TV-Anytime
Phase 1

— a decisive milestone in open standards for Personal Video Recorders

Jean-Pierre Evain
European Broadcasting Union

Hervé Murret-Labarthe
CANAL+ Technologies

TV-Anytime is an "open" set of specifications for use with personal video recorders. It is being adapted for use in Europe (the DVB Consortium), Japan (ARIB), the USA (ATSC) and other areas. This article describes Phase 1 of the specifications, which will shortly be published as ETSI Technical Specifications and Reports.

Personal Video Recorders (PVRs) – also known as **Personal Digital Recorders** (PDRs) and sometimes as **Digital Video Recorders** (DVRs) – may soon fundamentally change the media delivery industry. Although several proprietary PVR systems are already available in some markets (e.g. TiVo in the USA), many believe that the real international age of PVRs will arrive with the use of "open" systems.

TV-Anytime (TVA) – a worldwide pre-standardization body – has developed open specifications for the next generation of PVR products to be retailed in a horizontal market of equipment and services. Continuing on DAVIC's vision, TV-Anytime has specified a set of tools that will allow richer relationships to be established between content producers, service providers and consumers. The two main objectives of TV-Anytime are:

❍ to ensure that users have access to personalised content (i.e. according to their specific interests) from the largest possible variety of content providers who, themselves, will benefit from these exchanges.

❍ to add value by allowing the users to access and use this content when and where they like, without being bound by restrictive access and usage rules.

With Phase 1, the TV-Anytime Forum has developed a set of open specifications that enable the interoperable searching, selection, acquisition and management of content – independent of the means of delivery. It addresses unidirectional broadcasts that are associated with bi-directional ancillary information / metadata services. This is made possible using the tools proposed by TV-Anytime, covering (i) content and user-related description metadata, (ii) content identification and location, and (iii) access to metadata services and associated security mechanisms.

ARIB (in Japan), ATSC (in the USA), DVB (in Europe) and others are working on the adaptation of TV-Anytime in their respective environments. This process is being supported through cross-membership of the respective Fora.

Liaisons have also been established with the EBU, MPEG and Pro-MPEG to continue the on-going harmonization effort on user profiling. The next task will be the introduction of TV-Anytime tools in the production and playout centres of TV broadcasters, and their adoption by content creators to produce richer programme material. The EBU is committed to this important challenge.

The TV-Anytime specifications will soon be published as ETSI Technical Specifications and Reports. The metadata specification will be published as ETSI TS.102802-3

This article gives an overview of the main features of the TV-Anytime metadata specification, focusing in particular on its key features: **SP003v13 [Metadata]** and **SP006v10 [Metadata Services over a Bi-directional Network]**.

The TV-Anytime Phase 1 specification also includes four other documents known as **SP001v12 [Phase 1 Benchmark Features]**, **SP002v13 [System Description]**, **SP004v12 [Content Referencing]** and **SP007 [Bi-directional Metadata Delivery Protection]**.

These documents can be found on the Forum's website: **http://www.tv-anytime.org/**

TV-Anytime metadata: what is in the specification?

In TV-Anytime, the metadata is descriptive information about content. It is generically qualified as **attractors**, as this data is used to attract the user towards content of interest to him/her.

With Phase 1, the TV-Anytime Forum has defined a set of specifications that targets PVR-based applications in a unidirectional broadcast environment. This was complemented with methods for accessing ancillary metadata services using bandwidth-limited bi-directional networks.

The TV-Anytime metadata specification (SP003v13) contains two main parts:

❍ **Part A – the schemas**
The TV-Anytime Forum has adopted the XML-based MPEG-7 Description Definition Language (DDL) [ISO/IEC 15938-2] as its representation format for metadata. XML is now widely used and offers many advantages such as extensibility and the facility to separate data from the application. Part A specifies the format of metadata to be exchanged, e.g. between content / information / metadata providers and the consumers – including service, content and user description schemas and classification schemes

❍ **Part B – system aspects**
This part contains a recommended binary format (MPEG-7 BiM [ISO/IEC 15938-1]), a fragmentation model, a mode of encapsulation of these fragments and an indexing method.

All the XML files necessary to implement the specification are provided in SP003v13.

TV-Anytime is "transport agnostic" and can be adapted to different environments such as in ARIB, ATSC and DVB. The manner in which metadata is stored, accessed and used on the PVR is not covered by the TV-Anytime specifications.

Document SP006v10 defines the tools for accessing ancillary metadata services over a bi-directional network.

Part A: the schemas

TV-Anytime has defined a unique document structure *(see Fig. 1)* to aggregate **programme descriptions** (programme, services, etc.), **user descriptions** or **classification schemes** (e.g. ContentCS/genre, ActionTypeCS, ContentCommercialCS, HowRelatedCS, TVARoleCS).

In order to help in the development of attractive services, TV-Anytime has defined the following minimum interoperability restrictions:

❍ A valid description of a programme shall always at least contain a Title.

❍ All other TV-Anytime metadata is optional. However, TV-Anytime recommends the thorough documenting of the following elements and attributes of a programme description:

- **synopsis**;
- **genre** (intended audience, content origination, content intention and atmosphere);
- **language**;
- **member of**, and
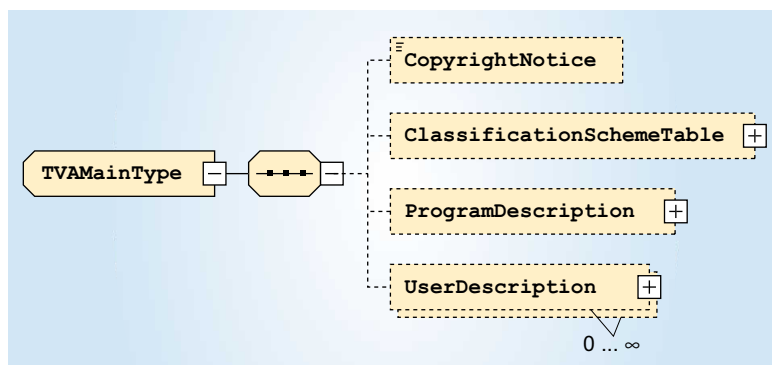- **credits list** (director, provider, key talent, key character, writer).

Figure 1
TVAMainType – Main document type

The TV-Anytime identifiers and their role

As shown in *Fig. 2*, the TV-Anytime schemas form different clusters:

- ❍ The programme information and segment information schemas are related to a programme, and inter-related via the Content Referencing IDentifier – the so-called **CRID**.

- ❍ The programme location information is also linked to a programme via the CRID – in particular through the instance description of a broadcast, schedule or on-demand event.

- ❍ The service information is related to the programme location information via the Service Identifier.

- ❍ User information is connected through the User Identifier. Programme-specific information is identified by the CRID.
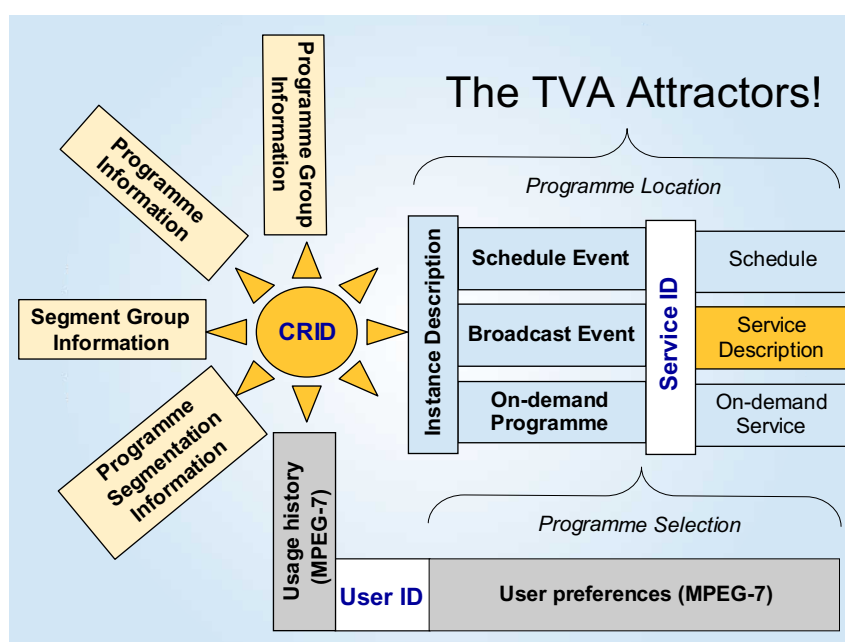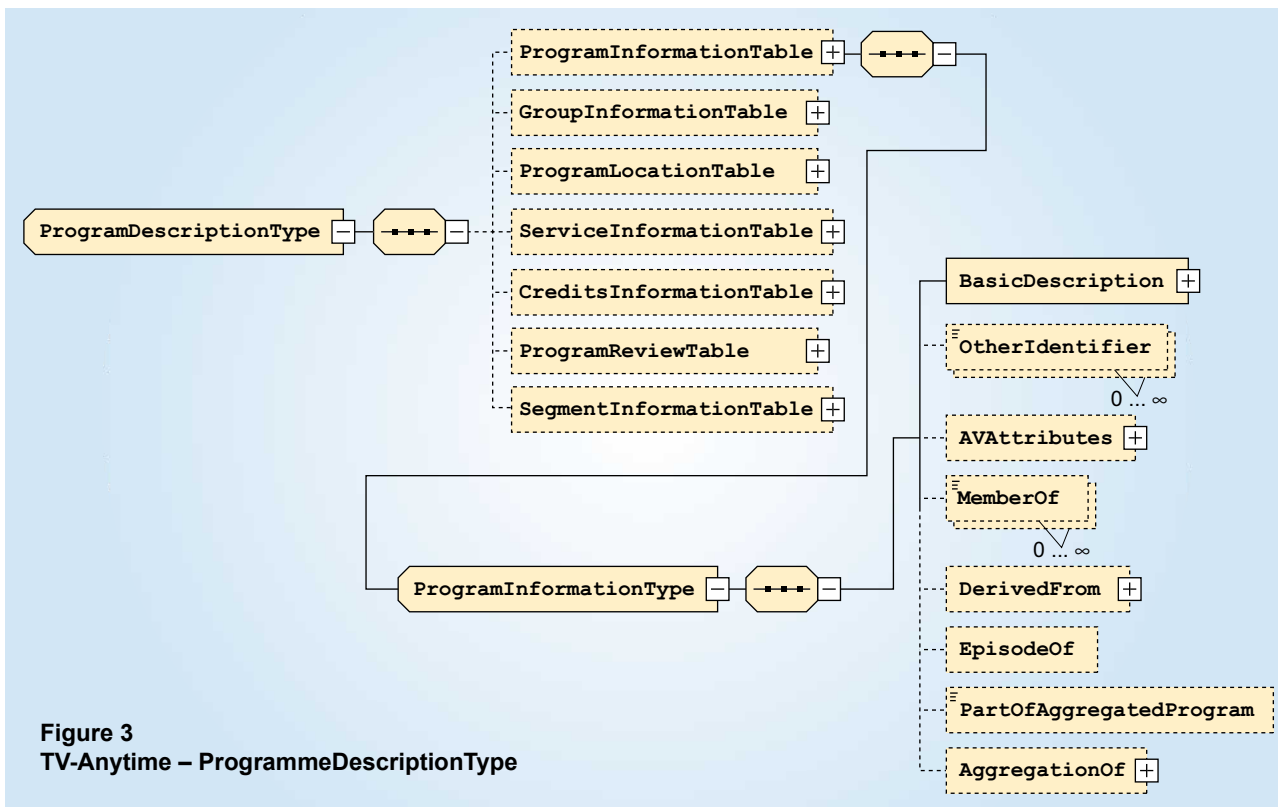

Figure 2
Inter-relationships between the TV-Anytime identifiers
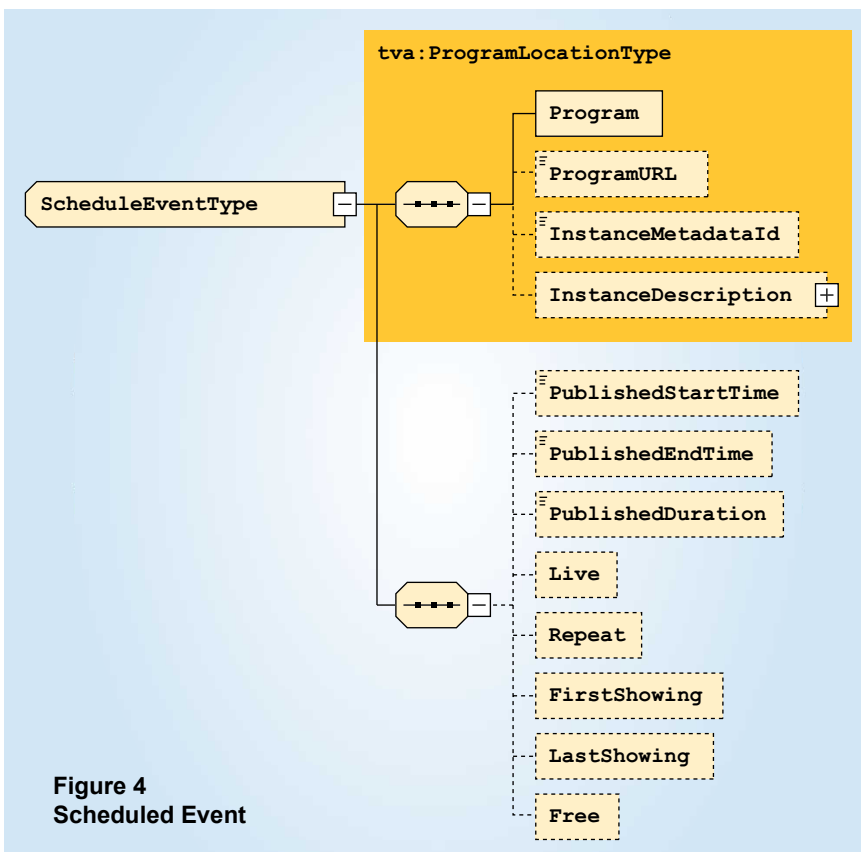
Programme Description

As reflected in the structure of `ProgramDescription` *(Fig. 3)* the TV-Anytime model has been designed to describe the following content concepts (and more...):

1) Simple programmes using `ProgramInformation` descriptions (e.g. TV-on-demand programmes).

2) Programme versions (e.g. different edits) differentiated using `BasicDescription` (Title, genre, synopsis, language(s), etc.).

3) Commercials (programme trailers), e.g. using the `PromotionalInformation` in a `BasicDescription`.

4) Groups of related programmes with `ProgramInformation` (using `MemberOf` and `EpisodeOf`) and `GroupInformation` (using the appropriate `GroupType`) e.g. to describe a programme being broadcast in two parts, or a series (ordered or unordered), or related programmes sharing common concepts, etc.

Figure 3
TV-Anytime – ProgrammeDescriptionType

5) A programme that is a concatenation/group of sequences of other programmes (`ProgramInformation` / `PartOfAggregatedProgram`), identified as an aggregated programme (`ProgramInformation` / `AggregationOf`)

6) The publication of a programme that may have publication-dependent attributes (e.g. a film tribute to a recently deceased actor which would have a different description) using a `ScheduleEvents` or `BroadcastEvents` or `OnDemandPrograms InstanceDescription`.

In this context, the TV-Anytime CRID links the descriptions to content referenced by this CRID.

Programme Location

The same programme may be found in one or more locations according to the results of the location resolution process.

TV-Anytime supports the definition of schedules using the `ScheduleEventType` *(see Fig. 4)* that will bind programmes (using the CRID as the link) to a service. The link to a service is established using the service ID that also links to the corresponding `ServiceInformation` description.

It is also possible to define a broadcast event using the

Figure 4
Scheduled Event

BroadcastEventType (not represented here). It is an extension of the ScheduleEvent-Type, as it is not required to reference a service in this case.

TV-Anytime allows the defining of on-demand services that propose a collection of on-demand programmes described using the OnDemandProgramType *(see Fig. 5)*.

Segment Information

Segmentation metadata is an important innovative feature of the TV-Anytime specification. It will allow the creation of richer content. It is believed that its simplicity, in comparison with MPEG-7 segmentation tools, better responds to the physical and operational limitations of broadcasting.
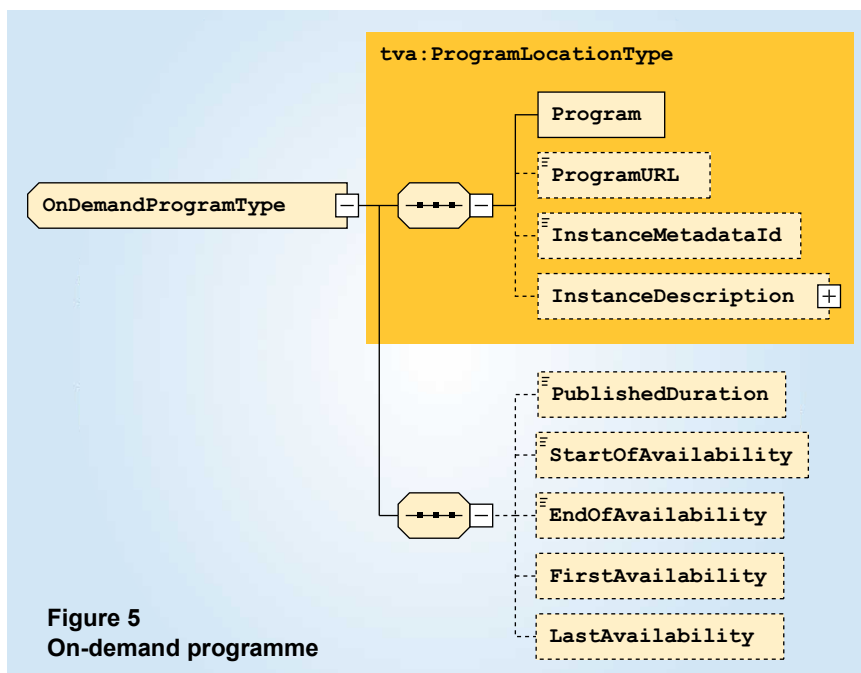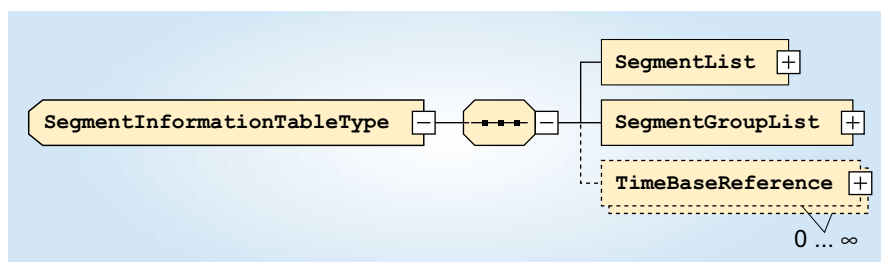

Figure 5
On-demand programme

Figure 6
TV-Anytime simple segment information structure

Segmentation refers to the ability to define, access and manipulate temporal intervals (*i.e.* segments) within an audio-visual (AV) stream. It is possible to restructure and re-purpose an AV stream to generate alternative consumption and navigation modes (e.g. a summary of the content with highlights, or a set of bookmarks, or re-purposing the content for educational purposes) by associating metadata to segments and segment groups.

The description model is very similar to the generic "content" and "content group" description models developed by TV-Anytime. However, segmentation requires additional precise segment timing and location information.

User Description

TV-Anytime uses the MPEG-7 "user preference" and "usage history" tools [ISO/IEC 15938-5] currently grouped in a draft MPEG-7 "User Description profile", which has the support of TV-Anytime. TV-Anytime decided to select a common set of user description metadata in an adequate interchangeable format in order to support different scenarios such as, but not limited to:

❍ selecting content that matches the users' viewing habits using e.g. software agents;

❍ tracking and monitoring the content viewing habits of users, for commercial purposes.

Usage history *(Fig. 7)* enables the tracking and monitoring of user actions while consuming content e.g. record, pause, fast-forward, etc. This can be done to develop a user profile that will be used to select content that matches the user's personal interests. This information can also be shared with a service provider as a means to designing the content better and targeting the programme offers. Different users accessing the same content at different times can be identified separately, if required, by one of the possible applications having access to this information.

User preferences *(Fig. 8)* are used to filter content from a large variety of sources according to a rich combination of criteria such as genre, time, date, channel, etc. This operation may require user interaction to confirm a selection. It is also possible for software agents to accurately map the user preferences to media descriptions. It is possible to personalise a profile or a set of preferences by weighting the different selection criteria.
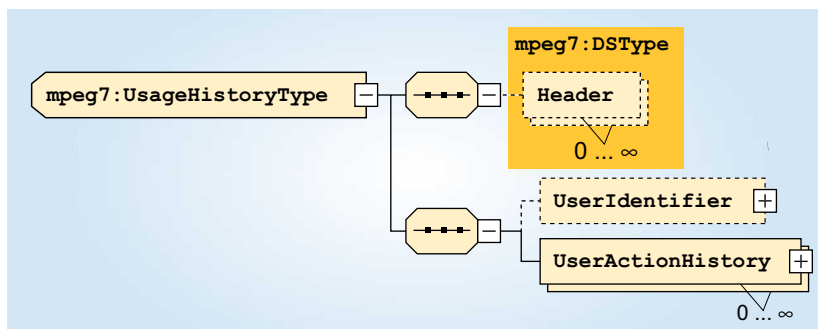
Figure 7
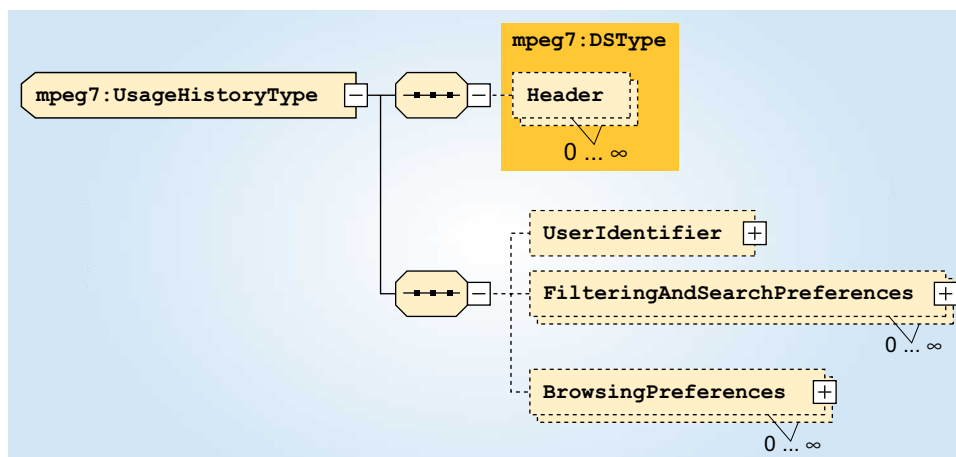**TV-Anytime and MPEG-7 common UsageHistoryType**

The protection of user privacy has been duly taken into account. TV-Anytime Phase 1 scenarios do not support unauthorised access to private data. Particular attention has been paid to ensuring that the exchange of user description data shall remain anonymous. This is possible e.g. by using the appropriate protection flags in the MPEG-7 schemas, appropriately set to "anonymous" by default. However, it is envisaged that future phases of TV-Anytime will need to address a wider range of business models where user-authorised (e.g. contractual agreement) and user-controlled access to more user data will be possible.

Figure 8
TV-Anytime and MPEG-7 common UserPreferencesType

Part B: System aspects in a unidirectional environment

Part B defines a set of mechanisms to enable and optimize the delivery of TV-Anytime *(Fig. 9)*. The main technical requirements can be summarized as follows:

❍ bandwidth efficiency;

❍ capacity for this data to be delivered asynchronously – using a carousel;

Figure 9
Processing of a TVA metadata description for its delivery over a unidirectional link

❍ modularization of the information carried – so as to allow partial and targeted updates, and to enable a certain prioritization in the way the information is cyclically transmitted;

❍ improved navigability within this information – so as to provide, when needed, an efficient way to retrieve pieces of priority access.
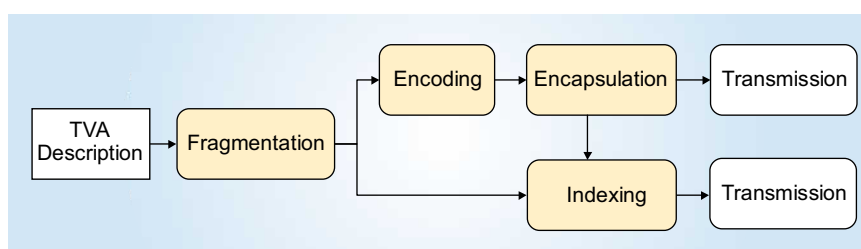
The principal object to be transmitted is a TV-Anytime **metadata description**. It is the actual XML document instantiating the schema (Part A) and containing all the metadata provided by the same *entity,* which has to be delivered to a TV-Anytime terminal at a given time.

Fragmentation is the generic decomposition mechanism of a TV-Anytime metadata description into self-consistent units of data, called **TVA fragments**. A fragment is the ultimate atomic part of a metadata description that can be transmitted independently to a terminal. A fragment is self-consistent in the sense that it is capable of being updated independently from other fragments. The way it is processed and accessed is independent of the order in which it is transmitted, relative to other fragments.

The decoding of a fragment by a terminal and its addition to the *partial description* shall eventually provide a TV-Anytime schema-valid description. A partial description is the document rebuilt from, at least, the fragment delivering the root element (the *TVA Main* fragment in *Fig. 9*) plus, possibly, other previously-decoded fragments.

TV-Anytime has specified a set of standard TVA fragments such as:

❍ a fragment containing the description of a programme, the review of a single content, or descriptive of a given content group;

❍ a fragment bringing the description of an instance of a given content, either on-demand or broadcast;

❍ a fragment carrying information about a broadcast or an on-demand service;

❍ a schedule fragment for the description of a sequence of broadcast events on a given service;

❍ A `SegmentInformation` fragment and/or `SegmentGroupInformation` fragment, carrying segmentation information for a given content.

Each of these fragments can be acquired and processed independently of the others. A possible scenario is when fragments carrying information about content are broadcast along with this content so as to provide the viewer with more information about what he/she is watching (for example, for the promotion of a related material such as a web page or a link to the content group to which this content belongs, e.g. an episode of a series).
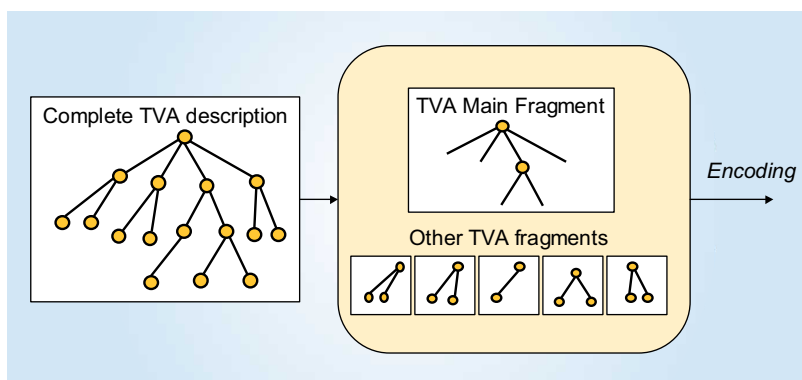
Figure 10
**Illustration of the mechanism of fragmentation of a TVA metadata description**
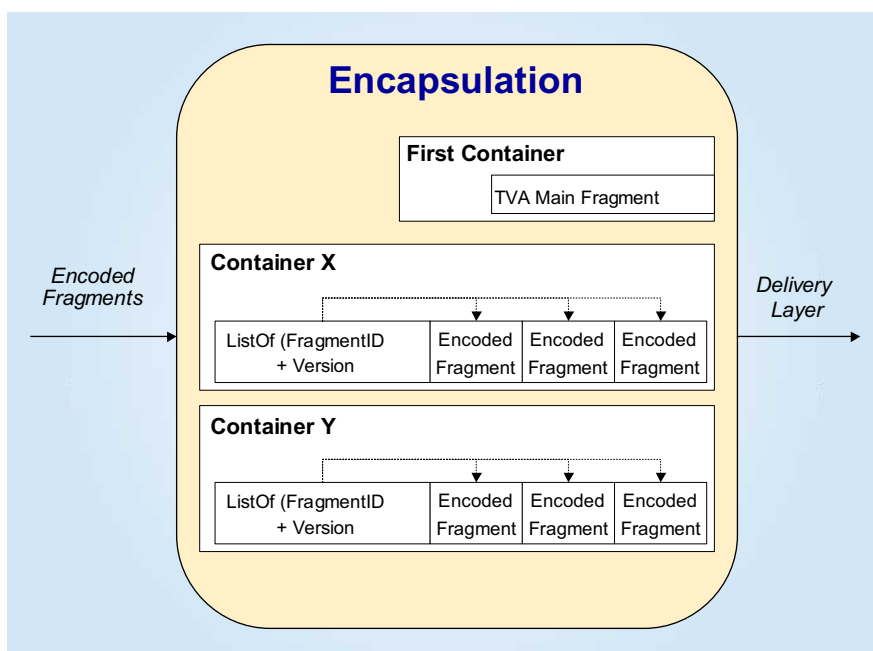
Figure 11
Mechanism of encapsulation of a TVA metadata description

As shown in *Fig. 10,* for bandwidth efficiency the TVA metadata fragments must be *encoded* (e.g. binarised) for transport and delivery. For that purpose, TV-Anytime recommends using MPEG-7 BiM in association with ZLib compression for textual data (e.g. a programme synopsis or review). BiM encoding is based on the tokenization of the structure of each fragment with respect to a state diagram produced from the TV-Anytime schema.

Encapsulation is the process that enables the grouping of encoded fragments in "containers" ready for transmission *(Fig. 11)*. It associates further information to

these fragments such as a unique identifier and a version number that enable the monitoring and management of updates.

Indexing is an optional mechanism *(Fig. 12)* to deliver TV-Anytime metadata to receivers with limited processing and storage capabilities. It provides a mechanism for locating information from within a fragment stream, forming a TVA metadata description. Indexing structures accompanying a fragment stream provide direct access to each fragment by listing the values of a particular node and describing where the matching fragment(s) can be found within the delivery layer.
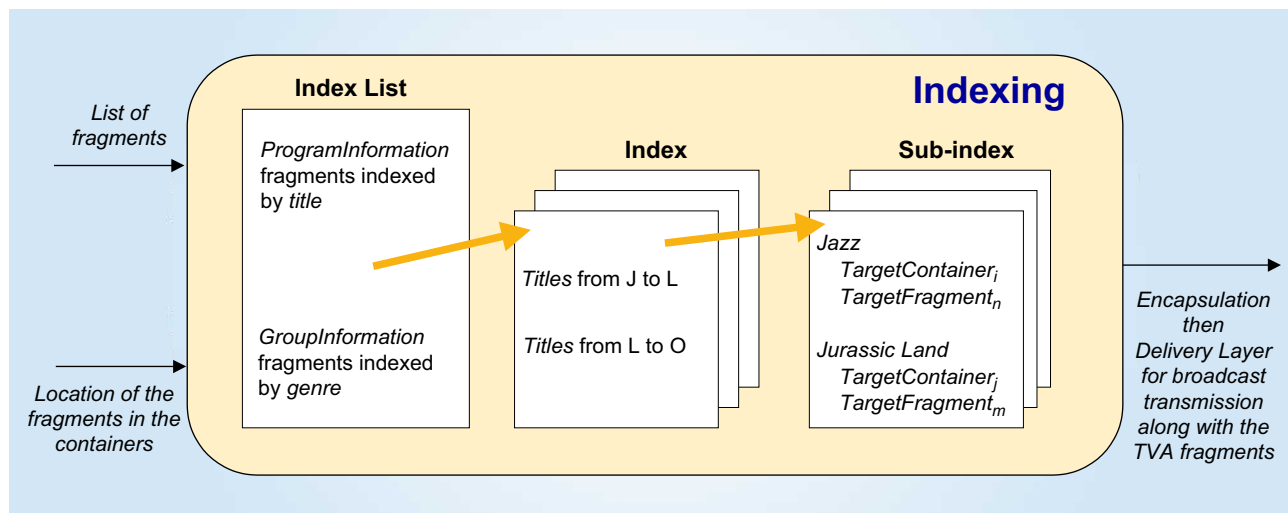
Figure 12
Abstract representation of indexing of a TVA metadata description

TV-Anytime does not define the exact way in which containers and indexing structures should be carried, as TV-Anytime wishes to remain transport agnostic. This is left to standardization bodies that are adopting the TV-Anytime solution (e.g. ARIB, ATSC and DVB).

Metadata access via bi-directional networks

The methods and protocols specified in TVA specification SP006v10 allow a richer set of ancillary metadata to be exchanged between TV-Anytime clients and metadata servers over a bi-directional network in complement to unidirectional services. It also allows service providers to access anonymous consumer profile / preference information.

Metadata service discovery occurs either using the mechanisms defined by TV-Anytime to provide appropriate URLs through a unidirectional stream, or using other generic mechanisms (e.g. W3C standards) for web service discovery (UDDI and WS-Inspection). The purpose is to allow the client to retrieve location information about servers from which TV-Anytime metadata can be retrieved.

Specification SP006v10 describes a client-initiated means for requesting metadata from, and submitting user-centric data to, IP-based web services:

❍ The `get_Data` operation allows a client to query a server in order to retrieve TV-Anytime data such as a set of programmes or programme groups (e.g. a list of CRID-related resolving data, additional programme description data). A `get_Data` operation can, in principle, support complex queries using XPath expressions.

❍ The `submit_Data` operation is much simpler and limits the data that can be submitted to a defined set of *anonymous profile data* that has been created via manual input or intelligent agents based on usage of services and content.

SP006v10 also defines mechanisms for describing such metadata services.

Abbreviations

ARIB	Association of Radio Industries and Businesses (Japan)		**IP**	Internet Protocol
ATSC	Advanced Television Systems Committee (USA)		**ISO**	International Organization for Standardization
AV	Audio-Visual		**HTTP**	HyperText Transfer Protocol
CRID	(TV-Anytime) Content Referencing IDentifier		**KLV**	(SMPTE) Key Length Value
DAVIC	Digital Audio-Visual Council		**MPEG**	(ISO/IEC) Moving Picture Experts Group
DDL	Description Definition Language		**MXF**	Material eXchange Format
DVB	Digital Video Broadcasting		**PDR**	Personal Digital Recorder
DVR	Digital Video Recorder		**PVR**	Personal Video Recorder
EPG	Electronic Programme Guide		**SMPTE**	Society of Motion Picture and Television Engineers (USA)
ETRI	Electronics and Telecommunications Research Institute (Korea)		**SOAP**	Simple Object Access Protocol
ETSI	European Telecommunication Standards Institute		**TCP/IP**	Transmission Control Protocol / Internet Protocol
HTTP	HyperText Transfer Protocol		**TVA**	TV-Anytime
ID	IDentification / IDentity / IDentifier		**UDDI**	Universal Description, Discovery and Integration
IEC	International Electrotechnical Commission		**W3C**	World Wide Web Consortium
			XML	Extensible Markup Language

SP006v10 completely specifies the transport- and network-layer protocols (TCP/IP) necessary for end-to-end interoperability. SOAP and HTTP are used for delivering TV-Anytime XML data over the IP networks, since this combination is very well suited to the point-to-point, request-response nature of TV-Anytime operations.

Developments in ARIB, ATSC and DVB

ARIB

ARIB has now published "ARIB-STD B38: *Coding, Transmission and Storage Specification for Broadcasting System Based on Home Servers*" based on the TV-Anytime Phase 1 specifications. This has been an official standard for broadcasting in Japan since 6th February 2003. ARIB's Metadata Task Group has been actively working on implementation guidelines that were scheduled for publication in April 2003 by the Ministry of Posts and Telecommunications. There are several on-going projects such as:

❍ the "Large-scale Content Distribution Experiment" funded by the Ministry of Posts and Telecommunications (NHK, TBS, NTT, etc.);

❍ mobile digital terrestrial broadcasting experiments such as the "Tokyo Pilot" (TBS, Hakuhodo, NTT Data, NTT DoCoMo, Mitsubishi, etc.);

❍ "Operation CRID Akasaka" (TBS, Hakuhodo, NTT Data, NTT Labs, Expway and Waseda University).

ATSC

The TV-Anytime metadata specification has been selected by ATSC to develop a T3/S8 draft AdvEPG (advanced EPG) specification. T3/S8 has decided to base the AdvEPG on the TV-Anytime metadata model, using at least `ProgramInformation`, `ProgramLocation`, `GroupInformation`, `ServiceInformation`, and possibly `SegmentInformation` and `SegmentGroupInformation`. ATSC will not use the TV-Anytime classification schemes, which are optional, to maintain compatibility with the PSIP categories. T3/S8 will not use TV-Anytime content referencing and instead is defining alternative methods to link metadata to content and channels. Interest has however been expressed in using MPEG-7 BiM (binary encoding format) as recommended by TV-Anytime.

DVB

DVB has now agreed a set of PVR-related commercial requirements. These requirements cover the carriage of TV-Anytime data over DVB networks and the broadcast of PVR-related DVB-MHP applications using this

data. DVB-GBS is the DVB technical group now looking at a solution to address these requirements. DVB-GBS is making rapid progress in specifying mechanisms for the transport and delivery of TV-Anytime data (content referencing and metadata) over DVB streams. This work, still in progress, should be completed by the end of 2003.

Other initiatives

There are many other initiatives. For example, the TV-Anytime members from Korea have demonstrated very interesting developments and more will certainly be seen at the TV-Anytime implementers' workshop, to be organized in June 2003 in Seoul.

The EBU response: B/ITVA

The EBU's Broadcast Technology Management Committee (BMC) and the EBU Technical Committee have launched a new Project Group B/ITVA to study the introduction of TV-Anytime services. The first on-going task of the group consists of identifying viable scenarios from a simple Personal Digital Recorder with limited storage capacity and supporting "Live Pause and Play" – to more complex scenarios relying on the introduction of new content and services.

More information on B/ITVA can be found at:

> **http://www.ebu.ch/departments/technical/broadcast_technology/projects.php**.

B/ITVA works in close relationship with the DVB Consortium and the UK Digital Terrestrial Group (DTG) who are also working on TVA-related specifications and implementation plans.

B/ITVA also intends to communicate with manufacturers to anticipate the evolution of the PDR market in the near future.

ETSI publication

The TV-Anytime specifications are in the final stages of ETSI publication as Technical Specifications (TS 102 822 series) and Technical Reports.

Jean-Pierre Evain joined the EBU's Technical Department in 1992 to work on "New Systems and Services", having spent six years in the R&D laboratories of France-Telecom (CCETT) and Deutsche Telekom. After several years centered around DVB MHP, he currently chairs the Metadata AHG in TV-Anytime for which he mainatins several liaisons with the ATSC - T3/S8 AdvEPG Group and ISO/IEC MPEG-7.

Mr Evain represents the EBU in the PDR-related activities of the DVB Project as well as in different standardization groups on Copy Protection and Digital Rights Management, including DVB, CENELEC and ISO/IEC MPEG-21.

Hervé Murret-Labarthe joined CANAL+ Technologies as a standards officer in 1999. As an expert in digital TV systems, he has represented this company for the past four years in different international standardization bodies such as MPEG, SCTE and DVB, where he acted as chairman of the Simulcrypt TM ad-hoc group until June 2003.

Mr Murret-Labarthe has also been involved in the activities of the TV-Anytime forum since its creation. He played an active part in the specification of the Phase 1 metadata standard, but more specifically in Part B of the specification. Born in 1973, he holds a post-graduate engineering degree in information and digital image technology from the university of Rennes I (FR).

Future challenges

There is a general need for continuing the harmonization effort on the metadata dictionaries. TVA and MPEG-7 already share a large proportion of common terms. However, the TV-Anytime classification schemes have been further extended since the MPEG-7 standard was frozen.

The SMPTE allows for reference to external dictionaries – and a pointer to TV-Anytime should be considered.

EBU Project Group P/Meta has developed a metadata exchange scheme that shares a significant amount of common elements and attributes with TV-Anytime. This means that most TVA data can be used as a P/Meta criteria for business-to-business searches and the exchange of content. Work is still needed to ensure that these mechanisms are implemented in the production arena and used by content creators and programme makers.

TVA and Pro-MPEG are in the process of formalizing liaison to discuss the possible support of TV-Anytime by MXF (Media eXchange Format). It can be foreseen that the following issues will be addressed:

❍ Harmonization of metadata, including elements, attributes, classification schemes and enumerated values, and mapping to the Pro-MPEG descriptive metadata scheme, DMS1.

❍ Harmonization to further support the already well-covered TV-Anytime programme groups and segment concepts.

❍ Adaptation of TV-Anytime for metadata encoding using the SMPTE's Key-Length-Value (KLV) codes as currently specified in the MXF specification, and/or investigating the possible insertion of TV-Anytime XML descriptions (textual or binary encoded) in MXF streams.

Acknowledgements

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