currently tuned service; there is no special behaviour in this case and the service tune shall be executed as if the two services were different.

During the period of the tune itself and the subsequent attempt to attach to a carousel in the new service the running application shall continue to operate in the same manner as if no service tune had occurred: in particular there shall be no disruption to the presentation of I-Frames and/or audio from memory at any point during this process. The only exceptions to this are as follows:Broadcast file system

requests

During the non-destructive tune there will be a period where there is no mounted carousel and so no broadcast file system will be available to the running application. Consequently any outstanding requests for items in the broadcast file system at the start of this period shall be queued and any new requests during this period added to the queue. This shall apply to all requests even if they could potentially be resolved directly from receiver cache, i.e. requests made with a non-zero even value of ContentCachePriority (see Section 17.5.3) or GroupCachePriority (see Section 17.5.4).

However, this shall not apply to requests made to other file systems such as IP requests. This shall also not apply to requests made to the hybrid file system (see Section 17.13) unless such a request is resolved as a broadcast file system request.

Once the non-destructive service tune has been successfully completed and a carousel in the new service has been attached, all queued requests shall be processed in the context of this new carousel.

Only requests made with a non-zero even value of ContentCachePriority or GroupCachePriority may be resolved using files obtained and cached from a previous carousel. It is not possible to resolve requests using a transparent cache as version numbers may not be the same between the new and previous object carousels.

Timers

The receiver shall maintain any outstanding or new timers. However it is recognised that the accuracy of any active timers may degrade during the tune itself.

Carousel Identity

On successful mount of a carousel in the new service (see Section 13.10.6.4 "SI_TuneIndexInfo") this carousel shall become the Current Carousel (see Section 16.2.7 "Application context"). The running application shall be considered to have originated from the mounted DSM-CC carousel and as such may be terminated in accordance with Life Cycle Signalling as defined in sections 16.2.3 and 16.2.4.

If an auto-mount broadcast file system is present in the new service (see Section 16.2.4, "Network-level application lifecycle signalling") this shall become the Initial Carousel (see Section 16.2.7 "Application context"), otherwise no Initial Carousel is defined.

Once the tune to the new service has been completed and the receiver has identified and attached to the requested carousel, the following steps shall be executed:

Application Stack

1. The application stack shall be reset, i.e. all applications shall be removed, in line with section 16.9, "Application stacking". The currently running application shall remain on the application stack.

Indication of successful completion

2. A "NonDestructiveTuneOK" Engine Event shall be generated (see Section 13.8, "Engine Events").

Note: receivers are not required to acquire a DSI from the new carousel before beginning these steps.

Broadcast file system

There is no requirement for the carousel attached to as part of a non-destructive service tune (the new Current Carousel) to be the same as the (previous) Current Carousel in the previous service at the point that the application initiated the non-destructive tune. This is true both in terms of the broadcast file system that it delivers and the encoding of the underlying Object and Data Carousel structures. Furthermore, there is no requirement that this broadcast file system contain the currently running MHEG-5 Application object. See also Section 19.25, "Non-destructive service tunes and carousel structure".

Network and service boot info

Following a non-destructive service tune, the receiver shall examine the PMT of the new service to look for a new source of service- and network-level application lifecycle signalling as follows:

The receiver shall look for a data_broadcast_id_descriptor on whichever component carries the carousel_id_descriptor for the carousel selected by the non-destructive tune process. The receiver shall use the NB_info and service_boot information parsed from the new data_broadcast_id_descriptor if one exists. If this descriptor is not found, the receiver shall continue to use the service_boot information from the previous service but shall discard any NB_info field from the previous service.

The receiver shall ignore any change in the value of the NB_version field between the last PMT of the previous service and the first received PMT of the new service.

Regardless of whether the receiver uses information from a service_boot_info sub-descriptor from the new or previous service, it shall resolve the assocTag value using the new PMT.

Behaviour of stream decoders

The running application may include active MHEG-5 Stream objects at the point of initiating the non-destructive service tune.

If the Storage attribute for an active MHEG-5 Stream object is set to memory, or if the Storage attribute is set to stream and the reference is not to a broadcast stream then decoding and presentation of the relevant stream components shall continue without disruption as if no service tune had occurred.

If the Storage attribute for an active MHEG-5 Stream object is set to stream and references a broadcast stream then:

If the target service for the non-destructive tune is in the same MPEG transport stream as the current service then decoding and presentation of the stream components based on the current context shall continue until the tune has been successful at which point the effect of the MHEG-5 Stream object is re-evaluated (see below).

If the target service for the non-destructive tune is in a different MPEG transport stream to the current service then decoding and presentation of the stream components based on the current context may cease at any point following initiation of the tune by the application. In this case video presentation shall default to black and audio output shall be muted.

Once the new service has been tuned to:

1. The URLs "rec://svc/def" and "rec://svc/cur" shall change to mean the new service for this re-evaluation and for future references.
2. Any prepared MHEG-5 Stream objects shall be re-evaluated according to the context of the new service as if a SetData action had occurred. Where the Content internal attribute for a prepared MHEG-5 Stream object contains a URL format reference, re-evaluation can commence immediately, without having to wait for a carousel in the new service to be attached.

Note: where a Stream object uses an explicit reference before a non-destructive tune, this will mean that subsequent use of "rec://svc/cur" will be resolved differently from "rec://svc/def".

The receiver shall not fire a StreamStopped or StreamPlaying event during a successful tune. However, should the receiver fail to re-evaluate a running MHEG-5 Stream object on re-attachment, presentation of the Stream object shall cease and the receiver shall fire a StreamStopped event.

At no point during or after the tune should the receiver present the user with any video, audio or subtitles unless explicitly requested by the application.

Content management

Where the content provided by an MHEG-5 Stream object changes following a non-destructive tune, receivers shall ensure that the content management controls that are observed are those that apply to the service containing the newly selected stream components. See Section 8.13.

Receiver keys

Any of the receiver's keys (which is outside the set of keys that generate MHEG-5 UserInput events) that immediately terminates any running MHEG-5 application shall return the viewer directly to the channel associated with the viewer service context (see Section 13.10.6.4 "SI_TuneIndexInfo"). Note this channel may not be the active channel if an MHEG-5 application has performed a channel tune with tune_quietly_flag set.

Interaction with resident programs

If a non-destructive tune occurs while any of the following resident programs has been invoked and the procedural code for that resident program is still running, the effect of the resident program shall be undefined.

SI_TuneIndex

SI_TuneIndexInfo

GetBootInfo

Interaction channel security Following a non-destructive tune, any cached application signing certificates, server list files and TLS certificates are invalidated. When an application signing certificate, server list file or TLS certificate is next required, an up-to-date version must be obtained from the attached carousel in the new service.

Autoboot behaviour When the current application quits and the application stack is empty, the receiver shall perform a full autoboot as defined in section 17.4.

True persistent storage Following a non-destructive tune, the current service for the purposes of writing to true persistent storage shall be the service associated with the viewer service context. See 16.7a, "True persistent storage".

16.3 Management of stream decoders

16.3.1 Application killed by receiver

A number of scenarios can result in an application being killed by the receiver Section 16.2.2 "Launching and terminating MHEG-5 applications". In this situation the receiver shall set all stream decoders to decode the default components for the default service as determined by the receiver and set their presentation (including any video scaling and/or offset, and audio volume control) to the default state. The receiver shall ensure that the presentation of any stream components selected under application control ends before removal of the OSD resource from the application.

16.3.1.1 On change of service

This is a special case of the above, caused by the receiver executing a tune to a new service.

I.e. if the user interacts with the receiver's navigator functions to change channel the video, audio and subtitle decoders are all stopped and then restarted on the new service.

16.3.2 Effect of lockscreen

The continued rendering of any active Visible Stream components, i.e. Video, shall not be affected by the LockScreen elementary action and the displayed image shall continue to change in response to data delivered by the referenced stream.

Note Section 10.1.3 of ISO/IEC 13522-5 says "…the updating of the graphical presentation of these objects during locked screen is optional. On some engines their physical rendering continues running, on some others the image is stopped until the screen is unlocked". This profile requires that the physical rendering continues running.

16.3.3 Stream inheritance on Application object activation

A launched application may inherit the streams as previously defined. Whether this is an auto-boot application that inherits from the default service settings or a launched/spawned application that inherits from the previous application, the behaviour is the same.

When an MHEG-5 application is launched the Video, Audio and DVB Subtitling stream decoders shall continue operating in their current state until the Application object's activation phase is complete, as defined by Section 16.3.3.1.

Once the Application object is activated, stream decoders will only continue running if there are initially active MHEG-5 Video and/or Audio objects within an initially active MHEG-5 Stream object or objects. This includes the case where the MHEG-5 Stream reference is to a DSM-CC Stream object.

If the receiver determines that the application is trying to continue playing any or all of the stream components that were active when it was launched, there shall be no disruption to the decoding and presentation of these streams.

16.3.3.1 Synchronising stream decoder state

When an application is started, the receiver shall delay synchronising the state of its stream decoders with the new state set by the application (as determined by the presence or absence of any active MHEG-5 Stream or I-frame Bitmap objects) until the point when the synchronous action queue first becomes empty after the completion of the Application object's Activation behaviour.

Note this point occurs after the processing of any Links handling Application IsRunning events but before any processing in response to asynchronous events, such as ContentAvailable. This means that the synchronisation also occurs after any Scene transition performed by such an IsRunning Link but before a Scene transition performed in response to a ContentAvailable or other asynchronous event.

If at this point, the screen has been locked, this synchronisation of the state of any Stream and I-Frame Bitmap objects shall be delayed until the screen is unlocked, in accordance with clause 10.1.3 of ISO/IEC 13522-5.

Synchronisation comprises:

1. Turning audio and video stream decoders on or off (as a result of the presence, state or absence of the corresponding MHEG-5 Video and Audio objects i.e. control 'E1' in Figures 16-1 and 16-2).
2. If enabled, setting the presentation state of the audio and video decoders to reflect that of the internal attributes of the corresponding MHEG-5 Video and Audio objects i.e. presentation control 'P1' in Figures 16-1 and 16-2.
3. Turning subtitles on or off in receivers which support simultaneous presentation of MHEG-5 and subtitles i.e. in response to the states of controls 'E1' and 'E2' in Figure 16-3.
4. Initiating presentation of any I-frame Bitmap image in the video plane. Note: presentation of I-frames from a previous application shall not continue following a Launch, Spawn or Quit elementary action.

	Note: this behaviour delays some of the effects of the Preparation and Activation behaviours described in Section 37.3 of ISO/IEC 13522-5 when these occur during application startup.
Graphics plane	Unless the screen is locked, it is implementation dependent whether changes to the graphics plane resulting from Video and Bitmap object operations take effect prior to the synchronisation point.
Stream component selection	The timing of the selection of the appropriate components from the broadcast i.e. selection control 'S1' in Figures 16-1 and 16-2 is controlled by the behaviours described in section 37.3 of ISO/IEC 13522-5 and is not delayed. This includes both service and component selection.

16.3.4 Stream continuance on Application object deactivation

When an MHEG-5 Application is deactivated all other objects, including any active Stream objects, are also deactivated. ISO/IEC 13522-5 section 37.3 describes the deactivation behaviour for Stream objects. In *UKEngineProfile1*, Stream objects with the Storage attribute set to memory observe this specification.

If the Stream object is deactivated following Quit, Spawn or Launch actions then the following shall apply:

- If the Stream object has the Storage attribute set to memory, or if the object has the Storage attribute set to stream and does not reference a broadcast stream, observe the standard behaviour.
- If the Stream object has the Storage attribute set to stream and it references a broadcast stream override this behaviour. Specifically, the stream decoders associated with a Stream object don't automatically stop, and audio, video and subtitles (as relevant) will continue to be presented. Furthermore control over the presentation of these streams (including any video scaling and/or offset, and audio volume control) shall also remain unchanged. See also Section 16.9 "Application stacking".

Note this deactivation behaviour is irrelevant if the Application is being killed by the receiver, see Section 16.3.1 "Application killed by receiver".

16.3.5 Locating components carried in Transport Streams

Note this is only relevant for Stream objects with the Storage attribute set to stream.

The MHEG-5 Stream class identifies streams using a two step process:

1. Identify a "multiplex" via the Content internal attribute.

   The MHEG-5 term "multiplex" is used in a generic sense (i.e. a collection of elementary streams), **in this profile** it corresponds to a DVB Service / MPEG program, and should not be confused with other uses of the term such as a DTT multiplex (which is an MPEG Transport Stream).

   There are four ways of defining a reference to a multiplex. For broadcast multiplexes the data resolves to identifying a service via the triple: original_network_id, transport_stream_id and service_id. For Interaction Channel references the "multiplex" is described by a URI that is resolved by the remote server to a file or data stream containing an MPEG program.

2. Identify individual components within this "multiplex" via the ComponentTag attribute.

16.3.5.1 Multiplex references

DSM-CC Stream Object: In this mechanism the OrigContent attribute identifies a DSM-CC Stream Object. For this profile the receiver is only required to support Taps in the Stream Object of use BIOP_PROGRAM_USE. This kind of Tap maps the "multiplex" onto a single DVB Service. See Table 17-18 "BIOP::StreamMessage syntax".

URL explicit format: In this mechanism the OrigContent attribute contains a URL, as described in Section 18.3.3 "URL formats for access to broadcast services". This maps the "multiplex" onto a single DVB Service.
Although most of this functionality can be provided by the DSM-CC Stream object, it allows references to be built into the application. Also it is the same notation as used for the SI_TuneIndex Resident Program so provides a degree of consistency, i.e. the same data can be used both to preview and then to tune to a service.

UK-DTT URL inheritance formats

In this mechanism the OrigContent attribute contains one of two forms of a UK-DTT URL:

- The OctetString "rec://svc/def" maps the "multiplex" to the service most recently tuned to. For example, by the receiver's built-in navigator or the SI_TuneIndex ResidentProgram.

- The OctetString "rec://svc/cur" maps the "multiplex" to the service currently being received. If the components are from more than one service, then the order of priority of mapping shall be video then audio.

  The service referenced by "rec://svc/cur" may be different from that referenced by "rec://svc/def" if, since the last service tune, an MHEG-5 application has set the service being decoded using a Stream object with OrigContent specifying either a service URL or a reference to a DSM-CC Stream Object.

  The services referenced by "rec://svc/cur" and "rec://svc/def" will be the same if service selection was done by the receiver's built-in navigator or the SI_TuneIndex ResidentProgram.

See also Section18.1 "Names within the receiver".

Interaction Channel format — In this mechanism the OrigContent attribute contains a URI with a source of "http:". This indicates that the "multiplex" refers to a data stream that is sourced via the Interaction Channel. The data stream delivered is a Transport Stream containing a single MPEG Program, from which components are selected.

Services in other transport streams

In this profile all forms of multiplex reference are constrained to refer to services in the same transport stream as that delivering the current object carousel. Selection of services in other transport streams is supported by SI_TuneIndex.

StreamEvent events

Streams shall only support StreamEvents when referenced as a DSM-CC Stream Object, and where the contained events are "do-it-now" events.

Because an NPT time base is not supported in this profile DSM-CC scheduled events are not supported.

See Section 17.2.4.5 "Stream Descriptors"

CounterTrigger events — CounterTrigger events shall only be generated in the case where the Stream class references a stream obtained from the IP connection.

See Section13.13.2 "CounterPosition attribute".

Content management — Receivers shall ensure that any content management controls that apply to the referenced service are observed. See section 8.13.

16.3.5.2 Component references

The mapping of ComponentTag values to service components is described in Section17.3 "AssociationTag mapping".

16.3.5.3 Example

An application object might include:

```
{:Stream 1
  :OrigContent :ContentRef( "rec://svc/cur" )
  :Shared True
  :Multiplex ( {:Audio 2 :ComponentTag -1 } )
}
```

This allows the current service's default audio to continue without disruption. However, if present in the service video and subtitles will stop at the end of application object preparation.

16.3.6 Locating components carried in an Elementary Stream

Note: this is only relevant for Stream objects with the Storage attribute set to memory.

The stream is identified via the Content internal attribute, which provides a reference to the relevant file. The ComponentTag attribute shall be ignored.

16.3.6.1 Example

An application object might include:

```
{:Stream 117
   :InitiallyActive false
   :CHook 11
   :OrigContent :ContentRef('/sound1')
   :Shared true
   :Multiplex
   (
      {:Audio 118
        :ComponentTag 2 //this tag value is ignored
      }
   )
   :Storage memory // must be this type
}
```

16.3.7 Stream presentation errors

Where an application requests presentation of media that cannot be presented by the receiver, no other media shall be presented in its place. For example: a request to present video from a DVB service that is not known to the receiver shall not cause that service to be substituted with another; neither shall failure to resolve the ComponentTag of a stream component cause that component to be replaced with another.

Service references using DSM-CC Stream or StreamEvent messages shall also follow this behaviour but note that default behaviour *is* defined within the association tag mapping rules (see Section 17.3.1.2 "deferred_association_tags_descriptor").

Failure to resolve a reference to a broadcast service in a Stream object shall not cause a ContentRefError engine event to be raised, except where the failure is in retrieving data from the carousel.

16.3.8 IC Stream buffering

This section defines a buffer reference model that allows an application to :

- present "near seamless" transitions between successive content
- insert secondary content such as adverts at arbitrary points within primary content.

The implementation of IC Stream content buffering is receiver dependent but shall support the buffer reference model as a minimum.

16.3.8.1 Buffer reference model

The IC stream buffer reference model defines how Stream content delivered by IP shall be downloaded and buffered in response to application control of MHEG-5 Stream objects. The model defines a single buffer which is managed by the receiver. Content is written to the buffer as it is downloaded and is consumed from the buffer as it is presented.

Content associated with a playing or paused Stream can be considered as 'primary'. Content associated with a 'prepared' Stream can be considered as 'secondary'. The application declares content as primary by activating the Stream object and as secondary by 'preparing' the Stream object as defined in 16.3.8.2.

When the last byte of downloading content is written to the buffer the receiver shall begin downloading and buffering any secondary content. If more than one Stream has been prepared then the associated secondary content shall be buffered sequentially in the order in which the Streams were prepared.

16.3.8.2 Application control of the IC stream buffer

IP-delivered stream content may be 'prepared' by an application by executing one of the following elementary actions on a Stream:

- A Preload on a Stream object with AvailabilityStatus set to False
- A SetData on a Stream object with RunningStatus set to False
- A SetCounterPosition on a Stream object with RunningStatus set to False.

The content associated with a prepared Stream object is considered secondary and shall therefore be downloaded when buffer space becomes available.

The application may define the end point of a Stream's content by executing the SetCounterEndPosition elementary action. When the last byte of content associated with this counter position has been acquired the receiver shall halt the download and begin downloading any secondary content. The application may reset the content end point to the natural end by executing a SetCounterEndPosition with a value of -1.

When the first byte of IP-delivered stream content is buffered a ContentAvailable event shall be generated. The event shall be generated as a result of the Preload or SetData elementary actions (when the content is to be started from the beginning) and as a result of a SetCounterPostion elementary action (when the content is to be started from some arbitrary mid point). If a secondary Stream's buffered content is discarded for any reason (e.g. as a result of a SetCounterPosition or SetData on a primary Stream) then the content shall be re-buffered when possible but shall not result in further ContentAvailable events being generated.

16.3.8.3 Restrictions

The receiver shall not buffer more than 3 x 10^6 bytes of content associated with each prepared or active Stream object prior to that content being presented.

A receiver may also provide additional buffering of presented content to improve skip backwards performance but this is not defined within the scope of the Buffer Reference Model.

Receivers shall discard any previously buffered content for a Stream object when that object is destroyed or when the ContentPreparation behaviour begins for new content as defined in section 20.6 of ISO/IEC 13522-5:1997/Cor.1:1999(E) [41].

When reading the data from a URL into the buffer, receivers shall not make multiple concurrent HTTP requests for this streaming data. Some implementations may need to read an amount of the data prior to playback for the purposes of configuring stream playback. In this case, a receiver may read data from a URL prior to buffering the data for playback provided that this does not use multiple concurrent HTTP requests. During uninterrupted linear playback under ideal network conditions receivers SHALL NOT make multiple requests for the content.
"NOTE: This is so as to minimise the overheads on the server.

All buffer management must be done by the client application reading not more than the required amount of data from the TCP socket. This allows the TCP stack to manage the TCP session.

16.3.8.4 Example

Figure 16-0 shows the application, reference buffer and presentation over time Streams B and C are inserted into Stream A.
NOTE: The diagram is not drawn to scale and exaggerates the gaps in presentation.

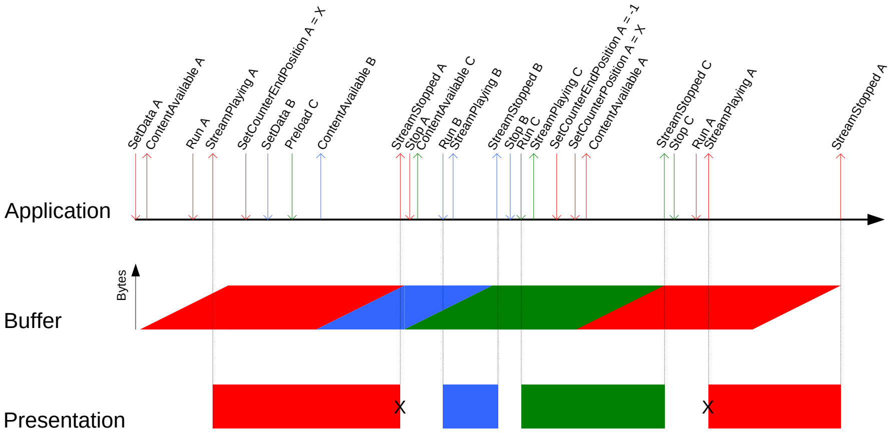


Figure 16-0 Non-linear stream buffer example

The application prepares Stream A by executing a SetData and content download begins. When sufficient content has been stored a ContentAvailable is generated. The application then Runs A and a StreamPlaying event is generated when A is presented.

The application then sets Stream A insertion position X with SetCounterEndPosition and prepares Streams B and C with SetData and Preload respectively. When the presentation of Stream A ends at position X a StreamStopped event is generated and the application stops A and runs B.

When presentation of Stream B ends a StreamStopped event is generated and the application stops B and runs C. Stream A end point is reset with SetCounterEndPosition and then prepared to begin at position X with SetCounterPosition. When Stream C's StreamStopped event is generated the application stops C and runs A and the presentation begins from position X.

16.4 Application Interaction with user control of Linear Content Decoders

This section addresses how the presentation of linear components (video, audio and subtitles) is affected by viewer and application controls. The figures in this section define a logical model for each component type on the basis that an application is running. Consequently actual implementation may vary.

16.4.1 Video Decoder

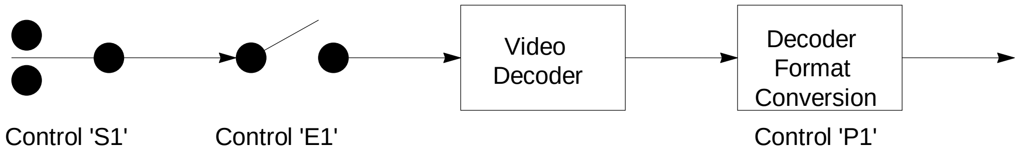


Figure 16-1. Video Control - logical model

Enabling controls

EI This is the application's control over whether or not video is displayed. It is achieved by the presence of an active MHEG-5 Video object within an active MHEG-5 Stream object. See Section 16.3.3 "Stream inheritance on Application object activation".

Selection controls

SI This is the selection of a video component from broadcast. This selection is based on the attributes of the MHEG-5 Stream and Video objects identified above.

Presentation controls

PI This represents processing to control the scaling and positioning of the decoded video. It is based a number of factors including (but not exclusively) viewer preferences and application signalling. See Section16.6 "Application control of aspect ratio".

16.4.2 Audio decoder

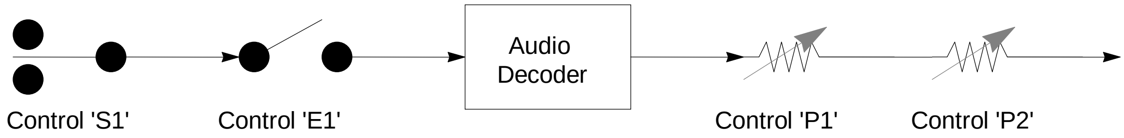


Figure 16-2. Audio Control - logical model

Enabling controls

EI — This is the application's control over whether or not audio is presented. It is achieved by the presence of an active MHEG-5 Audio object within an active MHEG-5 Stream object. See Section 16.3.3 "Stream inheritance on Application object activation".

Selection controls

SI — This is the selection of an audio component from broadcast or from memory. This selection is based on the attributes of the MHEG-5 Stream and Audio objects identified above, and viewer preferences e.g. language.

Presentation controls

PI — This is the application's control of the audio volume level. In *UKEngineProfile1* this control is only required to be on/off. The volume adjustment defined by an MHEG-5 Audio object is measured in dB and shall be interpreted as follows:

0 dB	Means that P1 does not increase or decrease the volume of the audio coming from the audio decoder
< –256 dB	Means that P1 mutes the audio
> 0 dB	Shall be implemented as 0 dB or louder Note: May be approximated as 0 dB
< 0 dB	Shall be implemented quieter than 0 dB Note: May be approximated as mute

P2 — This is the viewer's control of audio volume level. Typically it will be operated by the "Mute", "Vol+", & "Vol-" keys on the remote controller.

16.4.3 Subtitle decoder

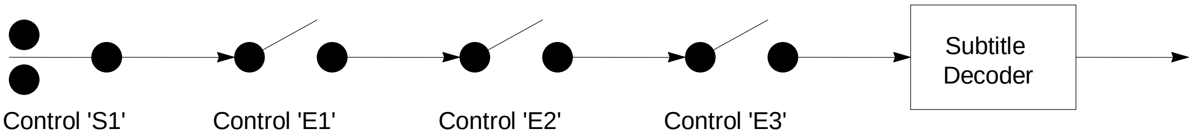


Figure 16-3. Subtitle decoder control - logical model

Enabling controls

E1 This is the first point of application control over whether or not subtitles are presented. It is achieved by the presence of an active MHEG-5 Video object within an active MHEG-5 Stream object, with the displayed video scaled to full-size. See Section 16.5.1.1 "Flexibility of control".

E2 This is the second point of application control over whether or not subtitles are presented. It is dependent on the state of subtitle presentation as determined by the SetSubtitleMode ResidentProgram. See Section 13.10.8.4 "SetSubtitleMode".

E3 This is the viewer's control of over whether or not subtitles are presented based on their preference setting. Typically this will be defined as part of receiver set-up and/or a "Subtitle" key on the remote controller.

Selection controls

SI This is the selection of a subtitle component from broadcast. This selection is based on the attributes of the MHEG-5 Stream object containing the MHEG-5 Video object identified above, and viewer preferences e.g. language.

Presentation controls

None.

16.5 Application impact on stream decoder specification

16.5.1 DVB Subtitles

16.5.1.1 Flexibility of control

If the receiver implements *ICStreamingExtension* then it shall support the simultaneous presentation of MHEG-5 applications and DVB subtitles.

Subtitles are a facet of full screen video

In this profile subtitles are treated as a facet of the video stream and hence maintain the same position in the display stack as the video component, therefore, MHEG-5 Visible objects may overlay the TV service's DVB Subtitles.

If video is scaled to other than full size by a ScaleVideo elementary action, or the origin of decode is moved to a point other than (0,0), the subtitles shall not be presented.

Subtitles have priority if enabled

If a platform does not support the simultaneous display of subtitles and MHEG-5 applications then subtitles shall be presented in preference to MHEG-5 applications if:

- The viewer has selected to view subtitles (by a subtitle key or a stored user preference), and
- A subtitle component is signalled in the PMT of the service.

If the user deactivates presentation of subtitles then normal presentation of the MHEG-5 application shall return.

Where a platform supports the simultaneous display of subtitles and MHEG-5 applications the application author may choose to disable presentation of subtitles using the SetSubtitleMode ResidentProgram.

16.5.2 Video decoder performance

The real-time performance of the MPEG Video [34] decoder shall be maintained regardless of the number of visibles that obscure it.

16.5.3 Trick modes

Receivers shall not implement trick modes. However, as described in ISO/IEC 13522-5, speed > 0 shall be treated as normal decoding, speed ≤ 0 shall pause the decoding.

Pause behaviour

The effect of pausing a stream object (by using the SetSpeed(0) action) on its StreamComponents is as follows:

- If the stream object contains an active Video object, the video decoder output freezes on and maintains the current or a subsequent frame in an implementation dependent way. If subtitles are active, they shall either freeze or disappear from the screen.
- If the stream object contains an active Audio object and has its Storage attribute set to stream then whilst it is paused, the audio output is muted and the associated stream component decoders shall discard incoming data.
- If the stream object contains an active Audio object and has its Storage attribute set to memory then whilst it is paused, the audio output is muted. If the stream object is resumed (e.g. by using the SetSpeed(1) action), the presentation of the audio will continue from the point at which it was paused.

Stream component decoders that are controlled by other stream objects shall not be affected by this behaviour.

If the stream object is playing streamed content from an IP connection then whilst it is paused, the audio output is muted and video is paused. If the stream object is resumed (e.g. by using the SetSpeed(1) action), the presentation of the stream will continue from the point at which it was paused.

16.5.4 MPEG presentation

This clause describes the scaling of the output of the video decoder when an MHEG-5 application is executing. It applies to the presentation of video streams, MPEG-2 I-frames and, where supported, H.264/AVC I-Frames.

16.5.4.1 MPEG Scaling Reference Model

The model of the relationship between the output of the MPEG Video Decoder and the On Screen Display (OSD) is shown in Figure 16-4. Significantly, the OSD is modelled as being inserted *after* the decoder's format conversion (which typically provides functions such as centre-cut-out and letter boxing to adapt a 16:9 signal for 4:3 displays) but before the display's format conversion (which typically provides functions to adapt a 4:3 signal to a 16:9 display). The MHEG-5 ScaleVideo and ScaleBitmap actions are considered to act on the decoder's format conversion circuits, i.e. before the OSD is added.

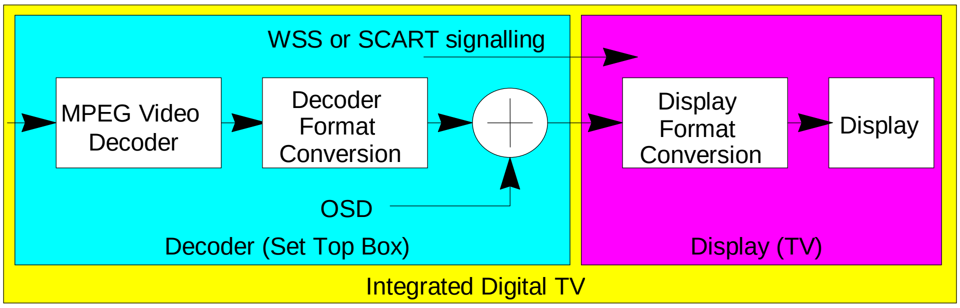


Figure 16-4. Receiver and display format processing reference model

Default scaling values

Attribute		**Default value**
BitmapScale Note: in this profile, bitmap scaling is only supported for content hook 2 and where supported content hook 7	XBitmapScale	720
	YBitmapScale	576
VideoScale	XVideoScale	720
	YVideoScale	576

16.5.4.2 Transparency of MPEG encoding

The resolution at which the MPEG video [37] is encoded is transparent to the application and is always considered logically to be 720x576. This affects MHEG-5 scaling of video and I-frames and the VideoToGraphics resident program (see Section13.10.8.1).

The examples below illustrate this principle. However, for simplicity, they ignore the effects of letter box or centre cutout processing that may additionally be required to adapt the video aspect ratio to that of the display. See also Section16.6.

Example 1

Consider MPEG video encoded at 352x288 resolution (whichTR 101 154 [9] regards as a "full screen" format). When an MHEG-5 application requests "full screen" presentation of this video it logically (from MHEG-5's point-of-view) requires 100% scaling.

For this case, transparently to the MHEG-5 engine, the receiver must implement x2 horizontal and vertical scaling to reconstruct the image to the full screen size. The result of the x2 scaling (a 704x576 image) shall be centred within the 720x576 display. The gap between the 720x576 display and the reconstructed MPEG shall be filled with black.

The gap between the 720x576 display and the reconstructed 352x288 MPEG is outside of the analogue active line and so is not generally visible. However, in theory the MPEG image might be smaller, 300x200 for example. This would be considered as a cropped 352x288 image and so reconstruct to 600x400. In this case the gap around the 600x400 image centred in the 720x576 display would be significant and visible.

Example 2

Consider MPEG video encoded at 544x576 resolution and an MHEG-5 application requesting "full screen" presentation of this video.

Transparently to the MHEG-5 engine the receiver implements x4/3 horizontal and x1 vertical scaling to reconstruct the image to 725x576 from which the central 720x576 area is extracted for display.

16.5.4.3 Quarter-screen MPEG

Where the content is MPEG a ScaleVideo action on a Video object and a ScaleBitmap action applied to a Bitmap object is logically applied to the MPEG decoding pipeline after the reconstruction of the MPEG image to full-screen size as described in Section16.5.4.2 "Transparency of MPEG encoding".

The mandatory scaling factors supported by this profile are as follows:

Full-screen (720x576) and quarter-screen (360x288) are required for all video resolutions. For source video that has a horizontal_size of 545 to 720 pixels (i.e. where no up-sampling applies), additional scaling factors are required for which the resulting image width is any one of 1440, 1080, 720, 540 and 360 and the image height is any of 1152, 576 and 288.

When MPEG is shown full-screen the limits of the analogue active line and the display overscan naturally conceals defective or inactive pixels at the margins of the picture. When the picture is scaled to less than full-screen size these pixels may be revealed. To prevent this, applications should mask quarter-screen MPEG video and bitmaps using a box size of 344x284 and centre the MPEG decode using a position offset of (-8, -2) (see "SetVideo-DecodeOffset(NewXOffset, NewYOffset)").

Subtitles and scaled videoSee Section16.5.1.1 "Flexibility of control".

16.5.4.4 BoxSize for MPEG images

If the scaled decoded image does not completely fill the area described by the Video or Bitmap object's BoxSize attribute, the remaining area of the object shall appear black.

16.5.4.5 Video / I-frame object placement12

All receivers are required to display images that meet the following restrictions:

- The decoded image, before any masking, meets the requirements defined in Sections 13.4.1.1 and 13.4.1.2.

If applications erroneously invoke conditions that do not meet these criteria (for example an illegal position) the engine shall either not present the object or shall correctly present it. Note that applications may transiently position objects such that the above conditions are not met.

Restricted capability

Some receivers do not have the capability to place decoded images at odd pixel positions on one or more axes. In these cases, it is acceptable for receivers to round down an odd co-ordinate of the decoded image to the nearest even co-ordinate value. The implementation of the VideoToGraphics resident program shall take into account any such deterministic errors.

Example

If an MHEG Video object were positioned at co-ordinates (25,34) with a decode offset of (-12,45), then normally a receiver would apply a decode position of (13,79). For receivers with restricted capability, a decode position of one of (12,79), (13,78) or (12,78) may be applied instead.

16.5.5 Content management of IC streams

Receivers shall not allow streamed content delivered by IP to be:

- redistributed through any local or remote network
- stored on storage media other than as required by the buffer reference model, see Section 16.3.8 IC Stream buffering
- presented through any HDMI output without HDCP being enabled.

16.5.6 Multiple stream objects

The components of a single MPEG program and components sharing a common
PCR may be divided among more than one stream object. See Section16.8.2 "Numbers of objects".

Pausing one stream object has no effect on any other active stream objects including those associated with the same program.
So, for example, if the video and audio components of a program are associated with two different stream objects the video can be paused (using a SetSpeed action targeted at its stream object) while allowing the audio to continue decoding.

Receivers are not required to support the simultaneous presentation of Streams from both broadcast and an IP connection.

Receivers are not required to support the simultaneous presentation of more than one Stream object that is playing streamed content from an IP connection.

Simultaneous Demultiplexing Receivers supporting the InteractionChannelExtension are required to present A/V stream components from IC delivered streams whilst simultaneously monitoring broadcast delivered life cycle signalling and DSM-CC object carousel updates. Receivers shall be able to simultaneously demultiplex at least one IC delivered transport stream and at least one broadcast delivered transport streams.

16.6 Application control of aspect ratio

In the MPEG Scaling Reference Model (see Section16.5.4.1), two transformation stages combine to influence the final appearance of the displayed picture:

- The Decoder Format Conversion (DecFC) governs how the video and MHEG-5 graphics are combined.
- The Display Format Conversion, influenced by Widescreen Signalling information (WSS) and viewer preferences, determines the size and shape of the final image.

The two controls, DecFC and WSS, are influenced by a combination of the following factors:

- the display aspect ratio
- the presence and scaling of video
- the aspect ratio of any video, as well as any associated Active Format Descriptor (AFD)
- the AspectRatio attribute of any MHEG-5 Scene
- the current "Widescreen Alignment Mode" (see Section13.10.8.2 "SetWidescreenAlignment")

The following sections describe the required behaviour for the three cases of no video, quarter-screen video and video greater than quarter-screen.

16.6.1 No active video object

Where there is no active Video object, only control of the WSS is relevant. If the current scene has no explicit AspectRatio, the receiver shall attempt to fill the display with the MHEG-5 scene, otherwise the receiver shall signal the specified AspectRatio to the display.

In summary, the WSS shall be as follows:

	Scene AspectRatio		
Display aspect ratio	**4:3**	**16:9**	**unspecified**
4:3	4:3	16:9[a]	4:3
16:9	4:3[b]	16:9	16:9

Table 16-2. WSS signalling - no active Video object

a] WSS signalling to 4:3 displays will in many cases not be correctly interpreted. See 19.5.4.

b] 4:3 presentation may not be supported over HDMI and the presentation may be distorted to the display's native aspect ratio. See 19.5.5

16.6.2 I-frames

MPEG-2 and H.264/AVC I-frames shall be presented with no DecFC (except for any scaling) i.e. the raster's encoded aspect ratio and any AFD shall be ignored. Note: at full-screen size, this means that pixels of a 720x576 I-frame align precisely with the SD pixels of an MHEG-5 Scene.

16.6.3 Quarter-screen video

When an active Video object is scaled to quarter-screen size, WSS shall be the same as when no video is present (see Section16.6.1).

The DecFC shall, as far as possible, be set so as to preserve the video aspect ratio and fill the 360x288 quarter-screen video decode area. It is recognised that some receivers cannot perform a pillarbox transformation in the decoder and may have to distort 4:3 pictures for display in 16:9.

The following table illustrates the preferred DecFC transformations for each state of WSS (obtained from Section16.6.1):

	Video coded frame	
WSS	**4:3**	**16:9**
4:3	None	Centre cut-
16:9	Pillarbox[a]	None

Table 16-3. WSS signalling - quarter screen video

a] Where a pillarbox transformation cannot be supported, the preferred DecFC is None.

16.6.4 Video greater than quarter-screen

Where the MHEG-5 Scene's AspectRatio is unspecified, both WSS and DecFC shall be the same as if no MHEG-5 application were running.

Where the active MHEG-5 Scene *does* specify an AspectRatio, the WSS and DecFC shall be set according to the video format and Scene AspectRatio, as follows. This mode is intended to support the alignment of MHEG-5 graphics over video.

Video	**4:3 coded frame**		**16:9 coded frame**	
Scene	**4:3**	**16:9[a]**	**4:3**	**16:9**
WSS[b]	4:3	16:9	4:3	16:9
DecFC	None	None	As	None[d]

Table 16-4. Video full-screen or greater

a] The case of aligned presentation of 4:3 video with a 16:9 Scene is defined for completeness but is unlikely to be of use to applications. Video aspect ratio will not be preserved in this case.

b] WSS follows the Scene AspectRatio, as in Section 16.6.1 "No active video object" and Section 16.6.3 "Quarter-screen video" cases. See Section19.5.4 and Section 19.5.5.

c] The DecFC to be used for display of 16:9 pictures on 4:3 displays is determined by the currently-selected WidescreenAlignmentMode when an explicit 4:3 Scene AspectRatio is used (see Section 13.10.8.2 "SetWidescreenAlignment").

d] This mode gives an anamorphic picture on 4:3 displays that do not observe WSS signalling. It is intended that this mode be used when the video is not aspect ratio sensitive.

16.6.5 Decision trees

The behaviour described above can be summarised as shown in the following two diagrams:

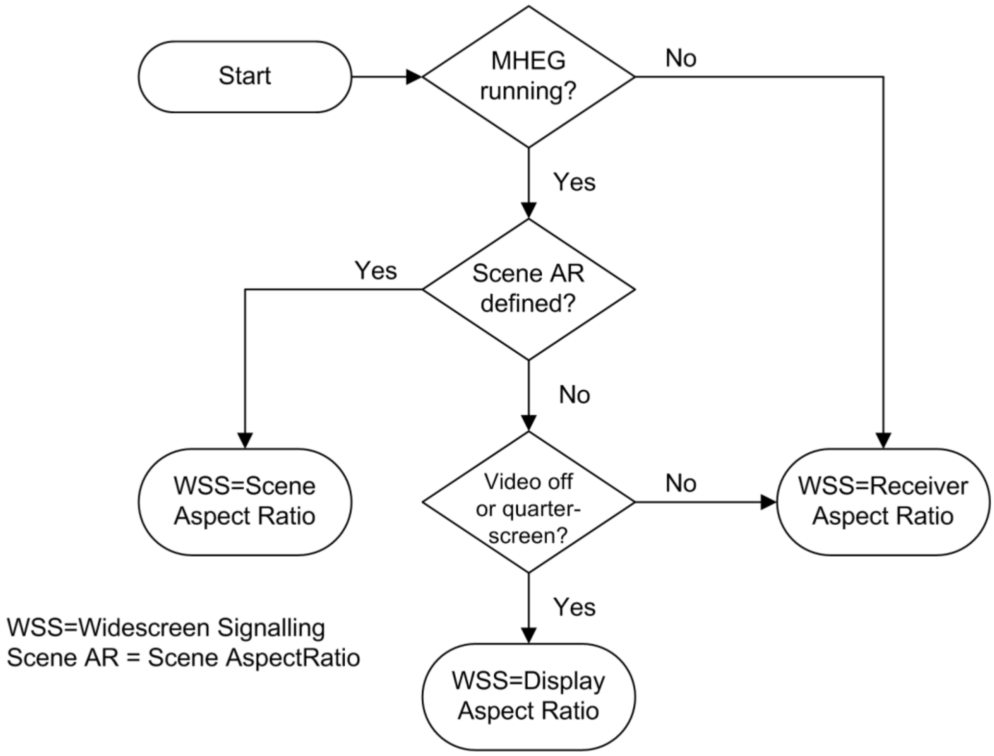
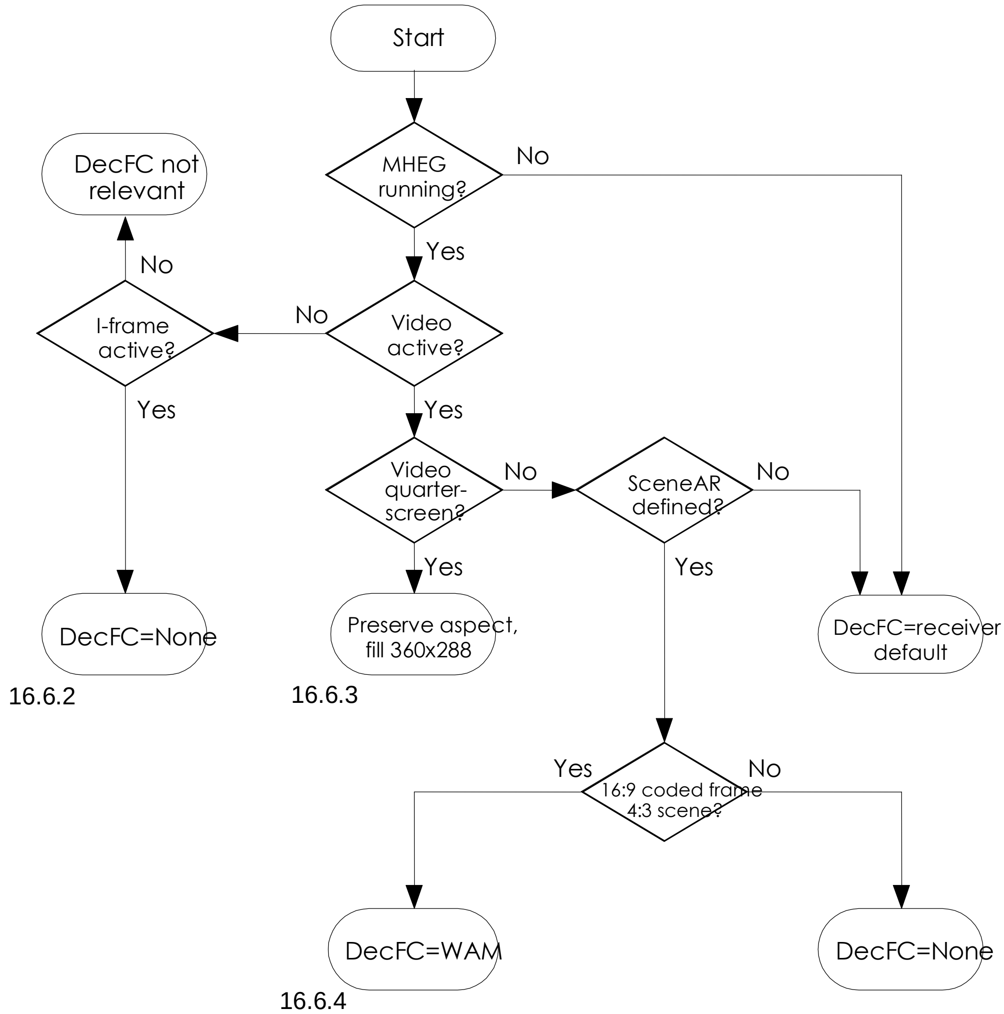


Figure 16-5. Widescreen Signalling (WSS) decision tree



DecFC=Decoder Format Conversion
SceneAR=Scene AspectRatio
WAM=Widescreen Alignment Mode

Figure 16-6. Decoder Format Conversion (DecFC) decision tree

16.7 Persistent storage

The engine shall provide "persistent" storage for at least 1024 bytes of data.

For receivers that implement *InteractionChannelExtension* the persistent storage should be implemented in such a way that data is retained whilst the receiver is in standby mode.

The file name used to access this storage shall be of the form "ram://<name>". It is the responsibility of the broadcasters to arrange a practise for the use of <name> such that there is no accidental collision of file names.

Receivers that implement *InteractionChannelExtension* shall implement storage that persists through a power cycle. This is referred to as "true persistent storage" and is described in 16.7a, "True persistent storage".

When writing a file to persistent storage the receiver shall execute the following steps:

1. If the file to be written is larger than the total size of the persistent store the action shall complete returning StoreSucceeded is False.
2. Regardless of the availability of free memory, if a file of the same name as the file to be written already exists in the persistent storage it shall be deleted.
3. If there is insufficient free memory in the persistent storage for the file to be written, existing files shall be deleted in chronological order, i.e. oldest first, as required.
4. The action shall complete returning StoreSucceeded is True.

Also note:

1. Only the data is stored (not type information)
2. The decoder model for memory use in the persistent store is:

Data	
Integer	**4 bytes** This shall be able to contain all of the possible values for an IntegerVariable as defined under Section 13.11 "Limitations on standard data-types".
Boolean	**1 byte** This shall be able to contain all of the possible values for a BooleanVariable as defined in Section 13.11 "Limitations on standard data-types".
OctetString	**Number of bytes in OctetString + 4 bytes** This shall be able to contain all of the possible values for an OctetString as defined in Section13.11 "Limitations on standard data-types". This model assumes an integer encoding the length of the string is stored in addition to the string data.
ObjectReference	**Number of bytes in GroupIdentifier+ 8 bytes** This shall be able to contain all of the possible values for an Object Reference given the allowed values for GroupIdentifier & ContentReference and Integer as defined in Section 13.11, "Limitations on standard data-types". This model assumes ObjectReferences are stored like an OctetString with an Integer.
ContentReference	**Number of bytes in ContentReference+ 4 bytes** This shall be able to contain all of the possible values for an OctetString as defined in Section13.11 "Limitations on standard data-types". This model assumes ContentReferences are stored like an OctetString.

Table 16-5. Memory model for persistent storage

3. The set of values is stored in the order they are enumerated in the ASN.1 DER encoding of the StorePersistent InVariables list.
4. The behaviour of ReadPersistent() is undefined unless the set of values is enumerated in the same order as the StorePersistent() that created them.

16.7a True persistent storage

For receivers that implement *InteractionChannelExtension*, true persistent storage shall be provided. True persistent storage is defined as storage that persists through a power cycle of the device.

A receiver shall make available at least 100 bytes of true persistent storage per service for at least 800 services, which can be used by a service to store one file. The receiver only needs to provide the ability for each file to be overwritten a minimum of 64 times every 28 days. The file name used to access this storage shall be of the form “pst://<name>”.

The <name> part of the file name “pst://<name>” shall be a maximum of 8 bytes long. The first 3 bytes shall be a unique 3 character string provided to the broadcaster/application author by the DTG.

If more than 800 services have stored true persistent files, the receiver may delete true persistent files assigned to services that are not in the current service list.

Once a file has been stored, it can be read or overwritten by any service. If a service that did not originally create the file overwrites it, the service that the file is assigned to is changed to be that of the new service and any file assigned to that service is deleted. The restriction that the file is not overwritten more often than 64 times every 28 days is independent of the service that is trying to overwrite it.

When writing a file to true persistent storage the receiver shall execute the following steps:

1. If true persistent storage has been disallowed by a user (see 16.7a.1), the file shall not be saved and the action shall complete returning StoreSucceeded is False.
2. If the size of the file is greater than 100 bytes, the file shall not be saved and the action shall complete returning StoreSucceeded is False.
3. If there is a true persistent file already assigned to the current service which was overwritten more than 64 times within the 28 day period, the receiver may choose not to save the file and complete the action returning StoreSucceeded is False
4. If there is a true persistent file of the same file name assigned to any service which was overwritten more than 64 times within the 28 day period, the receiver may choose not to save the file and complete the action returning StoreSucceeded is False
5. If there is a true persistent file of the same file name assigned to any service, the file shall be overwritten, assigned to the current service, any other file assigned to the current service shall be deleted, and the action shall complete returning StoreSucceeded is True
6. The file shall be written, assigned to the current service, any other file assigned to the current service shall be deleted, and the action shall complete returning StoreSucceeded is True.

Also note:

The memory model and other rules for writing a file to persistent storage (described in 16.7) apply equally to true persistent storage. References to the hybrid file system cannot be used to access true persistent storage.

16.7a.1 Management of true persistent storage

Receivers shall clear all true persistent storage and any associated write counters when the user invokes a 'Factory Reset', but shall not clear the storage when a retune is performed, even if the service that a particular file is assigned to is not found.

Receivers may implement a true persistent storage management utility where the user is able to delete files assigned to particular services.

Receivers may implement a utility to allow a user to disable all access to true persistent storage. By default, access shall be enabled.

16.7.1 Storage of file names

The <name> part of the file name "ram://<name>" shall be 8 bytes long. The receiver shall provide storage for at least 32 such file names associated with the "ram://" persistent store.

Note that references to the hybrid file system cannot be used to access persistent storage. See "File names in persistent storage (mandatory)".

16.8 Receiver resource model

16.8.1 Memory

A complete model of how receiver memory is consumed by a running application does not currently exist. However, some aspects have been defined in this profile as follows:

- Persistent file store and directory structures (see Section16.7 "Persistent storage").
- The application identifier stack (see Section16.9 "Application stacking").
- Buffers required to receive data from the network (see Section17.2.7 "Mapping of objects to modules").
- HTTP cookies (see Section17.8.5, "Cookie support").
- The hybrid file system mapping table (Section17.13, "Hybrid file system").
- Downloadable fonts (see section 15.3.1.4, "Font resource model").

16.8.2 Numbers of objects

The minimum number of concurrently active MHEG-5 objects using stream decoders that this profile of engine is required to support are:

- 1 Video object (an MPEG video stream) **OR** 1 Bitmap object using MPEG-2 or H.264 I-frame encoding
- 1 Audio object (an MPEG audio stream) with source stream or memory

See Section 19.4.1 "Number of decoders".

The numbers of other presentable object types (e.g. PNG bitmaps, buttons etc.) are only limited by the decoder memory model.

Single PCR

More than one Stream object and StreamComponent may be playing at a single time provided that:

- the above rules for the number of concurrently active objects are observed
- at any point in time the receiver shall have to handle at most a single PCR

  So, for example, an MPEG audio and an MPEG video stream from different MPEG programs (with a common PCR_PID) could each be associated with a different Stream object. If both objects are running at normal speed the audio and video shall be synchronous.

  Or, broadcast MPEG video (with a defined PCR_PID) could be presented at the same time as MPEG audio from a file, which does not rely on a related PCR.

  Or, MPEG audio from a file, which does not rely on a related PCR, could be the only stream based content being presented.

  See also Section16.5.3 "Trick modes".

16.8.3 Link recursion behaviour

Engines shall allow at least 256 concurrent Actions, and at least 4096 ElementaryActions, pending processing.

16.8.4 Timer count and granularity

Engines shall allow at least 16 concurrent MHEG-5 timers to be active.

When no more than 4 timers are active they shall maintain an accuracy of ±10 ms. Note that the time required to generate an MHEG-5 TimerFired event is not specified.

When more than 4 timers are active the accuracy may degrade in a platform-specific manner.

16.8.5 Timer duration

Receivers shall support timer durations up to at least 86,400,000 ms (24 hours).

16.8.6 HD graphics bitmap requirements

Receivers supporting *HDGraphicsPlaneExtension* shall be able to decode and present PNG and JPEG bitmaps totalling 2.08 Mpixels simultaneously with either full-screen HD video or an H.264/AVC I-frame.

Receivers shall be deemed to pass this requirement if they can present:

1. full-screen HD video, together with either:
   - a half full-screen 1920x1080 resolution PNG bitmap (1.04 Mpixels) concurrently with 99 equally sized PNG bitmaps totalling 1.04 Mpixels
   - the above scenario using JPEG images
2. an H.264/AVC I-frame, together with either:
   - a half full-screen 1920x1080 resolution PNG bitmap (1.04 Mpixels) concurrently with 99 equally sized PNG bitmaps totalling 1.04 Mpixels
   - the above scenario using JPEG images

16.9 Application stacking

To support application stacking receivers shall implement an application identifier stack capable of holding references to 5 applications.

> Since the spawned application may be in a different Service Domain (i.e. delivered by a different Object Carousel) which may be in a different service, each element in the stack shall be able to store not only the spawning application's GroupIdentifier but also information about how to locate the relevant Service Domain.

See:

- "GroupIdentifier & ContentReference"
- Section 18.3.2 "Mapping rules for GroupIdentifier and ContentReference
- "LiteOptionsProfileBody"

This is in accordance with the ISO/IEC 13522-5. Note particularly the corrigenda to ISO/IEC 13522-5 with regard to the behaviour of Launch, Spawn & Quit.

If an application terminates following a Quit action and the stack is empty or the application identifier on the top of the stack is not valid, then the receiver shall:

1. set all stream component decoders to decode the default components for the default service as determined by the receiver and set their presentation (including any video scaling and/or offset, and audio volume control) to the default state.
2. launch (if present) the autoboot application for the default service following the rules in Section17.4 "Application identification and boot".

The application identifier stack shall be reset in the following circumstances:

- each time there is a service change
- if invalid information is found on the stack
- an application is introduced by a CI module (using a RequestStart message) displacing an already executing application.

16.10 Receiver process priority

16.10.1 OSD arbitration

Access to display resources is (in order of decreasing priority):

1. Other display using processes (e.g. receiver displays such as the navigator, displays produced by a CA system, CI module etc.)
2. Broadcast components, e.g. video, audio, DVB Subtitles, MHEG-5 applications. See also Section 16.5.1.1.

When a process with higher priority requests access to the display resources it shall be granted it. This specification defines three scenarios for handling this (see below). Although it doesn't specify in detail the actual implementation, in all cases the receiver shall manage stream decoders appropriately.

Note a receiver may use different scenarios under different circumstances as convenient.

The scenarios are:

- Overlay receiver graphics on top of the MHEG-5 DisplayStack.

In this scenario the MHEG-5 application loses the "focus" (so can't get user interaction) but otherwise executes as normal. Use of the display by a competing process is "transparent" to the MHEG-5 application and no special management of stream decoders is required. The effects are identical to the user having left the room for a period.

- Remove the display resource from the MHEG-5 engine.

In this scenario the receiver shall set all stream component decoders to decode the default components for the default service as determined by the receiver and set their presentation (including any video scaling and/or offset, and audio volume control) to the default state. The receiver shall ensure that the presentation of any stream components selected under application control ends before removal of the OSD resource from the application – this is to ensure that the viewer is not exposed to video normally (partially) obscured by application graphics.

When the display resource is returned to the application, the engine is responsible for re-establishing the state of the display, including the presentation of stream components. When the MHEG application is re-prioritised the presentation of streamed content should continue in the same state (for example scaling, screen position and time offset) as when the application was de-prioritised.

Note other resources may also be removed from the MHEG engine and in the limiting case the engine is completely descheduled, see Section 16.10.2 "Event handling whilst de-prioritised".

- Kill the application.

The management of stream decoders is as described in Section 16.3.1 "Application killed by receiver".

When the display resource is returned to the MHEG-5 engine the receiver is responsible for re-establishing the state of the display, including the presentation of stream components and I-frames. Stream components shall be restored to the state of the MHEG objects representing them. Any stream components that the Application has paused shall return to the paused state after the display resource is returned. Where the receiver cannot restore a paused video frame, it shall present black until the video is restarted.

16.10.2 Event handling whilst de-prioritised

16.10.2.1 Transparently

If the MHEG-5 engine is 'transparently' de-prioritised it ceases to get the asynchronous events that are a consequence of user interaction but receives and processes all other asynchronous events.

With respect to this profile the events not received are: AnchorFired, EntryFieldFull, InteractionCompleted and UserInput. The events that are received are: AsynchStopped, ContentAvailable, EngineEvent, StreamEvent, StreamPlaying, StreamStopped, and TimerFired.

When an Application is transparently de-prioritised, StreamPlaying and StreamStopped events are generated only as a result of the application's actions. No StreamPlaying or StreamStopped events relating to the deprioritisation itself shall be delivered to the running application, for example if video were suspended for the display of a receiver guide.

16.10.2.2 Non-transparently

If the MHEG-5 engine is 'non-transparently' de-prioritised the state of the application is preserved, but some or all of the resources supporting the engine are removed. For example, demultiplexer resources may be allocated to the foreground process in which case the application may miss stream events. In the limiting case the engine may receive no processor cycle while de-prioritised.

While de-prioritised the engine's behaviour shall be self consistent. For example, if the engine's resources allow continued loading of content then the consequences of such content loading, such as generation of ContentAvailable events, shall be correct.

On being re-prioritised as the foreground process the MHEG-5 engine shall raise the PauseResume EngineEvent (Table 13-9).

16.11 Interaction with DVB Common Interface module system

16.11.1 Overview

In addition to the automatic booting of broadcast applications described in Section17.4 "Application identification and boot" a file system and an application can be introduced by a DVB CI module so that it can use MHEG-5 to interact with the user.

This section is only relevant to receivers that implement the DVB CI.

16.11.2 Introduction of CI sourced file system

Under certain conditions (see Section16.11.3.1) the Application MMI mechanism described in [15] can be used to:

- mount a CI module as a file source

  See Section 18.3 "Namespace mapping"

- launch an application object

16.11.3 Guidelines for using Application MMI resource

This clause describes the use of the Application MMI introduced by [15] in the context of this profile.

16.11.3.1 Resource contention

See 6.5.1 in [15]

A module shall be guaranteed access to the Application MMI in the following circumstance, in addition to those defined by [24] and [15].

The reasons defined by [24] and [15] are:

- following a CA_PMT message whose ca_pmt_id is 'ok_mmi'
- when responding to an EnterMenu from the host
- when responding to a GetServiceReq (see [15])

These are extended by:

- Following the receipt of a CA_PMT message whose ca_pmt_cmd_id is 'ok_descrambling' when the reason for issuing the CA_PMT message is the selection of a new service.

  Note: In the context this profile it is guaranteed that any MHEG-5 application will have been terminated prior to the channel change occurring.

Additionally the CA_PMT may be transmitted to the module when the version number of the PMT changes or there is a change in the PMT's current_next_indicator. However, in these cases the module is not guaranteed a MMI session by the host.

16.11.3.2 RequestStart

See 6.5.2 in [15]

Application Domain Identifier

The string "UKMHEGP1" (0x554B4D4845475031) shall be used in the RequestStart message to identify that the required application domain is UK Profile 1 MHEG-5.

Initial object

In addition to the defined semantics in [15] it shall be possible to transmit a RequestStart message from the module to the host that contains an InitialObjectLength of 0 and therefore no InitialObject. This case modifies the normal semantic of RequestStart:

- If InitialObjectLength is 0 and an MHEG-5 application is currently running then the application is NOT killed and the CI file system is mounted and becomes available to the application.
- If InitialObjectLength is 0 and no MHEG-5 application is currently running then the CI file system is mounted and the receiver continues looking for a broadcast auto-boot application (its normal behaviour see Section16.2.5 "Auto boot broadcast application").
- If the InitialObjectLength > 0 then the RequestStart message specifies a new application object that is to be run, any currently running application is killed to make way for the application specified by RequestStart (this is the standard semantic defined in [15]). The CI file system is mounted.

Also, with reference to the "Application context":

- If InitialObjectLength is 0 there is no change in the application context for any currently running application.

  In particular the mounted Object Carousel (if any) remains the same and the "Current Source" remains unchanged.

- If InitialObjectLength is > 0 then the application context becomes that of the newly introduced application.

  In particular the service's "Initial Carousel" (if any) is mounted and the "Current Source" becomes the CI file system (i.e. "CI:").

When InitialObjectLength > 0 then InitialObject shall specify a valid DVB-CI Application Object. The source of the file path is implicitly "CI://" so the string "foo/bar" specifies file "bar" in the sub-directory "foo" of the root of the CI device

16.11.3.3 RequestStartAck

See 6.5.3 in [15]

As defined in [15]

16.11.3.4 FileRequest

See 6.5.4 in [15]

The FileRequest message will be overloaded to allow the transmission to the module of two different request types. The first is a file request as defined in [15]. This is used to retrieve MHEG-5 files and content from the module. The second allows the creation of a private data pipe between the host and the module.

Syntax	No. of bits	Mnemonic
`RequestType`	8 bits	
`if (RequestType == 'file') {`		
`for ( i = 0; i < (N -1); i++ ) {`		
`FileNameByte`	8 bits	
`}`		
`}`		
`if (RequestType == 'data') {`		
`for ( i= 0; i < (N - 1); i++ ) {`		
`DataBytes`	8 bits	
`}`		
`}`		

Table 16-6. FileNameByte field of the FileRequest

RequestType Defines the type of request being made by the host.

RequestType	RequestType value
File	0x00
Data	0x01

Table 16-7.

FileNameByte FileNameByte is a valid name for a DVB CI file as defined in Section16.2.5 "Auto boot broadcast application").

DataBytes The data bytes for the module.

16.11.3.5 FileAcknowledge

See 6.5.5 [15]

The FileAcknowledge will be overloaded to permit the transmission from the module to the host of either file request replies or data replies.The semantics shall be as defined in [15] except for the following.

FileOK This 1 bit field is set to '1' if the file is available or this message is an acknowledgement for a FileRequest message with RequestType 'data' and '0' otherwise.

Syntax	No. of bits	Mnemonic
RequestType	8 bits	
if (RequestType == 'file') {		
FileNameLength	8 bits	
for (i = 0; i < FileNameLength; i++) {		
FileNameByte	8 bits	
}		
FileDataLength	32 bits	
for (i = 0; i < FileDataLength; i++) {		
FileDataByte	8 bits	
}		
}		
if (RequestType == 'data') {		
For (i= 0; i < (N-1); i++) {		
DataBytes	8 bits	
}		
}		

Table 16-8. FileByte field of the FileAcknowledge

RequestType Defines the type of request being responded to by the host.

RequestType	RequestType value
File	0x00
Data	0x01

Table 16-9.

FileNameLength The number of bytes in the name of the file.

FileNameByte FileNameByte is the name of the file requested by the host. This data is returned to the host to allow for implementations that may request more than one file simultaneously.

FileDataLength The number of bytes of data in the file.

FileDataByte A byte of the file requested.

DataBytes The data bytes for the host.

16.11.3.6 AppAbortRequest

See 6.5.6 in [15]

As defined in [15].

No values of AbortReqCode are defined for this application domain. So, the host shall terminate any MHEG-5 application on the host that has been started as a consequence of the current Application MMI session. Broadcast applications will not be terminated by this message. The host will follow the UK profile [13] defined auto-boot procedure following the termination of an application, see Section 16.2.2 "Launching and termination MHEG-5 applications".

16.11.3.7 AppAbortAck

See 6.5.7 in [15]

As defined in [15].

No values of AbortAckCode are defined in this application domain.

16.11.3.8 Asynchronous events

A mechanism for the DVB CI module to send asynchronous events or messages to an MHEG-5 application does not currently exist.

16.11.4 Application Info Resource "Enter_Menu"

The host shall provide access to module applications under user control from the resident navigator software.

17 File System profile for UK DTT

17.1 Introduction

17.1.1 Broadcast file system

The broadcast applications are transmitted using the DSM-CC User-to-User Object Carousels.

This specification is based on the following specifications:

- ISO/IEC 13818-1 [36] - MPEG 2 systems
- ISO/IEC 13818-6 [39] - DSM-CC
- EN 301 192 [7] - DVB specification for data broadcasting
- TR 101 202 [12] - Implementation Guidelines for Data Broadcasting

With the constraints and extensions described here.

Certain notations are used in the "value" columns of the syntax tables:

Key to notation

Symbol	
+	A value that is "allocated" e.g. configuration parameter of the object carousel server.
*	A value that is "calculated" e.g. a field whose value is calculated by the carousel server as a consequence of the number of bytes in other fields
	Grey shading indicates optional fields that receivers may ignore

Table 17-1. Key to notation

17.1.2 Interaction channel

Receivers that implement *InteractionChannelExtension* shall implement the IC file system. This is based on the following specifications:

- IETF RFC 1034 [119] - Domain Names
- IETF RFC 1035 [120] - Domain Names
- IETF RFC 1982 [121] - Serial Number Arithmetic
- IETF RFC 2109 [122] - HTTP State Management Mechanism
- IETF RFC 2131 [123] - DHCP
- IETF RFC 2132 [124] - DHCP options
- IETF RFC 2181 [125] - DNS
- IETF RFC 2246 [126] - The TLS Protocol Version 1.0
- IETF RFC 2459 [127] - Internet X.509 Public Key Infrastructure Certificate and CRL Profile
- IETF RFC 2616 [118] - HTTP/1.1
- IETF RFC 2818 [128] - HTTP Over TLS
- IETF RFC 3986 [129] - URI syntax

- ITU-T X.509 [130] - Information technology – Open Systems Interconnection – The Directory: Authentication framework
- ITU-T X.680 [32] - INFORMATION TECHNOLOGY – ABSTRACT SYNTAX NOTATION ONE (ASN.1): SPECIFICATION OF BASIC NOTATION
- ITU-T X.690 [33] - Information Technology – ASN.1 Encoding Rules: Specification Of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) And Distinguished Encoding Rules (DER)
- ETSI TS 101 812 [16] - Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification 1.1.3

with the constraints and extensions described here.

17.2 Object Carousel profile

17.2.1 DSM-CC sections

All object carousels messages are transmitted using DSM-CC section format. The DSM-CC Section format is defined in chapter 9.2 of the DSM-CC specification.

The DSM-CC standard provides an option to use either a CRC32 or a checksum for detecting bit errors. For UK DTT, we make the following restriction:

Field	Restrictions	Source
section_syntax_indicator	1 (indicating the use of the CRC32)	UK DTT
last_section_number	For sections transporting DownloadDataBlock fragments: – all modules intended to be retrieved by all receivers in conformance with this profile shall have the last section number <= 0xFE – if the last section number = 0xFF then receiver behaviour is undefined	UK DTT

Table 17-2. Restrictions on DSM-CC Section format

The maximum section length is 4096 bytes for all types of sections used in Object Carousels. The section overhead is 12 bytes, leaving a maximum of 4084 bytes of payload per section.

Sections per TS packet

The payload of no more than 4 sections shall be delivered by any single TS packet.

17.2.2 Data Carousel

17.2.2.1 General

The definitions in Table 17-3 apply to both the dsmccDownloadDataHeader and the similar dsmccMessageHeader.

Field	Restrictions	Source
TransactionId	See "Assignment and use of transactionId values"	UK DTT
AdaptationLength	The receiver may ignore the possible contents of the dsmccAdaptationHeader field.	UK DTT

Table 17-3. Restrictions on DSM-CC DownloadData and Message headers

17.2.2.2 DownloadInfoIndication

The DownloadInfoIndication is a message that describes a set of modules and gives the necessary parameters to locate the module and retrieve it.

Field	Restrictions	Source
blockSize	maximum size 4066 (max. section payload - DDB-header size (18)) The recommended blockSize is 4066.	DSM-CC (UK DTT rec.)
windowSize	0 (not used for Object Carousels)	DSM-CC
ackPeriod	0 (not used for Object Carousels)	DSM-CC
tCDownloadWindow	0 (not used for Object Carousels)	DSM-CC
tCDownloadScenario	0 (not used for Object Carousels)	DSM-CC
compatibilityDescriptor(): compatibilityDescriptorLength	0 (no compatibility descriptor for Object Carousels)	DSM-CC
PrivateDataLength	The receiver may ignore the possible contents of the privateData field	DVB

Table 17-4. Restrictions on the DII

17.2.2.3 DownloadServerInitiate

The DownloadServerInitiate is used in the case of object carousels to provide the object reference to the ServiceGateway (i.e. root directory) of the object carousel.

Field	Restrictions	Source

Field	Restrictions	Source
compatibilityDescriptor(): compatibilityDescriptorLength	0 (no compatibility descriptor for Object Carousels)	DSM-CC
privateData	Contains the ServiceGatewayInfo structure	DSM-CC
serverId	Shall be set to 20 bytes with the value of 0xFF	DVB / UK DTT

Table 17-5. Restrictions on the DSI

17.2.2.4 DownloadDataBlock

Field	Restrictions	Source
moduleId	Module ids are unique within the scope of the object carousel. See DSM-CC 11.2.3.	DSM-CC

Table 17-6. Restrictions on the DDB

17.2.2.5 ModuleInfo

The moduleInfo structure is placed in the moduleInfo field of the DownloadInfoIndication of the data carousel. It contains the information needed to locate the module.

Field	Restrictions	Source
moduleTimeOut, blockTimeOut, minBlockTime	These fields are defined in units of µs. An appropriate value must be explicitly encoded by carousel generation equipment. There is no default value that may be encoded, i.e. 0xFFFFFFFF has no special meaning. Receivers shall not employ an in-built default instead of the signalled value as there is no way to define these without knowledge of the construction of a particular carousel. See Section 19.17.3 "Timeouts (mandatory)" .	UK DTT
BIOP::ModuleInfo::Taps	The first tap shall have the "use" value 0x0017 (BIOP_OBJECT_USE). The id and selector fields are not used and the receiver may ignore them. The receiver may ignore possible other taps in the list.	DVB
BIOP::ModuleInfo::UserInfo	The userInfo field contains a loop of descriptors. These are specified in the DVB Data Broadcasting standard. The receiver shall support the compressed_module_descriptor (tag 0x09) used to signal that the module is transmitted in compressed form.	DVB / UK DTT

Table 17-7. Restrictions on the DII moduleInfo field

Syntax	bits	Type	Value	Comment
`BIOP::ModuleInfo() {`				
`moduleTimeOut`	32	uimsbf	+	
`blockTimeOut`	32	uimsbf	+	
`minBlockTime`	32	uimsbf	+	
`taps_count`	8	uimsbf	N1	≥ 1
`{`				
`id`	16	uimsbf	0x0000	user private
`use`	16	uimsbf	0x0017	BIOP_OBJECT_USE
`assocTag`	16	uimsbf	+	
`selector_length`	8	uimsbf	0x00	
`}`				
`for (j=1; j<N1; j++) {`				Possible additional taps that may be ignored by receivers.
`id`	16	uimsbf	+	
`use`	16	uimsbf	+	
`assocTag`	16	uimsbf	+	
`selector_length`	8	uimsbf	N2	
`for (j=0; j<N2; j++) {`				
`selector_data`	8	uimsbf	+	
`}`				
`}`				
`userInfoLength`	8	uimsbf	N3	
`for (k=0; k<N3; j++) {`				
`userInfo_data`	8	uimsbf	+	
`}`				
`}`				

Table 17-8. BIOP::ModuleInfo syntax

17.2.2.6 ServiceGatewayInfo

The ServiceGatewayInfo structure is carried in the DownloadServerInitiate message and provides the object reference to the ServiceGateway object.

Field	Restrictions	Source
BIOP::ServiceGatewayInfo::downloadTaps	The receiver may ignore the downloadTap list.	UK DTT
BIOP::ServiceGatewayInfo::serviceContextList	The receiver may ignore the service context list.	UK DTT
BIOP::ServiceGatewayInfo::UserInfo	The receiver may ignore the user info.	UK DTT

Table 17-9. Restrictions on the ServiceGatewayInfo

Syntax	bits	Type	Value	Comment
`ServiceGatewayInfo(){`				
`IOP::IOR()`			+	See Table 17-23
`downloadTaps_count`	8	uimsbf	N1	software download Taps
`for (i=0; i<N1; i++) {`				
`DSM::Tap()`				
`}`				
`serviceContextList_count`	8	uimsbf	N2	serviceContextList
`for (i=0; i<N2; i++) {`				
`context_id`	32	uimsbf		
`context_data_length`	16	uimsbf	N3	
`for (j=0; j<N3; j++) {`				
`context_data_byte`	8	uimsbf	+	
`}`				
`}`				
`userInfoLength`	16	uimsbf	N5	user info
`for (i=0; i<N5; i++) {`				
`userInfo_data`	8	uimsbf	+	
`}`				
`}`				

Table 17-10. ServiceGatewayInfo() syntax

17.2.2.7 Download Cancel

There is no semantic for this message in this profile. Receivers may ignore them.

17.2.3 The Object Carousel

17.2.3.1 BIOP Generic Object Message

The BIOP Generic Object Message is a common structure used by all the BIOP (Broadcast Inter-ORB Protocol) messages.

Field	Restrictions	Source
`MessageHeader::byte_order`	0 (indicating big-endian byte order)	DVB
`MessageSubHeader::objectKey`	Maximum length of the key shall be four bytes.	DVB
`MessageSubHeader::objectKind`	The short three-letter aliases shall be used, plus the null-terminator.	DVB
`Access attributes`	Access attributes are not transmitted in object carousels	DSM-CC

Table 17-11. Restrictions on the BIOP Generic Object Message

17.2.3.2 CORBA strings

In a number of places Object Carousel messages include text strings. These are formatted in accordance with 12.3.2 of CORBA V2.0 and using CDR-Lite encoding as specified by DSM-CC. I.e. the text is preceded by an integer specifying the length of the string and followed by a null terminator. The size of this integer depends on the string concerned and can be seen clearly in the syntax tables that follow. However, for clarity CORBA format strings and the size of their length fields are summarised in Table 17-12:

string	length field size (bits)	location
`objectKind_data`	32	Table 17-14 "BIOP::FileMessagesyntax"

`objectKind_data`
`id_data`
`kind_data`
	32
	8
	8
		Table 17-16 "BIOP::DirectoryMessage syntax"

`objectKind_data`	32	Table 17-18 "BIOP::StreamMessage syntax"
`objectKind_data` `eventName_data`	32 8	Table 17-20 "BIOP::StreamEventMessage syntax"
`type_id_byte`	32	Table 17-23 "IOP::IOR syntax"
`id_data` `kind_data`	32 32	Table 17-27 "Syntax of Lite Options Profile Body with ServiceLocation component"

Table 17-12. Location of CORBA format strings

17.2.3.3 BIOP FileMessage

The BIOP FileMessage is used for carrying file objects.

Field	Restrictions	Source
`MessageSubHeader::ObjectInfo`	The receiver may skip the possible objectInfo bytes.	UK DTT
`MessageSubHeader::ServiceContextList`	The receiver may skip the possible serviceContextList structures.	UK DTT

Table 17-13. Restrictions on the BIOP File Message

Syntax	bits	Type	Value	Comment
`BIOP::FileMessage() {`				
`magic`	4x8	uimsbf	0x42494F50	"BIOP"
`biop_version.major`	8	uimsbf	0x01	BIOP major version 1
`biop_version.minor`	8	uimsbf	0x00	BIOP minor version 0
`byte_order`	8	uimsbf	0x00	Big endian byte ordering
`message_type`	8	uimsbf	0x00	
`message_size`	32	uimsbf	*	
`objectKey_length`	8	uimsbf	N1	<= 4
`for (i=0; i<N1; i++) {`				
`objectKey_data`	8	uimsbf	+	
`}`				
`objectKind_length`	32	uimsbf	0x00000004	
`objectKind_data`	4x8	uimsbf	0x66696C00	"fil" type_id alias
`objectInfo_length`	16	uimsbf	N2	
`DSM::File::ContentSize`	64	uimsbf	+	objectInfo
`for (i=0; i<N2-8; i++) {`				
`objectInfo_data`	8	uimsbf	+	
`}`				
`serviceContextList_count`	8	uimsbf	N3	serviceContextList
`for (i=0; i<N3; i++) {`				
`context_id`	32	uimsbf		
`context_data_length`	16	uimsbf	N4	
`for (j=0; j<N4; j++) {`				
`context_data_byte`	8	uimsbf	+	
`}`				
`}`				
`messageBody_length`	32	uimsbf	*	
`content_length`	32	uimsbf	N5	
`for (i=0; i<N5; i++) {`				
`content_byte`	8	uimsbf	+	actual file content
`}`				
`}`				

Table 17-14. BIOP::FileMessage syntax

17.2.3.4 BIOP DirectoryMessage

The BIOP DirectoryMessage is used for carrying the directory objects.

Field	Restrictions	Source
`MessageSubHeader::ObjectInfo`	The receiver may skip the N2 possible bytes in the objectInfo field.	UK DTT
`MessageSubHeader::ServiceContextList`	The receiver may skip the N3 possible serviceContextList structures.	UK DTT
`BIOP::Name`	The name shall contain exactly one NameComponent.	UK DTT
`BIOP::Binding::bindingType`	Either "ncontext" (in the case of a Directory object) or "nobject" (in the case of a File or a Stream object). Binding type "composite" shall not be used.	DVB
`MessageBody::ObjectInfo`	The receiver may skip the possible objectInfo bytes.	UK DTT

Table 17-15. Restrictions on the BIOP Directory Message

Syntax	bits	Type	Value	Comment
`BIOP::DirectoryMessage() {`				
`magic`	4x8	uimsbf	0x42494F50	"BIOP"
`biop_version.major`	8	uimsbf	0x01	BIOP major version 1
`biop_version.minor`	8	uimsbf	0x00	BIOP minor version 0
`byte_order`	8	uimsbf	0x00	big endian byte ordering
`message_type`	8	uimsbf	0x00	
`message_size`	32	uimsbf	*	
`objectKey_length`	8	uimsbf	N1	<= 4
`for (i=0; i<N1; i++) {`				
`objectKey_data`	8	uimsbf	+	
`}`				
`objectKind_length`	32	uimsbf	0x00000004	
`objectKind_data`	4x8	uimsbf	0x64697200	"dir" type_id alias
`objectInfo_length`	16	uimsbf	N2=0[a]	objectInfo
`for (i=0; i<N2; i++) {`				
`objectInfo_data`	8	uimsbf	+	
`}`				
`serviceContextList_count`	8	uimsbf	N3	serviceContextList
`for (i=0; i<N3; i++) {`				
`context_id`	32	uimsbf		
`context_data_length`	16	uimsbf	N4	
`for (j=0; j<N4; j++) {`				
`context_data_byte`	8	uimsbf	+	
`}`				
`}`				

Table 17-16. BIOP::DirectoryMessage syntax (Sheet 1 of 2)

a] See ISO/IEC 13818-6 [39] item 2 under 11.3.2.2 "Directory Message Format" in DSM-CC "the objectInfo field shall be empty".

Syntax	bits	Type	Value	Comment
messageBody_length	32	uimsbf	*	
bindings_count	16	uimsbf	N5	
for (i=0; i<N5; i++) {				Binding
BIOP::Name() {				
nameComponents_count	8	uimsbf	N6 = 1	See Table 17-13.
for (i=0; i<N6; i++) {				
id_length	8	uimsbf	N7	NameComponent id
for (j=0; j<N7; j++) {				
id_data	8	uimsbf	+	
}				
kind_length	8	uimsbf	N8	NameComponent kind
for (j=0; j<N8; j++) {				
kind_data	8	uimsbf	+	as type_id (see Table 4-4 in TR 101 202)
}				
}				
}				
BindingType	8	uimsbf	+	0x01 for nobject 0x02 for ncontext
IOP::IOR()			+	objectRef see Table 17-23
objectInfo_length	16	uimsbf	N9	
if(kind_data == 'fil'){				
DSM::File::ContentSize	64	uimsbf	+	0 means that file size is not signalled
for (j=0; j<N9-8; j++) {				
objectInfo_byte	8	uimsbf	+	
}				
}				
else {				
for (j=0; j<N9; j++) {				
objectInfo_byte	8	uimsbf	+	
}				
}				
}				
}				

Table 17-16. BIOP::DirectoryMessage syntax (Sheet 2 of 2)

17.2.3.5 BIOP ServiceGateway message

The syntax of the BIOP ServiceGateway message is identical to that of the BIOP DirectoryMessage (described above) with the following exceptions:

- the object kind is “srg” rather than “dir”.
- use is made of the serviceContextList see Section17.4.4.1 “ServiceContextList”.

17.2.4 Streams and Stream Events

There are two versions of stream messages. The BIOP StreamMessage is used for carrying stream objects that don’t use DSM-CC Stream Events. The BIOP StreamEventMessage is used for carrying stream objects that include a stream carrying DSM-CC Stream Events.

17.2.4.1 BIOP StreamMessage

Field	Restrictions	Source
`MessageSubHeader::ObjectInfo`	The ObjectInfo field contains the DSM::Stream::Info_T structure and optionally other data after the Stream Info structure. Within this profile there is no defined use of the DSM::Stream::Info_T structure and the possible other object info data following it. Receivers conforming to this profile shall ignore this information. Broadcasts may set the duration field to zero to indicate undefined duration.	UK DTT
`MessageSubHeader::ServiceContextList`	The receiver may skip the possible serviceContextList structures.	UK DTT
`MessageSubHeader::MessageBody`	The MessageBody carries a sequence of taps. There shall be at most one tap of use BIOP_PROGRAM_USE. This tap identifies the service that provides the media stream associated with the Stream object (via a deferred_association_tags_descriptor in the PMT). The tap may only reference programs that are broadcast on the same multiplex (i.e. receivers shall not need to tune to a different multiplex in order to receive the referenced media stream). Receivers may ignore possible other Taps (such as BIOP_ES_USE and STR_NPT_USE). Note: although the tap will be ignored, if present there shall be at most one instance of a STR_NPT_USE tap for compatibility with MHP.	UK DTT

Table 17-17. Restrictions on the BIOP Stream Message

Syntax	bits	Type	Value	Comment
`BIOP::StreamMessage() {`				
`magic`	4x8	uimsbf	0x42494F50	"BIOP"
`biop_version.major`	8	uimsbf	0x01	BIOP major version 1
`biop_version.minor`	8	uimsbf	0x00	BIOP minor version 0
`byte_order`	8	uimsbf	0x00	big endian byte ordering
`message_type`	8	uimsbf	0x00	
`message_size`	32	uimsbf	*	
`objectKey_length`	8	uimsbf	N1	<= 4
`for (i=0; i<N1; i++) {`				
`objectKey_data`	8	uimsbf	+	
`}`				
`objectKind_length`	32	uimsbf	0x00000004	
`objectKind_data`	8	uimsbf	0x73747200	"str" type_id alias

Table 17-18. BIOP::StreamMessage syntax (Sheet 1 of 2)

Syntax	bits	Type	Value	Comment
objectInfo_length	16	uimsbf	N2	
DSM::Stream::Info_T {				objectInfo
aDescription_length	8	uimsbf	N3	aDescription
for (i=0; i<N3; i++) {				
aDescription_bytes	8	uimsbf	+	
}				
duration.aSeconds	32	simsbf	+	may be set to 0 to indicate undefined
duration.aMicroSeconds	32	uimsbf	+	may be set to 0 to indicate undefined
audio	8	uimsbf	+	
video	8	uimsbf	+	
data	8	uimsbf	+	
}				
for (i=0; i<N2-(N3+12); i++) {				
objectInfo_byte	8	uimsbf	+	
}				
serviceContextList_count	8	uimsbf	N4	serviceContextList
for (i=0; i<N4; i++) {				
context_id	32	uimsbf		
context_data_length	16	uimsbf	N5	
for (j=0; j<N5; j++) {				
context_data_byte	8	uimsbf	+	
}				
}				
messageBody_length	32	uimsbf	*	
taps_count	8	uimsbf	N6	
for (i=0; i<N6; i++) {				
id	16	uimsbf	0x0000	undefined
use	16	uimsbf	+	See also Sections 17.2.4.3 and 17.3.1.1 and Table 4-12 in DVB Implementation guidelines for Data Broadcasting TR 101 202 [12]
assocTag	16	uimsbf	+	
selector_length	8	uimsbf	0x00	no selector
}				
}				

Table 17-18. BIOP::StreamMessage syntax (Sheet 2 of 2)

17.2.4.2 BIOP StreamEventMessage

Field	Restrictions	Source
`MessageSubHeader::ObjectInfo`	The ObjectInfo field contains the DSM::Stream::Info_T and DSM::Stream::EventList_T structures followed optionally by other object info data (which may be ignored by receivers). See Table 17-17 regarding the DSM::Stream::Info_T. Receivers may ignore the possible other data following the DSM::Stream::EventList_T. The EventList_T defines a sequence of event names that correlates to the sequence of event ids in the MessageBody. eventNames_count shall equal eventIds_count.	UK DTT
`MessageSubHeader::ServiceContextList`	The receiver may skip the possible serviceContextList structures.	UK DTT
`MessageSubHeader::MessageBody`	The MessageBody carries a sequence of taps followed by a sequence of event ids. The sequence of taps follows the following rules: • There shall be at most one tap of use BIOP_PROGRAM_USE. This tap identifies the service that provides the media stream associated with the Stream object (via a deferred_association_tags_descriptor in the PMT). The tap may only reference programs that are broadcast on the same multiplex (i.e. receivers shall not need to tune to a different multiplex in order to receive the referenced media stream). • There shall be at most one tap with use STR_EVENT_USE or STR_STATUS_AND_EVENT_USE. This tap indicates the PID where all StreamEvent descriptors related to the StreamEvent object are broadcast. Receivers may ignore possible other Taps (such as BIOP_ES_USE and STR_NPT_USE). Note: although the tap will be ignored, if present there shall be at most one instance of a STR_NPT_USE tap for compatibility with MHP.	UK DTT

Table 17-19. Restrictions on the BIOP Stream Event Message

Syntax	bits	Type	Value	Comment
`BIOP::StreamEventMessage() {`				
`  magic`	4x8	uimsbf	0x42494F50	"BIOP"
`  biop_version.major`	8	uimsbf	0x01	BIOP major version 1
`  biop_version.minor`	8	uimsbf	0x00	BIOP minor version 0
`  byte_order`	8	uimsbf	0x00	big endian byte ordering
`  message_type`	8	uimsbf	0x00	
`  message_size`	32	uimsbf	*	
`  objectKey_length`	8	uimsbf	N1	
`  for (i=0; i<N1; i++) {`				
`    objectKey_data`	8	uimsbf	+	
`  }`				
`  objectKind_length`	32	uimsbf	0x00000004	
`  objectKind_data`	4x8	uimsbf	0x73746500	"ste" type_id alias
`  objectInfo_length`	16	uimsbf	N2	
`  DSM::Stream::Info_T {`				
`    aDescription_length`	8	uimsbf	N3	aDescription
`    for (i=0; i<N3; i++) {`				
`      aDescription_bytes`	8	uimsbf	+	see BIOP StreamMessage
`    }`				
`    duration.aSeconds`	32	simsbf	+	see BIOP StreamMessage
`    duration.aMicroSeconds`	32	uimsbf	+	see BIOP StreamMessage

Table 17-20. BIOP::StreamEventMessage syntax (Sheet 1 of 2)

Syntax	bits	Type	Value	Comment
`audio`	8	uimsbf	+	see BIOP StreamMessage
`video`	8	uimsbf	+	see BIOP StreamMessage
`data`	8	uimsbf	+	see BIOP StreamMessage
`}`				
`DSM::Event::EventList_T {`				
`eventNames_count`	16	uimsbf	N4	
`for (i=0; i<N4; i++) {`				
`eventName_length`	8	uimsbf	N5	
`for (j=0; j<N5; j++) {`				
`eventName_data`	8	uimsbf	+	(including zero terminator)
`}`				
`}`				
`}`				
`for (i=0; i<N2-((N3+12) length(DSM::Event::EventList_T)); i++) {`				
`objectInfo_byte`	8	uimsbf	+	
`}`				
`serviceContextList_count`	8	uimsbf	N6	
`for (i=0; i<N6; i++) {`				
`context_id`	32	uimsbf		
`context_data_length`	16	uimsbf	N7	
`for (j=0; j<N7; j++) {`				
`context_data_byte`	8	uimsbf	+	
`}`				
`}`				
`messageBody_length`	32	uimsbf	*	
`taps_count`	8	uimsbf	N8	
`for (i=0; i<N8; i++) {`				
`id`	16	uimsbf	0x0000	Undefined
`use`	16	uimsbf	+	See also Sections 17.2.4.3 and 17.3.1.1 and Table 4-12 in DVB Implementation guidelines for Data Broadcasting TR 101 202 [12]
`assocTag`	16	uimsbf	+	
`selector_length`	8	uimsbf	0x00	no selector
`}`				
`eventIds_count`	8	uimsbf	N4	(= eventNames_count)
`for (i=0; i<N4; i++) {`				
`eventId`	16	uimsbf	+	
`}`				
`}`				

Table 17-20. BIOP::StreamEventMessage syntax (Sheet 2 of 2)

Stream event names and event ids

The EventList_T defines a sequence of event names that correlates 1:1 to the sequence of event ids in the MessageBody. Within each BIOP::StreamEventMessage the event names uniquely associate to event id values.

- The eventNames_count shall equal eventIds_count.
- The names in the EventList_T are zero-terminated strings.
- The eventID values in the StreamEventMessage correspond to the eventID values carried in StreamEventDescriptors.

Generating MHEG-5 StreamEvents

To generate a MHEG-5 StreamEvent the following data are used:

- The EventSource is the MHEG-5 Stream instance associated with the DSMCC::StreamEvent instance;
- The EventData is an OctetString comprised of the data bytes BIOP::StreamEventMessage::eventName_data, excluding the zero termination byte, for the associated eventID of this event (see clarification above). Where the eventName_length is 0 or 1 the OctetString will be empty.

The OctetString shall contain a valid UTF-8 text string.

Tap longevity

Any taps contained within a BIOP::StreamMessage or BIOP::StreamEventMessage are resolved during the ContentPreparation behaviour of the relevant MHEG-5 Stream object. Thus subsequent changes to the BIOP::StreamEventMessage are only enacted by the receiver on future SetData actions on the MHEG-5 Stream object.

Stream event subscription longevity

On subscribing to a BIOP::StreamEventMessage event the *eventName* to *eventId* mapping is resolved during the ContentPreparation behaviour of the MHEG-5 Stream object. Thus subsequent changes to the BIOP::StreamEventMessage are only enacted by the receiver on future SetData actions.

17.2.4.3 Identifying services using StreamMessages and StreamEventMessages

BIOP_PROGRAM_USE tap

StreamMessages and StreamEventMessages use the BIOP_PROGRAM_USE tap to identify a service. This tap contains an association tag value that may map to an association tag contained within a deferred_association_tags_descriptor. Note that this association tag resolves to a *service* rather than an individual component, as detailed in see Section17.3.1 "Using an AssociationTag to reference a service".

17.2.4.4 DSM-CC Sections carrying Stream Descriptors

"do it now" events

The only events required to be supported in this profile are "do-it-now" events. During subscription, receivers shall respond to the first instance of a "do it now" event detected under a particular combination of table id, table id extension & version number. Reception of subsequent copies of the particular event shall be ignored until a different version number is detected. At this point, the event shall be "re-fired". See Section17.2.4.6 "Mapping Stream Descriptors into the MHEG-5 domain".

Section number

For this profile receivers shall only consider section number zero.

Current_next indicator

For this profile the current_next_indicator shall be set to 1 for DSM-CC Sections carrying Stream Descriptors (i.e. sections with a table_id of 0x3d).

Stream event life time

The set of stream events described in a particular BIOP::StreamEventMessage may be a subset of the events used by an application. Similarly the set of stream event descriptors being transmitted at any time may not correspond to the set of events described by any active BIOP::StreamEventMessages.

Encoding of table id extension

The section's table id extension field provides information on the stream descriptor(s) carried by the section:

table_id_extension bits				Payload of DSM-CC section with table ID 0x3D
[15]	**[14]**	**[13…8]**	**[7…0]**	
0	0	eventID[13…8]	eventID[7…0]	Section carries a single "do it now" event
0	1	xx xxxx	xxxx xxxx	Reserved for future use
1	0	xx xxxx	xxxx xxxx	Reserved for future use
1	1	xx xxxx	xxxx xxxx	Reserved for future use

Table 17-21. Encoding of table id extension for DSMCC_descriptor_lists

Note: The value of eventID for "do it now" events shall be in the range 0x0001…0x3FFF. The value 0 is not allowed (see 5.5.2.2.1 in ISO/IEC 13818-6 [39]).

"do it now" events

"do it now" events are single shot events, accordingly receivers need to make special efforts to ensure a high probability that they can be reliably received.

Broadcasters are responsible for placing all "do it now" stream descriptors that may be of interest to an application on a single PID. This may be the same PID as is used for other DSM-CC sections.

Resources to monitor stream events

Receivers shall dedicate a section filter to monitoring the possible transmission of "do it now" events while there is any active links waiting for such events.

See "Stream events".

17.2.4.5 Stream Descriptors

Stream Event descriptor In this profile all stream event descriptors shall only carry "do-it-now" events. Thus any eventNPT signalled in a StreamEventDescriptor shall be ignored. As the eventId for a "do-it-now" event is signalled in the section header, and the eventNPT field is ignored, the receiver only needs to parse the section header in order to act upon the event. This stream event descriptor is included in the section to provide future compatibility.

The privateDataByte field shall be ignored by the receiver.

NPT Reference descriptorReceivers may ignore this descriptor if present.

NPT Endpoint descriptor Receivers may ignore this descriptor if present.

Stream Mode descriptor Receivers may ignore this descriptor if present.

17.2.4.6 Mapping Stream Descriptors into the MHEG-5 domain

The DSM-CC Event interface provides a means for delivering events through the MPEG-2 stream. This interface has three primitives, which according to ISO/IEC 13818-6 [39] are:

DSM Event subscribe	Subscribe to receive an event over an MPEG stream.
DSM Event unsubscribe	Indicate desire to no longer receive an event.
DSM Event notify	Obtain event data from a Stream Event descriptor.

The occurrence of subscribe and unsubscribe shall be determined by the state of MHEG-5 objects in the currently running application. An event is said to be 'subscribed' when the MHEG-5 Stream object referencing the relevant StreamEvent message is running and at least one MHEG-5 Link object that captures the event is active. An event is'unsubscribed' when either the Stream object is no longer running or all Links that capture the event are deactivated. The occurrence of the 'unsubscribe' primitive shall be independent of the 'notify' primitive.

The notify primitive shall occur whenever a relevant Stream Event descriptor is received. In the case of "do-it-now" events the notify primitive shall occur on every version change of the descriptor carrying the event, or when the descriptor is received for the first time since subscription. This allows multiple programme events to be trapped by the same MHEG-5 Link object without any need to re-subscribe.

17.2.5 BIOP Interoperable Object References

An Interoperable Object Reference (IOR) is a reference to an object and it contains the necessary information to locate the object. The IOR structure may contain different options to be able to point to objects that can be reached via different types of connections. For this receiver profile, the use of IORs is limited to references to objects carried in broadcast object carousels. For object carousels, there are two types of object references: one to be used to reference objects carried in the same object carousel and one to be used to reference objects in other object carousels.

Field	Restrictions	Source
`IOP::IOR::type_id`	Contains the objectKind of the referenced object. A short three-letter aliases shall be used, plus a null-terminator.	UK DTT
`IOP::IOR::taggedProfileList`	There shall be at least 1 taggedProfile included in an IOR. For objects carried in a broadcast object carousel, the first taggedProfile shall be either a TAG_BIOP profile or a TAG_LITE_OPTIONS. If the first tagged profile is some other profile, the object is not carried in a broadcast object carousel and the receiver shall ignore the object.	UK DTT

Table 17-22. Restrictions on the BIOP IOR

Syntax	bits	Type	Value	Comment
`IOP::IOR {`				
`  type_id_length`	32	uimsbf	N1	
`  for (i=0; i<N1; i++) {`				
`    type_id_byte`	8	uimsbf	+	Short alias type_id (e.g. "dir")
`  }`				
`  taggedProfiles_count`	32	uimsbf	N2	Profile bodies
`  IOP::taggedProfile()`				For objects in broadcast carousels: either BIOPProfileBody or LiteOptionsProfileBody.
`  for (n=0; n<N2-1;n++) {`				
`    IOP::taggedProfile()`				Receiver may ignore other profiles (2...N1) if present
`  }`				
`}`				

Table 17-23. IOP::IOR syntax 17

BIOPProfileBody

The BiopProfileBody is used for references to objects within the same object carousel.

Field	Restrictions	Source
`BiopProfileBody::byte_order`	0 (indicating big-endian byte order)	DVB
`BiopProfileBody::LiteOptionComponents`	The list shall contain a exactly 1 BiopObjectLocation and exactly 1 DSM::ConnBinder as the first two components in that order. The receiver may ignore possible other components in the list.	UK DTT
`DSM::ConnBinder`	For objects carried in the broadcast object carousel, the first Tap shall be of type BIOP_DELIVERY_PARA_USE. If there is another type of tap in the first position, the receiver may ignore this object reference, as it is a reference for object accessed using another type of protocol (e.g. for return channel use). The receiver may ignore possible other taps in the list.	UK DTT
`DSM::Tap`	In the BIOP_DELIVER_PARA_USE tap, the id field is not used and may be ignored by the receiver.	UK DTT
`DSM::Tap::timeout`	This field is defined in units of µs. An appropriate value must be explicitly encoded by carousel generation equipment. There is no default value that may be encoded, i.e. 0xFFFFFFFF has no special meaning. Receivers shall not employ an in-built default instead of the signalled value as there is no way to define these without knowledge of the construction of a particular carousel. See Section 19.17.3 "Timeouts (mandatory)".	UK DTT

Table 17-24. Restrictions on the BIOP Profile Body

Syntax	bits	Type	Value	Comment
BIOPProfileBody {				
profileId_tag	32	uimsbf	0x49534F06	TAG_BIOP (BIOP Profile Body)
profile_data_length	32	uimsbf	*	
profile_data_byte_order	8	uimsbf	0x00	big endian byte order
lite_component_count	8	uimsbf	N1	
BIOP::ObjectLocation {				
componentId_tag	32	uimsbf	0x49534F50	TAG_ObjectLocation
component_data_length	8	uimsbf	*	
carouselId	32	uimsbf	+	
moduleId	16	uimsbf	+	
version.major	8	uimsbf	0x01	BIOP protocol major version 1
version.minor	8	uimsbf	0x00	BIOP protocol minor version 0
objectKey_length	8	uimsbf	N2	<= 4
for (k=0; k<N2; k++) {				
objectKey_data	8	uimsbf	+	
}				

Table 17-25. BIOP Profile Body syntax (Sheet 1 of 2)

}				
DSM::ConnBinder {				
componentId_tag	32	uimsbf	0x49534F40	TAG_ConnBinder
component_data_length	8	uimsbf	N4	
taps_count	8	uimsbf	N3	
DSM::Tap {				
id	16	uimsbf	0x0000	user private
use	16	uimsbf	0x0016	If BIOP_DELIVERY_PARA_USE is provided it shall be the first tap. If there is another type of tap in the first position, the receiver may ignore this object reference, as it is a reference for an object accessed using another type of protocol (e.g. for return channel use).
assocTag	16	uimsbf	+	
selector_length	8	uimsbf	0x0A	
selector_type	16	uimsbf	0x0001	
transactionId	32	uimsbf	*	
timeout	32	uimsbf	*	
}				
for (n=0; n<N4-18; n++) {				The receiver may skip over the possible additional taps
additional_tap_byte	8	uimsbf		
}				
}				
for (n=0;n<N6;n++) {				N6=N1-2

Syntax	bits	Type	Value	Comment
`BIOP::LiteComponent{`				
`componentId_tag`	32	uimsbf	+	
`component_data_length`	8	uimsbf	N7	
`for (i=0; i<N7; i++) {`				
`component_data_byte`	8	uimsbf		
`}`				
`}`				
`}`				
`}`				

Table 17-25. BIOP Profile Body syntax (Sheet 2 of 2)

LiteOptionsProfileBody

The LiteOptionsProfileBody is used for making links to objects carried in other object carousels.
For this receiver profile, the following restrictions apply:

- LiteOptionsProfileBody shall only refer to objects within the same transport stream.

  So, the use of the object carousel will not require tuning to a new transport stream.

- Target MHEG-5 objects in other ServiceGateways are restricted to being application objects.

  So, the only MHEG-5 actions that can specify MHEG-5 objects in other ServiceGateways are Launch and Spawn. As above this shall not require re-tuning.

Field	Restrictions	Source
LiteOptionsProfileBody::profile_data_byte_order	0 (indicating big-endian byte order)	DVB
LiteOptionsProfileBody::LiteOptionComponents	The list shall contain a ServiceLocation component as the first component. The receiver may ignore possible other components in the list.	UK DTT
DSM::ServiceLocation	For objects carried in the broadcast object carousel, the service domain NSAP address shall follow the Carousel NSAP address format. If there is another type of NSAP address, the receiver may ignore this object reference, as it is a reference for object accessed using another type of protocol (e.g. for return channel use). The carousel NSAP address shall point to an object carousel in the same transport stream. If the NSAP address points to another transport stream, the receiver may ignore the object reference.	UK DTT
DSM::ServiceLocation::InitialContext	The receiver may ignore the initial context	UK DTT

Table 17-26. Restrictions on the Lite Options Profile Body

Syntax	bits	Type	Value	Comment
`LiteOptionsProfileBody {`				
`profileId_tag`	32	uimsbf	0x49534F05	TAG_LITE_OPTIONS (Lite Options Profile Body)
`profile_data_length`	32	uimsbf	*	
`profile_data_byte_order`	8	uimsbf	0x00	big endian byte order
`lite_component_count`	8	uimsbf	N1	
`DSM::ServiceLocation {`				
`componentId_tag`	32	uimsbf	0x49534F46	TAG_ServiceLocation
`component_data_length`	8	uimsbf	*	
`serviceDomain_length`	8	uimsbf	0x14	Length of carousel NSAP address
`serviceDomain_data()`	160	uimsbf	+	Table 17-28 "DVB Carousel NSAP Address"
`CosNaming::Name() {`				pathName
`nameComponents_count`	32	uimsbf	N2	
`for (i=0; i<N2; i++) {`				
`id_length`	32	uimsbf	N3	NameComponent id
`for (j=0; j<N3 j++) {`				
`id_data`	8	uimsbf	+	
`}`				
`kind_length`	32	uimsbf	N4	NameComponent kind
`for (j=0; j<N4 j++) {`				
`kind_data`	8	uimsbf	+	as type_id (see Table 4-4 in TR 101 202)
`}`				
`}`				
`}`				

Table 17-27. Syntax of Lite Options Profile Body with ServiceLocationcomponent. (Sheet 1 of 2)

Syntax	bits	Type	Value	Comment
initialContext_length	32	uimsbf	N5	
for (n=0; n<N5 n++) {				
InitialContext_data_byte	8	uimsbf		
}				
}				
for (n=0;n<N6;n++) {				N6=N1-1
BIOP::LiteComponent{				
componentId_tag	32	uimsbf	+	
component_data_length	8	uimsbf	N7	
for (i=0; i<N7; i++) {				
component_data_byte	8	uimsbf		
}				
}				
}				
}				

Table 17-27. Syntax of Lite Options Profile Body with ServiceLocation component. (Sheet 2 of 2)

Syntax	bits	Type	Value	Comment
DVBcarouselNSAPaddress()				
AFI	8	uimsbf	0x00	NSAP for private use
Type	8	uimsbf	0x00	Object carousel NSAP Address.
carouselId	32	uimsbf	+	To resolve this reference a carousel_id_descriptor with the same carousel_id as indicated in this field must be present in the PMT signalling for the service identified below.
specifierType	8	uimsbf	0x01	IEEE OUI
specifierData { IEEE OUI }	24	uimsbf	0x<DVB>	Constant for DVB OUI
dvb_service_location () {				
transport_stream_id	16	uimsbf	+	This may be set to 0x0000 which indicates that the receiver shall not use the transport_stream_id when locating the service. For any other value then this field shall be used.
original_network_id	16	uimsbf	+	0x233A (UK-DTT)
service_id	16	uimsbf	+	(= MPEG-2 program_number)
reserved	32	bslbf	0xFFFFFFFF	
}				
}				

Table 17-28. DVB Carousel NSAP Address

17.2.6 Assignment and use of transactionId values

17.2.6.1 Background (informative)

The use of the transactionId in the object carousel is inherited from its use as defined by the DSM-CC specification, and as such it can appear somewhat complex. The transactionId has a dual role, providing both identification and versioning mechanisms for download control messages, i.e. DownloadInfoIndication and DownloadServerInitiate messages. The transactionId uniquely identifies a download control message, however it is "incremented" whenever any field of the message is modified.

17.2.6.2 Use in this profile

The term "incremented" is used in the DSM-CC specification. Within the scope of the UK DTT object carousel this shall be interpreted as "changed".

When a module is changed, the version number of the module needs to be changed. This implies that the DownloadInfoIndication message that references the module needs to be also updated. Since the DownloadInfoIndication is updated, the transactionId needs to be also changed. However, the transactionId of the DownloadInfoIndication message is used in other messages also, but the need to change the other messages should specifically be avoided and the implications of updating a module should be limited to the module itself and the DownloadInfoIndication that references the module. Therefore, additional rules on the usage of the transactionId have been specified as follows.

The transactionId has been split up into a number of sub-fields defined in Table 17-29. This reflects the dual role of the transactionId (outlined above) and constraints imposed to reduce the effects of updating a module. However, to increase interoperability the assignment of the transactionId has been designed to be independent of the expected filtering in target receivers.

Bits	Value	Sub-field	Description
0	User-defined	Updated flag	This must be toggled every time the control message is updated
1-15	User-defined	Identification	This must and can only be all zeros for the DownloadServerInitiate message. All other control messages must have one or more non-zero bit(s).
16-29	User-defined	Version	This must be incremented/changed every time the control message is updated.
30-31	Bit 30 - zero Bit 31 - non-zero	Originator	This is defined in the DSM-CC specification [39] as 0x02 if the transactionId has been assigned by the network - in a broadcast scenario this is implicit.

Table 17-29. Sub-fields of the transactionId

Due to the role of the transactionId as a versioning mechanism, any change to a control message will cause the transactionId of that control message to be incremented. Any change to a Module will necessitate incrementing its moduleVersion field. This change must be reflected in the

corresponding field in the description of the Module in the DownloadInfoIndication message(s) that describes it. Since a field in the DownloadInfoIndication message is changed its transactionId must be incremented to indicate a new version of the message. Also, any change in the DownloadServerInitiate message implies that its transactionId must also be incremented. However, when the transactionId is divided into subfields as specified above, updating a message will change only the Version part of the transactionId while the Identification part remains the same.
Since the transactionId is used also for identifying the messages when referencing the messages in other structures, it is very desirable that these referenced would not need to be updated every time the control message is update. Therefore the following rule shall be applied when locating the messages based on the references:

When locating a message based on the transactionId value used for referencing the message, only the Identification part (bits 1...15) shall be matched.

Using this rule, the implications of updating a module can be limited to the module itself and the DownloadInfoIndication message describing the module. Also, this implies that if a receiver wants to find out if a particular module that it has retrieved earlier has changed, it needs to filter the DownloadInfoIndication message that described that module and check if it has been changed.

17.2.7 Mapping of objects to modules

DSM-CC Object Carousels allow one or more objects to be carried in each module. In order to optimize the performance and memory requirements two additional requirements are specified:

- If in the process of retrieving an object from the carousel a receiver acquires a module containing multiple objects, it should attempt to cache these since the expectation is that the other objects are related to the object requested and probably will be needed soon (see Section19.19.2.1 "Placing associated objects in a module").
- The size of a module that contains multiple objects shall not exceed 65536 bytes in its decompressed form. For modules containing only a single object, there is no limit for the size (except what is determined by the memory in the receivers and the size of the length fields).

  Note the size of a module does not include any overhead caused by the delivery protocol, i.e. Download Data Block message headers.

17.2.8 Compression of modules

The modules may be transmitted either in uncompressed or compressed form. If the module is transmitted in compressed form, this is signalled by including the compressed_module_descriptor in the userInfo field of the moduleInfo in the DownloadInfoIndication message.

Presence of the compressed_module_descriptor indicates that the data in the module has the "zlib" structure as defined in RFC 1950.

Table 17-30 shows the syntax of the compressed_module_descriptor:

	No. of bytes	Mnemonic	Value
`compressed_module_descriptor(){`			
`descriptor_tag`	1	uimsbf	0x09
`descriptor_length`	1	uimsbf	
`compression_method`	1	uimsbf	
`original_size`	4	uimsbf	
`}`			

Table 17-30. compressed_module_descriptor

Presence of the compressed_module_descriptor indicates that the data in the module has the "zlib" structure as defined in RFC 1950. Table 17-31 shows the syntax of the ZLIB structure.

	No. of bytes	Value	
`zlib structure(){`			
`compression_method`	1		
`flags_check`	1		
`compressed_data`	n		
`check value`	4		
`}`			

Table 17-31. zlib structure

The receiver shall support the Deflate compression algorithm as specified in RFC 1951. This is signalled setting the least significant nibble of the compression_method to 0x8 (i.e. compression_method is xxxx1000). The receiver is not required to support other compression algorithms.

17.3 AssociationTag mapping

Association Tags in "Taps" The DSM-CC U-U protocol defines a "Tap", which is used to communicate with a lower layer communication channel. A Tap contains an identifier, a "use" (which indicates the type of connection) and a 16-bit association tag (which uniquely identifies the lower level resource to be used).

Different uses of "Taps" In the UK Profile, Taps are used to reference either a service (BIOP_PROGRAM_USE tap) or an elementary stream (all other types of tap).

Note Some confusion is caused by the fact that both MHEG-5 and DVB have separately made use of the term "component tag". These fields are not directly interchangeable so care must be taken when referring to either. In this section the term will always be preceded by "MHEG-5" or "DVB" as appropriate.

17.3.1 Using an AssociationTag to reference a service

17.3.1.1 BIOP_PROGRAM_USE tap

Stream and StreamEvent objects within a U-U Object Carousel use the BIOP_PROGRAM_USE tap to identify a service (see Section 17.2.4.1 "BIOP StreamMessage" and Section 17.2.4.2 "BIOP StreamEventMessage"). This tap contains a DSM-CC association tag value that may match an association tag contained within a deferred_association_tags_descriptor, contained within the first descriptor loop of the PMT.

17.3.1.2 deferred_association_tags_descriptor

Resolving a service The deferred_association_tags_descriptor, as described by EN 301 192 [7] section 9.3.2, is used to resolve an association_tag to a different PMT (i.e. a different service). If the association_tag contained in a BIOP_PROGRAM_USE tap matches an association_tag contained within a deferred_association_tags_descriptor then the service indicated by the appropriate "service_id", "transport_stream_id" and "original_network_id" triple is resolved.

Default behaviour If the association tag value in the BIOP_PROGRAM_USE tap does not match an association tag value in any deferred_association_tags_descriptor contained within the current service's PMT, the tag is resolved to the current service.

Transport_stream_id field If the "transport_stream_id" field of the deferred_association_tags_descriptor is set to 0x0000 then it shall be ignored and the receiver is free to choose which transport stream ID it selects.

17.3.1.3 Service association tag mapping decision tree

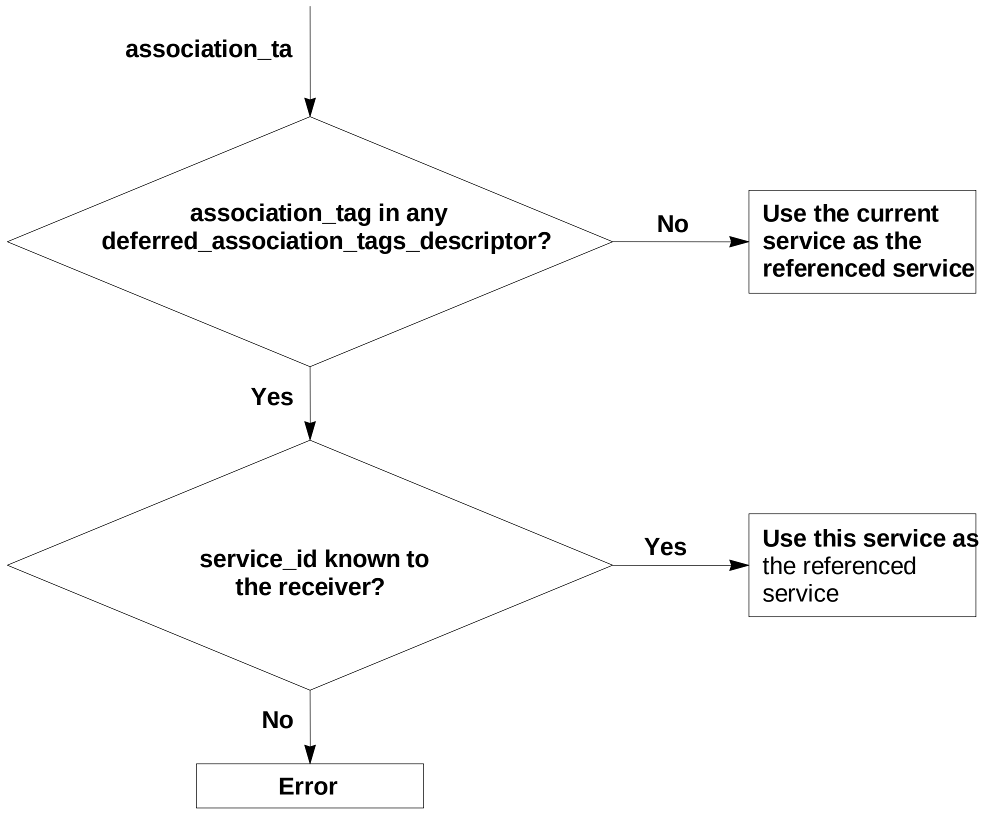


Figure 17-1. Service Association Tag mapping decision tree

17.3.2 Using an association tag to reference an elementary stream

17.3.2.1 MHEG-5 ComponentTags to DSM-CC association tags

The MHEG-5 ComponentTag attribute of MHEG-5 Audio or Video objects is used to select the elementary stream which is to be decoded within the service indicated by the enclosing MHEG-5 Stream object (see Section 16.3.5 "Locating components carried in Transport Streams"). The two least signification bytes of the MHEG-5 ComponentTag are to be treated as a 16-bit association_tag and mapped to an elementary stream from the service indicated by the enclosing MHEG-5 Stream object, using the elementary stream association_tag mapping rules detailed below.

Tag values for default components

The special value "-1" may be used as the MHEG-5 ComponentTag attribute of Video or Audio. This associates the object with the "default" media component of the appropriate type.

Note Here "default" normally means the components that the receiver would decode if the service had been selected via the receiver navigator or the SI_TuneIndex ResidentProgram. So, for example, the audio component should normally be selected with regard to the viewer's language preference.

Exceptionally, when the service is selected with "rec://svc/cur", ComponentTag '-1' means the **currently selected components rather than the default** component. No other value of MHEG-5 ComponentTag shall be used if the multiplex is specified as "rec://svc/cur". Receivers may ignore the value of ComponentTag in this case.

See also Section16.3.5.2 "Component references".

Explicit component references

Receivers must resolve explicit (non "-1") component tag values regardless of stream type information signalled within the PMT. In this case, when components are selected under control of an application, the application author is responsible for ensuring that the components carry data suitable for the MHEG-5 stream component type.

Receivers shall, by default, use the stream_type information from the PMT to determine the correct codec to use to decode the stream component. Where the stream_type does not indicate the correct codec to be used (for example, if the stream_type indicates private PES data), the receiver shall use the service_type value for the relevant service to determine the codec, as shown in the following table:

Service type	MHEG stream component	Codec
0xA, 0x16, 0x19	Video Audio	H.264 See below
0x1, 0x2, 0xC	Video Audio	MPEG-2 MPEG-1 layer II

The service_type shall be that listed in the service_descriptor of the SDT.

If the service_type value is 0xA, 0x16 or 0x19, receivers shall determine the audio codec as follows:

- If the PMT contains an Enhanced_AC-3_descriptor (descriptor tag 0x7A) for the stream component, the Enhanced AC-3 codec shall be used.
- If the PMT contains an AAC_descriptor (descriptor tag 0x7C) for the stream component, the receiver shall use the AAC, HE AAC or HE AACv2 codec according to the AAC_type value indicated in the descriptor.

If necessary, receivers may additionally make use of information from a component_descriptor, if present.

Mapping errors

If the receiver is unable to map an MHEG-5 ComponentTag in an MHEG-5 Stream object to a DVB component, presentation of that element of the Stream object shall cease (i.e. if there is a component tag mapping error for the video it shall display 'black').

17.3.2.2 Mapping DSM-CC association_tags to DVB component_tags

The DVB component_tag is an 8-bit value that maybe used to identify an elementary stream without directly referring to its PID value. Likewise, 16-bit association_tags are used by DSM-CC in order to refer to an elementary stream without directly referencing its PID value. The 16-bit association_tag value shall be used to identify an elementary stream by matching its least significant byte with a DVB component_tag.

stream_identifier_descriptor

In UK DTT, the DVB stream_identifier_descriptor shall always be used for assigning a DVB component_tag for the elementary streams. Its is mandatory for all components referenced by an MHEG-5 application and/or object carousel.

association_tag descriptors

However, broadcasters may choose to use association_tag_descriptors (as defined by ISO/IEC 13818-6 [39]) to indicate elementary streams. If the association_tag_descriptor is optionally used, a stream_identifier_descriptor shall still be present and the tag values shall be set consistently in each descriptor. This restriction simplifies the decision tree shown in Section17.3.2.3 "Elementary stream mapping pseudo code and decision tree"so that the second decision can be skipped.

Elementary stream matching using the deferred_association_tags_descriptor

Use of the deferred_association_tags_descriptor to match elementary streams is not required for this profile. All components that constitute a valid carousel broadcast to this profile must be present in the PMT from which the carousel was mounted.

Receivers are free to implement support for elementary stream matching using the deferred_association_tags_descriptor should it be required for any other profile or for compatibility with another standard.

PMT changes

If the PMT changes then all active DVB component_tag references should be re-evaluated according to the elementary stream mapping decision tree (see Section17.3.2.3 "Elementary stream mapping pseudo code and decision tree").

17.3.2.3 Elementary stream mapping pseudo code and decision tree

```
//Test for default value
if (MHEG_component_tag == -1)
{
  select default PID for this
component type and exit
}

//Create assoc. tag
assocation_tag = (uint16)
(0x0000FFFF &&
MHEG_component_tag)

// Match assoc. tag into atd
// This stage can be
// implemented but is not
// required for this profile
if (association_tag matches
into atd)
{
  select identified pid
and exit
}

//Create DVB component_tag
component_tag = (uint8)
(0x00FF &&
DSM-CC association_tag)

// Match component_tag into
// stream_identifier_
descriptor
if (component_tag matches
into sid)
{
  select identified pid
and exit
} else {
  error
}
```

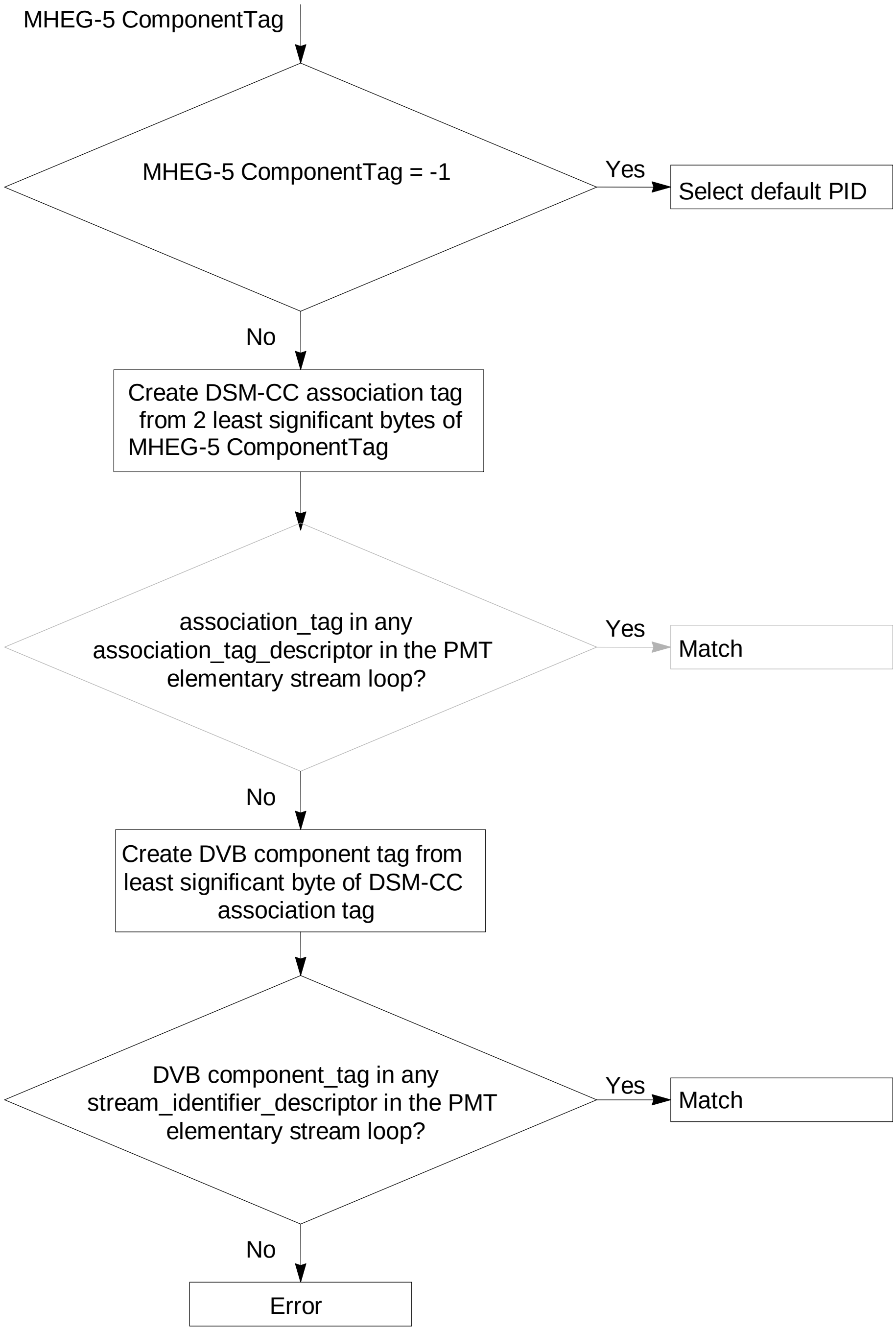


Figure 17-2. Elementary stream mapping pseudo code and decision tree

17.4 Application identification and boot

17.4.1 Introduction

This section covers the identification and boot of an application by a receiver. The term "application" in this section of the specification will describe the use of the broadcast stream. So, the application defined in this specification can be described as:

> UK DTT Profile Version 1 of MHEG-5 delivered using the DVB Object Carousel Revision 1

The mechanism specified is designed to rely only on information in the PMT and the Service Gateway, i.e. there is no need to access the SDT or EIT to be able to identify and boot the application.

The boot process consists of three steps:

- Identification of an auto-boot application conforming to this profile.
- Acquisition of the ServiceGateway object.
- Acquisition of the auto-boot object - in this profile an MHEG-5 Application object. This may be explicitly via signalling in the ServiceContextList of the ServiceGateway object or implicitly by applying the default identification rules.

17.4.2 Identification of auto-boot application

Before commencing any boot process the receiver needs to know that there is an auto-boot application of a supported type being broadcast, and from which PID it shall auto-boot. This signalling is achieved by using the data_broadcast_id_descriptor which may be included in a second descriptor loop of a PMT and effectively identifies a "boot-PID", i.e. the elementary stream on which a DSI message can be found.

In this profile the use of the data_broadcast_id_descriptor for signalling is mandatory.

17.4.2.1 data_broadcast_id_descriptor

This descriptor is DVB defined and may be included in the second descriptor loop of a PMT. Its exact use and meaning is dependent upon the value of the data_broadcast_id field.

When used with the data_broadcast_id value of 0x0106, the descriptor lists the application types that can be booted from the elementary stream (component) with which it is associated. Also provided is an indication of the application type that shall be booted by receivers that support more than one of the application types listed. Depending on the application type, additional application type specific data may also be provided.

There shall be at most one instance of a data_broadcast_id_descriptor with this value of data_broadcast_id for each elementary stream within a PMT. This single descriptor is capable of identifying multiple application types within that elementary stream if necessary. Note that this does not preclude there being other data_broadcast_id_descriptors in this elementary stream descriptor loop that contain different values of data_broadcast_id.

The generic form of the data_broadcast_id_descriptor when used with the data_broadcast_id value of 0x0106 is shown in Table 17-32. Receivers shall be able to parse the descriptor regardless of the value(s) of application_type_code and shall be able to skip the application_specific_data_byte values if they don't recognise the application_type_code.

	Size (bytes)	Value
`data_broadcast_id_descriptor{`		
`descriptor_tag`	1	0x66
`descriptor_length`	1	N1
`data_broadcast_id`	2	0x0106
`for( i=0; i<N1-2; i++){`		
`application_type_code`	2	
`boot_priority_hint`	1	
`application_specific_data_length`	1	N2
`for( j=0; j<N2; j++ ){`		
`application_specific_data_byte`	1	
`}`		
`}`		
`}`		

Table 17-32. Data broadcast ID descriptor

descriptor_tag The value 0x66 in this 8 bit field identifies the descriptor.

data_broadcast_id The value 0x0106 in this 16 bit field identifies descriptors with this structure and semantics.

application_type_code The value of this field identifies that an auto-boot application of this application type is carried by this data broadcast. The value is valid within the scope of this data_broadcast_id.

A receiver compliant with this profile shall respond to the values specified in Annex C.1 with the exception of the null application type code (0x0000).

In this profile there shall be at most one instance of any of these particular application_type_codes within the PMT.

If more than one of these application_type_codes are signalled in the PMT then the receiver shall use the boot_priority_hint to determine which to select. The data_broadcast_id_descriptor containing the selected application_type_code identifies the "boot-PID".

boot_priority_hint This provides a mechanism for the receiver to decide which application type to boot when it supports more than one of those broadcast and no other rules dictate how to chose between them. The hint is provided by the broadcaster, with 0 the lowest preference. No two application types shall have the same boot priority.

application_specific_data_length

The value in this 8 bit field specifies the number of bytes of application specific data that follow.

application_specific_data_byte

In this profile these bytes may contain zero or more of the following sub-descriptors:

Network boot info sub-descriptor

The network_boot_info sub-descriptor provides a method by which a network operator may signal a running application to perform a specified action. This signal is provided in the data_broadcast_id descriptor so as to become independent of the data broadcast itself.

	Size (bytes)	Value
`network_boot{`		
`tag`	1	0x01 (Local to UKProfile1)
`length`	1	(N+2)
`NB_version`	1	
`NB_action`	1	0x00 - No action 0x01 - Initiate autoboot for DSM-CC mounted applications, generate "NetworkBootInfo" EngineEvent for CI mounted applications. 0x02 - Generate "NetworkBootInfo" EngineEvent
`NB_info`	N	Allocated by Broadcaster
`}`		

Table 17-33. Network boot info sub-descriptor

If the value of the NB_version changes then the receiver shall execute the appropriate action as indicated by the value of the NB_action field as indicated in Section 13.8 "EngineEvents" and Section 16.2.4 "Network-level application lifecycle signalling".

Service boot info sub-descriptor

The service_boot_info sub-descriptor indicates the location of any service-level application lifecycle signalling.

	Size (bytes)	Value
`service_boot{`		
`tag`	1	0x02 (Local to UKProfile1)
`length`	1	2
`assocTag`	2	+
`}`		

Table 17-34. Service boot info sub-descriptor

The value of assocTag indicates the association tag (and thus component) which the receiver must filter for the signalling sections described in Section 16.2.3 "Service-level application lifecycle signalling".

Note that if any DsmccDescriptorList sections are provided as part of the currently active Object Carousel (e.g. to provide stream event information), service-level application lifecycle signalling sections must be broadcast on the same component.

17.4.3 Acquisition of the ServiceGateway object

For a receiver supporting this profile, the next step is to acquire the ServiceGateway object. This object is the root directory of the file system delivered by an Object Carousel and must be acquired before any other object can be downloaded. The presence of an Object Carousel is indicated by the carousel_id_descriptor. This descriptor may be included in the second descriptor loop of a PMT corresponding to a PID on which the DSI message for an Object Carousel is broadcast, i.e. the boot-PID.

In this profile the use of the carousel_id_descriptor for signalling is mandatory. The consequence is that if a PMT second descriptor loop contains a data_broadcast_id_descriptor that provides signalling for this profile, it shall also contain a carousel_id_descriptor.

Note: A single PID shall only contain messages from a single Object Carousel and so only one carousel_id_descriptor shall be present in any second descriptor loop. However, a single service may contain more than one Object Carousel. Consequently, the carousel_id_descriptor may appear more than once in any single PMT.

17.4.3.1 carousel_id_descriptor

This descriptor is MPEG defined and in this profile may be included in the second descriptor loop of a PMT.

Syntax	bits	Type	Value
`carousel_identifier_descriptor {`			
`descriptor_tag`	8	uimsbf	0x13
`descriptor_length`	8	uimsbf	N1
`carousel_id`	32	uimsbf	
`FormatID`	8	uimsbf	
`for( i=0; i<N1-5; i++ ){`			
`private_data_byte`	8		
`}`			
`}`			

Table 17-35. Carousel identifier descriptor syntax

carousel_id This 32 bit field identifies the object carousel with the corresponding carouselId.

FormatID The use of this field and following data bytes is defined in TR 101 202 [12]. It is not used in this profile. Receivers compliant with this profile may ignore this field and any subsequent private data.

17.4.4 Acquisition of the auto-boot object

The location of the auto-boot object within the file system delivered by an Object Carousel may be explicit via signalling in the ServiceContextList of the ServiceGateway object or implicit by applying the default identification rules.

17.4.4.1 ServiceContextList

This defines the use of the MessageSubHeader::ServiceContextList for the BIOP::ServiceGatewayMessage. This structure is used to provide a potential location (in addition to the data_broadcast_id_descriptor in the PMT) for the inclusion of application specific data.

The ServiceContextList contains a loop over "ServiceID". In this profile the 4 byte ServiceID is generated by the combination of data_broadcast_id and application_type_code. The inclusion of an entry in this list optional and is defined in the specification of each registered application type, i.e. an application type signalled in the PMT may not necessarily have a corresponding element in this list. There are no rules regarding the ordering of entries in this list.

If the ServiceContextList is absent, or does not list a supported application_type_code, then the implicit identification rules apply. See "Locating the initial object".

The generic form of the ServiceContextList adapted to carry application specific data is shown in Table 17-36. Receivers shall be able to parse the structure regardless of the value(s) of application_type_code and shall be able to skip the application_specific_data_byte values if they don't recognise the application_type_code.

	Size (bytes)	Value
ServiceContextList{		
serviceContextList_count	1	N1
for(i=0; i<N1; j++){		
ServiceID{		
data_broadcast_id	2	
application_type_code	2	
}		
application_specific_data_length	2	N2
for(j=0; j<N2; j++){		
application_specific_data_byte	1	
}		
}		
}		

Table 17-36. Service context list

serviceContextList_count

The value in this 8 bit field is the number of different application types that have data in this structure.

ServiceID The value in this 32 bit field is the concatenation of data_broadcast_id and application_type_code as shown in the table above.

A receiver compliant with this profile shall recognise the ServiceID that is a concatenation of the data_broadcast_id 0x0106 and the selected application_type_code (see Section 17.4.2.1 "data_broadcast_id_descriptor").

application_specific_data_length

The value in this 16 bit field specifies the number of bytes of application specific data that follow.

application_specific_data_byte

In this profile these bytes may contain a set of language specific initial objects (as defined in the table below).

If the receiver does not provide a mechanism for selection based on language preference for any of the initial objects specified then the implicit identification rules apply. See "Locating the initial object". The receiver shall as a minimum support the language code "und".

	Size (bytes)	Value
`application_specific_data{`		
`number_languages`	1	N3 ≥ 1
`for( k=0; k<N3; k++){`		
`ISO_639_language_code`	3	
`initial_object_length`	1	N4 ≥ 2
`for( l=0; l<N4; l++){`		
`initial_object_byte`	1	
`}`		
`}`		
`}`		

Table 17-37. Application boot service context list

number_languages Specifies the number of different languages for the application type.

ISO_639_language_code Specifies the target language of the application.

To specify a default choice or a single, language independent choice, the ISO language code "und" shall be used.

initial_object_length The value in this 8 bit field specifies the length of the null terminated initial object string. The null termination is included in the length.

The initial object string shall not be empty. So, its length shall be ≥ 2.

initial_object_byte In this profile these 8 bit values form a null terminated string specifying the name of the initial object. This optionally may include a path from the root of the ServiceGateway with directories delimited by the character '/' (0x2F).

There shall be only one initial object specified for each combination of application_type_code and ISO_639_language_code.

17.4.4.2 Locating the initial object

Explicit Initial Object Identified

If an appropriate **initial_object** field can be identified from the ServiceContextList of the ServiceGateway then the receiver shall first use this to locate the initial Application object. See Section17.4.4.1"ServiceContextList".

If the **initial_object** field identifies a File object, this shall be the initial object.

If the **initial_object** field identifies a Directory object, the receiver shall use the default names "a" and "startup", in that order, to locate the initial Application object in this Directory object.

No Explicit Initial Object Identified

If no appropriate **initial_object** field can be identified in the ServiceContextList message or the initial Application object identified can not be acquired from the Object Carousel then the receiver shall use the default names "a" and "startup" in that order to locate the initial Application object in the ServiceGateway object.

If the receiver does not implement *InteractionChannelExtension* these are invariably references to the Object Carousel and so are equivalent to the following references:

"DSM://a"

"DSM://startup"

Initial File System

If the receiver implements *InteractionChannelExtension* then the initial object shall be launched via the hybrid file system such that "hybrid:" becomes the "Current Source" and all relative file references shall be made through it.

When the auto-boot process begins, the hybrid mapping table is reset to contain only the default mapping, so that "hybrid://" is equivalent to "DSM://" (Section 17.13 "Hybrid file system").

Example

So for the **initial_object** bytes:

```
"my_app"
```

The receiver shall work down the list until it is able to locate a file or reaches the end of the list.

```
"<source>://my_app"
"<source>://my_app/a"
"<source>://my_app/startup"
"<source>://a"
"<source>://startup"
```

If the receiver does not implement *InteractionChannelExtension* then "<source>" is explicitly "DSM:". If the receiver does implement *InteractionChannelExtension* then "<source>" is "hybrid:".

17.4.5 Example of steps required for auto-boot

"Identification of auto-boot application"

1. Tune to the transport stream of the service (MPEG Program).
2. Acquire the PAT.
3. Acquire the PMT of the service using the information in the PAT.
4. Search through the second descriptor loops in the PMT, i.e. the descriptor loop for each elementary stream, for an instance of the data_broadcast_id_descriptor containing an appropriate application_type_code value. This identifies the boot-PID.

   If there is no match, there is no auto-boot application for this service.

"Acquisition of the ServiceGateway object"

5. Search through the second descriptor loop corresponding to the boot-PID for an instance of the carousel_id_descriptor.
6. Acquire the DSI from this elementary stream.
7. Acquire the DII message (DII1) that identifies the module (Module1) containing the ServiceGateway object, using information in the DSI message (IOR1).
8. Acquire Module1 using information in DII1.
9. Extract the ServiceGateway object from Module1 using information in IOR1.

"Acquisition of the auto-boot object"

10. Get the name of the initial File object (in this case containing an MHEG-5 Application object) using the ServiceContextList information in the ServiceGateway message and/or default values. The location of this File object is relative to the ServiceGateway object.
11. If the name points to subdirectories follow the whole path, filtering the appropriate Directory objects (essentially repeating steps 7 to 9 in a more generic fashion as required).
12. Acquire the DII message (DII2) that identifies the module (Module2) containing the initial File object, using information in the ServiceGateway object (IOR2).
13. Acquire Module2 using information in DII2.
14. Extract the initial File object from Module2 using information in IOR2.

For receivers that implement *InteractionChannelExtension* step (1) is preceded by initialising the mapping table for the hybrid file system so that it contains only the default mapping ("//" maps to "DSM://"). Additionally, after step (14) the "Current Source" is initialised to "hybrid:" before the file that was retrieved is launched.

17.5 Caching

17.5.1 Transparent cache model

The default cache behaviour is 'transparent', i.e. the functional behaviour of receivers shall be the same regardless of their cache provision.

So, in each of the following cases the engine shall ensure that it has an up to date version of the required file object:

- a group object is *prepared*
- an ingredient object with referenced content is *prepared*
- the *content* internal attribute of an ingredient object with referenced content is set

Even cache priority values (excluding zero) are reserved to indicate content or groups that are constant through the life time of the application. These can be retrieved from the cache without first verifying that the file version is current. See Table 17-38.

17.5.2 Determining file version

There is no version number directly related to files (or other BIOP messages), the closest association is the *moduleVersion* in the DII that references the module that contains the BIOP message. Therefore, to ensure that a file is up to date the engine must determine that the *moduleVersion* for the appropriate module is current and reacquire if necessary.

This specification does not specify how an implementation determines that the module version is current. Valid approaches include:
a) having a section filter dedicated to the acquisition of all DII messages, testing the *transactionID* field of DII's of interest to see if the DII has been updated. If the DII has been updated then testing the *moduleVersion* field for the module of interest.
b) sampling the DII *transactionID* field and module *moduleVersion* field when a file is requested.
These and other options have different implications for performance, use of resources etc.

Note The 'update' flag (LSB of *transactionID* mapped into the table_id_extension field of DSM-CC section) is NOT a reliable indication of section update (as it may change more than once between receiver observations). Control message (DII/DSI) update is most reliably determined by inspecting the full *transactionID* field carried in the control message header.

17.5.2.1 Module acquisition

The Object Carousel effectively implements a "broadcast filespace". From the perspective of a running MHEG-5 service (and so the application author) requests are made for files without any real knowledge of how they are delivered. Crucially the MHEG-5 application has no concept of any versioning information and is reliant on other relevant functional blocks in the receiver to cope with this. This needs to be borne in mind when acquiring a Module (containing a requested file) from the broadcast stream.

Module acquisition from the broadcast stream is a two step process:

1. acquire DII and extract module download parameters.

2. acquire module using extracted parameters.

Since these steps happen sequentially, it is possible for the module download parameters to change between the two steps – due to one of the objects within the module being updated. Continuing to use the original parameters will mean that the module is never acquired.

Thus, when acquiring a module it is important to continue to monitor the DII from which the download parameters were extracted and react to any changes by redefining any relevant filters. This ensures that filters setup to catch the DDB messages delivering the module remain appropriate.

17.5.3 Content cache priority

The value of ContentCachePriority in content references and SetData actions specifies the checks that the receiver must make before returning cached content and suggests how the content could be cached thereafter. A ContentCachePriority value is associated with a piece of content until overridden by another value.

cache priority	semantic
Even values (excluding zero)	Even non-zero values of cache priority (2, 4 etc.) indicate that the object can be fetched from the local cache without reference to the broadcast stream. They also hint that the data is likely to remain static. Application authors can use higher values to indicate content that they think it is more useful to cache
Odd values	Odd values of cache priority (1, 3 etc., including the default 127) indicate that the receiver must verify that the file is current before using data from the cache and hint that the data is not expected to be static within the Application object's life time. Application authors can use higher values to indicate content that they think it is more useful to cache.
Zero	ISO/IEC 13522-5 states that when an object is declared with ContentCachePriority of zero: Specific value: 0 means caching is not allowed for external content data referenced by this Ingredient. So, when the action SetData is targeted at an object with ContentCachePriority of zero it is guaranteed to fetch the content from the broadcast stream rather than from any cache. This functionality is introduced deliberately to bypass any receiver cache allowing an application to be synchronised with the broadcast carousel. It should not be used simply to ensure up-to-date content is retrieved: use an odd value for this purpose

Table 17-38. Semantics for the allowed values of content cache priority

17.5.4 Group cache priority

The following interpretation is placed on group cache priority:

- 0 transparently cached
- Odd transparently cached
- Even non-transparently cached

The default group cache priority is 127 and hence transparent.

17.5.5 Cache validity

All information held in either a module and/or object cache shall only remain valid whilst the relevant Object Carousel remains mounted and so monitored.

For avoidance of doubt, changes to DSI messages shall not be considered an unmounting of the carousel.

This rule is provided since on remounting an Object Carousel it is possible (if unlikely) for objects to have changed in a way that is undetectable, i.e. version numbers to have been incremented such that they are the same as when the object was originally cached.

All information held in either a module and/or object cache shall only be valid within the context of the Object Carousel from which they were originally acquired.

This rule is provided since object names in Object Carousels are not globally unique and so it is possible that files with the same name but different content exist in different carousels.

The validity of any cached item is only dependent on the relevant Object Carousel and consequently is independent of the lifecycle of individual MHEG-5 applications that may be delivered as objects within that carousel.

Any item that is deemed as invalid shall be flushed from the cache.

A specific example of when the cache should be flushed is on selection of a new service since any associated Object Carousel will be unmounted as part of the service change process (see Section 16.2.6 "Auto kill application").

17.5.6 Dynamic carousel structure

The Object Carousel may change structure over time, i.e. both files and directories may be added or deleted. Also, modules are not guaranteed to carry the same objects over the lifetime of the carousel. Therefore receivers shall not assume that directory structures are static or that a given path will resolve always to the same object. All cached directory information shall be cached transparently. This means that before using an object that has been cached receivers shall validate the path to it.

> Note: Validating a path does not necessarily mean downloading all elements in the path every time. For example, simply determining that none of the objects on the path have changed since it was last fully traversed is sufficient to confirm that the path itself has not changed.

17.6 Receiver demultiplexer resources

This specification places no upper limit on the number of elementary streams or sections used to transport Object Carousel data (including Stream Events). Receivers shall be able to support applications carried by any legal Object Carousel.

To ensure reasonable performance receivers shall allocate sufficient resources to acquire DSM-CC sections from at least 4 elementary streams to support a single MHEG-5 presentation. See also Section19.17.1 "DIIs and elementary streams".

InteractionChannelExtension

Clauses 17.7 to 17.17 are specific to receivers implementing InteractionChannelExtension

17.7 IC file system

Receivers shall be able to retrieve content from a server over an IP connection using HTTP; such content must be identified using an http URI. Receivers shall be able to retrieve content from a server over an IP connection using HTTP with security provided by TLS; such content must be identified using an https URI. See "Non-equivalence of URIs with different sources".

Receivers shall implement an IC file system that accesses content identified by valid http and https URIs (as defined by IETF RFC 2616 [118], IETF RFC 2818 [128] and IETF RFC 3986 [129]). Given a suitable URI, receivers shall respond to a request to read content from this file system by connecting to the server specified by the URI and sending an HTTP GET request for the required file.

17.8 MHEG profile of HTTP

Receivers shall support HTTP/1.1, as defined in IETF RFC 2616 [xx], except as specified below. This profile shall be used for access to both static files and IP delivered streams.

17.8.1 Protocol parameters

Receivers are not required to make use of character sets, content codings and language tags. Receivers shall accept responses with the chunked transfer coding but are not otherwise required to make use of transfer codings.

Receivers are not required to make use of entity tags (see Section17.11 "Caching").

Receivers are not required to support Access Authentication.

Receivers are not required to support Content Negotiation.

Receivers are not required to transmit media type information, however the ReturnData resident program shall as a minimum transmit the following header field:

Content-Type: application/x-www-form-urlencoded

Receivers may ignore media type information sent by servers. Application providers must ensure that the content of the response is valid for the target MHEG object.

17.8.2 Methods

For standard file requests, receivers shall access content using the GET method. The HEAD method should only be used by the reference checking resident programs (see Section 13.10.7 "Checking references"). The ReturnData resident program (see Section13.10.9a.2 "ReturnData") shall use the POST method. Receivers shall not use the PUT and DELETE methods. Receivers should not use any other method.

17.8.3 Response status codes

Receivers shall consider the status codes (specified in HTTP/1.1) returned by the server. The response to status codes shall be as follows:

- Informational 1xx: this class of status code indicates a provisional response and receivers shall continue with the request being made. The request shall not be considered to be completed. Where a request is made by the ReturnData resident program, these status codes shall not be returned to the application.
- Successful 2xx: the request shall be considered to be completed successfully.
- Redirection 3xx: receivers shall follow the redirection according to IETF RFC 2616 [118]. However, if the request method was POST (i.e. the request was made by the ReturnData resident program), no redirection shall occur as this would require interaction with the user. In this case, the request shall be considered to have failed and the 3xx status code shall be returned to the application.
  In order to prevent infinite redirection loops, a maximum of 5 redirections shall be followed. Receivers shall support redirection where the new URI scheme is different from the initial request (for example “https” instead of “http”).
- 201 Created is an error and the request shall be considered to have failed

• 206 Partial Content: this code may be used in response to a Range request for Stream content delivered by IP•300 Multiple Choices is an error and the request shall be considered to have failed

- 306 (Unused) is an error and the request shall be considered to have failed
- All other values, including unrecognised responses, are an error and the request shall be considered to have failed.

17.8.4 Header fields

17.8.4.1 Request header fields

Receivers are not required to send any of the following header fields:

- Accept
- Accept-Charset
- Accept-Encoding
- Accept-Language
- Authorization
- Expect
- From
- Max-Forwards
- Proxy-Authorization
- Referer
- TE

Receivers that use only the If-Modified-Since header field for caching (see Section17.11 "Caching") are not required to transmit the following header fields:

- If-Match
- If-None-Match
- If-Unmodified-Since

User agent string

Receivers shall transmit three additional tokens in the User-Agent header field. These tokens shall appear consecutively in the order they are described below. The tokens are as follows:

The first product token shall be the string "UK-MHEG/" followed by the largest value of N which would generate a "true" response in the UEP(N) GetEngineSupport request (see C.2, "UniversalEngineProfile(N)").

The second product token shall be a string that uniquely identifies the receiver via its make, model and version number. This string shall be as defined in Section13.4.1.3 "Engine identification strings" but with a "/" character before the version number, i.e. "mmmccc/vvv".

The third product token shall be a string that identifies the MHEG engine provider and version number. This string shall be as defined in Section 13.4.1.3 "Engine identification strings" but with a "/" character before the version number, i.e. "MHGmmm/vvv".

Receivers may add further product tokens as defined by section 3.8 of IETF RFC 2616 [118].

Example

A particular receiver might transmit the header as:

```
User-Agent: UK-MHEG/2 FEG001/103 MHGFEG/056
```

17.8.4.2 Response header fields

Receivers may ignore the following header fields:

- Proxy-Authenticate
- Server
- WWW-Authenticate

Receivers that use only the If-Modified-Since header field for caching (see Section17.11 "Caching") may ignore the following header fields:

- Age
- ETag

17.8.4.3 General header fields

Receivers are not required to transmit, and may ignore, the following header fields:

- Pragma, except as specified by Section17.11 "Caching"
- Trailer
- Upgrade
- Via

Receivers shall accept a response that includes the Transfer-Encoding header field to indicate the use of chunked transfer-coding but otherwise may ignore the Transfer-Encoding header field. Receivers are not required to transmit the Transfer-Encoding header field.

Receivers that use only the If-Modified-Since header field for caching (see Section17.11 "Caching") are not required to transmit, and may ignore, the following header fields:

- Warning
- Cache-Control (except as specified by Section17.11 "Caching")

17.8.4.4 Entity header fields

Receivers are not required to transmit, and may ignore, the following header fields:

- Allow
- Content-Encoding
- Content-Language
- Content-Location
- Content-MD5
- Content-Type (except as specified for the ReturnData resident program by Section17.8 "Protocol parameters")

Receivers that use only the If-Modified-Since header field for caching (see Section17.11 "Caching") are not required to transmit, and may ignore, the following header fields:

- Expires

17.8.5 Cookie support

Receivers shall support the use of cookies via the Cookie request header and Set Cookie response header as defined by IETF RFC 2109 [122]. All cookies shall be stored transiently, regardless of any specified expiration date or age.

Cookies shall be retained until the auto-boot process begins (see Section 17.4.4.2 “Locating the initial object”). Receivers shall provide storage for at least 32 cookies with a minimum combined size of 8 192 bytes of data. Receivers may discard older cookies to make space for newer ones, using, for example, a least recently-used algorithm, along with constraints on the maximum number of cookies that each origin server may set.

For compatibility with existing HTTP/1.0 servers, receivers are recommended to also accept cookies in other common formats such as “Netscape” format. Cookies created using the SetCookie Resident Program shall use the RFC2109 format

See 13.10.9a.6, "SetCookie", and 13.10.9a.7, "GetCookie".

17.9 Connection setup

Receivers shall be able to:

- resolve host names
- establish HTTP, HTTP/TLS connections

The requirements of the infrastructure that supports these is outside the scope of this MHEG-5 profile but is addressed in Chapter 22 “Receiver Requirements”.

17.10 Multiple connections

There is no priority mechanism for arbitrating between multiple uses of the interaction channel. The number of connections that can be kept open simultaneously is not specified by the present document. Receivers shall adopt a policy to manage any such restriction, queuing further content requests if any implementation-specific limit is reached.

This document does not specify when a receiver should close a keep-alive connection. This behaviour is implementation-dependent.

17.11 Caching

Receivers shall support the same cache behaviour as specified in the object carousel profile (see Section17.5.1 “Transparent cache model”, Section17.5.3 “Content cache priority” and Section17.5.4, “Group cache priority”), except that the words “broadcast stream” and “broadcast carousel” are replaced by “interaction channel”.

The HTTP/1.1 caching specification (see section 13 of IETF RFC 2616 [118]) allows clients to use a number of optional techniques for working with cached data. As a minimum, receivers shall at least use the If-Modified-Since and Last-Modified header fields to implement a transparent cache.

When ContentCachePriority or GroupCachePriority is even and non-zero, the receiver shall not make a request to a server if it holds a cached copy of the data. If a request is made, the receiver shall generate a request with the following characteristics:

- A Cache-Control: max-stale, no-transform header shall be present

When ContentCachePriority is odd, or when GroupCachePriority is odd or zero, the receiver shall generate a request that will ensure that up-to-date content is retrieved. The request shall have the following characteristics:

- Appropriate header fields shall be present to ensure that up-to-date content is retrieved, as specified by section 13 of IETF RFC 2616 [118].
- If the request is conditional and no other header field relating to caching is present, an If-Modified-Since header field shall be present.
- A Cache-Control: no-transform header field shall be present.

When ContentCachePriority is zero, the receiver shall cause cached copies of the resource (if present) to be invalidated and shall generate a request with the following characteristics:

- An If-Modified-Since header field shall not be present.
- A Cache-Control: no-cache no-transform header field shall be present.
- A Pragma: no-cache header field shall be present if the server is not known to be HTTP/1.1 compliant.

17.12 Timeouts

The receiver shall consider the file request to have failed if an attempt to initially establish a connection to a server takes more than a timeout period. This timeout period shall be at least 30 seconds.

The receiver shall not time out whilst waiting for a server to communicate over an established connection after an HTTP request has been sent.

Where a file transfer from a server has started, the receiver shall consider the transfer to have failed if it does not complete within a timeout period. This timeout period shall be at least 30 seconds.

These timeouts shall also be used for requests using the ReturnData ResidentProgram.

17.13 Hybrid file system

Introduction

Receivers shall implement a "virtual" hybrid file system, which takes file requests and passes them on to one of the actual file systems available to the receiver, such as the broadcast carousel or the IC file system.

The hybrid file system is modelled as a mapping table. Each mapping in the table defines a name within the hybrid file space which maps to one or more target names in the file systems available to the receiver.

When content is requested from the hybrid file system, there is first a resolution procedure to determine which of the file systems available to the receiver should be used and what request should be made to it. This resolution procedure involves a search of the mapping table and some manipulation of the string values contained within the table. Only after this procedure is complete does the hybrid file system make a request to one of the underlying file systems.

Resolution of references

A hybrid file reference of the form defined in Section18.1, "Names within the receiver" is resolved as follows:

1. The Source ("hybrid:") is removed.
2. The reference produced by step 1 is processed according to Section18.3.2.3 "Structure of file references".
3. The mapping table is searched for mappings that match the reference produced by step 2. A match is made as follows:
   - If the mapping corresponds to a file pathname (i.e. the name does not end with a "/") then the name must match the entire reference.
   - If the mapping corresponds to a directory pathname (i.e. the name does end with a "/") then the name need only match the leftmost part of the reference.

   For example, if the reference used for a request is "hybrid://A/B/C1/D" then the mappings:

   • //A/, //A/B/C1/ and //A/B/C1/D (should they exist) would all match;

   while the mappings:

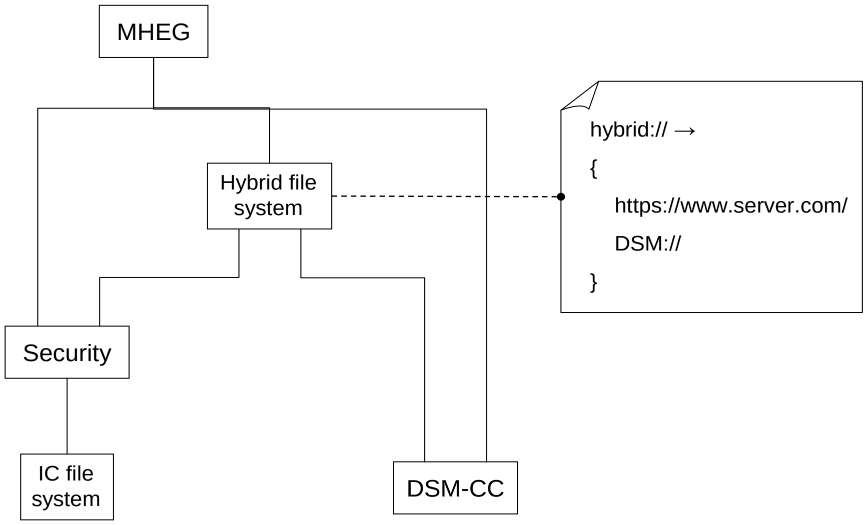
   • //B/, //A/X/C1/D, //A/B/C1/X, //A/B/C, //A/B/C/, //A/B/C1 and //A/B/C1/D/X (should they exist) would not match.
4. The mapping with the most complete match, i.e. with the longest matching name if there is more than one, is used to resolve the requested reference.
5. There shall be a default mapping associated with the name //, which matches all hybrid references. The default mapping maps the name // to DSM://. If there is no other matching name and no mapping for the name // has been defined, the default mapping is used. For example, if no name matches hybrid://A/B/C/D then that reference is resolved as DSM://A/B/C/D.
6. Where a hybrid name is mapped to more than one target name, content shall be requested using each target name in order until a request is successful. If content is not available from the location resolved from the first target name, the next will be tried and so on until content is available from a location or all target names have been tried. This

behaviour shall not be affected by the value of ContentCachePriority or GroupCachePriority.

Note: different file systems may return different data if asked to resolve a particular request. This provides a convenient means to adapt the behaviour of a running MHEG application depending on the available data delivery means.

Resolution example	Assume the table contains: Mapping 1: // is mapped to {DSM://} Mapping 2: //A/ is mapped to {DSM://foo/, http://www.com/foo/} Mapping 3: //B/ is mapped to {http://www.com/bar/} Mapping 4: //B/C/ is mapped to {http://www.com/baz/, DSM://} When a request is made for "hybrid://B/my_file", mapping 1 and mapping 3 are both considered as matches. Mapping 2 and mapping 4 are not matches because "//B/my_file" does not begin with the string "//A/" or the string "//B/C/". The chosen mapping is the most specific one, which will always be the one with the longest pathname in the hybrid file space. In this case, mapping 3 is more specific than mapping 1. Having chosen mapping 3, a request for "http://www.com/bar/my_file" is made. When a request is made for "hybrid://my_file", only mapping 1 matches, so a request is made for "DSM://my_file". With a request for "hybrid://B/C/my_file", mappings 1, 3 and 4 would match, with mapping 4 being chosen as the most specific. A request is made for "http://www.com/baz/my_file". If this request is unsuccessful, a request is then made for "DSM://my_file". If this second request is also unsuccessful, the request to the hybrid file system is considered to have failed. Note that this specification does not mandate a particular implementation. Hybrid references may be resolved by any method. One alternative is to "prune" the requested reference to make less specific references until a string that exists in the mapping table is found. With this method, a request for "//A/B/my_file" would consider "//A/B/my_file", then "//A/B/", then "//A/". At this point, the search would stop and mapping 2 would be selected, leading to a request for "DSM://foo/B/my_file".
Caching	The hybrid file system shall not itself implement caching of files, rather it presents the results of the caching implemented in the underlying file systems and reflects the effect of the value of ContentCachePriority or GroupCachePriority as it applies to those file sytems.
Synchronous file loading	Resolution of hybrid references takes place within the synchronous part of the ContentPreparation behaviour of an MHEG object.
Size of mapping table	Receivers shall provide storage for at least 32 mappings each of which is capable of storing at least 2048 bytes.
Configure mapping table	The mapping table is configured for each MHEG application through the MHEG ResidentProgram SetHybridFileSystem (see 13.10.9b.1, "SetHybridFileSystem").
Interaction with security (informative)	The hybrid file system does not itself implement security for MHEG code and content. Instead, the security level of each underlying file system is applied.

The following example shows how a signed application might be loaded through the hybrid file system.



1) An application transitions to hybrid://scene.mhg

2) The appropriate mapping is looked up in the hybrid mapping table. hybrid:// is mapped to {https://www.server.com, DSM://} in that order. This mapping is stored in memory until the file request is complete.

Attempt to load file from first location

3) DSM://auth.servers is retrieved. This server list file permits access to https://www.server.com/scene.mhg

4) https://www.server.com/scene.mhg is retrieved using the TLS certificate in DSM://auth.tls.1.

5) https://www.server.com/auth.hash is retrieved (using the server list file and TLS certificate as before). The hash file exists, its digest_count is greater than zero and scene.mhg is listed with digest_type 2.

6) The digest value is successfully checked against the contents of scene.mhg.

7) https://www.server.com/auth.sig.1 is retrieved (again using the server list file and TLS certificate).

8) DSM://auth.cert.1 does not contain a certificate that matches the signature. There are no other certificates in the object carousel and no other signature files on the server. Authentication has failed.

Attempt to load file from second location

9) The second location is looked up from the mapping that was stored in memory.

10) DSM://scene.mhg is retrieved and can be returned to the MHEG engine.

Example See Section19.24.1 for an example showing the use of the SetHybridFileSystem resident program.

17.14 Authentication of applications

17.14.1 Overview (informative)

This section defines a mechanism for authentication of applications. This ensures that all interaction channel content accessed when the receiver is tuned to a particular broadcast service is authorized by the provider of that broadcast service.

The basic method by which this is achieved is by signing files with a private key. The corresponding public key is then placed in the broadcast carousel of any service from which access to the signed files is required.

Since the verification of public key signatures is time consuming, this specification allows for a number of files to be signed with a single signature. This is achieved by computing a cryptographic hash for each file to be signed, and then signing a file listing those hashes.

Different sources of content in a digital TV receiver have different inherent levels of security. For example, a broadcast delivery mechanism might be considered more secure than an Internet delivery mechanism.

17.14.2 Authentication levels

The present document defines the level of authentication required for each file system available to the receiver.

These authentication levels are defined in the table below:

Level	Check authentic-cation?	Action if verification successful	Action if verified unsigned	Action if verification fails
1	No	N/A – files always to be loaded		
2	Yes	Load file	Load file	Load file, disable interaction channel
3	Yes	Load file	Load file, disable interaction channel	Load file, disable interaction channel
4	Yes	Load file	Load file	Fail
5	Yes	Load file	Fail	Fail
6	No	N/A – file accesses always fail		

Rows shaded in grey (levels 2, 3 and 6) are not employed in the present document.

The security levels for the various file systems shall be as follows:

File system source	Requests for MHEG code	Requests for content
CI	1	1
DSM	1	1
http	5	4
https	5	4
hybrid	Level of underlying file system applies	Level of underlying file system applies

Interpretation: Authentication is assumed for content obtained from the carousel. All application code obtained from the Internet *must* be signed; content obtained from the Internet *may* be signed. IP delivered streamed content shall not be signed Internet code and content that fails verification is not loaded.

17.14.3 Hash files

Each directory containing files that the author wishes to be authenticated contains a single hash file. The hash file contains a hash value for each of the authenticated files in the directory. Any files that are not to be authenticated are listed in the hash file but have no hash value.

An entire directory can also be marked as non-authenticated.

The hash computation considers the content of the files rather than transport specific information. As a result, the authentication is independent of the underlying transport protocol.

17.14.4 Signatures

The hash files described above provide a concise summary of the content in a directory. In order to prove that content has not been tampered with, this summary must be signed[38] with the private key of a signatory that is trusted by the receiver. Such signatures are stored in one or more signature files within each directory to be authenticated.

It is possible for different signatories to sign different parts of an interactive service. It is also possible for some parts of a service to be signed by more than one signatory. Therefore, there may be more than one signature file present in a directory. A receiver need only ensure that files needing to be authenticated have been signed by at least one signatory that is trusted.

Each signature file:

- references a *certificate* containing the public key required to decode the signature
- identifies the hash algorithm used
- contains the value of the signature

[38]. Since public key signature mechanisms can only sign small quantities of data, in fact the hash file to be signed is first hashed again to produce a small, fixed size digest. It is the digest that is then encrypted with the signatory's private key to create the signature.

17.14.5 Application signing certificates

A certificate is a signed file that binds the identity of a signatory to the signatory's public key. Certificates are used to create a 'chain of trust' up to an entity that is implicitly trusted by the receiver.

Receivers use certificates to check the signatures described above.

A certificate file contains a chain of one or more certificates ending with a self-signed certificate. Application signing certificates placed in the carousel are deemed valid.

The figure below illustrates how a chain of certificates and a signature are used.

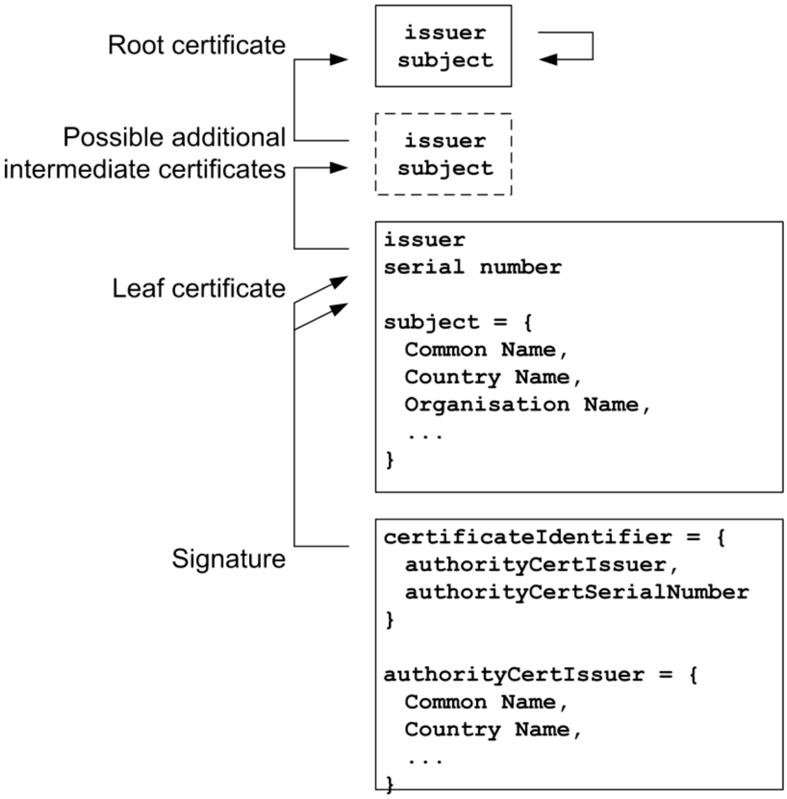


Figure 17.1: Chain of certificates

17.14.6 Authentication process

This section defines the process by which receivers verify the authenticity of files. This description references the syntax defined in Section 17.14.7 "Authentication file formats". The process is only used for accesses to file systems for which the authentication level requires it. The process has two parts: verification of hash files and verification of signatures. It leads to one of a number of outcomes, the effects of which are defined by the authentication level in force. The possible outcomes are:

- file authentication successfully verified
- file verified as being unsigned
- verification failure

Hash file verification

The hash file verification process is as follows:

1. retrieve the hash file from the same directory as the requested file (the 'current' directory)
2. if no hash file exists, return a verification error
3. if the hash file has digest_count <> 0, perform the following steps:
    a. if the requested file is not listed in the hash file, return a verification error
    b. if the file is listed and has a zero digest type, the file is verified unsigned subject to signature verification; proceed to step 5
    c. if the file is listed and has a non-zero digest type, perform a consistency check of the file contents against the corresponding digest value
    d. if the file contents are not consistent with the digest, return a verification error
    e. otherwise the file is verified subject to signature verification; proceed to step 5
4. if the hash file has digest_count = 0, perform the following steps:
    a. if the pathname encoded in the hash file does not contain at least one path element, return a verification error
    b. if the pathname elements in the hash file do not match the path to the current directory, return a verification error
    c. otherwise, the file (along with all the files in the directory) is verified unsigned subject to signature verification; proceed to step 5
5. proceed to signature verification for the hash file

Signature verification

The process of signature verification is as follows:

1. retrieve a signature file from the current directory
2. search the available certificates provided in the root directory of the DSM-CC carousel for one that matches the issuer and serial number information in the signature file
3. if no matching certificate is found, verification for this signature has failed; repeat from step 1 for the next signature file (if any)
4. use the certificate to verify that the signature correctly signs the hash file
5. if the signature is incorrect, verification for this signature has failed; repeat from step 1 for the next signature file (if any)

6. if none of the signatures present can be verified correctly, return a verification error

Optimisations	Signature verification may be time consuming. If the receiver has previously determined that the signature is authentic and has confirmed that the relevant certificate and signature files have not changed then it is not necessary to re-verify the signature file. Implementers should use caution when considering other optimisations without diligent security audit.
Certificate caching	Subject to the constraints defined below, receivers may cache certificates to avoid loading them from the carousel each time a signature requires verification and to allow a cache of signature verifications to be maintained for each certificate. Receivers shall verify that any cached copy of a broadcast certificate is consistent with the file being broadcast each time the application auto-boot process begins as described in section 17.4 of the UK Profile. This verification process shall include performing a complete binary comparison of the broadcast file with the cached copy and shall be completed before any use of the cached certificate is made following the start of the auto-boot process. In addition, receivers shall not allow a cached copy of a certificate to be used more than four hours after that certificate was last verified as being up to date. For the purpose of these additional checks, it is sufficient to verify that the module containing the certificate and the module containing the service gateway have not changed. Where a signature to be checked references a certificate that is not available from cache, receivers shall check for the certificate in the carousel even if previous attempts to load the certificate have failed.
Handling race conditions	Hash verification and signature verification require data from two or more files to be compared. Since these files may be dynamic, there is the possibility that verification will fail if attempted at the same time as the files are being updated. If verification fails, receivers shall retry at intervals of 0.5 seconds as long as one of the relevant files continues to change. If, upon retrying, the files contain the same content as on the previous attempt, verification has failed and no further attempt shall be made. To minimise the possibility of such retries, receivers should retrieve the files needed for verification within as short a period of time as possible. Similarly, authors should aim to update all the relevant files at the same time.
Redirection	When a file request results in one or more redirections, authentication shall be performed on the final resource loaded. I.e. the 'current' folder, and the source of the hash and certificate files used for authentication shall be the one indicated in the final redirection header as the source of the file.

17.14.7 Authentication file formats

17.14.7.1 Hash file

The hash file normally lists all of the files present in the relevant directory except itself. Signature files may be listed, in which case they shall have a digest_type of non-authenticated. Those elements to be authenticated are associated with hash codes. Subdirectories may be listed but such entries are ignored.

The directory that contains the hash file can be marked as unsigned in its entirety by setting digest_count to zero. In this case, the hash file must include part of the pathname of the directory, as described below.

The syntax of the hash file is shown in the following table.

Syntax	Num. Bits	Format
`Hashfile () {`		
`digest_count`	16	uimsbf
`for( i=0; i<digest_count; i++ ) {`		
`digest_type`	8	uimsbf
`name_count`	16	uimsbf
`for( j=0; j<name_count; j++ ) {`		
`name_length`	8	uimsbf
`for( k=0; k<name_length; k++ ) {`		
`name_byte`	8	bslbf
`}`		
`}`		
`for( j=0; j<digest_length; j++ ) {`		
`digest_byte`	8	bslbf
`}`		
`}`		
`}`		
`if (digest_count == 0) {`		
`pathname_length`	16	uimsbf
`for( i=0; i<pathname_length; i++ ) {`		
`pathname_byte`	8	bslbf
`}`		
`}`		
Other data may follow but can be ignored by implementations conforming to this profile.		

digest_count: This 16 bit value identifies the number of digest values in this hash file.

digest_type: This 8 bit value identifies the digest computation rules and the digest algorithm, if any, used for the associated objects. The following table lists the allowed values for this field. The digest computation rules are defined in Section 17.14.7.1.3 “Digest value computation rules”.

value	digest len.	algorithm
0	0	Non-authenticated
1	n/a	Reserved
2	20	Digest computation rules without prefix and with SHA-1 as defined in FIPS-180-1
3	20	Digest computation rules with prefix and with SHA-1 as defined in FIPS-180-1
Other values		Reserved for future use

name_count: This 16 bit value identifies the number of object names associated with the digest value. The value of this field shall be equal to one.

name_length: This 8 bit value identifies the number of bytes in the object name.

name_byte: This 8 bit value holds one byte of the object name.

Each name shall be the name of an object in the directory that contains the hash file. So, file names are the names of files in the directory and directory names are the names of direct subdirectories of the directory. No path information shall be included in the name.

The names carried by this field are binary identical to the payload part of names in the file system. So, any name matching process can be binary and ignorant of character encoding, letter case etc. Also, terminating null characters are not considered to be part of the file name.

digest_length: This integer value gives the number of bytes in each digest value. It depends upon the digest type as tabulated above. Receivers shall support all digest algorithms.

Note non-authenticated objects have a zero length digest.

digest_byte: This 8 bit value holds one byte of the digest value. See Section 17.14.7.1.3 “Digest value computation rules” .

pathname_length: This integer value gives the number of bytes in the path name.

pathname_byte: This 8 bit value holds one byte of the pathname.

17.14.7.1.1 Hash file pathname matching

The pathname bytes are required if digest_count is zero.

A pathname is illustrated by the following pattern:

scheme://hostname/path element/path element…

For the purposes of the following text "scheme" and "hostname" are treated identically to other path elements. Also, the scheme separator "://" is treated the same as the normal directory separator "/" (0x2F). So, the pattern above is considered as if it was the following:

path element/path element/path element/path element…

There shall be at least one path element.

".." is not a valid path element and shall not be present.

Trailing directory separator slashes are optional and shall be ignored by receivers.

A hash file shall be authenticated by the matching all of the pathname from the hash file with the rightmost path elements of the path to the hash file.

When matching pathnames from the hash file the pathname shall be compared using a binary comparison of complete path elements.

For example, the file:

http://www.server.com/applications/app1/auth.hash

could contain a pathname of any of the following:

- app1
- applications/app1
- www.server.com/applications/app1
- http://www.server.com/applications/app1

All of these validate the location of the hash file with varying degrees of precision.

Whereas the hash file:

http://www.server.com/auth.hash

could only contain one of the following:

- www.server.com/
- http://www.server.com/

17.14.7.1.2 Hash file location and naming conventions

A hash file is required for each directory containing objects that need to be authenticated.

The name of the hash file shall be:

auth.hash

There shall only be one instance of hash file per directory that contains authenticated resources. See also Section

17.14.8 Example of creating an application that can be authenticated".

17.14.7.1.3 Digest value computation rules

The digest value is computed over the object named in the hash file.

In this specification, the method for calculating a digest of a directory is undefined.

Digest type	entry_type	Relevant data
1	Reserved	
2	not applicable	The entire content of the file
3	1	A prefix concatenated with the entire content of the file. The prefix is made of the entry_type encoded as a 32 bit uimsbf and concatenated with the file length in bytes encoded as a 32 bit uimsbf.
NOTE 1: All other values of entry_type are reserved for future use		

Example: Consider a directory that contains file1 and file 2. A digest of type 2 shall be computed for file1 and a digest of type 3 shall be computed for file2:

The digest of file1 is simply SHA-1(contents of file1).

The digest of file2 is SHA-1 ((uimsbf 32) 1 + (uimsbf 32) FileLength(file2) + contents of file2).

17.14.7.1.4 Special authentication rules

The following rules shall also be observed:

a. Each hash file shall either provide a complete list of all the files named in the directory that are to be accessible, except itself and the signature file, mentioning each name exactly one time, or shall list no files.

b. Where the hash file contains a set of names, the set of names acts as a filter for the set of objects that can be accessed. In this case, attempts to access a file that is not named in the hash file and is not the hash file itself shall fail as if a hash could not be verified.

   These rules apply regardless of the value of digest_type associated with the object.

c. If the digest_count is equal to 0, every entry in the directory is non-authenticated subject to the encoded pathname elements matching (see "Hash file pathname matching") those of the directory.

d. If any name_length is equal to zero the associated digest shall be ignored.

e. Where the hash file is present in a DSM-CC carousel, Stream or StreamEvent objects shall specify a digest_type of zero.

f. Subdirectories may be listed in the hash file but shall be ignored if present.

g. Any item that cannot be successfully parsed due to an unsupported digest_type, or any unexpected, corrupt or missing data shall be ignored and no subsequent entries in the hash file shall be considered.

17.14.7.2 Signature file

The signature file is a file containing one digital signature. It contains the following ASN.1 DER structure:

```
Signature ::= SEQUENCE {
  certificateIdentifier AuthorityKeyIdentifier,
  hashSignatureAlgorithm OBJECT IDENTIFIER,
  signatureValue   BIT STRING
}
```

certificateIdentifier: The certificateIdentifier field shall be as defined in the ITU-T X.509 extension for the AuthorityKeyIdentifier field. It identifies the certificate that carries the certified public key that is used to check the signature.

```
AuthorityKeyIdentifier ::= SEQUENCE {
  keyIdentifier   [0] KeyIdentifier OPTIONAL,
  authorityCertIssuer [1] GeneralNames OPTIONAL,
  authorityCertSerialNumber[2]
CertificateSerialNumber OPTIONAL
}
```

Implementations are not required to use the optional keyIdentifier element of the AuthorityKeyIdentifier. The AuthorityKeyIdentifier structure shall contain both the authorityCertIssuer and authorityCertSerialNumber elements.

The authorityCertIssuer shall contain the field 'directoryName'; this field shall be equal to the issuerName of the certificate that carries the public key used to check the signature.

The authorityCertSerialNumber shall be equal to the serialNumber of the certificate that carries the public key used to check the signature.

hashSignatureAlgorithm: The hashSignatureAlgorithm field identifies the hash algorithm that is used. Note that the encryption algorithm used to compute the signature itself is already described in the SubjectKeyInfo field of the certificate that certifies this key, and thus only the identification of the hash algorithm is needed here. The supported algorithm shall be SHA-1.

```
sha-1 OBJECT IDENTIFIER ::=
  { iso(1) identified-organization(3) oiw(14)
  secsig(3) algorithm(2) 26 }
```

signatureValue: The RSA signature generation process and the encoding of the result are described in detail in IETF RFC 3447 [132].

17.14.7.2.1 Signature file location and naming conventions

The signature file is located in the directory whose hash file it signs. There can be several signature files, as there can be several entities that sign the structure. See Section 17.14.6 "Authentication process".

The name of a signature file shall be:

auth.sig.<x>

where the <x> is a textual representation of an integer decimal number without leading zeroes. The range of values represented in any single directory shall start with 1 and increment in steps of 1. The first unused integer value in the ascending sequence indicates the end of the range.

The purpose of this x is to allow the hash file of an authenticated directory to be signed by more than one entity. It is *independent* of the x value in the file name of the certificate files; receivers must use the certificate issuer and serial number values to identify the corresponding certificate. See Section 17.14.7.3.5 "Certificate file location and naming conventions" and Section 17.14.6 "Authentication process".

17.14.7.2.2 Supported algorithms

Signing the hash file is a two-step process:

1. first a hash is computed over the contents of the hash file
2. the resulting hash value is then encrypted using an encryption algorithm

This specification requires that the hash algorithm be SHA-1.

The encryption algorithm used to compute the signature is indicated in the certificate that carries this key. This specification requires that the encryption algorithm be RSA.

17.14.7.3 Certificate file

17.14.7.3.1 Description

The certificate file contains all of the certificates in a certificate chain up to, and including, the root certificate. The leaf certificate is placed first in the file. The last certificate in the file is the root certificate. The encoding of the certificate is defined in ITU-T X.509 [130]. The profile of ITU-T X.509 [130] for use in authenticating applications is specified by section 12.5 of ETSI TS 101 812 [16]. All references to 'MHP terminals' or 'decoders' shall be treated as references to a receiver conforming to the present document. Further, the rules for encoding the organizationName in section 12.5.6 shall be ignored.

The syntax of the certificate file is shown in the following table:

Syntax	Num. Bits	Format
`Certificatefile () {`		
`certificate_count`	16	uimsbf
`for( i=0; i<certificate_count; i++ ) {`		
`certificate_length`	24	uimsbf
`certificate()`		
`}`		
`}`		

certificate_count: This 16-bit integer carries the number of certificates in the certificate file. Receivers shall support counts up to and including 5.

certificate_length: This 24-bit integer specifies the number of bytes in the certificate. This length value shall be no more than 65,535.

certificate(): This field carries a single 'Certificate' data structure as defined by ITU-T X.509 [130]. See IETF RFC 2459 [127] and section 12.5 of ETSI TS 101 812 [16].

17.14.7.3.2 ASN.1 encoding

The basic specification of the ASN.1 DER encoding used in IETF RFC 2459 [127] is given in the ASN.1 specifications, ITU-T X.680 [32] and ITU-T X.690 [33]. However, IETF RFC 2459 [127] defines some extensions that are required to implement this specification.

17.14.7.3.3 Supported algorithms

There are various algorithm identifiers in the certificate structure. The OID of the algorithm used in the SubjectPublicKeyInfo structure shall be RSA.

The values for AlgorithmIdentifier used both in the certificate structure and in the TBSCertificate structure that are supported in this specification are listed in section 12.5.1 of ETSI TS 101 812 [16].

Receivers shall support certificate key lengths up to and including 2048 bits.

17.14.7.3.4 Name matching

The only allowed encoding of attributes of distinguished names shall be UTF8String.

NOTE: The use of this encoding allows name matching to be a binary comparison.

17.14.7.3.5 Certificate file location and naming conventions

A certificate chain is a hierarchy of certificates that enable the implementation to verify the validity of the key used to check a signature. For consistency, the file shall carry all of the certificate chain up to, and including, the root certificate.

The certificate file that leads to the public key of a signature shall be placed in the root directory of the DSM-CC object carousel.

The name of a certificate file shall be:

auth.cert.<x>

where the <x> is a textual representation of an integer decimal number without leading zeroes. The range of values represented in any single directory shall start with 1 and increment in steps of 1. The first unused integer value in the ascending sequence indicates the end of the range.

The purpose of this x is to allow multiple signatories to sign files. When trying to find a certificate to verify a signature, the receiver shall try all certificates in turn until one is found that matches the certificate issuer and serial number values in the signature. See Section 17.14.6 "Authentication process".

Certificates are considered to be the same if they have bitwise identical contents.

17.14.7.3.6 Authentication rules

Where multiple signature files authenticate an application, the receiver shall check each one before deciding that a file fails authentication.

17.14.8 Example of creating an application that can be authenticated

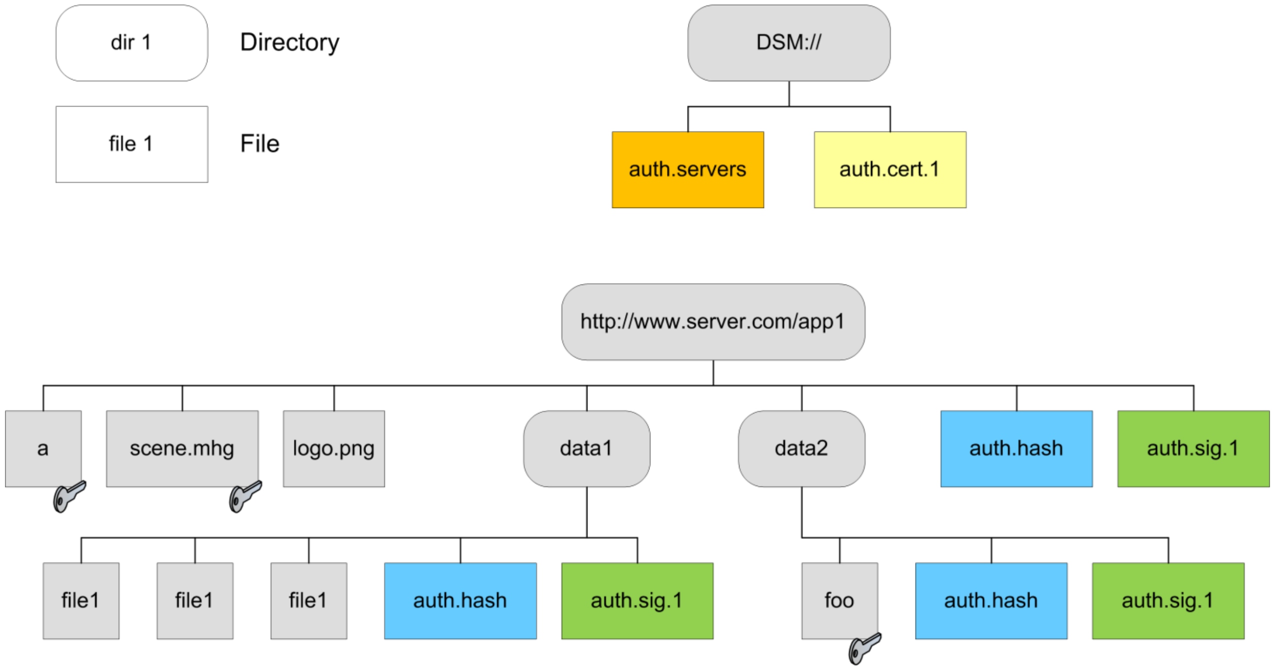
17.14.8.1 Scenario (informative)

This section is informative and gives an example of how a file system carrying an application can be organised.

In this example, the file system carries single signed application app1.

The application is comprised of the files app1/a and app1/scene.mhg, which are both signed. The file app1/data2/foo is also signed. The file app1/logo.png and the contents of the directory app1/data1 are marked as non-authenticated.

The file structure is shown below:



17.14.8.2 Hash and signature computations

17.14.8.2.1 Computation of the hashes of the app1 directory

a) initialise the SHA-1 algorithm

b) apply the SHA-1algorithm to the contents of the file a to compute H1 then apply the SHA-1algorithm to the contents of the file scene.mhg to compute H2

c) construct the contents of the hash file for the app1 directory as follows:

Field	Comment
3	Three digests
2	Type of digest algorithm = SHA-1
1	Entries over which an SHA-1 hash has been computed
a	Name of entry
H1	SHA-1 hash of file a
2	Type of digest algorithm = SHA-1
1	Entries over which an SHA-1 hash has been computed

Field	Comment
scene.mhg	Name of entry
H2	SHA-1 hash of file scene.mhg
0	Type of digest algorithm = non-authenticated data
1	Number of entries
logo.png	Name of entry
<no digest in this case>	

d) create the hash file app1/auth.hash with the above contents.

17.14.8.2.2 Computation of the hashes of the app1/data1 directory

a) construct the contents of the hash file for the directory app1/data1 as follows:

Field	Comment
0	No digests
app1/data1	Pathname

b) create the hash file app1/data1/auth.hash with the above contents.

17.14.8.2.3 Computation of the hashes of the app1/data2 directory

a) initialise the SHA-1 algorithm and compute the SHA-1 hash H3 using the contents of the file app1/data2/foo

b) construct the contents of the hash file for the directory app1/data2 as follows:

Field	Comment
1	One digest
2	Type of digest algorithm = SHA-1
1	Entries over which an SHA-1 hash has been computed
foo	Name of entry
H3	SHA-1 hash of file foo

c) create the hash file app1/data2/auth.hash with the above contents.

17.14.8.2.4 Computation of the signatures

a) initialise the SHA-1 algorithm and compute the SHA-1 hash H4 using the contents of the file app1/auth.hash

b) ASN.1 encode the following structure (DigestInfo):

- DigestAlgorithm: SHA-1
- Digest: H4

c) RSA-encrypt the result of step (b) with the private key corresponding to the public key that can be found in the leaf certificate in the file DSM://auth.cert.1. In this example this has serial number 0123456.

d) ASN.1 encode the following structure:

- AuthorityCertIssuerName: Name of the CA
- AuthorityCertSerialNumber: 0123456
- HashSignatureAlgorithm: SHA-1
- SignatureValue: result of step (c)

e) put this structure into the signature file app1/auth.sig.1

This procedure is repeated for the app1/data1 and app1/data2 directories to create the files app1/data1/auth.sig.1 and app1/data2/auth.sig.1.

17.15 Controlling access to Internet servers

17.15.1 Overview

This section describes a mechanism to restrict the set of Internet servers that an application can access under normal operating conditions. The mechanism is intended to limit the extent to which applications could, accidentally or otherwise, send sensitive information to unauthorised servers.

This specification provides no explicit signalling to control access to Internet servers beyond removal of the broadcast carousel or server list file. This is based on an inherent trust model for the broadcast chain in the UK. It is recognised that the same trust model may not apply in other markets; specifications derived from this may wish to add explicit signalling to enable interaction channel usage.

17.15.2 Restricting access to Internet servers

Access to the Internet is restricted to specified directories on servers that are listed in a 'server list' file. If no such file is present, the receiver shall not establish HTTP or TLS connections to any Internet server.

Before connecting to an Internet server following a request from an application, receivers shall verify that the connection being made is permitted by the server list file. If the connection is not permitted, the operation shall fail as if the connection could not be established. A ContentRefError, GroupIDRefError, or StreamRefError event shall be generated (as appropriate). The engine events ICLocalError, ICNetworkError and ICRemoteError shall not be generated.

Receivers shall also verify that the connection is permitted when making a POST request, although no authentication is required for the data returned in the response. See section 13.10.9a.2 "ReturnData".

Where a file request results in redirection the server list file shall not be used to verify subsequent connection. The behaviour for caching the server list file shall be the same as that for the application signing certificate (see "Certificate caching").

17.15.2.1 Server list file

Location

The name of the server list file shall be:

`auth.servers`

Receivers shall look for this file in the root directory of the "Current Carousel" (see "Current Carousel").

The server list file specifies the hosts for which interaction channel access is permitted and whether interaction channel authentication is required for content from each host.

File format

The server list file shall contain zero or more entries, each separated by a newline (0x0A) character. Empty lines and lines beginning with '#' (0x23) shall be ignored. The format of each entry is:

`[!]source://servername[:portnumber][/path_elements][/]`

where:

- *source* is http or https
- *servername* is the host name or IPv4 address (dotted decimal) of a server for which interaction channel access is to be permitted
- *portnumber* is the optional IP port number (decimal) to which access is to be permitted.
- the optional *path_elements* field consists of one or more path elements such that access is restricted to those directories on *servername* whose path begins with *path_elements*
- The source field may be optionally prepended with an "!". If the source field is prepended with an "!", then content (but not MHEG code) shall be loaded from matching hosts by ignoring the "!" and loading content as if the authentication level were 1 (i.e. authentication is not required) for any subsequent redirecion.
- If the source field is not prepended by an "!", or the source field is prepended with a "!" but the content is MHEG code, then authentication must take place according to the authentication level as described in 17.14.2, "Authentication levels".

Receivers shall determine whether URLs match by performing a binary comparison between the first parts of the string requested by the application and the whole entry in the server list file appended with a directory separator ('/') if the entry does not end with one.

Example

An entry for http://www.server.com/mheg is implicitly http://www.server.com/mheg/ and allows interaction channel access for the /mheg directory on the HTTP server with domain name www.server.com. It does not permit access to any of the following:

- a file named /mheg
- a directory named /mhegstuff
- a TLS connection to a server called www.server.com
- an entry for !http://www.server.com allows interaction channel access to content on the HTTP server with domain name www.server.com without requiring a valid hash file to be present. It would not allow access to MHEG code without a valid hash file.

17.16 Transport Layer Security

17.16.1 Overview

Where applications need to send or receive data over the Internet securely, secure connections can be established using the TLS (Transport Layer Security) protocol as described in IETF RFC 2246 [126]. Certificates for authentication of TLS servers are provided in the broadcast carousel. TLS connections are requested by applications by using the "https:" URI scheme in place of "http:". See "Non-equivalence of URIs with different sources".

17.16.2 Not required features

Receivers are not required to implement the following features of TLS:

- the functionality of being a server for the TLS protocol
- compliance with SSL 3.0
- TLS client authentication

17.16.3 TLS cipher suites

The minimum set of cipher tools that implementations of this profile of TLS shall implement are:

- RSA
- MD5
- SHA-1
- DES
- AES

More detail of this requirement is given in the following table which identifies which methods are required in a receiver (see IETF RFC 2246 and RFC 3268 for definition of the terms).

CipherSuite	Key Exchange	Cipher	Hash	Value (hex)	Status
TLS_NULL_WITH_NULL_NULL (note 1)	NULL	NULL	NULL	00, 00	Required
TLS_RSA_WITH_NULL_MD5	RSA	NULL	MD5	00, 01	Required
TLS_RSA_WITH_NULL_SHA	RSA	NULL	SHA-1	00, 02	Required
TLS_RSA_EXPORT_WITH_DES40_CBC_SHA	RSA_EXPORT	DES40_CBC	SHA-1	00, 08	Required
TLS_RSA_WITH_DES_CBC_SHA	RSA	DES_CBC	SHA-1	00, 09	Required
TLS_RSA_WITH_3DES_EDE_CBC_SHA	RSA	3DES_EDE_CBC	SHA-1	00, 0A	Required
TLS_RSA_WITH_AES_128_CBC_SHA	RSA	AES_128_CBC	SHA-1	00, 2F	Required
TLS_RSA_WITH_AES_256_CBC_SHA	RSA	AES_256_CBC	SHA-1	00, 35	Required
NOTE: This cipher suite is only used by a TLS implementation during the negotiation of a connection. It is not required to be enabled as a cipher suite that is available for a negotiated connection.					

Note data encryption is very time consuming for a server. The ciphers TLS_RSA_WITH_NULL_MD5 and TLS_RSA_WITH_NULL_SHA provide integrity checking but without confidentiality (i.e. data are in the clear). They are useful for applications in which data don't need to be encrypted but in which data integrity is very important. For these applications, the server will only have to compute an HMAC for every message exchanged.

17.16.4 Server authentication for TLS

Before the TLS connection can be established, the receiver has to ensure that the certificate list sent by a server contains at least one trusted certificate. In the computer environment, this is simply done by checking the list of certificates against a root certificate that is resident in the computer.

In the MHEG environment, an application author knows which servers an application will connect to and can provide a copy of the appropriate certificate with the application. To allow the receiver to check the certificate chain, at least one certificate from it must be placed in the root directory of the DSM-CC carousel. The receiver shall check the signatures on all certificates in the chain from the leaf certificate to a certificate that is present in the carousel.

When the certificate chain sent by the TLS server cannot be verified against any of the TLS certificates present in the DSM-CC carousel, the receiver shall not use the connection to the TLS server.

Receivers shall ignore any ‘CRL distribution point’ fields during TLS server authentication.

17.16.4.1Certificate files

Location	The TLS certificates shall be located in the root directory of the “Current Carousel” (see “Current Carousel”). The name of a certificate file shall be: auth.tls.<x> where the <x> is a textual representation of an integer decimal number without leading zeroes. The range of values represented shall start with 1 and increment in steps of 1. The first unused integer value in the ascending sequence indicates the end of the range. Receivers shall check each certificate file in turn until a certificate is found that matches a certificate from the certificate chain presented by the server.
File format	Each TLS certificate file shall contain a single certificate. The file format is otherwise the same as that used by certificate files for application authentication, see Section

17.14.7.3 Certificate file".

Certificate caching	Receivers may cache certificates for up to 24 hours to avoid loading them from the carousel each time a TLS session is established. Where a signature to be checked references a certificate that is not available from cache, receivers shall check for the certificate in the carousel even if previous attempts to load the certificate have failed. Receivers shall discard all cached certificates each time the auto-boot process begins (see Section 17.4.4.2 "Locating the initial object").

17.17 HTTP profile for delivering encrypted streams

This section describes additional behaviour in the HTTP profile to support the delivery of encrypted streams over HTTP. This behaviour is required for receivers that implement *ICEncryptedStreamExtension*.

17.17.1 Additional response headers

Receivers shall handle the following response headers in the manner described in this section:

- X-Keys
- X-KeyLocation

If these headers are present in a Redirection response (3xx) they shall be applied to any media ultimately obtained from the destination of the redirect. If a header is received more than once, then the last value obtained shall be acted upon.

If the media is encrypted then the specified decryption keys shall be used to decrypt the media as described in 17.17.3.

17.17.1.1 X-Keys

When the X-Keys header is present it indicates that the transport stream is encrypted. This header contains the keys needed to decrypt the transport stream. Section 17.17.3 describes how these keys should be used.

17.17.1.2 X-KeyLocation

When the X-KeyLocation header is present it indicates that the transport stream is encrypted. The value of this header is the URL from which the keys needed to decrypt the transport stream can be obtained. Section 17.17.3 describes how that file is used.

17.17.2 Redirects

When a receiver encounters a redirect response when accessing a media URL it shall follow the redirect. Any of the additional headers, specified in section 17.17.1, “Additional response headers”, which it encounters in a redirect response should be obeyed, unless they are overridden by another header obtained by a later response.

Although media shall not be streamed over a TLS connection, it is permitted for an https URL to be used initially, allowing decryption keys to be returned together with a redirect to an http URL.

When a receiver follows a 301 (Moved Permanently) redirect it shall not re-request the same URL which returned the redirect unless the MHEG application resets the Content attribute of a Stream object to that location.

17.17.3 Encrypted content

The presence of an X-Keys or an X-KeyLocation header in a response indicates that encryption has been applied to the payload of transport stream packets. This header may be present in a redirect response (see section 17.17.2). The receiver shall load the specified keys into the transport stream decryption unit before commencing playback. Receivers shall support loading keys from either header. If both headers are present receivers may choose to use either one. If a receiver is unable to retrieve the file indicated by the X-KeysLocation header, or the file cannot be parsed, then the KeyFileError engine event shall be raised.

When the X-KeyLocation header is present the server list file shall not be used to verify any subsequent connection required to retrieve the key file. The content of the X-KeyLocation file is not required to be authenticated.

Receivers shall not implement any mechanisms designed to expose the keys to the user, to MHEG applications or to other devices.

17.17.3.1 Encryption scheme

Where content is encrypted it shall be done so using Transport Stream level AES encryption, as described here. This is compatible with the specification in section 6.4 of IEC 62455:2007 [144]. The encryption algorithm shall be AES-128 in CBC mode, described in FIPS PUB 197:2001 [145], with the termination mode as described in section 4.2 and 4.3 of ANSI/SCTE 52 2003 [146] (note that the DES encryption referred to in that standard shall not be used). In this specification, all encrypted PIDs shall use the same odd key, even key and initialisation vector. The same initialisation vector shall be used for all packets, regardless of whether the odd or even key was used.

The decryptor is re-initialised with the specified IV before the decryption of every TS packet.

The transport_scrambling_control bits in the transport packet header of each packet indicate whether the packet has been encrypted with the odd or even key, or is in the clear as follows:

transport_scrambling_control value	Meaning
00	Not encrypted
01	Not used in this profile.
10	Encrypted with Even Key
11	Encrypted with Odd Key

17.17.3.2 Format of key file or X-Keys header

For each PID to which encryption has been applied the following information is contained within the key file or header:

- PID
- IV
- Odd Key
- Even Key

The PID is encoded as a decimal number in ASCII. All other values are binary, encoded as Base64. The contents of the key file and the header have exactly the same format.

```
KeyFile ::= KeyString
KeyHeader ::= 'X-Keys:' <space> KeyString
KeyString ::= PIDString [ ':' KeyString]
PIDString ::= PID ':' IV ':' OddKey ':' EvenKey
PID ::= <integer encoded as decimal ascii value>
```

```
IV ::= <128bit binary value encoded as Base64>
OddKey ::= <128bit binary value encoded as Base64>
EvenKey ::= <128bit binary value encoded as Base64>
```

Note: this format allows the key and IV data to be specified separately for each PID. However, in this profile, receiver behaviour is undefined if different PIDs have different data specified.

18 Name Mapping

18.1 Names within the receiver

Name Format	Use	Comment
rec://svc/def	ContentReference for a Stream object	This ContentReference identifies the receiver's **default service**. I.e. that most recently selected by a service change. See Section 16.3.5 "Locating components carried in Transport Streams".
rec://svc/cur		This ContentReference identifies the receiver's **currently selected service**. This may be different to the default if, since the last service change, an application has explicitly set the Multiplex specified for a Stream object. See Section 16.3.5 "Locating components carried in Transport Streams".
rec://svc/lcn/<LCN >		This ContentReference identifies a service based on the associated "logical channel number" (or LCN). See Section 18.3.3.2 "Logical Channel Number format".
rec://font/uk1	Font attribute of Application class or OriginalFont attribute of Text class	This identifies the in-built receiver font described in Section 15.3.2 "Embedded font".
ram://<name>	Name space for persistent storage.	See Section 16.7 "Persistent storage".
rec://htext/top	Anchor text for navigation boundary events within the HyperText class.	These Anchor texts identify that either the top or bottom of the HyperText object have been navigated to as described in Section 15.8.1 "HyperText anchors".
rec://htext/bot		
pst://<name>	Name space for true persistent storage	See 16.7a, "True persistent storage".

Table 18-1. Names within the receiver

18.2 MHEG-5 component tags

See Section 17.3 "AssociationTag mapping".

18.3 Namespace mapping

For an application to start, at least one of the file systems available to the receiver must have been mounted. The file systems are listed in Section 16.2.8 "Accessible file systems". Data may be retrieved from one or more unambiguous namespaces.

The high-level API differentiates between three types of retrieved data:

- objects that comply with the high-level API definition, i.e. MHEG-5,
- the content (such as bitmaps or text) of those objects, and
- streams (such as video and audio).

For accessing the application data on the server side, the DSM-CC Directory, File and Stream objects are used. Note that the server, in this context, does not have to be a physical server, but could be implemented, for example, as a broadcast carousel in a pure-broadcast topology.

Each file accessed by an MHEG engine is either a Scene object, an Application object, or the content data of an Ingredient object. Each Scene object, Application object and content data is stored in a separate file.

18.3.1 MHEG-5 object references

MHEG-5 objects can be exchanged in two ways. Application and Scene objects are exchanged as files, which may be retrieved from any mounted file system. All other objects are classed as Ingredients and are exchanged within another high-level API object, i.e. within an Application or Scene object.

MHEG-5 references objects by an ObjectReference, consisting of an optional byte string GroupIdentifier, followed by an integer, the ObjectNumber.

For the mapping on files, the following additional rules are defined:

1. For any GroupIdentifier, the mapping rules defined in Section18.3.2 "Mapping rules for GroupIdentifier and ContentReference" apply. The GroupIdentifier must be a string which, when expanded according to those rules, gives the pathname (URI) of the file.
2. Specifically, each Application and Scene object shall have in its GroupIdentifier a byte string which maps on the name of the file which contains that object. These objects shall have their ObjectNumber set to 0.
3. Each application shall have exactly one Application object. That object shall be contained in a file. Only one Application object shall be contained in each such file.

   See Section17.4.4.2 "Locating the initial object".
4. Ingredient objects may
   - either leave out the GroupIdentifier, in which case it is assumed to be a string which maps on the name of a file which contains the object (Application or Scene) of which this object is a part,
   - or fill in the GroupIdentifier with such a string.
5. Ingredient objects shall have their ObjectNumber set to a value which is unique within that Group.

18.3.1.1 MHEG-5 content references

MHEG-5 has a separate way of referencing the actual content of objects belonging to the Ingredient class. This is done by way of a ContentReference which is simply an octet string. The format of this is defined by the mapping rules in Section 18.3.2 "Mapping rules for GroupIdentifier and ContentReference".

18.3.1.2 DSMCC Stream objects

Note that the mapping of ContentReference and GroupIdentifier allow references to both DSM-CC File and DSM-CC Stream objects. Although this is possible, applications shall not refer to DSM-CC Stream objects using a

GroupIdentifier. GroupIdentifiers are always expected to refer to DSM-CC File objects.

The ContentReference of an MHEG-5 Stream object may refer to both DSM-CC File and DSM-CC Stream objects. If the ContentReference refers to a DSM-CC File object, the MHEG-5 Stream object shall have its Storage attribute set to memory. If the ContentReference refers to a DSM-CC Stream object, the MHEG-5 Stream object shall have its Storage attribute set to stream. ContentReferences of MHEG-5 Ingredients other than Stream objects must always refer to a DSM-CC File object.

18.3.2 Mapping rules for GroupIdentifier and ContentReference

18.3.2.1 Void

18.3.2.2 Case sensitivity

The BIOP::Name in the DSM-CC directory and service gateway messages (see Section 17.2.3.4 "BIOP DirectoryMessage") provides a *case sensitive* file name.

Additionally in receivers that implement *InteractionChannelExtension* http and https URIs (see 17.7, "IC file system") and the hybrid file system (Section 17.13 "Hybrid file system") both provide *case sensitive* file names.

So an MHEG-5 group identifier or content references of "foo" won't match a file named "Foo". Indeed a directory might contain both "Foo" and "foo". However, Section19.8 "File naming" recommends that file names should be distinguishable on a case insensitive file system to ease development of applications.

18.3.2.3 Structure of file references

GroupIdentifiers and ContentReferences are composed of the following four components in sequence:

- Source
- Path Origin
- Path
- Filename

Table 18-2 specifies the allowed contents of each of these components and their meaning.

Source	Path Origin	Path[a]	File Name	Meaning
"DSM:"				The service gateway of the "Current Carousel".
"~"				For receivers not implementing *InteractionChannelExtension:* This is shorthand for "DSM:" For receivers implementing *InteractionChannelExtension:* This is shorthand for "hybrid:"
"CI:"				The root of the file system provided by a CI module while application MMI session is open after a RequestStart has been sent by the module. See Section16.11.
empty string ""				Shorthand for "Current Source". Resolves to a source as appropriate.
	//			Root directory of the specified source.
	/			Shorthand for the path from "//" to the active application.
		dir/		A component of a path to a sub directory. The text "dir" is one or more characters long. In the Object Carousel the text "dir" corresponds to a name component in the directory message binding where the bound object is a directory. Each "/" delimits a name component.
		../		"Move back up on directory level" see "Notes on resolving "../"".

a] Zero or more instances

Source	Path Origin	Path[a]	File Name	Meaning
"DSM:"				The service gateway of the "Current Carousel".
"~"				For receivers not implementing *InteractionChannelExtension:* This is shorthand for "DSM:" For receivers implementing *InteractionChannelExtension:* This is shorthand for "hybrid:"
"CI:"				The root of the file system provided by a CI module while application MMI session is open after a RequestStart has been sent by the module. See Section16.11.
empty string ""				Shorthand for "Current Source". Resolves to a source as appropriate.
	//			Root directory of the specified source.
	/			Shorthand for the path from "//" to the active application.
		dir/		A component of a path to a sub directory. The text "dir" is one or more characters long. In the Object Carousel the text "dir" corresponds to a name component in the directory message binding where the bound object is a directory. Each "/" delimits a name component.
		../		"Move back up on directory level" see "Notes on resolving "../"".
			file	The name of the file. See Section 18.3.2.1 "Identifier length limitations" for limitations. In the Object Carousel the text "file" corresponds to a name component in the directory message binding where the bound object is a file, stream or stream event.

Table 18-2. Definition of reference components

Source	Path Origin	Path	File Name	Meaning
"http:"				Denotes that the file reference is an http URI, to be retrieved by the IC file system see Section17.7 "IC file system" or delivered via the Interaction Channel in the case of a stream reference.
"https:"				Denotes that the file reference is an https URI, to be retrieved by the IC file system. See Section17.7 "IC file system" or delivered via the Interaction Channel in the case of a stream reference..
"hybrid: "				The root of the hybrid file space. See Section 17.13 "Hybrid file system").

Table 18-2a. Additional components for receivers implementing *InteractionChannelExtension*

Resolution of file referencesThe process for resolving file references is equivalent to:

- Expand any short hand components:

  - an empty source expands to the string represented by the "Current Source" (see Section 16.2.7 "Application context")

  - the path origin "/" expands to a path such as "//weather/today/"

  - the source and path origin together might be "DSM://weather/today/"

  So "/cloud" might become "DSM://weather/today/cloud"

- Allow each "../" component to consume the path component preceding it. So:

  "/../tomorrow/app" might first become "DSM://weather/today/../tomorrow/app" before it collapses to "DSM://weather/tomorrow/app"

Notes on resolving "../"

The general process for resolving "../" is shown above. In addition:

- The process for "../" components to consume super directory components operates left to right.
- There may be many "../" components in a path and these are not required to be contiguous.
- The reference is unresolvable (and hence invalid) if the "../" components imply "climbing above" the file system root.

So:

```
"DSM://A/B/../F/../X/Y" collapses to "DSM://A/X/Y"

"DSM://A/../../X/Y" is unresolvable
```

"../" is resolved before the indirection through any file system. Additionally the file path shall never contain "../" when presented to the file system.

URI syntax

A file reference with a source of "http:" or "https:" must conform to the syntax for an http or https URI, even if this does not match the four components described above. In particular, the part of the URI corresponding to Path Origin must be "//" and not "/".

Non-equivalence of URIs with different sources

Note that no assumption can be made that URIs that are equivalent in their path but different in the source reference the same resource. In particular "http" and "https" URI schemes define separate namespaces (http://example.org/ and https://example.org/ are not, or may not be, equivalent).

Maximum reference lengthThe following limitations apply to resolved file references:

- DSM-CC reference shall be at most 64 bytes
- Interaction Channel references shall be at most 1024 bytes
- CI references shall be at most 64 bytes
- HFS references have no restrictions but references to the underlying file system will have limitations.

This limitation applies to the length of the reference after complete resolution (i.e. the final "DSM://weather/tomorrow/app" form) and after any hybrid mapping has been applied.

Implementers should be aware that this limitation does not apply to an unresolved reference (e.g. "DSM://weather/today/../tomorrow/app"). These may require significantly more memory.

Character codes

For the avoidance of doubt the character codes used for the components of a reference are as follows:

- `"DSM:" is 0x44534D3A`
- `"CI:" is 0x43493A`
- `"//" is 0x2F2F`
- `"/" 0x2F`
- `"~/" 0x7E2F`

Additionally, for receivers that implement *InteractionChannelExtension* the following clarifications apply:

- `"http:" is 0x687474703A`
- `"https:" is 0x68747470733A`
- `"hybrid:" is 0x6879627269643A`

Examples

If the fully resolved reference for the current application object is 'DSM://dir1/foo' then:

```
'//bar' resolves to 'DSM://bar'
'/bar' resolves to 'DSM://dir1/bar'
'~/bar' resolves to 'DSM://dir1/bar'
'~/../bar' resolves to 'DSM://bar'
'//../bar' is an invalid reference
```

18.3.2.4 Shorthand notation

A second meaning for the abbreviation '/' meaning "absolute Path Origin" was defined by DAVIC [50]. This **is not permitted** as it cannot be distinguished from the meaning of '/' defined above.

18.3.2.5 Reserved characters in HTTP URIs

For ContentReferences or GroupIdentifiers that contain an HTTP URI (or for references in the hybrid file system that resolve to an HTTP URI), receivers shall not perform percent-encoding; it is the responsibility of application authors to ensure that URIs are correctly encoded. This also applies to the URI to which data is sent using the ReturnData resident program (see Section 13.10.9a.2, "ReturnData").

18.3.3 URL formats for access to broadcast services

18.3.3.1 Numerical format

DVB TS 101 812 [16] defines a URL format for locating DVB entities. To reference a DVB service it has the following numerical form:

```
dvb://<original_network_id>.[<transport_stream_id>].<service_id>
```

The textual_service_identifier form of reference to a service is not supported.

The values of <original_network_id>, <transport_stream_id> and <service_id> are represented as hexadecimal strings without any "0x" prefix (for example, "4d2e").

See TS 101 211 [13]. Services are unique within the scope of a single original network ID. So, transport stream ID is not required to uniquely specify a service within an original network. The transport stream id (0x1234 in this case) is optional in URLs and can be left empty.

Example — URLs specifying a service might be of the form:

dvb://abcd.1234.5679
or
dvb://abcd..5679

18.3.3.2 Logical Channel Number format

UK-DTT supports the use of a "Logical Channel Number" to identify a "channel" from the viewer perspective, e.g. Logical Channel Number 4 is "Channel Four". This is particularly useful when trying to provide a single reference to a service which is composed of a number of regional variants, e.g. "ITV1".

A reference to a service may be made by the use of its Logical Channel Number using the following syntax:

```
rec://svc/lcn/<LCN>
```

where <LCN> is the Logical Channel Number of the service encoded textually as a decimal integer with no leading zeros. So a URL specifying "Channel 4" (LCN 4) would be:

```
rec://svc/lcn/4
```

18.3.3.3 Handling duplicate services

In terrestrial networks the same service may be available to the receiver on more than one transport stream. This can lead to a particular service URL matching more than one service in the receiver's channel list regardless of whether the Numerical or Logical Channel Number format is used. In such circumstances the following resolution rules shall be observed:

```
if (one of the candidate services is in current multiplex)
  return service_index of this service;
else
```

```
return service_index of the candidate service nearest to
the start of the receiver's ordered channel list;
```

19 MHEG-5 Authoring Rules & Guidelines

19.1 Introduction

This section describes the measures that should be taken by the broadcaster to ensure good application behaviour. It also provides tutorial illustrations of certain advanced techniques to clarify their use and behaviour.

The techniques described in sub-sections indicated as being mandatory have been found to prevent both confusion of the user and degradation of overall system performance and thus shall be observed by application authors. Receiver implementations shall not attempt to enforce these rules.

Note — This part of this specification is not necessarily exhaustive. It is envisaged that this section is just the starting point for documents that record the accumulated experience of the industry.

19.2 Avoiding confusion with navigator functions

19.2.1 Use of user inputs (mandatory)

The user shall be able to "surf" through services with MHEG-5 applications using either the Prog+/- keys or the number keys without a change in the user interface behaviour.

Selecting & Entering

Two concepts are introduced *selecting* the MHEG-5 application and *entering* it.

When the user first navigates to a service that is wholly or partly implemented as an MHEG-5 application it is "selected". If the user subsequently interacts with the MHEG-5 aspects of that service (using a key available from input event register 3) they are deemed to have "entered" it.

Until the user "enters" the application:

- **The application shall only use input event register 3**
- **The application shall ensure that the InteractionStatus of all Interactibles shall be False**

Leaving

An exception to the above is that through use of "Persistent storage" (see Section 16.7) an application can launch a second application that transitions immediately to an interior "entered" Scene. This shall only be done after the user has "entered" the first application.

Applications shall provide a means of returning to the "selected" state. Such means should be clear and simple for the viewer to use.

19.2.2 Broadcast-triggered native applications

Receivers supporting *NativeApplicationExtension* may give control of one or more keys to a broadcast-triggered native application instead of an MHEG-5 application, or may allow such a native application to overlay an MHEG-5 application. MHEG-5 application authors should be aware that a broadcast-triggered native application may be signalled by SI on the current service, or may be present on the new service following a service tune.

The effect on a running MHEG-5 application can be controlled through use of the *SetBroadcasterInterruptions* resident program. See Sections 13.10.8.5 and 8.5.11.

Following a service tune the effect can be controlled by the *broadcaster_interrupt_flag*. See Section13.10.6.4.

19.3 Use of the "Text" and "Cancel" functions

The "Text" user input event has a specific meaning that should be observed by all applications to avoid confusing the user. It means "toggle" the visibility of the MHEG-5 aspect of the service.

The "CancelKeyFunction" user input event has a specific meaning that should be observed by all applications to avoid confusing the user. It means "go back" to a previous or higher page or item of content, either in a hierarchical or historical manner, or terminate the "interacting" state of an interactible (see also Section 13.13.6 "Interactibles").

If the "CancelKeyFunction" is invoked at the top level of an application, or when there is no historical content to return to, the application should be made no longer visible to the user (i.e. it would appear to the user that the application has been terminated).

19.3.1 The traditional "teletext" key

In Figure 19-1 "Text" toggles between conventional TV and a full screen MHEG-5 application. This is very similar to the behaviour of today's "teletext" button.

An available elaboration is that a single "teletext" service can be shared by a number of TV services.

Entering

In this case the first Scene of the "Auto boot broadcast application" associated with the service produces no visible effect. This first "invisible" Scene responds to "Text" either by transitioning to another Scene within the same application or by launching a different application.

Leaving

If the application is part of the service then the "return" when "Text" is used a second time can be implemented in various ways:

- TransitionTo the first Scene
- Quitting the application (which will automatically be restarted on the first Scene)
- Launching the application (which will automatically start on the first Scene)
- Service change (resident program) to the information application

If the information application is NOT part of the service (i.e. the "invisible" application launched it) then the options are for the visible application to:

- Launch the invisible application
- Service change (resident program) to the invisible application

If there is a one-to-one relationship between the TV service (with invisible "springboard" application) and the information service then the return link can be explicitly coded into the application.

If more than one TV service directs its viewers to a single information service, then each of the "invisible" applications should store appropriate information in persistent storage to allow returning to the point of origin (see Section 16.7 "Persistent storage").

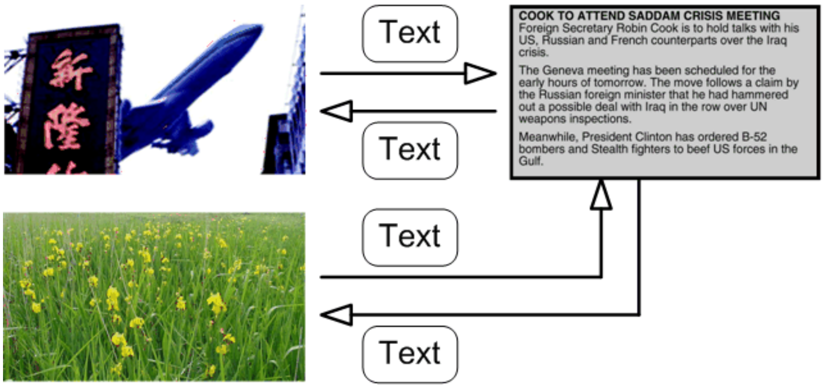


Figure 19-1. "Text" accesses "Teletext"

19.3.2 Accessing additional programme information

In Figure 19-2 the service by default has a visual prompt that more information is available. Using "Red" reveals the additional information. Using "Text" restores the original presentation (alternatively a coloured key might be used to take the viewer back to the original presentation and the "Text" key might take the viewer to a full-screen text service).

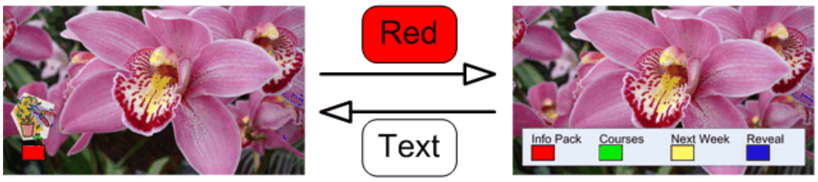


Figure 19-2. "Text" provides more information

Exactly how such visual prompts are used is the broadcaster's choice. For example, this graphic might be visible throughout the programme. Alternatively, it be shown for short periods e.g. after the programme is first selected and at the end of each "item" within the programme.

19.3.3 "Text" has no effect

In Figure 19-3 the TV service has no MHEG-5 application. In this case "Text" is not required to have any effect. However, the receiver may *optionally* provide a response.

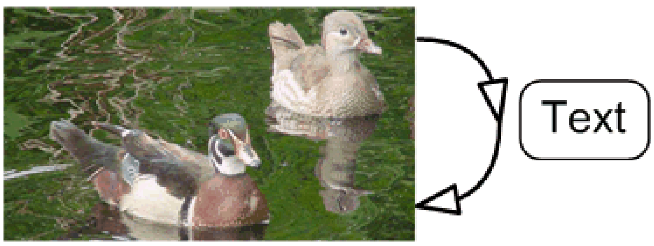


Figure 19-3. TV with no MHEG-5 application

In Figure 19-4 a predominantly MHEG-5 service has no related TV service revert to. Alternatively, the application may have been launched by a user channel change and so has no knowledge of any previous service to which it should return. In either case "Text" cannot return the user to a "logical" TV service.

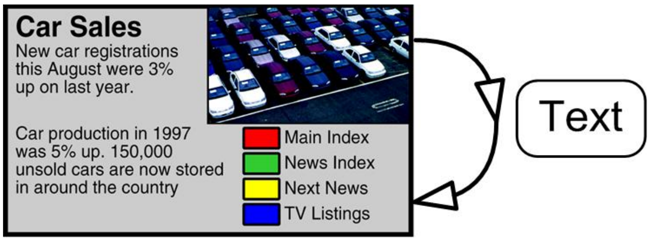


Figure 19-4. MHEG-5 services has no TV alternate

In the case shown in Figure 19-4 it may be appropriate for the application to toggle between "selected" and "entered" conditions (even if there is no visible change in the display) to allow the user to navigate to another service using the numeric keys.

19.3.4 On-screen prompts

The "CancelKeyFunction" user input event is used to "go back" to a previous or higher page or item of content. If the application is displaying an interactive on-screen prompt (such as a "press red" prompt) and this user input event is invoked, the application should remove the prompt. It is also recommended that such prompts time out appropriately.

19.4 Use of stream decoders

19.4.1 Number of decoders

Receivers conforming to *UKEngineProfile1* are modelled as providing just one of each of the following decoders:

- MPEG video or still picture
- MPEG audio
- DVB Subtitle

(mandatory) To obtain deterministic behaviour authors shall not build applications that attempt to activate more than one of each type of decoder. E.g. applications shall Stop a running Stream object using MPEG video before Running a Bitmap object with MPEG I-frame content (content hook 2 or 7).

See Section16.8.2 "Numbers of objects".

19.4.2 Visible area

Typically a 5% border region is lost due to monitor overscan. This leaves a central 632x518 area of the graphics plane which will normally be visible provided that the user does not configure their equipment in an unusual way. For example, additional area may be lost if a 4/3 service is “zoomed” to fill a 16/9 display.

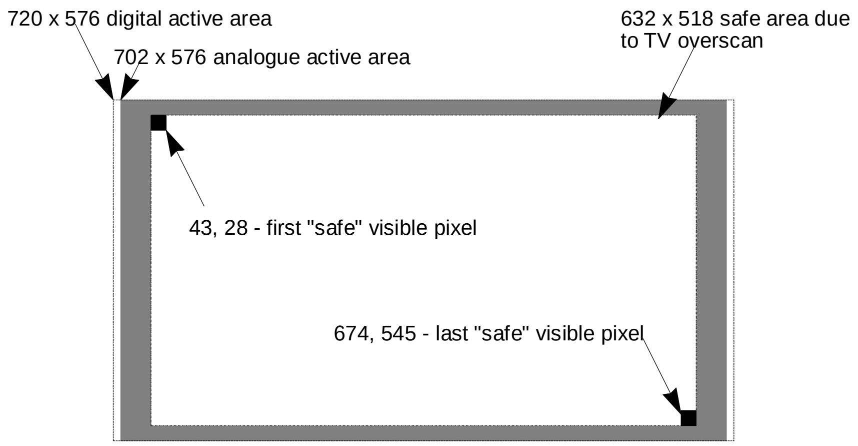


Figure 19-5. Authoring "safe" area

Note These suggested figures for safe area have not been verified. Authors should use their own experiments to develop their own rules for the safe areas that apply to their circumstances.

19.4.3 Conflicts between Subtitles and MHEG-5 graphics

Not all receivers are able to present subtitles and other MHEG-5 graphics together effectively.

Where a receiver is not able to present the two together the MHEG-5 application will not start whilst subtitles are being presented. When an application is being run, therefore, the author may assume that:

- There are no subtitles being displayed, or
- The platform is able to support simultaneous subtitles and MHEG-5 presentation.

The author may choose to suppress the subtitles for compositional reasons. Calling the resident program SetSubtitleMode(false) will ensure that subtitles are not visible even on receivers capable of simultaneous presentation. SetSubtitleMode(true) will re-enable presentation if it has been requested by the viewer (see Section16.4.3 “Subtitle decoder”).

19.4.4 Accuracy of video positioning

Authors should note that some platforms have limited video positioning accuracy. The degree of error may be affected by the position and by the scaling factor employed but may be up to 2 pixels horizontally or vertically in the *source* video or I-frame.

If greater accuracy than this is required then authors should consider using the VideoToGraphics ResidentProgram. The return values from this should be accurate to within 2 *destination* graphics pixels.

19.4.5 Defensive behaviour (mandatory)

Applications shall take steps to prevent inappropriate behaviour if the receiver cannot provide stream components when requested, for example if the service in question is badly specified or not known to the receiver. This may be achieved by checking service references using the SI_GetServiceIndex resident program or by appropriate handling of StreamPlaying and StreamStopped events. Suitable behaviour could be the display of an appropriate apology message.

19.5 Aspect ratio

19.5.1 Inheritance of video (mandatory)

Applications that inherit a default video stream and continue to present it full screen shall not change the aspect ratio of the presentation until the application has been 'entered' (see Section 19.2.1). This means that such an application must begin with a Scene whose AspectRatio is undefined.

19.5.2 MHEG-5 only services

Where there is no aspect-ratio-sensitive content in an MHEG-5 Scene, the Scene's AspectRatio attribute should be left undefined. This allows the receiver to show the Scene filling the screen on both 4:3 and 16:9 displays.

Scenes that do have aspect-ratio-sensitive content may use an explicit AspectRatio. Where possible, such Scenes will be displayed in the requested ratio. However, authors should avoid frequent aspect ratio changes as many receivers take a finite time to adjust the display and the transition may not be smooth.

19.5.3 I-frames

I-frames are combined with other MHEG-5 graphics without any decoder format conversion. 4:3 I-frames will therefore appear in the correct aspect ratio if the containing Scene is 4:3. 16:9 I-frames cannot be displayed without distortion on most 4:3 displays.

19.5.4 Presentation of 16:9 AspectRatio Scenes on 4:3 displays

Application authors should note that predictable representation of 16:9 Scenes on 4:3 displays is unlikely to be possible.

19.5.5 Presentation of 4:3 AspectRatio Scenes over HDMI

Application authors should note that predictable representation of 4:3 Scenes over HDMI is unlikely to be possible.

19.6 PNG bitmaps

19.6.1 Interlaced formats

Authors should be aware that good approximation of colours with dithering requires much greater receiver resources when decoding PNG bitmaps using interlace methods other than 0 (no interlace). As a consequence receivers may produce pictures of much lower quality when an interlace method (such as Adam7) is used.

19.7 Missed events

Applications are not guaranteed to receive all events. For example, stream events and timer events may be missed while an application is paused as a consequence of losing priority access to the display. See Section16.10 "Receiver process priority".

19.8 File naming

Name length (mandatory)The length of file references is limited. See "GroupIdentifier & ContentReference".

Name character coding To ease development of applications on computer platforms using traditional file systems it is suggested that the set of character codes used in file names is in the range 0x21 to 0x7E but excluding the following codes as they have special meaning, or cause other problems, on some platforms: 0x22, 0x27, 0x3A, 0x3B, 0x5C (double quote, single quote, colon, semi-colon, backslash).

Case sensitive file names File names are case sensitive (see Section 18.3.2.2 "Case sensitivity"). Application developers should be aware that several desk top computer operating systems are insensitive to the case of characters in filenames. Also, some operating systems fail to accurately display the case of file names.

Using filenames that can be distinguished on non-case sensitive file systems will help authoring and content interchange.

File names in persistent storage (mandatory)

The <name> part of the file name "ram://<name>" used to access files in persistent storage (see Section 16.7 "Persistent storage") shall be managed to avoid accidental file name collision between the applications of different service providers.

The length of <name> is defined in see Section16.7.1 "Storage of file names". The first characters of these names are allocated to multiplex operators as shown in Table 19-1 where 'xxxxx' indicates characters that may be allocated by the multiplex operator to services and applications as they choose.

<name> format	multiplex operator
BBCxxxxx	BBC
D34xxxxx	Digital 3/4
SDNxxxxx	SDN
BDBxxxxx	BDB
CCIxxxxx	Crown Castle

Table 19-1. Format of file names for persistent storage

Where an application (or co-operating applications) is (are) delivered by more than one multiplex operator the application author shall be responsible for liaising with the multiplex operators to obtain a <name> allocated within the space of one operator.

Further names "roots" may be allocated following mutual agreement between all the multiplex operators.

File names in true persistent storage (mandatory)

The <name> part of the file name "pst://<name>" used to access files in true persistent storage (see section 16.7a, "True persistent storage") shall be managed to avoid accidental file name collision between the applications of different service providers.

The first 3 characters of <name> shall be allocated to a broadcaster/application author by the DTG.

19.9 Text encoding

19.9.1 Mark-up

Mark-up coding for Text objects is described in Section15.6 "Text mark-up" is functionally equivalent to a small subset of HTML re-coded to improve transmission efficiency. A simple translation process between the two formats is possible.

HTML mark-up	broadcast mark-up codes
(no equivalent)	0x09[a]
(no equivalent)	0x20[b]
	0xC2 0xA0
 	0x0D
<P>	
</P>	0x0D 0x0D
<B> [text in bold] </B>	0x1B 0x42 0x00 [text in bold] 0x1B 0x62
<FONT COLOR="#rrggbbtt"> [coloured text] </FONT>	0x1B 0x43 0x04 0xrr 0xgg 0xbb 0xtt [coloured text] 0x1B 0x63
<	0x3C
>	0x3E
&[c]	0x26
<A HREF="tag bytes"> [anchor text] </A>	0x1B 0x41 0xnn tag_bytes [anchor text] 0x1B 0x61
<body	0x1B 0x44 0xnn body_attr_bytes 0x1B 0x64
bgcolor=colour text=colour link=colour vlink=colour alink=colour>	HyperText object BackgroundColour HyperText object TextColour body_attr_bytes "anchor_colour" body_attr_bytes "visited_anchor_colour" body_attr_bytes "active_anchor_colour"

Table 19-2. Text object mark-up codes

a] Tab characters have meaning Section 15.5.9 "Tabulation".
b] All space characters are significant.
c] And so on. I.e. the HTML "named character entities" can be directly represented with a simple character code where they exist in the Table 15-18 "Set of characters supported by the engine".

19.9.2 Text flow control

Authors should note that it is optional for receivers to implement certain of the text flow modes, see Section 15.4.2 "Control of text flow". Applications, should not use these modes or should give acceptable behaviour on receivers that instead implement one of the alternative modes listed in Table 15-8.

19.9.3 Width of row of characters

Certain characters may have a representation that extends beyond their logical width. This can potentially result in a partially rendered character if such a character was the last in a line of text to render *and* if the logical width of this line is very close (or even equal) to the available width. However, whilst this is a potential hazard for content providers no special behaviour is expected of engines conformant to this profile. This is because for all such known characters the intended usage is in combination with other characters, i.e. they should always be directly followed by another character and so should not appear as the last in a line of text to render.

19.10 Reference checking

19.10.1 Application design issues when checking references

Where operations may take significant time to complete (e.g. loading infrequently broadcast content) applications can be designed to reduce the length of time that they "block" and to enable the user to change their mind while content is loading.

The main tools here are the use of the CheckContentRef or CheckGroupIDRef resident programs. These can be used to asynchronously check the availability of carousel files.

19.10.1.1 Preloading is not mandatory

A side effect of the CheckContentRef or CheckGroupIDRef resident programs is that they may load the referenced file into receiver memory. If the receiver has done this loading subsequent SetData or TransitionTo actions may complete much more rapidly. However, as the preloading behaviour is not mandatory some receivers may still block for a significant time at this stage.

19.10.1.2 Stopping a reference check

The application can be designed to allow the user to change their mind while the CheckContentRef or CheckGroupIDRef resident programs are asynchronously running (for example, to give behaviour analogous to selecting a different link on a web browser or pressing 'stop').

One authoring approach is to use the Stop action to abandon the previously invoked resident program and then use Fork to start another instance of this resident program. Due to the asynchronous behaviour of the forked program it is possible that the Stop action will occur after the program has naturally completed its processing but before the AsynchStopped event has been processed. In this case an application may execute sequentially Stop then Fork actions and immediately receive an AsynchStopped event. In this case the application programmer is responsible for determining which instance of the forked resident program produced the event. In the example given below this is done by examining the parameters returned by the resident program when it completes. Other approaches are possible. For example, more than one resident program object might be used.

19.10.2 Code example

This section illustrates (by way of an annotated code example) the expected use of the reference checking resident programs defined under Section13.10.

This example relies on particular engine behaviour described in Section 13.10.12 "Data exchange with ResidentPrograms". I.e. that a forked process will not modify variables it shares with an application while that application is executing a LinkEffect.

```
//the CheckContentRef program
//accepts ref-to-check, returns ref-valid-var & ref-checked-var.
//need one resident-program object per concurrent check.
```

The instance of the resident program object and the variables used to communicate with it

```
{:ResidentPrg 1
  :Name "CCR"
}

//variable for ref-to-check input value
{:ObjectRefVar 2
  :OrigValue ("/newscene.mheg" 0)
}

//variable for ref-valid return value
{:BooleanVar 3
  :OrigValue true
}

//variable for ref-checked return value
{:ObjectRefVar 4
  :OrigValue ("" 0)
}

//variable for fork-succeeded return value
{:BooleanVar 5
  :OrigValue true
}
```

This is where it all starts, possibly a response to a user input

```
//...link off some event that causes reference to be checked
{:Link 10
  :EventSource ??
  :EventType ??
  :EventData ??
  :LinkEffect {
    //stop any previously invoked fork of the resident program
    :Stop(1)
    //if required set the ref-to-check variable here

    //invoke the check reference resident program
    :Fork( 1 // object number of the resident program
           5 // fork-succeeded boolean variable
           :GContentRef :IndirectRef 2 // reference to be checked
           :GBoolean :IndirectRef 3 // ref-valid variable
           :GContentRef :IndirectRef 4 // ref_checked variable
           )
  }
}
```

When the resident program complete it generates an AsynchStopped event which this link processes

```
{:Link 11
  :EventSource 1
  :EventType AsynchStopped :LinkEffect {
    //test that the fork of the check object resident program
    // was successful. If it was go on to other tests before
    // ultimately going on to transition to another Scene
    :Activate 12
    :TestVariable( 5 1 :GBoolean true )
    :Deactivate 12
  }
}

// This link fires if the test of the ForkSucceeded variable yields
true.
// It confirms that the resident program completed successfully.
// Go on to test if this is invocation of the resident program
// we had in mind by comparing the returned checked object
// ref against the object ref most recently passed to the resident
// program
{:Link 12
  :EventSource 5
  :EventType TestEvent
  :EventData true
  :LinkEffect {
    :Activate 13
    // Compare the returned object ref (4) with the
    // reference we most recently asked to be checked (2)
    :TestVariable( 2 1 :GObjectRef :IndirectRef 4 )
    :Deactivate 13
  }
}

// If this link fires it means that the check reference resident
// program completed its fork successfully and was checking the
// correct reference.
// Now see if the file was found to be available.
{:Link 13
  :EventSource 2
  :EventType TestEvent
  :EventData true
  :LinkEffect {
    // Is the ref-valid returned variable (3) true
    :Activate 14
    :TestVariable( 3 1 :GBoolean true )
    :Deactivate 14
  }
}

// This link fires if check reference program returned true
// This is the culmination of links 11, 12 & 13. In effect
// we have implemented:
// if( fork returned OK &&
//   we've checked the right reference &&
//   the file referenced is available )
//   {
//     TransitionTo( the next Scene )
// }
{:Link 14
  :EventSource 3
  :EventType TestEvent
```

```
  :EventData true
  :LinkEffect {
    :TransitionTo(:IndirectRef 2)
  }
}
```

19.11 Dynamically updated content

MHEG-5 operates a "pull model" for acquisition of content. Where applications require to use the latest version of changing content they must request the content after it has changed. It is the author's responsibility to determine when to request the content (e.g. through the use of StreamEvents, periodic polling etc.).

See Section 17.5 "Caching".

19.12 Stream events

See Section 17.2.4 "Streams and Stream Events".

Application authors should be aware that there is no absolute guarantee that a "do-it-now" stream event will reach the application. The event may be lost, for example, due to transmission errors.

(mandatory) The BIOP StreamEventMessage eventId and eventName pairing shall not be altered while an application(s) is waiting for an event to be signalled. A change in the event id/name pairing (or deletion of the event) is not detected by the receiver for outstanding events. Modification may result in the receiver waiting indefinitely for an event that will never be broadcast.

19.13 User input events

19.13.1 Obtaining user input from an application with no Scene (mandatory)

Section 13.8 "EngineEvents" indicates that engine events relating to the members of the "Register 3 group" are generated only when there is an active Scene object. Authors may wish to create an application which does not transition to a Scene until a "Register 3 group" key is pressed - this is no longer possible. Instead the application should transition to a simple transparent Scene and wait for an EngineEvent or UserInputEvent related to the required key.

19.13.2 Use of user input related engine events.

An application may be driven from two classes of user input related asynchronous events:

- UserInputEvents are generated by the current Scene when there is no active interactible.
- EngineEvents (TextKeyFunction, RedKeyFunction etc.) are generated by the current application. They are always generated even if there is an active interactible (but see Section19.13.1 "Obtaining user input from an application with no Scene (mandatory)").

When both are generated the EngineEvent is generated before the UserInputEvent

19.14 Undefined behaviour (mandatory)

Some aspects of MHEG-5 engine behaviour are undefined both in the ISO/IEC 13522-5 standard, and in this profile. Authors shall avoid reliance on any one implementation and the behaviour observed on that platform.

19.14.1 Synchronous event processing

Certain Elementary Actions involve the raising of more than one synchronous events during execution, most notably the Launch, Spawn and TransitionTo actions. How these events are handled, and which links will fire is not well defined in ISO/IEC 13522-5 and has led to receiver implementations varying in behaviour. Some receivers will queue all of the events, and others will mark Link objects as fired at the point the event was raised.

Authors should beware of the following example:

as part of an application:

```
{:rectangle 20
  ...
}
{:link 10
  :eventsource 20
  :eventtype isavailable
  :linkeffect (
    …
  )
}
{:link 11
  :eventsource 20
  :eventtype isrunning
  :linkeffect (
    …
  )
}
```

The Link objects 10 and 11 may or may not fire, depending on the receiver implementation.

19.14.2 Order of parallel links firing

If two Link objects source the same object and event, then the order of execution of the two LinkEffects is undefined. If one of those LinkEffects includes a context switch (Launch, TransitionTo etc.) then the second LinkEffect may never run depending on the receiver implementation.

19.15 Use of Call and Fork with ResidentPrograms

ResidentProgram objects possess the unusual property of being in the Active/Running state only whilst their procedural code is actually being executed.

Step 2 of the descriptions for the Call and Fork actions in section 14.4 of the MHEG-5 specification (ISO/IEC 13522-5 [40]) stipulates:

> If the Program is active, disregard this action

Therefore, a Fork or Call to a ResidentProgram instance immediately following a Fork to the same ResidentProgram instance but before the AsynchStopped event has occurred will be ignored.

19.16 Catching failure of TransitionTo

Background

It is good authoring practice to use LockScreen prior to a transition to another Scene (using TransitionTo).

However, authors should recognise that the expected transition may not succeed.

For example, the target object specified in a TransitionTo may not be available (for example because of an OC construction error) or may not be loadable by the receiver (due to memory limitations). In this case the receiver will continue to process actions in the current Scene. If the screen is still locked the user will perceive that the receiver has locked-up.

(mandatory)

Authors shall write defensively to ensure that the application will continue to interact with the user if an expected transition fails.

Typically this defensive coding will include placing one (or more) UnlockScreen elementary actions following the TransitionTo elementary action.

19.17 Elements of the Object Carousel

19.17.1 DIIs and elementary streams

The following recommendations are made to aid good receiver performance:

- Ensure that 8 or fewer DIIs are required to be monitored to achieve any single presentation
- Ensure that the DSM-CC sections that require monitoring for any single presentation are distributed over 4 or fewer elementary streams

19.17.2 Directory structure (mandatory)

- The maximum allowed number of bindings in each directory or service gateway message is 512.
- The fully resolved path to a file shall be ≤ 64 bytes (see Section 18.3.2 "Mapping rules for Group Identifier and ContentReference") this places limitations on the length of file and directory names and the depth of directory structure.

19.17.3 Timeouts (mandatory)

Timeouts are encoded for both DII messages and Modules (see Section 17.2.2.5 and Section 17.2.5). These values have no defaults and must be explicitly encoded when constructing the carousel. The encoded value must be chosen to allow sufficient time to download the relevant broadcast message(s) whilst ensuring that any error in carousel construction does not leave the receiver hanging unnecessarily.

19.17.4 Examples of Object Carousels

Figure 19.6 below illustrates an object carousel that is distributed over three elementary streams belonging to the same service.

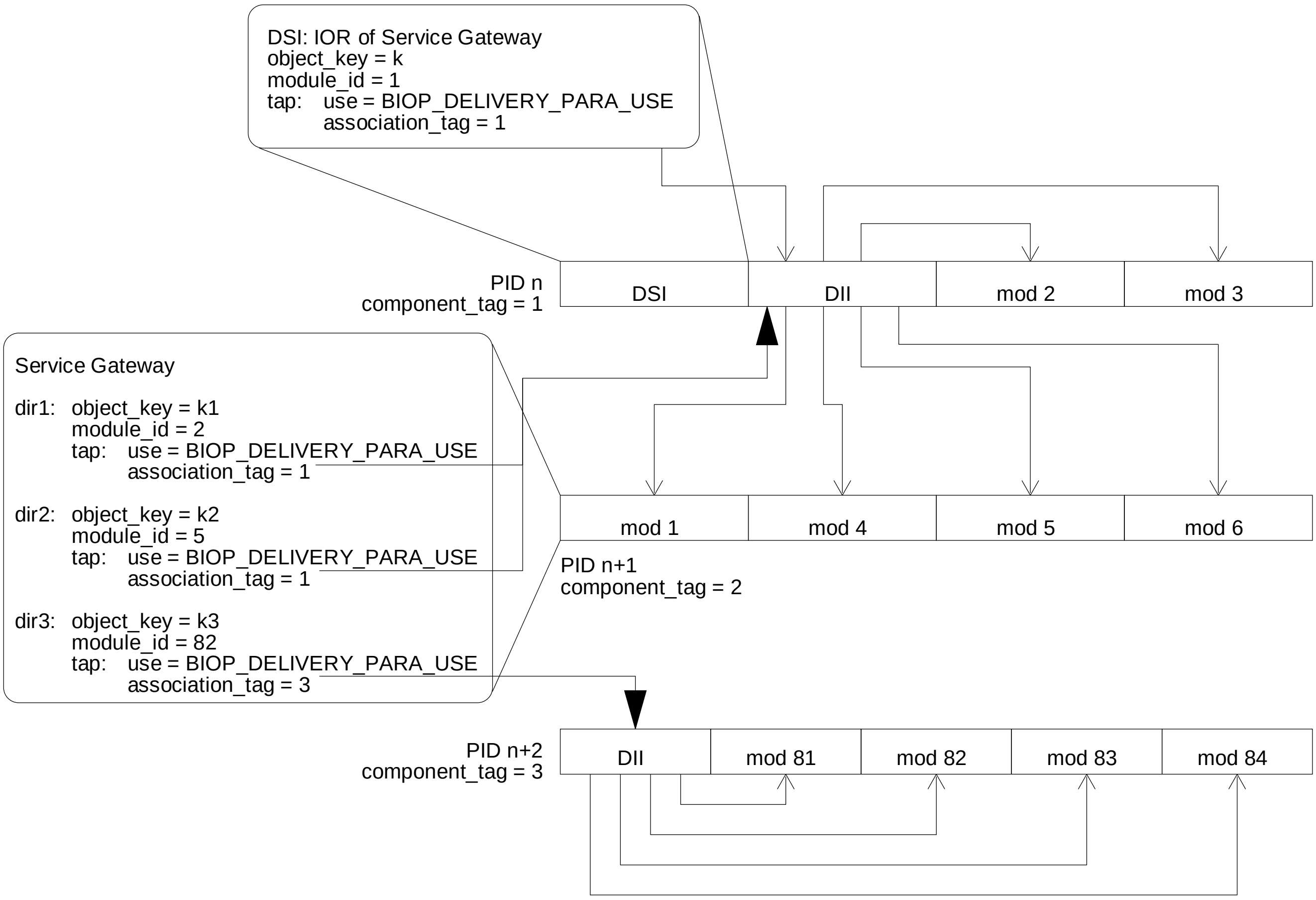


Figure 19-6. First example carousel

The DownloadServerInitiate (DSI) message is carried on the first elementary stream. It contains the object reference that points to the ServiceGateway. The tap with the BIOP_DELIVERY_PARA_USE points to a DownloadInfoIndication (DII) message that provides the information about the module and the location where the module is being broadcasted. In the example, the ServiceGateway object is in the module number 1 that is carried on the second elementary stream (indicated by a BIOP_OBJECT_USE tap structure in the DII message).

The ServiceGateway object is a root directory that, in this example, references three subdirectories. Taps with BIOP_DELIVERY_PARA_USE are used in the object references of the subdirectories to provide links to the modules via the DownloadInfoIndication (DII) message. The two first subdirectories “dir1” and “dir2” are referenced in the DII message that is carried in the first elementary stream. The third subdirectory is referenced in the DII message carried in the third elementary stream.

It is important to note that the third elementary stream may originate from a completely separate source than the first two elementary streams. The directory hierarchy and objects contained in the third elementary stream are “mounted” in the root directory by providing the “dir3” directory entry with the appropriate location information.

This type of structure could be used, for example, in a national information service that contains some regional parts. The common national parts could be carried in this example case on the two first elementary streams that are distributed unmodified in the whole country. The regional parts are carried in the third elementary stream that is locally inserted at each region. From the application's point of view, the common national parts are in the "dir1" and "dir2" subdirectories while the regional parts are in the "dir3" subdirectory.

Another example where this type of structure could be used is if the service contains multiple independent applications. In this case, each application could be placed in its own subdirectory and these subdirectories might be carried on different elementary streams.

The first example carousel does not reveal the role of the transactionId. This part of the DSM::Tap augments the information on how to locate the required DII. The assocTag first identifies the elementary stream carrying the DII, the transactionId then discriminates between DIIs on the same elementary stream, as illustrated in the figure below. To aid acquisition of DIIs the least significant 2 bytes of the transactionId field are reproduced in the table_id_extension field of the MPEG section carrying the DII.

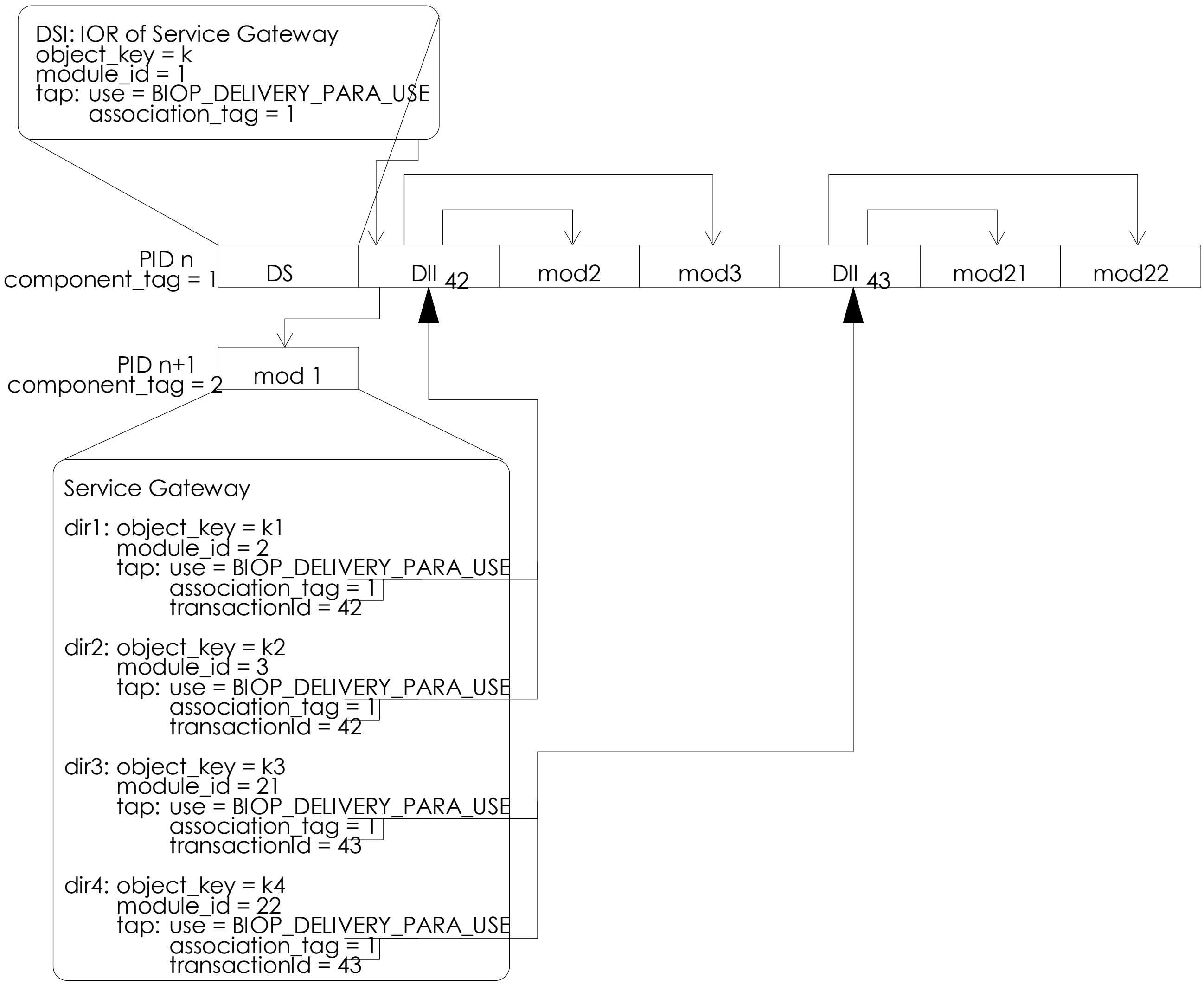


Figure 19-7. Second example carousel

19.18 Possible uses of persistent storage (informative)

Start-up Scene reference	An application can store the ObjectReference of a specific scene within another application prior to launching that application. The launched application can retrieve the ObjectReference and TransitionTo the specified scene. This allows transitions between scenes in two different applications. Without this applications could only be launched to start at their root scene.
Return Application reference	An application can store an ObjectReference to itself before launching another application. This allows the launched application to return to the “calling” application (although the Spawn action might be a better way of doing this).
Return Application Start-up Scene reference	A scene can store an ObjectReference to itself before launching another application. This allows the “calling” application to TransitionTo the “calling” scene if it is restarted.
Persistent store size	Receivers only guarantee that 1024 bytes of persistent storage is available. Consequently, applications should be authored to write at most 1024 bytes of data, unless they are coded defensively to fall back to an alternative option should a StorePersistent elementary action fail.
Interaction channel	Authors should be aware that data written to persistent storage (including true persistent storage) may be read by any application. Such data could potentially be sent over the interaction channel (if the receiver supports *InteractionChannelExtension*).

19.18a Use of true persistent storage

True persistent storage is not intended to store transient or frequently changing data and as a result is limited to a maximum of 64 writes per file/service per 28 day period. Typically, applications will store a unique ID assigned by a server. This can be used as a key by the application to reference a database on the server to retrieve personalised data.

Authors should write their applications in such a way that it is not possible to use up their 64 writes per file/service per 28 day period (e.g. add a date stamp to the file to enable a check to only write the file once a day). The author could also add defensive code into their application, such that if the 64 writes are used up, the application falls back to an alternative non-receiver storage solution, so as not to degrade the user experience. Applications shall not stop working if they have run out of 'writes', even if it is caused by unusual user behaviour (e.g. a user changing their login multiple times).

19.19 Hints and tips for good authoring

This section presents ideas on how to create better performing applications. It is primarily aimed at educating authors, however, it should also help to inform receiver implementers when trying to improve receiver performance.

19.19.1 Structure of the file system

19.19.1.1 Directories

- Structure applications in to some sort of directory hierarchy.
- Use multiple directories rather than few directories containing large numbers of files.

  Small directories are easier to cache and quicker to search when trying to locate a file.
- Place more frequently accessed files earlier in the directory list.

  They may be found more quickly when searching.

19.19.1.2 File names

- Use the shortest file name that is practical.

  Short file names reduce broadcast bandwidth, reduce receiver memory requirements and can be tested more quickly.

19.19.2 Structure of the object carousel

19.19.2.1 Placing associated objects in a module

Closely related objects (e.g. objects of one MHEG-5 scene) should be put in the same module (see Section17.2.7 "Mapping of objects to modules").

19.19.2.2 Cache priority and modules

If a Scene contains an object that has an initial CCP (content cache priority) of zero this may delay Scene start-up as it may force the receiver to reload a module and hence delay loading of other objects. This problem can be addressed in a number of ways:

- Only set the CCP of the required object to zero after the Scene is running
- Place files for objects which have CCP set to zero in a different module to other assets.

SetData on a CCP=0 object may cause other commonly used objects in the same module to be flushed from the receiver. For example, this may delay Scene transitions. This can be addressed by:

- Placing files for objects which have CCP set to zero in a different module to other assets.

  These hints reflect that some implementations have module rather than object based caching strategies.

It should also be noted here that this feature is provided to fulfil very specific application requirements (where other provided methods may not be suitable) and misuse of this functionality may seriously affect application/receiver performance.

19.19.2.3 Object ordering

The suggested order of messages within a module is:

- Directory messages on the path to urgently required files
- Files required urgently
- Files and directories required less urgently

  In principle receivers can extract files from partially loaded modules. So, placing these files and the directories that provide access to them early in the module provides a theoretical opportunity for receivers to deliver the files to the MHEG-5 engine more rapidly.

19.19.2.4 Conflict between MHEG cache policy and MHP cache_priority_descriptors

In some implementations the Object Carousel client used by the MHEG engine may be written to understand cache_priority_descriptors as specified for the MHP profile Object Carousel. These provide module caching hints to the carousel client.

It should be noted that, under certain circumstances, it is possible for cache_priority_descriptors to cause an MHEG application to operate incorrectly. Application authors should ensure that, if such descriptors are transmitted, they do not conflict with the caching policy required by the application. This profile does not define the receiver's behaviour when there is such a conflict.

19.19.2.5 Carriage of content for HD receivers in DSMCC carousels

Application authors may wish to provide high resolution versions of certain graphics for use by HD-capable receivers. Such images will not be required by standard definition receivers. Application authors can minimise the impact of such content on the caching of carousel data by SD-only receivers by placing it in modules that contain only content for HD receivers.

19.19.2.6 Carriage of "auth" files

Application authors should minimise the number of auth.tls.<x> and auth.cert.<x> files to ensure speedy access to HTTP data, and should not author applications that rely on excessive numbers of such files, e.g. 1000+. Ideally, all auth.servers, auth.tls.<x> and auth.cert.<x> files should be placed in the same carousel module.

19.19.3 Use of memory

19.19.3.1 Forked resident programs

When a resident program is invoked with Call there is only one execution thread. So, the resident program can safely work directly on the variable storage of the MHEG-5 application.

When a resident program is invoked with Fork the resident program executes concurrently with the main MHEG-5 application. As described in Section 13.10.12 "Data exchange with ResidentPrograms", forked resident program acts on a snapshot (i.e. a copy) of its In and In-Out parameters.

Authors should note that there are memory budget benefits of invoking resident programs with Call rather than Fork. This may be significant where the parameters of the resident programs have large quantities of data, which may be the case with the string manipulation RPs.

19.19.3.2 Original content never goes away!

Note that the requirement to support cloning means that each Ingredient must hold a copy of its OriginalContent forever and that the OriginalContent is converted into a runtime form as soon as the object is prepared.

If an Ingredient is cloned it inherits the OriginalContent of the parent object and then manufactures a run-time version of this content. So, each clone has a redundant copy of the OriginalContent of its parent.

More efficient use of memory is made if the object to be cloned has minimal OriginalContent and then SetData is used to initialise each instance.

19.19.3.3 Multiple references to the same content

If multiple Ingredients reference the same file normally only one copy of the content is held in receiver memory. However, if the file version changes between preparing objects then multiple versions of the content may be loaded into memory.

Authors should note that as files don't have individual file version information (the version information is on the module) there may be unexpected side-effects where a "static" file is in the same module as a "dynamic" file.

Separating dynamic and static files into different modules will prevent this problem.

19.19.3.4 Simultaneous file requests

Loading of many files simultaneously places demands on receivers in terms of memory required to hold state information for the file request. Authors should endeavour to limit the number of simultaneous file requests to avoid any degradation in performance.

Note that Scenes with a large number of initially-active Ingredients with referenced content will initiate large numbers of file requests simultaneously.

Applications should not cause more than 401 simultaneous file requests to be made as receivers will not have been tested beyond this limit. However, authors should not expect even this number of requests to be possible where there are large demands on memory from other parts of the MHEG application.

19.19.4 Encoding of reserved fields

To ensure future compatibility all reserved fields shall be set to 0 unless otherwise specified.

19.20 GetEngineSupport feature strings

19.20.1 Engine profile

Certain legacy (non-compliant) receivers respond true when N=1 (character code 0x31) or N=2 (character code 0x32). Receivers that respond true to N=1 should not return true for any value of manufacturer-specific string.

19.20.2 Engine identification

This specification provides two mechanisms for applications to obtain information about the receiver it is running on. Normally, applications will use the UEP(N) GetEngineSupport request (see Section 13.4.1 "GetEngineSupport "feature" strings") to test for a particular MHEG-5 engine version, or a particular receiver type and version. The WhoAmI resident program (see Section13.10.10.1 "WhoAmI") provides a means for an application to find out the set of UEP(N) feature strings that the receiver will respond to. This would typically be used to characterise a particular receiver during application development, to determine an appropriate GetEngineSupport request to use subsequently.

19.21 Appearance of Application Visibles with no Scene

It is implementation dependent whether active Visible objects in an MHEG Application are visible before the first Scene transition (but note that the presentation of any pre-existing stream components will initially continue as specified in Section 16.3.3).

(mandatory) Visible objects not intended for immediate presentation shall be defined 'InitiallyActive false'.

19.22 Colour representation

Application authors should be aware that attempting to use colours that are not present in the colour palette may result in inconsistent appearance between receivers. Authors should further note that blending of semi-transparency within the graphics plane may give differing results. Consequently, colours should be chosen carefully to ensure that graphics appear as intended. In the extreme case, badly chosen colours could become invisible against similarly coloured background objects.

19.23 Text width

Text that fits in a particular size box on one receiver may not fit on another conformant receiver when text wrapping is disabled due to the way truncation is specified in the UK Profile. This is most likely to affect centred and end justified text. The issue arises because truncation of individual lines is performed at the rendering stage and not as part of the text flow calculations.

(mandatory) Authors must apply the logical text width rules to ensure that text will display as intended on all conformant receivers.

19.24 Interaction Channel

This clause applies to applications that address receivers that implement *InteractionChannelExtension*.

19.24.1 Example of SetHybridFileSystem resident program

The use of the SHF ResidentProgram is demonstrated by the following example:

SHF("//i/", "http://iptv1.bbc.co.uk/content/ http://iptv2.bbc.co.uk/content/")
SHF("//i/r/", "DSM://c/r/")
SHF("//c/c2", "http://iptv1.bbc.co.uk/c2_web DSM://c/c2")

With these three calls to the SHF ResidentProgram, the mapping table is set up as shown below:

Pathname	Mapping
//	DSM://
//i/	http://iptv1.bbc.co.uk/content/ http://iptv2.bbc.co.uk/content/
//i/r/	DSM://c/r/
//c/c2	http://iptv.bbc.co.uk/c2_web DSM://c/c2

The hybrid file space resulting from this mapping table is shown diagrammatically below.

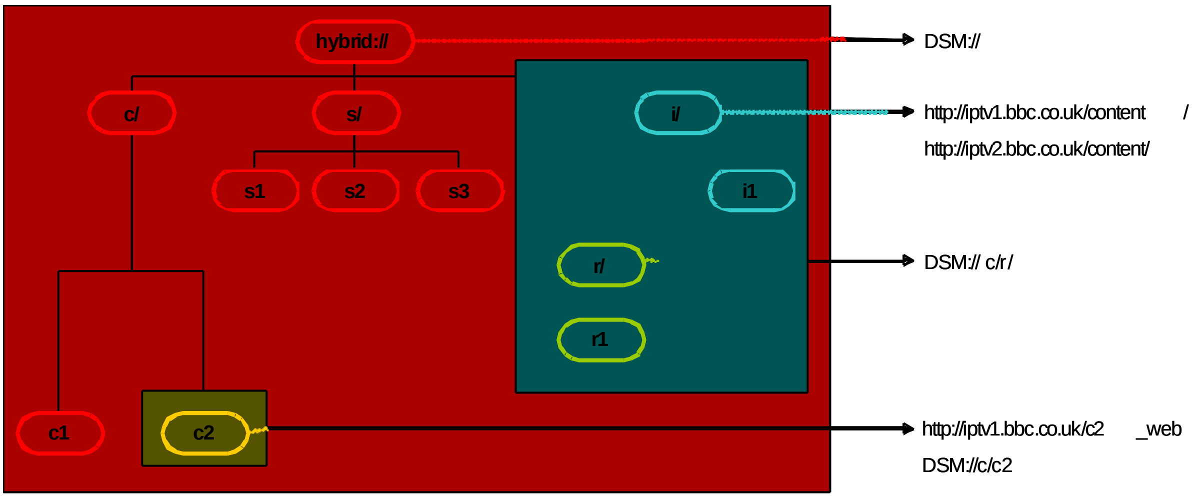


Figure 19-8. Hybrid example

According to this mapping table, the following filenames would be resolved as indicated below. Where a filename is shown as resolving to multiple locations, the second location is used if the first location is found to be unavailable.

```
//i/i1   →  http://iptv1.bbc.co.uk/content/i1
         →  http://iptv2.bbc.co.uk/content/i1
//s/s1   →  DSM://s/s1
//i/r/r1 →  DSM://c/r/r1
//c/c1   →  DSM://c/c1
//c/c2   →  http://iptv1.bbc.co.uk/c2_web
         →  DSM://c/c2
```

19.24.2 Example of ReturnData resident program

The ReturnData resident program can be used for any situation in which it is desirable to send data to a remote server using HTTP POST. A typical use case would be that of allowing the viewer to vote on some issue.

In this case, the application would allow the viewer to choose from a number of items and then POST data of the form “vote=A”, “vote=B” and so on. The application can, if its author wishes, check the response code from the server in order to act defensively should an error occur.

There is no requirement for a server to return any data. It may, however, return data (with an appropriate Content-Type header), which, regardless of the Content-Type header, will be interpreted by the resident program as an OctetString. Typically, any returned data will be of type text/plain, perhaps a message to be displayed by the application, although arbitrary binary data (such as an image) could also be returned. Alternatively, a returned string could be cast into a ContentReference and used to retrieve further content.

Another possibility would be for regional variants of an MHEG application to send different data e.g. “vote=C&region=wales”, thereby facilitating voting by region.

The use of the RDa ResidentProgram is demonstrated by the following example:

```
{:ResidentPrg 100
  :InitiallyActive False
  :Name "RDa"
}
{:BooleanVar 101
  :OrigValue False
}
{:ContentRefVar 102
  :OrigValue :ContentRef "/content"
}
{:IntegerVar 103
  :OrigValue 0
}
{:OStringVar 104
  :OrigValue ""
}

...

:Call (100 101
    :GOctetString "http://www.somesite.com/cgi-bin/example.cgi"
    :GOctetString "name1"
    :GOctetString 'String wi?th var=C3=80ious %characters~'
    :GOctetString "name2"
    :GInteger 275
    :GOctetString "name3"
    :GBoolean True
    :GOctetString "name4"
    :GContentRef :IndirectRef 102
    :GOctetString "name5"
    :GObjectRef ("/scene.mhg 20")
    :GInteger :IndirectRef 103 // Response code
    :GOctetString :IndirectRef 104 // Response data
```

```
)
```

This call to the ReturnData resident program would result in the following data being sent to the server www.somesite.com

```
POST /cgi-bin/example.cgi HTTP/1.1
Content-Length: 111
Content-Type: application/x-www-form-urlencoded
[Other headers]

name1=String+wi%3Fth+var%C3%80ious+%25characters~&name2=275&name3=t
rue&name4=%2Fcontent&name5=%2Fscene.mhg%2C20
```

If the POST request was successful, the server will reply HTTP/1.1 200 OK and the response code (returned in object 103) will have the value 200. The server may return some data such as

```
Content-type: text/plain

Your vote has been registered
```

in which case the response data (returned in object 104) will have the value “Your vote has been registered”.

19.24.3 GroupIdentifiers in the hybrid file system

When an Application or Scene is accessed through the hybrid file system, the corresponding file will be delivered by one of the other file systems available to the receiver. To ensure that the rules for mapping object references on files are not broken, application authors should avoid encoding the source in files that may be accessed through the hybrid file system. See Section17.4.4.2 “Locating the initial object” and Section 18.3.1 “MHEG-5 object references”.

19.24.4 Cache priority in the IC file system

The default value of ContentCachePriority and GroupCachePriority is 127, which enables transparent caching (see Section 17.5.3 "Content cache priority" and Section 17.5.4 "Group cache priority"). This behaviour could degrade the performance of the IC file system in certain circumstances. When requesting files that may be delivered over the interaction channel and do not change dynamically, authors should use an even, non-zero value of ContentCachePriority or GroupCachePriority.

19.24.5 Use of Spawn with the hybrid file system

Authors should be aware that when a spawned application exits, the state of the hybrid file system that is used to restart the original application will be the state that was in force at the time of the spawn.

Consider the following sequence:

The hybrid file system mapping table is in state 0
Application 'A' starts
Application 'A' sets the mapping table to state 1
Application 'A' spawns application 'B'
Application 'B' set the mapping table to state 2
Application 'B' quits
The mapping table is reset to state 1
Application 'A' is restarted and any OnRestart actions executed

Authors (in this scenario, the author of application 'A' in particular) should note that the application object for application 'A' will be reacquired, and any OnRestart actions will be executed, in the context of state 1 of the mapping table. This may not be the same as state 0.

It is possible to configure state 1 so that the instance of application 'A' that loads after application 'B' terminates is different from the instance that loaded originally under state 0. Application authors should avoid changing the hybrid mapping table such that the application itself is no longer available.

19.24.6 Interaction channel engine events

When an application fails to access an object or content over the interaction channel, one of three engine events may be generated (in addition to ContentRefError or GroupIDRefError).

The ICLocalError engine event indicates that no interaction channel connection is available. An application may wish to display a message asking the viewer to check that their receiver is connected and that the correct settings have been entered.

Application authors may choose to use the GetICStatus resident program and/or to monitor the ICStatusChanged engine event to modify the application behaviour to avoid attempting accesses when no connection is possible and optionally to inform the viewer of the limitations on the application when no connection is available.

The ICNetworkError engine event indicates that a remote server did not respond. The problem may lie within that part of the network under the viewer's control, or elsewhere. An application may wish to display a message asking the viewer to check that their network is correctly set up and to try again.

The ICRemoteError engine event indicates that a remote server responded but could not provide the requested resource. An application may wish to display a message explaining that this resource is temporarily unavailable.

The following table summarises a number of situations that may occur and the Engine Events that may be generated as a result.

	Reason for failure	Content / GroupIdRef event generated?	IC event generated
1	Server access file is not in the current DSM-CC object carousel	Y	
2	Server access file cannot be parsed	Y	
3	Access to server is not allowed	Y	
4	Host name could not be resolved	Y	Network
5	Connection cannot be created (but IC is active)	Y	Local
6	TLS connection failed for various reasons	Y	
7	Connection timed-out	Y	Network
8	Connection closed before request was sent	Y	Network
9	Server time-out during reply	Y	Remote
10	HTTP server failure (HTTP code 5xx)	Y	Remote
11	Other HTTP failures that are not 4xx	Y	Remote
12	Hash file cannot be loaded	Y	
13	Hash file cannot be parsed	Y	
14	File is not in the hash file (and digest_count is not zero)	Y	
15	Invalid pathname in hash file (and digest_count is zero)	Y	
16	File hash is invalid	Y	
17	First signature file cannot be loaded	Y	
18	Signature file(s) cannot be parsed	Y	
19	Signature doesn't match	Y	
20	First certificate file cannot be loaded	Y	
21	Certificate file(s) cannot be parsed (or certificate cannot be parsed)	Y	
22	No matching certificate is found	Y	
23	Out of memory during this process	N	

19.24.7 Presenting restricted content

Applications that present streams delivered by the Interaction Channel should consider using the PromptForGuidance resident program to verify that the viewer should be allowed to view the content. The policy for determining suitability for presentation is not defined in this specification but in general any content that is not believed to be “suitable for all” should be verified before presentation.

The PromptForGuidance resident program provides an optional OctetString that describes the reason for the restriction. The text used should be human readable, for example “Contains scenes of mild peril”. Note that where parental controls are not implemented or are disabled the resident program will return immediately without presenting the text to the viewer.

The guidance mechanism for the Interaction Channel is independent of any other guidance mechanisms defined in the present document.

19.24.8 Use of remote control keys to control A/V streams

Receivers supporting *ICStreamingExtension* may also provide recording functionality and may have additional keys on the remote control such as play, stop, fast forward and rewind.

Users of such receivers will naturally expect these DVR keys to function when viewing content streamed over IP.

Input event register 6 allows applications to access any DVR control keys that exist on the remote control. Applications are recommended to handle these user input events in the appropriate way. However, applications must also provide alternative means of controlling playback of IP-delivered streams since not all receivers will provide these keys. Applications can query the *NonLinearPlaybackKeys* engine support string to check whether a minimum set of these keys is available on the receiver.

Since *ICStreamingExtension* does not support variable speed playback, applications are recommended to map both the 'skip forwards' and 'fast forwards' user input events to a skip function, where one is provided by the application. Similarly, 'skip backwards' and 'rewind' should both perform a skip back function if one exists.

19.24.9 Use of '../' in the Hybrid File System mapping table

The interpretation of the '../' form in the pathName parameter to the SHF Resident Program is implementation specific and should be avoided.

19.24.10 Use of SetCounterPosition on IC streams

Applications may present IC Stream content from an arbitrary mid-point by calling the SetCounterPosition Elementary Action on the associated Stream object. When doing so the application should choose a CounterPosition that corresponds to an H.264 IDR Frame otherwise the stream decoder will discard any preceding content until the next IDR Frame is acquired. Further, if the stream is being started from a mid-point or after another stream has been decoding then the decoder may also need to re-acquire the stream’s PSI tables.

19.25 HD intelligent rendering

19.25.1 Sizing images for HD presentation

Depending on the location of an object in the SD co-ordinate system, its final size in the HD co-ordinate system may vary by 1 pixel.

If an image were to be provided at an HD resolution, ideally it would be prepared for its new dimension in the HD co-ordinate system. This can be calculated based on its position in the SD co-ordinate system using the co-ordinate transform given in Section14.11.3.1. If this calculation is not performed, or if the same image is to be used in different locations in different scenes, then it is recommended that HD images are prepared for the largest possible size for the HD resolution in question. The image will then either fill the image object exactly, or it will be cropped by 1 pixel at the right-hand or bottom edge such that it fits the available size. This prevents any gaps between image objects and objects that the image is intended to touch.

19.25.2 Appearance of objects on HD resolution graphics planes

Adjacent pixels in the SD co-ordinate system do not map to adjacent pixels in an HD co-ordinate system. Furthermore, the addressable pixels in the HD co-ordinate system are not evenly spaced. This means that objects spaced equally in the SD co-ordinate system may have spacing that varies by 1 HD pixel when rendered on an HD graphics plane. This includes lines of text within a multi-line Text object.

This effect is generally too small to be visible. However, if an application moves an object one SD pixel at a time across the screen, receivers performing HD intelligent rendering will show the object with slightly uneven motion as the object moves between addressable HD pixels.

Depending on the location of an object in the SD co-ordinate system, its final size in the HD co-ordinate system may vary by 1 pixel. Again, the effect of this is generally too small to be visible but an effect may be noticed on very small moving objects. Authors may hide the effect of these size changes by using a PNG image on a transparent background inside a larger MHEG Bitmap object as an alternative to small rectangle objects.

19.25.3 PNG bitmap resolution

For compatibility with receivers supporting HDGraphicsPlaneExtension, authors should avoid encoding resolution information in SD PNG images.

19.26 Non-destructive service tunes

This clause applies to receivers that implement *LifecycleExtension*.

19.26.1 Non-availability of broadcast file system during tune

During a non-destructive service tune (see section 16.2.9) any object carousel file requests made by the running application will be queued and only resolved following completion of the tune and the successful attachment of a carousel in the new service. Hence, any visual effects employed to "distract" the viewer during the tune need to be based on content already loaded into active MHEG-5 objects or available from a file system other than the broadcast file system. Fortunately, there are a number of ways of achieving animated visual effects within this constraint, including:

Cycling the appearance of one in a sequence of MHEG-5 objects using either the Run/Stop or DisplayStack manipulation actions.

Executing SetData actions where the NewContent exchanged attribute shall be set or refer to included data.

19.26.2 Carousel structure

As was specified in Section 16.2.9 there is no requirement for the new Current Carousel, attached to as a result of a non-destructive service tune, to be the same as the previous Current Carousel in the previous service at the point that the application initiated the non-destructive tune. This is true both in terms of the broadcast file system that it delivers and the encoding of the underlying Object and Data Carousel structures.

It is up to the author to ensure that the new carousel delivers a broadcast file system that is appropriate for the running application.

Whilst it is not necessary for the broadcast file system delivered by this new carousel to contain the currently running MHEG-5 Application object, it is necessary for it to contain a directory structure corresponding to that in which the MHEG-5 Application object was located when launched if file references with the path origin set to '/' are used.

For example, an application "DSM://foo/bar/a" will retrieve content with the path origin set to '/' from "DSM://foo/bar". Unless "DSM://foo/bar" exists in the target carousel, references with the path origin set to '/' will fail.

19.26.3 Behaviour of Spawn during tune

During a non-destructive service tune (see section 16.2.9) the application stack will be reset. Consequently the behaviour of Spawn ElementaryActions shall be undefined during this period and therefore should be avoided until the "NonDestructiveTuneOK" Engine Event has been received, indicating successful completion.

20 Conditional Access

20.1 Scrambling

20.1.1 References

- ETR 289 [18]
- DVB A011 [47]
- Advanced Television Directive (95/47/EC) [48]

20.1.2 Requirements

Where scrambling is employed in DTG compatible transmissions then the DVB Common Scrambling Algorithm shall be used. It shall be implemented in compliance with ETR 289.

It should be noted that the advanced television directive doesn't forbid the use of other scrambling systems. In the case of DTG transmissions however, the use of the common scrambling algorithm shall be regarded as mandatory for all compliant broadcasts.

20.1.3 Additional information (Encrypted services)

Where a receiver design is intended to support the reception, de-scrambling and display of encrypted/scrambled services via a common interface and suitable 'plug-in' module, it is strongly recommended that receiver manufacturers clarify the availability of encrypted services and the technical requirements to support such service.

An encrypted service may require the support of CI plus within the receiver and in such a case the manufacturer are strongly recommended to clarify the service provider requirements. Some requirements for implementation maybe optional within the latest CI Plus specification, however some optional items can be mandatory within the service provider requirements.

20.2 Simulcrypt

20.2.1 References

- TS 101 197 [11], Digital Video Broadcasting (DVB); Head-end implementation of DVB SimulCrypt

20.2.2 Constraints and extensions

CA systems and head-end equipment used for DTG broadcasts shall be compliant with the DVB guidelines. These specifications are currently under development. At the time of writing document [11] embodies the current state of this work.

21 Common Interface

21.1 Scope

This section defines the specifications applicable to the common interface in DTG compliant reception equipment.

21.2 References

- EN 50221 [24]: "Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications."
- R206-001 [25]: "Guidelines for implementation and use of the common interface for DVB decoder applications. CENELEC."
- CIT057r6 [26]: "Errata in EN 50221 [24] and R206-001 [25]"
- TS 101 699 [15]: "Digital Video Broadcasting (DVB); Extensions to the Common Interface Specification."

21.3 Minimum requirements

Receivers should support the following Common Interface functionality to enable the full range of service features offered by the UK DTT Broadcasters to be received.
Receivers shall implement at least the following mandatory resources defined in EN 50221:

- Resource Manager
- Application Information
- CA support
- Date-time
- MMI

The following limitations, changes and clarification apply.

21.3.1 CA support

Modules conforming to this specification should support all ca_pmt_list_management values. MMI messages should be used if the current service selection exceeds the technical capabilities or CA authorizations.

Only the ok_descrambling value has to be supported for the ca_pmt_cmd_id.

21.3.2 Host control

It is recommended that the Host Control resource (EN50221 section 8.5.1) should to be supported.

Due to the exclusive nature of the Host control resource, modules conforming to this specification should only connect to this resource, when they intend to make active use of it.

21.3.3 MMI

Support for Low-Level MMI is optional.

Receivers that do not implement Low-Level MMI have to send a display_reply APDU with a display_reply_id unknown_mmi_mode in response to a display_control APDU with an unsupported mmi_mode. This allows a safe fallback to the High-Level or MHEG-5 based MMI.

Receivers shall be able to truncate or wrap long text objects. Receivers shall support dynamically opening, changing and closing MMI menus without requiring user interaction.

Text objects are encoded according to EN 300 468 Annex A. Receivers shall not enforce the conversion of MMI texts to ASCII or a static codepage. Receivers should at least support the same character set(s) as for the decoding of the EIT-based EPG data and service names. Control codes for character emphasis and CR/LF shall be ignored.

21.3.4 Common Interface Initialisation

21.3.4.1 Specification

PCMCIA standard defines in volume 2, section 4.4.6 that the Host has to wait 5s for the ready signal to be set. As a reminder, a specification extract is shown below in italic.

A card that requires more than 20 ms for internal initialization before access shall negate READY until it is ready for initial access, a period of time which is not to exceed five seconds following the time at which the RESET signal is negated (or if no RESET is implemented, VCC is stable).

21.3.4.2 Recommendation

The Host shall explicitly check for the READY signal until it is set by the module or until a timeout of 5s has expired.

21.3.5 CA_PMT in Clear

21.3.5.1 Specification

DVB-CI specifications define in the "Guidelines for Implementation and Use of the Common Interface for DVB Decoder Applications (R206-001:1998)" [24] that the Host has to send the ca_pmt object even when the selected programme is in the clear. As a reminder, a specification extract is shown below in italic.

CA_PMT is sent by the Host even when a programme in clear is selected by the user (typically a programme for which there are no CA_descriptor in the PMT). In this case, the Host shall issue a CA_PMT without any CA_descriptors (i.e: CA_PMT with program_info_length == 0 and ES_info_length == 0).

21.3.5.2 Recommendation

Hosts shall send CA_PMT even when selected programme is in the clear (FTA).

21.3.6 CA_PMT Clear to Scrambled / Scrambled to Clear

21.3.6.1 Specification

Guidelines for Implementation and Use of the Common Interface for DVB Decoder Applications (R206-001 [24]; section 9.5.6.2) states the following:

Switch from scrambled to unscrambled and vice-versa

When one programme switches from scrambled to clear, there are several possibilities:

1. *This change is not signalled in the PMT, but only in the TSC field of the packet header or in the PES_SC field of the PES header. In this case, there is no reason for the Host to send a new CA_PMT to remove the programme from the list. The programme remains selected and the Host keeps on sending CA_PMT when the version_number of the PMT evolves.*
2. *This change results in a modification of the PMT. In this case, a CA_PMT is issued by the Host.*

When one programme switches from clear to scrambled, there are several possibilities:

1. *This change is not signalled in the PMT, but only in the TSC field of the packet header or in the PES_SC field of the PES header. In this case, the Host does not send a new CA_PMT. The CA application must detect that switch.*
2. *This change results in a modification of the PMT (e.g: CA_descriptors are removed). In this case, a CA_PMT is issued by the Host.*

In both cases it is recommended that the CA application attempt to create a user dialogue to inform the user.

21.3.6.2 Recommendation

The CA application shall not create a user dialogue when not necessary.

21.3.7 PMT Update and New CA_PMT

21.3.7.1 Specification

It has been described in R206-001 [24] (section 9.5.5.1) that:

If the Host wants to update a CA_PMT of one of the programmes of the list it sends a CA_PMT with

ca_pmt_list_management == update. This happens when the Host detects that the version_number or the current_next_indicator of the PMT has changed. The CA application in the module then checks whether this change has consequences in the CA operations or not. It also happens when the list of elementary streams of a selected programme changes (e.g.: the user has selected another language). In this case, the Host has to resend the whole list of elementary streams of that updated programme.

21.3.7.2 Recommendation

When the PMT version is changed, the CA_PMT_Update object shall be used in order to avoid a black screen.

21.3.8 Spontaneous MMI

21.3.8.1 Specification

It has been defined in Guidelines for Implementation and Use of the Common Interface for DVB Decoder Applications R206-001 [24] (section 9.5.6.1):

CA applications currently not active for any current programmes selected by the user may create MMI sessions for user dialogue, for example to warn of an impending PPV event on another programme previously purchased by the user.

21.3.8.2 Resolution

Display all MMI messages sent by the CICAM. Do not allow automatic MMI closing, allow the user to close the MMI. The CICAM shall deal with situations when the host is busy and cannot service the CICAM's request to display a spontaneous MMI message. In this case, the host returns an open_session_response object with session_status F3 (resource busy) when the module tries to open the MMI session. The module may retry opening an MMI session until the host is able to open the session but it must take into account that some messages become obsolete when the current service is changed (e.g. a spontaneous MMI message saying "you are not allowed to watch this programme").

21.3.9 Transport Stream to CICAM

21.3.9.1 Specification

DVB-CI specifications define in EN 50221 [7] (section 5.4.3) that a transport stream connection has to be established if the module is found as DVB conformant. As a reminder, a specification extract is shown below in italic.

When a module is not connected the Transport Stream Interface shall bypass the module, and the Command Interface to that module shall be inactive. On connection of a module, the Host shall initiate a low-level initialisation sequence with the module. This will carry out whatever low-level connection establishment procedures are used by the particular Physical Layer, and then establish that the module is a conformant DVB module. If successfully completed, the Host shall establish the Transport Stream connection by inserting the module into the Host's Transport Stream path. It is acceptable that some Transport Stream data is lost during this process.

21.3.9.2 Resolution

Always send the transport stream to the CICAM when it has been initialized.

21.3.10 Profile Reply

21.3.10.1 Specification

DVB-CI specifications define in EN 50221 [7] (section 8.4.1.1) that when a profile enquiry is sent by Host or module, a profile reply has to be sent by module or Host. As a reminder, a specification extract is shown below in italic.

When a module is plugged in or the Host is powered up one or perhaps two transport connections are created to the module, serving an application and/or a resource provider.

The first thing an application or resource provider does is to request a session to the Resource Manager resource, which is invariably created as the Resource Manager has no session limit. The Resource Manager then sends a Profile Enquiry to the application or resource provider which responds with a Profile Reply listing the resources it provides (if any). The application or resource provider must now wait for a Profile Change object. Whilst waiting for Profile Change it can neither create sessions to other resources nor can it accept sessions from other applications, returning a reply of 'resource non-existent' or 'resource exists but unavailable' as appropriate.

21.3.10.2 Recommendation

Reply to profile enquiry object.

21.3.11 Operation on a Shared Bus

21.3.11.1 Background

In many setups, a PCMCIA slot shares address and data lines with other devices such as a second PCMCIA slot or a flash memory chip. Each device will have its own Chip Enable line that is negated when the current access refers to this particular device. For a PCMCIA slot, this Chip Enable line is connected to the CICAM's Chip Enable #1 (CE1#) pin, Chip Enable #2 (CE2#) is ignored.

21.3.11.2 Recommendation

The CICAM shall check its CE1# pin and make sure it is low before processing any data from the bus. When Chip Enable #1 (CE1#) pin is high, the CICAM shall not send any data or change its internal state based on signals from the bus.

21.3.12 Maximum APDU Size

EN 50221 [7] section 7 states:

The objects are coded by means of a general Tag-Length-Value coding derived from that used to code ASN.1 syntax.

And later in this section:

Any value field length up to 65535 can thus be encoded by three bytes.

ASN.1 Basic Encoding Rules (BER) allow for the encoding of lengths using more than three bytes. Using the long form a length value may occupy a maximum of 127 bytes giving an encoded length which is 128 bytes long that may represent a length of greater than 10305 bytes.

The second fragment of EN 50221 text is in fact an example of how one can use three bytes to encode a length. One could equally give the example of using four bytes which could encode a length of up to 16 777 216 bytes.

21.3.13 APDU summary

apdu_tag	tag value(hex)	Resource	Direction host ⇔app	support requirement
T profile_enq	9F 80 10	resource mgr	⇔	**mandatory**
T profile	9F 80 11	resource mgr.	⇔	**mandatory**
T profile_change	9F 80 12	resource mgr.	⇔	**mandatory**
T application_info_enq	9F 80 20	application info.	→	**mandatory**
T application_info	9F 80 21	application info.	←	**mandatory**
T enter_menu	9F 80 22	application info.	→	**mandatory**
T ca_info_enq	9F 80 30	CA Support	→	**mandatory**
T ca_info	9F 80 31	CA Support	←	**mandatory**
T ca_pmt	9F 80 32	CA Support	→	**mandatory**
T ca_pmt_reply	9F 80 33	CA Support	←	**optional**
T tune	9F 84 00	Host Control	←	**optional**
T replace	9F 84 01	Host Control	←	**optional**
T clear_replace	9F 84 02	Host Control	←	**optional**
T ask_release	9F 84 03	Host Control	→	**optional**
T close_mmi	9F 88 00	MMI	→	**mandatory**
T display_control	9F 88 01	MMI	←	**mandatory**
T display_reply	9F 88 02	MMI	→	**mandatory**
T text-last	9F 88 03	MMI	←	**mandatory**
T text-more	9F 88 04	MMI	←	**mandatory**
T keypad_control	9F 88 05	MMI	←	**optional**
T keypress	9F 88 06	MMI	→	**optional**
T enq	9F 88 07	MMI	←	**mandatory**
T answ	9F 88 08	MMI	→	**mandatory**
T menu_last	9F 88 09	MMI	←	**mandatory**
T menu_more	9F 88 0A	MMI	←	**mandatory**
T menu_answ	9F 88 0B	MMI	→	**mandatory**
T list_last	9F 88 0C	MMI	←	**mandatory**
T list_more	9F 88 0D	MMI	←	**mandatory**
T subtitle_segment_last	9F 88 0E	MMI	←	**optional**
T subtitle_segment_more	9F 88 0F	MMI	→	**optional**
T display_message	9F 88 10	MMI	←	**optional**
T scene_end_mark	9F 88 11	MMI	←	**optional**
T scene_done	9F 88 12	MMI	←	**optional**
T scene_control	9F 88 13	MMI	→	**optional**
T subtitle_download_last	9F 88 14	MMI	←	**optional**
T subtitle_download_more	9F 88 15	MMI	→	**optional**
T flush_download	9F 88 16	MMI	←	**optional**
T download_reply	9F 88 17	MMI	←	**optional**

21.4 Numbers of sockets

Digital television receivers with an integral viewing screen of visible diagonal dimension greater than 30 cm shall provide at least one open interface socket (conforming to an industry wide specification) e.g. the DVB common interface connector, permitting both the simple connection of peripherals and able to pass all the elements of a digital television signal, including information relating to interactive and conditionally accessed services.

21.5 Enter menu

The host shall provide access to module applications under user control from the resident navigator software.

21.6 Application domain specific extensions

21.6.1 Copy protection

Receivers shall provide a Copy Protection resource as defined in TS 101 699 and operating at least the specific protocol described here.

CopyProtectionID

The Copy Protection resource shall at least recognise copy protection messages with CopyProtectionID of 0x00D07F.

CP_query

As specified in TS 101 699.

CP_reply

As specified in TS 101 699.

CP_command

This specification uses a single byte message carried in the CPCommandByte field described by TS 101 699. The encoding of this byte is as follows:

- the value 0 commands ‘deactivate copy protection’
- the value 1 commands ‘activate copy protection’

Other values of CPCommandByte are reserved. The meaning of command byte strings longer than 1 byte is reserved. Receivers shall consider commands with values other than 0 or 1, and lengths other than a single byte, as an error.

CP_response

The cp_response_bytes described by TS 101 699 encode the reply of the receiver to the command. This specification uses a single byte message:

1 - means ‘command understood & implemented’

0 - means ‘error’

The meaning of other values or longer strings is reserved.

Implementation of copy protection

This specification does not address the method used by the receiver to make its output non-recordable.

Default state

The default state for the receiver shall be with copy protection inactive. Copy protection only becomes active following a CP_command to activate it.

21.6.2 Interface with MHEG-5 applications

The methods by which MHEG-5 applications can interact with a Common Interface module are described in the "Data Services" part of this specification. These build on the Application MMI described in TS 101 699. Below is a summary of the features used:

- CI_SendMessage described in Section13.10.9.1
- Chapter 16 "Receiver Requirements" in particular:
  - Section 16.2 "Application lifecycle"
  - Section 16.9 "Application stacking"
  - Section 16.11 "Interaction with DVB Common Interface module system"
- Chapter 18 "Name mapping" in particular:
  - Section 18.3 "Namespace mapping"

22 Receiver Requirements

22.0 Introduction

This chapter is provided as a guide for manufacturers who wish to achieve a minimum level of performance in their products that will give an acceptable user experience of UK DTT services. It therefore specifies a set of requirements with which receivers shall comply when in the receiver's DTT mode. These requirements can then be referenced by Freeview as part of their Trade Mark License (TML) and by the Department of Business Innovation and Skills (BIS) as part of the Digital Tick TML.

There are many types of receiver available for use with UK DTT services. For the purposes of this chapter, the term "receiver" refers to the complete product that the consumer purchases in order to use UK DTT services. Some examples are:

- television receiver
- digital video recorder
- set top box
- portable receiver
- PC card and its associated application software

Four classes of receiver are considered in this chapter, each with their own set of requirements. They are:

- Standard definition MPEG-2 DVB-T receiver (see Section 22.1);
- Standard definition MPEG-2 DVB-T recorder (see Section 22.2);
- High definition AVC DVB-T2 receiver (see Section 22.3);
- High definition AVC DVB-T2 recorder (see Section 22.4).

All receivers shall comply with Section 22.1 whilst additional compliance with the other sections depends upon the class of receiver. This chapter is applicable when receivers are operating exclusively in a mode where they can receive services compliant with this document. This means that, for example, multi-function devices are in their UK DTT mode.

22.1 SD MPEG-2 DVB-T Receiver

22.1.0 Introduction

This section sets out the requirements on receivers that are able to receive and decode SD MPEG-2 services transmitted on DVB-T multiplexes. Additional requirements for receivers with enhanced capabilities are set out in following sections.

22.1.1 Services

Receivers shall be capable of decoding all UK free-to-air DVB-T broadcasts of television, radio and enhanced services. This shall include the capability to:

- present MHEG services (see Section 22.1.6);
- present subtitles (where broadcast) if selected by the viewer (see Section 22.1.1.3);
- handle both widescreen and 4:3 picture and display formats as required (see Section 22.1.1.5 below).

The support of Audio Description (as defined in Section 22.1.1.4 below) is recommended.

Receivers shall comply with the mandatory requirements set out in Section 6.3.

22.1.1.1 Time-exclusive services

Some services, called time exclusive services, only broadcast for part of each day and share their multiplex capacity with other services.

The receiver shall handle the transition between the active and inactive states of a time exclusive service presenting clean transitions into and out of video, audio and MHEG streams without presentation of any content or application not intended for the selected service.

Receivers shall comply with the mandatory requirements set out in Section 7.4.2.3.

22.1.1.2 Video and Audio Decoding

All receivers shall include MPEG-2 video (ISO/IEC 13818-2) decoding, as constrained by the ETSI TS 101 154 Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream. As a minimum, the following resolutions (at interlaced 25 frames/s) shall be supported: 720x576, 544x576, 480x576 and 352x576.

All receivers shall include MPEG-2 audio (ISO/IEC 13818-3) decoding, as constrained by ETSI TS 101 154.

Receivers shall comply with the mandatory requirements set out in Sections 2.3, 2.4.5, 3.2.1.3, 3.3.3, 3.3.4, 3.4.2.9 and 4.3.

22.1.1.3 Subtitles

All receivers shall be capable of decoding and presenting DVB subtitles in accordance with EN 300 743.

Receivers shall comply with the mandatory requirements set out in Chapter 5.

22.1.1.3.1 Simultaneous display of subtitles and MHEG

Not all receivers are able to present subtitles and MHEG graphics together effectively. Receivers capable of simultaneously presenting both subtitles and MHEG application graphics shall observe the rules enabling MHEG applications to suspend presentation of subtitles where editorially required.

Receivers shall comply with the mandatory requirements set out in Sections 14.2 and 16.5.1.

22.1.1.4 Audio Description

Receivers that support audio description shall provide a means of adjusting the relative levels of the main audio and the audio description channel.

Such receivers shall comply with the mandatory requirements set out in Section 4.5.

22.1.1.5 Active Format Descriptions

Active format descriptions (AFDs) as defined in ETSI TS 101 154 are broadcast to describe the portion of the 16:9 or 4:3 coded frame that is "of interest". Receivers shall be able to present the video for the type of display in use according to the AFDs transmitted.

Receivers shall comply with the mandatory requirements set out in Chapter 24. If the user has selected HDMI as the primary output, any other outputs may follow the HDMI video format with appropriate signalling.

22.1.1.6 Service component changes

Receivers shall continually monitor the PSI (PAT and PMT) for changes and act accordingly.

Receivers shall comply with the mandatory requirements set out in Section 7.3.

22.1.2 Front End

Receivers shall be capable of demodulating all non-hierarchical modes specified in ETSI EN 300 744. There is no requirement to demodulate hierarchical modes, but their presence should not cause the receiver to malfunction.

Three modulation options have been specified by OFCOM (formerly ITC) for current UK DVB-T broadcasts and a fourth is currently under test:

OFDM Parameters	Values (Option 1)	Values (Option 2)	Values (Option 3)	Values (Option 8)
Number of carriers	1705 (2K)	1705 (2K)	6817 (8K)	6817 (8K)
Modulation	64 QAM	16 QAM	64 QAM	64 QAM
Inner coding R_C	2/3	3/4	2/3	3/4
Guard interval (Δ/T_U)	1/32	1/32	1/32	1/32
TS data rate (Mbit/s)	24.1283422	18.0962567	24.1283422	27.1443850

For the degradation criteria of "picture failure", receivers shall achieve a minimum level of performance for each of these four options according to the tests defined in section 10.3[36] .

22.1.3 Service Information & Selection

During installation and subsequent full UHF band retunes, receivers shall:

- be able to manage receiving signals from multiple transmitters each with multiple multiplexes each with multiple services as defined in section 8.4.5 and shall be capable of storing the total number of services defined in 8.4.5.1..

Following installation, receivers shall:

- offer the viewer all UK free-to-air DVB-T broadcasts of television, radio and enhanced services (compatible with the requirements set out in Sections 22.1.1.2 and 22.1.6.1) that may be received at the current location, which may include regional variants of a service (see Section 22.1.3.1). Services which can not be received (as defined by section 8.8.2) shall not be offered to the viewer.
- ensure that service selection by the viewer using numeric entry shall select a service with the corresponding UK broadcaster assigned Logical Channel Number.

Receivers shall always:

- ensure that the display of time is local time, not UTC, taking account of daylight saving transitions, and shall be accurate to 10s. The time and date shall be available to the user.

22.1.3.1 Logical channel numbers

Receivers shall be able to locate, store and handle services with Logical Channel Numbers (LCNs) within the Broadcast range (see Table 8-11). Broadcasters transmit LCNs for broadcast services only from this range.

Any broadcast services which cannot be allocated to the entry indicated by their associated LCN, or which do not have an associated LCN, shall be allocated a value by the receiver in the Variant or Manufacturer ranges.

Multiple services with the same LCN value include both regional variants (same ONID, different SID and NID) and identical instances of a service (same ONID, same SID). Receivers shall offer the viewer a means of selecting their preferred regional variants. The information in the target_region descriptor (as defined in section 8.5.3.21) shall be used to identify regional variants. In the case where identical instances are found in the preferred region, receivers shall determine the most appropriate identical instance to place within the broadcast range based on signal strength or signal quality and store only that instance.

Note If a receiver offers the feature to select regional variants on a service by service basis or multiplex by multiplex basis, it should be aware that it may not receive SI data for those services in a different network to the one currently being decoded.

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36 A temporary concession may be granted regarding the LTE tests. Refer to Freeview TML for more information.

Receivers shall not offer a function to select, or prompt the user to accept, an alternative set of LCNs for multiple services, or in any other way modify the LCNs assigned to multiple services in a single operation. Receivers shall ensure that service selection from within an MHEG application always selects the correct service regardless of any service re-arrangement made by the user.

It shall always be possible for the user to easily revert to the DMOL assigned LCNs (e.g. by rescanning). This shall be easy to perform.

Receivers shall comply with the mandatory requirements set out in Section 8.5.3.6.

22.1.3.2 Identification of service changes

The services being broadcast in the DTT network will change over time. To ensure that the viewer is able to access all services being broadcast, receivers shall automatically identify new services (i.e. a service with a new DVB triplet) or service changes (a change to the service name, LCN value, or service attributes). The receiver may achieve this by using the network_change_notify descriptor (see Section 8.5.3.14)) or an alternate mechanism. These service changes shall be either stored without the need for user intervention or notified to the user. This shall normally be achieved within 24 hours of such broadcast change, provided that this feature is not disabled by the viewer.

22.1.3.3 Basic navigation

22.1.3.3.1 Service selection

Service selection may be by a number of mechanisms, including (but not restricted to) being picked from a service list, identified via numeric entry, EPG grid or programme up/down functions. The default service ordering shall be in ascending order of LCN. The receiver may allow the viewer to re-order the services in a favourites list.

22.1.3.3.2 Favourites

The receiver may optionally allow the viewer to re-arrange the displayed order/range of services according to personal preference as a favourites list. New services shall not automatically disturb existing services in this list.

22.1.3.3.3 Selection via numeric entry

When the receiver is in its default state, service selection via direct numeric entry shall select a service with a corresponding LCN except when the numeric_selection_flag in the service attribute descriptor is set to ‘0’ for the requested service.

Note that services accessible via numeric entry may be “hidden” (see Section 21.1.3.3.4).

Receivers shall comply with the mandatory requirements set out in Section 8.5.3.9.

22.1.3.3.4 Hidden services

Services identified as “hidden” shall not appear in the list of services presented to the viewer.

Note that "hidden" services may still be accessible via numeric entry (see Section 21.1.3.3.3).

Receivers shall comply with the mandatory requirements set out in Section 8.5.3.9.

22.1.3.3.5 Language selection

UK broadcasters may provide multiple audio and subtitle components signalled as different languages. Receivers shall provide a means for the viewer to set their preferred language for audio, subtitles and audio description components. Viewers shall be offered as a minimum English, Welsh, Gaelic and Irish (as described in Table 8-1). Receivers shall use the viewer's preference to select the correct component when multiple language components are broadcast. If the preferred language is not present, the receiver shall default to the English language component. In order to accommodate the different language preferences of individual members of a household, receivers should provide a quick means for viewers to swap between the transmitted languages of the audio and subtitle components.

Receivers shall always select the audio component, from the range of those that it can decode, based on the language settings in preference to the codec or other parameters.

Behaviour around Original Language "qaa" is not defined.

22.1.3.4 Now and Next

Receivers shall use data from DVB SI EIT p/f tables to provide the 'now' information linked to the 'info' control function (see Table 25-1). If "next" information is also provided, its data shall also be taken from EIT p/f. At least the start time, end time (or duration), title and synopsis shall be displayed.

If 'next' information is not displayed from the 'info' control function, the receiver shall provide an alternative means of displaying the start time, end time (or duration), title and synopsis, e.g. via the Programme Guide (see Section 22.1.3.5). If this alternative means only displays "now" and "next" programmes or only the "next" programme, the receiver shall use EIT p/f as the data source; if more programmes are displayed, the data source shall be as defined in Section 22.1.3.5.

When a receiver caches the EIT information, it should ensure that updates to the broadcast EIT tables are reflected in the cache within one cycle of the modified table.

22.1.3.5 EPG

Receivers shall provide a programme guide. It is preferable that this uses data from the transmitted DVB EIT schedule tables. This is because these tables are continually updated by broadcasters to reflect schedule changes.

If the source of the schedule data is $EIT_{schedule}$, acquisition shall be continuous and not dependent upon the reception of the first sections of any tables for acquisition to start. If a receiver is unable to maintain continuous acquisition such that a section is missed, it should be acquired at the next available opportunity. Receivers shall concurrently acquire $EIT_{schedule}$ for all receivable services.

When a receiver caches the EIT information, it should ensure that updates to the broadcast EIT tables are reflected in the cache within one cycle of the modified table.

If an equivalent data source is used but is unavailable, the receiver shall use EIT instead. An "equivalent data source" is defined to be a data source that provides sufficient information in a suitably timely manner to meet all of the mandatory requirements in this chapter.

The EPG display shall be available at all times (excluding standby) following initial acquisition.

22.1.3.5.1 EPG Scope and Accuracy

The receiver shall display a minimum of 8 days of schedule data in the EPG (subject to the purging of data for past events by the receiver). This can be derived from the $EIT_{schedule}$ information (recommended because of its accuracy) or from an alternative source providing an equivalent level of information (see Section 22.1.3.5.5). When possible, the accuracy of the EPG should be improved further by use of the $EIT_{p/f}$ information.

Note Broadcasters may delete some or all of the current day's past events during $EIT_{schedule}$ updates. Consequently, receivers should not rely on the information about past events in the broadcast schedule when displaying the EPG.

22.1.3.5.2 EPG Updating

When the user accesses the EPG, it shall be displayed regardless of the state of the receiver's schedule database (for example, database is partially populated in the minutes after power-on). In normal operation, the receiver shall maintain the full EPG up to date and be able to display the full EPG within 10 seconds of selection. The receiver shall display EPG information as soon as it is received without requiring user interaction to update the display.

22.1.3.5.3 EPG and Local time

The EPG shall always display events with the correct local time offset which applies at the time for which the event is billed.

22.1.3.5.4 Guidance

By default, where present, it is strongly recommended that the guidance text (as signalled in the guidance descriptor as defined in Section 8.5.3.20) should be displayed as part of the programme guide, whenever the synopsis is displayed.

22.1.3.5.5 Equivalent EIT Data Sources

It is recognised that some receivers may wish to obtain their schedule data from sources other than $EIT_{schedule}$. These may be used as long as they conform to the equivalence rules below.

An alternate source of schedule data shall be deemed to be equivalent to $EIT_{schedule}$ if it can:

- Provide schedule data for at least 8 days for all channels on the Freeview platform;
- Deliver the title, synopsis, duration, start time and date of each programme in the schedule, together with genre and access service availability;
- Provide a means of associating the programmes in the schedule data with the correct entry in $EIT_{p/f}$;
- Ensure that the receiver can provide timely updates (within a few minutes of the update being reflected in the transmitted $EIT_{schedule}$) to the EPG display;
- Provide information on Series and Recommendations (when used by the receiver);
- Deliver the guidance information and SD/HD event linkage information for each programme (when used by the receiver).

Any receiver manufacturer using an alternate source of schedule data shall provide the appropriate test equipment and test streams to the appropriate testing authority to allow it to perform the tests described in the test specification. The manufacturer shall provide sufficient training and documentation to enable the appropriate testing authority to operate the test equipment and shall provide sufficient documentation to prove, to the satisfaction of the appropriate testing authority, that the provided test streams are suitable for the test for which they are being used.

22.1.3.6 Private descriptor tags

When receivers interpret, and act upon, the private descriptors defined in Section 8.5.4, they shall only do so when the descriptors are within the scope of the private data specifier with the UK DTT value 0x0000233A.

22.1.3.7 Channel change information

Whenever the user changes channel, the receiver shall minimally display information identifying the name or the logo (as recognised by the service provider) of the new service being decoded.

22.1.3.8 Text presentation

Receivers may provide a means for the viewer to set their preferred language for the selection of DVB SI. Receivers shall use this preference to select the correct version when multiple language versions are broadcast. If the preferred language is not present, the receiver shall default to the English language version.

Receivers shall, as a minimum, support the character encoding defined in Section 8.5.6 and display strings appropriately.

22.1.4 Set-up and Connections

Receivers should be both easy to install and use. An existing viewer of analogue services needs to be able to complete a basic digital installation, i.e. just for viewing, using only what has been supplied with the receiver. In addition, on-screen information should be provided in a clear and consistent manner both to aid installation and (if required) to enable an easy dialogue with any support staff, e.g. call-centre.

22.1.4.1 User documentation

Receivers should be simple to set up and operate and be provided with clear easy to understand user documentation in line with that requirement.

For general guidance on best practice in documentation, see the "How to write in plain English" guide (www.plainenglish.co.uk/howto.pdf).

22.1.4.2 Support package

For receivers without an integrated display, the following items shall be included in the support package:

- RF fly lead (1m minimum screened coax cable) or captive equivalent (only required when the receiver has an RF output).
- A/V lead for connection to the display device (e.g. fully wired SCART or HDMI) or captive equivalent where there is a direct connection from the receiver to the display.

For all receivers, the support package shall include all items required to provide the user with basic functionality, e.g. power lead, remote control (including batteries), instruction manual.

22.1.4.3 Diagnostics

Receivers should be capable of displaying the receiver type, software versions and signal quality.

22.1.4.4 External connections

22.1.4.4.1 RF connections

RF Input	Receivers shall have an IEC 61169-2 female connector with nominal input impedance value of 75Ω for RF input.
RF Output	Receivers without an integrated display should have an RF loop-through arrangement that provides an output of the RF signals present at the RF input with minimal degradation whilst the receiver is "on" and in "standby". This RF output shall be provided on an IEC 61169-2 male connector with a nominal output impedance of 75 Ω. For more information, see Section 9.11.3.
Modulator Output	Receivers without an integrated display should have a re-modulated output for use with a PAL receiver. This must be tuneable to any UHF channel 21 to 68 and have a nominal peak signal level of 3mV across 75 Ω. It is desirable, but not essential that the user should be able to switch off the re-modulated output. For more information, see Section 9.11.3.

22.1.4.4.2 Receivers without integrated display

Receivers without an integrated video display shall comply with Section 22.1.4.4.1 and also the requirements in this section.

SCART Output

For receivers whose primary output is an A/V connection to a display, a SCART connector (conforming to EN 50049) shall be provided including the following signals:

- RGB and composite video
- Stereo audio
- Fast blanking (pin 16)
- Slow blanking (pin 8)

This connector may be omitted if an HDMI connector is provided.

HDMI Output

Receivers whose primary output is an A/V connection to a display may provide an HDMI output[40] according to HDMI™ - HDMI Licensing, LLC, "High-Definition Multimedia Interface" incorporating HDCP content protection according to HDCP - Intel, "High-Bandwidth Digital Content Protection System".

The digital audio stream output via HDMI shall be capable of carrying at least two channel PCM .

Audio output

Receivers whose primary output is an A/V connection to a display should provide either RCA stereo output connectors or a 3.5mm jack connector carrying a mono or stereo signal.

22.1.4.4.3 Receivers with integrated display

Receivers shall comply with Section 22.1.4.4.1 and should provide an audio output as specified in Section 22.1.4.4.2.

22.1.5 User Input Controls

Receivers shall support all user input control functions marked as essential in Table 25-1. This can be achieved through the provision of a traditional remote control or using an alternative user control technology, provided it is capable of generating the specified functions.

For more information, refer to Chapter 25.

22.1.6 Interactivity

22.1.6.1 MHEG 5

Receivers shall support interactive TV implemented as MHEG-5 v1.06 services.

Receivers shall comply with the mandatory requirements set out in Chapters 11 to 19.

22.1.7 Common Interface

Where a receiver supports a Common Interface connector, it shall comply with the mandatory requirements set out in Chapter 21.

Note: At the time of writing, it is a requirement for some equipment to include a Common Interface connector. More detail is given in Section 22.1.9.2.

Receivers shall display a suitable message on-screen to inform the user

[40]. The receiver should rely on the (E-)EDID information returned by the display device - indicating the video formats the display device can receive and render - to stay within the capabilities of and avoid interoperability issues with non-HD / non-"HD ready" display devices.

when a CA-controlled service to which they do not have access is selected.

22.1.8 Maintenance & upgrade

Receivers shall support a mechanism for firmware update. This may be via over-air download, internet, distribution on physical media, product recall or some other means. In order to test this feature, a software upgrade and subsequent downgrade to the current version shall be provided by the manufacturer at the time of conformance testing.

22.1.8.1 Auto-upgrade of firmware

If receivers support firmware upgrade by over-air download, they shall be capable of automatic (i.e. not user initiated) upgrade from any multiplex with minimal interruption to the viewer, preferably within 24 hours of the download first being made available. Such receivers shall implement the DVB SSU mechanism and may optionally also implement the UK OAD mechanism.Such receivers shall comply with the mandatory requirements set out in Chapter 23.

22.1.9 Compliance

22.1.9.1 Energy efficiency

Receivers shall conform to the current version the relevant EU Regulations on energy efficiency for digital TV equipment. For example, at the time of writing, (EC) No 1275/2008 electric power consumption of electrical and electronic household and office equipment, (EC) No 107/2009 Ecodesign requirements for simple set-top boxes and others apply.

22.1.9.2 Other standards and regulations

Receivers shall conform to all applicable UK and EC law.

22.2 SD MPEG-2 DVB-T Recorder

A MPEG-2 SD DVB-T DTR shall comply with all the requirements set out in Section 22.1. In addition, there are recorder specific requirements presented in this section.

22.2.1 Services

It is not a requirement that the recorder be able to record interactive applications, e.g. MHEG-5. The recorder shall be able to record at least the following essential signal components:

- The video (if a TV service)
- The audio, as selected by the user
- The subtitles, as selected by the user
- The audio description (AD), as selected by the user and if the recorder has AD functionality

NOTE: There are some services in which access to the audio and video components is through a “Gateway” MHEG-5 application on a different service. If a user is viewing the components in this way it is not a requirement that they be recorded when the “Gateway” service is selected.

Where the components above are recorded separately, the user shall be able to switch them on or off during playback. It is acceptable for recorders to record the video as a combination of the video and the decoded subtitles, and to record the audio as a mix of the audio and the AD.

If the recorder has a suitable display, other than that used to display the content, it shall indicate to the user when a recording is in progress.

The recorder shall be capable of replaying and recording simultaneously. The recorder should be able to decode and present to the viewer one programme whilst simultaneously recording another (with the two programmes being broadcast on different multiplexes).

On-screen informational messages or menus generated by the recorder shall not be recorded with the programme content.

22.2.2 Front End

No additional requirements beyond Section 22.1.2.

22.2.3 Service Information & Selection

22.2.3.1 Recording split-events and series events

A programme may consist of multiple EIT events as signalled by the broadcaster (for example, a film divided into two parts by a news programme would be three events). Signalling carried in the SI (see Section 8.5.3.12) allows the recorder to identify and record the events containing the parts of a single programme. A recorder shall implement this function.

The individual events carrying programmes that comprise a series are also identified by SI signalling, enabling all the programmes in a series to be recorded. A recorder shall implement this function, selectable by the user.

22.2.3.2 Pause live TV

As a minimum requirement, when no recordings are in progress the user shall be able to pause live TV. It shall be possible to pause for at least 30 minutes, subject to any device limitations (e.g. available space) or recording conflicts.

22.2.3.3 One touch recording (OTR)

The recorder shall incorporate a One-touch Recording (OTR) function which allows the user to start a recording, while watching live TV, with a single action.

Recording shall not be delayed by further requests for user interaction unless to proceed would affect a recording that is either already underway or scheduled to start before the end of the OTR operation.

The duration of the recording operation shall be based on either a pre-set time or events, subject to any device limitations (e.g. available space).

22.2.3.4 Selection from EPG

The user shall be able to select a programme to be recorded from the EPG display.

Once selected, the appropriate programme(s) shall be marked as selected on the EPG display. See Sections 8.7.2.3 and 8.7.2.1 for more details.

22.2.3.4.1 Split Events, Series Events

When the programme selected is comprised of more than one event, all constituent events shall be selected so that the complete programme is recorded.

When the programme selected is one of a series, the recorder shall offer the option to record the single programme or the series, if available.

Once selected, the appropriate programme(s) shall be marked as selected on the EPG display.

22.2.3.5 Scheduled Recordings Display

A mechanism for displaying programmes selected for recording shall be available, showing a minimum of billed dates, billed times and event name. The billed time shall be offset appropriately by any signalled local time offset. The event name shall be extracted from the broadcast signalling as defined in Section 8.5.3.18.

The programmes' synopses and channels shall be available to the user on demand.

The display of programmes selected for recording shall include an indication if the programme is included as a consequence of being one of a series or recommendation.

22.2.3.6 Recommendations

Programmes listed in the EPG may have other programmes (or series) associated with them in the form of Recommendations (see Section 8.7.2.4 for more details). The recorder shall have a method of presenting such recommended programmes or series to the user to enable them to be selected for recording.

22.2.3.7 Tracking schedule changes

When the recorder is not in passive standby and a schedule change occurs, the affected programmes in the schedule of recordings and any recordings in progress shall be updated.

In standby, a recorder shall monitor the EITp/f sufficiently frequently and for sufficient duration to allow a programme to be recorded successfully even when the start time is brought forward by up to ten minutes and the schedule information is updated at least 5 minutes before the new start time.

Note Passive standby is defined as that state in which the recorder is inactive as far as the user is concerned and no broadcast signal is being decoded.

22.2.3.8 Modification of the recording schedule

The recorder shall allow the user to deselect a programme or series for recording.

22.2.3.9 Accuracy of recording

As a minimum, the recorder shall incorporate a default mechanism for controlling the starting and stopping of a recording based on the broadcast EITp/f . Additional mechanisms may be incorporated as an option.

The mechanism used shall allow complete events, as defined by the broadcaster in the EITp/f, to be recorded (less up to 10s for channel changing and service acquisition) and shall track changes to the start time and end time of the event.

The start of an event is indicated by its transition to the present event for the specified service. The end of an event is indicated by the event being replaced by a different event as the present event for that service It is permissible for a recording to start before the start of an event and to finish after the event, but this may create unnecessary conflicts with the requirement for a back-to-back recording capability.

Note The information about the now/next events and the transitions between them is the only broadcast information sufficiently accurately related to the broadcast events to give accurate control of event recording. See Section 8.10.1.

22.2.3.10 Conflict resolution

The recorder shall be able to record back-to-back events on the same service without registering this as a conflict

A conflict which is detected at the time of making a booking shall be indicated immediately, together with details of the cause, so that the user can take appropriate action.

The default action taken by the recorder (with no user interaction) shall be made clear to the user in the manual and there shall be a mechanism for informing the user of failed or incomplete recordings.

22.2.3.11 Use of Alternate Instance Information

When scheduled recordings overlap, the recorder shall use the alternate instance information, when provided, to record one or more of the programmes at their alternate times thereby minimising the conflict, subject to any device limitations (e.g. available space).

22.2.3.12 Trailer booking

The recorder shall have the ability to decode and process Related Content Signalling as defined in Sections 8.5.2.5 and 8.12 in order to drive broadcast-triggered native applications defined in Section 8.5.11 (e.g. Promotional Linking). The decoding and display of information referenced by descriptors carried in the RCT shall be supported as defined in Sections 8.5.3.17, 8.5.3.18 and 8.12.3. The recorder shall also support the *NativeApplicationExtension* to MHEG-5 described in Section 13.6.4 and 13.10.8.5.

The receiver shall display all combinations of the broadcast icon and default icon in accordance with Section 8.12.2.

22.2.3.13 Recording capacity

The recorder shall be equipped with a means of indicating the available recording capacity. The basis for the indication shall be explained in the instruction manual and shall be in terms of percentage or time, based on a notional capacity requirement per hour of recording.

22.2.3.14 Runaway recordings

The recorder shall incorporate a mechanism for handling a runaway recording (e.g as could occur if the EITp/f transition fails because of a fault in the distribution network). If the EITp/f now event extends for more than two hours beyond the billed duration then the recorder may terminate the recording at any time.

22.2.3.15 Replay Functions

22.2.3.15.1 Recordings list

A mechanism for displaying recorded programmes shall be available, showing a minimum of billed dates, billed times and titles. The billed time shall be offset appropriately by any signalled local time offset applicable at the time of recording.

The programmes' synopses and channels shall be available to the user on demand, subject to any device limitations.

22.2.3.15.2 Fast forward and reverse trick modes

Fast playback at speeds up to at least x16 shall be possible in both forward and reverse directions. At all speeds, the user shall be presented with a series of images taken from the video stream as they are passed.

22.2.3.15.3 Chase playback

The user shall be able to start the playback of a programme for which the recording has not yet completed.

22.2.4 User input controls

Receivers shall support all user input control functions marked as essential in Table 25-1 and 25-2.

22.3 HD AVC DVB-T2 Receiver

A HD AVC DVB-T2 receiver shall comply with all the requirements set out in Section 22.1. In addition, there are further requirements presented in this section.

22.3.1 Services

Receivers shall be capable of decoding all UK free-to-air DVB-T and DVB-T2 broadcasts of television, radio and enhanced services. This shall include the capability to:

- present HD MHEG services (see Section 22.3.5 below);
- present HD subtitles (where broadcast) if selected by the viewer (see Section 22.3.1.3 below);

Receivers shall support Audio Description (as defined in Section 22.3.1.4 below).

Receivers shall comply with the mandatory requirements set out in Section 6.3.

22.3.1.1 Video and Audio Decoding

All receivers shall include MPEG-4 AVC video (ISO/IEC 14496-10) decoding, as constrained by the ETSI TS 101 154 Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream. As a minimum, the following resolutions shall be supported: 720x576, 544x576, 480x576, 352x288, 1920x1080, 1440x1080, 1280x1080 at interlaced 25 frames/s; 1280x720, 960x720 at progressive 50 frames/s; 1280x720, 960x720, 1920x1080, 1440x1080, 1280x1080 at progressive 25 frames/s.

All receivers shall include E-AC-3 audio (ETSI TS 102 366) decoding and MPEG-4 HE-AAC (ISO/IEC 14496-3) decoding, as constrained by the ETSI TS 101 154.

Receivers shall comply with the mandatory requirements set out in sections 2.3.1, 2.3.2 2.4.5.3, 2.4.5.5, 2.4.5.6, 2.4.6.2, 3.2.1.4, 3.3.1.3, 3.3.4.1, 3.4.2.5.2, 4.3, 4.4.1.2 and 4.4.2.

22.3.1.3 Subtitles

All receivers shall be capable of decoding and presenting DVB subtitles in accordance with ETSI EN 300 743 v1.3.1 or later.

Receivers shall comply with the mandatory requirements set out in Chapter 5 including support for the display definition segment (DDS).

Receivers that support *ICStreamingExtension* shall be able to present subtitles and MHEG simultaneously as defined in 16.5.1.1.

22.3.1.4 Audio Description

All receivers shall support audio description delivered via DVB-T/T2 with the mandatory requirements set out in Section 4.5 including 4.5.3.1 and 4.5.5.

Any digital audio output may be restricted to two channel pulse-code modulation (PCM) instead of multi-channel bitstream when a receiver is outputting audio with receiver mixed audio description.[46]

22.3.1.5 User Interface

Minimum usability requirements will be added at a later date

22.3.1.5.1 Receivers without integrated display

Text and graphics shall be rendered at the native resolution of the UI graphics plane. The minimum resolution of the UI graphics plane shall be 1280x720 pixels.Full HD resolution (1920x1080 pixels) and anti-aliased fonts are strongly recommended.

22.3.1.5.2 Receivers with integrated display

Text and graphics shall be rendered at the native resolution of the UI graphics plane. The resolution of the UI graphics plane shall be at least half the native resolution (Horizontal and Vertical) of the display. Full HD resolution (1920x1080 pixels) and anti-aliased fonts are strongly recommended.

22.3.2 Front End

Receivers shall be compliant with the functional test list in Annex G, based on ETSI EN 302 755 [108]. There is no requirement for receivers to support Time Frequency Slicing (TFS). Receivers shall support the simultaneous reception of at least one common and one data PLP.

In particular, five modulation modes have been defined in section 9.4.2:

OFDM Parameters	Values (Option 4) DTG104	Values (Option 5) DTG106	Values (Option 6) DTG109
Number of carriers	6913 (8K)	27841 (32KE[47])	27841 (32KE[47])
Modulation	64QAM	256 QAM	256 QAM
Inner coding Rc	4/5	3/5	2/3
Guard interval (Δ/Tu)	1/32	1/128	1/128
Pilot Pattern	PP7	PP7	PP7
Frame Length (data symbols)	242	59	59
Transport stream data rate	34.6880914	36.1407594	40.2146452

OFDM Parameters	Values (Option 9)	Values (Option 10)
Number of carriers	27265 (32KN[47])	27265 (32KN[47])
Modulation	256 QAM	256 QAM
Inner coding Rc	3/5	2/3
Guard interval (Δ/Tu)	1/128	1/128

[46]. This concession may be removed in a future version of this document.

[47] The term 32KE means "extended carrier" mode, whereas 32KN means non-extended carrier mode.

Pilot Pattern	PP7	PP7
Frame Length (data symbols)	59	59
Transport stream data rate	35.2461861	39.2192332

Receivers shall achieve the minimum performance in these five modes according to the tests defined in section 10.3[48]

For more information, refer to Chapters 9 and 10.

22.3.3 Service Information & Selection

Following installation, receivers shall offer the viewer all UK free-to-air DVB-T and DVB-T2 broadcasts of television, radio and enhanced services (compatible with the requirements set out in Sections 22.1.1.2, 22.3.1.1 and 22.1.6.1) that may be received at the current location, which may include regional variants of a service.

Receivers shall be capable of storing the total number of services defined in 8.4.5.2

22.3.3.1 Logical channel numbers

Receivers shall use the *HD_Simulcast_logical_channel* descriptor as defined in Section 8.5.3.23 when assigning logical channel numbers to services and modifying their visibility.

22.3.3.2 SD/HD Event Linkage

Receivers shall offer the user the ability to view the alternate HD event when signalled as simulcast "(i.e. where event_simulcast=1)" via the event linkage type in a linkage descriptor as described in EN 300 468 section 6.2.19.

22.3.3.3 String compression

Basic string compression may be used in some of the SI tables and shall be supported by receivers. See Section 8.5.6.2.

22.3.3.4 Content Management

Content management shall be implemented as defined in Section 8.13.

22.3.4 Connections

22.3.4.4 External connections

22.3.4.4.1 Receivers without integrated display

Receivers without an integrated video display shall comply with Section 22.1.4.4.1 and also the requirements in this section, but do not need to comply with Section 22.1.4.4.2.

Receivers SHALL NOT provide any functional analogue HD component outputs.

HDMI Output Receivers shall provide an HDMI output[50] according to HDMI™ - HDMI

[48]A temporary concession may be granted regarding the LTE tests. Refer to Freeview TML for more information.

[50]. The receiver should rely on the (E-)EDID information returned by the display device - indicating the video formats the display device can receive and render - to

Licensing, LLC, "High-Definition Multimedia Interface", incorporating HDCP content protection according to HDCP - Intel, "High-Bandwidth Digital Content Protection System". By default, HDCP shall be enabled at all times to prevent unnecessary video disturbances from changes in HDCP state. However, receivers should provide the user with an option to disable HDCP for broadcasts that do not require it (see Section 22.3.3.4).

Receivers shall output YCrCb format video and should output YCrCb 4:2:2 at up to 12-bits. This does not imply a requirement for the support of "Deep Color" as defined in HDMI specification [134], (HDMI 1.3a section 6.5).

Receivers shall support HD output resolutions up to and including 1080p50. Receivers shall by default output one of the video formats declared in the EDID of the sink, selected from the following ordered list (highest priority first): 1920x1080p50 (CEA format 31), 1920x1080i25 (CEA format 20), 1280x720p50 (CEA format 19). This format shall be used until explicitly changed by the user. The behaviour of the receiver is not specified if the EDID of the sink does not include any of the video formats listed here.

Receivers shall be capable of outputting at least (but not simultaneously) two channel PCM and pass-through of the native bitstream audio where supported by the HDMI specification.

Where the HDMI sink does not support the native bitstream audio, the receiver shall be able to perform one of the following, presenting the same number of channels as broadcast:

- Transcode to AC-3.
- Transcode to DTS.
- Output linear PCM.

Receivers are recommended to implement the CEC "One-Touch-Play" and "System Standby" functions.The Auto Lipsync Correction feature is strongly recommended.

Audio output

Digital audio output via optical or coaxial S/PDIF should be supported. If it is supported:

1) A manual method of adjusting the A/V synchronisation shall be implemented, to delay the audio by up to 250ms.

2) The receiver shall be able to output any multi-channel audio, regardless of the broadcast encoding, in one of the following formats, presenting the same number of channels as broadcast:

- AC-3.
- DTS.

RF Output

Receivers shall provide a connector with a loop-through of the input RF signal as defined in Section 22.1.4.4.1. This signal shall be present when the receiver is "on" and in "stand-by".

22.3.4.4.2 Receivers with integrated display

Receivers with an integrated video display shall comply with Section

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stay within the capabilities of and avoid interoperability issues with non-HD / non-"HD ready" display devices.

22.1.4.4.1 and also the requirements in this section, but do not need to comply with Section 22.1.4.4.3.

Receivers SHALL NOT provide any functional analogue HD component outputs.

Audio output

Digital audio output via optical or coaxial S/PDIF should be supported. If it is supported, the receiver shall be able to output any multi-channel audio, regardless of the broadcast encoding, in one of the following formats, presenting the same number of channels as broadcast:

- AC-3.
- DTS.

22.3.5 Interactivity

22.3.5.1 HD MHEG 5

Receivers shall support the *HDVideoExtension* and the *HDGraphicsPlaneExtension* as defined in Section 13.4.3.

22.3.5.2 MHEG 5 Interaction Channel

Receivers shall support the *InteractionChannelExtension* and *ICStreamingExtension* and *ICEncryptedStreamExtension*, as defined in Section 13.4.3. This requires receivers to provide a broadband network interface supporting TCP/IP (e.g. Ethernet or IEEE 802.11).

The required protocols supported are defined in Section 17.1.2. A method for manual assignment of IP address, subnet mask, default gateway and DNS server address(es) shall be provided in addition to DHCP. The user shall be able to access the MAC address.

Receivers shall support the features represented by values of ICProfile(N) where N is between 1 and 4 inclusive.

22.3.5.3 Non-destructive tuning

Receivers shall support *LifecycleExtension* as defined in Section 13.4.3.

22.3.5.4 Downloadable fonts

Receivers should support *DownloadableFontExtension* as defined in Section 13.4.3.

22.3.5.5 Persistent Storage

It is expected that MHEG applications may refer to the True Persistent Storage feature (Section 16.7a) as "Digital Text Cookies". It is strongly recommended that receivers use the same terminology in their UI.

Receivers shall provide a means by which viewers can clear the True Persistent Storage area (e.g. factory reset)[52a].

22.3.5.6 PIN entry

Receivers shall support a PIN protection feature that is used for the GetPINSupport resident program (see section 13.10.9a.8) and PromptForGuidance resident program (see section 13.10.9a.4). This feature

[52a]. A temporary concession may be granted regarding the means to flush the True Persistent Storage. Refer to Freeview TML for more information.

should be off by default but there shall be a user option to enable it.[52b]

22.3.5.7 Accessibility

Receivers shall support the GetAudioDescPref resident program (see section 13.10.8.6) and GetSubtitlePref resident program (see section 13.10.8.7) and the SubtitlePrefChanged and AudioDescPrefChanged engine events (see Table 13-9) [52c].

22.3.6 Maintenance & upgrade

Receivers shall include support for an Over Air Download mechanism. If using the Engineering Channel, receivers shall support DVB-SSU as defined in Section 23.6. Support for other methods is optional. Receivers shall additionally support a local mechanism for firmware update (e.g. USB).

[52b]. A temporary concession may be granted regarding the support of a PIN protection feature for PromptForGuidance. Refer to Freeview TML for more information.

[52c]. A temporary concession may be granted regarding Accessablity resident programs. Refer to Freeview TML for more information.

22.4 HD AVC DVB-T2 Recorder

A HD AVC DVB-T2 digital television recorder must comply with all the requirements set out in Sections 22.1, 22.2 and 22.3. In addition, there are further requirements presented in this section.

22.4.1 Services

The recorder shall be able to decode and present to the viewer one programme whilst simultaneously recording another (with the two programmes being broadcast on different multiplexes on any combination of DVB-T and DVB-T2).

22.4.3 Service Information & Selection

22.4.3.1 EPG

When the EPG is displayed, receivers shall provide immediate access (i.e. within 10 seconds) to at least the relevant schedule data that was available for display before the receiver last went into a power down state (through an orderly shut down), taking into account any further schedule data received since coming out of that power down state (as per Section 22.1.3.5.2).

Note Relevant schedule data means schedule data that is for current or future events. Schedule data for services that are no longer available may be omitted.

22.4.3.2 SD/HD Event Linkage

When the programme selected for recording is signalled as being available in HD (via the event linkage type in the linkage descriptor), the recorder shall have the option to record the HD version instead. Depending upon the implementation, this option may be in a menu (to set the default behaviour), activated by a button press or explicitly presented to the user (or some other method).

22.4.3.3 Guidance

The guidance (as signalled in the guidance descriptor as defined in Section 8.5.3.20) for programmes that have been recorded or are in a list to be recorded shall be available to the user on demand, subject to any device limitations.

Recorded programmes that have the guidance available to the user shall be PIN protected on playback if the guidance_type in the guidance descriptor was set to 0x00 and playback starts outside the "watershed hours" (defined here as 2100 to 0530 local time). The PIN protection feature should be off by default but there shall be user option to enable it.

22.4.3.4 Trailer booking and recommendations

Recorders shall support trailer booking and recommendations as described in Sections 22.2.3.12 and 22.2.3.6.

22.4.4 Broadcast Record lists

An HD receiver may implement the Broadcast Record List feature described in secion 8.14. If the feature is supported, it shall comply with the requirements set out in section 8.14 and this section.

22.4.4.1 Disk Space

For the avoidance of doubt, there are no additional requirements on disk space management specific to Broadcast Record Lists.

22.4.4.2 Broadcast Record List Entry Point

Receivers shall provide a static entry point for displaying the available broadcast record lists, e.g. through a native UI menu.

22.4.4.3 Presentation of Broadcast Record Lists

Receivers shall have a means to present all broadcast record lists in the default broadcast record list group (see section 8.14.2.4).Receivers shall not present broadcast record lists from groups with a different root unless specifically recognised.

Receivers shall only display broadcast record lists that are:

- included in the last received version of the metadata, and
- lists to which the user is currently subscribed, even when that list is no longer in

  the metadata, subject to the rules in 22.4.4.8.

It is possible that the metadata associated with a broadcast record list will change from time to time. When presenting broadcast record lists, the receiver shall always present the last received metadata. The receiver shall present at least the title and synopsis of each broadcast record list.

22.4.4.4 Broadcast Record List Subscription and Un-subscription

Users shall be able to subscribe to any broadcast record list (as profiled by section 22.4.4.3) and unsubscribe from any previously subscribed broadcast record list. Lists that are currently subscribed to shall be identified.

22.4.4.5 Presentation of Acquired Recordings

The receiver shall have a means to present a list of available recordings acquired using the broadcast record list functionality. The receiver shall have a means to present the title and synopsis for all such recordings. It is strongly recommended that receivers indicate to the user the subscribed broadcast record list(s) in which the acquired event was contained at the time of recording.

If the event has an expiry time, information regarding expiry of that recording shall be available. Recordings that have passed their mandatory expiry time (see 8.14.2.6) shall be clearly identified as expired and shall not be playable.

If the event has an embargo time, information regarding the embargo time shall be available, unless the embargo time has passed.

22.4.4.6 Broadcast Record List Removal

A broadcast record list that has been subscribed to shall be automatically unsubscribed from when it has not been received in the broadcast metadata for 13 weeks.

22.4.4.7 Recording Conflicts

Any user initiated activity in the receiver shall take precedence over recording of Broadcast Record List events.

It is strongly recommended that, in the case where a broadcast record list event could not be acquired due to a lack of resources, alternate instances of the event be located and re-booked.

The behaviour defined in this subsection may be modified through previously set user preferences.

22.4.4.8 Broadcast Record List Updates

A receiver shall within 10 minutes act upon updates to the received metadata.

22.4.4.9 External Media

In addition to any content management signalling, storage of broadcast record list content to optical or other removable media shall be permissible provided that

- any embargo time has passed and
- the content is not signalled with a mandatory expiry time.

22.4.5 Interactivity

22.4.5.1 MHEG 5

MHEG PVR Extensions will be added at a later date.

22.4.6 Content Management

Recorders shall implement content management on all media as specified in Section 8.13.[53]

[53]. Consumer Receiver Equipment manufacturers have concerns over legal and commercial issues of the content management requirements including but not limited to (1) sufficiency of consumer awareness of the restrictions, (2) effectiveness of the enforcement mechanism and (3) appropriateness of mandating content management requirements as licensing condition of certain technology.

23 Receiver Software Upgrading

23.1 Scope - general

This section describes two methods for updating receiver firmware which are supported over the transmitted services of the UK DTT multiplex operators.

Section 23.5 describes the method currently used which has been specified in previous versions of this document for carrying Over-Air Download (OAD) data carried in object carousel format.

Section 23.6 describes the DTG profile of the alternative method which is added in this version of this document using data carousels and based on the DVB-SSU specification TS 102 006 [SSU spec]. This shall be used for DVB-T2 capable receivers but it may also be used for other UK DTT receivers.

Other methods for updating receiver firmware from broadcasts and by other means are not precluded[54].

23.2 Reference documents - general

- EN 300 468 [2]
- EN 301 192 [7]
- ISO/IEC 13818-1 [36]
- ISO/IEC 13818-6 [39]
- TR 101 202 [12]
- TR 101 162 [10]
- TS 102 006 [17]
- DTG ECOM [91]
- DTG ADM [92]
- MHEG-5 UKPROFILE [94]

23.3 Introduction - general

This Engineering Channel specification defines the method to be used to broadcast software updates to receivers using capacity made available to manufacturers in the UK DTT multiplexes. Terms and conditions for the use of the Engineering Channel may be obtained from *DTG Testing Ltd, No 1, Nine Elms Lane, Vauxhall, London, SW8 5NQ*.

Note that this specification defines a generic method for implementation of the Engineering Channel. The extent of the implementation will be set out in the Operations Manual (DTG ECOM [91]).

The key features of the scheme apply to both the current object-carousel based system and the data-carousel based DVB-SSU system and are:

- The system uses standard MPEG data structures and should be able to pass through the UK network without problem

54. A second method for updating receiver software (DVB-SSU) is under consideration for deployment in the long term.

- The signalling in the PMT is static, allowing a one-off configuration of the broadcast network
- The signalling in the PMT is light weight, making good use of bit rate
- Simple signalling is included in the download information so that receivers can determine if there is a broadcast of relevance to them
- Manufacturers are identified by Organisational Unique Identifiers (OUIs)[55] . The scheme is flexible allowing any number of OUI representatives to be supported in the same broadcast download carousel

The method described in section 23.5 below represents current practice on the UK DTT platform, which predates the current DVB standard for system software updates, DVB-SSU (ETSI TS 102 006 [17]). A DTG profile of DVB SSU to be used initially by DVB-T2 capable receivers is described in this version of this specification and it is expected that the platform will move to adopt DVB-SSU in the near future for use by all DTT receivers, as described in Section 23.6.

The information in Section 23.4 applies to both systems.

23.4 Service structure - general

Each data broadcast will be carried as a download carousel (as specified in this document) on a component in one of the existing services in the network. Note that this does not preclude there being more than one download carousel that conforms to this specification broadcast on the same T2 system.

The implementation of the current OAD system and the initial implementation of the DVB SSU methods both use static PSI signalling only. This allows the download to be encoded in a single format and inserted at a central point in a network operator's distribution network.

The PSI signalling conforms to ISO/IEC 13818-1 [36].

23.5 UK DTT-Specific Firmware Update method (OAD)

DTG Engineering Channel operates a firmware update service to DTT receivers based on a specification which is unique to the UK. This specification for this method is given in this section.

23.5.1 Signalling

23.5.1.1 SI

In the implementation used in the UK DTT service for downloading firmware updates no SI signalling is used and the information carried in the PSI is quasi-static.

It is not intended that the service should be advertised in the receiver GUIDE or ESG.

The receiver should not immediately change to the service carrying the download but the presence of the indicator should allow a "background" application to manage the download in an appropriate manner.

55.Information about the OUI and the IEEE Registration Authority is available at http://standards.ieee.org/regauth/

23.5.1.2 PSI

Each download carousel will appear as a data component within an existing service. The PMT information required to support this service and the download signalling may be static (see note below).

Although the download carousel can be carried over more than a single PID, for legacy reasons any download carousels conforming to this specification are carried on a single PID.

A data_broadcast_id descriptor in the PMT (as defined in EN 300 468 [2]) identifies the elementary stream that carries the download carousel's DSI. The data_broadcast_id value in TR 101 162 [10] is 0x0111. No extended information is included in the data_broadcast_id descriptor - so it takes the minimal form shown in EN 300 468 [2].

No information is included in the data_broadcast_id descriptor regarding the targeting of the firmware update file, that information is carried in the userInfo field of the ServiceGatewayInfo() structure within the Object Carousel described in 23.5.2.1.

Syntax	No. bits	Identifier	Value
`data_broadcast_id_descriptor(){`			
`descriptor_tag`	8	uimsbf	
`descriptor_length`	8	uimsbf	
`data_broadcast_id`	16	uimsbf	0x0111
`}`			

Table 23-1. Syntax of data_broadcast_id descriptor in PMT

Semantics of the data_broadcast_id descriptor:

data_broadcast_id: This 16 bit field identifies the data broadcast specification which is used to broadcast the data in the broadcast network. Allocations of values in this field are found in TR 101 162 [10].

Note If no download is currently available, the PMT may continue to signal the presence of the component but the component itself may be absent. Alternatively, a null stream can be broadcast, i.e. no download carousel is present on the signalled component.

23.5.2 Update File transport – Object Carousel

All of the information in the download broadcast is carried in a DSM-CC Object Carousel. For legacy reasons this carousel will be broadcast on a single data component.

23.5.2.1 Update information signalling

The "Manufacturer Information Structure" (MIS, see Section 23.5.1.1) shall be used to identify the receivers for which the download is intended.

A loop of these structures is carried in the userInfo field of the ServiceGatewayInfo() structure. Each MIS in the loop indicates a download available in the carousel for that particular OUI representative.

This ServiceGatewayInfo() structure is carried in the privateData field of a DownloadServerInitiate message (see Section17.2.2.3

"DownloadServerInitiate" and Section17.2.2.6 "ServiceGatewayInfo" of this document and section11.3.3.3 of ISO/IEC 13818-6 [39]).

For information, the format of the DownloadServerInitiate message is reproduced below from section 7.3.6 of ISO/IEC 13818-6 [39]:

Syntax	No. bytes
`downloadServerInitiate{`	
`dsmccMessageHeader()`	
`serverId`	20
`privateDataLength`	2
`for(i=0;i<PrivateDataLength;i++){`	
`privateDataByte`	1
`}`	
`}`	

Table 23-3. DownloadServerInitiate (DSI) syntax

Note that in this case the compatabilityDescriptor() field is not used and has zero length.

23.5.2.2 Manufacturer information in the UserInfo data field

The userInfo field of the ServiceGatewayInfo structure carries a loop of Manufacturer Information Structures. Each MIS provides information on the manufacturer and receiver models supported by the current download broadcast; optionally information on download times and some other download specific data can be carried in a manufacturer specific manner. The purpose of the MIS is to provide a lightweight structure that receivers can inspect using minimum receiver resources.

Note Ambiguity in a previous version of this document did not make it clear whether one only or more than one MIS could be carried. For clarity, this specification allows for one or more Manufacturer Information Structures to be carried in the userInfo field. This means that a download carousel can contain update data for one or more OUI representatives at any one time. (It should be noted that the construction of the download carousel is the responsibility of the manufacturer and so all OUIs and other information to be included must be available to the builder of the carousel.)

It is recommended that the DSI be broadcast at a repetition interval of not more than 5 seconds.

The table following shows the overall syntax of the loop of MISs that are placed in the
userInfo field of the ServiceGatewayInfo structure. Note that "N" indicates the number of OUI representatives with downloads available in the same download carousel. There shall be at least one MIS in a download carousel that conforms to this data broadcast specification (i.e. it is illegal for N = 0).

Syntax	No. bits	Identifier	Value
for(i=0;i<N;i++) {			
manufacturer_information_structure(){			
manufacturer_information_tag	8	bslbf	0xE0
manufacturer_data_length	16	uimsbf	M
manufacturer_id	24	uimsbf	
version_id	32	uimsbf	
for(j=0;j<(M-7);j++){			
manufacturer specific data byte	8	bslbf	
}			
}			
}			

Table 23-4. Manufacturer Information Structure (MIS) syntax

descriptor_tag: This 8 bit integer with value 0xE0 identifies this descriptor.

manufacturer_data_length (M in Table 23-4):

This 16-bit field gives the total length in bytes of the following manufacturer specific data. This field may be empty if the broadcast currently contains no active downloads.

manufacturer_id: This 24-bit field carries an IEEE OUI uniquely identifying the origin of the software download. This will identify the receiver manufacturer.

version_id: This 32 bit field identifies the receivers that require this download in a manufacturer specific way.

To prevent unexpected behaviour or crashes if the received download is intended for a legacy receiver, and contains carousel data that does not conform to this specification, receivers should refrain from further parsing of the download carousel (including the manufacturer specific data described in 23.5.1.2) if none of the manufacturer_id fields in the MIS loop match their own OUI.

23.5.2.2.1 Manufacturer specific data

The structure of the manufacturer specific data is determined by the individual manufacturer. This data may be in any form.

For example, this data may be in descriptor form. Examples of possible descriptors are:

- Optional download slot descriptor (current download)
- Optional next download slot descriptor
- Optional download priority descriptor
- Optional user information

These descriptors are for information only and shall not be considered essential for interoperability between receivers.

Download_slot_descriptor: describes the temporal characteristics of the current download associated with that manufacturer/model/software combination (if any).

Syntax	No. bits	Identifier	Value
download_slot_descriptor() {			
descriptor_tag	8	uimsbf	0x01
descriptor_length	8	uimsbf	
slot_start_time	40	bslbf	
slot_duration	24	uimsbf	
download_time_estimate	8	uimsbf	
}			

Table 23-5. Download slot descriptor syntax

descriptor_tag: This 8 bit integer with value 0x01 identifies this descriptor.

slot_start_time: This 40 bit field encodes the start time of the download. The encoding is the same as the EIT start_time field and includes the date.

slot_duration: This 24 bit field encodes the duration of the download broadcast slot. The encoding is the same as the EIT duration field.

download_time_estimate: This 8 bit field specifies the predicted time in minutes that it will take the receiver to acquire the download.

Priority_descriptor (if present) indicates the importance of the download data.

Syntax	No. bits	Identifier	Value
priority_descriptor() {			
descriptor_tag	8	uimsbf	0x02
descriptor_length	8	uimsbf	
download_priority	8	uimsbf	
}			

Table 23-6. Download priority descriptor syntax

descriptor_tag: This 8 bit integer with value 0x02 identifies this descriptor.

download_priority: This byte indicates the importance of the download data, the suggested values are shown in Table 23-7.

Priority level	Value
Normal, download optional	0x00
High, download must be carried out	0x01
Reserved for future use	0x02 - 0xFF

Table 23-7. Download_priority indicator values

User_information_descriptor:
provides optional information for presentation to the user.

Syntax	No. bits	Identifier	Value
`user_information_descriptor() {`			
`  descriptor_tag`	8	uimsbf	0x03
`  descriptor_length`	8	uimsbf	
`  for (i=0; i<N; i++) {`			
`    user_information`	8	uimsbf	
`  }`			
`}`			

Table 23-8. User information descriptor syntax

descriptor_tag: This 8 bit integer with value 0x03 identifies this descriptor.

user_information: These bytes provide manufacturer specific information intended for presentation to the user. For example, this might include a short description of the software upgrade and might provide a telephone number for enquiries. This information is expected to be textual, the choice of character encoding is left to the individual manufacturer.

23.5.3 Data download

The download data is carried as files in a DSM-CC Object Carousel. This object carousel conforms to the specification in the MHEG-5 UK Profile [94].

For each manufacturer with current download data (as indicated by a matching OUI and manufacturer_id in a MIS) there is one directory in the service gateway. The directory name shall be the manufacturer's OUI as a hexadecimal value in textual form using lower-case characters. Hence these top level directory names are 6 characters long.

The details of the files and the directories in the file tree beneath the top level manufacturer directory are manufacturer specific and are thus outside of the scope of this specification.

Note TR 101 202 (Guidelines for data broadcasting) section 4.7.2.2 defines the following as objects:

DSM::Directory	Access, Directory
DSM::File	Base, Access, File
DSM::Stream	Base, Access, Stream
DSM::ServiceGateway	Access, ServiceGateway
BIOP::StreamEvent	Base, Access, Stream, Event

D-Book v5.0 section 17.2.7 (Mapping of objects to modules) defines that any module containing multiple objects is limited to 65536 bytes (64K).

23.5.4 Data Compression

It is recommended that ZLIB is used to compress the module data in the carousel as this is a function of the DSM-CC stack. Because of the algorithm used this will also give an additional method of data checking on reception and a small degree of data obfuscation.

23.5.5 Data Security

Control over the security of the download data is an issue for manufacturers to decide on an individual basis, but may be a requirement imposed by the broadcaster.

It is highly recommended that, for error checking and data verification purposes, some form of data security be employed, for example MD5 or RSA.

If data encryption or obfuscation is considered necessary then this is also a manufacturer option.

23.6 DVB-SSU Firmware Update Method

The ability to use the methods contained in the DVB-SSU specification for receiver firmware updates is added in this version of the D-Book specification, initially for receivers designed for the DVB-T2 services but it is intended that this will ultimately be used for all UK DTT receivers.

Two profiles are defined for DVB SSU, these are Simple Profile and Enhanced Profile, the detailed description of these is given in TS 102 006 [17].

Initially, the Simple Profile will be used but migration to the Enhanced Profile is likely, to take advantage of the additional features that this method permits.

The DVB-SSU download protocol is based on the MPEG Data Carousel specification (ISO/IEC 13818-6 [39]) and the specification for DVB data carousels (ETSI EN 301 192 [7].

23.6.1 DVB-SSU Transmission

The DTG usage of DVB SSU described in this document considers only the use of standard data carousel transport methods described in section 8 of ETSI TS 102 006 [17].

23.6.2 Signalling

Initially only the DVB-SSU Simple Profile will be used. This profile uses signalling in the NIT and PMT table sections to enable the receiver to detect and locate a software download. As with the current system based on Object Carousels, the UK profile of the DVB-SSU system will use static signalling in both the NIT and PMT.

23.6.2.1 SI Signalling

A linkage descriptor carried in the first loop of the NIT is used. The linkage descriptor carries a linkage type of 0x09 (*system software update* service) conveying the location of the transport stream carrying a system software update service within a network.

The DVB-SSU data carousel is carried as a component of a service. However, there may be multiple services carrying data carousels; in this case each will be specified by a separate SSU Linkage Descriptor. More than one data carousel may be carried on a given service, subject to the constraints of bandwidth availability and agreement of the transmission organisation.

The SSU Linkage Descriptor shall be carried in the NIT of all multiplexes.

The SSU scan_linkage_descriptor (type=0x0A) will not be transmitted in UK DTT services.

Syntax	No. bits	Identifier
SSU Linkage Descriptor() {		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
transport_stream_id	16	uimsbf
original_network_id	16	uimsbf
service_id	16	uimsbf
linkage_type	8	uimsbf
for (i=0;i<N;i++){		
OUI_data_length	8	uimsbf
for (j=0; j<N; j++){		
OUI	24	bslbf
selector_length	8	uimsbf
}		
}		
}		

Table 23-9. Linkage Descriptor for System_Software_Update (based on EN 300 468 section 6.2.19 and TS 102 006 section 6.1, included for information only)

transport_stream_id, original_network_id, service_id:

these indicate the location of the System Software Update service.

linkage_type: shall be set to 0x09 to indicate linkage to a System Software Update service.

OUI: This shall be set to the DVB OUI value of 0x00015a to indicate that the stream is for all OUIs.

selector_length: set to zero as there is no further data included in this linkage descriptor. Target receivers are identified in the Compatibility Descriptor in the DSI of the data carousel.

No private data is carried in this descriptor.

23.6.2.2 PSI Signalling

The PMT of the service carrying the SSU data shall contain the data_broadcast_id descriptor with the data_broadcast_id set to 0x000A, indicating an elementary stream used for the SSU service. This provides an entry point to either a standard update carousel, or a proprietary stream (not included in DTG profile), without the need for further reference from a table.

The data_broadcast_id shall be carried in the ES_info_loop of the PMT. If an SSU service is temporarily absent, this descriptor shall NOT be removed from the PMT.

The data_broadcast_ID descriptor (defined in EN 300 468 [2]) shall carry a *system_software_update_info* data structure, which is defined in TS 102 006 [17]. They are reproduced here for convenience:

Syntax	No. bits	Identifier
`data_broadcast_id_descriptor() {`		
`descriptor_tag`	8	uimsbf
`descriptor_length`	8	uimsbf
`data_broadcast_id`	16	uimsbf
`OUI_data_length`	8	uimsbf
`for (i=0;i<N;i++){`		
`OUI`	24	bslbf
`Reserved`	4	
`update_type`	4	
`reserved`	2	
`update_versioning_flag`	1	
`update_version`	5	
`selector_length`	8	uimsbf
`}`		
`}`		

Table 23-10. Data Broadcast ID descriptor for System_Software_Update (based on ETSI EN 300 468 section 6.1.12 and TS 102 006 section 7.1 and included for information only)

descriptor_tag: shall be set to 0x66.

data_broadcast_id: shall be set to 0x000A to indicate System Software Update

OUI: This shall be set to the DVB OUI value of 0x00015a to indicate that the stream is for all OUIs.

update_type: For Simple Profile, this shall be set to 0x01; For Enhanced Profile, this shall be set to 0x02.

update_versioning_flag: shall be set to zero to indicate that there is no version information in the update_version field.

update_version: value set to zero as update_versioning_flag has fixed value.

selector_length: set to zero as there is no further data is included in this descriptor. Target receivers are identified in the Compatibility Descriptor in the DSI of the data carousel.

No private data is carried in this descriptor.

23.6.3 Structure of the Download Carousel

The standard one- or two-layer carousel protocol is based on the MPEG DSM-CC data carousel specification (ISO/IEC 13818-6 [39]) and the specification for DVB data carousels (EN 301 192 [3]).

Note: there is an incompatibility between the DVB-SSU and the DVB Data Carousel specifications relating to the structure of the DSI's GroupInfoIndication structure which must be considered when designing DVB-SSU download carousel data parsers. . This UK profile specification requires that the GroupInfoIndication structure for SSU data carousels adhere to ETSI TS 102 006 [17].

The standard two-layer carousel protocol described in section 8.1 of ETSI TS 102 006 [17] is applicable to both the Simple Profile (without reference to the UNT) and the Enhanced profile (with reference to a UNT).

A receiver may capture and analyse the DSI in the data carousel to determine whether the OUI of the SSU Carousel matches the manufacturer's own OUI and thus accept or reject the SSU download. It is recommended that receivers check the OUI in the DSI before downloading the complete carousel.

It is recommended that the DSI be broadcast at a repetition interval of not more than 5 seconds.

Manufacturers should continue to monitor the DSI during reception of a download to detect if the carousel has changed to that for a different manufacturer.

23.6.3.1 Compatibility Descriptor

Target receivers are identified in the Compatibility Descriptor and may be identified by either Hardware (*system hardware descriptor)* or by Software (*system software descriptor*) or both. In the Simple Profile, this is carried in the GroupCompatibility field of the GroupInfoIndication. In the Enhanced Profile it is carried in the Update Notification Table.

The Compatibility Descriptor is defined in ISO/IEC 13818-6 [39] and is shown here for convenience:

Syntax	No. bits	Identifier
`CompatibilityDescriptor() {`		
`  CompatibilityDescriptorLength`	16	uimsbf
`  DescriptorCount`	16	uimsbf
`  for (i = 0; i < descriptorCount; i++) {`		
`    descriptorType`	8	uimsbf
`    descriptorLength`	8	uimsbf
`    specifierType`	8	uimsbf
`    SpecifierData`	24	uimsbf
`    model`	16	uimsbf
`    version`	16	uimsbf
`    subDescriptorCount`	8	uimsbf
`    for (j = 0; j < subDescriptorCount; j++ {`		
`      subDescriptor () {`		
`        subDescriptorType`	8	uimsbf
`        subDescriptorLength`	8	uimsbf
`        for (k = 0; k < subDescriptorLength; k++ {`		
`          additionalInformation`	8	uimsbf
`        }`		
`      }`		
`    }`		
`  }`		
`}`		

Table 23-11. Compatibility Descriptor[56]

The compatibilityDescriptor is profiled as below in this DTG specification.

CompatilityDescriptorLength:

including any subDescriptors (which may contain additional information).

DescriptorCount: indicates the number of descriptors in the main descriptor loop. Multiple hardware and software descriptors are possible.

descriptorType: this shall be set to either 0x01 (for a *system hardware descriptor*) or 0x02 (for a *system software descriptor)*. A system hardware or a system software descriptor shall be present.

specifierType : shall be set to 1 to indicate an OUI

SpecifierData: indicates the OUI of the manufacturer of the receiver for which this software

[56]. Information about the OUI and the IEEE Registration Authority is available at http://standards.ieee.org/regauth/

e shop: www.bsigroup.com/Shop or by contacting BSI Customer Services for hard copies only: Tel: +44 (0)20 8996 9001, Email: cservices@bsigroup.com

	download is intended
model:	manufacturer specific data sufficient to uniquely identify the target receiver model. when set to zero, this indicates that the model information is transmitted in a manufacturer private location. when set to 0xFFFF, this indicates that the enhanced profile is in use. Other values indicate the model in a manufacturer-specific manner.
version:	manufacturer specific data sufficient to uniquely identify the target receiver version. when set to zero, this indicates that the version information is transmitted in a manufacturer private location. when set to 0xFFFF, this indicates that the enhanced profile is in use. Other values indicate the version in a manufacturer-specific manner.
subDescriptorCount:	number of following manufacturer-specified subDescriptors. If none are present, this shall be set to zero.
subDescriptor:	a manufacturer may include other descriptors as necessary.
additionalInformation:	a manufacturer may include additional information as necessary. The syntax and semantics of any additional information are specified by the organisation identified by the specifier.

23.6.4 Data Security

Control over the security of the download data is an issue for manufacturers to decide on an individual basis, but may be a requirement imposed by the broadcaster.

It is hightly recommended that, for error checking and data verification purpose, some form of data security be emplyed, for example MD5 or RSA.

If data encryption or obfuscation is considered necessary then this is also a manufacturer option.

23.6.5 Receiver Requirements

While the DVB-SSU specification is both backward and forward compatible in terms of profiles (see ETSI TS 102 006 [17]), it is recommended that all receivers should also implement the enhanced profile.

24 Recommended Receiver Reaction to Aspect Ratio Signalling in Digital Video Broadcasting

24.1 Preface

UK digital TV broadcasts carry a mixture of widescreen (16:9) and standard (4:3) format programmes. At the receiving end, both set-top boxes and television sets allow viewers to choose between several different display conditions. Broadcasters transmit codes embedded in the digital transmission which describe picture shape. All transmissions signal either 16:9 or 4:3 raster using the elementary stream header. A second code, the Active Format Description (AFD) can be used additionally to send more information mainly about the 'protected' area inside a widescreen picture which may be cut off for viewing on non-widescreen sets.

Set-top boxes use this information to create the appropriate raster, and also pass information about the preferred display mode to the TV set. But to be effective, the set-top box and TV set must be set-up correctly, and even then the viewer preference selected on the TV set may override the signalling. With all these variables, broadcasters often do not know how their programmes are being watched, and viewers may unwittingly be viewing a less than perfect picture shape.

These Guidelines set out to address these issues, and recommend that all TV sets must have an ex-factory default setting which makes the set follow the broadcaster's transmitted picture format codes in the elementary stream header and the AFD. This will allow some viewer preferences to operate automatically, but only those which the broadcaster has catered for in making the programme. For example, it will allow a viewer to fill the screen of a 4:3 TV set with the centre portion of a widescreen picture, but only for programmes 'shot and protected' to allow for this, so that cutting off the edges won't lose important action in the scene.

Recognising that viewers may not always be satisfied with the broadcaster's recommended display format or choice of formats, the Guidelines state that TV sets may also have a 'viewer preference' setting, in which the viewer's wishes override that of the broadcaster, and a 'feature mode', where the TV set takes control using the manufacturer's 'trick' features - like black area sensing or non-linear distortion of 4:3 pictures on 16:9 screens. But the viewer will have to select these other modes deliberately, and might therefore be expected to do so only if dissatisfied with the broadcaster's recommendation.

These guidelines now include the signalling carried via an HDMI connection to achieve the same results on the display. When in automatic AFD mode, 21:9 displays should show a 16:9 image with pillar-box to retain the intended aspect ratio; zoom and fill screen functions are permitted.

24.2 Digital receiver implementation guidelines

24.2.1 Display options for iDTVs

Integrated Digital TVs (iDTVs) should follow the broadcast AFD plus elementary stream header signalling completely. In this condition, the viewer option 'letterbox' for 4:3 displays shall be interpreted as 'best compromise', e.g. 16:9 LB, 14:9 LB or 4:3 CCO dependent upon shoot & protect regime employed and signalled via the transmitted AFD (see Section 24.2.2).

iDTVs may in addition offer the viewer two additional alternative display settings:

- viewer preference - in which viewer display preferences shall take priority
- manufacturer's 'feature' mode - in which the set may employ automatic in-built features, including non-linear distortion and black area sensing

and the set should remember the viewer preference settings used last time a 4:3 programme was watched, and when the set is turned off.

24.2.2 AFD implementation guidelines

Section 24.3 provides details of how receivers should respond to AFDs. This section must be read in conjunction with Chapter 3 "Video Display Formatting".

Note that AFDs supplement and qualify - *but do not replace* - the aspect ratio signalling carried in the broadcast's elementary stream header. Receivers must interpret both the aspect ratio signalling and the AFD in order to present the image in the correct manner.

24.2.3 Support for 14:9 presentation

All 16:9 TVs should support 14:9 scaling for scaling 4:3 sources.

Set-top boxes should be capable of providing a 14:9 letterbox presentation to a 4:3 display.

24.2.4 Behaviour of digital receiver and device combinations

A set-top box/analogue TV set combination should offer the same capability to follow the broadcast AFD plus elementary stream header signalling completely, and the set should remember the user setting last time a 4:3 programme was watched, and when the set is turned off.

Both SCART Pin 8/Line 23 signalling should be supported, with appropriate Line 23 signalling inserted by the digital receiver. Where both are present, Line 23 signalling should take priority.

iDTVs should output line 23 signalling to analogue recorders as well as respond to line 23 signalling incoming.

On HDMI connections the aspect ratio information is carried in the AVI_Infoframe in three parts (as specified in CEA-861.E):

- Active Format Information Present (A_0)
- Coded Frame Aspect Ratio (M_1, M_0)

- Active Portion Aspect Ratio (R_3, R_2, R_1, R_0)

Displays with HDMI input should support and interpret the appropriate AVI_Infoframe signalling correctly.

A digital receiver with HDMI output should support the insertion of appropriate AVI_Infoframe signalling.

24.2.5 Black area sensing

Black area sensing has the disadvantage of being incapable of differentiation between raster black (as in black bands caused by letterboxing) and intentional - or 'editorial' - black which is deliberately included in a programme scene.

Therefore black area sensing in TV sets should be disabled in the presence of valid aspect ratio signalling.

24.2.6 Reformatting response times

The time taken for a set to adjust display parameters on receipt of a change of AFD (and/or elementary stream header) should be as short as possible. Typical targets should be less than 250ms (i.e. 125 ms in a set-top box + 125 ms in a display). Time for channel change and resolution format change should be in parallel with AFD response time and not in addition.

24.2.7 High Definition services

When High Definition services are received and downscaled to Standard Definition (SD) for output via an alternate interface, (e.g. SCART) the correct signalling according to the AFD should be used.

24.3 Detailed treatment

24.3.1 Notes

24.3.1.1 General

1. This section contains tables detailing receiver response to aspect ratio signalling. These are divided into two parts, dealing with 4:3 rasters and 16:9 rasters respectively. The tables consider a receiving installation (see Figure 3-3 "Receiver and display format processing reference model") consisting of a decoder and display (a 4:3 or 16:9 television). The tables define:

   - the action of the decoder in response to aspect ratio signalling (aspect ratio and AFD) carried in the elementary stream
   - the signalling between decoder and display:

   for SCART outputs – Wide Screen Signalling on line 23 and Pin 8 status voltage.

   for HDMI outputs – AVI_Infoframe signalling.

   - the action of the display in response to the Line 23 and SCART Pin 8 signalling or HDMI AVI_Infoframe signalling.

The resulting images, illustrated in this appendix, are those recommended by broadcasters. Other display options are permitted but are not recommended.

2. The response of iDTVs to aspect ratio signalling should be equivalent to that of a separate decoder and display. In addition, iDTV analogue outputs (for example to recorders) should carry Line 23 signalling, and iDTV analogue inputs should respond to incoming Line 23 signalling. HDMI inputs should respond appropriately to AVI_Infoframes.

24.3.1.2 Decoder functions

3. Decoders should offer the viewer the following display options:
   - 16:9 (for use with a widescreen display)
   - For use with a 4:3 display:

     Centre Cut-Out, for the viewer who prefers to view only the centre portion of widescreen material (where possible);

     Letterbox, for the viewer who prefers to view widescreen material in

     the transmitted format (where possible)

   Decoders should support 14:9 and 16:9 letterbox presentations for use with 4:3 displays.
4. A default selection of preference for CCO or LB may be made by the user. This may be via a set-up menu in the receiver or, preferably, by a dedicated function on the receiver's remote control handset. The factory setting should be Letterbox.
5. The decoder should respond to the elementary stream header and AFD as defined in the following tables, according to the decoder option selected. AFDs supplement and qualify - and do not replace - the aspect ratio signalling carried in the elementary stream header. The elementary stream header denotes the raster shape (4:3 or 16:9 as appropriate) to which the AFD adds information about the picture (its shape and any protected areas within it) carried on that raster.
6. If no AFD is transmitted, the decoder will behave as if AFD value $=1000_2$ is present. NOTE that AFD value $=1000_2$ effectively means "no safe area defined".
7. Broadcasters should take note that AFD value $=1010_2$ should be used only for 16:9 pictures with no protect areas and which therefore can be adequately displayed only in deep letterbox (e.g. movies).
8. If the reserved value AFD$=1100_2$ is transmitted in error, the receiver will behave as if AFD value $=1000_2$ is present.
9. AFD values are shown in the sequence (b3) b2 b1 b0 where (b3) accommodates additional options not currently adopted in the UK. See TS 101 154 / EACEM TR-030 for details of (b3) functionality.

24.3.1.3 Output signalling

10. WSS codes are shown in the sequence b0 b1 b2 b3, where b3 represents the odd parity bit. For HDMI, bit values are defined for Coded Frame Aspect Ratio M0 M1 and Active Portion Aspect Ratio R3 R2 R1 R0. When the Active Portion Aspect Ratio bits are set, the Active Format Information Present bit A0 shall be set to 1.

24.3.1.4 Display functions

11. Widescreen displays should offer an "Auto" function, in addition to other user preference modes as detailed in Table 3-10 and manufacturers' own modes. The factory setting should be "Auto".
12. In "Auto" mode, displays should respond to WSS codes and SCART pin 8 and HDMI AVI_Infoframe signalling as defined in the following tables. Receiver display response to WSS codes should take priority over SCART pin 8 signalling.
13. It is assumed in this document that 4:3 displays cannot perform image manipulation (although some modern devices may offer this).

24.3.1.5 Other

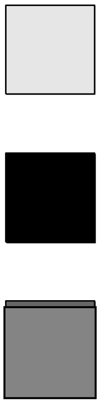
14. Some decoder devices may be able to convert the aspect ratio in silicon and present expanded full frame 4:3 or 16:9 images to the display. In some instances the resultant displayed image will appear identical to the full frame presentation achieved by display manipulation. However, this is not a recommended approach as, in some circumstances, the viewer is left unable to choose viewing preferences which remove black transmitted by the broadcaster.

24.3.1.6 HDMI Output Signalling

15. HDMI signalling for 4:3 displays is not considered in the tables as the market for displays with HDMI is almost exclusively 16:9.

24.3.2 Transmissions with MPEG aspect ratio of 4:3

Key:

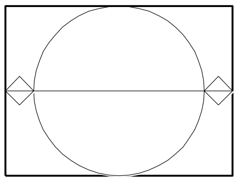
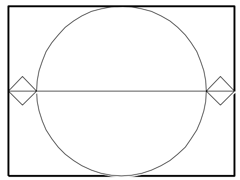
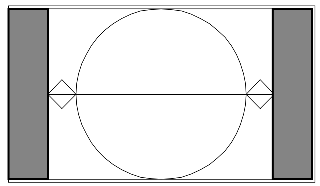
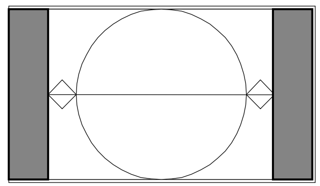


Is used to indicate Protected Area: consisting of picture which may be cropped for optimum display on screens of the other aspect ratio

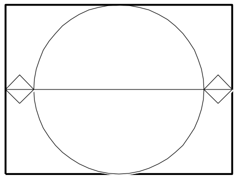
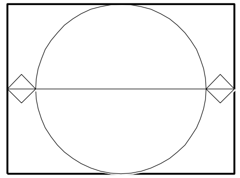
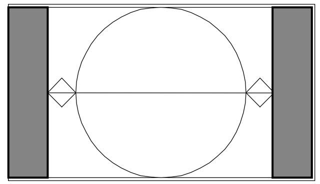
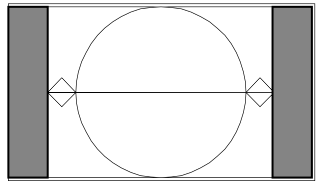
Is used to indicate black which is transmitted as part of the broadcast frame

Is used to indicate black which is generated by the receiver (either in the decoder or display)

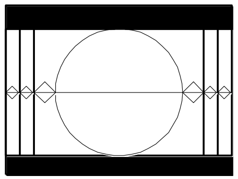
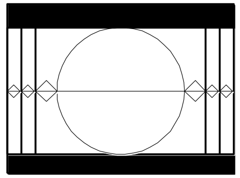
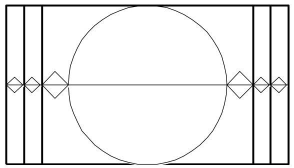
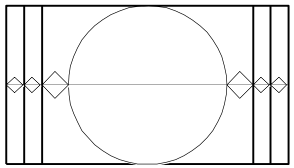
Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1000_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
4:3 Full Frame Image In a 4:3 Frame 		4:3		None	0001	12V	N/A	N/A	None		
		16:9		None	0001	12V	01	1000	Reduce image width to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		"Pillar-Box" the 4:3 image into a 16:9 frame	N/A	N/A	N/A (see comment)	N/A (see comment)	None		Bit A_0 in the AVI Infoframe should be set to Zero to indicate that the R bits are not valid.

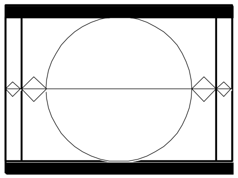
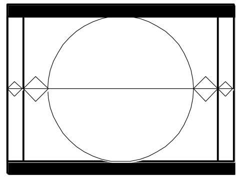
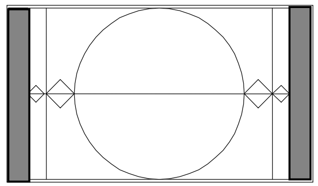
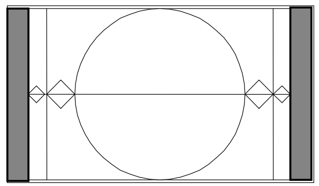
Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1001_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
4:3 Full Frame Image In a 4:3 Frame 		4:3		None	0001	12V	N/A	N/A	None		
		16:9		None	0001	12V	01	1001	Reduce image width to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		"Pillar-Box" the 4:3 image into a 16:9 frame	N/A	N/A	10	1001	None		

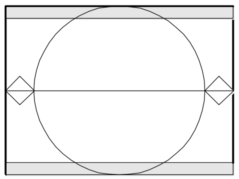
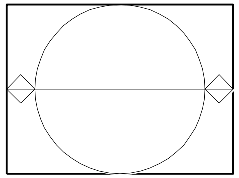
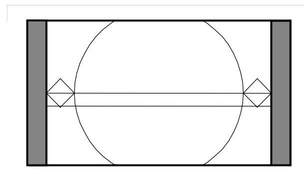
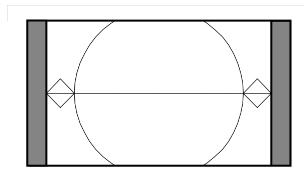
Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1010_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
16:9 Letterbox Image In a 4:3 Frame 		4:3		None	1101	12V	N/A	N/A	None		See Note 7
		16:9		None	1101	12V	01	1010	Increase display height to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		Scaling to 16:9 Frame	1110	6V	10	1010	None		ALTERNATE 16:9 display option where supported by decoder

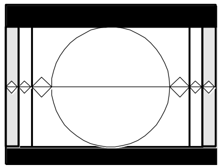
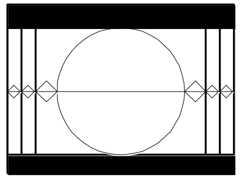
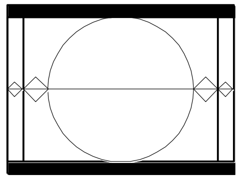
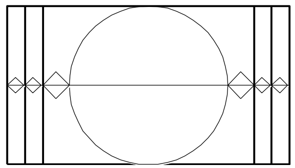
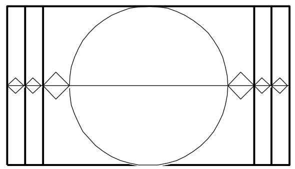
Transmission **Receiver**

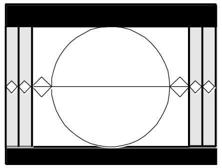
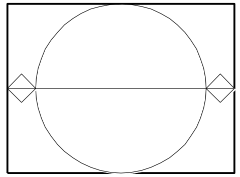
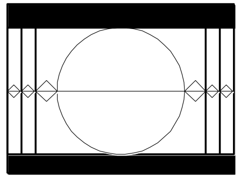
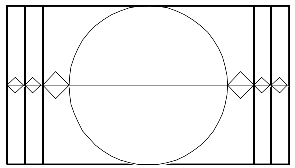
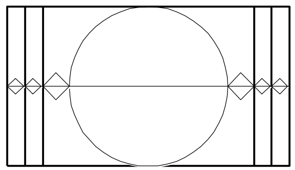
Transmitted Signalling: 4:3 RASTER	Transmitted Signalling: AFD value 1011_2	Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling: WSS Line 23	SCART Output Signalling: SCART pin 8	HDMI Output Signalling: $M_1 M_0$	HDMI Output Signalling: $R_3 R_2 R_1 R_0$	Display Action	Display Appearance	Comments
14:9 letterbox Image In a 4:3 Frame 		4:3		None	1000	12V	N/A	N/A	None		
		16:9		None	1000	12V	01	1011	Increase image height to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		Scale the 14:9 image into a 16:9 frame	N/A	N/A	10	1011	None		

Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1101_2				WSS Line 23	SCART pin 8	$M_1 M_0$	$R_3 R_2 R_1 R_0$			
4:3 Image Shoot & Protect 14:9 in a 4:3 Frame 		4:3		None	0111	12V	N/A	N/A	None		
		16:9		None	0111	12V	01	1101	Increase image height to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		Scale the 14:9 image into a 16:9 frame	N/A	N/A	10	1011	None		

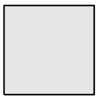
Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1110_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
16:9 Letterbox Image Shoot and Protect 14:9 In a 4:3 Frame 		4:3		None	1101	12V	N/A	N/A	None		
		4:3		Scaling to 14:9 Image	1000	12V	N/A	N/A	None		PREFERRED 4:3 display option where supported by decoder
		16:9		None	1101	12V	01	1110	Increase image height to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		Scaling to 16:9 Frame	1110	6V	10	1110	None		ALTERNATE 16:9 display option where supported by decoder

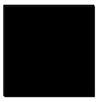
Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
4:3 RASTER	AFD value 1111_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
16:9 Letterbox Image Shoot and Protect 4:3 In a 4:3 Frame 		4:3		Scaling 4:3 Full Frame Image	0001	12V	N/A	N/A	None		PREFERRED 4:3 display option where supported by decoder
		4:3		None	1101	12V	N/A	N/A	None		
		16:9		None	1101	12V	01	1111	Increase image height to correct geometry		For HDMI only use if display indicates support for the required 4:3 format
		16:9		Scaling to 16:9 Frame	1110	6V	10	1111	None		ALTERNATE 16:9 display option where supported by decoder

24.3.3 Transmissions with MPEG aspect ratio of 16:9

Key:



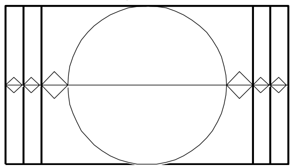
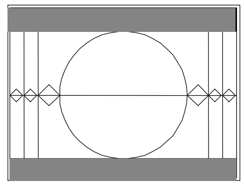
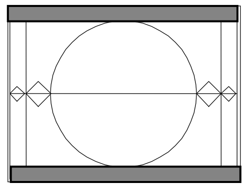
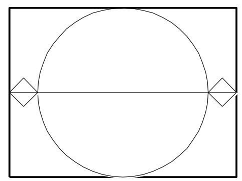
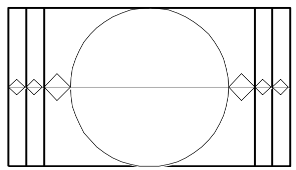
Is used to indicate Protected Area: consisting of picture which may be cropped for optimum display on screens of the other aspect ratio



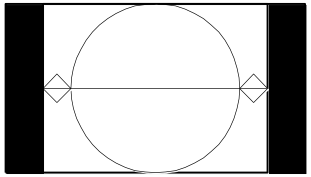
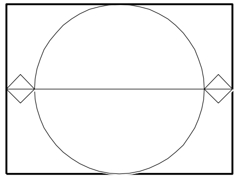
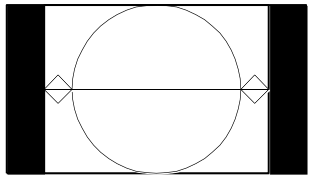
Is used to indicate black which is transmitted as part of the broadcast frame

Is used to indicate black which is generated by the receiver (either in the decoder or display)

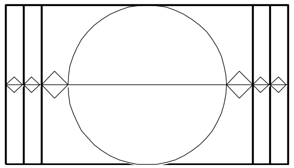
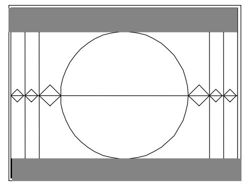
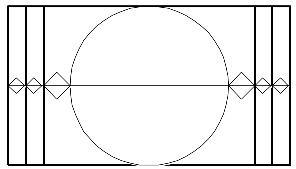
Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
16:9 RASTER	AFD value 1000_2				WSS Line 23	SCART pin 8	$M_1 M_0$	$R_3 R_2 R_1 R_0$			
16:9 Full Frame Image In a 16:9 Frame 		4:3	Letterbox	Scaling to 16:9 Letterbox	1101	12V	N/A	N/A	None		"Best Compromise" 4:3 display option See Note 6
		4:3	Letterbox	Scaling to 14:9 Letterbox	1000	12V	N/A	N/A	None		ALTERNATIVE user selectable option (if supported by decoder chipset)
		4:3	CCO	Centre Cutout	0001	12V	N/A	N/A	None		ALTERNATIVE user selectable option
		16:9		None	1110	6V	10	1000	None		

Transmission **Receiver**

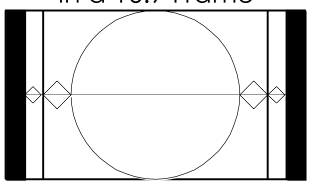
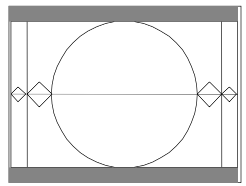
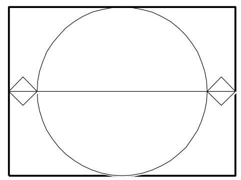
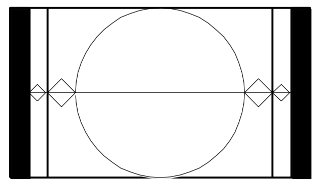
<table>
<tr><th colspan="2">Transmitted Signalling</th><th rowspan="2">Display Aspect Ratio</th><th rowspan="2">Decoder User Option</th><th rowspan="2">Decoder Format Conversion</th><th colspan="2">SCART Output Signalling</th><th colspan="2">HDMI Output Signalling</th><th rowspan="2">Display Action</th><th rowspan="2">Display Appearance</th><th rowspan="2">Comments</th></tr>
<tr><th>16:9 RASTER</th><th>AFD value 1001_2</th><th>WSS Line 23</th><th>SCART pin 8</th><th>$M_1 M_0$</th><th>$R_3 R_2 R_1 R_0$</th></tr>
<tr><td colspan="2" rowspan="3">4:3 Pillarbox Image in a 16:9 Frame
</td><td>4:3</td><td>Letterbox and CCO</td><td>Centre Cutout</td><td>0001</td><td>12V</td><td>N/A</td><td>N/A</td><td>None</td><td></td><td>“Best Compromise” 4:3 display option</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>16:9</td><td></td><td>None</td><td>1110</td><td>6V</td><td>10</td><td>1001</td><td>None</td><td></td><td></td></tr>
</table>

Transmission **Receiver**

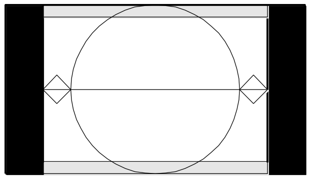
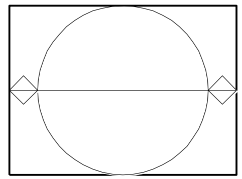
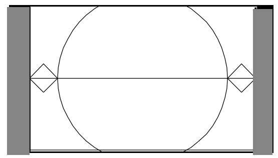
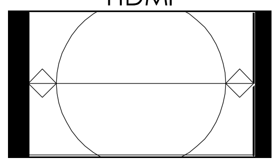
<table>
<tr><th colspan="2">Transmitted Signalling</th><th rowspan="2">Display Aspect Ratio</th><th rowspan="2">Decoder User Option</th><th rowspan="2">Decoder Format Conversion</th><th colspan="2">SCART Output Signalling</th><th colspan="2">HDMI Output Signalling</th><th rowspan="2">Display Action</th><th rowspan="2">Display Appearance</th><th rowspan="2">Comments</th></tr>
<tr><th>16:9 RASTER</th><th>AFD value 1010_2</th><th>WSS Line 23</th><th>SCART pin 8</th><th>$M_1 M_0$</th><th>$R_3 R_2 R_1 R_0$</th></tr>
<tr><td colspan="2" rowspan="2">16:9 Full Frame Image in a 16:9 Frame
</td><td>4:3</td><td>Letterbox and CCO</td><td>16:9 Letterbox</td><td>1101</td><td>12V</td><td>N/A</td><td>N/A</td><td>None</td><td></td><td>“Best Compromise” 4:3 display option See Note Below</td></tr>
<tr><td>16:9</td><td></td><td>None</td><td>1110</td><td>6V</td><td>10</td><td>1010</td><td>None</td><td></td><td></td></tr>
</table>

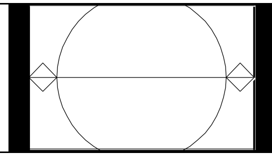
Note: AFD 2 is intended for use only with 16:9 pictures with no protect areas (e.g. widescreen movies) and which therefore can only be adequately displayed in deep letterbox. All viewer options should give rise to a deep letterbox presentation.

Transmission **Receiver**

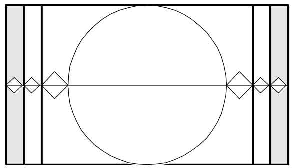
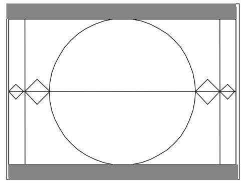
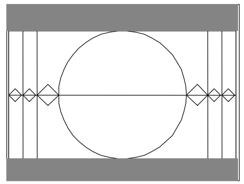
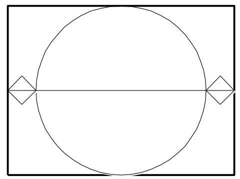
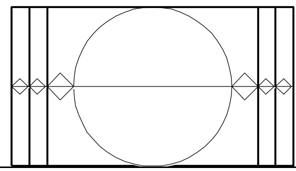
Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
16:9 RASTER	AFD value 1011_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
14:9 Pillarbox Image in a 16:9 Frame 		4:3	Letterbox	Scaling to 14:9 Letterbox	1000	12V	N/A	N/A	None		"Best Compromise" 4:3 display option where supported by decoder
		4:3	CCO	Centre Cutout	0001	12V	N/A	N/A	None		ALTERNATIVE user selectable option "Best Compromise" if no 14:9 LB
		16:9		None	1110	6V	10	1011	None		

Transmission **Receiver**

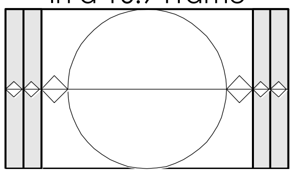
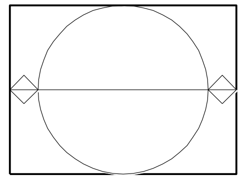
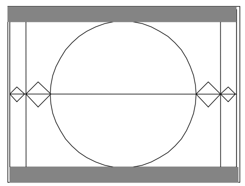
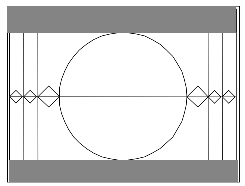
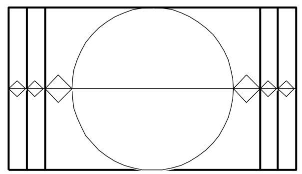
Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
16:9 RASTER	AFD value 1101_2				WSS Line 23	SCART pin 8	M_1 M_0	R_3 R_2 R_1 R_0			
4:3 Pillarbox Image Shoot & Protect 14:9 in a 16:9 Frame 		4:3	Letterbox and CCO	Centre Cutout	0111	12V	N/A	N/A	None		"Best Compromise" 4:3 display option
		16:9		Centre Cutout	0111	12V	N/A	N/A	Increase image height and reduce display width to correct geometry		For receivers without HDMI output
		16:9		None	N/A	N/A	10	1101	Image zoomed into 14:9 area with correct geometry None	HDMI  SCART	For receivers with HDMI output

Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
16:9 RASTER	AFD value 1110_2				WSS Line 23	SCART pin 8	$M_1 M_0$	$R_3 R_2 R_1 R_0$			
16:9 Image Shoot & Protect 14:9 In a 16:9 Frame 		4:3	Letterbox	Scaling to 14:9 image in 4:3 Frame	1000	12V	N/A	N/A	None		"Best Compromise" 4:3 display option where supported by decoder
		4:3	Letterbox	Scaling to 16:9 Letterbox	1101	12V	N/A	N/A	None		"Best Compromise" if no 14:9LB
		4:3	CCO	Centre Cutout	0001	12V	N/A	N/A	None		ALTERNATIVE user selectable option
		16:9		None	1110	6V	10	1110	None		

Transmission **Receiver**

Transmitted Signalling		Display Aspect Ratio	Decoder User Option	Decoder Format Conversion	SCART Output Signalling		HDMI Output Signalling		Display Action	Display Appearance	Comments
16:9 RASTER	AFD value 1111_2				WSS Line 23	SCART pin 8	$M_1 M_0$	$R_3 R_2 R_1 R_0$			
16:9 Full Frame Image Shoot & Protect 4:3 In a 16:9 Frame 		4:3	Letterbox and CCO	Centre Cutout	0001	12V	N/A	N/A	None		"Best Compromise" 4:3 display option
		4:3	Letterbox	Scaling to 14:9 image in 4:3 Frame	1000	12V	N/A	N/A	None		ALTERNATIVE user selectable option (if supported by decoder chipset)
		4:3	Letterbox	Scaling to 16:9 Letterbox	1101	12V	N/A	N/A	None		ALTERNATIVE user selectable option
		16:9		None	1110	6V	10	1111	None		

25 Control of Receiver Functions

25.1 Introduction

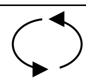
All receivers shall provide the user with control of the functions shown as "essential" in the table. The means by which control is implemented is not specified; however, control of the accessibility functions (subtitles and audio description) should be as straightforward and convenient as possible, bearing in mind that in the case of audio description the viewer may be partially sighted.

Guidance notes on the design of remote control handsets and on-screen displays are included in Annex I.

25.2 Standard receiver control functions

Table 25.1 lists the standard control functions offered by a typical DTT receiver.
To facilitate references to functions by broadcasters and interactive content developers when referencing receiver functions in on-screen instructions, the functions should be identified as shown in column 4 of the table. This will also provide consistency between different control interfaces.

Function	**Description of function**	Support/Control of function (Essential/ Strongly Recommended)	**Recommendation for Identification or Preferred Symbols**
On/standby	To switch a receiver to the active state. To switch a receiver to the standby state.	Essential	⏻
Numerals 0-9	"0", "1", "2", "3", "4", "5", "6", "7", "8", "9".	Essential	"0", "1", "2", "3", "4", "5", "6", "7", "8", "9"
Up, Down, Left, Right	Provides directional user interaction to a variety of receiver functions.	Essential	▲ ▼ ◀ ▶
OK/Select	Allows the user to confirm or select a particular screen choice or action.	Essential	"OK"
Back	This function allows the user to move back one step in an interactive application, EPG or other user interaction function. It returns the receiver to the previous "level" in an interactive application or other receiver function (e.g. EPG). If the function is invoked and the user is at the "top level" of an interactive application or receiver function the result will normally be an exit from that application or receiver function. In DTT, this function should be mapped to the MHEG "cancel" function (see Section 13.6 "User input").	Essential	"back" or "return"
Info	This function causes the receiver to display "now" and/or "next" information.	Essential	**i**

Function	**Description of function**	Support/Control of function (Essential/ Strongly Recommended)	**Recommendation for Identification or Preferred Symbols**
Text	See Section 19.3 “Use of the “Text” function”.	Essential	“text”
Red, Green, Yellow, Blue	Inputs available to receiver functions to aid user interaction.	Essential	
Sound Mute	To mute or unmute the audio output. The mute function should be overridden by pressing “Volume up” or “Volume down”. (On TTS-equipped receivers, when the user mutes the audio, no further TTS audio information shall be presented, except for feedback from pressing the mute key. Audio beeps (e.g. from remote) will continue to be audible after pressing the mute key.)	Essential	
Programme up/down	Step up or down to the next service available to the user.	Essential	“P+”, “P-”, P▲”, ”P▼”, “CH+”,” CH-”, “CH▲”,”CH▼”
Menu	Access the receiver’s menus.	Essential	“Menu”
Subtitles On/Off	To enable or disable the display of subtitles. This function is used to control the display of subtitles (if available with the selected service). An implementation may comprise a single function that toggles subtitles on or off, or as two separate functions. Control of this function should be achieved as conveniently and straightforwardly as possible.	Essential	“S”
Volume up, Volume down	Increase or decrease the audio level.	Essential for receivers with integrated display. Strongly recommended for receivers without integrated display.	“Vol+”, “Vol-“
Return to sound and/or vision	This function returns the user directly to the last selected service or known channel, and acts as though the user has just tuned to that service using the EPG or P+/P- functions (i.e. any running EPG or interactive application(s) is immediately terminated and the user views the video/audio for that service if present). If there is an auto-boot application present in this selected service the boot process is started.	Strongly recommended	“TV” or “exit”
Guide	This function is used to access an EPG.	Strongly recommended	“Guide”
Previous Channel	Selects last viewed channel.	Strongly recommended	 or “Pre Ch”
Audio	To enable or disable the presentation of audio	Strongly	“AD”

Function	Description of function	Support/Control of function (Essential/ Strongly Recommended)	Recommendation for Identification or Preferred Symbols
Description On/Off	description. This function is used to switch between presenting Audio Description (AD) mixed with programme sound and presenting only programme sound. The receiver may be capable of directing the mix to independent audio outputs (e.g. phono and/or headphone), in which case this function controls the relevant output. An implementation may comprise a single function that toggles AD on or off, or as two separate functions. Control of this function should be achieved as conveniently and straightforwardly as possible bearing in mind that the viewer may be partially sighted.	recommended	

Table 25-1 Recommended control functions for DTT Receiver

25.2 Recorder control functions

This section details the additional functions that are considered essential or strongly recommended for control by the user of a recorder. Table 25-2 below also details the recommendation for function identification or the preferred symbol to be used.

Function	Description	Support/Control of function (Essential/ Strongly Recommended)	Recommendation for Identification or Preferred Symbols
Play	To start or resume playback of a recording or buffered event. See also **Play/Pause** for further detail on combination with Pause.	Essential	▶
Pause	To pause a live broadcast or the current selected recording. See also **Play/Pause** for further detail on combination with Play.	Essential	❚❚
Play/Pause	To combine the Play and Pause functions as described above in one single function.	Alternative to **Play** and **Pause**	▶ ❚❚
Stop	To stop playback	Strongly recommended	■
Record	To initiate a recording of the current event and optionally the selected event.	Essential	●
Fast forward	Fast forward the replay.	Essential	▶▶
Fast reverse	Fast reverse the replay.	Essential	◀◀
Library	Shows the current list of recorded events.	Strongly recommended	"Lib", "library", "Library"

Function	Description	Support/Control of function (Essential/ Strongly Recommended)	Recommendation for Identification or Preferred Symbols
Timer list	To show scheduled recordings.	Strongly recommended	"Timer" or "timer"

Table 25-2 Recommended control functions for DTV Recorder

25.3 Control functions for receivers with Text to Speech

This section details the additional functions that are considered essential or strongly recommended for control by the user of a receiver incorporating the Text to Speech translation facility. Table 25-3 below also details the recommendation for function identification or the preferred symbol to be used.

Function	Description	Support/Control of function (Essential/ Strongly Recommended)	Recommendation for Identification or Preferred Symbols
TTS On/Off	Enables/disables the TTS function.	Essential	"TTS"
Where Am I	Provides audio information about the current screen context followed by the navigation options available at that point, e.g. navigation information for the current screen. If the information has changed since the last presentation (e.g. time display), the new information shall be presented rather than a simple repeat of the previous information.	Strongly recommended	"?"
Repeat	Repeats the currently playing or previously played (if none currently playing) audio information.	Strongly recommended	"Repeat TTS"
Shut Up	Cancels the presentation of the audio information currently playing.	Strongly recommended	"Cancel TTS"
TTS Menu	Gives access to set-up functions such as selection of TTS volume, voice type, delivery speed and audio pitch. This function may be incorporated in the set-up menu of an integrated receiver.	Strongly recommended	"TTS menu"

Table 25-3 Recommended control functions for a receiver with TTS

NOTE: On TTS-capable receivers, audio information or feedback (e.g. a key click sound) should be provided whenever a control function is used (front panel, remote controller or by other means). This should be within a maximum of three seconds. This is not mandatory when the result of the action is to put the receiver into a non-active state (e.g. going into standby or power off state). However this is mandatory when entering an active state (e.g. coming out of standby or power on state).

26 Connectivity Guidelines

26.1 Introduction

This section provides guidelines to dealers/installers and manufacturers on the issues of connectivity relating to viewing digital television programmes, with special emphasis on connection to facilitate recording from a digital broadcast source.

For dealers & installers it compliments R-Book 2 [83] by concentrating on the interconnection of the products in the consumer's A/V "cluster".

For manufacturers, there are recommendations on product implementation that aim to prevent interconnectivity problems occurring with the consumer's installation and to simplify the ever complex task of viewing and recording digitally received programmes.

26.2 RF Connections

RF connections should be made using high quality cable as recommended in R-Book 2 [83].
The recommended connection sequence for RF aerial signals is shown in the diagram below:

The RF connection must go to DTT first (if present) so that the signal has not been through additional modulation stages before reaching the DTT receiver.

The RF connection must go via DTT and/or D-SAT/D-CAB first, so that signals from those devices can be recorded and viewed on the VCR and TV respectively.

The modulators of all devices must be set to different frequencies, which must not overlap any of the existing ATT or DTT frequencies. Choose frequencies that provide optimum, interference-free, performance when all devices are active.

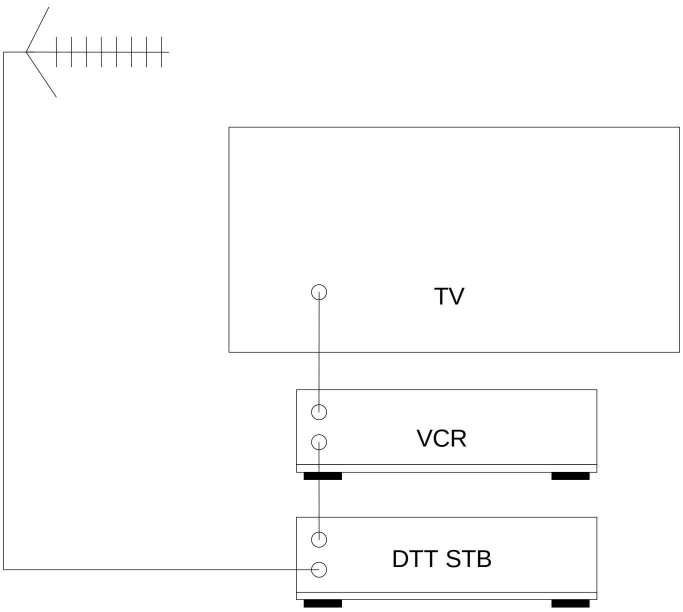


Figure 26-1.

26.3 SCART Connections

Connecting via SCART gives better picture quality and avoids the need to tune the TV to the RF outputs of STB and VCR. The recommended connection sequence for SCART signals is shown in the diagram below:

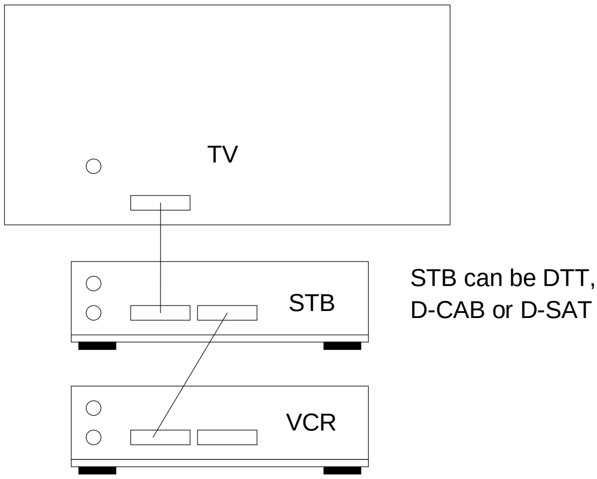


Figure 26-2.

Using fully wired cables avoids the potential problem of the wrong cable being used on the wrong product if any of the connections are removed and later re-connected. A visual check to ensure that all pins are present in both plugs gives some confidence that the cable is fully wired. It is difficult to quantify a "quality" cable, but SCART cables manufactured with individually screened cores will provide much better immunity to interference/crosstalk and thus help to improve signal quality.

26.3.1 Choice of SCART 1 or 2

The choice of using SCART socket 1 or 2 on the VCR may depend on the type of VCR:

For most VCRs, SCART 1 will be used; the VCR will assert pin 8 during tape playback and the STB will loop-through the VCR's signal to the TV.

If the STB supports AV.link/NexTViewLink recording and the VCR is an AV.link VCR, then the VCR's AV.link SCART socket should be used (most likely to be SCART 1). The STB can now control the VCR for unattended recordings.

If the STB supports pin 8 recording and the VCR supports pin 8 recording, then the SCART socket that supports pin 8 input should be connected to the STB (most likely to be SCART 2). The STB can now control the VCR for unattended recordings.

If VCR SCART 2 is used, and the VCR does not support pin 8 output on this SCART socket, then the user will not be able to view VCR tape playback without putting the STB into stand-by or loop-through mode.

26.3.2 AV Link

An AV.link VCR or STB must be connected to the AV.link socket on the TV / IDTV. AV.link features will only be available if AV.link peripherals are connected to an AV.link SCART on the TV / IDTV. Typically, TVs / IDTVs only support AV.link on one of their SCART connectors, but some manufacturers use TV SCART 1, some TV SCART 2, etc. Check the TV user manual for details of the correct socket to use.

If an AV.link VCR and STB are connected to a TV / IDTV, the VCR must be lower in the SCART "chain" than the STB. AV.link requires that VCRs are at the bottom of the SCART chain (EN 50157-1 [20], EN 50157-2-1 [21], EN 50157-2-2 [22], EN 50157-2-3 [23]). If this rule is not obeyed, then the recording features will not work.

Connecting a RGB non-AV.link product between an AV.link TV, IDTV or STB and an AV.link S-VHS VCR may prevent Y/C recordings being made on the VCR. If a non-AV.link product loops-through the AV.link control signal, but does not support the bi-directional switching on SCART pin 7 (EN 50157-1 [20], EN 50157-2-1 [21], EN 50157-2-2 [22], EN 50157-2-3 [23]), then Y/C recordings between an IDTV and a VCR or an STB and a VCR will fail if the C signal "downstream" towards the VCR is not looped-through correctly.

26.3.3 SCART Switch Boxes

In general, the use of SCART switch boxes is best avoided. There are so many different types of SCART switch box available that it is impossible to provide any guidelines as to their use. In addition, many have been found to incorrectly loop-through one or more of the SCART signals – thus causing more problems for the end user. For example, unless all three signalling levels of pin 8 are supported, then widescreen playback & recording may not work correctly on products connected via the switch box. The recommendation is, therefore, that it is preferable not to use such boxes.

26.4 Connection using both RF and SCART

26.4.1 Connection to an Analogue TV

The connection scheme when connecting to an analogue TV is shown below:

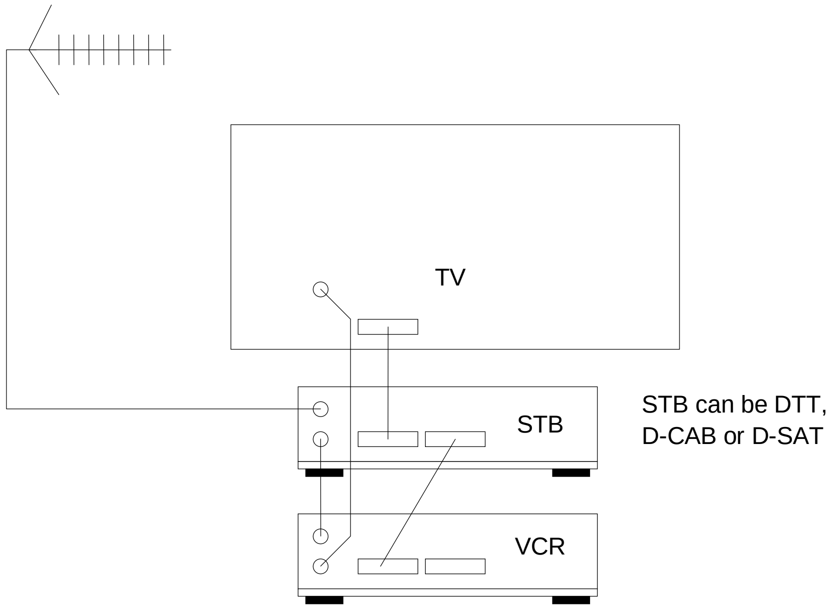


Figure 26-3.

Note that the order of products is different between the RF connection scheme and the SCART connection scheme.

For an RF connection scheme, the DTT aerial should first go to the DTT STB, then the D-CAB/D-SAT (if present), then VCR and TV.

For a SCART connection scheme, the order is TV, D-CAB/D-SAT/DTT, VCR.

26.4.2 Connection to an IDTV

The connection scheme when connecting to an IDTV is shown below:

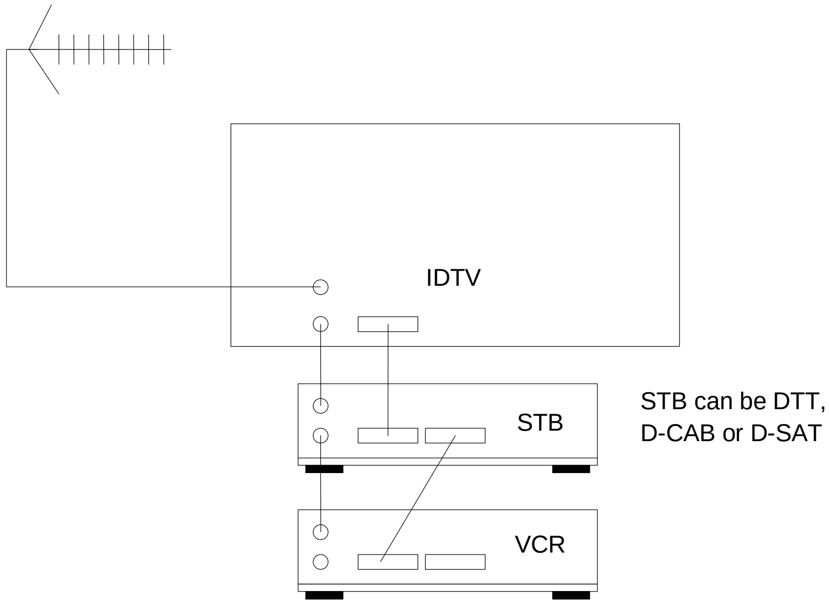


Figure 26-4.

Note that the order of products is the same for the RF connection scheme and the SCART connection scheme: IDTV, D-CAB/D-SAT/DTT, VCR.

26.5 Connecting Other Products such as DVD

The situation for other products such as a DVD player is less clear cut. Much depends on the SCART capability of the individual DVD player and also the other products in the system such as the STB and TV / IDTV.

The DVD player presents a particular problem in that it ideally needs to connect to the TV using RGB. DVD players also do not always have RF output capability and so this is not further considered here.

26.5.1 DVD with SCART loop-through to Analogue TV

When connecting to Analogue TV, then if the DVD player has full RGB loop-through capability, the ideal connection is as shown below:

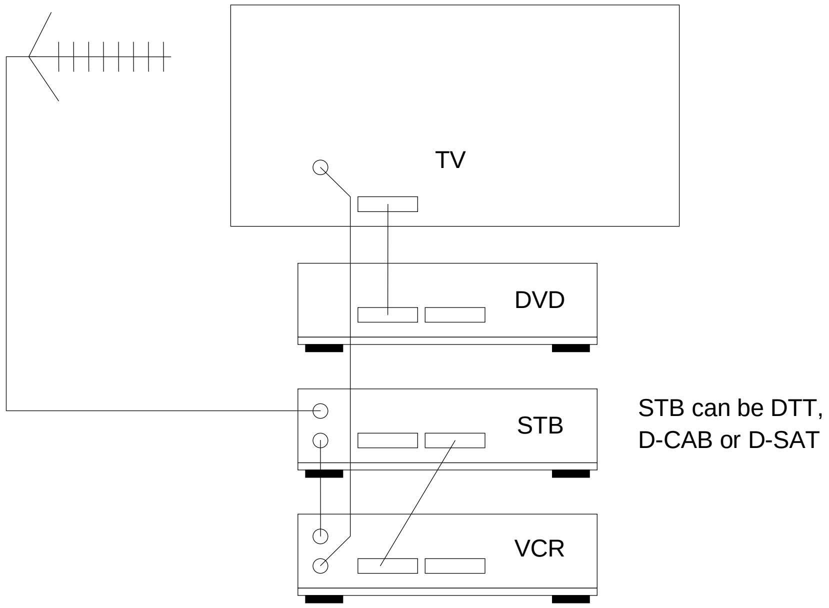


Figure 26-5.

The RGB from the STB can be looped-through the DVD to the TV. This will give optimum performance with TV sets that have just one SCART connector with RGB input.

26.5.2 DVD with SCART loop-through to IDTV

When connecting to IDTV, then if the DVD player has full RGB loop-through capability, the ideal connection is as shown below:

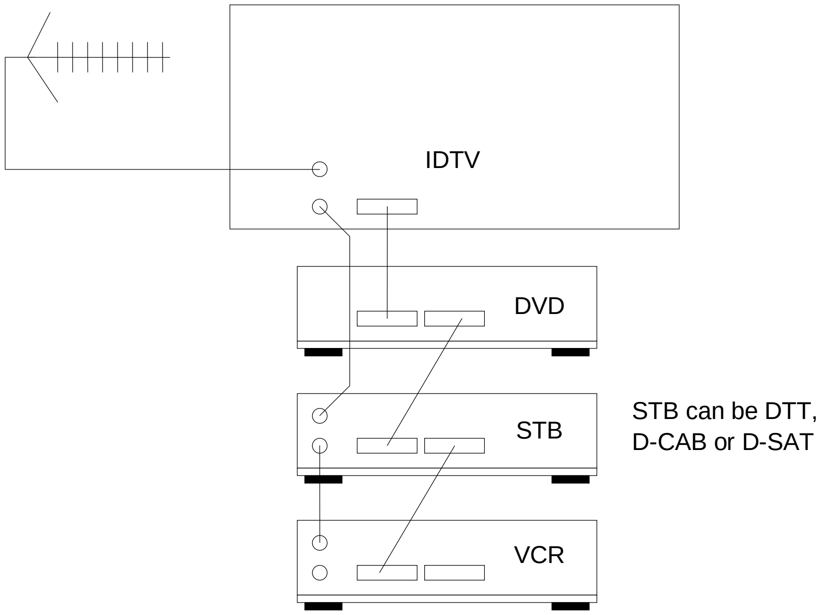


Figure 26-6.

The RGB from the STB can be passed through the DVD to the IDTV. This will give optimum performance with IDTVs that have just one SCART connector with RGB input.

26.5.3 DVD without SCART loop-through

The connection will depend on the SCART capability of the TV or IDTV. Where the TV has 2 SCART sockets each with RGB capability, the DVD should be connected to the second RGB SCART connector as shown below:

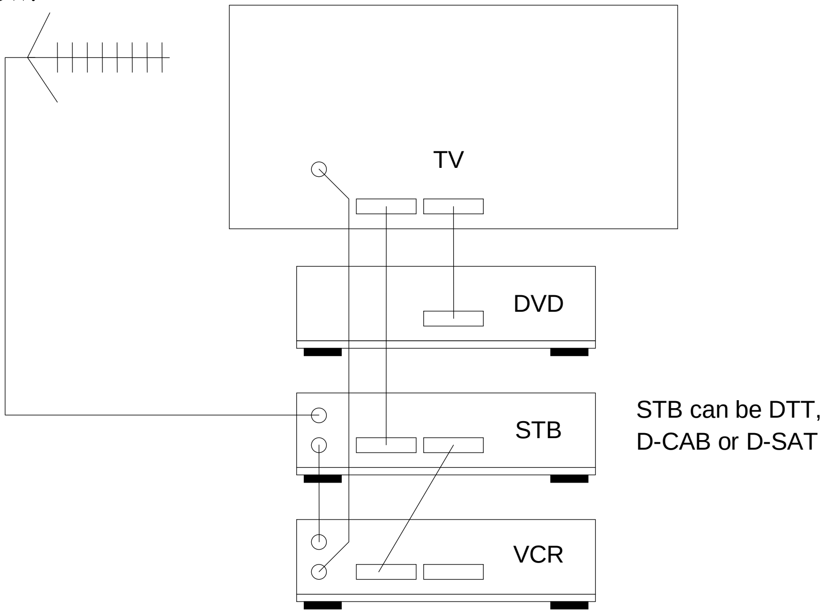


Figure 26-7.

For an IDTV, the RF lead should loop though the IDTV first.

Where the analogue TV or IDTV does not have 2 SCART sockets with RGB input capability, a decision will have to be made as to which device (STB/VCR or DVD) should be connected to the SCART socket with RGB input capability. In general, if the STB and VCR have AV.link, then they should be connected to the SCART socket which has AV.link. If AV.link is not available, then they should be connected to the socket which can assert Pin 8 to initiate a recording.

1. If the TV / IDTV, STB and VCR support AV.link, then these should be connected to the TV / IDTV AV.link SCART socket.

   Note that if the AV.link socket is also the RGB socket, then the DVD player will suffer a consequent reduction in picture quality.

   Note that if the AV.link socket is not the RGB socket, then the STB will suffer a consequent reduction in picture quality.

2. If the TV / IDTV, STB and VCR only support Pin 8 recording, then these should be connected to the TV / IDTV SCART socket that supports Pin 8 recording.

   Note that if this socket is also the RGB socket, then the DVD player will suffer a consequent reduction in picture quality.

   Note that if this socket is not the RGB socket, then the STB will suffer a consequent reduction in picture quality.

3. If TV / IDTV, STB or VCR do not support AV.link or Pin 8 recording, then the user will have to choose between viewing the STB/VCR product chain or the DVD player via the TV / IDTV RGB SCART. The recommendation is to connect the STB at RGB, since the more complex graphical text displays of the STB will benefit from the better signal quality. Note, there will be a consequent reduction in picture quality for the product(s) not connected via RGB. This prioritises the connection methods so as to preserve the maximum usability and automatic recording features when there is no simple signal quality recommendation.

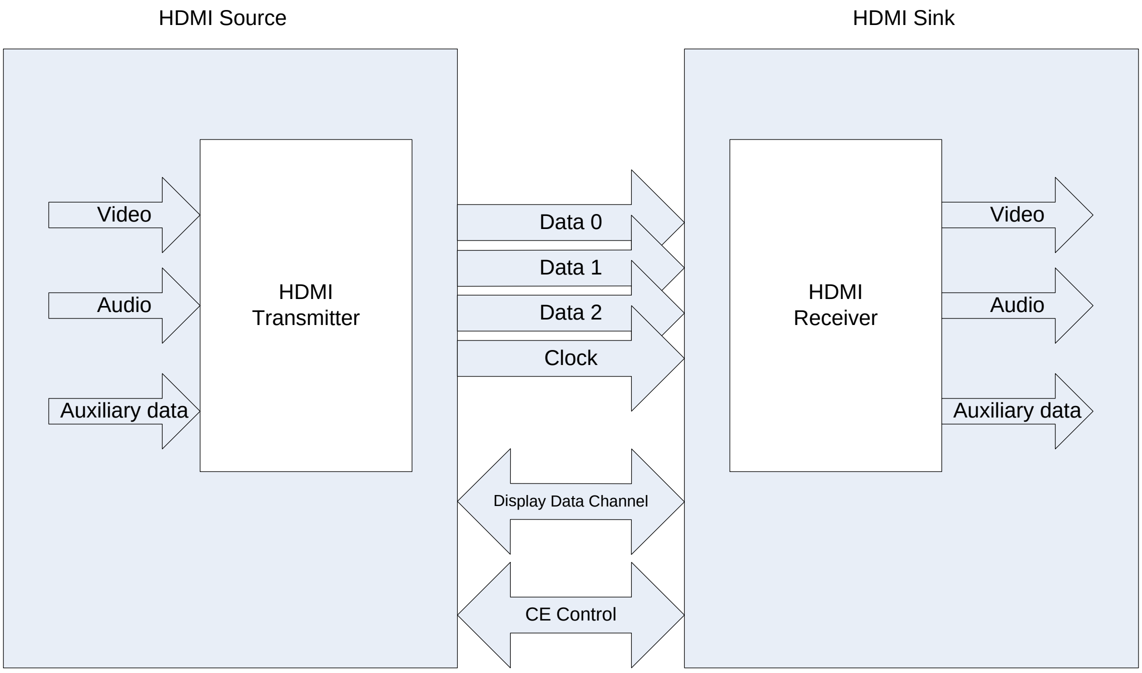
26.6 HDMI Guidelines

26.6.1 References

- HDMI 1.3a [134] - High-Definition Multimedia Interface Specification Version 1.3a, HDMI Licensing, LLC
- CEA-861-E [135] - A DTV Profile for Uncompressed High Speed Digital Interfaces, Consumer Electronics Association

26.6.2 Introduction

The High Definition Multimedia Interface (HDMI) supports uncompressed digital video (SD and HD), digital audio (stereo and multichannel) and control on a single cable.



Video, audio and auxiliary information relating to the AV content is carried on three data paths. The Display Data Channel is used for reading the Sink's Enhanced Extended Display Identification Data (E-EDID) and for HDCP authentication. The CE Control (CEC) protocol provides high-level control functions between a user's interconnected products.
HDMI Licensing, LLC provides a conformance testing regime that confirms compliance to the HDMI Specification, but there are many aspects of implementation that can impact on the usability of products for the consumer. This document aims to highlight some of those areas and advise on best practice for maximum interoperability performance between

products.
An HDMI device can be a Source, a Sink or both, in which case the device is known as a Repeater:

Source	A device with one or more HDMI outputs (e.g. Set Top Box, DVD player)
Sink	A device with one or more HDMI inputs (e.g. TV, projector)
Repeater	A device with one or more HDMI outputs, one or more HDMI inputs, and a retransmission function (e.g. Audio Receiver, Switch).

26.6.3 Guidelines

26.6.3.1 AVI Infoframe

AVI Infoframes are data packets carried in the HDMI datastream which allow a Source to inform a Sink of the characteristics of the AV content being transmitted. Information is carried to describe the following:

Picture Aspect Ratio, Overscan, Scaling and Active Format information.
Colour sampling, Colorimetry and Pixel Repetition information.
Video Format Identification Code (CEA-861 short video descriptor).

Source

An HDMI Source shall always provide valid and fully populated AVI Infoframes. Ensure that any local video processing is accurately reflected in the transmitted AVI Infoframes.

Sink

An HDMI Sink shall decode and make use of the information contained in AVI Infoframes in order to provide optimal presentation of the content.

Repeater

An HDMI Repeater shall leave AVI Infoframes untouched unless the Repeater itself is modifying the content before retransmission, in which case it follows the rules above for an HDMI Source.

26.6.3.2 E-EDID (Enhanced Extended Display Identification Data)

The EDID of an HDMI Sink provides information about the Sink's capabilities. An HDMI Source uses this information in order to provide correctly formatted content. If a Sink provides incorrect information or a Source fails to correctly interpret the information provided, undesirable system behaviour may occur.
The handling of EDID information becomes more critical when one or more HDMI Repeaters are added to a system. This is because a Repeater must present an EDID to a connected Source (or Repeater) that represents a combination of the capabilities of the Repeater and the Sink (or Repeater) to which it is connected.

Sink

A Sink shall ensure that all supported video formats are described in its EDID. Although it is not possible to fully describe all formats using Detailed Timing Descriptors, the Sink should use Short Video Descriptors for all supported formats – not forgetting 1080p24.
A Sink shall ensure that the indication of its native video format is correct.

A Sink shall ensure that all supported audio formats are described in its EDID, using Short Audio Descriptors for all formats above basic audio (2 channel L-PCM).
A Sink shall ensure that the EDID presented on each of its inputs contains a correctly discovered and unique CEC source physical address.
A Sink shall ensure that all optional HDMI features (e.g. Deep Colour) are described in its EDID.
It is strongly recommended that a Sink provides valid latency information in its EDID.
A Sink shall pulse the Hot Plug Detect Signal on all its HDMI inputs whenever the contents of its EDID are changed.

Source
A Source shall always perform a full read of all the blocks of the EDID in a connected Sink and ensure that all Detailed Timing Descriptors, Short Video Descriptors and Short Audio Descriptors are read.
A Source shall only send video and audio using formats for which the Sink indicates support in its EDID. Two exceptions to this are 640x480p video and 2 channel L-PCM audio, which can be used regardless of EDID declared support.
A Source shall re-read the EDID of a connected Sink when it sees a pulse on the Hot Plug Detect signal.

Repeater
The EDID of a Repeater shall represent a combination of its own capabilities and those of a connected Sink.
A Repeater shall re-read the EDID of a connected Sink when it sees a pulse on the Hot Plug Detect signal and, having updated its own EDID(s), shall pulse the Hot Plug Detect Signal on all its HDMI inputs.

26.6.3.3 Hot Plug Detect Signal (HPD)

The Hot Plug Detect signal is provided by an HDMI Sink to an HDMI Source. It indicates to the Source that the Sink's EDID is available for reading and that it is able to accept HDMI signals. If the contents of a Sink's EDID change, the Sink pulses the Hot Plug Detect signal to indicate this to a connected Source.

Sink
When a Sink is able to accept HDMI signals, it is strongly recommended that it asserts Hot Plug Detect on all its HDMI inputs, including unselected inputs. This would typically be when the Sink is either powered fully on or is in a standby state from which a CEC command can bring it out of standby. If a Source device is to be able to bring a Sink out of standby (for example, using the CEC "One Touch Play" command), then Hot Plug Detect must remain active on all a Sink's HDMI inputs when it is in standby.

Source
A Source shall re-read the EDID of a connected Sink when it sees a pulse on the Hot Plug Detect signal.

Repeater
A Repeater shall follow the rules above for both an HDMI Source and an HDMI Sink.

26.6.3.4 Consumer Electronics Control (CEC)

CEC is a protocol that allows HDMI products to communicate with one another. It is used to support features that work across more than one device in the system. For example, the "One Touch Play" feature allows a source device to bring a display device out of standby, configured to the appropriate HDMI input. If the connection path between the source device and the display also includes HDMI switches with CEC, then these will switch automatically to configure the correct signal path between the source and the display.

Sink, Source, Repeater

Support for CEC is strongly recommended. This ensures support for the "One Touch Play" feature, which is effectively the HDMI equivalent of pin 8 on SCART, and the "System Standby" feature, which enables better power management by enabling one device to put the whole system to standby. HDMI devices that do not support CEC shall ensure that their electrical interface to the CEC line does not prevent CEC communication between other connected devices in all power states (ie: Off, On, & Standby).

26.6.3.5 High Definition Content Protection (HDCP)

HDCP provides content protection by encrypting the data carried over the HDMI cable between an HDMI Source and an HDMI Sink. Before the encrypted data can be transmitted, the Source and Sink must complete an authentication process that validates the authenticity of the connection. When one or more HDMI Repeaters are added to a system, the HDCP authentication becomes more complex. Each link between Source and Sink undergoes its own authentication process and all must complete successfully before data can be transmitted.
HDCP authentication is a complex process involving a number of steps with durations in the order of hundreds of milliseconds.

Sink, Source, Repeater

All HDMI devices shall successfully complete HDCP authentication in both simple Source/Sink systems and in configurations involving one or more Repeaters.
All HDMI devices shall ensure that HDCP authentication completes successfully when a Sink is switched to an HDMI input on which an authenticated HDCP connection was previously established.
All HDMI devices must allow sufficiently long timeouts for HDCP authentication to complete, in order to prevent false authentication failures. This is particularly critical in a system containing Repeaters in addition to the Source and Sink.

26.6.4 General Issues

26.6.4.1 Scaling

Source

HDMI Sources should attempt to avoid "double scaling". For example, scaling content to a format which is not a native format of the display, thus causing the display to scale the content for a second time before presentation to the viewer. See Appendix F of the HDMI Specification.

26.6.4.2 Presentation of 4:3 content

Sink

HDMI Sinks that declare support for 4:3 video formats shall ensure that 4:3

material is correctly displayed, taking into account any Active Format information carried in the AVI Infoframe.

Source

HDMI Sources should correctly present 4:3 content in a 16:9 frame when connected to Sinks that do not support 4:3 video formats and shall provide the appropriate Active Format information in the AVI Infoframe.

26.7 Manufacturer Guidelines

26.7.1 TV / IDTV

26.7.1.1 SCART Sockets

Where a TV / IDTV has multiple SCART inputs, it would be beneficial if at least two of them supported RGB and/or Y/C signal quality. A user may have a DVD player and an STB that can both provide superior RGB or Y/C signals. If only one SCART supports RGB, then the user will have to connect one product at CVBS.

Where TVs / IDTVs are fitted with an AV.link SCART socket, it should support the full range of signal quality options (RGB, Y/C and CVBS), thus ensuring maximum compatibility with the higher quality signals of AV.link STBs and DVDs. The user will lose the benefits of watching the STB with RGB or Y/C picture quality if the AV.link SCART supports only CVBS.

A TV / IDTV must never prevent a channel/source change if pin 8 and/or pin 16 on the currently viewed SCART input is asserted. Some STBs, DVDs, etc. will leave pin 8 (and pin 16 if RGB signals are in use) asserted all the time that they are powered. If the user wishes to change to an internal TV preset or another SCART input without powering down the currently active peripheral, the TV must respond to this request – it must not "lock" the user to the currently viewed SCART input.

A TV / IDTV must prevent RGB "breakthrough" from SCART sockets that are not currently being viewed. Some STBs will leave their RGB output signals on all the time that they are powered, or may switch on their output signals if they are making a recording via an attached VCR. If the user is watching an analogue TV preset and calls up teletext or the TV's menus, it is undesirable to have the STB's RGB signals breaking through over the teletext/menu display.

26.7.1.2 Widescreen display

When displaying a signal from an STB connected via SCART, a TV / IDTV can adjust its aspect ratio and display format based on available information from 3 sources: line 23 WSS, AV.link aspect ratio information and SCART pin 8. Provided that the user has not made any manual override, the TV should use the information (that it supports) in that order of priority. The TV user manual should clearly explain the advantages/disadvantages of overriding the TV's choice of (best) display format. The information provided by line 23 and pin 8 will ensure that the most appropriate picture format (e.g. full format 4:3, full format 16:9, movie expand 14:9, etc.) is selected. If the user overrides the selected format with a manual setting, then the image may not always be displayed with the correct geometry. See Chapter 24, "Recommended Receiver Reaction to Aspect Ratio Signalling in Digital Video Broadcasting".

When displaying a signal from an STB connected via RF, a TV / IDTV can adjust its aspect ratio and display format based only on line 23 WSS information. Provided that the user has not made any manual override, the TV should use the line 23 information to select the most appropriate display format. The TV user manual should clearly explain the advantages/dis-advantages of overriding the TV's choice of (best) display format. The information provided by line 23 will ensure that the most appropriate picture format (e.g. full format 4:3, full format 16:9, movie expand 14:9, etc.) is selected. If the user overrides the selected format with a manual setting, then the image may not always be displayed with the correct geometry. See Chapter 24, "Recommended Receiver Reaction to Aspect Ratio Signalling in Digital Video Broadcasting".

26.7.2 IDTVs

Regulations 6 & 7 of the Advanced Television Services Regulations 2003[58] are intended to establish a standardised approach to the connection of peripheral equipment to television sets by requiring the inclusion of standardised open interface sockets. Regulation 6 is generally taken to require the inclusion of at least one SCART socket on a television set. Regulation 7 requires the inclusion on digital televisions of a socket which permits the passage of all elements of a digital television signal, including information relating to interactive and conditionally accessed services. It is Regulation 7 that is generally understood to be relevant to a Common Interface socket. Regulation 7 applies to all digital televisions above 30cm, except where the product was introduced before 25 July 2003 and as such is a European legislative requirement.

BIS has published guidance on the regulations at:

http://www.berr.gov.uk/whatwedo/sectors/broadcasting/broadcaststandards/page10210.html

26.7.2.1 Common Interface

The DVB common interface connector permits the simple connection of a peripheral and is able to pass all the elements of a digital television signal, including information relating to interactive and conditionally accessed services. More information is provided in chapter 21.

26.7.2.2 Pin 8 recording

IDTVs that use pin 8 recording signalling to a VCR should ensure that they assert pin 8 to the correct level (1A or 1B EN50049-1 [19]) to indicate the aspect ratio of the signal. If the aspect ratio of the signal changes during a recording, then the pin 8 signal level should be modified to reflect this change. If pin 8 is left at its initial level and the aspect ratio of the signal changes during the recording then, on playback, the user will see part of the recording in the correct aspect ratio and part of it displayed in the incorrect aspect ratio (unless the IDTV provides a line 23 WSS signal to the VCR and the TV responds to this on playback).

26.7.2.3 AV.link recording

IDTVs that use AV.link signalling to control recordings on an AV.link VCR, should try to use Y/C signals for the recording if their design makes this

58. http://www.opsi.gov.uk/si/si2003/20031901.htm

possible. The IDTV should negotiate the signal quality with the VCR and then output the resultant signal quality (Y/C or CVBS) as necessary. This will ensure that recordings on AV.link S-VHS VCRs (and PVRs) are made at the highest "downstream" signal quality (Y/C) that SCART supports EN50049-1 [19].

IDTVs that use AV.link signalling to control recordings on an AV.link VCR, should ensure that they use the correct widescreen arbitration bit value based on the aspect ratio of the signal being recorded. If the aspect ratio of the signal changes during a recording, then the IDTV should re-negotiate the aspect ratio to reflect this change. If the aspect ratio of the signal changes during the recording without the IDTV informing the VCR then, on playback, the user will see part of the recording in the correct aspect ratio and part of it displayed in the incorrect aspect ratio (unless the IDTV provides a line 23 WSS signal to the VCR and the TV responds to this on playback). The IDTV can ensure that the VCR records the correct aspect ratio by renegotiating the signal quality of the AV.link "downstream" connection with the VCR on every change of aspect ratio.

IDTVs that use AV.link signalling to control recordings on an AV.link VCR, should ensure that they output the correct aspect ratio signal, as indicated by the resultant AV.link widescreen arbitration bit. This may mean that the IDTV has to change its output signal to 4:3 to match a VCR that cannot handle widescreen recordings. If the VCR cannot support widescreen recordings, then it will arbitrate to 4:3 in its AV.link communication with the IDTV. If the IDTV continues to output a widescreen signal then the user will get a recording in the incorrect aspect ratio. By changing the output signal to the VCR to 4:3, the IDTV ensures that the aspect ratio of the recording will be correct; however, this will almost certainly mean that the display on the IDTV will also change to 4:3. If the IDTV does change to 4:3 display – it should use a *4:3 letterbox* format in preference to *4:3 centre cutout* format.

26.7.3 Set-top Boxes

26.7.3.1 SCART sockets

STBs that can loop-through signals from their "VCR" SCART to their "TV" SCART should support all signal qualities (CVBS, Y/C & RGB) on the loopthrough connection. Unless all signal qualities are supported on loop-through, the user may not be able to get the best picture quality from the peripheral (e.g. DVD, VCR, PVR etc.) connected to the STB's VCR SCART socket.

STBs that can loop-through signals from their "VCR" SCART to their "TV" SCART must support both level 1A and level 1B pin 8 loop-through. Unless both levels of pin 8 can be looped-through by the STB, the user may not be able to watch widescreen VCR recordings in the correct aspect ratio.

STBs that can loop-through signals from their "VCR" SCART to their "TV" SCART must go to loop-through mode when a transition from level 0 to level 1A or level 1B is detected on pin 8 of their VCR SCART. Subsequent user input (RC or local controls) to the STB can disable loop-through mode. A rising edge on the VCR SCART pin 8 indicates that the user has started the VCR playing. The STB must respond to this by going to loop-through mode to enable the VCR signals to reach the TV. If the user starts using the STB again (by RC command or local STB control), then it is likely that they wish to view the STB output and loop-through mode can be disabled, until such time as another rising edge on pin 8 of the VCR SCART occurs.

26.7.3.2 Pin 8 recording

STBs that use pin 8 recording signalling to a VCR should ensure that they assert pin 8 to the correct level (1A or 1B EN50049-1 [19]) to indicate the aspect ratio of the signal. If the aspect ratio of the signal changes during a recording, then the pin 8 signal level should be modified to reflect this change. If pin 8 is left at its initial level and the aspect ratio of the signal changes during the recording then, on playback, the user will see part of the recording in the correct aspect ratio and part of it displayed in the incorrect aspect ratio (unless the STB provides a line 23 WSS signal to the VCR and the TV responds to this on playback).

26.7.3.3 AV.link recording

STBs that use AV.link signalling to control recordings on an AV.link VCR, should try to use Y/C signals for the recording if their design makes this possible. The STB should negotiate the signal quality with the VCR and then output the resultant signal quality (Y/C or CVBS) as necessary. This will ensure that recordings on AV.link S-VHS VCRs (and PVRs) are made at the highest "downstream" signal quality (Y/C) that SCART supports EN50049-1 [19].

STBs that use AV.link signalling to control recordings on an AV.link VCR, should ensure that they use the correct widescreen arbitration bit value based on the aspect ratio of the signal being recorded. If the aspect ratio of the signal changes during a recording, then the STB should re-negotiate the aspect ratio to reflect this change. If the aspect ratio of the signal changes during the recording without the STB informing the VCR then, on playback, the user will see part of the recording in the correct aspect ratio and part of it displayed in the incorrect aspect ratio (unless the STB provides a line 23 WSS signal to the VCR and the TV responds to this on playback). The STB can ensure that the VCR records the correct aspect ratio by renegotiating the signal quality of the AV.link "downstream" connection with the VCR on every change of aspect ratio.

STBs that use AV.link signalling to control recordings on an AV.link VCR, should ensure that they output the correct aspect ratio signal, as indicated by the resultant AV.link widescreen arbitration bit. This may mean that the STB has to change its output signal to 4:3 to match a VCR that cannot handle widescreen recordings. If the VCR cannot support widescreen recordings, then it will arbitrate to 4:3 in its AV.link communication with the STB. If the STB continues to output a widescreen signal then the user will get a recording in the incorrect aspect ratio. By changing the output signal to the VCR to 4:3, the STB ensures that the aspect ratio of the recording will be correct; however, this will almost certainly mean that the display on the TV will also change to 4:3. If the STB does change to 4:3 display– it should use a *4:3 letterbox* format in preference to *4:3 centre cutout* format.

26.7.3.4 AV.link widescreen setup

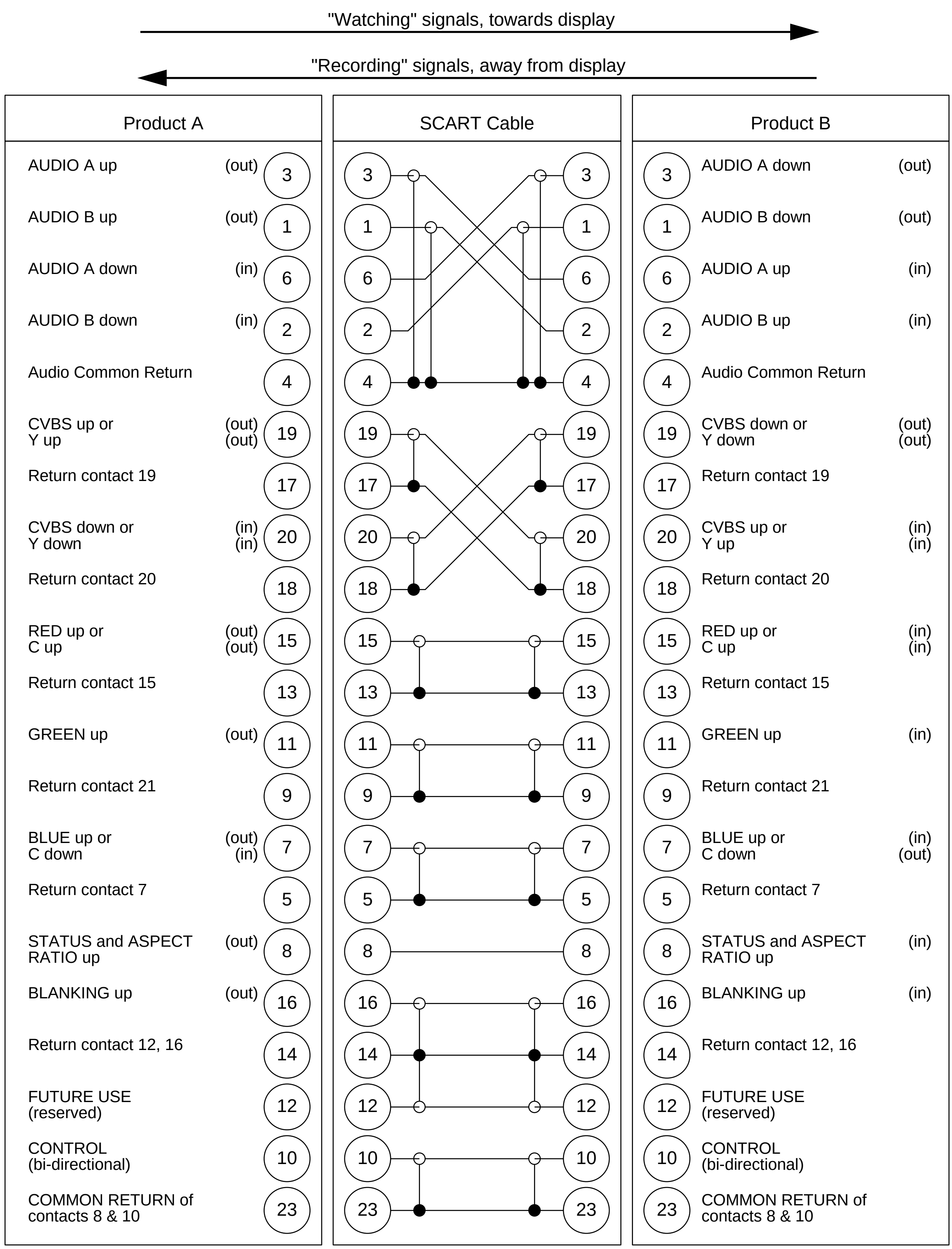
AV.link STBs should use the aspect ratio system information from an AV.link TV (when available) to automatically configure the default value in the STB's display output aspect ratio menu setting. If the aspect ratio is 4:3, the STB should use a *4:3 letterbox* format in preference to *4:3 centre cutout format*. Setting the output display aspect ratio automatically removes the need for the user to set the aspect ratio manually (and possibly incorrectly).

AV.link STBs must not use the resultant value of the aspect ratio arbitration bit in order to automatically configure the STB's display output aspect ratio

menu setting. A 4:3 TV may indicate that it can handle widescreen signals because it can reduce its vertical scan height to correct the aspect ratio. However, it is preferable to use *4:3 letterbox* format with a 4:3 TV, because the full screen can still be used for OSDs.

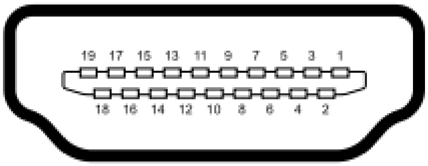
26.8 SCART interconnection

The diagram below shows the interconnecting SCART cable between two products and the signal connections on the products' SCART connectors



26.9 HDMI Physical connector

The diagram below shows the HDMI Type A connector:



Pin 1	TMDS Data2+
Pin 2	TMDS Data2 Shield
Pin 3	TMDS Data2–
Pin 4	TMDS Data1+
Pin 5	TMDS Data1 Shield
Pin 6	TMDS Data1–
Pin 7	TMDS Data0+
Pin 8	TMDS Data0 Shield
Pin 9	TMDS Data0–
Pin 10	TMDS Clock+
Pin 11	TMDS Clock Shield
Pin 12	TMDS Clock–
Pin 13	CEC
Pin 14	Reserved (N.C. on device)
Pin 15	SCL
Pin 16	SDA
Pin 17	DDC/CEC Ground
Pin 18	+5 V Power (max 50 mA)
Pin 19	Hot Plug Detect

27 Standardised Engineering Diagnostics

27.1 Purpose

Retailers are becoming very aware of the time and cost of after-sales service of set-top box products. With the high volumes now being sold, it becomes all the more important that calls to retail or manufacturer call-centres are minimised by product optimisation and, where calls are made, they are dealt with in as timely a way as possible. Standardising diagnostic menus between manufacturers, based on the experience of call centres, offers the prospect of real improvements.

Many users suffer from “techno fear”. The watchword for menus is simplicity.

27.2 Simplifying the out-of-the-box experience

In order to simplify the out-of-the-box experience, the first item on the menu list should be “getting started” which initiates a tuning / scan process.

Any previously discovered services will be lost – the viewer should be warned of this to avoid accidental operation.

The scan should be manually initiated; otherwise the box may scan before the consumer has plugged in the aerial.

27.3 Entering the diagnostic menu

The diagnostic menu shall be a menu item at the top level accessed by pressing the *Menu* button on the remote control and should be labelled *“Diagnostics”*.

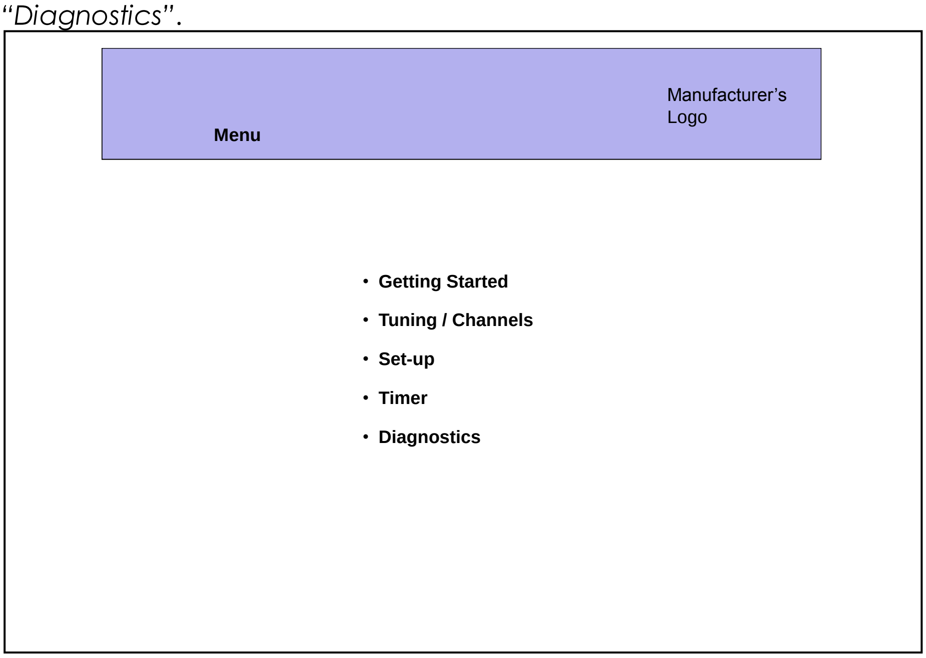


Figure 27-1. Typical menu screen

The word ‘diagnostic’ has negative connotations but it may be good to discourage users from straying into this part of the menu. (It’s intended for use only when the user is acting under instruction from the dealer or call-centre.)

It is recommended that *"Diagnostics"* is the last item in the menu list.

27.4 System information

System information should be displayed on the top level diagnostic screen and should consist of the following as a minimum:

- Manufacturer
- Product model / hardware version
- Serial number
- Software version number

The first screen displayed under *"Diagnostics"* should also display signal information consisting of a list of all of the received multiplexes and a bar showing signal strength.

The display design should enable the simultaneous display of signals from more than one transmitter.

The viewer should be able to scroll down the list of multiplexes and select each one for additional information.

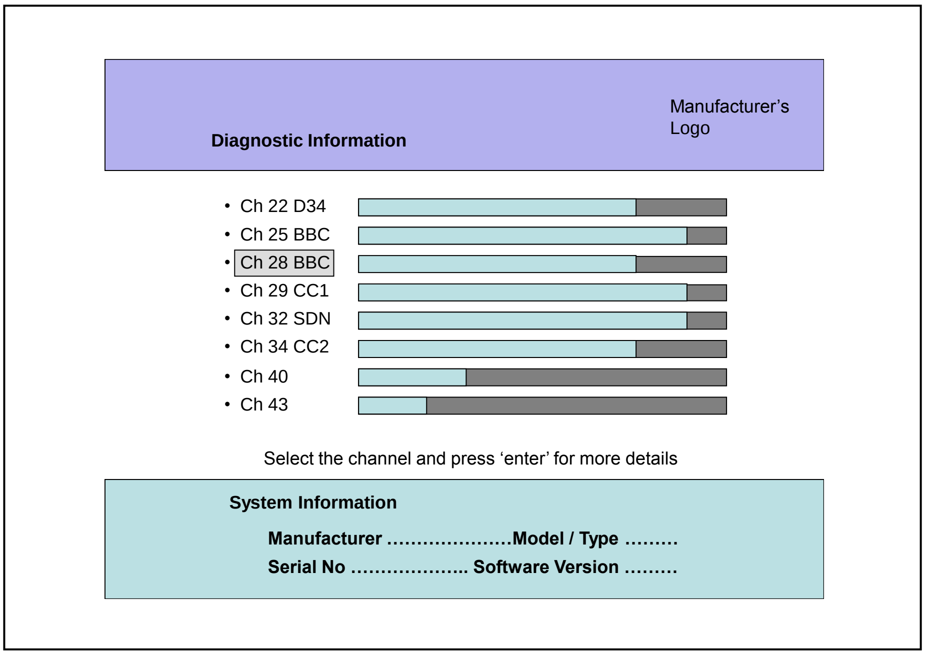


Figure 27-2. Top-level diagnostic screen

27.5 Signal information – multiplex details screen

For each multiplex received, the following information should be displayed:

- Channel number and transmitter (network_name_descriptor)
- Signal strength bar
- Signal quality bar
- List of channels by logical channel number (scrolling enabled)
- Optional information about the multiplex – COFDM mode, Network ID, etc.
- Optional information about channels such as CA, parental control set, etc.

The calculation and display of signal strength and signal quality should be standardised.

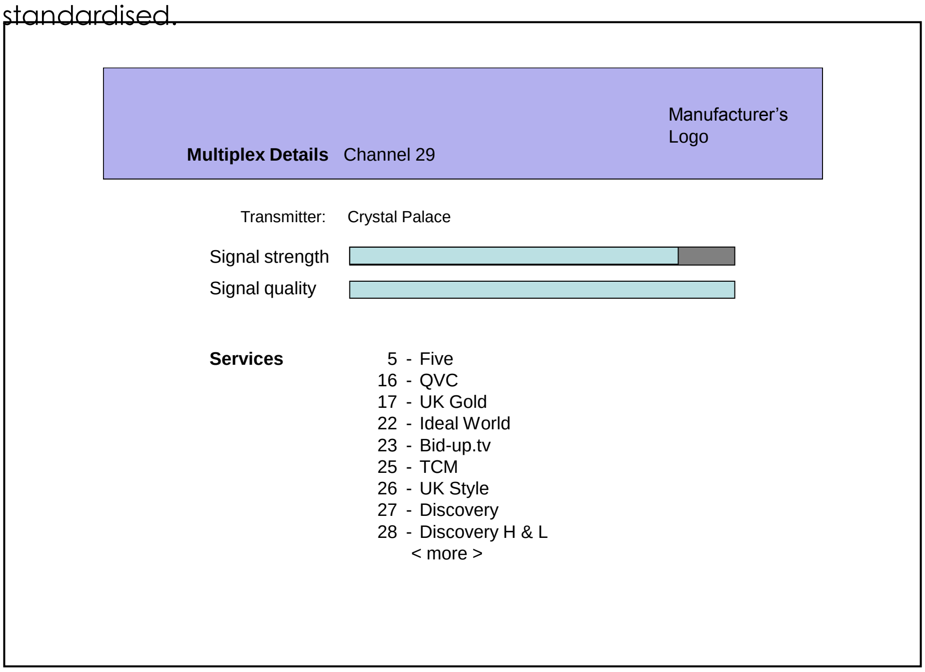


Figure 27-3. Second level diagnostic – multiplex details

27.6 Additional recommendations

Customers are sometimes resistant to the fact there is a problem. The diagnostic process needs to help them draw their own conclusions, for example drawing attention to low signal strength.

Where there is a problem, the menu needs to lead to a definite outcome. "*There may be an aerial problem*" needs to be supported by "*Check aerial connections*" or "*Consult your dealer*".

Δ	Guard interval, one of the parameters of DVB-T modulation.
access unit	A coded representation of a presentation unit. In the case of audio, an access unit is the coded representation of an audio frame. In the case of video, an access unit includes all the coded data for a picture, and any stuffing that follows it, up to but not including the start of the next access unit. If a picture is not preceded by a group_start_code or a sequence_header_code, the access unit begins with the picture start code. If a picture is preceded by a group_start_code and/or a sequence_header_code, the access unit begins with the first byte of the first of these start codes. If it is the last picture preceding a sequence_end_code in the bitstream all bytes between the last byte of the coded picture and the sequence_end_code (including the sequence_end_code) belong to the access unit.
AC-3	Audio codec. Also known as Dolby Digital.
AVC	Advanced Video Coding – also known as H.264 / MPEG-4 AVC. See ISO/IEC 14496-10.
Bouquet	A collection of services marketed as a single entity. Defined in EN 300 468.
bouquet_id	Defined in EN 300 468.
BAT	Bouquet Association Table - Defined in EN 300 468.
BER	Bit Error Ratio
BERR	Department of Business Enterprise and Regulatory Reform, UK Goverment
BIOP	Broadcast Inter-Orb Protocol
broadcaster	An organisation which assembles a sequence of events or programmes to be delivered to the viewer based upon a schedule.
byte aligned	A bit in a coded bit stream is byte-aligned if its position is a multiple of 8-bits from the first bit in the stream.
Conditional Access (CA)	A system to control subscriber access to services, programmes and events e.g. Videoguard, Eurocrypt.
CAI	Confederation of Aerial Industries Limited
CEC	Consumer Electronic Control. See HDMI 1.3a.
CENELEC	European Committee for Electrotechnical Standardisation. Central Secretariat: rue de Stassart 35, B - 1050 Brussels.
CI	Common Interface

'D' picture	ISO/IEC 13818-2
delivery system	The physical medium by which one or more multiplexes are transmitted e.g. satellite transponder, wide-band coaxial cable, fibre optics.
DHCP	Dynamic Host Configuration Protocol
DSI	Download Server Initiate
DTCP	Digital Transmission Copy Protection
DTG	Digital Television Group
DTT	Digital Terrestrial Television
DVB **Digital Video Broadcasting**	DVB Project Office, c/o European Broadcasting Union, 17 A Ancienne Route, CH-1218 Grand-Saconnex, Geneva, Switzerland. Phone: +41 22 717 27 19. Fax: +41 22 717 27 27. Email: dvb@ebu.ch
DVB-SSU	DVB System Software Update. See ETSI TS 102 006.
DVB-T	DVB Terrestrial
DVB-T2	Second generation Digital Video Broadcasting Terrestrial
E-AC-3	Enhanced Audio Codec, also known as Dolby Digital Plus (DD+)
ERP	Effective Radiated Power
EPG	Electronic Program Guide
elementary stream **ES**	ISO/IEC 13818-1: A generic term for one of the coded video, coded audio or other coded bit streams in PES packets. One elementary stream is carried in a sequence of PES packets with one and only one stream_id.
END	Equivalent Noise Degradation
ENF	Equivalent Noise Floor
Entitlement Control Message **ECM**	Entitlement Control Messages are private conditional access information which specify control words and possibly other, typically stream-specific, scrambling and/or control parameters.
Entitlement Management Message **EMM**	Are private Conditional Access information which specify the authorization levels or the services of specific decoders. They may be addressed to individual decoder or groups of decoders.
ETSI **European Telecommunications Standards Institute**	ETSI Secretariat. Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE. Internet: secretariat@etsi.fr. Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16
Event	A grouping of elementary broadcast data streams with a defined start and end time belonging to a common service, e.g. first half of a football match, News Flash, first part of an entertainment show
event_id	Defined in EN 300 468.
Event Information Table **EIT**	Defined in EN 300 468.
EIT_{pf}	Event Information Table, present/following
EIT_{pfo}	Event Information Table, present/following (other)

EIT_{sch}	Event Information Table, schedule
EIT_{scho}	Event Information Table, schedule (other)
extended event descriptor	Defined in EN 300 468.
FTA **Free To Air**	TV services for which there is no viewing fee.
Forbidden	The term "forbidden" when used in the clauses defining the coded bit stream, indicates that the value shall never be used.
HDCP	High-bandwidth Digital Copy Protection. See HDCP 1.3.
HDMI	High Definition Multimedia Interface. See HDMI 1.3a.
HE-AAC	Highly efficient advanced audio coding. S|ee ISO/IEC 14496-3.
horizontal_size	ISO/IEC 13818-2
HTML	HyperText Markup Language
ID	Identifier
IEEE 802.11	IEEE 802.11Wireless Local Area Networks (WLAN)
IOR	Interoperable Object Reference
ITC	Independant Television Commision
LCN	Logical Channel Number
LNB	Low Noise Block
MHEG	Multimedia and Hypermedia Experts Group. ISO/IEC 13522-5 [40].
MPEG	Motion Picture Experts Group
MPEG-2	Refers to the standard ISO/IEC 13818. Systems coding is defined in ISO/IEC 13818-1. Video coding is defined in ISO/IEC 13818-2. Audio coding is defined in ISO/IEC 13818-3.
MPEG-4	See AVC.
MTBF	Mean Time Between Failures
Multiplex	A stream of all the digital data carrying one or more services within a single physical channel.
network	A collection of MPEG-2 Transport Stream multiplexes transmitted on a single delivery system, e.g. all digital channels on a specific cable system.
network_id	Defined in EN 300 468.
Network Information Table (NIT)	Defined in EN 300 468.
Non-scheduled service	A data or other service which is not scheduled, and for which the concept of an 'event' therefore has no meaning.
NVoD	Near Video on Demand
PNG	Portable Network Graphics

On Screen Display **OSD**	Graphical information, locally generated by a piece of equipment, providing information to the user of a that equipment.
original_network_id	A unique identifier of a network. Defined in EN 300 468.
Packet Identifier **PID**	A unique integer value used to associate elementary streams of a program in a single or multi-program
PES	ISO/IEC 13818-1 An abbreviation for Packetized Elementary Stream.
PES packet	ISO/IEC 13818-1 The data structure used to carry elementary stream data. It consists of a PES packet header followed by PES packet payload.
PES packet header	ISO/IEC 13818-1 The leading fields in a PES packet up to and not including the PES_packet_data_byte fields, where the stream is not a padding stream. In the case of a padding stream the PES packet header is similarly defined as the leading fields in a PES packet up to and not including padding_byte fields.
PES Stream	ISO/IEC 13818-1 A PES Stream consists of PES packets, all of whose payloads consist of data from a single elementary stream, and all of which have the same stream_id. Specific semantic constraints apply.
presentation time-stamp **PTS**	ISO/IEC 13818-1 A field that may be present in a PES packet header that indicates the time that a presentation unit is presented in the system target decoder.
presentation unit **PU**	ISO/IEC 13818-1 A decoded Audio Access Unit or a decoded picture.
Program	A program is a collection of program elements. Program elements may be elementary streams. Program elements need not have any defined time base; those that do, have a common time base and are intended for synchronized presentation.
PAT	Program Association Table, ISO/IEC 13818-1
Programme	A concatenation of one or more events under the control of a broadcaster e.g. news show, entertainment show
PMT	Program Map Table
program_number	Identifier that identifies an MPEG program. An MPEG program is equivalent to a DVB Service. The program number is identical to a DVB service id.
PSI	Program Specific Information
QEF	Quasi-Error-Free is defined as a transport stream bit error ratio (BER) of less than 10^{-11}, equivalent to about one error per hour. See also reference BER.
RAM	Random Access Memory
RCT	Related Content Table. See Section 8.5.2.5.
RCU	Remote Control Unit
Receiver Channel Number	Receiver Channel Number is the value assigned to a service in the user interface 'service list' following receiver LCN assignment and any subsequent user action (where permitted)
Reference BER	A BER value of 2×10^{-4} post Viterbi decoder is called the 'reference BER'.

Reserved	The term "reserved" when used in the clause defining the coded bit stream, indicates that the value may be used in the future for ISO defined extensions. Unless otherwise specified within this ETS all "reserved" bits shall be set to "1".
reserved_future_use	The term "reserved_future_use", when used in the clause defining the coded bit stream, indicates that the value may be used in the future for ETSI defined extensions. Unless otherwise specified within this ETS all "reserved_future_use" bits shall be set to "1".
Running Status Table	Defined in EN 300 468.
RST	
SDT	Service Description Table, defined in EN 300 468.
SDT_o	Service Description Table (other)
section	A section is a syntactic structure used for mapping all service information defined in this ETS into ISO/IEC 13818-1 Transport Stream packets.
segment	Defined in TS 101 211.
Service	A sequence of programmes under the control of a broadcaster which can be broadcast as part of a schedule.
service_id	A unique identifier of a service within a transport stream. Defined in EN 300 468.
service provider	See broadcaster.
SI	Service Information. See EN 300 468. Digital data describing the delivery system, content and scheduling/timing of broadcast data streams etc. It includes MPEG-2 PSI together with independently defined extensions.
SIP	Service Insertion Point: A logical entity, the output of which is a set of co-operating multiplexes with consistent cross-carried SI as defined by this document.
SMATV	Satellite Master Antenna TV
sub_table	From EN 300 468 sub_table is collection of sections with the same value of table_id and: for a NIT: the same table_id_extension (network_id) and version_number; for a BAT: the same table_id_extension (bouquet_id) and version_number; for a SDT: the same table_id_extension (transport_stream_id), the same original_network_id and version_number; for a EIT: the same table_id_extension (service_id), the same transport_stream_id, the same original_network_id and version_number The table_id_extension field is equivalent to the fourth and fifth byte of a section when the section_syntax_indicator is set to a value of "1".
table	A table is comprised of a number of sub_tables with the same value of table_id.

table_id	An identifier of an MPEG table. Within a particular context this identifies the data carried by that table.
table_id_extension	An identifier typically identifying a subdivision of the data identified by a table's table id.
TCP/IP	Transfer Control Protocol over Internet Protocol
TDT	Time and Date Table, defined in EN 300 468.
TOT	Time Offset Table, Defined in EN 300 468.
TS	A Transport Stream is a data structure defined in ISO/IEC 13818-1.
Transport Stream	
transport_stream_id	A unique identifier of a transport stream within an original network. Defined in EN 300 468.
Tx	Transmitter
UK DTT	Digital Terrestrial Television within the UK
USB	Universal Serial Bus
UTF-8	Universal Character Set Transformation Format, 8-bit format
VOD	Video On Demand

B Normative References

[1]	EN 300 294	Television Systems; 625-line television Wide Screen Signalling (WSS). Equivalent to ITU-R BT.1119.
[2]	EN 300 468	Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems. v1.11.1.
[3]	ETS 300 473	Digital broadcasting systems for television, sound and data services; Satellite Master Antenna Television (SMATV) distribution systems.
[4]	EN 300 743	Digital broadcasting systems for television, sound and data services; *Subtitling systems*.
[5]	ETS 300 640	Human Factors (HF); Assignment of alphabetic letters to digits on standard telephone keypad arrays
[6]	EN 300 744	Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for *digital terrestrial television*.
[7]	EN 301 192	EN 301 192 v1.4.1: Digital Video Broadcasting (DVB); DVB specification for data broadcasting.
[8]	ES 201 381	Human Factors (HF); Telecommunications keypads and keyboards; Tactile identifiers
[9]	TS 101 154	TS 101 154 v1.7.1: Digital broadcasting systems for television; Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in Satellite and Cable Broadcasting Applications.
[10]	TR 101 162	Digital broadcasting systems for television, sound and data services; Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems.
[11]	TS 101 197	Digital Video Broadcasting (DVB); Head-end implementation of DVB SimulCrypt
[12]	TR 101 202	TR 101 202 V1.2.1: Digital Video Broadcasting (DVB); Implementation guidelines for Data Broadcasting.
[13]	TS 101 211	TS 101 211 v1.10.1: "Digital Video Broadcasting (DVB); Guidelines on implementation and usage of Service Information (SI)"
[14]	TR 101 290	TR 101 290 V1.2.1: Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems.
[15]	TS 101 699	Digital Video Broadcasting (DVB); Extensions to the Common Interface Specification.
[16]	TS 201 812	Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification.
[17]	TS 102 006	TS 102 006 v1.3.1 Digital Video Broadcasting (DVB); Specification for System Software Update in DVB systems.
[18]	ETR 289	Digital Video Broadcasting (DVB); Support for use of scrambling and Conditional Access (CA) within digital broadcasting systems.
[19]	EN50049-1	Peritelevision Connector.
[20]	EN 50157-1	Domestic and similar electronic equipment interconnection requirements: AV.link -- Part 1: General
[21]	EN 50157-2-1	Domestic and similar electronic equipment interconnection requirements: AV.link -- Part 2-1: Signal quality matching and

automatic selection of source devices

[22] EN 50157-2-2 Domestic and similar electronic equipment interconnection requirements: AV.link -- Part 2-2: Basic system oriented commands

[23] EN 50157-2-3 Domestic and similar electronic equipment interconnection requirements: AV.link -- Part 2-3: System oriented application

[24] EN 50221 Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications. CENELEC.

[25] R206-001 Guidelines for implementation and use of the common interface for DVB decoder applications. CENELEC.

[26] Removed Removed

[27] ITU-R BS.775-2 Multi-channel stereophonic sound system with or without accompanying picture.

[28] ITU-R BT.470-6 CONVENTIONAL TELEVISION SYSTEMS

[29] ITU-R BT.601-5 Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios

[30] ITU-R BT.656-4 Interfaces for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601-5 [29] (Part A).

[31] ITU-R BT.1119-2 Wide-screen signalling for broadcasting (Signalling for wide-screen and other enhanced television parameters). *Equivalent to EN 300 294*.

[32] ITU-T X.680 INFORMATION TECHNOLOGY – ABSTRACT SYNTAX NOTATION ONE (ASN.1): SPECIFICATION OF BASIC NOTATION

Also published as ISO/IEC International Standard 8824-1.

ASN.1

[33] ITU-T X.690 INFORMATION TECHNOLOGY – ASN.1 ENCODING RULES: SPECIFICATION OF BASIC ENCODING RULES (BER), CANONICAL ENCODING RULES (CER) AND DISTINGUISHED ENCODING RULES (DER)

Also published as ISO/IEC International Standard 8825-1.

DER

[34] ISO/IEC 11172-2 MPEG 1 video.

[35] ISO/IEC 11172-3 MPEG 1 audio.

[36] ISO/IEC 13818-1 Information technology - Generic coding of moving pictures and associated audio information: Systems. ISO/IEC 13818-1:1996(E).

[37] ISO/IEC 13818-2 Information technology - Generic coding of moving pictures and associated audio information: Video.

[38] ISO/IEC 13818-3 Information technology - Generic coding of moving pictures and associated audio information: Audio.

[39] ISO/IEC 13818-6 Information technology - Generic coding of moving pictures and associated audio information: Extensions for Digital Storage Media Command and Control.

[40] ISO/IEC 13522-5 MHEG-5. Information technology - Coding of multimedia and hypermedia information: Support for Base-Level Interactive

		Applications.
[41]	ISO/IEC 13522-5:1997/Cor.1:1999(E)	MHEG-5. Information technology - Coding of multimedia and hypermedia information: Support for Base-Level Interactive Applications. Technical Corrigendum 1.
[42]	ISO/IEC 6937	Information Technology - Coded graphic character set for text communication - Latin alphabet.
[43]	ISO 8859-1	Information technology - 8-bit single-byte coded graphic character sets - Part 1: Latin alphabet No. 1.
[44]	ISO 10646	Information technology - Universal Multiple-Octet Coded Character Set (UCS).
[45]	ISO 639-2	Codes for the representation of names of languages - Part 2: Alpha-3 code.
[46]	ISO/IEC 62216-1	ISO/IEC 62216-1, Digital terrestrial television receivers for the DVB-T system, part 1: Baseline receiver specification. (Commonly known as the E-Book)
[47]	DVB A011	DVB Common scrambling algorithm - distribution agreements.
[48]	Advanced Television Directive (95/47/EC)	Directive 95/47/EC Directive of the European parliament and of the Council of 24 October 1995 on the use of standards for the transmission of television signals.
[49]	Energy Efficiency	EU Code of Conduct on Energy Efficiency of Digital TV Service Systems, Version 7. European Commission - DG JRC TP 450 I-21020 Ispra (VA)
[50]	DAVIC 1.4.1 Part 09	DAVIC 1.4.1. Specification Part 09, Information Representation.
[51]	PNG	Portable Network Graphics Specification, Version 1.0, 01-October-1996 available at http://www.w3.org/TR/REC-png.html
[52]	BS 6330	British Standard Code of Practice for Reception of sound and television broadcasting BS 6330 1983. This standard has been withdrawn.
[53]	AC106 VALIDATE	Digital TV transmitter performance specification. Submitted to DVB as TM1925.
[54]	ITC GNPQ	ITC Guidance Note on Picture Quality in Digital Television (31 Oct. 1996).
[55]	OFCOM DTT	Reference Parameters for Digital Terrestrial Television Transmissions in the United Kingdom, Ofcom, December 2006.
[56]	WRC-95	Final Acts of the World Radiocommunication Conference (WRC-95).
[57]	RADIO REG	Current UK Radio Regulations (1990, revised 1994).
[58]	UK FPLAN	UK Frequency Plan for Digital Television Broadcasting being developed by ITC, BBC and NTL in collaboration with UK regulatory authorities.
[59]	Chester 1997	The Chester 1997 Multilateral Coordination Agreement relating to Technical Criteria, Coordination Principles and Procedures for the introduction of Terrestrial Digital Video Broadcasting (DVB-T) (Chester, 25 July 1997).
[60]	ITC DVB-T	Draft ITC Rules on the Use of the DVB-T Specification.
[61]	Stott J H	The effects of phase noise in COFDM - EBU Technical Review, Summer 1998.

[62] DTG RF 16 DTG RF Sub-Group Document No.16 - Digital Television Services: Calculating phase noise contributions.

[63] DTG RF 17 DTG RF Sub-Group Document No. 17 - Digital Television Services: Amplitude response errors and equivalent noise degradations.

[64] DTG RF 18 Digital Television Services: Echoes and receiver performance

[65] DTG RF 29 DTG RF Sub-Group Document No. 29 - Digital Television Services: Loss of Noise Margin within the COFDM Transmission Channel

[66] DTG RF 32 DTG Short Delay echo profile. John Salter. BBC R&D.

[67] DTG RF 33 Baseline Digital Terrestrial TV Receiver Specification (the EACEM E-Book), Chapter 12.

[68] DTG RF 40 Proposal for the Long-term Echo Testing of DVB-T Receivers. Pekka Talmola. Nokia.

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[70] DTG RF 43 Analysis of echo profile measurements made on off-air DVB-T signals. Ian Pullen. BBC R&D.

[71] DTG RF 44 Echoes and DVB-T Receivers: A Further Investigation, Part 1. Ranulph Poole. BBC R&D.

[72] DTG RF 45 Echoes and DVB-T Receivers: A Further Investigation, Part 2. Ranulph Poole. BBC R&D.

[73] DTG RF 46 DVB-T Generators and Receivers: The Determination of Noise Floors.

[74] DTG RF 52 Measurements of COFDM out-of-band intermodulation and sinc-squared components.

[75] DTG RF 59 A Spreadsheet for Relating Channel Response to Echo Profile. John Salter. BBC R&D

[76] DTG RF 61 Using Channel State Information (CSI) to Characterise DVB-T Reception.

[77] DTG RF 62 DVB-T Transmission and Reception: A Technical Summary.

[78] DTG RF 68 Echoes, Doppler and DVB-T Receivers: Some Theory and Practice.

[79] DTG RF 74n Practical Aspects of Impulsive Interference Immunity Tests Using Gated Gaussian Noise. Peter Lewis. Philips Semiconductors.

[80] DTG RF 74m Generating the DTG Impulsive Interference Test Waveforms José Lago-Fernandez: BBC R&D.

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[84] R-Book 5 Installing Digital Terrestrial Television: MATV Systems & Integrated Reception Systems.

[85] Removed R-Books 3 & 4 have been replaced by R-Book 5 [84]

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[105] Removed — DVB Bluebook replaced by ETSI TS 302 755 [108]

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[110] IEC 62002-1	Mobile and Portable DVB-T/H Radio Access — Part 1: Interface Specification
[111] IEC 62002-2	Mobile and Portable DVB-T/H Radio Access — Part 1: Interface Conformance Testing
[112] DTG RF 22	Digital television services: Specifying Permissible Emission Levels in Adjacent Digital Channels
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[114] DTG RF 104	Channel Model for Diversity Reception using Set-Top Aerials
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[117] IETF RFC 1738	Uniform Resource Locators (URL)
[118] IETF RFC 2616	Hypertext Transfer Protocol -- HTTP/1.1
[119] IETF RFC 1034	Domain Names
[120] IETF RFC 1035	Domain Names
[121] IETF RFC 1982	Serial Number Arithmetic
[122] IETF RFC 2109	HTTP State Management Mechanism
[123] IETF RFC 2131	DHCP
[124] IETF RFC 2132	DHCP options
[125] IETF RFC 2181	DNS
[126] IETF RFC 2246	The TLS Protocol Version 1.0
[127] IETF RFC 2459	Internet X.509 Public Key Infrastructure Certificate and CRL Profile
[128] IETF RFC 2818	HTTP Over TLS
[129] IETF RFC 3986	URI syntax

[130] ITU-T X.509	Information technology – Open Systems Interconnection – The Directory: Authentication framework
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[133] IETF RFC 3268	Advanced Encryption Standard (AES) Ciphersuites for Transport Layer Security (TLS)
[134] HDMI 1.3a	High-Definition Multimedia Interface Specification Version 1.3a, HDMI Licensing, LLC
[135] CEA-861-E	A DTV Profile for Uncompressed High Speed Digital Interfaces, Consumer Electronics Association
[136] Removed	Duplicate with [108]
[137] Removed	Duplicate with [106]
[138] Removed	Duplicate with [107]
[139] HDCP 1.3	High-bandwidth Digital Copy Protection System Specification, Revision 1.3, Digital Content Protection LLC.
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[142] CAI Code of Practice	CAI Code of Practice for the Installation of Aerials/Antennas and Receiving Equipment in the Single Dwelling Unit
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[145] FIPS PUB 197:2001	Advanced Encryption Standard (aes)
[146] ANSI/SCTE 52:2003	Data Encryption Standard – Cipher Block Chaining Packet Encryption Specification
[147] TS 102 822-3-1	Broadcast and On-line Services: Search, select, and rightful use of content on personal storage systems ("TV-Anytime"); Part 3: Metadata; Sub-part 1: Phase 1 – Metadata Schemas.
[148] TS 102 822-3-2	Broadcast and On-line Services: Search, select, and rightful use of content on personal storage systems ("TV-Anytime"); Part 3: Metadata; Sub-part 2: System aspects in a uni-directional environment.

[149] ISO 639-1	Codes for the representation of names of languages - Part 1: Alpha-2 code
[150] DVB BlueBook A142	Uniform Resource Identifiers (URI) for DVB Systems (12/10)
[151] DVB BlueBook A038	Specification for Service Information (SI) in DVB systems (dEN 300 468 v1.12.1) (01/2011)

C Allocation of codes for use with the UK DTT MHEG-5 spec

C.1 Application type codes

The allocated values for application_type_code for use in the data_broadcast_id_descriptor with data_broadcast_id value 0x0106 are:

Value	Description
0x0505	Baseline application type: the application has been authored to run on a receiver that is fully conformant with this baseline specification.
0x0000	Null application type: there is no auto-boot application. This value is intended for use where no auto-boot application is present but a data_broadcast_id_descriptor is needed to provide lifecycle signalling (such as following a non-destructive tune for receivers implementing *LifecycleExtension*).
0x0101	Transition application type: the application has been authored to run on a wider range of receivers, in addition to receivers fully conformant with this Baseline specification. This application_type_code was created at the launch of UK-DTT in 1998 to allow receivers that were not yet fully conformant with this Baseline specification to be deployed.

Table C-1. Application type code

C.2 UniversalEngineProfile(N)

N	Description
1285	Baseline profile: the receiver is fully conformant with this baseline specification.

Table C-2. UniversalEngineProfile(N) GetEngineSupport "feature" string

Note receivers based on this specification but which have not been verified as fully conformant shall not return true when N=**1285**. Instead they shall return true when N=2.

D DTT MHEG Interoperability Code of Practice

Introduction

Collaboration between relevant industry experts representing both manufacturers and broadcasters has led to the completion of the baseline specification of the UK Profile of MHEG (v1.06) and a corresponding version of the DTG MHEG Test Suite, the latter providing a truly objective means of evaluating receiver conformance. A group of broadcasters, manufacturers and other interested parties has subsequently developed the concept of an Interoperability Code of Practice to maximise the benefits arising through application of this test tool.

The aim of this Code of Practice is to achieve a situation where deployed receivers implement all features of the UK Profile of MHEG in a conformant manner, as determined by the DTG MHEG Test Suite, and that all interactive services operate as intended on such receivers[59]. From a viewer's perspective this will deliver a less-problematic and richer experience, to the general benefit of the DTT platform.

This Code of Practice is voluntary. It complements the testing regime in place at DTG Testing Ltd to support the 'Digital Tick' logo conformance scheme which requires conformance to MHEG UK Profile 1.06.[60] There are no penalties or constraints held against any of the parties in the event that shortcomings are highlighted through the additional test procedures described. However, by considering a wide range of interests and opinions in the drafting of this Code the intention was to make it easy to adopt by all relevant parties. The clearer and more objective testing regime for both applications and receivers embodied by this Code, coupled with a more co-ordinated information flow through a spirit of collaboration and engagement will provide a significant step towards a more stable and reliable experience for the viewer.

Any enquiries regarding this Code should be directed to the Test Centre Manager at DTG Testing Ltd (mheg@testing.dtg.org.uk)

Information described in this document is published on the MHEG Interoperability web site at www.dtg.org.uk/testing/mheg

Note that this Code does not attempt to address issues of interoperability relating to any other elements of the DTG D-Book specification, whether included in DTG Testing Ltd's test activities or not.

D.1 Scope

This document describes an agreed Code of Practice (Code) to be followed by any party involved in the provision of receiver hardware or broadcast interactive services in the UK DTT Marketplace.

[59]. It is recognised that at any point in time there may be a significant population of receivers that will not meet this measure of conformance and may never do so. There are no obligations with respect to such receivers under this Code. However, application providers are encouraged to support such receivers where reasonable to do so.

[60]. See http://www.digitallogo.co.uk/company_intro.php

D.2 Definitions

The Parties	Any individual or organisation that agrees to operate by this Code of Practice.
The Specification	The UK Profile of MHEG, major version 1.06. Currently copyright BBC, on behalf of TDN and published by the DTG, either in the DTG D-Book or on the DTG Testing Limited website. The Specification shall be taken as being the most recently published minor revision (currently 1.06.05). Note: Such minor revisions may have been generated: ▪ In response to minor issues identified during the creation of the corresponding Test Suite. ▪ To take advantage of ETSI ES 202 184, MHEG-5 Broadcast Profile. ▪ In response to Interoperability Issues (see D.5).
The Test Suite	The DTG MHEG Test Suite. This is a means to determine the conformance of a receiver to the Specification. This has been developed by DTG Testing Limited, in collaboration with the wider industry and consists of: ▪ A set of individual tests for specific features of the Specification. ▪ A library of Conformant Applications, including a description of the intended viewer proposition for each, provided by application developers.
Multiplex Operator	The license holder of one or more of the UK DTT multiplex licenses of which there are six at the time of writing.
Application Provider	Responsible for the commissioning and development of an Interactive Application. The actual development may take place directly or under contract with a third party.
Receiver Manufacturer	The Brand Owner, OEM, UK licensee, appointed agent or importer of DTT Receiver equipment in (to) the UK.
Receiver	The combination of hardware and specific deployed software, known as the Nominated Software Build. This may manifest itself as a set top box or adaptor or integrated Digital Television (iDTV) capable of receiving services via DTT.
Receiver Zoo	The collection of receivers used for application testing at an approved test centre.
Software Build	Software that is deployed on appropriate hardware as part of the implementation of a Receiver.
Registered Receiver	A Receiver that has been explicitly identified to DTG Testing Limited.
Identifiable Receiver	A Receiver that may be uniquely identified using

	mechanisms provided by the Specification. For some Receivers it may also be possible to identify sub-systems by a similar mechanism.
Conformant Receiver	A Receiver that is conformant with the Specification as determined by the Test Suite.

D.3 Framework

D.3.1 Overview (informative)

The key principle underlying this Code of Practice is that all Parties will benefit from increasing conformance in the deployed base of Receivers. This requires all Parties to acknowledge the Specification as the definitive description of the features that a Receiver will provide and the Test Suite as the definitive means of determining that a Receiver implements all of these features in a conformant manner.

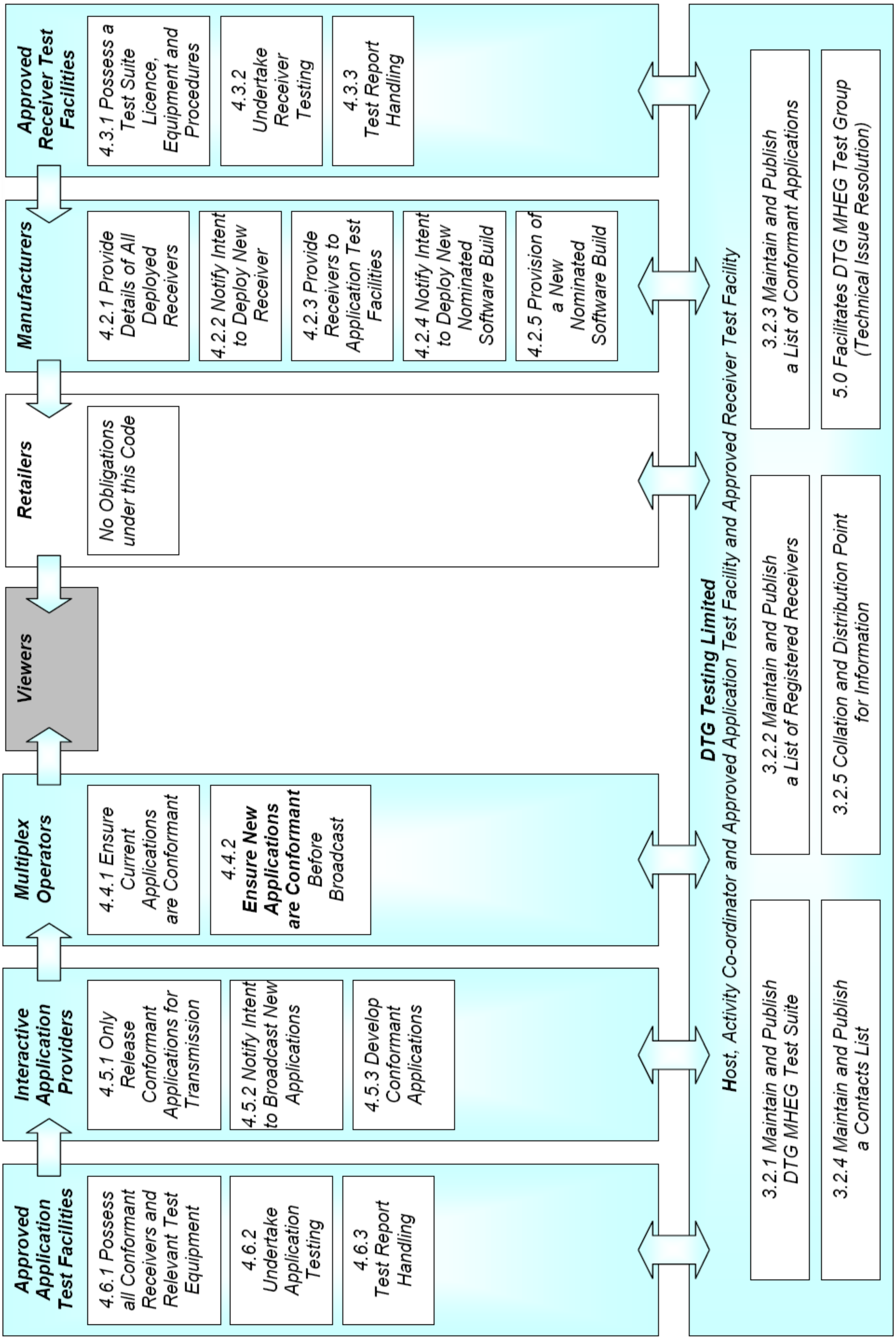
Receiver Manufacturers need to ensure that their new Receivers are conformant (Conformant Receivers). In addition, manufacturers may choose to upgrade product that has already been deployed.

Under this Code, Receiver conformance needs to be established through the use of an Approved Receiver Test Facility. DTG Testing Limited is setup to act as such a Facility. In addition, a Receiver Manufacturer may set up such a Facility internally, allowing it to conformance test its own Receivers.

Application Providers need to ensure that for all Interactive Applications they provide the viewer experience on all Conformant Receivers is as intended. There are some obligations with respect to non-Conformant Receivers, but not in terms of whether or how Interactive Applications run.

Under this Code, Interactive Application conformance needs to be established through the use of an Approved Application Test Facility. DTG Testing Limited is setup to act as such a Facility. In addition, third parties may set up such a Facility.

Roles and obligations are summarised in the following diagram with references to sections within this Code of Practice provided as a link to more detail.


Approved Receiver Test Facilities
4.3.1 Possess a Test Suite Licence, Equipment and Procedures
4.3.2 Undertake Receiver Testing
4.3.3 Test Report Handling
Manufacturers
4.2.1 Provide Details of All Deployed Receivers
4.2.2 Notify Intent to Deploy New Receiver
4.2.3 Provide Receivers to Application Test Facilities
4.2.4 Notify Intent to Deploy New Nominated Software Build
4.2.5 Provision of a New Nominated Software Build
Retailers
No Obligations under this Code
Viewers
Multiplex Operators
4.4.1 Ensure Current Applications are Conformant
4.4.2 Ensure New Applications are Conformant Before Broadcast
Interactive Application Providers
4.5.1 Only Release Conformant Applications for Transmission
4.5.2 Notify Intent to Broadcast New Applications
4.5.3 Develop Conformant Applications
Approved Application Test Facilities
4.6.1 Possess all Conformant Receivers and Relevant Test Equipment
4.6.2 Undertake Application Testing
4.6.3 Test Report Handling
DTG Testing Limited
Host, Activity Co-ordinator and Approved Application Test Facility and Approved Receiver Test Facility
3.2.3 Maintain and Publish a List of Conformant Applications
5.0 Facilitates DTG MHEG Test Group (Technical Issue Resolution)
3.2.2 Maintain and Publish a List of Registered Receivers
3.2.5 Collation and Distribution Point for Information
3.2.1 Maintain and Publish DTG MHEG Test Suite
3.2.4 Maintain and Publish a Contacts List

D.3.2 DTG Testing Limited

D.3.2.1 Maintain and publish the Test Suite

With the agreement of those involved in the development of the Test Suite, specific iterations of it will be issued by DTG Testing Limited as a formal release, identified by a unique version number.

New iterations may be produced as the library of Conformant Applications grows and in response to interoperability issues (see D.5).

Since more than one iteration of the Test Suite may be formally released, at any point in time DTG Testing Limited will identify a specific iteration as that to be used by all Parties within the context of this Code. The iteration identified may change over time but must always be a formal release of the Test Suite that has been available for at least three months prior to its identification.

D.3.2.2 Maintain and publish a List of Registered Receivers

The List of Registered Receivers will list all Receivers explicitly identified by Receiver Manufacturers observing the Code. It may also list Receivers from Receiver Manufacturers not adopting the Code where such information is available and deemed to be of value to the wider industry.

Associated with each Receiver in the List will be the following mandatory information that must have been provided by the relevant Receiver Manufacturer:

- An indication as to whether the Receiver is deployed and if not a planned deployment date.
- A single, unique Software Build identified as the Nominated Software Build. This is the only Software Build that needs to be considered for this Receiver within the context of this Code.
- An indication as to whether this Nominated Software Build makes the Receiver an Identifiable Receiver, and if so a list the unique identifying codes.
- An indication as to whether this Nominated Software Build makes the Receiver a Conformant Receiver, and if so a reference to the Statement of Receiver Conformance (see D.4.3.2).

Optionally for each Receiver in the List there may be additional information that may have been provided by the relevant Receiver Manufacturer:

- An indication of how this Receiver can be grouped with other Receivers such that testing an Interactive Application against one Receiver in that group is sufficient to act as a testing for all Receivers in the group.
- Any number of other Software Builds identified, which have previously been deployed.

For each of these additional, optional Software Builds there will be an indication as to whether it would make the Receiver identifiable and/or conformant. However, this information has no relevance within the context of the rest of this Code.

Note for avoidance of doubt this means that for a particular Receiver (or product) the only obligation in terms of Interactive Application development and testing is to those units containing the Nominated Software Build.

Since a Receiver may be upgraded with a new Software Build the relevant information may change over time.

D.3.2.3 Maintain and publish a List of Conformant Applications

The List of Conformant Applications will list all currently active Conformant Applications. In this context "active" means any Conformant Application of which DTG Testing Limited has been notified of (see D.4.5.2), which either is currently being transmitted or has not yet been transmitted for the last time – this is to cover both permanently available "text" applications and periodic "enhanced television" applications.

D.3.2.4 Maintain and publish a Contacts List

The Contacts List will provide contact details for two individuals from each Party adopting the Code. It may also identify contacts for other Parties not adopting the Code where such information is available and deemed to be of value to the wider industry.

D.3.2.5 Act as a collation and distribution point for information pertinent to this Code

Using any and all appropriate means.

D.4 Responsibilities of Parties

D.4.1 All Parties

D.4.1.1 Immediate obligations

All Parties are required:

- To acknowledge the Specification as the description of the features that a Receiver shall provide.
- To acknowledge the Test Suite as the means of determining Receiver conformance.
- To provide details for two named individuals to appear on the Contacts List and who are responsible for dealing with relevant issues of interoperability.

D.4.2 Receiver Manufacturers

D.4.2.1 Immediate obligations

In addition to the obligations on all Parties defined in D.4.1.1, Receiver Manufacturers are required to:

- Identify all Receivers to be treated as Registered Receivers under the Code. For each identified Receiver provide all mandatory information necessary (and any optional information as appropriate) to complete its entry in the List of Registered Receivers (see D.3.2.2).
- For each Software Build identified provide DTG Testing Limited with either the files used to create the over-air download or an equivalent that can be used to update receivers. These files may be made available to other Parties via a secure FTP site or similar.
- Acknowledge the obligations described in this Code relating to the resolution of issues of interoperability (see D.5). This applies to Receivers

both before and after deployment and in extreme cases may even require changes to an already deployed Conformant Receiver.

D.4.2.2 Notification of intent to deploy a new Receiver

Receiver Manufacturers shall provide DTG Testing Limited with notice of their intent to deploy a new Receiver. Where possible at least three months notice shall be provided to give maximum opportunity for new Receivers to be included in the test plans of Application Providers.

As part of this notification the Receiver Manufacturer becomes obliged to:

- Provide, as it becomes available, and update, where it changes, all mandatory information necessary (and any optional information as appropriate) to complete the relevant entry in the List of Registered Receivers (see D.3.2.2).

D.4.2.3 Provision of a new Receiver to Approved Application Test Facilities

Receiver Manufacturers shall provide all Approved Application Test Facilities with a sample of all new Receivers prior to their deployment. This shall include all necessary equipment and documentation.

In the case of DTG Testing Limited such samples shall be provided free of cost. In the case of all other Approved Application Test Facilities such samples shall be provided at trade pricing at the discretion of the relevant Receiver Manufacturer.

In all cases samples shall be made available no less than one month prior to first deployment.

There are no obligations under this Code in terms of Interactive Application development, testing and deployment against Receivers for which samples have not been made available.

D.4.2.4 Notification of intent to deploy a new Nominated Software Build

Receiver Manufacturers shall provide DTG Testing Limited with notice of their intent to deploy a new Nominated Software Build for a particular Receiver. In this context "new" shall be taken to include deployment of the initial Nominated Software Build as part of the deployment of a new Receiver as well as any subsequent updates.

As much notice as possible should be provided to give maximum opportunity for the new Nominated Software Build to be included in the test plans of Application Providers. However it is recognised that some Receivers are upgraded at short notice in response to interoperability issues, which is to the benefit of the whole platform.

As part of this notification the Receiver Manufacturer becomes obliged to:

- Notify any change to any mandatory information necessary (and any optional information as appropriate) to complete the relevant entry in the List of Registered Receivers (see D.3.2.2).
- Provide, as it becomes available, DTG Testing Limited with either the files used to create the over-air download for the new Nominated Software Build or an equivalent that can be used to update Receivers. These files may be made available to other Parties via a secure FTP site, over-air download (OAD) or similar.

D.4.2.5 Provision of a new Nominated Software Build

The new Nominated Software Build should be made available to DTG Testing Limited no less than one month prior to first deployment. This shall consist of the files used to create the over-air download for the new Nominated Software Build or an equivalent that can be used to update Receivers. These files may be made available to other Parties via a secure FTP site or similar.

There are no obligations under this Code in terms of Interactive Application development, testing and deployment against Receivers for which the Nominated Software Build has not been made available.

D.4.3 Approved Receiver Test Facility

D.4.3.1 Immediate obligations

In addition to the obligations on all Parties defined in D.4.1.1, Approved Receiver Test Facilities are required to:

- Be in possession of a license to use the Test Suite and the Test Suite itself
- Be in possession of appropriate test equipment and the definition of operational procedures so as to ensure consistent use and interpretation of the results from the Test Suite.

D.4.3.2 Receiver testing

Approved Receiver Test Facilities shall apply all tests within the Test Suite against a Receiver under test. Each test shall be correctly applied through the use of appropriate test equipment and execution of relevant operational procedures. The result of each test shall be documented as part of a Statement of Receiver Conformance, using a standard document template to be provided by DTG Testing Limited.

The Approved Receiver Test Facility shall also test the Receiver against all currently active Conformant Applications in the List of Conformant Applications (see D.3.2.3) as per the associated description of intended viewer experience.

After all testing has been completed the Receiver under test shall be confirmed by the Approved Receiver Test Facility as a Conformant Receiver if:

- All mandatory features of the Specification have been implemented such that they pass all relevant tests
- Where implemented, all features declared as optional in the Specification have been implemented such that they pass all relevant tests
- The Receiver correctly runs all Conformant Applications that it has been tested against.

D.4.3.3 Report of testing

The Statement of Receiver Conformance shall not be distributed to any party other than the relevant Receiver Manufacturer without prior agreement.

D.4.4 Multiplex Operators

D.4.4.1 Immediate obligations

In addition to the obligations on all Parties defined in D.4.1.1, Multiplex Operators are required to:

- To ensure for each Interactive Application already being transmitted that the relevant Application Provider can confirm it to be a Conformant Application (see D.4.5.3) that has been suitably tested (see D.4.5.4).

D.4.4.2 Broadcast of a new Interactive Application

Before allowing the transmission of any new Interactive Application to commence the Multiplex Operator shall ensure that the relevant Application Provider can confirm the Interactive Application to be a Conformant Application (see D.4.5.3) that has been suitably tested (see D.4.5.4).

D.4.5 Application Providers

D.4.5.1 Immediate obligations

In addition to the obligations on all Parties defined in D.4.1.1, Application Providers are required to:

- Only release Interactive Applications for transmission that can be confirmed as being Conformant Applications (see D.4.5.3) that have been suitably tested (see D.4.5.4).
- Acknowledge the obligations described in this Code relating to the resolution of issues of interoperability (see D.5). This applies to Interactive Applications both before and after deployment and in extreme cases may even require changes to an already deployed Conformant Application.

D.4.5.2 Notification of intent to broadcast a new Interactive Application

Application Providers shall provide DTG Testing Limited with notice of their intent to broadcast a new Interactive Application. This shall include provision of a description of the intended viewer experience to assist with Receiver testing (see D.4.3.2).

Where possible at least two days notice shall be given to allow call centre briefings to be performed.

D.4.5.3 Conformant Application development

The development of a Conformant Application shall require the following:

The Interactive Application shall be developed such that on Conformant Receivers it runs as intended.

At the discretion of the Application Provider, the Interactive Application may be developed such that on Registered Receivers that are not Conformant Receivers it runs either as intended or with some partial (including zero) proposition.

Regardless of the above, the Interactive Application shall be developed so as to ensure that:

- Exploitation of any Specification feature is in accordance with the relevant definition
- The Authoring Rules defined in the Specification are observed

- No Identifiable Receiver is caused to malfunction simply by the presence of the Interactive Application in the broadcast stream, i.e. basic operations such as channel changing and presentation of video and audio work as usual. This is dependent on the Receiver not containing a bug that means the simple act of transmitting MHEG will cause it to malfunction.

D.4.5.4 Interactive Application testing

Prior to releasing an Interactive Application for transmission Application Providers shall validate it as being a Conformant Application through the use of suitable testing.

The testing of Interactive Applications shall require the use of an Approved Application Test Facility.

In general, and certainly where there is any doubt, all Interactive Applications shall be tested according to a standard process. However, in cases where an existing Conformant Application is being re-used either in its entirety or with very minor changes, e.g. re-skinning, it may be reasonable to perform a simplified testing process. This shall be agreed between the Application Provider and the Approved Application Test Facility.

For a specific Interactive Application the Application Provider shall provide the relevant Approved Application Test Facility with:

- A description of the intended viewer experience sufficient to allow the Approved Application Test Facility to undertake the necessary testing
- A list of the Registered Receivers that are not Conformant Receivers for which the Interactive Application has been authored such that it will only offer a partial or zero proposition, i.e. different to the viewer experience offered on a Conformant Receiver
- The Interactive Application itself.

Note the form of the Interactive Application provided to the Approved Application Test Facility may vary. Whilst some Interactive Applications will consist of pre-built, i.e. static, MHEG code, some will be supported by systems that dynamically write-out MHEG code and in both cases data used by the MHEG code may be dynamically generated. So in some cases it may be MHEG code generation systems rather than actual MHEG code which is being tested. This will require some flexibility from both parties in ensuring suitable testing takes place.

D.4.5.5 Supply of Conformant Applications to DTG Testing Limited

Where possible Application Providers should release Conformant Applications to DTG Testing Limited for inclusion in the DTG MHEG Test Suite. This shall include provision of a description of the intended viewer experience to assist with Receiver testing (see D.4.3.2). Such Conformant Applications will be distributed to DTG MHEG Test Suite licensees by inclusion in subsequent revisions but only where copyright holders' permission has been granted. Such Conformant Applications shall be subject to confidentiality terms contained within the relevant licensing agreements.

D.4.6 Approved Application Test Facilities

D.4.6.1 Immediate obligations

In addition to the obligations on all Parties defined in D.4.1.1, Approved Application Test Facilities are required to:

- Be in possession of a suitable Receiver Zoo so that an Interactive Application can be effectively tested. In the case of an Interactive Application that will be transmitted using signalling such that it will only run on Conformant Receivers, the minimum requirement of the Receiver Zoo is to include all Conformant Receivers. In the case of an Interactive Application that will be transmitted using signalling such that it may run on any Receiver the minimum requirement of the zoo is to include all Identifiable Receivers, which inherently includes all Conformant Receivers.

D.4.6.2 Interactive Application testing

The Approved Application Test Facility shall suitably test the Interactive Application (see D.4.5.4) against all Receivers in its zoo. This testing shall include:

- The use of test equipment that recreates a representative environment to that which will be used during actual transmission. Note there is no requirement for all Approved Application Test Facilities to be able to recreate a representative environment for the play-out of all Interactive Applications in all multiplexes. The corollary of this is that certain Approved Application Test Facilities may only be able to test Interactive Applications intended for transmission in certain multiplexes.
- Comparing the observed behaviour against that expected given the information provided by the Application Provider (see D.4.5.4).
- Soak testing the Interactive Application for at least as long as it is likely to be resident in the Receiver.

The results of testing against each Receiver shall be documented as part of a Statement of Application Conformance, using a standard document template should one be provided by DTG Testing Limited.

After all testing has been completed the Interactive Application under test shall be confirmed by the Approved Application Test Facility as a Conformant Application if:

- The Interactive Application runs as intended on all Conformant Receivers.
- The Authoring Rules defined in the Specification are observed.
- No Identifiable Receiver is caused to malfunction simply by the presence of the Interactive Application in the broadcast stream.
- The Interactive Application runs successfully for the period of soak testing.

D.4.6.3 Report of testing

The Statement of Application Conformance shall not be distributed to any party other than the relevant Application Provider without prior agreement.

D.5 Interoperability Issue Resolution

D.5.1 General Responsibilities

Interoperability issues may identified during the development or testing of a product, whether an Interactive Application or a Receiver. All Parties deploying product have a responsibility to the wider industry to acknowledge and deal with any issue of interoperability that may arise. This applies both before and after product deployment and irrespective of whether or not the product has been deemed as conformant under the definition provided by this Code.

D.5.2 Dealing with an interoperability issue

As a first step in resolution the Party that uncovered the interoperability issue shall directly contact all other affected Parties and work collaboratively to resolve the issue prior to deployment of the new Interactive Application or Receiver. This shall extend to the co-ordination of Call Centre briefings where necessary.

In most cases the issue should be resolvable through careful analysis of the relevant Interactive Application running on the relevant Receiver and reference to the Specification, the Test Suite and this Code.

D.5.3 Reducing the risk of an interoperability issue re-occurring

Despite the considerable effort put into the creation of the Test Suite and this Code, they cannot guarantee interoperability under all possible conditions due to the scope and complexity of the Specification. Where the interoperability issue cannot be resolved within the scope of the Specification, the Test Suite and this Code but is due to a clear bug in a particular product there is an obligation on the relevant Party deploying this product to take appropriate action so as to resolve the issue.

Whether or not this process leads to a successful resolution, any interoperability issue that identifies a mistake or omission in the Specification and/or the Test Suite shall be reported to DTG Testing Limited. DTG Testing Limited will pass this on to the relevant technical group for consideration. This may result in minor corrigenda to either the Specification and/or the Test Suite.

E Removed

This section has been removed

F Displayable Character Repertoire

F.1 Introduction

Table F-1 lists the displayable characters that shall be implemented by all decoders conforming to this specification.

Note that the UK MHEG-5 profile specifies several characters that are not defined within ISO/IEC 6937 [42] on which the DVB SI specifications are based. These characters may be broadcast in, and shall be displayed correctly within MHEG-5 applications; there is no guarantee that they will be displayed correctly within SI delivered text. The characters in the shaded cells are shown only to emphasise gaps.

UCS-2	UTF-8	ISO/IEC 6937 [42]	Glyph	Unicode Name For Character	Mandatory for MHEG	Mandatory for SI
0020	20	20		Space	Y	Y
0021	21	21	!	Exclamation Mark	Y	Y
0022	22	22	"	Quotation Mark	Y	Y
0023	23	23	#	Number Sign	Y	Y
0024	24	24	$	Dollar Sign	Y	Y
0025	25	25	%	Percent Sign	Y	Y
0026	26	26	&	Ampersand	Y	Y
0027	27	27	'	Apostrophe	Y	Y
0028	28	28	(	Left Parenthesis	Y	Y
0029	29	29	)	Right Parenthesis	Y	Y
002A	2A	2A	*	Asterisk	Y	Y
002B	2B	2B	+	Plus Sign	Y	Y
002C	2C	2C	,	Comma	Y	Y
002D	2D	2D	-	Hyphen-minus	Y	Y
002E	2E	2E	.	Full Stop	Y	Y
002F	2F	2F	/	Solidus	Y	Y
0030	30	30	0	Digit Zero	Y	Y
0031	31	31	1	Digit One [a]	Y	Y
0032	32	32	2	Digit Two [a]	Y	Y
0033	33	33	3	Digit Three [a]	Y	Y
0034	34	34	4	Digit Four [a]	Y	Y

0035	35	35	5	Digit Five [a]	Y	Y
0036	36	36	6	Digit Six [a]	Y	Y
0037	37	37	7	Digit Seven [a]	Y	Y
0038	38	38	8	Digit Eight [a]	Y	Y
0039	39	39	9	Digit Nine [a]	Y	Y
003A	3A	3A	:	Colon	Y	Y
003B	3B	3B	;	Semicolon	Y	Y
003C	3C	3C	<	Less-than Sign	Y	Y
003D	3D	3D	=	Equals Sign	Y	Y
003E	3E	3E	>	Greater-than Sign	Y	Y
003F	3F	3F	?	Question Mark	Y	Y
0040	40	40	@	Commercial At	Y	Y
0041	41	41	A	Latin Capital Letter A	Y	Y
0042	42	42	B	Latin Capital Letter B	Y	Y
0043	43	43	C	Latin Capital Letter C	Y	Y
0044	44	44	D	Latin Capital Letter D	Y	Y
0045	45	45	E	Latin Capital Letter E	Y	Y
0046	46	46	F	Latin Capital Letter F	Y	Y
0047	47	47	G	Latin Capital Letter G	Y	Y
0048	48	48	H	Latin Capital Letter H	Y	Y
0049	49	49	I	Latin Capital Letter I	Y	Y
004A	4A	4A	J	Latin Capital Letter J	Y	Y
004B	4B	4B	K	Latin Capital Letter K	Y	Y
004C	4C	4C	L	Latin Capital Letter L	Y	Y
004D	4D	4D	M	Latin Capital Letter M	Y	Y
004E	4E	4E	N	Latin Capital Letter N	Y	Y
004F	4F	4F	O	Latin Capital Letter O	Y	Y
0050	50	50	P	Latin Capital Letter P	Y	Y
0051	51	51	Q	Latin Capital Letter Q	Y	Y
0052	52	52	R	Latin Capital Letter R	Y	Y
0053	53	53	S	Latin Capital Letter S	Y	Y
0054	54	54	T	Latin Capital Letter T	Y	Y
0055	55	55	U	Latin Capital Letter U	Y	Y
0056	56	56	V	Latin Capital Letter V	Y	Y
0057	57	57	W	Latin Capital Letter W	Y	Y
0058	58	58	X	Latin Capital Letter X	Y	Y
0059	59	59	Y	Latin Capital Letter Y	Y	Y

005A	5A	5A	Z	Latin Capital Letter Z	Y	Y
005B	5B	5B	[	Left Square Bracket	Y	Y
005C	5C	5C	\	Reverse Solidus	Y	Y
005D	5D	5D	]	Right Square Bracket	Y	Y
005E	5E	5E	^	Circumflex Accent	Y	Y
005F	5F	5F	_	Low Line	Y	Y
0060	60	60	`	Grave Accent	Y	Y
0061	61	61	a	Latin Small Letter A	Y	Y
0062	62	62	b	Latin Small Letter B	Y	Y
0063	63	63	c	Latin Small Letter C	Y	Y
0064	64	64	d	Latin Small Letter D	Y	Y
0065	65	65	e	Latin Small Letter E	Y	Y
0066	66	66	f	Latin Small Letter F	Y	Y
0067	67	67	g	Latin Small Letter G	Y	Y
0068	68	68	h	Latin Small Letter H	Y	Y
0069	69	69	i	Latin Small Letter I	Y	Y
006A	6A	6A	j	Latin Small Letter J	Y	Y
006B	6B	6B	k	Latin Small Letter K	Y	Y
006C	6C	6C	l	Latin Small Letter L	Y	Y
006D	6D	6D	m	Latin Small Letter M	Y	Y
006E	6E	6E	n	Latin Small Letter N	Y	Y
006F	6F	6F	o	Latin Small Letter O	Y	Y
0070	70	70	p	Latin Small Letter P	Y	Y
0071	71	71	q	Latin Small Letter Q	Y	Y
0072	72	72	r	Latin Small Letter R	Y	Y
0073	73	73	s	Latin Small Letter S	Y	Y
0074	74	74	t	Latin Small Letter T	Y	Y
0075	75	75	u	Latin Small Letter U	Y	Y
0076	76	76	v	Latin Small Letter V	Y	Y
0077	77	77	w	Latin Small Letter W	Y	Y
0078	78	78	x	Latin Small Letter X	Y	Y
0079	79	79	y	Latin Small Letter Y	Y	Y
007A	7A	7A	z	Latin Small Letter Z	Y	Y
007B	7B	7B	{	Left Curly Bracket	Y	Y
007C	7C	7C	|	Vertical Line	Y	Y
007D	7D	7D	}	Right Curly Bracket	Y	Y
007E	7E	7E	~	Tilde	Y	Y

00A0	C2A0	A0		No-break Space	Y	Y
00A1	C2A1	A1	¡	Inverted Exclamation Mark	Y	Y
00A2	C2A2	A2	¢	Cent Sign	Y	Y
00A3	C2A3	A3	£	Pound Sign	Y	Y
00A5	C2A5	A5	¥	Yen Sign	Y	Y
00A9	C2A9	D3	©	Copyright Sign	Y	Y
00AB	C2AB	AB	«	Left-pointing Double Angle Quotation Mark	Y	Y
00AE	C2AE	D2	®	Registered Sign	Y	Y
00B0	C2B0	B0	°	Degree Sign	Y	Y
00B6	C2B6	B6	¶	Pilcrow Sign	Y	Y
00B7	C2B7	B7	·	Middle Dot	Y	Y
00BB	C2BB	BB	»	Right-pointing Double Angle Quotation Mark	Y	Y
00BC	C2BC	BC	¼	Vulgar Fraction One Quarter	Y	Y
00BD	C2BD	BD	½	Vulgar Fraction One Half	Y	Y
00BE	C2BE	BE	¾	Vulgar Fraction Three Quarters	Y	Y
00BF	C2BF	BF	¿	Inverted Question Mark	Y	Y
00C0	C380	C1 41	À	Latin Capital Letter A With Grave	Y	Y
00C1	C381	C2 41	Á	Latin Capital Letter A With Acute	Y	Y
00C2	C382	C3 41	Â	Latin Capital Letter A With Circumflex	Y	Y
00C3	C383	C4 41	Ã	Latin Capital Letter A With Tilde	Y	Y
00C4	C384	C8 41	Ä	Latin Capital Letter A With Diaeresis	Y	Y
00C5	C385	CA 41	Å	Latin Capital Letter A With Ring Above	Y	Y
00C6	C386	E1	Æ	Latin Capital Letter Ae	Y	Y
00C7	C387	CB 43	Ç	Latin Capital Letter C With Cedilla	Y	Y
00C8	C388	C1 45	È	Latin Capital Letter E With Grave	Y	Y
00C9	C389	C2 45	É	Latin Capital Letter E With Acute	Y	Y
00CA	C38A	C3 45	Ê	Latin Capital Letter E With Circumflex	Y	Y
00CB	C38B	C8 45	Ë	Latin Capital Letter E With Diaeresis	Y	Y
00CC	C38C	C1 49	Ì	Latin Capital Letter I With Grave	Y	Y
00CD	C38D	C2 49	Í	Latin Capital Letter I With Acute	Y	Y
00CE	C38E	C3 49	Î	Latin Capital Letter I With Circumflex	Y	Y

00CF	C38F	C8 49	Ï	Latin Capital Letter I With Diaeresis	Y	Y
00D1	C391	C4 4E	Ñ	Latin Capital Letter N With Tilde	Y	Y
00D2	C392	C1 4F	Ò	Latin Capital Letter O With Grave	Y	Y
00D3	C393	C2 4F	Ó	Latin Capital Letter O With Acute	Y	Y
00D4	C394	C3 4F	Ô	Latin Capital Letter O With Circumflex	Y	Y
00D5	C395	C4 4F	Õ	Latin Capital Letter O With Tilde	Y	Y
00D6	C396	C8 4F	Ö	Latin Capital Letter O With Diaeresis	Y	Y
00D7	C397	B4	×	Multiplication Sign [a]	Y	Y
00D8	C398	E9	Ø	Latin Capital Letter O With Stroke	Y	Y
00D9	C399	C1 55	Ù	Latin Capital Letter U With Grave	Y	Y
00DA	C39A	C2 55	Ú	Latin Capital Letter U With Acute	Y	Y
00DB	C39B	C3 55	Û	Latin Capital Letter U With Circumflex	Y	Y
00DC	C39C	C8 55	Ü	Latin Capital Letter U With Diaeresis	Y	Y
00DD	C39D	C2 59	Ý	Latin Capital Letter Y With Acute	Y	Y
00DF	C39F	FB	ß	Latin Small Letter Sharp S	Y	Y
00E0	C3A0	C1 61	à	Latin Small Letter A With Grave	Y	Y
00E1	C3A1	C2 61	á	Latin Small Letter A With Acute	Y	Y
00E2	C3A2	C3 61	â	Latin Small Letter A With Circumflex	Y	Y
00E3	C3A3	C4 61	ã	Latin Small Letter A With Tilde	Y	Y
00E4	C3A4	C8 61	ä	Latin Small Letter A With Diaeresis	Y	Y
00E5	C3A5	CA 61	å	Latin Small Letter A With Ring Above	Y	Y
00E6	C3A6	F1	æ	Latin Small Letter Ae	Y	Y
00E7	C3A7	CB 63	ç	Latin Small Letter C With Cedilla	Y	Y
00E8	C3A8	C1 65	è	Latin Small Letter E With Grave	Y	Y
00E9	C3A9	C2 65	é	Latin Small Letter E With Acute	Y	Y
00EA	C3AA	C3 65	ê	Latin Small Letter E With Circumflex	Y	Y
00EB	C3AB	C8 65	ë	Latin Small Letter E With Diaeresis	Y	Y
00EC	C3AC	C1 69	ì	Latin Small Letter I With Grave	Y	Y
00ED	C3AD	C2 69	í	Latin Small Letter I With Acute	Y	Y

00EE	C3AE	C3 69	î	Latin Small Letter I With Circumflex	Y	Y
00EF	C3AF	C8 69	ï	Latin Small Letter I With Diaeresis	Y	Y
00F1	C3B1	C4 6E	ñ	Latin Small Letter N With Tilde	Y	Y
00F2	C3B2	C1 6F	ò	Latin Small Letter O With Grave	Y	Y
00F3	C3B3	C2 6F	ó	Latin Small Letter O With Acute	Y	Y
00F4	C3B4	C3 6F	ô	Latin Small Letter O With Circumflex	Y	Y
00F5	C3B5	C4 6F	õ	Latin Small Letter O With Tilde	Y	Y
00F6	C3B6	C8 6F	ö	Latin Small Letter O With Diaeresis	Y	Y
00F7	C3B7	B8	÷	Division Sign [a]	Y	Y
00F8	C3B8	F9	ø	Latin Small Letter O With Stroke	Y	Y
00F9	C3B9	C1 75	ù	Latin Small Letter U With Grave	Y	Y
00FA	C3BA	C2 75	ú	Latin Small Letter U With Acute	Y	Y
00FB	C3BB	C3 75	û	Latin Small Letter U With Circumflex	Y	Y
00FC	C3BC	C8 75	ü	Latin Small Letter U With Diaeresis	Y	Y
00FD	C3BD	C2 79	ý	Latin Small Letter Y With Acute	Y	Y
00FF	C3BF	C8 79	ÿ	Latin Small Letter Y With Diaeresis	Y	Y
0131	C4B1	F5	ı	Latin Small Letter Dotless I	Y	Y
0152	C592	EA	Œ	Latin Capital Ligature OE	Y	Y
0153	C593	FA	œ	Latin Small Ligature OE	Y	Y
0174	C5B4	C3 57	Ŵ	Latin Capital Letter W With Circumflex	Y	Y
0175	C5B5	C3 77	ŵ	Latin Small Letter W With Circumflex	Y	Y
0176	C5B6	C3 59	Ŷ	Latin Capital Letter Y With Circumflex	Y	Y
0177	C5B7	C3 79	ŷ	Latin Small Letter Y With Circumflex	Y	Y
0178	C5B8	C8 59	Ÿ	Latin Capital Letter Y With Diaeresis	Y	Y
066B	D9AB	-	٫	Decimal Separator [a]	Y	n
1E80	E1BA80	-	Ẁ	Latin Capital Letter W With Grave	Y	n
1E81	E1BA81	-	ẁ	Latin Small Letter W With Grave	Y	n
1E82	E1BA82	-	Ẃ	Latin Capital Letter W With Acute	Y	n

1E83	E1BA83	-	ẃ	Latin Small Letter W With Acute	Y	n
1E84	E1BA84	-	Ẅ	Latin Capital Letter W With Diaeresis	Y	n
1E85	E1BA85	-	ẅ	Latin Small Letter W With Diaeresis	Y	n
1EF2	E1BBB2	-	Ỳ	Latin Capital Letter Y With Grave	Y	n
1EF3	E1BBB3	-	ỳ	Latin Small Letter Y With Grave	Y	n
2007	E28087	-		Figure Space [a]	Y	n
2013	E28093	-	–	En Dash	Y	n
2014	E28094	D0	—	Em Dash	Y	Y
2018	E28098	A9	‘	Left Single Quotation Mark	Y	Y
2019	E28099	B9	’	Right Single Quotation Mark	Y	Y
201C	E2809C	AA	“	Left Double Quotation Mark	Y	Y
201D	E2809D	BA	”	Right Double Quotation Mark	Y	Y
2022	E280A2	-	•	Bullet	Y	n
2039	E280B9	-	‹	Single Left-pointing Angle Quotation Mark	Y	n
203A	E280BA	-	›	Single Right-pointing Angle Quotation Mark	Y	n
2044	E28184	-	⁄	Fraction Slash	Y	n
20AC	E282AC	A4	€	Euro-currency Sign	Y	Y
2122	E284A2	D4	™	Trade Mark Sign	Y	Y
2190	E28690	AC	←	Leftwards Arrow	Y	Y
2191	E28691	AD	↑	Upwards Arrow	Y	Y
2192	E28692	AE	→	Rightwards Arrow	Y	Y
2193	E28693	AF	↓	Downwards Arrow	Y	Y
2212	E28892	-	−	Minus Sign [a]	Y	n
2214	E28894	-	∔	Plus (monospaced)[a]	Y	n
2215	E28895	-	∕	Division Slash[a]	Y	n
221E	E2889E	-	∞	Infinity	Y	n
266B	E299AB	-	♫	Beamed Eighth Notes	Y	n
2713	E29C93	-	✓	Check Mark	Y	n
2717	E29C97	-	✗	Ballot X	Y	n

Table F-1. Set of displayable characters supported by a compliant receiver.

[a] Digits have the same width as the Digit Zero (0x0030)

G DVB-T2 Functional test modes

G.1 Introduction

The tables below detail the list of DVB-T2 parameters required for each of the functional test modes which form part of the conformance regime.

Note that the Stream Name field is an identifier, giving the key features of what makes that mode different. For example 1K_NRM_G4_PP1 means 1K FFT, Normal Mode, Guard interval 1/4 Pilot pattern PP1. It has no connection at all with any transport stream SI names.

Note also that modes DTG102 and DTG108 are identical, but both are retained for their association with the respective test cases identified in the Nordig specification and during the Ofcom DVB-T2 pilot.

G.2 Single PLP Modes without FEFs

All single PLP modes use HEM input stage mode with the exception of DTG052 which uses Normal Mode (NM). There is no Null Packet Deletion or in band signalling. L1 repetition and auxiliary streams are not used. The modes without FEFs do not use ISSY. All single PLP modes except DTG162/163/164 use T2 specification version 1.1.1. DTG162 /163/164 use version 1.2.1.

Identifier	**DTG000**	**DTG001**	**DTG002**	**DTG003**	**DTG004**	**DTG005**	**DTG006**	**DTG007**	**DTG008**	**DTG009**
Stream Name	**1K_NRM_G4_PP1**	**1K_NRM_G8_PP2**	**1K_NRM_G8_PP3**	**1K_NRM_G16_PP4**	**1K_NRM_G16_PP5**	**2K_NRM_G4_PP1**	**2K_NRM_G8_PP2**	**2K_NRM_G8_PP3**	**2K_NRM_G16_PP4**	**2K_NRM_G16_PP5**
Overall										
FFTSIZE	1K	1K	1K	1K	1K	2K	2K	2K	2K	2K
GI	1/4	1/8	1/8	1/16	1/16	1/4	1/8	1/8	1/16	1/16
Data Symbols	1768	499	7	2082	7	489	499	972	7	500
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	No	No	No
Pilot Pattern	PP1	PP2	PP3	PP4	PP5	PP1	PP2	PP3	PP4	PP5
L1 Modulation	BPSK	QPSK	BPSK	QPSK	QPSK	QPSK	16QAM	BPSK	QPSK	16QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	QPSK	16QAM	QPSK	16QAM	16QAM	16QAM	64QAM	QPSK	16QAM	64QAM
Rate	1/2	3/5	2/3	1/2	3/5	2/3	3/4	1/2	3/5	2/3
FEC Type	16200	64800	16200	16200	16200	64800	64800	16200	16200	64800
Rotated QAM	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
FEC blocks per interleaving frame	167	24	1	414	2	46	71	192	4	76
TI blocks per frame (N_TI)	3	3	1	4	1	3	3	3	2	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1

Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	1	4	1	3	3	3	2	3

Identifier	DTG010	DTG011	DTG012	DTG013	DTG014	DTG015	DTG016	DTG017	DTG018	DTG019
Stream Name	**2K_NRM_G32_PP7**	**2K_NRM_G32_PP4**	**4K_NRM_G4_PP1**	**4K_NRM_G8_PP2**	**4K_NRM_G8_PP3**	**4K_NRM_G16_PP4**	**4K_NRM_G16_PP5**	**4K_NRM_G32_PP7**	**4K_NRM_G32_PP4**	**8K_EXT_G4_PP1**
							No time interleaving			
Overall										
FFTSIZE	2K	2K	4K	4K	4K	4K	4K	4K	4K	8K
GI	1/32	1/32	1/4	1/8	1/8	1/16	1/16	1/32	1/32	1/4
Data Symbols	1073	500	97	491	7	499	500	536	7	213
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	No	No	Yes
Pilot Pattern	PP7	PP4	PP1	PP2	PP3	PP4	PP5	PP7	PP4	PP1
L1 Modulation	BPSK	QPSK	16QAM	BPSK	QPSK	16QAM	QPSK	QPSK	16QAM	QPSK
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	QPSK	16QAM	64QAM	QPSK	16QAM	64QAM	QPSK	64QAM	16QAM	QPSK
Rate	3/4	3/5	1/2	3/5	2/3	3/4	4/5	3/5	5/6	1/2
FEC Type	64800	16200	16200	64800	64800	16200	16200	64800	64800	16200
Rotated QAM	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Yes
FEC blocks per interleaving frame	54	199	112	47	1	600	204	165	1	165
TI blocks per frame (N_TI)	4	3	3	3	1	3	1	4	1	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	4	3	3	3	1	3	0	4	1	3

Identifier	DTG020	DTG021	DTG022	DTG023	DTG024	DTG025	DTG026	DTG027	DTG028	DTG029
Stream Name	**8K_NRM_G4_PP1**	**8K_EXT_G19_128_PP2**	**8K_NRM_G19_128_PP2**	**8K_EXT_G19_128_PP3**	**8K_NRM_G19_128_PP3**	**8K_EXT_G8_PP2**	**8K_NRM_G8_PP2**	**8K_EXT_G8_PP3**	**8K_NRM_G8_PP3**	**8K_EXT_G19_256_PP4**
Overall										
FFTSIZE	8K	8K	8K	8K	8K	8K	8K	8K	8K	8K
GI	1/4	19/128	19/128	19/128	19/128	1/8	1/8	1/8	1/8	19/256
Data Symbols	102	7	201	202	240	205	135	245	150	150
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	None	TR	TR	None	TR	None	None	TR	TR
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP1	PP2	PP2	PP3	PP3	PP2	PP2	PP3	PP3	PP4
L1 Modulation	16QAM	QPSK	16QAM	64QAM	64QAM	64QAM	64QAM	QPSK	QPSK	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	16QAM	QPSK	16QAM	64QAM	256QAM	64QAM	256QAM	QPSK	16QAM	64QAM
Rate	3/5	4/5	5/6	1/2	3/5	4/5	5/6	1/2	3/5	1/2
FEC Type	16200	16200	16200	64800	64800	64800	64800	16200	64800	16200
Rotated QAM	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	155	6	306	122	192	118	104	199	59	364
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	3	3	3

Identifier	DTG030	DTG031	DTG032	DTG033	DTG034	DTG035	DTG036	DTG037	DTG038	DTG039
Stream Name	**8K_NRM_G19_256_PP4**	**8K_EXT_G19_256_PP5**	**8K_NRM_G19_256_PP5**	**8K_EXT_G16_PP5**	**8K_NRM_G16_PP5**	**8K_EXT_G16_PP4**	**8K_NRM_G16_PP4**	**8K_EXT_G32_PP4**	**8K_NRM_G32_PP4**	**8K_EXT_G32_PP7**
Overall										
FFTSIZE	8K	8K	8K	8K	8K	8K	8K	8K	8K	8K
GI	19/256	19/256	19/256	1/16	1/16	1/16	1/16	1/32	1/32	1/32
Data Symbols	150	257	11	150	150	150	150	150	150	150
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	TR	TR	None	None	TR	None	TR	TR
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP4	PP5	PP5	PP5	PP5	PP4	PP4	PP4	PP4	PP7
L1 Modulation	64QAM	QPSK	16QAM	64QAM	64QAM	QPSK	QPSK	QPSK	16QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	QPSK	16QAM	64QAM	256QAM	QPSK	16QAM	QPSK	16QAM	64QAM
Rate	3/5	2/3	3/4	4/5	5/6	1/2	1/2	3/4	4/5	5/6
FEC Type	64800	64800	16200	16200	64800	64800	16200	64800	16200	16200
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
FEC blocks per interleaving frame	121	53	18	371	123	30	239	30	239	375
TI blocks per frame (N_TI)	3	4	2	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	4	2	3	3	3	3	3	3	3

Identifier	DTG040	DTG041	DTG042	DTG043	DTG044	DTG045	DTG046	DTG047	DTG048	DTG049
Stream Name	**8K_NRM_G32_PP7**	**8K_EXT_G128_PP7**	**8K_NRM_G128_PP7**	**16K_EXT_G4_PP1**	**16K_NRM_G4_PP1**	**16K_EXT_G19_128_PP2**	**16K_NRM_G19_128_PP2**	**16K_EXT_G19_128_PP3**	**16K_NRM_G19_128_PP3**	**16K_EXT_G8_PP2**
Overall										
FFTSIZE	8K	8K	8K	16K	16K	16K	16K	16K	16K	16K
GI	1/32	1/128	1/128	1/4	1/4	19/128	19/128	19/128	19/128	1/8
Data Symbols	150	274	9	110	7	120	119	119	8	119
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	TR	None	None	TR	None	TR	TR	None	TR
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP7	PP7	PP7	PP1	PP1	PP2	PP2	PP3	PP3	PP2
L1 Modulation	64QAM	BPSK	16QAM	16QAM	16QAM	64QAM	64QAM	16QAM	64QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	QPSK	16QAM	16QAM	64QAM	64QAM	256QAM	16QAM	64QAM	64QAM
Rate	1/2	3/5	2/3	3/4	4/5	2/3	3/5	2/3	3/4	2/3
FEC Type	64800	64800	16200	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	123	56	16	86	8	141	181	96	9	138
TI blocks per frame (N_TI)	3	4	3	3	3	3	3	3	2	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	4	3	3	3	3	3	3	2	3

Identifier	DTG050	DTG051	DTG052	DTG053	DTG054	DTG055	DTG056	DTG057	DTG058	DTG059
Stream Name	**16K_NRM_G8_PP2**	**16K_EXT_G8_PP3**	**16K_NRM_G8_PP3**	**16K_EXT_G19_256_PP2**	**16K_NRM_G19_256_PP2**	**16K_EXT_G19_256_PP4**	**16K_NRM_G19_256_PP4**	**16K_EXT_G19_256_PP5**	**16K_NRM_G19_256_PP5**	**16K_EXT_G16_PP2**
			Normal mode							
Overall										
FFTSIZE	16K	16K	16K	16K	16K	16K	16K	16K	16K	16K
GI	1/8	1/8	1/8	19/256	19/256	19/256	19/256	19/256	19/256	1/16
Data Symbols	100	119	100	119	8	119	100	119	100	129
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	TR	None	TR	None	TR	TR	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP2	PP3	PP3	PP2	PP2	PP4	PP4	PP5	PP5	PP2
L1 Modulation	64QAM	QPSK	64QAM	64QAM	64QAM	64QAM	16QAM	64QAM	64QAM	16QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	16QAM	64QAM	64QAM	256QAM	256QAM	16QAM	64QAM	256QAM	16QAM
Rate	3/5	2/3	3/4	2/3	3/5	4/5	5/6	3/4	4/5	5/6
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	154	97	119	140	12	195	79	147	164	101
TI blocks per frame (N_TI)	3	3	3	3	1	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	1	3	3	3	3	3

Identifier	DTG060	DTG061	DTG062	DTG063	DTG064	DTG065	DTG066	DTG067	DTG068	DTG069
Stream Name	**16K_NRM_G16_PP2**	**16K_EXT_G16_PP4**	**16K_NRM_G16_PP4**	**16K_EXT_G16_PP5**	**16K_NRM_G16_PP5**	**16K_EXT_G32_PP7**	**16K_NRM_G32_PP7**	**16K_EXT_G32_PP4**	**16K_NRM_G32_PP4**	**16K_EXT_G32_PP6**
Overall										
FFTSIZE	16K	16K	16K	16K	16K	16K	16K	16K	16K	16K
GI	1/16	1/16	1/16	1/16	1/16	1/32	1/32	1/32	1/32	1/32
Data Symbols	100	122	130	129	128	127	100	127	100	134
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	None	TR	TR	None	None	TR	TR	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP2	PP4	PP4	PP5	PP5	PP7	PP7	PP4	PP4	PP6
L1 Modulation	64QAM	64QAM	64QAM	QPSK	64QAM	64QAM	16QAM	64QAM	64QAM	QPSK
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	64QAM	64QAM	256QAM	16QAM	64QAM	256QAM	16QAM	64QAM	256QAM	16QAM
Rate	3/5	4/5	5/6	3/5	2/3	3/4	4/5	5/6	3/5	2/3
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	114	150	207	106	157	215	82	155	161	112
TI blocks per frame (N_TI)	3	3	4	4	4	4	3	4	3	4
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	4	4	4	4	3	4	3	4

Identifier	DTG070	DTG071	DTG072	DTG073	DTG074	DTG075	DTG076	DTG077	DTG078	DTG079
Stream Name	**16K_NRM_G32_PP6**	**16K_EXT_G128_PP7**	**16K_NRM_G128_PP7**	**32K_EXT_G19_128_PP2**	**32K_NRM_G19_128_PP2**	**32K_EXT_G8_PP2**	**32K_NRM_G8_PP2**	**32K_EXT_G19_256_PP2**	**32K_NRM_G19_256_PP2**	**32K_EXT_G19_256_PP4**
Overall										
FFTSIZE	16K	16K	16K	32K	32K	32K	32K	32K	32K	32K
GI	1/32	1/128	1/128	19/128	19/128	1/8	1/8	19/256	19/256	19/256
Data Symbols	127	132	125	59	59	59	59	63	63	57
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	TR	None	TR	None	None	None	TR	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP6	PP7	PP7	PP2	PP2	PP2	PP2	PP2	PP2	PP4
L1 Modulation	64QAM	64QAM	16QAM	64QAM	QPSK	64QAM	64QAM	64QAM	64QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	64QAM	16QAM	64QAM	QPSK	64QAM	256QAM	64QAM	256QAM	64QAM
Rate	3/4	4/5	5/6	3/4	2/3	5/6	3/5	4/5	5/6	3/4
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	206	166	103	138	45	140	183	148	196	141
TI blocks per frame (N_TI)	4	4	4	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	4	4	4	3	3	3	3	3	3	3

Identifier	**DTG080**	**DTG081**	**DTG082**	**DTG083**	**DTG084**	**DTG085**	**DTG086**	**DTG087**	**DTG088**	**DTG089**
Stream Name	**32K_NRM_G19_256_PP4**	**32K_EXT_G16_PP2**	**32K_NRM_G16_PP2**	**32K_EXT_G16_PP4**	**32K_NRM_G16_PP4**	**32K_EXT_G32_PP4**	**32K_NRM_G32_PP4**	**32K_EXT_G32_PP6**	**32K_NRM_G32_PP6**	**32K_EXT_G128_PP7**
Overall										
FFTSIZE	32K	32K	32K	32K	32K	32K	32K	32K	32K	32K
GI	19/256	1/16	1/16	1/16	1/16	1/32	1/32	1/32	1/32	1/128
Data Symbols	55	63	3	57	63	59	29	65	49	59
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	None	TR	None	TR	None	TR	TR	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Pilot Pattern	PP4	PP2	PP2	PP4	PP4	PP4	PP4	PP6	PP6	PP7
L1 Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	QPSK
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	256QAM	64QAM	256QAM	64QAM	64QAM	256QAM	256QAM	64QAM	QPSK
Rate	4/5	5/6	3/5	4/5	5/6	3/5	2/3	3/4	4/5	2/3
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	176	200	8	189	151	147	94	217	122	50
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	4	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	4	3	3

Identifier	DTG090	DTG091	DTG092	DTG093	DTG094	DTG095	DTG096	DTG097	DTG098	DTG099
Stream Name	**32K_NRM_G 128_PP7**	**NORDIG_1**	**NORDIG_2**	**NORDIG_3**	**NORDIG_4**	**NORDIG_5**	**NORDIG_6**	**NORDIG_7**	**NORDIG_8**	**NORDIG_9**
Overall										
FFTSIZE	32K	32K	32K	32K	32K	32K	32K	32K	32K	32K
GI	1/128	1/8	1/8	1/8	1/128	1/128	1/128	1/16	1/16	1/32
Data Symbols	59	53	53	53	59	59	59	59	59	59
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	7MHz	7MHz	7MHz	7MHz	7MHz	7MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	Yes	Yes	Yes
Pilot Pattern	PP7	PP2	PP2	PP2	PP7	PP7	PP7	PP4	PP4	PP4
L1 Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM
Rate	5/6	3/5	2/3	3/4	3/5	2/3	3/4	3/5	2/3	3/5
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	195	162	162	162	195	195	195	193	193	193
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	3	3	3

Identifier	**DTG100**	**DTG101**	**DTG102**	**DTG103**	**DTG104**	**DTG105**	**DTG106**	**DTG107**	**DTG108**	**DTG109**
Stream Name	**NORDIG_10**	**NORDIG_11**	**NORDIG_12**	**OFCOM_1**	**OFCOM_2**	**OFCOM_3**	**OFCOM_4**	**OFCOM_5**	**OFCOM_6**	**OFCOM_7**
				VV014	VV012	VV013	VV001	VV015	VV016	VV003
Overall										
FFTSIZE	32K	32K	32K	8K	8K	8K	32K	8K	32K	32K
GI	1/32	1/128	1/128	1/32	1/32	1/32	1/128	1/32	1/128	1/128
Data Symbols	59	59	59	242	242	242	59	238	59	59
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	TR	TR	TR	TR	TR	TR	None	None	TR	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pilot Pattern	PP6	PP7	PP7	PP7	PP7	PP7	PP7	PP7	PP7	PP7
L1 Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	256QAM	256QAM	64QAM	64QAM	64QAM	256QAM	256QAM	256QAM	256QAM
Rate	3/5	2/3	3/4	3/4	4/5	5/6	3/5	3/5	3/4	2/3
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	197	200	200	151	151	151	202	200	200	202
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	3	3	3

Identifier	DTG110	DTG111	DTG112	DTG113	DTG114	DTG115	DTG116	DTG117	DTG118	DTG119
Stream Name	**MISO_1K_NRM_G8_PP1**	**MISO_1K_NRM_G16_PP3**	**MISO_2K_NRM_G8_PP1**	**MISO_2K_NRM_G16_PP3**	**MISO_2K_NRM_G32_PP4**	**MISO_2K_NRM_G32_PP5**	**MISO_4K_NRM_G8_PP1**	**MISO_4K_NRM_G16_PP3**	**MISO_4K_NRM_G32_PP4**	**MISO_4K_NRM_G32_PP5**
Overall										
FFTSIZE	1K	1K	2K	2K	2K	2K	4K	4K	4K	4K
GI	1/8	1/16	1/8	1/16	1/32	1/32	1/8	1/16	1/32	1/32
Data Symbols	1742	1881	869	920	981	1000	482	466	504	500
SISO/MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	No	No	No
Pilot Pattern	PP1	PP3	PP1	PP3	PP4	PP5	PP1	PP3	PP4	PP5
L1 Modulation	BPSK	QPSK	QPSK	BPSK	64QAM	BPSK	16QAM	QPSK	QPSK	16QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	QPSK	16QAM	QPSK	16QAM	64QAM	QPSK	16QAM	64QAM	QPSK	16QAM
Rate	1/2	3/5	2/3	1/2	3/5	2/3	3/4	1/2	3/5	2/3
FEC Type	16200	64800	16200	64800	16200	64800	16200	64800	16200	64800
Rotated QAM	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No
FEC blocks per interleaving frame	164	93	163	90	584	50	368	139	201	102
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	3	3	3

Identifier	DTG120	DTG121	DTG122	DTG123	DTG124	DTG125	DTG126	DTG127	DTG128	DTG129
Stream Name	**MISO_8K_NRM_G19_128_PP1**	**MISO_8K_NRM_G8_PP1**	**MISO_8K_NRM_G19_256_PP3**	**MISO_8K_NRM_G16_PP3**	**MISO_8K_NRM_G32_PP4**	**MISO_8K_NRM_G32_PP5**	**MISO_8K_NRM_G128_PP4**	**MISO_8K_NRM_G128_PP5**	**MISO_16K_NRM_G19_128_PP1**	**MISO_16K_NRM_G8_PP1**
Overall										
FFTSIZE	8K	8K	8K	8K	8K	8K	8K	8K	16K	16K
GI	19/128	1/8	19/256	1/16	1/32	1/32	1/128	1/128	19/128	1/8
Data Symbols	216	240	254	257	255	249	259	203	120	111
SISO/MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	No	No	No
Pilot Pattern	PP1	PP1	PP3	PP3	PP4	PP5	PP4	PP5	PP1	PP1
L1 Modulation	BPSK	64QAM	BPSK	QPSK	QPSK	QPSK	64QAM	BPSK	QPSK	QPSK
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	QPSK	64QAM	QPSK	64QAM	QPSK	16QAM	256QAM	QPSK	64QAM	QPSK
Rate	3/4	5/6	2/3	4/5	3/5	2/3	4/5	5/6	2/3	4/5
FEC Type	16200	16200	16200	16200	16200	64800	64800	16200	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	165	553	203	619	205	102	208	166	138	42
TI blocks per frame (N_TI)	3	3	3	4	4	3	4	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	4	4	3	4	3	3	3

Identifier	DTG130	DTG131	DTG132	DTG133	DTG134	DTG135	DTG136	DTG137	DTG138	DTG139
Stream Name	**MISO_16K_NRM_G19_256_PP3**	**MISO_16K_NRM_G16_PP3**	**MISO_16K_NRM_G32_PP4**	**MISO_16K_NRM_G32_PP5**	**MISO_16K_NRM_G128_PP4**	**MISO_16K_NRM_G128_PP5**	**MISO_32K_NRM_G19_256_PP2**	**MISO_32K_NRM_G16_PP2**	**MISO_32K_NRM_G32_PP4**	**MISO_32K_NRM_G128_PP4**
Overall										
FFTSIZE	16K	16K	16K	16K	16K	16K	32K	32K	32K	32K
GI	19/256	1/16	1/32	1/32	1/128	1/128	19/256	1/16	1/32	1/128
Data Symbols	126	126	126	124	126	124	51	21	63	63
SISO/MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	No	No	No	No	No	No	No	No	No
Pilot Pattern	PP3	PP3	PP4	PP5	PP4	PP5	PP2	PP2	PP4	PP4
L1 Modulation	16QAM	64QAM	16QAM	64QAM	64QAM	16QAM	16QAM	16QAM	64QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	64QAM	64QAM	64QAM	256QAM	64QAM	256QAM	64QAM	256QAM	256QAM	64QAM
Rate	2/3	4/5	3/5	2/3	4/5	5/6	2/3	4/5	3/5	3/4
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	151	151	152	203	152	203	118	65	203	152
TI blocks per frame (N_TI)	3	3	3	3	3	3	3	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	3	3	3	3	3	3	3

Identifier	DTG140	DTG141	DTG142	DTG143	DTG144	DTG145	DTG146	DTG147	DTG148	DTG149
Stream Name	**MISO_32K_NRM_G128_PP6**	**MISO_8K_EXT_G19_128_PP1**	**MISO_8K_EXT_G8_PP1**	**MISO_8K_EXT_G19_256_PP3**	**MISO_8K_EXT_G16_PP3**	**MISO_8K_EXT_G32_PP4**	**MISO_8K_EXT_G32_PP5**	**MISO_8K_EXT_G128_PP4**	**MISO_8K_EXT_G128_PP5**	**MISO_16K_EXT_G19_128_PP1**
Overall										
FFTSIZE	32K	8K	8K	8K	8K	8K	8K	8K	8K	16K
GI	1/128	19/128	1/8	19/256	1/16	1/32	1/32	1/128	1/128	19/128
Data Symbols	61	216	240	254	257	255	249	259	203	119
SISO/MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pilot Pattern	PP6	PP1	PP1	PP3	PP3	PP4	PP5	PP4	PP5	PP1
L1 Modulation	64QAM	16QAM	64QAM	64QAM	16QAM	64QAM	16QAM	64QAM	16QAM	64QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	256QAM	16QAM	256QAM	64QAM	16QAM	256QAM	16QAM	256QAM	16QAM	256QAM
Rate	4/5	1/2	2/3	4/5	3/5	3/4	4/5	1/2	3/5	3/4
FEC Type	64800	16200	16200	16200	16200	16200	64800	64800	16200	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	201	336	748	620	418	832	103	211	338	186
TI blocks per frame (N_TI)	3	3	3	4	4	4	4	4	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	3	3	4	4	4	4	4	3	3

Identifier	DTG150	DTG151	DTG152	DTG153	DTG154	DTG155	DTG156	DTG157	DTG158	DTG159
Stream Name	**MISO_16K_EXT_G8_PP1**	**MISO_16K_EXT_G19_256_PP3**	**MISO_16K_EXT_G16_PP3**	**MISO_16K_EXT_G32_PP4**	**MISO_16K_EXT_G32_PP5**	**MISO_16K_EXT_G128_PP4**	**MISO_16K_EXT_G128_PP5**	**MISO_32K_EXT_G19_256_PP2**	**MISO_32K_EXT_G16_PP2**	**MISO_32K_EXT_G32_PP4**
Overall										
FFTSIZE	16K	16K	16K	16K	16K	16K	16K	32K	32K	32K
GI	1/8	19/256	1/16	1/32	1/32	1/128	1/128	19/256	1/16	1/32
Data Symbols	122	126	126	126	124	126	124	63	63	63
SISO/MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO	MISO
PAPR	None	None	None	None	None	None	None	None	None	None
Frames per superframe	2	2	2	2	2	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pilot Pattern	PP1	PP3	PP3	PP4	PP5	PP4	PP5	PP2	PP2	PP4
L1 Modulation	64QAM	64QAM	64QAM	64QAM	64QAM	16QAM	64QAM	64QAM	64QAM	16QAM
PLP #0										
Type	1	1	1	1	1	1	1	1	1	1
Modulation	64QAM	256QAM	256QAM	256QAM	64QAM	64QAM	256QAM	256QAM	256QAM	256QAM
Rate	5/6	2/3	4/5	3/5	2/3	4/5	5/6	2/3	4/5	3/5
FEC Type	64800	64800	64800	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	143	206	206	207	155	155	207	199	199	208
TI blocks per frame (N_TI)	3	4	4	4	4	4	4	3	3	4
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0	0	0	0	0	0
Time Interleaving Length	3	4	4	4	4	4	4	3	3	4

Identifier	DTG160	DTG161	DTG162	DTG163	DTG164
Stream Name	**MISO_32K_EXT_G128_PP4**	**MISO_32K_EXT_G128_PP6**	**V121**	**16QAM_EXT**	**16QAM_NRM**
Overall					
FFTSIZE	32K	32K	32K	32K	32K
GI	1/128	1/128	1/128	1/128	1/128
Data Symbols	63	61	59	59	59
SISO/MISO	MISO	MISO	SISO	SISO	SISO
PAPR	None	None	None	None	None
Frames per superframe	2	2	2	2	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	Yes	Yes	Yes	Yes	No
Pilot Pattern	PP4	PP6	PP7	PP7	PP7
L1 Modulation	64QAM	64QAM	64QAM	QPSK	QPSK
PLP #0					
Type	1	1	1	1	1
Modulation	256QAM	64QAM	256QAM	16QAM	16QAM
Rate	3/4	4/5	2/3	1/2	1/2
FEC Type	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	208	154	202	101	98
TI blocks per frame (N_TI)	4	4	3	3	3
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1
Type of time-interleaving	0	0	0	0	0
Time Interleaving Length	4	4	3	3	3

Note:

DTG162 is identical to DTG109, except that it uses T2 specification version 1.2.1.

G.3 Single PLP Modes with FEFs

All single PLP modes with FEFs use HEM input stage mode, and ISSY. There is no Null Packet Deletion or in band signalling. L1 repetition and auxiliary streams are not used.

Identifier	**DTG201**	**DTG202**	**DTG203**	**DTG204**	**DTG205**	**DTG206**	**DTG207**
Stream Name	**FEF_1**	**FEF_2**	**FEF_3**	**FEF_4**	**FEF_5**	**FEF_6**	**FEF_7**
	VV020	**FEF 40ms**	**FEF 20ms**	**FEF 10ms**	**FEF 5ms**	**FEF 60ms** **FEF has power equal to T2 frame**	**FEF 100ms** **FEF has power equal to T2 frame**
Overall							
FFTSIZE	4K	32K	32K	32K	32K	32K	32K
GI	1/4	1/128	1/128	1/128	1/128	1/128	1/128
Data Symbols	15	59	59	29	15	59	19
SISO/MISO	SISO	SISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	None	None	None	None	None
Frames per superframe	4	4	2	2	2	4	4
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	No	Yes	Yes	Yes	Yes	Yes	Yes
Pilot Pattern	PP1	PP7	PP7	PP7	PP7	PP7	PP7
L1 Modulation	QPSK	BPSK	BPSK	BPSK	BPSK	BPSK	BPSK
FEF Type	0	0	0	0	0	0	0
FEF Length (samples)	78848	365713	182856	91428	45714	550000	914286
FEF Interval	2	4	2	2	2	1	1
FEF P1: S1 Value	2	2	2	2	2	2	2
FEF P1: S2 Value	1	1	1	1	1	1	1
L1 Repetition	0	0	0	0	0	0	0
PLP #0							
Type	1	1	1	1	1	1	1
Modulation	16QAM	256QAM	256QAM	256QAM	256QAM	256QAM	256QAM
Rate	1/2	2/3	2/3	2/3	2/3	2/3	2/3
FEC Type	64800	64800	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	3	201	201	99	53	201	66
TI blocks per frame (N_TI)	1	3	3	3	1	3	1
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1	1	1

Type of time-interleaving	0	0	0	0	0	0	0
Time Interleaving Length	1	3	3	3	1	3	1

G.4 Multiple PLP Modes

Identifier	DTG400	DTG401	DTG402	DTG403	DTG404
Stream Name	MPLP1	MPLP_RATE56	MPLP_QPSK	MPLP_2GRPS	MPLP_PI2
Overall					
T2 Specification Version	1.1.1	1.1.1	1.1.1	1.1.1	1.1.1
FFTSIZE	32K	32K	32K	8K	32K
GI	1/128	1/128	1/128	1/32	1/128
Data Symbols	27	27	27	108	27
SISO/MISO	SISO	SISO	SISO	SISO	SISO
PAPR	None	None	None	None	None
Frames per superframe	2	2	2	56	2
Bandwidth	8MHz	8MHz	8MHz	8MHz	8MHz
Extended Bandwidth Mode	Yes	Yes	Yes	Yes	Yes
Pilot Pattern	PP7	PP7	PP7	PP7	PP7
L1 Modulation	16QAM	64QAM	BPSK	BPSK	16QAM
Sub Slices per Frame	108	108	108	108	108
FEF	No	No	No	Yes	No
FEF Type				0	
FEF Length (samples)				476000	
FEF Interval				56	
FEF P1: S1 Value				010	
FEF P1: S2 Value				0001	
Number of PLPs	5	5	3	9	5
Number of PLP groups	1	1	1	2	1
L1 Repetition	No	No	No	No	No
TR Vclip	-	-	-	-	-
L1 Extension Present?	No	No	No	No	No
L1 Extension Block Type	-	-	-	-	-
L1 Extension Data Length	-	-	-	-	-
L1 Bias balancing cells present?	No	No	No	No	No
Number of Active L1 Bias balancing cells (per P2)	-	-	-	-	-
L1_ACE_MAX	-	-	-	-	-
Pseudo Fixed Frame Structure	No	No	No	No	No

Identifier	DTG400	DTG401	DTG402	DTG403	DTG404
Stream Name	MPLP1	MPLP_RATE56	MPLP_QPSK	MPLP_2GRPS	MPLP_PI2
***PLP Group 1* – Parameters used for data PLPs**					
Number of data PLPs	4	4	2	3	4
PLP_IDs	0,1,2,3	0,1,2,3	0,1	0,1,2	0,1,2,3
PLP_GROUP_ID	0	0	0	0	0
Type	2	2	2	2	2
Modulation	256QAM	256QAM	QPSK	256QAM	256QAM
Rate	2/3	5/6	1/2	2/3	2/3
FEC Type	64800	64800	64800	64800	64800
Rotated QAM	Yes	Yes	Yes	Yes	Yes
Max FEC blocks per interleaving frame	57	53	14	50	57
TI blocks per frame (N_TI)	1	1	1	1	1
T2 frames per Interleaving Frame (P_I)	1	1	1	1	1
Frame Interval (I_JUMP)	1	1	1	1	1
First frame index	0	0	0	0	0
Input Stage					
Mode	HEM	HEM	HEM	HEM	HEM
ISSY	Yes	Yes	Yes	Yes	Yes
BUFS (bits)	1613824	1671168	1048576	1769472	1613824
Design delay (samples)	938675	937468	949777	947563	938668
Null packet deletion	Yes	Yes	Yes	Yes	Yes
In Band Signalling	Yes	Yes	Yes	Yes	Yes
Number of other PLPs in-band signalling	0	0	0	0	0

Identifier	DTG400	DTG401	DTG402	DTG403	DTG404
Stream Name	MPLP1	MPLP_RATE56	MPLP_QPSK	MPLP_2GRPS	MPLP_PI2
***PLP Group 1* – Parameters used for common PLP**					
PLP_ID	4	4	2	3	4
PLP_GROUP_ID	0	0	0	0	0
Type	0	0	0	0	0
Modulation	64QAM	256QAM	QPSK	256QAM	64QAM
Rate	2/3	5/6	1/2	2/3	2/3
FEC Type	16200	16200	16200	16200	16200
Rotated QAM	Yes	Yes	Yes	Yes	Yes
FEC blocks per interleaving frame	35	23	9	20	35
TI blocks per frame (N_TI)	1	1	1	1	1
T2 frames per Interleaving Frame (P_I)	1	1	1	1	2
Frame Interval (I_JUMP)	1	1	1	1	1
First frame index	0	0	0	0	0
Input Stage					
Mode	HEM	HEM	HEM	HEM	HEM
ISSY	Yes	Yes	Yes	Yes	Yes
BUFS (bits)	483328	425984	1048576	327680	483328
Design delay (samples)	938675	937468	949777	947563	1865388
Null packet deletion	Yes	Yes	Yes	Yes	Yes
In Band Signalling	Yes	Yes	Yes	Yes	No
Number of other PLPs in-band signalling	0	0	0	0	

Identifier	DTG400	DTG401	DTG402	DTG403	DTG404
Stream Name	MPLP1	MPLP_RATE56	MPLP_QPSK	MPLP_2GRPS	MPLP_PI2
***PLP Group 2* – Parameters used for data PLPs**					
Number of data PLPs				4	
PLP_ID				4, 5, 6, 7	
PLP_GROUP_ID				1	
Type				1	
Modulation				QPSK	
Rate				2/3	
FEC Type				16200	
Rotated QAM				Yes	
FEC blocks per interleaving frame				12	
TI blocks per frame (N_TI)				1	
T2 frames per Interleaving Frame (P_I)				1	
Frame Interval (I_JUMP)				4	
First frame index				0, 1, 2, 3	
Input Stage					
Mode				HEM	
ISSY				Yes	
BUFS (bits)				1048576	
Design delay (samples)				3789343, 2858015, 1926687, 995359	
Null packet deletion				Yes	
In Band Signalling				No	
Number of other PLPs in-band signalling					

Identifier	DTG400	DTG401	DTG402	DTG403	DTG404
Stream Name	MPLP1	MPLP_RATE56	MPLP_QPSK	MPLP_2GRPS	MPLP_PI2
***PLP Group 2* – Parameters used for common PLP**					
PLP_ID				8	
PLP_GROUP_ID				1	
Type				0	
Modulation				QPSK	
Rate				2/3	
FEC Type				16200	
Rotated QAM				Yes	
FEC blocks per interleaving frame				3	
TI blocks per frame (N_TI)				1	
T2 frames per Interleaving Frame (P_I)				1	
Frame Interval (I_JUMP)				1	
First frame index				0	
Input Stage					
Mode				HEM	
ISSY				Yes	
BUFS (bits)				1048576	
Design delay (samples)				3789343	
Null packet deletion				Yes	
In Band Signalling				Yes	
Number of other PLPs in-band signalling				0	

Identifier	DTG411	DTG412
Stream Name	MPLP_L1_ACE 2	MPLP_L1_REP
Overall		
T2 Specification Version	1.2.1	1.2.1
FFTSIZE	16K	32K
GI	1/32	1/128
Data Symbols	54	27
SISO/MISO	SISO	SISO
PAPR	P2-TR & L1-ACE only	P2-TR & L1-ACE only
Frames per superframe	2	2
Bandwidth	8MHz	8MHz
Extended Bandwidth Mode	Yes	Yes
Pilot Pattern	PP7	PP7
L1 Modulation	BPSK	16QAM
Sub Slices per Frame	135	108
FEF	None	None
FEF Type	-	-
FEF Length (samples)	-	-
FEF Interval	-	-
FEF P1: S1 Value	-	-
FEF P1: S2 Value	-	-
Number of PLPs	19	5
Number of PLP groups	2	1
L1 Repetition	No	Yes
TR Vclip	3.55	infinity
L1 Extension Present?	No	No
L1 Extension Block Type	-	-
L1 Extension Data Length	-	-
L1 Bias balancing cells present?	Yes	No
Number of Active L1 Bias balancing cells (per P2)	178	-
L1_ACE_MAX	0.23	0
Pseudo Fixed Frame Structure	No	No

Identifier	DTG411	DTG412
Stream Name	MPLP_L1_ACE 2	MPLP_L1_REP
***PLP Group 1* – Parameters used for data PLPs**		
Number of data PLPs	3	4
PLP_IDs	0, 1, 2	0, 1, 2, 3
PLP_GROUP_ID	0	0
Type	2	2
Modulation	256QAM	256QAM
Rate	2/3	2/3
FEC Type	64800	64800
Rotated QAM	Yes	Yes
Max FEC blocks per interleaving frame	50	57
TI blocks per frame (N_TI)	1	1
T2 frames per Interleaving Frame (P_I)	1	1
Frame Interval (I_JUMP)	1	1
First frame index	0	0
Input Stage		
Mode	HEM	HEM
ISSY	Yes	Yes
BUFS (bits)	1769472	1613824
Design delay (samples)	949985	939294
Null packet deletion	Yes	Yes
In Band Signalling	Type A	Types A and B
Number of other PLPs in-band signalling	0	0

Identifier	**DTG411**	**DTG412**
Stream Name	MPLP_L1_ACE 2	MPLP_L1_REP
***PLP Group 1* – Parameters used for common PLP**		
PLP_ID	3	4
PLP_GROUP_ID	0	0
Type	0	0
Modulation	256QAM	64QAM
Rate	2/3	2/3
FEC Type	16200	16200
Rotated QAM	Yes	Yes
FEC blocks per interleaving frame	20	35
TI blocks per frame (N_TI)	1	1
T2 frames per Interleaving Frame (P_I)	1	1
Frame Interval (I_JUMP)	1	1
First frame index	0	0
Input Stage		
Mode	HEM	HEM
ISSY	Yes	Yes
BUFS (bits)	327680	483328
Design delay (samples)	949985	939294
Null packet deletion	Yes	Yes
In Band Signalling	Type A	Types A and B
Number of other PLPs in-band signalling	0	0

Identifier	DTG411	DTG412
Stream Name	MPLP_L1_ACE 2	MPLP_L1_REP
***PLP Group 2* – Parameters used for data PLPs**		
Number of data PLPs	14	
PLP_IDs	4..17	
PLP_GROUP_ID	1	
Type	2	
Modulation	256QAM	
Rate	2/3	
FEC Type	16200	
Rotated QAM	Yes	
Max FEC blocks per interleaving frame	1	
TI blocks per frame (N_TI)	1	
T2 frames per Interleaving Frame (P_I)	1	
Frame Interval (I_JUMP)	1	
First frame index	0	
Input Stage		
Mode	NM	
ISSY	Yes	
BUFS (bits)	1048576	
Design delay (samples)	999961	
Null packet deletion	Yes	
In Band Signalling	Type A	
Number of other PLPs in-band signalling	0	

Identifier	**DTG411**	**DTG412**
Stream Name	MPLP_L1_ACE 2	MPLP_L1_REP
***PLP Group 2* – Parameters used for common PLP**		
PLP_ID	18	
PLP_GROUP_ID	1	
Type	0	
Modulation	256QAM	
Rate	2/3	
FEC Type	16200	
Rotated QAM	Yes	
FEC blocks per interleaving frame	1	
TI blocks per frame (N_TI)	1	
T2 frames per Interleaving Frame (P_I)	1	
Frame Interval (I_JUMP)	1	
First frame index	0	
Input Stage		
Mode	NM	
ISSY	Yes	
BUFS (bits)	1048576	
Design delay (samples)	999961	
Null packet deletion	Yes	
In Band Signalling	Type A	
Number of other PLPs in-band signalling	0	

H LCN Use Case Scenarios

Use Case	Service Name	HD/ SD	ONID	SID	LCN	HD simulcast LCN	TRD				Description	TRD Resolution	Receiver Behaviour
							Country	Primary	Secondary	Tertiary			
1	BBC 1	SD	0x233A	1	1		GBR	England	South		The ONID and SID for both services are the same and therefore they are duplicate services. Both services are on the same branch of the TRD.		On a UK network this means that the services are identical. Since they have the same TRD, the receiver must discard one of the duplicate services using quality criteria.
	BBC 1	SD	0x233A	1	1		GBR	England	South				
2	BBC 1 Scotland	SD	0x233A	1	1		GBR	Scotland	South		The services clash on LCN but have different SID and are located on different branches of the TRD indicating that they are regional variants of BBC1.	Scotland/South	Receiver presents choice of region to viewer for manual selection. Services from the viewer's prefered region (in this case a single service) are stored in the broadcast range and the unselected service may optionally be stored in the variant range (800-899)
	BBC 1 England	SD	0x233A	5	1		GBR	England	North			England/North	
3	BBC 1	SD	0x233A	5	1		GBR	England	North		A range of services populated at different levels of TRD with two different regions at the secondary level.	GBR/England / North	The BBC1 service with SID 5 is stored in the broadcast range. The receiver may optionally store the regional variant in the variant range. BBC 2 and BBC 3 will be stored in the broadcast range.
	BBC 1	SD	0x233A	6	1		GBR	England	South				
	BBC 2	SD	0x233A	10	2		GBR	England				GBR/England / South	The BBC1 service with SID 6 is stored in the broadcast range. The receiver may optionally store the regional variant in the variant range. BBC 2 and BBC 3 will be stored in the broadcast range.
	BBC 3	SD	0x233A	11	7		GBR						
4	BBC 1	SD	0x233A	5	1		GBR	England	North		A range of services populated at different levels of TRD but all part of the same "branch".		There are no LCN or service clashes, so no region choice is presented to the viewer and the HD service is swapped with the SD service on LCN 1.
	BBC 1 HD	HD	0x233A	8	50	1	GBR	England	North				
	BBC 2	SD	0x233A	10	2		GBR	England					
	BBC 3	SD	0x233A	11	7		GBR						

Use Case	Service Name	HD/ SD	ONID	SID	LCN	HD simulcast LCN	TRD				Description	TRD Resolution	Receiver Behaviour
							Country	Primary	Secondary	Tertiary			
5	BBC 1 Scotland	SD	0x233A	1	1		GBR	Scotland	South		All three services are unique in terms of ONID and SID. There are two regional variant SD services and an HD service in one of the regions which has an HDS that points to the same LCN as the SD service.	England/North	The receiver first processes the LCNs and, based on TRD, offers the viewer a choice between Scotland/South and England/North. The viewer selects England/North. The receiver stores England services in the broadcast range. The receiver may optionally store the Scotland service in the variant range. The receiver then processes the HDS for services in the broadcast range. As the TRDs match, the HD service at LCN 50 is swapped with the SD service at LCN 1.
	BBC 1 England	SD	0x233A	5	1		GBR	England	North				
	BBC 1 England HD	HD	0x233A	12	50	1	GBR	England	North			Scotland/South	The receiver first processes the LCNs and, based on TRD, offers the viewer a choice between Scotland/South and England/North. The viewer selects Scotland/South. The receiver stores Scotland services (in this example a single service) in the broadcast range. If there is no clash of LCN, the receiver stores services from non-preferred regions in the broadcast range. The HD service will therefore be placed at LCN 50. Where there is a clash of LCN, the receiver may optionally store the non-preferred regional variant(s) (in this case the BBC1 England SD service) in the variant range. The receiver then processes the HDS for services in the broadcast range. As the TRD of the HD service does not match the viewer's preference, the HD service remains at LCN 50.
6	BBC 1 NI	SD	0x233A	1	1		GBR	NI	East		There are two foreign services, one with TRD and one without. There are two UK services, one SD and one HD. The HD service has an HDS for LCN 1.	GBR/NI/East	The SD service is placed at LCN 1. Since the TRD of the HD service does not match the viewer's preference, it is not swapped and remains at LCN 50.
	Eire 1	SD	1234	5	1								
	Calais 1	SD	5678	5			FRE	Nord	Calais				
	BBC 1 NI HD	HD	0x233A	8	50	1	GBR	NI	West			GBR/NI/West	The SD service is initially placed at LCN 1, because there is no service at that LCN from the user's preferred region. Since the TRD of the HD service matches the viewer's preference, it is swapped to LCN 1.

Use Case	Service Name	HD/ SD	ONID	SID	LCN	HD simulcast LCN	TRD				Description	TRD Resolution	Receiver Behaviour
							Country	Primary	Secondary	Tertiary			
7	BBC 1 HD	HD	0x233A	8	50	1	GBR	England			A range of services populated at different levels of TRD but all part of the same "branch". Due to local reception conditions, the SD service intended to be present at LCN 1 is not receivable.		There is no SD service at the LCN targetted by the HD service's HDS. Therefore, the HD service will move to LCN 1 and LCN 50 will be empty. BBC 2 and BBC 3 appear at their signalled LCNs.
	BBC 2	SD	0x233A	10	2		GBR	England					
	BBC 3	SD	0x233A	11	7		GBR						
8	CH4	SD	0x233A	5	4		GBR	England	West		There are multiple ONID/SID and LCN clashes plus HD services with HDS. There are TRDs present for GBR/England and GBR/Wales. There are LCN clashes on 1, 4, 50 & 52 and CH4 SID 5 has an LCN of 8 for Wales and an LCN of 4 for England. This scenario reflects the situation where a receiver sees services from two different regions on the border between Wales and England.	GBR/England /West	After processing LCNs and duplicate services, the broadcast range contains: BBC1 West at LCN 1, CH4 at LCN 4,BBC1 HD (SID 11) at LCN 50, CH4HD at LCN 52, S4CHD at LCN 53 (although "out of region" the LCN is available). The receiver may optionally store S4C, BBC1 Wales and BBC1 HD (SID 12) in the variant range. The CH4 signalled with LCN 8 is discarded as a duplicate service (ie: no service stored at LCN 8). The Ch4HD service with target region GBR/Wales is discarded as a duplicate service. Looking at services in the broadcast range, there is one HDS pointing at LCN 1 so this is swapped with LCN 50. There are two HDSs competing for LCN 4. However, CH4HD matches the user's TRD preference and is swapped with CH4 at LCN4. S4CHD remains at LCN 53. After the swaps the broadcast range contains: BBC1 HD (SID 11) at LCN 1, CH4HD at LCN 4, BBC1 West at LCN 50, CH4 at LCN 52, s4CHD at LCN 53.
	CH4HD	HD	0x233A	7	52	8	GBR	Wales					
	CH4HD	HD	0x233A	7	52	4	GBR	England					
	CH4	SD	0x233A	5	8		GBR	Wales					
	S4C	SD	0x233A	20	4		GBR	Wales					
	S4CHD	HD	0x233A	21	53	4	GBR	Wales				GBR/Wales	After processing LCNs and duplicate services, the broadcast range contains: BBC1 Wales at LCN 1, S4C at LCN 4, CH4 at LCN 8, BBC1 HD (SID 12) at LCN 50, CH4HD at LCN 52, s4CHD at LCN 53. The receiver may optionally store BBC1 West and
	BBC1 West	SD	0x233A	1	1		GBR	England	West				

Use Case	Service Name	HD/ SD	ONID	SID	LCN	HD simulcast LCN	TRD				Description	TRD Resolution	Receiver Behaviour
							Country	Primary	Secondary	Tertiary			
	BBC1 HD	HD	0x233A	11	50	1	GBR	England					BBC1 HD (SID 11) in the variant range. The CH4 service with target region GBR/England/West and CH4HD with target region GBR/England are discarded as duplicate services. Looking at services in the broadcast range, there are three HDSs each pointing to a unique LCN (1, 4 and 8) so these are all swapped. After the swaps the broadcast range contains: BBC1 HD (SID 12) at LCN 1, S4CHD at LCN 4, CH4HD at LCN 8, BBC1 Wales at LCN 50, CH4 at LCN 52, S4C at LCN 53.
	BBC1 Wales	SD	0x233A	2	1		GBR	Wales					
	BBC1 HD	HD	0x233A	12	50	1	GBR	Wales					

General principles in remote control design

I.1 Introduction

This section is intended to give prompts for design reviews of user interfaces for digital TV receivers.

I. 2 Handset feel and comfort

I.2.1 Size and shape

Is the handset large enough to hold comfortably? Is it easy to manipulate using the right or left hand? (e.g. are all buttons accessible with one-handed use?)

When the handset is placed on a flat surface, can it be operated with one finger?

Larger handsets enable larger buttons, labels, and spaces between buttons making them easier to use for people with sight loss and/or manual dexterity problems. In addition, they can be more comfortable to hold when designed to fit average human hand size.

For more information on anthropometric data see DTI DATA [96].

I.2.2 Centre of gravity and weight

Is the remote control well-balanced and heavy enough to hold comfortably?

The centre of gravity should be such that the remote control sits comfortably in the hand. This must be evaluated with the batteries in position. The remote control should also be designed to be easily operated with either the left or right hand. Whilst there is a tendency to develop lightweight products, consumers tend to prefer slightly heavier TV remote controls.

I.2.3 Texture

Is the remote control material non-slippery and easy to grip?

The remote control should be made of an easy grip material (without being abrasive) rather than smooth plastic that slips easily out of the hand. Avoid materials such as shiny metallic (chrome) or smooth plastic that produce glare which can make it difficult to see the buttons and labels.

Have the materials specified for the remote control taken in to account any necessary toxicity or allergy issues?

Each manufacturer should be able to provide details of raw material content to ensure that harmful or potentially allergic materials are not present (e.g. latex).

I.2.4 IR Transmission

Can the handset operate the target receiver from a range of angles?

The area (both horizontal and vertical) in which the digital receiver is able to detect the signal from the remote control should be as broad as possible as direct aim towards the digital receiver can be difficult for some users. Consideration must also be given to the physical mounting position of the receiver module as this can adversely affect both the angle and range of the IR transmission. Is the angle and range fully specified?

Has a suitable IR transmission protocol been selected?

The IR transmission protocol specified should ensure that there is no potential interference with other devices. Careful consideration should also be given to potential post installation support to ensure that alternative manufacturers could supply replacement product using the same IR transmission protocol.

I.3 Button layout and design

I.3.1 Functional groups

Are buttons of the same functional category grouped together?

It is easier to identify, operate, and differentiate functions when buttons are grouped together by similar category (for example, numeric buttons, colour buttons, navigation buttons, volume up/down, additional services).

I.3.2 Spacing

Is there variation in spacing between buttons (e.g. bigger spaces between functional groupings)?

Spaces between buttons should be greater between functional button groupings than within groupings, as this makes buttons and groupings of buttons easier to identify and locate.

Are the buttons within a functional group well separated (e.g. by I% to 50% of button width)?

I.3.3 Position

Are more frequently used buttons placed in the most easy to find locations?

Prioritise buttons for inclusion on the handset based on frequency of use. More frequently used functions include stand-by, channel and volume adjustment, and the EPG service and related buttons ("OK" and "back").

Are standardised or commonly used button layouts used where appropriate?

Consider the comfortable position of the thumb assuming that the user holds and manipulates the control with just one hand, left or right.

If the shape of the casing encourages a particular way of holding the remote (for example, with indents for fingers), ensure buttons are easy to reach when the remote is held in this way.

Section I.4 makes recommendations in this respect.

Do button positions conform to response stereotypes - "programme up" button above "programme down" button; "volume up" to right or above "volume down"?

The position of buttons relative to others can sometimes be indicative, or at least consistent, with their function. This can help locate buttons manually with reduced reliance on visual inspection. For example, at the simplest level, the relative positions of the arrow keys should be consistent with their direction ("arrow up" above "arrow down", and "arrow right" adjacent right to "arrow left"), decrease/increase (for example, volume, programme number) can be suggested by relative button positions that are left/right, below/above respectively.

I.3.4 Location marker

Is there a raised dot ("nib") on the number "5" button?

A raised dot ("nib") on the number "5" button should be provided to help users find the centre of the numeric keypad. This is especially helpful for people with visual impairments who may rely on the "5" button to orient themselves on the remote control. This is consistent with the European Telecommunications Standards Institute (ETSI) standard for tactile identifiers ETSI ES 201 381 [8].

I.3.5 Distinctiveness

Are buttons intuitively differentiable by size, shape, position and texture?

Intuitively distinctive buttons make the remote control easier to use by touch alone. Buttons can be differentiated by:

•Size

Larger button sizes that are well separated are preferred by users both with and without visual impairments. These facilitate discrete button selection and reduce the need to re-focus when switching visual attention between the television and the remote control.

The most important buttons should be the largest. Optimal button size may be informed by average thumb size data.

For more information on anthropometric data see DTI DATA [96].

•Shape

Button shape can be consistent with function (for example, the four directional keys for moving around the menus could be shaped as arrows pointing in their respective direction). Hollows in buttons (small circular centre) give clear ridges making them easy to find, comfortable to press, and easy to clean.

•Texture

Textures can be used to differentiate particularly important or frequently used buttons.

•Force / Sensitivity

The button should be designed to ensure that it is not over sensitive and will not be accidentally pressed while the user is locating the button by touch.

I.3.6 Colour

Are the four standard colour buttons (red, green, yellow, blue) coloured correctly and in the standard order (see Section I.4.11) and the only buttons with these as their background colours?

People are most familiar with the standard four colour buttons – red, green, yellow and blue. Ensure that the colours used are clear and unambiguous shades of those colours and could not be mistaken for another colour. Where possible, consistency with analogue is desirable. Having more than one button with their background as one of the reserved colours (red, green yellow, blue) may confuse the user when the on-screen display gives options that require the user to respond using the colour buttons. For example, a user may press a red stand-by button instead of the red colour button. See also Section I.4.1.

Is there sufficient contrast between the buttons, labels and background?

As a general rule, higher contrast increases visibility. Solid background colours (rather than patterned) are desirable.

I.3.7 Toggle

Do toggle buttons have only two states?

Toggle keys are useful in that they reduce the need for extra buttons, however, when they are associated with more than two states (options) it may be difficult for the user to remember the order of the options.

The state of a toggle button when it has been pressed should ideally be briefly represented by a suitable icon on the screen and as appropriate by some form of optional visual or acoustic feedback (see Section I.4.8)

I.3.8 Feedback

Is there one or more simple mechanisms to confirm button press (e.g. a click)?

Users like to know that they have successfully pressed a button. This is especially important for people with visual impairments. Feedback should be provided to notify users of each button press. Note that such feedback should ideally be a response of the receiver to signal that the remote control command initiated by the user has been received and understood by the receiver.

If possible, provide multi-sensory feedback (for example, auditory/visual/tactile). Buttons that elicit a more pronounced tone (as with mobile phones) could be optional and user specified. At the very least a receiver should provide some visual feedback visually that a button has been pressed, either by a light on the remote control, on the display or even set top box.

For more information see reference[57].

I.3.9 Labelling

Is button labelling clear and legible (font, size and colour contrast), durable, and consistent with on-screen display text?

Include clear, legible, and durable button labelling that is consistent with any on-screen text. Sans serif fonts (i.e. those without details at the extremities of characters) are easier to read. Abbreviations (e.g. such as OK, TV) should be in upper case. Strong colour contrasts between labels and background increase usability. The labelling should not easily become indistinct or wear off with use and time.

The remote control labels should directly match the on-screen options (for example, users may be confused when the on-screen "select" option is meant to relate to the remote control "OK" button). Labelling terms should be unambiguous and easily understood. Where practical, abbreviations should be avoided.

57. Trace R & D Centre, University of Wisconsin-Madison (working draft,1992) Accessible Design of Consumer Products: Guidelines for the Design of Consumer Products to Increase their Accessibility to People with Disabilities or Who Are Ageing: http://trace.wisc.edu/docs/consumer_product_guidelines/consumer.htm, accessed 2003.

I.4 Recommendations for remote control button labelling

The following table gives recommendations for remote control labelling of the core functions offered by a typical DTT receiver. The recommendation is made exactly as printed in quote marks in the table. Capitalization of button labels should be consistent, e.g. always lower case or always 'Sentence case'. If there is no recommendation in quote marks see the appropriate note for that function in Sections I.3.1 to I.3.16, and I.4.1 to I.4.9.

Broadcasters and interactive content developers should use the recommended labelling when referencing the receiver functions in on-screen instructions.

Unless specifically stated it is recommended to print the label either on or immediately adjacent to the button.

The fourth column of the table below shows whether the button is considered essential or strongly recommended for effective operation of the remote control.

The fifth column gives the recommendations for the actual button labelling.

Note the colours red, green, yellow, and blue should only be used as background colours for the buttons described in Section I.3.11 "Red, green, yellow and blue colour buttons". Other backgrounds colours may be used for all other buttons.

Number	Function	Description	Presence of button Essential/ Strongly Recommended	Recommendation for labelling
I.4.1	On/standby	To toggle between active and stand-by mode.	Essential	⏻
I.4.2	Numerals 0-9	"0", "1", "2", "3", "4", "5", "6", "7", "8", "9"	Essential	"0", "1", "2", "3", "4", "5", "6", "7", "8", "9"
I.4.4	Up, Down, Left, Right	"Cursor" button used to provide user interaction to a variety of receiver functions.	Essential	See Section
I.4.5	OK/Select	Allow the user to confirm or select a particular screen choice or action.	Essential	
I.4.6	Back	Allow the user to move back one step in an interactive application, EPG or other user interaction function	Essential	"back" or "return"
I.4.7	Return to sound and/or vision	Allow the user to immediately exit any receiver function currently in use and return to previously selected service. (see Section .	Strongly recommended	"TV" or "Exit"
I.4.8	Info	To display a now/next banner and/or selected/highlighted information.	Essential	**i**
I.4.9	Text	The text button may launch a broadcast interactive application of any kind.	Essential	"text"
I.4.10	Guide	To display event information for all services.	Strongly recommended	"guide"
I.4.11	Red, Green, Yellow, Blue	Buttons available to receiver functions to aid user interaction.	Essential	See Section
I.4.12	Volume up, Volume down	Increase or decrease the audio level.	Strongly recommended	See Section
I.4.13	Sound Mute	Mute or unmute the audio output.	Essential	🔇
I.4.14	Program up/down	Step up or down to the next service available to the user, normally ordered by number.	Essential	"P+", "P-", "P▲","P▼" "CH+"," CH-", "CH▲"," CH▼"
	Menu	Access the receiver top level screens	Essential	"menu"
I.4.15	Subtitles	Toggles visibility of subtitles.	Essential	"S"
I.4.16	Audio Description	Toggles description when available	Strongly recommended	"AD"

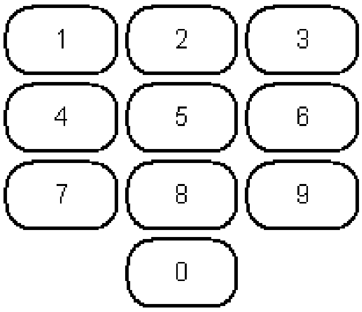
Table I-1. Remote control button labelling recommendation for DTT Receiver

I.4.1 On/stand-by

The on/stand-by button should be positioned away from the other buttons on the remote control. The ⏻ symbol should be used. The symbol should be moulded and/or printed on the button, or printed adjacent to the button. The button or symbol should **not** be coloured red (see Section I.2.3.6).

I.4.2 Numeric buttons 0-9

It is preferred that where practicable the numeric buttons 1-9 should be positioned in 3 rows of numbers, with "1" at the top left and "9" on the bottom right. The 0 (zero) key should be on an additional row beneath these three rows as is shown in Figure I-1:



FigureI-1. Preferred layout for numeric keys

The 5 (five) button should have a nib on or adjacent to the button (ETSI standard for tactile marking ETSI ES 201 381 [38]).

I.4.3 Alphabetic entry

Alpha entry on a standard handset (one without an inbuilt alpha-only keypad) should follow the format used by mobile telephones for SMS functionality (see ETSI ETS 300 640 [5]). This includes the numeric button "1" reserved for punctuation/symbols and the numeric button "0" for inserting a space. The letters should be printed either on or adjacent to the relevant button – the number in bold, the letters in normal type.

Lower case is preferred, but not essential.

I.4.4 Up, down, left, right (navigation/cursor buttons)

Navigation/cursor buttons should have symbols printed and/or moulded, in order to indicate direction – i.e. arrows or triangles. The buttons should be positioned in a discrete cluster around the "OK" button. The "up", "down", "left" and "right" cursor buttons should be positioned above, below, left and right of the "OK" buttons respectively.

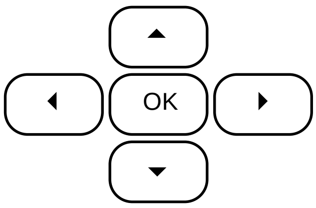


Figure 25-2. Preferred layout for navigation keys

I.4.5 OK/Select

The button is used to select user interaction items within an interactive application or other receiver function. This button should be clearly described in the user guide, particularly if the recommendation is not adopted. The EPG or User Interface must be consistent with the label that is chosen for the remote control.

The button should be positioned in the centre of the navigation cluster, and ideally be a discrete button rather than a rocker. The button should also be easily differentiated from others by touch.

I.4.6 Back

This button returns the user to the previous "level" in an interactive application or other receiver function (e.g. EPG). Note that using this button for a historical back function is also allowed. If the button is pressed and the user is at the "top level" of an interactive application or receiver function this function will normally invoke an exit from that application or receiver function.

In DTT, this button should be mapped to the MHEG "cancel" function (see Section 13.6 "User input"). This "cancel" function should **not** be mapped to a button called "exit" or "cancel" as implied in previous editions of this document.

I.4.7 Return to sound and/or vision

This button invokes a receiver function that returns the user directly to the last *selected* service or known channel, and acts as though the user has just tuned to that service using the EPG or P+/P- keys (i.e. any running EPG or interactive application(s) is immediately terminated and the user views the video/audio for that service if present).

If there is an auto-boot application present in this selected service the boot process is started.

I.4.8 Info

This button is used to display either a now/next banner, or information on the currently viewed event, or both.

I.4.9 Text

This button is used to toggle visibility of interactive services – see Section 19.3 "Use of the "Text"and "Cancel" function".

I.4.10 Guide

This button is normally used to display a full screen EPG if present.

I.4.11 Red, green, yellow and blue colour buttons

The buttons should be self-coloured. It is strongly preferred that they are in a horizontal or near horizontal line on the handset, and they shall be in order (from left to right) of red, green, yellow and blue. The four colours should contrast strongly against the remote control case colour.

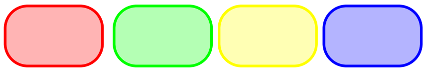


Figure 25-3. Preferred layout for colour buttons (red, green, yellow, blue)

I.4.12 Volume up, volume down

These buttons use the recognised symbol for volume (⊿) with a plus and minus symbol as appropriate. The text "Vol" may also be used.

Note that volume up/down function may exist as two distinct and separate buttons, or may exist as a single "rocker" button. The "+" button should be mounted above or to the right of the "-" button.

I.4.13 Mute

Mute function should be overridden by pressing "Volume up" or "Volume down".

I.4.14 Program up, program down

This button should select the next available service in the receiver's channel list.

The program up button (P+, CH+, P▲, CH▲) should be mounted above or to the right of the program down key (P-, CH-, P▼, CH▼)

I.4.15 Subtitles

This button is used to toggle between displaying subtitles (if available with the selected service) and not displaying them.

The function should be available directly from the remote control.

Note that the digital receiver should maintain the selected state ("display"/"don't display" subtitles) across channel changes unless otherwise determined by a user-setting in a suitable set-up menu.

I.4.16 Audio Description

This button is used to control the decoding of Audio Description if available with the selected service and event and if the receiver supports AD.

The button toggles between presenting Audio Description (AD) mixed with programme sound or just presenting programme sound. The receiver may be capable of directing the mix to independent audio outputs (e.g. phono and/or headphone) in which case this function controls the relevant output.

The function should be available directly from the remote control if the receiver supports AD.

Note that the digital receiver should maintain the selected state ("present AD"/"don't present AD") across channel changes.

I.5 Recorder labelling recommendations

This section details the additional specific buttons that are considered essential or strongly recommended for a recorder remote control. The table below also details the recommendation for labelling or the preferred symbol to be used.

When designing a recorder remote control the principles of sections I.1, I.2 and I.3 should be applied in conjunction with the additional recommendations of this section I.4.

Number	Recorder Function	Typical Product Behaviour	Presence of button (Essential / Strongly Recommended)	Recommendation for labelling or preferred symbols
I.5.1	Play	To start or resume playback of a recording or buffered event . See I.5.3 for further detail on combination with Pause button.	Essential	▶
I.5.2	Pause	To pause live broadcast or the current selected recording. - see also I.5.3 for further detail on combination with Play button.	Essential	❚❚
I.5.3	Play/Pause	To combine the Play and Pause functions as described above in one single button.	Alternative to I.4.1 and I.4.2	▶❚❚
I.5.4	Stop	To stop playback or pause live TV.	Strongly recommended	■
I.5.5	Record	Record the current event if available and optionally the selected event .	Essential	●
I.5.6	Fast forward	Fast forward the replay of a event or the contents of the live buffer.	Essential	⏩
I.5.7	Fast reverse	Fast reverse the replay of a event or the contents of the live buffer.	Essential	⏪
I.5.8	Library	Shows the current list of recorded events on the storage media.	Strongly recommended	“Lib”, “library”,"Library"

I.5.9	Timer list	To show planned recordings or add manual recordings	Strongly recommended	"Timer" or "timer"

Table I-2. Remote control button labelling recommendation for a Recorder

I.5.1 Play

This button has the dual function of starting to play either a live broadcast or selected recording and also to resume a live broadcast or selected recording that has been paused by the user. The play button should be positioned directly to the side or directly above / below the pause button (see I.5.2).

The play and pause buttons may be combined on a single rocker button.

When a rocker button is used then both symbols for play and pause must be clearly printed on the rocker button as 2 separate symbols. This should guide the user clearly where to press the rocker button to activate either the play or pause function.

Alternatively the play and pause buttons may be combined to be used as a single button toggle (see I.5.3).

I.5.2 Pause

This button pauses the current recording or playback of live broadcast. This will freeze the current frame on screen. The pause button may also have the function to resume the current recording or playback of live broadcast when pressed again.

The play and pause buttons may be combined on a single rocker button.

When a rocker button is used then both symbols for play and pause must be clearly printed on the rocker button as 2 separate symbols. This should guide the user clearly where to press the rocker button to activate either the play or pause function.

Alternatively the play and pause buttons may be combined to be used as a single button toggle (see I.5.3).

I.5.3 Play/Pause

This button may be used to combine the Play and Pause functions as described in I.5.1 and I.5.2. This single button will have the recommended symbol as shown in the table. The button will toggle between the Play and Pause functions.

I.5.4 Stop

This button is used to stop playback or pause live TV. This will return the device back to a previously reserved state or logical condition

I.5.5 Record

This buttonis used to record the current event if available, and optionally the selected event from an EPG. This button should be identified by a red circle printed on the centre of the button. The button itself shall not be red in colour to avoid confusion with the red button referred to in Section I.4.11. It is recommended that if the record button is a dark colour then a white circular border should be printed around the outside of the red circle to improve the visual contrast.

A white letter "R" printed on the red circle can be used for additional visual clarity.

I.5.6 Fast forward

This button is used to fast forward the replay of a event or the contents of the live buffer. This function may also have the feature that by pressing the button again the speed of fast forward would be increased.

This button should be located to the right of the Fast reverse button (see I.5.7and I.6).

I.5.7 Fast reverse

This button is used to fast reverse the content of a event or the contents of the live buffer. This function may also have the feature that by pressing the button again the speed of fast reverse would be increased.

This button should be located to the left of the Fast forward button (see I.5.6 and I.6).

I.5.8 Library

This button is used to display the current list of recorded events on the storage media. This button should be located close to the navigation keys (see I.4.1) to allow easy navigation once in the library.

I.5.9 Timer list

This button is used to display the planned recordings or give access to add further recordings manually.

I.6 Recorder Functional Groups

Good remote control design will ensure that the following Recorder specific keys are grouped together in a distinctive group (see principles outlined in I.4)

The following principles should apply to the grouping of particular Recorder specifc buttons:

Play, pause or play/pause, stop (if present), fast forward and fast reverse should be grouped as a clearly distinguishable set of buttons on the remote control.

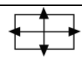
The record button may be part of this Recorder specific group of buttons or it may be more prominently located on its own for clarity.If the record button is located on its own it should be adjacent to the Recorder specific group of buttons.

Play and pause, if separate buttons, should be adjacent and either alongside or above and below one another.

The fast forward and fast reverse keys should be in the same horizontal row of buttons with fast forward positioned to the right of fast reverse.

I.7 Receiver with integrated display labelling recommendations

This section details the additional specific buttons that are considered essential or strongly recommended for a receiver with integrated display remote control. The table below also details the recommendation for

Number	Function	Description	Presence of button Essential/ Strongly Recommended	Recommendation for labelling
I.6.1	Aspect	To toggle between displayable aspect ratios	Essential	 or “aspect”
I.6.2	Input	Selects or toggles between the input sources	Essential	 or “input”
I.6.3	Previous Channel	Selects last viewed channel	Strongly Recommended	 or “Pre Ch”
I.6.12	Volume up, Volume down	Increase or decrease the audio level.	Essential	See Section

labelling or the preferred symbol to be used.

Table I-1 Recommended control functions for DTT Receiver