Digital Audio-Visual Council

DAVIC 1.4.1 Specification Part 9

Information Representation

(Technical Specification)

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CONTENTS

1. SCOPE 1

2. REFERENCES 2

2.1 **Normative References** 2
2.1.1 Identical Recommendations | International Standards 2
2.1.2 Similar Recommendations | International Standards 2
2.1.3 ANSI (American National Standards Institute) 2
2.1.4 ATSC (Advanced Television Systems Committee) 2
2.1.5 Apple Corporation Inc. 2
2.1.6 ETSI (European Telecommunications Standards Institute) 3
2.1.7 ISO (International Organization for Standardization) 3
2.1.8 ISO/IEC 3
2.1.9 SCTE (Society of Cable Telecommunications Engineers, Inc) 3
2.1.10 SMPTE (Society of Motion Picture and Television Engineers) 3
2.1.11 W3C 3
2.1.12 Sun Microsystems 4
2.1.13 OpenCard Consortium 4

2.2 **Informative references** 4
2.2.1 IEC (International Electrotechnical Commission) 4
2.2.2 ISO|IEC|ITU 4
2.2.3 ITU-R (International Telecommunications Union - Radio Communication Sector) 4
2.2.4 Sun Microsystems, Inc 4

3. DEFINITIONS 5

4. ACRONYMS AND ABBREVIATIONS 7

5. CONVENTIONS 10

6. MONOMEDIA COMPONENTS 11

6.1 **Character Information** 11

6.2 **Text Information** 12
6.2.1 Decoding requirements on HTML support 12
6.2.2 HTML encoding 13
6.2.3 HTML mapping to MHEG elements 13
6.2.4 Informative list of supported HTML Tags 13

6.3 **Outline Font Format** 15
6.3.1 Requirements 15
6.3.2 Font Format Specification 16
6.3.3 Font rendering 16

6.4 **Language Information** 18

6.5 **Service Information** 18

6.6 **Telephone Numbers** 18

6.7 Compressed Audio 19
6.7.1 Compressed audio coding using MPEG-1 Audio 19
6.7.2 Compressed audio coding using ATSC A/52 Audio 19

6.8 Scaleable Audio 20

6.9 Linear Audio 20

6.10 Compressed Video 21
6.10.1 Coding constraints for video with a resolution up to ITU-R 601 21
6.10.2 Coding constraints for video with a resolution beyond ITU-R 601 24
6.10.3 Decoding tool requirements 26

6.11 Still Pictures 27
6.11.1 Normal Resolution Still Pictures 27
6.11.2 Higher Resolution Still Pictures 27

6.12 Compressed Graphics 28
6.12.1 Requirements 28
6.12.2 Format for Compressed Graphics 28

6.13 Compressed Character Data 30

6.14 Network Graphics 30

7. MONOMEDIA STREAMS 31

7.1 Types of Monomedia Components 31

7.2 Real-time and Stored Monomedia Streams 32

7.3 Carriage of Monomedia Streams in PES Packets 33
7.3.1 Packetization of MPEG- and ATSC-defined Components 33
7.3.2 Packetization of DVB-defined Components 33
7.3.3 Packetization of DAVIC-defined Components 33

7.4 Packetization of Compressed Character Data 33

8. TRANSPORT OF MONOMEDIA STREAMS AND COMPONENTS 34

8.1 Transport of Real Time Streams 34

8.2 Transport of Stored Streams 34

8.3 Transport of Stand-alone Monomedia Components 34

9. APPLICATION FORMAT 35

9.1 Application Interchange Format 35

9.2 MHEG-5 Profile for the DAVIC Application Domain 36
9.2.1 Object Interchange Format 36
9.2.2 Set of Classes 36
9.2.3 Set of Features 36
9.2.4 Content Data Encoding 36
9.2.5 Attribute Encoding 38
9.2.6 UserInput Registers 39
9.2.7 Constraints on the Use of Variables 39

9.2.8 Semantic Constraints on the MHEG-5 Applications 39
9.2.9 EngineEvent 40
9.2.10 GetEngineSupport 40
9.2.11 TransitionEffect Parameter of the TransitionTo Elementary Action 40
9.2.12 MHEG-5 Resident Programs 44
9.2.13 Protocol Mapping and External Interaction 49

9.3 Mapping of MHEG-5 Elements to DSM-CC U-U 51
9.3.1 Stream Events and Normal Play Time Mapping 51
9.3.2 Namespace Mapping 51
9.3.3 MHEG-5 Object References 52
9.3.4 MHEG-5 Content References 53
9.3.5 Mapping of MHEG-5 ComponentTag to DSM-CC and DVB-SI 53
9.3.6 Java class File Names 54

9.4 Core set of Java APIs 55
9.4.1 java.lang 55
9.4.2 java.util 55
9.4.3 java.io 55
9.4.4 iso.mheg5 56
9.4.5 The DSM-CC User to User API 56
9.4.6 The Service Information (SI) API 56
9.4.7 The MPEG-2 Section Filter API 56
9.4.8 The Resource Notification API 56
9.4.9 The MPEG Component API 57
9.4.10 The Tuning API 57
9.4.11 The Conditional Access API 57
9.4.12 The java.awt package and User Interface API Extensions 57
9.4.13 The java.applet package 57
9.4.14 The java.net package 57
9.4.15 The Java Media Framework and the Media Player API 57
9.4.16 The DSM-CC User to Network API 58
9.4.17 The OpenCard API 58

9.5 URL Format for Access to Broadcast Services 59
9.5.1 Introduction 59
9.5.2 Specification of the extended DAVIC DVB URL format 59
9.5.3 Examples of Usage 60

9.6 Run-time execution environment 61
9.6.1 Application execution 61
9.6.2 User Input Events 61
9.6.3 IDL definition for RTE run remote call 61
9.6.4 Mapping of High-Level API Actions on DSM-CC Primitives 62

9.7 Access to DAVIC Services and Contents from Web Browsers 63
9.7.1 Background and system architecture 63
9.7.2 JMF Architecture and APIs to access DAVIC contents 64

10. DAVIC REFERENCE MODEL FOR CONTENTS DECODING 66

10.1 Scope 66

10.2 Reference Decoder Model 66

10.3 DAVIC Application Resource Descriptor 69

10.4 Minimum DAVIC 1.4.1 STU requirements 71

10.5 Support for Graphics in STUs 71

10.6 Persistent Memory 72

11. CONTENT PACKAGING AND METADATA 73

11.1 Content Package Structure 73
11.1.1 Content Item Elements 73
11.1.2 Content Item 73
11.1.3 Content Package 74

11.2 Content Metadata 75
11.2.1 Types 75
11.2.2 Semantics of the Loading Commands 76
11.2.3 Mapping 77

11.3 Content Packaging Format 84
11.3.1 Bento 84
11.3.2 Bento definition of DAVIC Objects 84

11.4 Content Loading Toolset 91
11.4.1 Scope 91
11.4.2 Toolset requirements 91
11.4.3 Toolset features 91
11.4.4 Toolset Specifications 92
11.4.5 Content Loading by CMSL 94

ANNEX A CODING OF OUTLINE FONTS 95

A.1 Font Format Specification 95

A.2 PFR Header 95

A.3 Logical font directory 97

A.4 Logical font section 98

A.5 Physical font record 100
A.5.1 Bitmap Information 103
A.5.2 Font ID 105
A.5.3 Stem snap tables 105
A.5.4 Bitmap character tables 106

A.6 Glyph program strings 106

A.7 Simple glyph program strings 107
A.7.1 MoveTo glyph record 110
A.7.2 LineTo glyph record 110
A.7.3 CurveTo glyph record 110
A.7.4 EndGlyph record 111
A.7.5 Short-form glyph records 112
A.7.6 hLineTo glyph record 112
A.7.7 vLineTo glyph record 112
A.7.8 hvCurveTo glyph record 112
A.7.9 vhCurveTo glyph record 113
A.7.10 Secondary stroke definitions 113
A.7.11 Secondary edge definitions 114

A.8 Compound glyph program strings 116

A.8.1 Bitmap glyph program string 117

A.9 Portable font resource trailer 120

A.10 Kerning data 120
A.10.1 Pair Kerning Data 120
A.10.2 Track Kerning Data 121

ANNEX B CODING OF LINEAR AUDIO 123

B.1 Coding format for Linear Audio 123

ANNEX C DEFAULT CLUT FOR SINGLE BITMAPS WITH COMPRESSED GRAPHICS 127

C.1 Default CLUT specification 127

ANNEX D PACKETIZATION OF DAVIC DEFINED MONOMEDIA COMPONENTS IN PES PACKETS 131

D.1 Packetization into PES packets 131

ANNEX E MPEG-2 SECTION FILTER API 133

E.1 Objective 133

E.2 Requirements 133
E.2.1 Non-Functional Requirements 133
E.2.2 Functional Requirements 133

E.3 Overview of Specification 134
E.3.1 Object diagram 134
E.3.2 Interclass relations 135
E.3.3 Event mechanism 135
E.3.4 SectionFilterGroups 136
E.3.5 SectionFilters 137

E.4 Interfaces 138
E.4.1 SectionFilterListener 138

E.5 Classes 138
E.5.1 SectionFilterGroup 138
E.5.2 SectionFilter 141
E.5.3 SimpleSectionFilter 147
E.5.4 RingSectionFilter 148
E.5.5 TableSectionFilter 148
E.5.6 Section 149

E.6 Events 152
E.6.1 SectionFilterEvent 152
E.6.2 SectionAvailableEvent 152
E.6.3 EndOfFilteringEvent 153
E.6.4 ForcedDisconnectedEvent 154
E.6.5 VersionChangeDetectedEvent 154
E.6.6 IncompleteFilteringEvent 155
E.6.7 TimeOutEvent 156
E.6.8 FilterResourcesAvailableEvent 156

E.7 Exceptions **157**
E.7.1 SectionFilterException 157
E.7.2 FilterResourceException 158
E.7.3 ConnectionLostException 158
E.7.4 InvalidSourceException 159
E.7.5 NoDataAvailableException 159
E.7.6 IllegalFilterDefinitionException 160
E.7.7 FilteringInterruptedException 160

E.8 Section filtering **161**
E.8.1 Filter options 161
E.8.2 MPEG2 section format (informative) 162

ANNEX F RESOURCE NOTIFICATION API **163**

F.1 Objective **163**

F.2 Interfaces **163**
F.2.1 ResourceProxy 163
F.2.2 ResourceServer 163
F.2.3 ResourceStatusListener 164
F.2.4 ResourceClient 164

F.3 Classes **165**
F.3.1 ResourceStatusEvent 165

ANNEX G MPEG COMPONENT API **167**

G.1 Objective **167**

G.2 Interfaces **167**
G.2.1 NotAuthorizedInterface 167

G.3 Classes **169**
G.3.1 TransportStream 169
G.3.2 Service 170
G.3.3 ElementaryStream 171
G.3.4 ApplicationOrigin 172

G.4 DVB Specific Classes **172**
G.4.1 DvbTransportStream 172
G.4.2 DvbElementaryStream 173
G.4.3 DvbService 173

G.5 Exceptions **174**
G.5.1 NotAuthorizedException 174
G.5.2 TuningException 174
G.5.3 ResourceException 175
G.5.4 ObjectUnavailableException 176

ANNEX H TUNING API **177**

H.1 Objective **177**

H.2 Requirements **177**
H.2.1 General Requirements 177
H.2.2 Functional Requirements 177
H.2.3 Access to Physical Tuner Parameters 178

H.3 General 178
H.3.1 The object model 179

H.4 Supporting Classes API Specification 181

H.5 NetworkInterface API Specification 187
H.5.1 Exceptions 187
H.5.2 Event-Listener model 190
H.5.3 Event-Listener model, resource status events 192
H.5.4 NetworkInterface 193
H.5.5 DeliverySystems 200

H.6 Example of using the Tuning API (informative) 201
H.6.1 Code example 201

ANNEX I CONDITIONAL ACCESS API 204

I.1 Objective 204

I.2 Requirements 204
I.2.1 General Requirements 204
I.2.2 CA System and Interface Requirements 204
I.2.3 Scalability Requirements 204
I.2.4 Descrambling Requirements 205

I.3 Introduction 205
I.3.1 The Object Model 205
I.3.2 State changes of the CA API 208

I.4 CA API 209
I.4.1 Exceptions 209
I.4.2 Event-Listener model 215
I.4.3 Event-Listener model, MMI 224
I.4.4 Event-Listener model, Message passing 226
I.4.10 MMI 248
I.4.11 Message Passing 251

ANNEX K : USER INTERFACE API EXTENSIONS 257

K.1 Objective 257

K.2 API Definitions 257
K.2.1 Extended Colour Support 257
K.2.2 Color 257

ANNEX L MEDIA PLAYER API 260

L.1 Introduction 260

L.2 Requirements 260
L.2.1 General Requirements 260
L.2.2 Synchronisation Requirements 260
L.2.3 Internet Compatibility 261
L.2.4 Playback Control Requirements 261

L.3 DAVIC Defined Extensions to JMF 262
L.3.2 Time Based Synchronisation 263
L.3.3 Event Based Synchronisation 265

L.3.4 Referencing Content at Startup 270
L.3.5 Referencing Content During Playback 270
L.3.6 Switching Content in a Player 272
L.3.7 Resource Handling 275
L.3.9 Visual Controls 278
L.3.10 Control of Positioning Media in Time 278
L.3.11 Application Origin 279
L.3.12 Freezing Playback of Media 280
L.3.13 MediaLocator 281
L.3.14 Enhanced State Transitions 281
L.3.15 Player LifeCycle 282
L.3.16 Mapping to JDK 1.0.2 282

ANNEX M APPLICATION LEVEL SOFTWARE ARCHITECTURE 283

M.1 Introduction 283

M.2 API structure 283
M.2.1 API Reference Model 283
M.2.2 Reference Decoder Model 284
M.2.3 Use of MHEG and Java 284
M.2.4 How MHEG and Java fit together 285
M.2.5 Relationship between APIs and Transport Protocols 285
M.2.6 Relationship between DAVIC and the Internet 285
M.2.7 Contours and different configurations 286

M.3 MHEG 286
M.3.1 Overview of MHEG-5 286
M.3.2 Overview of MHEG-6 287
M.3.3 Mapping to Transport Protocols 287

M.4 Java 288
M.4.1 Overview of the Java Virtual Machine 288
M.4.2 Java APIs and Packages 288
M.4.3 Java Package Naming 288
M.4.4 Overview of Java Packages 288
M.4.5 Security of the Java Virtual Machine 291

M.5 Contours 292
M.5.1 Overview of the Different Contours 292
M.5.2 The DAVIC range of configurations 292
M.5.3 Examples of Applications 294

M.6 Summary 295

ANNEX N DSM-CC USER-TO-NETWORK API 297

N.1 Objective 297

N.2 API Definitions 297
N.2.1 ResourceDescriptor 297
N.2.2 SessionEvent 297
N.2.3 SessionAddResourceEvent 298
N.2.4 SessionDelResourceEvent 299
N.2.5 SessionReleaseEvent 300
N.2.6 Interface SessionEventListener 301
N.2.7 SessionHandler 301
N.2.8 DsmStreamStream 302

N.3 Code examples (Informative) **303**
N.3.1 Example of an applet 303
N.3.2 Example of code using API 304

ANNEX O OPENCARD API **311**

O.1 Objective **311**

O.1 Security Issues **311**
O.1.1 Remarks to security options in OCF 311
O.1.1 Case Study: Secure Card Services 311
Problem Statement 311
Solution approach 312

ANNEX P CARRIAGE OF PRIVATE DATA **314**

P.1 General Method for Inclusion of Private Data **314**

ANNEX Q VIDEO INPUT FORMATS **315**

ANNEX S : STU VIDEO DISPLAY CAPABILITIES **316**

S.1 Background **316**

S.2 Display Considerations **316**

S.3 Implementation Examples **317**
S.3.1 Example 1 317
S.3.2 Example 2 318
S.3.3 Example 3 319

Encoder Constraints **319**
S.4.1 Setting N and M 319
S.4.2 Noise Reduction Prior to Encoding 320
S.4.3 Monitoring of Channel Buffer Fullness 320
S.4.4 Motion Vector Selection on a Grid 320

S.5 Bibliography **320**

ANNEX T CODING AND CARRIAGE OF A/52 AUDIO IN ATSC SYSTEMS **321**

T.1 Coding and Carriage of A/52 Audio in ATSC Systems **321**

ANNEX U TRANSITION EFFECTS FOR STILL PICTURE COMPOSITIONS **322**

U.1 Scope **322**

U.2 TransitionTo actions **322**

ANNEX V EXAMPLE OF AN OSI NSAP ADDRESS FORMAT **327**

V.1 Purpose **327**

V.2 Introduction **327**

V.3 E.164 NSAP 327

ANNEX W CONTENT METADATA SPECIFICATION LANGUAGE 329

W.1 CMSL Low Level Representations 329

W.2 Attribute / Property Types 329

W.3 Attributes 330
W.3.1 Generic Attributes 331

W.4 Properties 331

W.5 Attribute Groups 331

W.6 Property Packages 332

W.7 Property Groups 332

W.8 Association groups 332

W.9 Content Item Element 333

W.10 Content Item 333

W.11 CMSL Source Files 334

ANNEX X EXAMPLE OF SIMPLE MOVIE CONTENT ITEM 335

Table of Figures and Tables

Figure 9-12. MHEG-5 resident programs ---- *45*
Figure 9-13. Searching and extracting a sub-string within a string. ---- *48*
Figure 9-15. Searching and extracting a sub-string within a string. ---- *51*
Figure 9-18. System architecture for DAVIC Access from a Web browser ---- *63*
Figure 9-19. Block diagram for access to DAVIC content from a Web browser ---- *63*
Figure 9-20. Architecture of a DAVIC client using JMF ---- *65*
Figure 10-1. The DAVIC Reference Decoder Model ---- *67*
Figure 11-1. Illustration of a Content Item ---- *74*
Figure 11-2. The relationships between the items, item elements and packages. ---- *74*
Figure 11-4. Inheritance from Content Item Element ---- *77*
Figure 11-5. Entity Relationship Diagram ---- *93*
Figure E-1 Object diagram ---- *134*
Figure E-2 Class diagram of events generated by the SectionFilterGroup and the SectionFilter ---- *136*
Figure E-3 Finite State Machine for connection between TransportStream and SectionFilterGroup ---- *137*
Figure E-4 Format of long header of MPEG-2 section ---- *162*
Figure H-1: Tuning API object model: Base classes. ---- *180*
Figure H-2: Tuning API object model: Exceptions. ---- *180*
Figure H-3: Tuning API object model: Event Listener model. ---- *181*
Figure I-1 : Main class diagram ---- *206*
Figure I-2 : Message Passing ---- *207*
Figure I-3 : MMI ---- *208*
Figure I-1 : Exceptions ---- *208*
Figure I-4 : State changes of the CA system. ---- *209*

Figure M-1. API reference model ---------- *284*
Figure M-2. Example of an MHEG-5 Application ---------- *286*
Figure M-3. Java package naming structure ---------- *288*
Figure M-4. Java APIs and dependencies between packages ---------- *289*
Figure S-1. ---------- *317*
Figure S-2. ---------- *318*
Figure S-3. ---------- *319*
Figure X-1 Movie Offering CI/CIE Structures and Attributes. ---------- *335*

Table 6-1. Coding options of monomedia components *11*
Table 6-2. Examples of HTML 3.2 tags supported by DAVIC 1.4.1 ..... *13*
Table 6-3 Some typical values for display_horizontal_size for 4:3 window in 16:9 picture *21*
Table 6-4. Horizontal Upsampling Ratios for Full Screen Picture Sizes *22*
Table 6-5. Horizontal Upsampling Ratios For Non-Full Screen Pictures *23*
Table 6-6: Sequence Header Constraints *24*
Table 6-7. Compression Format Constraints *24*
Table 6-8. Sequence Extension Constraints *25*
Table 6-9. Sequence Display Extension Constraints *26*
Table 6-9 Default CLUT characteristics *29*
Table 7-1. Types of monomedia components *31*
Table 7-2. Real-time stream, stored stream and use of PES packets per monomedia component *32*
Table 9-1. Feature requirements *36*
Table 9-2. Content Encoding *36*
Table 9-3. Attribute Encoding *38*
Table 9-4. InputEventRegisters *39*
Table 9-5. Constraints to IntegerVariables *39*
Table 9-6. Feature Constraints *40*
Table 9-7. TransitionEffect parameter of "TransitionTo" action *40*
Table 9-8. Number of splits *43*
Table 9-9. Start positions of split-effects with n splits per Coordinate System *43*
Table 9-10. Coding of horizontal index of pixel where the effect starts *43*
Table 9-11. Coding of vertical index of line where the effect starts. *44*
Table 9-14. Protocol Mapping *49*
Table 16: DVB URL Examples *60*
Table 9-17. Examples of mapping of high-level API actions to DSM-CC primitives *62*
Table 10-2. Quality Levels *68*
Table 10-3. Size of Bn and value of Rx(n) for graphics per Quality Level *69*
Table 10-4. DAVIC application resource descriptor *69*
Table 10-5. Maximum full screen resolution applied in application. *70*
Table 10-6. Maximum number of colours in application *70*
Table 10-7. Leak rate Rx(n) for objects *70*
Table 10-8. Minimum buffer sizes required in DAVIC 1.4.1 STUs *71*
Table 10-9. Minimum requirement for the support of graphics in DAVIC 1.4.1 STUs *71*
Table 11-3. DSM-CC Directory Primitives *76*
Table A-1. PFR Header *95*
Table A-2. Logical Font Directory *97*
Table A-3. Logical Font Section *98*
Table A-4. Logical Font Record *98*
Table A-5. Physical Font Section *100*
Table A-6. Physical Font Record *100*
Table A-7. Character Record *102*
Table A-8. Bitmap Information Extra Data Item *103*
Table A-9. Bitmap Size Record *104*
Table A-10. Font ID Extra Data Item *105*
Table A-11. Stem Snap Tables *105*
Table A-12. Bitmap Character Record *106*
Table A-13. Simple Glyph Program String *107*
Table A-14. X - Coordinate Argument Format *109*
Table A-15. Y - Coordinate Argument Format *109*

Table A-16. Move To Glyph Record *110*
Table A-17. Line To Glyph Record *110*
Table A-18. Curve To Glyph Record *111*
Table A-19. End Glyph Record *111*
Table A-20. Horizontal Line To Glyph Outline Record *112*
Table A-21. Vertical Line To Glyph Outline Record *112*
Table A-22. Horizontal to Vertical Curve Glyph Outline Record *112*
Table A-23. Vertical to Horizontal Curve Glyph Outline Record *113*
Table A-24. Secondary Stroke Information Extra Data Item *114*
Table A-25. Secondary Edge Information Extra Data Item *114*
Table A-26. Simplified Secondary Edge Definition *115*
Table A-27. General Secondary Edge Definition *115*
Table A-28. Compound Glyph Program String *116*
Table A-29. Bitmap Glyph Program String *117*
Table A-30. PorTable Font Resource Trailer *120*
Table A-31. Pair Kerning Data *120*
Table A-32. Track Kerning Data *121*
Table B-1. Linear audio *123*
Table B-2. Sample rate assignments *125*
Table C-1. Default CLUT entries *127*
Table D-1. Extended PES Packet Header of Type Private Stream 1 ..... *131*
Table D-2. Data Identifier Assignments *131*
Table D-3. Private Stream Id Assignments for Objects with a Coding Format Defined in DAVIC 1.4.1 ..... *132*
Table E-5 Mapping of Mask and Value on Section Header *162*
Table Q-1. Standardized Video Input Formats *315*
Table V-1. The E.164 NSAP version of the AESA address. *327*
Table X-2. Sample CMSL Source *336*

Foreword

The Digital Audio-Visual Council (DAVIC) is a non-profit Association registered in Geneva in 1994. The objective of DAVIC is to promote the success of interactive digital audio-visual applications and services through specification of open interfaces and protocols.

The DAVIC 1.4.1 Specification was developed by representatives of DAVIC member organizations. It is a public document based on submissions from members and non-members in response to the public Calls For Proposals which were issued in October 1994, March 1995, September 1995, December 1995, March 1996 and September 1996. The specification has full backward compatibility with the earlier versions DAVIC 1.0, DAVIC 1.1 and DAVIC 1.2. DAVIC 1.3 has been available on the internet since June 1997. DAVIC 1.4.1 is a point release issued in Poitiers, June 1999.

DAVIC 1.4.1 is a single specification consisting of 14 parts.

Part 1: Description of Digital Audio-Visual Functionalities

Part 2: System Reference Models and Scenarios

Part 3: Service Provider System Architecture

Part 4: Delivery System Architecture and Interfaces

Part 5: Service Consumer System Architecture

Part 6: Management Architecture and Protocols

Part 7: High And Mid-Layer Protocols

Part 8: Lower-Layer Protocols and Physical Interfaces

Part 9: Information Representation

Part 10: Basic Security Tools

Part 11: Usage Information Protocols

Part 12: System Dynamics, Scenarios and Protocol Requirements

Part 13: Conformance and Interoperability

Part 14: Contours: Technology Domain

The DAVIC PAS (Publicly Available Specification) forwarded to ISO/IEC JTC 1 for transposition into an international standard is a subset of the DAVIC 1.4.1 specification consisting of the normative parts (2, 6-12 and 14). In addition, the essential informative Part 1 which provides categorised sets of user and market requirements and has two informative annexes which are closely integrated with the normative technology conformance details provided in Part 14 is proposed as an ISO/IEC JTC 1 Technical Report.

All versions and corrigenda of DAVIC specifications are available from the DAVIC web site.

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Introduction

DAVIC specifications define the minimum tools and dynamic behavior required by digital audio-visual systems for end-to-end interoperability across countries, applications and services. To achieve this interoperability, DAVIC specifications define the technologies and information flows to be used within and between the major components of generic digital audio-visual systems. Interoperability between these components and between individual sub-systems is assured through specification of tools and specification of dynamic systems behavior at defined reference points. A reference point can comprise one or more logical (non-physical) information-transfer interfaces, and one or more physical signal-transfer interfaces. A logical interface is defined by a set of information flows and associated protocol stacks. A physical interface is an external interface and is fully defined by its physical and electrical characteristics. Accessible reference points are used to determine and demonstrate compliance of a digital audio-visual subsystem with a DAVIC specification.

DAVIC 1.4.1 parts can be classified into four major groups. A summary of each part under each of the four headings follows.

Requirements and Framework (Parts 1-2)

Part 1 provides a detailed listing of the functionalities required by users and providers of digital audio-visual applications and systems. It introduces the concept of a contour and defines the IDB (Interactive Digital Broadcast) and EDB (Enhanced Digital Broadcast) functionality requirements which are used to define the normative contour technology toolsets provided in Part 14.

Part 2 defines the normative DAVIC technical framework. It provides a vocabulary and a Systems Reference Model, which identifies specific functional blocks and information flows, interfaces and reference points.

Architectural Guides (Parts 3-5)

Parts 3 and 4 and 5 are technical reports which provide additional architectural and other information for the server, the delivery-system, and the service consumer systems respectively.

Part 3 defines how to load an application, once created, onto a server and gives information and guidance on the protocols transmitted from the set-top user to the server, and those used to control the set-up and execution of a selected application.

Part 4 provides an overview of delivery systems and describes instances of specific DAVIC networked service architectures. These include physical and wireless networks. Non-networked delivery (e.g. local storage physical media like discs, tapes and CD-ROMS) are not specified.

Part 5 provides a service consumer systems architecture and a description of the DAVIC Set Top reference points defined elsewhere in the normative parts of the specification.

Technology Toolsets (Parts 6-11)

The next six parts are normative. They specify and comprise the technology toolsets and relevant protocols across the entire audio-visual creation and delivery chain.

Part 6 specifies the information model used for managing the DAVIC systems. In particular, this part defines the managed object classes and their associated characteristics for managing the access network and service-related data in the delivery system. Where these definitions are taken from existing standards, full reference to the required standards is provided. Otherwise a full description is integrated in the text of this part. Usage-related information model is defined in Part 11.

Part 7 defines the technologies used for high and mid-layer protocols for DAVIC systems. In particular, this part defines the specific protocol stacks and requirements on protocols at specific interfaces for the DAVIC content, control and management information flows.

Part 8 defines the toolbox of technologies used for lower layer protocols and physical interfaces. The tools specified are those required to digitize signals and information in the Core Network and in the Access Network. Each tool is applicable at one or more of the reference points specified within the delivery system. In addition a detailed specification is provided of the physical interfaces between the Network Interface Unit and the Set Top Unit and of the physical interfaces used to connect Set Top Boxes to various peripheral devices (digital video recorder, PC,

printer). The physical delivery system mechanisms included are copper pairs, coaxial cable, fiber, HFC, MMDS, LMDS, satellite and terrestrial broadcasting.

Part 9 defines what the user will eventually see and hear and with what quality. It specifies the way in which monomedia and multimedia information types are coded and exchanged. This includes the definition of a virtual machine and a set of APIs to support interoperable exchange of program code. Interoperability of applications is achieved, without specifying the internal design of a set top unit, by a normative Reference Decoder Model which defines specific memory and behavior constraints for content decoding. Separate profiles are defined for different sets of multimedia components.

Part 10 defines the interfaces and the security tools required for a DAVIC 1.4.1 system implementing security profiles. These tools include security protocols which operate across one or both of the defined conditional access interfaces CA0 and CA1. The interface CA0 is to all security and conditional access functions, including the high speed descrambling functions. The interface CA1 is to a tamper resistant device used for low speed cryptographic processing. This cryptographic processing function is implemented in a smart card.

Part 11 specifies the interface requirements and defines the formats for the collection of usage data used for billing, and other business-related operations such as customer profile maintenance. It also specifies the protocols for the transfer of Usage Information into and out of the DAVIC System. In summary, flows of audio, video and audio-visual works are monitored at defined usage data collection elements (e.g. servers, elements of the delivery system, set-top boxes). Information concerning these flows is then collected, processed and passed to external systems such as billing or a rights administration society via a standardised usage data transfer interface.

Systems Integration, Implementation and Conformance (Parts 12-14)

Part 12 is a normative part which defines system dynamic behavior and physical scenarios. It details the locations of the control functional entities along with the normative protocols needed to support the systems behavior. It is structured as a set of protocol walk-throughs, or “Application Notes”, that rehearse both the steady state and dynamic operation of the system at relevant reference points using specified protocols. Detailed dynamics are given for the following scenarios: video on demand, switched video broadcast, interactive broadcast, and internet access.

Part 13 is an informative report which provides guidelines on how to validate the systems, technology tools and protocols through conformance and / or interoperability testing.

Part 14 provides the normative definition of DAVIC Technology Contours. These are strict sets of Applications, Functionalities and Technologies which allow compliance and conformance criteria to be easily specified and assessed. DAVIC 1.4.1 contains the full details of two contours. These are the Enhanced Digital Broadcast (EDB) and Interactive Digital Broadcast (IDB). Part 14 specifies required technologies and is a mandatory compliance document for contour implementations.

Information Representation

1. Scope

Part 9 of this Specification takes a practical approach to the specification of Information Representation. Just the information types that cannot be dispensed with in producing the set of DAVIC applications (viz. broadcast, movies on demand, home shopping, etc.) are specified. The approach taken in Part 9 starts by defining the various monomedia information types. They include character, text, fonts, service information, audio, video, and graphics. Consistent with DAVIC principles, one tool is selected for the encoding of each information type. Multimedia components comprise one or more monomedia components. Part 9 defines the way in which multimedia information is coded and exchanged. This includes the definition of a virtual machine and a set of APIs to support interoperable exchange of program code. Finally, Part 9 defines a Reference Decoder Model for contents decoding which provides constraints on content. The major problem addressed by the model is to ensure interoperability of applications by specifying memory and behaviour constraints for contents decoding by a hypothetical STU, without specifying the internal design of an STU. An application built according to the reference decoder model will be a "DAVIC 1.4.1conforming application" and will successfully execute on a STU that is compliant to the DAVIC 1.4.1specification.

For each monomedia and multimedia component the coding format is specified, as well as applicable constraints for coding of the components. Three types of monomedia components are distinguished. Monomedia components which are included within other monomedia components, such as characters within text, are of type implied. Non-implied monomedia components that do not require synchronization with a time base at play back, are of type stand-alone. Finally, non-implied monomedia components of which the presentation may require synchronization with a time base are of type stream. Part 9 defines which type each DAVIC defined monomedia component may take, and specifies that the coded representation of monomedia components of type stream are packetized in PES packets (for definition of PES packets refer to ISO/IEC 13818-1). PES packets permit (1) to include time stamps to support mutual synchronisation of multiple monomedia components in reference to a common time base and (2) to define timing and buffer behaviour in a common reference model for contents decoding. While there are various ways to deliver the monomedia and multimedia components to the STU, Part 9 defines how the components are carried in an MPEG-2 Transport Stream.

DAVIC specifies a number of different profiles. In a specific profile there may be support of a subset of the monomedia components. Each STU that complies to a specific profile of DAVIC shall be capable of decoding and presenting each monomedia and multimedia component permitted within that profile.

Part 9 also specifies methods for packaging of contents and metadata. The way in which content is packaged for delivery is independent of the way in which content data is delivered to the SPS (it may be delivered to a Service Provider either on physical media or over a transmission system). All programming content is represented in the DAVIC system as multimedia components. Multimedia components comprise one or more monomedia components coupled with the logical relationships between the monomedia components. The multimedia components will be created by content providers for input to the servers.

2. References

The following documents contain provisions which, through reference in this text, constitute provisions of this Specification. At the time of publication, the editions indicated were valid. All referenced documents are subject to revision, and parties to agreements based on this Specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau (TSB) maintains a list of currently valid ITU-T Recommendations.

2.1 Normative References

2.1.1 Identical Recommendations | International Standards

1. ITU-T Recommendation H.222.0 (1995) | ISO/IEC 13818–1: 1995, Information technology—Generic coding of moving pictures and associated audio information—Part 1: Systems (Note: known as MPEG-2 Systems)

   ISO/IEC 13818-1/Amendment 1: 1996, Registration procedure for “copyright identifier”

   ISO/IEC 13818-1/Amendment 2: 1996, Registration procedure for “format identifier”

   ISO/IEC 13818-1/Amendment 3: 1996, Private data identifier
2. ITU-T Recommendation H.262 | ISO/IEC 13818–2, Information technology—Generic coding of moving pictures and associated audio information—Part 2: Video (Note: known as MPEG-2 Video)

   ISO/IEC 13818–2 /Amendment 1: Registration procedure for "copyright identifier"

2.1.2 Similar Recommendations | International Standards

The following Recommendations or International standards have equivalent technical content:

1. ITU-T (CCITT) Recommendation X.208 (1988), Specification of Abstract Syntax Notation One (ASN.1) | ISO/IEC 8824: 1990, Information Technology—Open Systems Interconnection—Specification of Abstract Syntax Notation One (ASN.1)
2. ITU-T (CCITT) Recommendation X.209 (1988) Specification of Basic Encoding rules for abstract syntax notation one (ASN.1) | ISO/IEC 8825: 1990, Information Technology—Open Systems Interconnection—Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1)

2.1.3 ANSI (American National Standards Institute)

1. ANSI SMPTE 274M-1995, Television - 1920x1080 Scanning and Interface
2. ANSI SMPTE 296M-1997, Television - 1280x720 Scanning, Analog and Digital Representation and Analog Interface

2.1.4 ATSC (Advanced Television Systems Committee)

1. ATSC A/52: Digital Audio Compression Standard (AC-3)

   available at ftp://ftp.atsc.org/pub/Standards/A52
2. ATSC A/53: Digital Television standard for HDTV Transmission

   available at ftp://ftp.atsc.org/pub/Standards/A53

2.1.5 Apple Corporation Inc.

1. AIFF-C Audio Interchange File Format, version C, allowing for Compression
2. Bento Specification, Revision 1.0d5, July 15, 1993

2.1.6 ETSI (European Telecommunications Standards Institute)

1. ETR 162 (October 1995): Digital broadcasting systems for television, sound and data services: Allocation of Service Information (SI) codes for Digital Broadcasting (DVB) systems
2. ETR 211: Digital broadcasting systems for television, sound, and data services; Guidelines for the usage of Service Information (SI) in Digital Video Broadcasting (DVB) systems
3. ETS 300 468 (January 1997): Specification for Service Information (SI) in DVB Systems
   - Informative Annex C: Conversion Between Time and Date Conventions
4. ETS 300 472, Digital broadcasting systems for television, sound, and data services; Specification for conveying ITU-R System B Teletext in Digital Video Broadcasting (DVB) bitstreams
5. ETS 300 743, Digital Video Broadcasting (DVB), DVB subtitling
6. ETS 300 777-2, Use of Digital Storage Media Command and Control (DSM-CC) for basic multimedia applications
7. ETSI DI / MTA-01074, Multimedia Terminals and Applications, Application Programming Interface (API) for DAVIC Service Information.

2.1.7 ISO (International Organization for Standardization)

1. ISO 639 Terminology - Codes for the representation of names of languages
2. ISO 3166 Codes for the representation of names of countries
3. ISO 8859-1 Information technology - 8-bit single-byte coded graphic character sets, Latin alphabets
4. ISO 10646-1 Information technology - Universal multiple-octet coded character set (UCS), part 1: Architecture and Basic Multilingual Plane" (also known as Unicode)

2.1.8 ISO/IEC

1. ISO/IEC 11172–2:1993, Information technology—Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s—Part 2: Video (Note: known as MPEG-1 Video)
2. ISO/IEC 11172–3:1993, Information technology—Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s—Part 3: Audio (Note: known as MPEG-1 Audio)
3. ISO/IEC 13522–5:1997, Information Technology—Coding of Multimedia and Hypermedia Information—Part 5: Support for Base-Level Interactive Applications (Note: known as MHEG-5)
4. ISO/IEC 13522-6, Information technology - Coding of multimedia and hypermedia information (MHEG) - Part 6: Support for Enhanced Interactive Applications
5. ISO/IEC 13818-3.2:1997, Information technology – Generic coding of moving pictures and associated audio information – Part 3: Audio (Note: known as MPEG-2 Audio)
6. ISO/IEC 13818–6, Information technology—Generic coding of moving pictures and associated audio information—Part 6: Digital Storage Media Command and Control (DSM-CC)

2.1.9 SCTE (Society of Cable Telecommunications Engineers, Inc)

1. SCTE DVS/026 - Digital Video : Subtitling methods for Broadcast Cable

2.1.10 SMPTE (Society of Motion Picture and Television Engineers)

See American National Standards Institute (ANSI), Clause 2.1.3.

2.1.11 W3C

1. CSS-1, Cascading Style Sheets, level 1; by Håkon Wium Lie and Bert Bos, 17-December-96
   available at http://www.w3.org/TR/REC-CSS1-961217
2. HTML 3.2, HyperText Mark-up Language reference specification, by Dave Raggett, 14-Jan-1997
   available at http://www.w3.org/TR/REC-html32.html
3. PNG Portable Network Graphics version 1, 01-October-1996

available at http://www.w3.org/TR/REC-png.html

2.1.12 Sun Microsystems

1. Sun Microsystems Java Media Player guide, Java Media Players. Version 1.03, November 6, 1997.
http://java.sun.com/products/java-media/jmf/forDevelopers/playerguide/index.html.
2. Sun Microsystems Java Media Player Specification. Version 1.0 (javadoc), September 2, 1997.
http://java.sun.com/products/java-media/jmf/forDevelopers/playerapi/packages.html
3. Java API, J. Gosling, F. Yellin and the Java team, The Java Application Programming Interface, Volume 1: Core Packages, Addison-Wesley, ISBN 0-201-63453-8
4. Sun Microsystems, PersonalJava Specification 1.0, http://java.sun.com/products/personaljava/spec-1-0-0/personalJavaSpec.html

2.1.13 OpenCard Consortium

1. OpenCard Consortium API Specification 1.1. , 1998. (http://www.opencard.org/docs/packages.html)

2.2 Informative references

2.2.1 IEC (International Electrotechnical Commission)

2. IEC 60958 (1989-02) Digital audio interface, with Amendment No. 1 (1993-01) and Amendment No. 2 (1995-11)
3. IEC CDV 61937 Interface for non-linear PCM encoded audio bitstreams applying IEC 60958

2.2.2 ISO|IEC|ITU

1. Guide for ITU-T and ISO/IEC JTC 1 cooperation. Appendix II: Rules for presentation of ITU-T | ISO/IEC common text (March, 1993)

2.2.3 ITU-R (International Telecommunications Union - Radio Communication Sector)

1. ITU-R BT.601-4, Encoding parameters of digital television for studios
2. ITU-R BT.709-1, Basic parameter values for the HDTV standard for the studio and for international program exchange
3. ITU-R BT.1208, Video coding for digital terrestrial television broadcasting

2.2.4 Sun Microsystems, Inc

4. Java VM, T. Lindholm and F. Yellin, The Java Virtual machine specification, Addison-Wesley, ISBN 0-201-63452-X

3. Definitions

This Section defines new terms, and the intended meaning of certain common terms used in this Specification. Part 02 Annex A defines additional terms and, in some cases, alternative interpretations that are appropriate in other contexts. The definitions in the annex were derived from various sources: some are direct quotes, others have been modified.

Supplementary definitions in Part 02 Annex A are informative and are provided for reference purposes only. (For convenience, copies of the normative definitions below are included in the annex.)

For the purposes of this Specification, the following definitions apply.

access control: Provides means to access services and protection against the unauthorized interception of the services.

anchor: one of two ends of a hyperlink

application: a set of objects that provides an environment for processing Application Service Layer information flows.

Application Programming Interface (API): set of inter-layer service request and service response messages, message formats, and the rules for message exchange between hierarchical clients and servers. API messages may be executed locally by the server, or the server may rely on remote resources to provide a response to the client.

assets: Things that a user sees or hears, e.g., bitmap, audio, text.

character: an atom of textual information, for example a letter or a digit

conditional access: A means of allowing system users to access only those services that are authorized to them.

Content Item: A collection of content items / content item elements that will form a complete application or a complete programme.

Content Item Element: the smallest (and indivisible) content component.

Content Package: A set of content item elements and/or content items for transfer across an A10 interface between Content Provider and Service Provider Systems.

Content Provider: one who owns or is licensed to sell content.

Control Word: the secret key used for a scrambling algorithm.

Delivery System (DS): The portion of the DAVIC System that enables the transfer of information between DS-users.

element: a component of the hierarchical structure defined by a document type definition; it is identified in a document instance by descriptive markup, usually a start-tag and end-tag.

end-tag: descriptive markup that identifies the end of an element

encryption: a mathematical technique used to ensure the confidentiality of security management information.

Entitlement Control Message (ECM): conditional access messages carrying an encrypted form of the control words or a means to recover the control words, together with access parameters, i.e., an identification of the service and of the conditions required for accessing this service.

Entitlement Management Message (EMM): conditional access messages used to convey entitlements or keys to users, or to invalidate or delete entitlements or keys.

key management: The generation, storage, distribution archiving, deletion, revocation, registration, and deregistration of cryptographic keys.

hyperlink: a relationship between two anchors

joint stereo: a coding option in MPEG-1 audio that exploits the redundancy between the left and right audio channels

logical interface: an interface where the semantic, syntactic, and symbolic attributes of information flows is defined. Logical interfaces do not define the physical properties of signals used to represent the information. A logical interface can be an internal or external interface. It is defined by a set of information flows and associated protocol stacks.

monomedia component: a collection of data representing a single type of audiovisual information.

monospace format: a presentation format of characters in which each character utilizes a character matrix of the same size, independent of the width and height of the character.

multimedia component: a collection of data comprising one or more multimedia components

navigation: the process of reaching a service objective by means of making successive choices; the term may be applied to the selection of a service category, a service provider or an offer within a particular service.

protocol: set of message formats (semantic, syntactic, and symbolic rules) and the rules for message exchange between peer layer entities (which messages are valid when).

real-time stream: an MPEG-2 transport stream containing monomedia components of which the timing of the decoding and presentation in an STU is controlled by the characteristics of the stream during the delivery of the stream to the STU.

rendering: the process in the STU to combine one or more monomedia components such as characters, text, and graphical objects into one presentation on a screen.

scrambling: The process of making a signal unintelligible at the transmission point in order that it can only be received if an appropriate descrambling system is in place at the point of reception. Scrambling can be applied to audio, video or data signals

server: any service providing system.

Service Information (SI): Digital data describing the delivery system, content and scheduling/timing of MPEG-2 Transport Streams. It includes MPEG-2 PSI together with independently defined extensions.

Service Provider: an entity that provides a service to a client.

session: an interval during which a logical, mutually agreed correspondence between two objects exists for the transfer of related information. A session defines a relationship between the participating users in a service instance.

Set Top Box (STB): a module that comprises both Set Top Unit (STU) and Network Interface Unit (NIU) functional elements. The STB may be either “integrated” or “modular”. An integrated STB is designed for connection to a single DAVIC A1 or equivalent interface. A modular STB may be equipped with a DAVIC A0 or equivalent interface to enable connection of a range of NIUs.

Set Top Unit (STU): a module that contains the “network independent” functionalities of a Set Top Box (STB). The following functionalities are contained in a typical STU:- Processing & Memory Functions; MPEG2 Demux & AV Decoders; Graphics Display; Modulator Output for TV; Peripheral Interfaces.

start-tag: descriptive markup that identifies the start of an element

tag: markup that delimits an element

virtual machine (VM): An abstract specification of a micro-processor and its behaviour

Note: A VM may be implemented on different hardware processors. A VM therefore implements the mechanism for all these processors to execute the same instruction set. It is also possible for a micro-processor to be designed so that its instruction set is identical to that of a VM. VM code can be used to make software portable. In the context of DAVIC, the VM is used to extend interoperability by allowing program code produced once to be delivered to and executed on any compliant STU.

4. Acronyms and abbreviations

Part 2 Annex B contains a complete set of acronyms and abbreviations used throughout the DAVIC 1.4.1 Specification. The following acronyms and abbreviations are used in this Specification:

AC-3	ATSC A52 Audio
AIFF	Audio Interchange File Format
API	Application Programming Interface
ASCII	American Standard Code for Information Exchange
ASN.1	Abstract Syntax Notation 1
ATSC	Advanced Television Systems Committee
BNF	Backus-Naur Form
bslbf	Bit string left bit first
CA	Conditional Access
CIE	Content Item Element
CI	Content Item
CLUT	Color LookUp Table
CMSL	Content Metadata Specification Language
CORBA	Common Object Request Broker Architecture
CPS	Content Provider System
CRC	Cyclic Redundancy Check
CW	Control Word
DIS	Draft International Standard
DSM-CC	Digital Storage Media - Command and Control
DSM-CC U-N	DSM-CC User to Network
DSM-CC U-U	DSM-CC User to User
DTS	Decoding Time Stamp
DVB	Digital Video Broadcasting
DVB-SI	DVB - Service Information
ECM	Entitlement Control Message
EMM	Entitlement Management Message
EPG	Electronic Program Guide
ESC	End Service Consumer
ESCS	End-Service Consumer System
ESP	End Service Provider
ESPS	End-Service Provider System
ETS	European Telecommunications Standard
ETSI	European Telecommunications Standards Institute
ETR	European Telecommunications Recommendation
FIFO	First In First Out

fpvsbf	Floating point value sign bit first
HDTV	High Definition Television
HTML	HyperText Markup Language
ID	Identification
IDL	Interface Definition Language
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPR	Intellectual Property Rights
ISO	International Standardization Organization
ITU	International Telecommunications Union
Mbps	Megabits per second
LSB	Least Significant Bit
MHEG	Multimedia and Hypermedia information coding Experts Group
MPEG	Moving Picture Experts Group
MPEG-TS	MPEG-2 Transport Stream
MSB	Most Significant Bit
MUX	Multiplex
NIU	Network Interface Unit
NPT	Normal Play Time
NTSC	National Television Systems Committee
OMG	Object Management Group
OMG-UNO	Object Management Group - Universal Networked Object
OS	Operating System
OSI	Open Systems Interconnection (Reference Model)
PC	Personal Computer
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Packet Identifier, or Program Identification
PMT	Program Map Table
PN	Program Number (MPEG-2)
PNG	Portable Network Graphics (specified by W3C)
PSI	Program Specific Information (MPEG-2)
PTS	Presentation Time Stamp
QoS	Quality of Service
RDM	Reference Decoder Model
RGB	Red Green Blue
RPC	Remote Procedure Call

RTE	RunTime Engine
SCS	Service Consumer System
SCTE	Society of Cable Telecommunications Engineers, Inc
SGML	Standard Generalized Markup Language
SI	Service Information
SPS	Service Provider System
SPV	Service Provider
SRC	Service Related Control
STU	Set-Top Unit
TBD	To be defined
TCP	Transmission Control Protocol
tcimsbf	Two's complement integer, msb (sign) bit first
TS	Transport Stream
T-STD	Transport System Target Decoder
TV	Television
UDP	User Datagram Protocol
uimsbf	Unsigned integer most significant bit first
UNO	Universal Networked Object
UTC	Universal Coordinated Time
VCR	Video Cassette Recorder
VM	Virtual Machine
W3C	World Wide Web Consortium

5. Conventions

The style of this Specification follows the “Guide for ITU-T and ISO/IEC JTC 1 cooperation, Appendix II: Rules for presentation of ITU-T | ISO/IEC common text (March, 1993)”.

6. Monomedia Components

The basic monomedia components in DAVIC 1.4.1 include the following elements with their associated coding formats. Various options within the coding standards and other file and packaging formats are allowed as detailed in the following clauses. If the content is encrypted the following descriptions pertain to the decrypted data.

Table 6-1. Coding options of monomedia components

Monomedia component	*Coding Options*
Characters	ISO 10646-1
Text	HTML 3.2
Outline Fonts	Defined in this specification
Language Information	ISO 639, part 2
Service Information	ETS 300-468
Telephone Numbers	ETS 300 468
Compressed Audio	MPEG-1 Audio, AC-3 Audio
Scaleable Audio	MPEG-2 BC Audio
Linear Audio	AIFF-C
Compressed Video	MPEG-2 Video (note that this includes constrained MPEG-1 video)
Still Picture	MPEG-2 Intra Frame and MPEG-2 Systems
Compressed graphics	ETS 300 743
Compressed Character Data	SCTE DVS/026
Network graphics	PNG (Portable Network Graphics)
Note : Network Graphics replaces the monomedia component ‘uncompressed graphics’ from DAVIC 1.0 up to DAVIC 1.2.	

6.1 Character Information

In DAVIC 1.4.1 coding of characters is based on Unicode, ISO 10646-1, to support multilingual text. Rather than extending the mandatory Latin characterset in each DAVIC compliant STU, as defined in DAVIC 1.0, DAVIC 1.4.1 provides a mechanism to download character images that are not residently available in a STU. To this effect character images can be downloaded. DAVIC 1.4.1 does not specify a coding format for character images. Future versions of DAVIC specifications are expected to adopt the result of the ongoing work in the World Wide Web Consortium on an outline format for character coding.

Character images for the Latin-1 characters as defined in ISO 8859-1 are mandatorily supported in DAVIC 1.4.1 STUs. The STU shall at least be capable to display 24 lines per screen with 40 monospaced characters per line with respect to ITU-R 601.

6.2 Text Information

The following requirements on coding of text information have been identified :

- the syntax provides a tag for hyperlinks consistent with MHEG-5 Hypertext class anchor
- the syntax provides tags for rendering control: new line (left, right, center, justify), italics, underline, bold, emphasis, strong emphasis, font selection, colour selection, size selection
- the syntax and semantics are suitable for verification in the Reference Decoder Model
- the syntax is extensible in order to accommodate the expected evolution of text coding requirements
- the syntax is efficient with respect to coding and parsing
- the syntax allows for error resilience
- the character encoding encompasses the full Latin character set (ISO 8859-1)
- the character encoding is multilingual and allow expansion (ISO 10646-1)
- the syntax allows control over the starting corner, text flow direction and rotation
- the syntax provides additional tags for sub-script, super-script, embedding bitmap objects and language specifiers

The DAVIC 1.4.1 text specification is based on the HTML 3.2 Reference Specification (W3C Recommendation 14-Jan-1997), including the support of RFC2070 Internationalization of the Hypertext Markup Language, as well as the support of Cascading Style Sheets (CSS). The specification supports the marking of fragments of text as being in a certain language or writing direction (left to right or right to left), so that proper formatting can be applied to them.

Language specifiers are included in the HTML 3.2 specification. The language is identified with attributes that are formed according to RFC 1766, which in turn is based on ISO-639 and ISO-3166. Also superscripts and subscripts are supported in HTML 3.2, as well as alignment attributes on most elements and selection of colour and size using the FONT tag. Increased presentational control and greater separation of structural and presentation information is provided by (Cascading) Style Sheets. Style Sheets also allow targeting for different types of display, for example, there might be one stylesheet for typical PC/workstation display, another for display on a DAVIC 1.4.1 compliant STU, another for handheld mobile devices, and a fourth for a laser printer.

DAVIC 1.4.1 text is coded as either a stand-alone <BODY> element or a full <HTML> element, both as defined in HTML 3.2. ISO 10646-1 as specified in HTML 3.2 is used both as the document character set as well as the character encoding scheme.

6.2.1 Decoding requirements on HTML support

DAVIC compliant decoders shall act upon all HTML 3.2 tags, except the following elements which may be optionally acted upon:

1. all HTML 3.2 deprecated elements; these include: LISTING, XMP.
2. all table-based elements; these include: TABLE, TD, TH, TR.
3. all form-based elements; these include: ISINDEX, FORM, INPUT, SELECT, TEXTAREA.
4. all applet or script-based elements (such as JavaScript), which should be parsed, but may not be displayed (except any alternate text ALT); these include: APPLET, SCRIPT.
5. all client-side image-map elements; these include MAP.
6. all URL modification tags; these include: BASE.

Tags specified in RFC2070 shall also be parsed, and it is recommended that these should be acted upon (in addition to the HTML 3.2 reference specification); these include: LANG, DIR, ALIGN, Q, SPAN plus additional character entities.

Tags specified in Cascading Style Sheets, level 1 (W3C Recommendation 17 Dec 1996) shall also be parsed, and it is recommended that these should be acted upon (in addition to the HTML 3.2 reference specification); these include: STYLE, STYLESHEET, CLASS, ID.

Additional tags shall be parsed and may either be discarded if no alternative text (ALT) is available, or display the alternative text if it is available, or may act upon the tag if it is known.

6.2.2 HTML encoding

DAVIC 1.4.1 specifies that HTML 3.2 documents are encoded using a variant of UTF-8 (Amendment 1 to ISO/IEC 10646-1) so that Unicode characters can be supported directly within HyperText objects. This variant of UTF-8 specifies the following :

- the null byte, (byte) 0, is encoded using the two-byte format, rather than the one-byte format — this ensures that there are no embedded null's in a UTF-8 string.
- Only one-, two- and three-byte formats are used; longer variants are not recognised.

This variant of UTF-8 encoding is also used in the Sun Java virtual machine.

The UTF-8 encoding ensures that the ASCII subset of Unicode is transmitted in a single byte, whilst other Unicode characters are transmitted in two or three bytes. This approach offers a significant advantage when most characters lie within the ASCII portion of Unicode.

See Clause 6.2.4 for an informative list of DAVIC supported HTML tags.

6.2.3 HTML mapping to MHEG elements

Various elements within an HTML document require a mapping to MHEG elements; these include: font-based elements and colour-based elements.

- Fonts: HTML supports a relative sizing model for fonts, ranging from 1–7. A mapping between HTML font sizes and MHEG fonts is to be provided.
- Colours: HTML specifies colours as a 24-bit RGB hex triple, e.g. #FF0000. Such colours may be mapped to MHEG absolute colours by considering the most significant 4 bits of each of the HTML RGB components to be mapped directly to each of the RGB components of an MHEG RGBα16 absolute colour. By default, the α component of the MHEG RGBα16 absolute colour may be considered to be opaque, i.e. 15.

6.2.4 Informative list of supported HTML Tags

In addition to standard SGML entities, such as document type and comments, the support of tags from HTML3.2 by DAVIC 1.4.1 includes :

Table 6-2. Examples of HTML 3.2 tags supported by DAVIC 1.4.1

HTML Tag	Meaning
A	Anchor: create a hyperlink
ADDRESS	Address: the enclosed text is an address
B	Bold: format the enclosed text as bold
BASEFONT	Base font: Specify the font size for subsequent text
BIG	Big: format the enclosed text using a bigger font
BLOCKQUOTE	Block quotation: the enclosed text is a block quotation
BODY	Body: delimit the body of the document text
BR	Break: break the current text flow
CAPTION	Caption: specify a caption for a table
CENTER	Centre: center the enclosed text
CITE	Citation: the enclosed text is a citation
CODE	Code: the enclosed text is a code sample
DD	Definition: define the definition portion of an element in a definition list
DFN	Definition: the enclosed text is a definition of a term

DIR	Directory: create a “directory” list
DIV	Division: create a division within a document
DL	Definition list: create a list of definitions and their terms
DT	Definition term: define the term portion of an element in a definition list
EM	Emphasis: the enclosed text should be emphasised
FONT	Font: set the size / colour of the font
H(1-6)	Heading: the enclosed text is a level 1–6 heading
HEAD	Head: delimit the head of a document
HR	Horizontal rule: draw a horizontal rule
HTML	HTML: delimit the extent of the whole HTML document
I	Italic: format the enclosed text as italic
IMG	Image: insert an image into the current text flow
KBD	Keyboard: the enclosed text is keyboard-like input
LI	List item: an item in an ordered or unordered list
LINK	Link: define a link between the current document and another document specified in the head — this can be used for CSS
MENU	Menu: define a menu list
META	Meta information: provide additional information about a document
OL	Ordered list: delimit an ordered list
P	Paragraph: define the start (and end) of a paragraph
PLAINTEXT	Plain text: format the remainder of the document as pre-formatted plain text
PRE	Pre-formatted text: format the enclosed text in its original pre-formatted version
SAMP	Sample: the enclosed text is a sample
SMALL	Small: format the enclosed text using a smaller font
STRIKE	Struck though: format the enclosed text as struck through with a horizontal line
STRONG	Strong: strongly emphasize the enclosed text
STYLE	Style: used for cascading style sheets (CSS)
SUB	Subscript: format the enclosed text as a subscript
SUP	Superscript: format the enclosed text as a superscript
TITLE	Title: specify the title of an HTML document
TT	Typewriter text: format the enclosed text in a typewrite (mono-spaced) font
U	Underlined text: format the enclosed text as underlined
UL	Unordered list: delimit an unordered list
VAR	Variable: the enclosed text is a variable

6.3 Outline Font Format

6.3.1 Requirements

General requirements for a font format to support DAVIC are listed below. The DAVIC font format may be implemented in a static or dynamic process. For example, a set of fonts may exist in ROM of a set-top unit, and are rendered on demand by applications executing within the set-top.

The DAVIC font format can be used by content providers in several ways. First, the content provider may render or rasterize the content and produce a MPEG, or PNG data that is then broadcast down to the set-top unit. Secondly for down loaded applications that require a variety of fonts, servers can dynamically create small DAVIC font objects that contain only the character data required to image the content, and they are downloaded to the set-top. Once the application has no further need, the small font objects can be deleted.

Specific details about dynamic generation of this format and rendering this format are outside the scope and purpose of this document. Those details are available from DAVIC member, Bitstream Inc. The DAVIC font format is intended to be used by members of DAVIC or developers of DAVIC technology. The requirements for the font format which extends the current bitmap DAVIC technology is as follows.

- Platform Independent font format: DAVIC requires a byte stream format that can be transferred to any platform within a DAVIC network. Network nodes may be running a variety of operating systems on a variety of processors so it is necessary the format is reduced to a byte stream of known format. Implementation of the format across processors and operating systems must not favor or require a particular processor or operating system.
- Scaleable outline font format: The request for a scaleable cubic outline format is required to resolve the differing resolutions or aspect ratios of the target devices. The format must be capable of supporting multiple fonts (logical fonts) with a variable number of characters. The format must be capable of supporting any font style or treatment for the purpose of imaging within a DAVIC device. In the event that static output devices such as printers are connected to a DAVIC device, the format must be suitably rendered in the resolution of the output device.
- Character Encoding: Digital content that references characters within DAVIC environments are based on UNICODE and the font format must fully support UNICODE.
- Default Character Set for Resident Font(s) within DAVIC devices: DAVIC devices may contain the ISO-Latin 8859-1 character set in a Bitmap or Outline format. It is desirable to extend the current text and UNICODE character access mechanism to support outline font technology. Augmenting the character set dynamically is highly desirable so that multi-lingual digital content can be imaged and displayed. Manufactures may implement any extra character sets to support target markets within their devices statically or by dynamic downloading. The default ISO-Latin 8859-1 character set is always assumed to be within the DAVIC device.
- Dynamic Merging of character sets: Character access via UNICODE implies multi-lingual support and can be accomplished by downloading either bitmap or outline font fragments. The selected font format must be easy to combine font fragments so that font fragments appear as a single font with a single unified character set.
- Memory, Font Format Size and Compression: Size of the outline font format must not burden the DAVIC devices with unnecessary data (ROM or RAM) or require specialized decompression logic. The selected format must be dense or tightly coded, and not require the commercial licensing of data compression logic.
- Floating Point Processing: DAVIC compliant network nodes, may not contain a FPP so the selected font format must not require floating point processing.
- Font Effects and Rendering Considerations: The selected scaleable cubic outline font format must be able to be rendered as follows:
  - Scaled independently in X and Y to accommodate asymmetric resolutions. Scaling is also required to produce bitmaps for devices which have higher resolutions, such as printers which may be connected to the set-top boxes in the future.
  - Scale to any arbitrary device context (in case static printouts are desired in the future)
  - Rotation of characters or text to any angle. This is important for down-loadable applications that wish to provide these effects. Orthogonal rotations as well as any increment in 10ths of a degree are required.

- Slanting or Obliqueing or shearing by using a transform matrix rather than requiring an Italic font must be optionally callable from any application. Usually a shear of 12 degrees is used to obtain an Italic effect. Shearing must be specified to any angle in 10ths of degree increments.
- Anti-aliased to arbitrary levels
- Filtered, gamma corrected, colored or blended
- Be made transparent or opaque

- Format and technology availability: DAVIC requires that the selected format be available to DAVIC members at no charge. DAVIC also requires commercially available technology to dynamically generate the format and render the format.
- Industry synergy: DAVIC devices may be connected to the Internet in the future, and therefore are expected to be capable of viewing Internet content. Synergy with the Internet industry and other standards is desirable.

6.3.2 Font Format Specification

The DAVIC specification of the format for outline fonts is contained in Annex A of this specification.

6.3.3 Font rendering

To ensure consistent text composition of rendering engines, the use of the following parameters in the rendering process are recommended :

- A default anti-alias bit depth of four.
- A default sub-pixel character placement of one quarter pixel accuracy.
- The use of a method for calculation of character string and algorithm for rounding to the nearest sub-pixel boundary with the same result as from the method given in the following example :

  Consider the word "DAVIC" to be written at a specified position (x0, y0) in device coordinates. Device coordinates should be stored in fractional pixels. DAVIC recommends to use a 16.16 representation of each coordinate in a 32-bit word. In other words, to describe x and y coordinates each in units of 1/65536 pixels.

  The first character 'D' is rendered with its character origin at the nearest sub-pixel boundary relative to (x0, y0). With a sub-pixel accuracy of the recommended 1/4 pixel, the rounded character origin (x, y) is calculated by:

  x = (x0 + 0x00002000) & 0xFFFFC000;

  y = (y0 + 0x00002000) & 0xFFFFC000;

  The set width of the 'D' is stored in the PFR in metricsResolution units. This is transformed into device coordinates by multiplying it by the current transformation matrix (CTM). The CTM is the product of the outputMatrix and the fontMatrix. The fontMatrix defines the size of the font in pixels per user unit. The outputMatrix defines the transformation from user units to pixels. Both matrices are expressed in 16.16 units. Multiplication of one 16.16 unit by another preserves the full precision except, of course, for the ultimate rounding to the nearest 1/65536 pixel.

  The formal expression for the transformation of the setWidth is:

$$\begin{vmatrix} \text{setWidth.x} \\ \text{setWidth.y} \end{vmatrix} = \begin{vmatrix} \text{outputMatrix} \end{vmatrix} * \begin{vmatrix} \text{fontMatrix} \end{vmatrix} * \begin{vmatrix} \text{charWidth} \\ 0 \end{vmatrix}$$

  where the value of charWidth is equal to the PFR-defined set width of the 'D' in metrics resolution units, multiplied by 65536 and then divided by its metrics resolution.

  The current position is then updated by adding (setWidth.x, setWidth.y) to it. Note that the rounding required to render the 'D' is not incuded in the update to the current position. This avoids any accumulation of rounding errors across a line and ensures that each character is positioned with the best possible accuracy.

The updated current position is then used to position the letter 'A'. Like the first character, it is rendered at the nearest sub-pixel boundary to its current position.

If pair kerning is enabled, the character pair 'D' and 'A' are looked up in the list of kerning pairs for the currently selected font. If a matching kerning pair is found, the adjustment is transformed into device coordinates by multiplying it with the CTM and the result added to the current position prior to rendering the letter 'A'.

If track kerning is enabled, the track kerning adjustment associated with the currently selecter font and the current nominal point size is also transformed into device coordinates by multiplying it with the CTM and the result added to the current position prior to rendering the letter 'A'.

If both pair kerning and track kerning apply to an inter-character space, the track and pair kerning adjustments are added together before transforming the composite adjustment into device coordinates. This improves performance by saving a transformation operation. It also improves precision by eliminating a rounding error.

The process of applying intercharacter kerning adjustments and rendering characters continues until the 'C' has been rendered. No kerning adjustment is applied after the last character. If additional characters are appended to the string, the appropriate kerning adjustment should be applied prior to the first character. This is unlike the first character in a new string.

6.4 Language Information

In DAVIC 1.4.1 coding of language information shall be based on ISO 639, part 2. If an elementary stream in a program represents a specific language, then the ISO 639 descriptor shall be used in the Program Map Table to identify that language. In the case of a compressed audio stream with two independent channels, each representing a different language, both languages shall be identified by first including the ISO 639 descriptor for channel 1, immediately followed by the same descriptor for channel 2.

6.5 Service Information

This clause describes the service information (SI) data which forms a part of compliant bitstreams, in order to provide the user with information to assist in the selection of services and/or events within the bitstream. In addition it provides physical transmission information to enable the set-top unit to access a service.

In DAVIC 1.4.1 the Service Information format shall comply to the ETS 300 468 specification.

In addition, the use of service information in DAVIC 1.4.1 shall adhere to the SI implementation guidelines, specified in ETR 211.

6.6 Telephone Numbers

In DAVIC 1.4.1 the coding of telephone numbers shall be according to the telephone number segmentation format specified for the ETSI SI telephony descriptor in ETSI ETS 300-468. This permits a common telephone number segmentation to be referenced by application objects in the STU. This would allow, for example the telephone number provided as part of a televote service to be automatically modified according to the users wishes before the number was dialed.

6.7 Compressed Audio

DAVIC 1.4.1 compressed audio includes two methods of compression that can be used to realise two sets of functionalities. These methods are described in the following subsections.

6.7.1 Compressed audio coding using MPEG-1 Audio

MPEG-1 Audio (ISO/IEC 11172-3) shall be coded with the following constraints:

- Compressed audio shall use MPEG-1 Layers I and II coding (layer = '11' or '10')
- Compressed audio shall be in single channel, dual channel, joint stereo or stereo.
- Compressed audio shall use a sampling rate of 32 kHz, 44.1 kHz, or 48 kHz.
- For Layer I, compressed audio may have each bit rate permitted in the range between 32 and 448 kbits/sec (32, 64, 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416 and 448) , with the exception of the free format bit rate.
- For Layer II, compressed audio may have each bit rate permitted in the range between 32 and 384 kbits/sec (32, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320 and 384), with the exception of the free format bit rate.
- Compressed audio shall not apply the free format bit rate (bitrate_index = '0000' is forbidden).
- Compressed audio shall have no emphasis (emphasis = '00').
- Compressed audio shall include the parity word check (crc_check) in each audio frame.

Note that the bit rate may be switched in compressed audio streams on audio frame boundaries.

6.7.2 Compressed audio coding using ATSC A/52 Audio

ATSC A/52 Audio, including support for multichannel surround sound, shall be coded with the following constraints:

- ATSC A/52 compressed audio shall be constrained to a maximum bit rate of 448 kb/s.

Note that the bit rate may be switched in compressed audio streams on audio frame boundaries.

Further information on coding and carriage of ATSC A/52 Audio in ATSC systems is described in Annex L.

6.8 Scaleable Audio

This section describes the information representation of audio content to be used in environments where scaleability is needed (i.e. a level of performance beyond the capability of the compressed audio tools in section 6.7 'Compressed Audio'), such as delivery of audio over bandwidth limited media or over media with contention (e.g. the internet or intranets with packet loss and variable delay, or over mobile channels), and non-guaranteed rates.

For scaleable audio, ISO/IEC 13818-3 (Second Edition, 1997) shall be used with the following constraints:

- Scaleable audio shall use MPEG-2 Layer II coding (layer = '10')
- Scaleable audio shall not apply the free format bit rate (bitrate_index = '0000' is forbidden).
- Scaleable audio shall have no emphasis (emphasis = '00').
- Scaleable audio shall include the parity word check (crc_check) in each audio base_frame.
- Scaleable audio shall not apply prediction (mc_prediction_on = '0')
- Scaleable audio shall not apply multilingual (no_of_multi_lingual_ch = '000')
- Scaleable audio decoders shall support a switch in base bit rate and extension bit rate on audio frame boundaries.

6.9 Linear Audio

Linear audio shall be coded using AIFF-C. The specification of AIFF-C is contained in Annex B of this specification. AIFF-C describes a very versatile audio coding format. In the AIFF-C specification, the audio sample is broken into 'chunks', four of which must be present in all audio samples: the Form chunk, the Format Version chunk, the Extended Common chunk, and the Sound Data chunk. The Form chunk must be present at the beginning of the audio sample. All other chunks including user defined chunks, referred to herein as Private chunks, are allowed to exist in any order after the Form chunk. Multiple instantiations of all chunks except the Format Version chunk and the Sound Data chunk are allowed within a sample.

Note : Support of Linear Audio as a real-time stream in future versions of the DAVIC specifications may require concatenation of objects containing linear audio with a play back duration of up to 0.7 second each.

6.10 Compressed Video

Video information shall be coded using MPEG-1 Video (ISO/IEC 11172-2) or MPEG-2 Video (ISO/IEC 13818-2). For MPEG-1 Video, the data must follow the constrained parameter set, i.e. in the MPEG-1 Video data the constrained_parameter_flag shall be set to '1'. For MPEG-2 Video, the data shall conform to Main Profile syntax. Next to coding of video up to the standard video resolution as specified in ITU-R 601, DAVIC specifies coding of video at higher resolutions. Informative Annex L provides examples of video input formats that may be used.

Constraints for the coding of video with a resolution up to ITU-R 601 are specified in Clause 6.10.1. Clause 6.10.2 specifies constraints for the coding of video with resolutions higher than ITU-R 601.

6.10.1 Coding constraints for video with a resolution up to ITU-R 601

6.10.1.1 Main Profile

For the coding of video with a resolution up to ITU-R 601, the constraints defined by MPEG for the Main Profile at Main Level (MP@ML) shall apply.

6.10.1.2 Aspect Ratio of 4:3 and Pan Vectors

Compressed video shall have a source aspect ratio of 1:1, 4:3 or 16:9. Specifically, the aspect_ratio_information shall have the value '0001', '0010' or '0011'. It is recommended that pan vectors for a 4:3 window are included in the video bitstream when the source aspect ratio is 16:9. The vertical component of each pan vector shall be zero. If pan vectors are included, then the sequence_display_extension shall be present in the bitstream and the aspect_ratio_information shall be set to '0010' (4:3 display). The display_vertical_size shall be equal to the vertical_size_value. The display_horizontal_size shall contain the resolution of the target 4:3 display. The value of the display_horizontal_size field may be calculated by the following formula :

display_horizontal_size = (3/4) * (horizontal_size_value)

The table below gives some typical examples.

Table 6-3 Some typical values for display_horizontal_size for 4:3 window in 16:9 picture

horizontal_size_value	*display_horizontal_size*
720	*540*
704	*528*
544	*408*
528	*396*
480	*360*
352	*264*

6.10.1.3 Full Screen

If no sequence _display_extension is present, then the coded picture size shall be any of the values from Table 6-4, with the required upsampling ratios for full screen display on 4:3 and 16:9 monitors with 720 pixels per line. Note that DAVIC does not constrain the horizontal display resolution of the STU to 720 pixels; the applied display resolution is fully at the discretion of the implementation.

Table 6-4. Horizontal Upsampling Ratios for Full Screen Picture Sizes

coded_picture_size 6)	*source_aspect_ratio*	*horizontal upsampling ratios to 720 active pixels per line*	
		4:3 monitor	*16:9 monitor*
720 x 576	4:3	x 1	x (3/4) 1)
	16:9	x (4/3) 7)	x 1
704 x 576	4:3	x 1 3)	x (3/4) 1)
	16:9	x (4/3) 3) 7)	x 1
544 x 576	4:3	x (4/3)	x 11)
	16:9	x (16/9) 7)	x (4/3)
528 x 576	4:3	x (4/3)	x 11)
	16:9	x (16/9) 7)	x (4/3)
480 x 576	4:3	x (3/2)	x (9/8) 1)
	16:9	x 27)	x (3/2)
352 x 576	4:3	x 2	x (3/2) 1)
	16:9	x (8/3) 7)	x 2
352 x 288	4:3	x 22)	x (3/2) 1) 2)
	16:9	x (8/3) 2) 7)	x 22)
720 x 480	4:3	x 1	x (3/4) 1)
	16:9	x (4/3) 7)	x 1
704 x 480	4:3	x 1	x (3/4) 1)
	16:9	x (4/3) 7)	x 1
640 x 480	4:3 4)	x (9/8) 5)	x (27/32) 1)
544 x 480	4:3	x (4/3)	x 11)
	16:9	x (16/9) 7)	x (4/3)
528 x 480	4:3	x (4/3)	x 11)
	16:9	x (16/9) 7)	x (4/3)
480 x 480	4:3	x (3/2)	x (9/8) 1)
	16:9	x 2 7)	x (3/2)
352 x 480	4:3	x 2	x (3/2) 1)
	16:9	x (8/3) 7)	x 2
352 x 240	4:3	x 22)	x (3/2) 1) 2)
	16:9	x (8/3) 2) 7)	x 22)

note 1 : this upsampling may be optional as 16:9 monitors can (in general) be switched to operate in 4:3 mode.
note 2 : also vertical upsampling x 2
note 3: upsampling to a window with a width of 704 pixels within an active area with a width of 720 pixels
note 4 : in this case the aspect_ratio_information field may be coded with ‘0001’, indicating an aspect ratio of 1
note 5 : x (11/10) in case of 704 active pixels per line
note 6 : the coded_picture_size is defined to be equal to the horizontal_size_value by the vertical_size_value
note 7 : this upsampling is only applied to the (3/4)x(horizontal_size_value) pixels from the 16:9 picture to be displayed on the 4:3 display

6.10.1.4 Non-Full Screen Pictures

If the sequence_display_extension is present, and the coded picture size is smaller than or equal to the display picture size, then the display picture size shall be any of the values from Table 6-5, with the required upsampling ratios for display on 4:3 and 16:9 monitors with 720 active pixels per line. For the purpose of this clause, the coded picture size is smaller than or equal to the display picture size if both the horizontal size and the vertical size of the coded picture are smaller than or equal to the horizontal size and the vertical size of the displayed picture respectively.

Table 6-5. Horizontal Upsampling Ratios For Non-Full Screen Pictures

displayed_picture_size 6)	*permitted coded_picture_size*	*source_aspect_ratio*	*horizontal upsampling ratios*	
			4:3 monitor	*16:9 monitor*
720 x 576	<=720 x <=576	4:3	x 1	x (3/4) 1)
		16:9	x (4/3) 7)	x 1
704 x 576	<=704 x <=576	4:3	x 13)	x (3/4) 1)
		16:9	x (4/3) 7)	x 1
544 x 576	<=544 x <=576	4:3	x (4/3)	x 11)
		16:9	x (16/9) 7)	x (4/3)
528 x 576	<=528 x <=576	4:3	x (4/3)	x 11)
		16:9	x (16/9) 7)	x (4/3)
480 x 576	<=480 x <=576	4:3	x (3/2)	x (9/8) 1)
		16:9	x 2 7)	x (3/2)
352 x 576	<=352 x <=576	4:3	x 2	x (3/2) 1)
		16:9	x (8/3) 7)	x 2
352 x 288	<=352 x <=288	4:3	x 22)	x (3/2) 1) 2)
		16:9	x (8/3) 2) 7)	x 22)
720 x 480	<=720 x <=480	4:3	x 1	x (3/4) 1)
		16:9	x (4/3) 7)	x 1
704 x 480	<=704 x <=480	4:3	x 1	x (3/4) 1)
		16:9	x (4/3) 7)	x 1
640 x 480	<=640 x <=480	4:3 4)	x (9/8) 5)	x (27/32) 1)
544 x 480	<=544 x <=480	4:3	x (4/3)	x 11)
		16:9	x (16/9) 7)	x (4/3)
528 x 480	<=528 x <=480	4:3	x (4/3)	x 11)
		16:9	x (16/9) 7)	x (4/3)
480 x 480	<=480 x <=480	4:3	x (3/2)	x (9/8) 1)
		16:9	x 2 7)	x (3/2)
352 x 480	<=352 x <=480	4:3	x 2	x (3/2) 1)
		16:9	x (8/3) 7)	x 2
352 x 240	<=352 x <=240	4:3	x 22)	x (3/2) 1) 2)
		16:9	x (8/3) 2) 7)	x 22)

note 1 : this upsampling is optional as 16:9 monitors can (in general) be switched to operate in 4:3 mode.
note 2 : also vertical upsampling x 2
note 3: upsampling to a window with a width of 704 pixels within an active area with a width of 720 pixels
note 4 : in this case the aspect_ratio_information field may be coded with ‘0001’, indicating an aspect ratio of 1
note 5 : x (11/10) in case of 704 active pixels per line
note 6 : displayed_picture_size is defined to be equal to the display_horizontal_size by the display_vertical_size
note 7 : this upsampling is only applied to the (3/4)x(horizontal_size_value) pixels from the 16:9 picture to be displayed on the 4:3 display

In the absence of control by the high-level API over the position of non-full screen video, the position of the coded picture video on the display (as defined by the displayed picture size), is defined by the pan vectors, when included. If no pan vectors are included, a default position shall be assumed in the center of the displayed picture. If the high-level API takes control over the position, the pan vectors, when included, may be disregarded.

DAVIC supports trick mode for compressed video by indicating the trick mode in the PES packet header in which the MPEG video data is contained, fully compliant to ISO/IEC 13818-1.

6.10.2 Coding constraints for video with a resolution beyond ITU-R 601

6.10.2.1 High profile

The allowable parameters shall be bounded by the upper limits specified for the Main Profile at High Level.[1] Additionally, the MPEG-2 video data shall meet the constraints and specifications described in the following sections[2].

6.10.2.2 Syntactical Constraints

The following tables list the allowed values for each of the ISO/IEC 13818-2 syntactic elements which are restricted beyond the limits imposed by MP@HL. In these tables conventional numbers denote decimal values, numbers preceded by 0x are to be interpreted as hexadecimal values and numbers within single quotes (e.g., '10010100') are to be interpreted as a string of binary digits. The following table identifies parameters in the sequence header of a bit stream that shall be constrained and lists the allowed values for each.

Table 6-6: Sequence Header Constraints

Sequence header syntactic element	*Allowed value*
horizontal_size_value	see Table 6-7
vertical_size_value	see Table 6-7
aspect_ratio_information	see Table 6-7
frame_rate_code	see Table 6-7
bit_rate_value (≤ 38.8 Mbps)	≤ 97000
vbv_buffer_size_value	≤ 488

6.10.2.3 Compression Format Constraints

The following table lists the allowed compression formats.

Table 6-7. Compression Format Constraints[3]

vertical_size_ value	*horizontal_size_ value*	*aspect_ratio_ information*	*frame_rate_ code*	*progressive_ sequence*
1080[4]	1920	1, 3	1,2,3,4,5	1
			3,4,5	0
10354	1920	3	4,5	0
720	1280	1,3	1,2,3,4,5,6,7,8	1
576	720	2, 3	6	1
			3	1
			3	0
	704	2, 3	6	1
			3	1

[1] See ISO/IEC 13818-2, Section 8 for more information regarding profiles and levels.

[2] The additional constraints and specifications are based on ATSC A/53 and, in part, on ITU-R BT.1208.

[3] Shaded areas describe formats up to ITU-R resolution. This information is provided for convenience and does not constrain in any manner the functionality for coding of video up to ITU-R 601 resolution.

[4] Note that 1088 lines are actually coded in order to satisfy the MPEG-2 requirement that the coded vertical size be a multiple of 16 (progressive scan) or 32 (interlaced scan) and to provide a common coding format for 1035 and 1080.

vertical_size_ value	*horizontal_size_ value*	*aspect_ratio_ information*	*frame_rate_ code*	*progressive_ sequence*
			3	0
	544	2, 3	3	1
			3	0
	528	2, 3	3	1
			3	0
	480	2, 3	3	1
			3	0
	352	2, 3	3	1
			3	0
480	720	2, 3	2,5,7,8	1
			1, 4	1
			5	0
			4	0
	704	2, 3	2,5,7,8	1
			1,4	1
			5	0
			4	0
	640	1, 2, 3	2,5,7,8	1
			1,4	1
			5	0
			4	0
	544	2, 3	1,4	1
			4	0
	528	2, 3	1,4	1
			4	0
	480	2, 3	1,4	1
			4	0
	352	2, 3	1,4	1
			4	0
288	352	2, 3	3	1
240	352	2, 3	1,4	1

Legend for MPEG-2 coded values
aspect_ratio_information 1 = square samples 2 = 4:3 display aspect ratio 3 = 16:9 display aspect ratio
frame_rate_code 1 = 23.976 Hz 2 = 24 Hz 3 = 25 Hz 4 = 29.97 Hz 5 = 30 Hz 6 = 50 Hz 7 = 59.94 Hz 8 = 60 Hz
progressive_sequence 0 = interlaced scan 1 = progressive scan

6.10.2.4 Sequence Extension Constraints

The following table identifies parameters in the sequence extension part of a bit stream that shall be constrained by the video subsystem and lists the allowed values for each. A sequence_extension structure is required to be present after every sequence_header structure.

Table 6-8. Sequence Extension Constraints

Sequence extension syntactic element	*Allowed values*
progressive_sequence	see Table 6-7
profile_and_level_indication	see Note
chroma_format	‘01’

Sequence extension syntactic element	*Allowed values*
horizontal_size_extension	'00'
vertical_size_extension	'00'
bit_rate_extension	'0000 0000 0000'
vbv_buffer_size_extension	'0000 0000'
frame_rate_extension_n	'00'
frame_rate_extension_d	'0000 0'

Note: The profile_and_level_indication field shall indicate the lowest profile and level defined in ISO/IEC 13818-2, Section 8, that is consistent with the parameters of the video elementary stream.

6.10.2.5 Sequence Display Extension Constraints

The following table identifies parameters in the sequence display extension part of a bit stream that shall be constrained by the video subsystem and lists the allowed values for each.

Table 6-9. Sequence Display Extension Constraints

Sequence display extension syntactic element	*Allowed values*
video_format	'000'

The preferred and default values for color_primaries, transfer_characteristics, and matrix_coefficients are defined to be SMPTE 274M[5] (value 0x01 in all three cases). While all values described by MPEG-2 are allowed in the transmitted bit stream, it is noted that SMPTE 170M values (0x06 in all three cases) will be the most likely alternate in common use.

6.10.2.6 Picture Header Constraints

In all cases other than when vbv_delay has the value 0xFFFF, the value of vbv_delay shall be constrained as follows:

vbv_delay • 45000

6.10.3 Decoding tool requirements

6.10.3.1 Decoding tools for video with a resolution up to ITU-R 601

DAVIC tools for decoding video with resolutions up to ITU-R 601 shall decode bitstreams of all of the specified resolutions into the output for which the specific STU was designed. When video encoded with 525 lines at a framerate of 29.97 Hz is delivered to the STU, the STU shall produce a baseband NTSC output signal or some other video output signal for which the STU was designed. Similarly, when video encoded with 625 lines at a framerate of 25 Hz is delivered to the STU, the STU shall produce a baseband PAL output signal or some other video output signal for which the STU was designed.

6.10.3.2 Decoding tools for video with a resolution beyond ITU-R 601

DAVIC tools for decoding video with resolutions higher than ITU-R 601 shall decode bitstreams of all of the specified resolutions into the output for which the specific STU was designed. The informative Annex K explains some implementation examples for providing compatibility with each video format such that each decoder can decode and display each DAVIC input bitstream resolution.

[5] At some point in the future, the color gamut may be extended by allowing negative values of RGB and defining the transfer characteristics for negative RGB values.

6.11 Still Pictures

Each still picture shall be encoded as an MPEG-2 Intra Frame; see ISO/IEC 13818-2. In the case of a series of still pictures with a presentation schedule associated to a time base (e.g. a series representing a slide show), then the still picture feature of MPEG-2 Systems (ISO/IEC 13818-1) shall be used. For the definition of still pictures in terms of MPEG Systems refer to Clause 2.1.52 of ISO/IEC 13818-1. In the case of a single still picture (bitmap), only ISO/IEC 13818-2 applies.

6.11.1 Normal Resolution Still Pictures

For still pictures with coded picture size smaller than or equal to 720 pixels by 576 lines, the picture size constraints specified in Clause 6.10.1 apply.

6.11.2 Higher Resolution Still Pictures

For still pictures with coded picture size larger than 720 pixels by 576 lines, the picture size constraints specified in Clause 6.10.2 apply.

6.12 Compressed Graphics

6.12.1 Requirements

The following prioritized list of criteria and requirements for compression of graphics have been identified. A larger value indicates a lower priority.

1. Ease and speed of software implementation in a STU
2. Minimum use of memory in the STU
3. Visual appearance while decoding is in progress in the STU
4. Lossless
5. Efficiency of compression
6. Technology available without IPR royalty

6.12.2 Format for Compressed Graphics

In DAVIC 1.4.1 compressed graphics shall be coded using ETS 300 743, also known as the DVB subtitling system.

6.12.2.1 Real-Time Compressed Graphic streams

If the presentation of the graphics is associated to the decoder system time clock (STC as defined in ISO/IEC 13818-1) then ETS 300 743 is fully applicable.

6.12.2.2 Single bitmaps with Compressed Graphics

In the case of single bitmaps with compressed graphics of which the presentation is not associated to a time base then each bitmap is represented by a “Region Composition Segment” followed by each “Object Data Segment” referred to; for the definition of these segments refer to Clauses 1.8.2 and 1.8.4 of ETS 300 743. For decoding a single bitmap with compressed graphics a separate colour palette may be available that fully complies to the “CLUT definition segment” as specified in Clause 1.8.3 of ETS 300 743. For single bitmaps with compressed graphics the encoded value of the following fields of Region Composition Segments, Object Data Segments and CLUT Definition Segments may be disregarded at decoding:

- page_id
- region_id
- region_version_number
- object_version_number
- CLUT-version_number

6.12.2.3 Default CLUT for single bitmaps with Compressed Graphics

DAVIC 1.4.1 specifies a default CLUT for single bitmaps with compressed graphics. The default CLUT is applicable when the use of no other CLUT is specified in this bitmap. A Visible Object, when referring to a Palette Object, will interpret specified IndexColours as entries in the default CLUT, except for Bitmap objects that use any specific Palette Object.

6.12.2.3.1 Requirements

The default CLUT for use by single bitmaps with compressed graphics is to meet the following requirements :

- the default CLUT shall define a CLUT with 256 entries
- the default CLUT shall support transparency values of 0 %, 25 %, 50 %, 75 % and 100 %
- the colours defined by default CLUT shall have a perceptually uniform distribution over the colour space

- the default CLUT shall leave some colours available for private use
- the colours defined by the default CLUT, when used in an STU implementation as the basic colours for the presentation of graphic images, are suitable for rendering any graphic image
- the R, G and B components of the colours defined by the default CLUT are orthogonal, i.e. quantization of a random colour towards a colour defined by the default CLUT is possible for each R, G or B component independently of the value and quantization of the other components.

6.12.2.3.2 Default CLUT characteristics

To meet the above requirements, a default CLUT is defined with properties as given in the following table, where for each transparency level the total number of CLUT entries is given, as well as the quantization levels for the Red, Green and Blue component of the colour associated to the entry. Each possible combination of component quantization levels is allowed for. As a consequence the total number of entries per transparency level is found by multiplying the number of quantization levels of the Red, Green and Blue components for that transparency level. The default CLUT reserves 12 entries for private use.

Table 6-9 Default CLUT characteristics

Transparency level	Total number of CLUT entries	Quantization levels for Red	Quantization levels for Green	Quantization levels for Blue
0 % (fully opaque)	135	5 levels : 0, 63, 127, 191, 255	9 levels : 0, 31, 63, 95, 127, 159, 191, 223, 255	3 levels : 0, 127, 255
25 %	56	4 levels : 0, 85, 170, 255	7 levels : 0, 42, 85, 127, 170, 212, 255	2 levels : 0, 255
50 %	36	3 levels : 0, 127, 255	6 levels : 0, 51, 102, 153, 204, 255	2 levels : 0, 255
75 %	16	2 levels : 0, 255	4 levels : 0, 85, 170, 255	2 levels : 0, 255
100 % (fully transparent)	1	-	-	-
privately defined	12	privately defined	privately defined	privately defined

6.12.2.3.3 Default CLUT specification

The colours of the default CLUT are defined in Annex C of this specification.

6.13 Compressed Character Data

Compressed character data shall be coded using SCTE DVS/026, defined by the Society of Cable Telecommunications Engineers (SCTE).

6.14 Network Graphics

As format for Network Graphics DAVIC supports the PNG format as defined by the World Wide Web Consortium (W3C Recommendation 01 October 1996, available at http://www.w3.org/TR/REC-png-multi.html).

7. Monomedia Streams

7.1 Types of Monomedia Components

DAVIC distinguishes three types of monomedia components. The first type are implied monomedia components; implied components are either included within other monomedia components (e.g. characters within text) or are implied by some other mechanism defined by DAVIC, such as the use of Service Information within an MPEG-2 Transport stream. The monomedia components which are not of the implied type are one of the two following types :

- Monomedia streams. The monomedia components of which the presentation requires synchronization with a time base are represented as monomedia streams. For such synchronization the mechanisms provided by MPEG Systems, ISO/IEC 13818-1, are used. To enable the use of time stamps as defined in ISO/IEC 13818-1, each monomedia stream is packetized in PES packets.
- Stand-alone monomedia components. Monomedia components that do not require synchronization with a time base at play back, are referred to as stand-alone monomedia components. Stand-alone monomedia components are not packetized in PES packets.

Table 7-1 defines which type each DAVIC defined monomedia component may take. Some monomedia components can be of more than one type, specifically they can be a monomedia stream and a stand-alone component. Specifically a graphical object may either be a single bitmap (such as a button for user control) or a graphical representation of text used within a graphical stream for subtitling. Furthermore a still picture may be a single bitmap, e.g. representing a background for a downloaded application, or may be part of a series of still pictures representing a slide show.

Table 7-1. Types of monomedia components

Monomedia component	*Representation*
Characters	implied component, e.g. in Text and Service Information
Text	stand-alone component
Outline Fonts	stand-alone component
Language Information	implied component, e.g. in Text and Service Information
Service Information	implied component in MPEG-2 Transport Stream
Telephone Numbers	implied component, e.g. in downloaded Application
Compressed Audio	stream
Scaleable Audio	stream
Linear Audio	stream
Compressed Video	stream
Still Picture series	stream
Still Picture bitmap	stand-alone component
Compressed graphic real-time stream	stream
Compressed graphic bitmap	stand-alone component
Compressed character data stream	stream
Network graphic bitmap	stand-alone component

7.2 Real-time and Stored Monomedia Streams

For monomedia streams DAVIC 1.4.1 distinguishes real-time streams and stored streams, which differ in the process which drives their play back.

- The playback of real-time streams is real time driven; real-time streams are played back in reference to a time base which is controlled by the PCR fields from the MPEG-2 Transport Stream that contains the real-time stream. With real-time streams the timing of the decoding and presentation in an STU is controlled by the characteristics of the stream during the delivery of the stream to the STU.
- The timing of the playback of stored streams is controlled by an application. The stream is stored in STU memory, providing the functionality of a local server that can be controlled from an application that also resides in the STU. As an example, in a certain application it may be possible for the user to play back a stored stream by pushing a specific button on a Remote Control.

Also transmission requirements differ for real-time streams and stored streams. In the case of real-time streams, constraints for real-time delivery apply to avoid problems such as buffer underflow and overflow. For synchronization of real-time streams and stored streams during playback, the mechanisms provided by ISO/IEC 13818-1 are applied by DAVIC 1.4.1. Therefore monomedia streams are stored in PES packets.

While the data structure used to carry real-time streams and stored streams in PES packets is the same, there are important consequences for the encoding and interpretation of PTSs and DTSs. In the case of real-time streams the time base of the program is used, as specified in ISO/IEC 13818-1 for MPEG audio and MPEG video. For real-time AC-3 audio streams the time base of the program specified in ISO/IEC 13818-1 is also used. In the case of stored streams an independent time base may be used, but the phase of the time base for playback of the stored streams is determined by the application. Each time a stored stream is played back, the time base (system time clock) starts with a value of zero.

Table 7-2 summarizes for each DAVIC 1.4.1 non-implied monomedia component whether it can be defined as a real-time stream, as a stored stream object and whether it is contained in a PES packet.

Table 7-2. Real-time stream, stored stream and use of PES packets per monomedia component

Monomedia component (non-implied)	*Real-time stream*	*Stored stream*	*contained in PES packets*
Text	no	no	no
Outline Fonts	no	no	no
Compressed Audio	yes	yes	yes
Scaleable Audio	yes	yes	yes
Linear Audio	no	yes	yes
Compressed Video	yes	yes	yes
Still Picture series	yes	yes	yes
Still Picture bitmap	no	no	no
Compressed graphic real-time stream	yes	yes	yes
Compressed graphic bitmap	no	no	no
Compressed character data stream	yes	no	no
Network graphic bitmap	no	no	no

7.3 Carriage of Monomedia Streams in PES Packets

Monomedia streams are carried in PES packets, with the only exception of Compressed Character Data. One of the advantages of applying PES packets is that they provide a general structure with the following major features :

- identification of monomedia components.
- association of Time Stamps with monomedia streams. Time Stamps (PTSs and DTSs) are essential to ensure synchronisation and to ensure correct buffer behavior in the T-STD defined in ISO/IEC 13818-1 and in the Reference Decoder Model for contents decoding defined in DAVIC 1.4.1.
- association of trick mode operation with monomedia streams, specifically compressed video.
- association of copyright information with monomedia streams.

7.3.1 Packetization of MPEG- and ATSC-defined Components

The packetization of MPEG- and ATSC-defined monomedia streams in PES packets shall fully comply to ISO13818-1. In addition the following constraints shall apply :

- In the case of a stored stream containing compressed audio, the first byte of the first PES packet with data from the stored stream shall be the first byte of an MPEG or AC-3 audio frame, i.e. the first byte of a sync word. In addition the last byte of the last PES packet containing data from the stored stream shall be the last byte from an audio frame. Consequently, each stored audio stream must have an integer number of audio frames.
- In the case of a stored stream containing compressed video or a series of still pictures, the first byte of the first PES packet with data from the stored stream shall be the first byte of a sequence_start_code. In addition, the PES_packet_length field shall not be encoded with the value of zero. The sequence header associated with this start code shall be followed immediately by an I-picture, optionally preceded by a GOP header. The last byte of the last PES packet containing data from the stored stream shall be the last byte of a sequence_end_code. Consequently, each stored video or still picture stream must have an integer number of video frames.

7.3.2 Packetization of DVB-defined Components

The packetization of DVB subtitling in PES packets shall fully comply to ETS 300 743.

7.3.3 Packetization of DAVIC-defined Components

The packetization in PES packets of monomedia streams with a coding format defined by DAVIC 1.4.1 is defined in Annex D of this specification.

7.4 Packetization of Compressed Character Data

Compressed character data are carried in MPEG private sections, defined in ISO/IEC 13818-1. The packetization of Compressed Character Data within private sections shall fully comply to SCTE DVS/026.

8. Transport of Monomedia Streams and Components

8.1 Transport of Real Time Streams

Real time streams are mapped directly to the MPEG-2 Transport Stream, without using DSM-CC. For real-time streams containing compressed audio, compressed video, or a series of still pictures, the mapping shall comply to ISO/IEC 13818-1. In the case of DAVIC 1.4.1 defined compressed graphics, the mapping shall comply to ETS 300 743. In the case of Compressed character data the mapping shall comply to SCTE DVS/026.

8.2 Transport of Stored Streams

In DAVIC 1.4.1 the transport method of stored streams depends on whether upstream information flow is used by the delivery system. For applications which utilize upstream information flow, the stored streams may be transmitted in reply to the DSM-CC File Read function (refer to clause 7.3.8.1; file access) with the UNO remote procedure call, data representation and transport mechanism (refer to clause 7.2.2, user-to-user interaction; 7.3.1 DSM-CC option choices summary; and 7.3.2, remote procedure call) as specified in part 7 of the DAVIC 1.4.1 specification. Alternatively, the stored streams are transmitted in “User-to-User-Object Carousels” within MPEG-2 Transport Streams, using private MPEG-2 sections, as specified by DSM-CC.

8.3 Transport of Stand-alone Monomedia Components

To transport stand-alone monomedia components the same mechanisms are used as for stored streams; see Clause 8.2.

9. Application Format

9.1 Application Interchange Format

To deliver multimedia information to STUs in an interoperable way, applications shall use the MHEG-5 final form interchange format, as defined by ISO/IEC 13522-5. The ASN.1 notation and encoding, as defined by Annex A of ISO/IEC 13522-5, shall be used to interchange MHEG-5 objects. This format defines the semantics and the encoding of the multimedia and hypermedia objects. Subclause 9.2 below specifies the MHEG-5 options whose support by the DAVIC platform is mandatory or optional, as well as the semantic extensions to MHEG-5 related to the DAVIC application domain.

To deliver program code to STUs in an interoperable way, applications shall use the MHEG-5 InterchangedProgram class to encapsulate Java[6] VM code, according to the semantics and encoding defined by ISO/IEC 13522-6. Java VM classes are called from MHEG-5 objects using the MHEG-5 Call and Fork actions.

The Java VM code interchange unit is a Java VM class. Java VM classes shall be encoded as defined by the Class File Format section of the Java Virtual machine specification. A Java class encapsulates data and methods that consist of sequences of instructions. The instruction set is defined by the Java Virtual machine instruction set section of the Java Virtual machine specification.

[6] Java is a trademark or a registered trademark of Sun Microsystems, Inc.

9.2 MHEG-5 Profile for the DAVIC Application Domain

This subclause specifies the features of ISO/IEC 13522-5 that shall be supported by the DAVIC application domain, according to the application domain definition principles set by Annex D of ISO/IEC 13522-5.

9.2.1 Object Interchange Format

The ASN.1 notation defined in Annex A of ISO/IEC 13522-5 shall be used as the application interchange format of ISO/IEC 13522-5, as well as the Distinguished Encoding Rules (DER) for the encoding of the interchanged objects.

9.2.2 Set of Classes

The following set of MHEG-5 classes shall be mandatory:

> Action, Application, Audio, Bitmap, BooleanVariable, ContentRefVariable, DynamicLineArt, EntryField, HotSpot, HyperText, IntegerVariable, InterchangedProgram, Link, ListGroup, ObjectRefVariable, OctetStringVariable, Palette, PushButton, Rectangle, RemoteProgram, ResidentProgram, RTGraphics, Scene, Slider, Stream, SwitchButton, Text, TokenGroup, Video.

9.2.3 Set of Features

The set of mandatory and optional features shall be as defined in Table 9-1.

Table 9-1. Feature requirements

Feature	*Requirement*
Caching	Optional
Cloning	Mandatory
Free moving cursor	Optional
Scaling (Video and Bitmap)	Optional
Stacking of Applications	Optional
Trick modes	Optional
Ancillary connections	Optional

9.2.4 Content Data Encoding

DAVIC specifies the content data encoding as defined in Table 9-2.

Table 9-2. Content Encoding

Type of content	*Specification (Data Types)*	*Hook values*	*Clause*
Font encoding format	DAVIC 1.4.1 defined Outline Font Format	1	6.3
Palette encoding format	CLUT Definition Segment (ETS 300 743) 1)	1	6.12.2.2
Bitmap encoding format	reserved	1	
	MPEG-2 Intra frame	2	6.11
	Region Definition Segment (ETS 300 743)	3	6.12.2.2
	PNG bitmap	4	6.14
Text encoding format	Subset of HTML 3.2	1	6.2

EntryField encoding format	Characters encoded according to ISO 10646-1 (Unicode) or according to ISO 8859-1, depending on the value of the CharacterSet Attribute of the Entryfield	1	6.1
HyperText encoding format	Subset of HTML 3.2	1	6.2
Stream encoding format	video: MPEG-1 Video (ISO/IEC 11172-2) MPEG-2 Video (ISO/IEC 13818-2) audio: MPEG-1 Audio (ISO/IEC 11172-3) rtgraphics: DVB Subtitling (ETS 300 743)	1 2)	6.10 6.10 6.7.1 6.12.2.1
	video: MPEG-2 Still (ISO/IEC 13818-2) audio: MPEG-1 Audio (ISO/IEC 11172-3) rtgraphics: DVB Subtitling (ETS 300 743)	2 2)	6.10 6.7.1 6.12.2.1
	video: - audio: DAVIC Linear Audio (AIFF-C) rtgraphics: -	3 3)	 6.9
	video: MPEG-1 Video (ISO/IEC 11172-2) MPEG-2 Video (ISO/IEC 13818-2) audio: AC-3 Audio (ATSC A52) rtgraphics: DVB Subtitling (ETS 300 743)	4 2)	6.10 6.10 6.7.2 6.12.2.1
	video: MPEG-2 Still (ISO/IEC 13818-2) audio: AC-3 Audio (ATSC A52) rtgraphics: DVB Subtitling (ETS 300 743)	5 2)	6.10 6.7.2 6.12.2.1
	video: MPEG-1 Video (ISO/IEC 11172-2) MPEG-2 Video (ISO/IEC 13818-2) scaleable audio: MPEG-2 Audio (ISO/IEC 13818-3, layer II) rtgraphics: DVB Subtitling (ETS 300 743)	6 2)	6.10 6.10 6.8 6.12.2.1
	video: MPEG-2 Still (ISO/IEC 13818-2) scaleable audio: MPEG-2 Audio (ISO/IEC 13818-3, layer II) rtgraphics: DVB Subtitling (ETS 300 743)	7 2)	6.10 6.8 6.12.2.1
LineArt encoding format	(None specified)		
CursorShape encoding format	(None specified)		
InterchangedProgram encoding format	MHEG-6 (ISO/IEC 13522-6)	1	9.1

Note 1 : Only for use by bitmaps coded in the Region Definition Segment format

Note 2 : For Stream objects with ContentHook 1, 2, 4, 5, 6 and 7, the value of the attribute Storage shall be "stream" or "memory".

Note 3 : For Stream objects with the ContentHook 3, the value of the attribute Storage shall be "memory".

9.2.5 Attribute Encoding

DAVIC specifies the attribute encoding as defined in Table 9-3.

Table 9-3. Attribute Encoding

Attribute	*Specification (Data Types)*
Permissible FontAttributes	"<style>.<size>" with <style> being "plain", "bold", "italic", "bold-italic", "emphasis" or "strong", and <size> being an integer. e.g. "bold-italic.20"
Permissible FontNames	"fixed" specifying a font with a fixed spacing "proportional" specifying a font with proportional spacing
TransitionEffects	See Clause 9.2.11
CharacterSet	1: ISO 8859-1 (Latin) 2: ISO 10646-1 (Unicode)
AbsoluteColour	RGBα32, that is coding of graphics in 32 bits per pixel, allocating 8 bits to the Red, Green and Blue components, as well as 8 bits for the translucency component. The first three bytes are unsigned integers, providing the value of the red, green and blue components of the pixel respectively. The value 0 indicates minimum value, while the value 255 indicates maximum value. The last byte specifies the transparency level of the pixel. The value zero indicates an opaque pixel, while the value 255 indicates full transparency. The value shall be coded as the big-endian octet string representation of the integer value.

9.2.6 UserInput Registers

DAVIC specifies the following InputEventRegisters defined in Table 9-4.

Table 9-4. InputEventRegisters

Register #	*UserInputEventTag*	*Name*
1	1	Up
	2	Down
	3	Left
	4	Right
	5 - 14	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, respectively
	15	Select
	16	Exit
	17	Help
	18-99	Reserved for future specification.
	>99	Vendor specific
2	1	Up
	2	Down
	3	Left
	4	Right
	5-14	Forbidden
	15	Select
	16	Exit
	17	Help
	18-99	Reserved for future specification.
	>99	Vendor specific

9.2.7 Constraints on the Use of Variables

The use of IntegerVariables shall be restricted as defined in Table 9-5.

Table 9-5. Constraints to IntegerVariables

type of value	default value	Size	min value	max. value
signed integer	0	32 bits	-214783648	214783647

9.2.8 Semantic Constraints on the MHEG-5 Applications

Table 9-6 provides a list of constraints that each MHEG-5 applications shall apply to features of ISO/IEC 13522-5. STUs may support the features to a higher or lesser degree.

Table 9-6. Feature Constraints

Feature	*Constraint*
SceneCoordinateSystem(X,Y)	The following coordinate systems are supported:. 720x576, 720x480, 640x480 and 1080x1920.
SceneAspectRatio(W,H)	The following aspect ratios are supported: 1/1, 4/3 and 16/9.
MultipleRTGraphicsStreams(N)	One active RTGraphic stream at a time.
MultipleAudioStreams(N)	One active MPEG-1 audio stream at a time and one active AIFF-C audio stream at a time.
MultipleVideoStreams(N)	One active video stream at a time.
OverlappingVisibles(N)	No constraint.
Cloning	Mandatory

9.2.9 EngineEvent

The DAVIC application domain reserves no particular value of EngineEvent. This is left to the application developer.

9.2.10 GetEngineSupport

DAVIC specifies no other strings for the GetEngineSupport action than the ones listed in ISO/IEC 13522-5.

9.2.11 TransitionEffect Parameter of the TransitionTo Elementary Action

To support transition effects between Still Picture Compositions in DAVIC 1.4.1, the TransitionEffect parameter of the TransitionTo elementary action can be used, as specified in this Clause. For a graphical description of the transition effects see Annex M.

The TransmissionEffect parameter consists of 32 bits. The structure of the parameter is as follows :

Transition Effect Parameter: [parameter_1] [parameter_2] [parameter_3] [parameter_4] [parameter_5]

[parameter_1] : Parameter_1 is 7 bits field of type uimsbf which defines transition effect type

[parameter_2] : Parameter_2 is 3 bits field of type uimsbf which defines number of splits

[parameter_3] : Parameter_3 is 6 bits field of type uimsbf which defines duration of effect time

[parameter_4] : Parameter_4 is 8 bits field of type uimsbf which defines horizontal position of effect start

[parameter_5] : Parameter_5 is 8 bits field of type uimsbf which defines vertical position of effect start

Table 9-7. TransitionEffect parameter of “TransitionTo” action

No.	Transition Effect type	Abbrevia-tion	Para-meter_1	Para-meter_2	Para-meter_3	Para-meter_4	Para-meter_5
0	Reserved		00				
1	Simple cut	CUT	01				
2	Dissolve	DIS	02		T		
3	Vertical wipe (top to bottom)	WVD	03		T		
4	Vertical wipe (bottom to top)	WVU	04		T		
5	Horizontal wipe (left to right)	WHR	05		T		
6	Horizontal wipe (right to left)	WHL	06		T		

7	Wipe that vertically opens from the center	WVO	07		T		Y
8	Wipe that vertically closes from both top and bottom	WVC	08		T		Y
9	Wipe that horizontally opens from the center	WHO	09		T	X	
10	Wipe that horizontally closes from both left and right	WHC	0A		T	X	
11	Square wipe (open)	WRO	0B		T	X	Y
12	Square wipe (close)	WRC	0C		T	X	Y
13	Vertical split wipe (top to bottom)	WDD	0D	N	T		
14	Vertical split wipe (bottom to top)	WDU	0E	N	T		
15	Horizontal split wipe (left to right)	WDR	0F	N	T		
16	Horizontal split wipe (right to left)	WDL	10	N	T		
17	Vertical slide-out (top to bottom)	SOD	11		T		
18	Vertical slide-out (bottom to top)	SOU	12		T		
19	Horizontal slide-out (left to right)	SOR	13		T		
20	Horizontal slide-out (right to left)	SOL	14		T		
21	Vertical slide-in (top to bottom)	SID	15		T		
22	Vertical slide-in (bottom to top)	SIU	16		T		
23	Horizontal slide-in (left to right)	SIR	17		T		
24	Horizontal slide-in (right to left)	SIL	18		T		
25	Vertical roll (top to bottom)	RVD	19		T		
26	Vertical roll (bottom to top)	RVU	1A		T		
27	Horizontal roll (left to right)	RHR	1B		T		
28	Horizontal roll (right to left)	RHL	1C		T		
29	Reserved		1D				
30	Reserved		1E				
31	Reserved		1F				
32	Reserved		20				
33	Reserved		21				
34	Reserved		22				
35	Reserved		23				
36	Half vertical roll (top to bottom)	RPD	24		T		Y
37	Half vertical roll (bottom to top)	RPU	25		T		Y
38	Half horizontal roll (left to right)	RPR	26		T	X	
39	Half horizontal roll(right to left)	RPL	27		T	X	
40	Reserved		28-7F				

The symbols used in Table 9-7 indicate the following:

N: An unsigned integer, specifying the number of splits as defined in Table 9-8. For the coordinate systems supported by DAVIC the start positions of the split-effects are defined in Table 9-9.

Table 9-8. Number of splits

Parameter Value	Number of splits
0x0	0
0x1	2
0x2	3
0x3	4
0x4	5
0x5	8
0x6	10
0x7	Reserved

Table 9-9. Start positions of split-effects with n splits per Coordinate System

Transition Effect number	Transition Effect type with Split Effect	Start position in Coordinate System (x * y) Supported coordinate systems by DAVIC : (720 * 576), (720 * 480), (640 * 480), and (1920 * 1080). Note : the most left pixel and the top line have index value zero.
13	Vertical split wipe (top to bottom)	lines (y*(n-k)/n), where k=n, n-1, ..., 1 and with truncation to zero after division.
14	Vertical split wipe (bottom to top)	lines ((y-1) - (y*(n-k)/n)), where k=n, n-1, ..., 1 and with truncation to zero after division.
15	Horizontal split wipe (right to left)	pixels (x*(n-k)/n), where k=n, n-1, ..., 1 and with truncation to zero after division.
16	Horizontal split wipe (left to right)	pixels ((x-1) - (x*(n-k)/n)), where k=n, n-1, ..., 1 and with truncation to zero after division.

T: An unsigned integer, specifying the duration time of the effect, with an inclusive range of 0 – 63 indicating the duration time of the transition effect in units of 0.5 seconds.

X: An unsigned 8 bit integer, specifying the horizontal start position of the effect. The horizontal start position indicates the horizontal index of the pixel of the coordinate system where the effect starts. The most left pixel of the coordinate system has index zero. For the four coordinate systems supported by DAVIC, 720 x 576, 720 x 480, 640 x 480 and 1920 x 1080 (see Table 9-6) the horizontal index of the pixel where the effect starts is defined by the formula in Table 9-10. If an index value larger than the index of the most right pixel of the coordinate system is indicated, then the effect is indicated to start at the most right pixel. Table 9-10 also specifies the range permitted for X.

Table 9-10. Coding of horizontal index of pixel where the effect starts

Horizontal resolution of Coordinate System	Horizontal index of pixel where effect starts	Permitted range of X (inclusive)
640	4*X	0 - 160
720	4*X	0 - 180
1920	8*X	0 - 240

Y: An unsigned 8 bit integer, specifying the vertical start position of the effect. The vertical start position indicates the vertical index of the line of the coordinate system where the effect starts. The top line of the

coordinate system has index zero. For the four coordinate systems supported by DAVIC, 720 x 576, 720 x 480, 640 x 480 and 1920 x 1080 (see Table 9-6) the vertical index of the line where the effect starts is defined by the formula in Table 9-11. The formula is defined such that the effect can be defined to start in the exact center position of the coordinate system. If an index value larger than the index of the bottom line of the coordinate system is indicated, then the effect is indicated to start at the bottom line. Table 9-11 also specifies the range permitted for Y.

Table 9-11. Coding of vertical index of line where the effect starts.

Vertical resolution of Coordinate System	Vertical index of line where effect starts	Permitted range of Y (inclusive)
480	2*Y	0 - 240
576	4*Y	0 - 144
1080	8*Y + 4	0 - 134

9.2.12 MHEG-5 Resident Programs

In order to improve the functionality of MHEG-5 applications, DAVIC has defined a set of MHEG-5 resident programs. These MHEG-5 resident programs offer the following facilities in a platform independent fashion :

- The ability to retrieve and manipulate date information
- The ability to request a random number
- The ability to manipulate strings
- The ability to convert an OctetString to a ContentReference or an object reference.

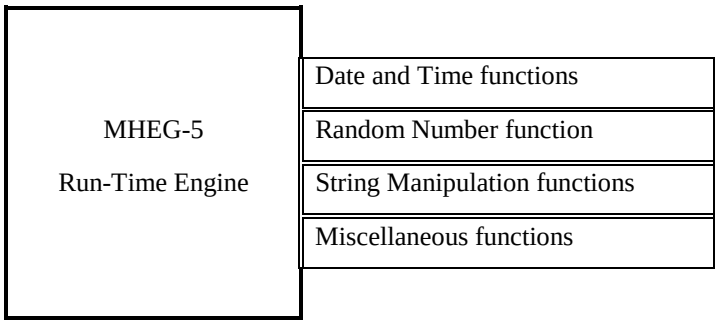


Figure 9-12. MHEG-5 resident programs

9.2.12.1 Date and Time functions

- GetCurrentDate() - Retrieves the current date and time

  Synopsis:

  GetCurrentDate(date, time)

  Arguments:

output	IntegerVariable	date
output	IntegerVariable	time

  Description:

  Retrieves the current date and time. The argument date is the Modified Julian date which is encoded as the number of days since Midnight on November 17, 1858 and the argument time is the current time encoded as the number of seconds since midnight. The date and time values represent Local Time.

- FormatDate() - Format a string representing a date according to a specifiable format

  Synopsis:

  FormatDate(dateFormat, date, dateTime, datestring)

  Arguments:

input	GenericOctetString	dateFormat
input	GenericInteger	date
input	Genericinteger	dateTime
output	OctetStringVariable	dateString

  Description:

  Returns a string in the argument string dateString formatted according to the string argument dateFormat. The function also takes the argument date as a date encoded as the Modified Julian date (number of days since Midnight on November 17 1858) and the argument dateTime as the number of seconds since midnight. The argument string dateString is the same as the dateFormat string except for the field codes (defined below) which start with a '%' character. Where encountered in the dateFormat string, the field codes must be replaced by the indicated part of the date. The following field codes have been defined:

  '%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

The following is an example of the use of this function at June 4, 1995, at 16:56, when the input argument dateFormat “%Y-%x-%d %I:%M %a” results an output argument dateString of “1995-6-4 4:56 pm”.

- GetDayOfWeek() - Returns the day of the week

  Synopsis:

  GetDayOfWeek(date, dayOfWeek)

  Arguments:

input	Genericinteger	date
output	IntegerVariable	dayOfWeek

  Description:

  Returns the day of the week. From the input argument date in the Modified Julian form, the argument dayOfWeek returns an integer starting from 0 representing Sunday, 1 Monday, 2 Tuesday … until 6 representing Saturday.

9.2.12.2 Random Number function

- Random() - Returns a random number

  Synopsis:

  Random(num, random)

  Arguments:

input	GenericInteger	num
output	IntegerVariable	random

  Description:

  Returns a random integer number between 1 and num (inclusive).

9.2.12.3 String Manipulation functions

In this clause a number of character string manipulation functions are defined; strings are either octet or double octet based. The semantics of a string are transparent to the string manipulation functions; that is the manipulation on a string is independent of the representation of the string. For example, when a string includes escape sequences, the octets representing such sequence are treated in the same way as any other octets.

- GetStringLength() - Returns the number of octets within the string

  Synopsis:

GetStringLength(string, length)

Arguments:

input	GenericOctetString	string
output	IntegerVariable	length

Description:

Returns in the output argument length the number of octets within the input argument string.

- GetSubString() - Extracts a sub-string from a string

  Synopsis:

  GetSubString(string, octetLengthSearch, beginExtract, endExtract, stringResult)

  Arguments:

input	GenericOctetString	string
input	GenericInteger	octetLengthSearch
input	GenericInteger	beginExtract
input	GenericInteger	endExtract
output	OctetStringVariable	stringResult

  Description:

  Extracts part of a string from an octet specified by argument beginExtract upto the octet specified by argument endExtract. The octets specified by the beginExtract and endExtract arguments are included. The substring is returned in the argument stringResult. The first octet in the string starts at index 1. A string can be octet based or double octet based. The argument octetLengthSearch specifies whether the extracted string is an octet or a double octet string. A value of 1 identifies an octet string and a value of 2 a double octet string.

- CompareString() - Compares two strings

  Synopsis:

  CompareString(string1, string2, octetLengthSearch, result)

  Arguments:

input	GenericOctetString	string1
input	GenericOctetString	string2
input	GenericInteger	octetLengthSearch
output	IntegerVariable	result

  Description:

  Compares two octet strings using lexicographical order, the result is -1 if string1<string2, 0 if string1=string2, + 1 if string1>string2. A string can be octet based or double octet based. The argument octetLengthSearch specifies whether the search is on an octet basis or a double octet basis. A value of 1 identifies an octet string and a value of 2 a double octet string.

- SearchSubString() - Searches for a sub-string within a string

  Synopsis:

  SearchSubString(string, octetLengthSearch, startIndex,
  searchedString, stringPosition)

  Arguments:

input	GenericOctetString	string
input	GenericInteger	octetLengthSearch
input	GenericInteger	startIndex

input	GenericOctetString	searchedString
output	IntegerVariable	stringPosition

Description:

Searches for a sub-string within a string from a specified starting index. The string is specified by the first argument string. The octet to start the search from is specified by the startIndex argument and the sub-string is specified by the searchedString argument. The argument stringPosition returns the index within the string of the first octet of the sub-string , -1 is returned if the string is not found. The first octet of the string is at index 1. A string can be octet based or double octet based. The argument octetLengthSearch specifies whether the comparison is on an octet basis or a double octet basis. A value of 1 identifies an octet based comparison and a value of 2 a double octet based comparison.

- SearchAndExtractSubString() - Searches and extracts a sub-string within a string

Synopsis:

SearchAndExtractSubString(string, octetLengthSearch, startIndex,
searchedString, stringResult, stringPosition)

Arguments:

input	GenericOctetString	string
input	GenericInteger	octetLengthSearch
input	GenericInteger	startIndex
input	GenericOctetString	searchedString
output	OctetStringVariable	stringResult
output	IntegerVariable	stringPosition

Description:

Searches and extracts a sub-string within a string from a specified starting index. The string is specified by the first argument string. The octet to start from is specified by the startIndex argument and the sub-string is specified by the searchedString argument.

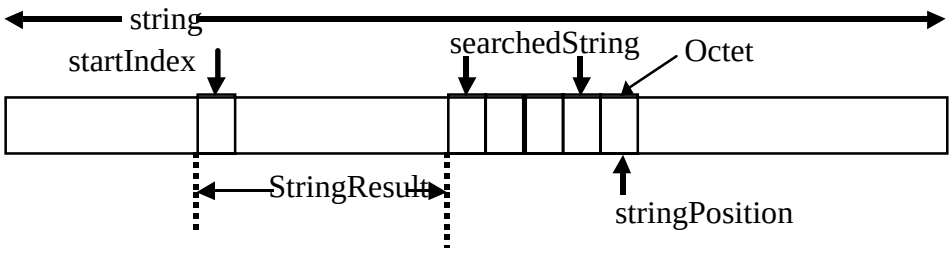


Figure 9-13. Searching and extracting a sub-string within a string.

The argument stringPosition returns the index of the octet immediately after the searchedString within the string, -1 if the string is not found. The index of thefirst octet of string equals 1. The stringPosition may if the substring is the last element within the string have an index beyond the end of the string i.e. the index = the number of octets within the string + 1. The argument stringResult returns the string itself between the startIndex upto not including the searched string. The first octet of the string is at index 1. A string can be octet based or double octet based. The argument octetLengthSearch specifies whether the search is on an octet basis or a double octet basis. A value of 1 identifies an octet search and a value of 2 a double octet search.

9.2.12.4 Miscellaneous functions

- CastToContentRef() - Casts an OctetString to a ContentReference.

  Synopsis:

  CastToContentRef(inString, outString)

  Arguments:

input	GenericOctetString	inString
output	ContentReferenceVariable	outString

  Description:

  Casts the OctetString variable inString to the ContentReference variable outString.

- CastToObjectRef() - Casts an OctetString and Object Identifier to an Object Reference

  Synopsis:

  CastToObjectRef(inString, ObjectId, outObjectRef)

  Arguments:

input	GenericOctetString	inString
input	GenericInteger	ObjectId
output	ObjectRefVariable	outObjectRef

  Description:

  Casts the combination of the OctetString variable inString and the Integer variable ObjectId to the Object Reference variable outObjectRef.

9.2.13 Protocol Mapping and External Interaction

Table 9-14 defines the mapping to the DAVIC external environment:

Table 9-14. Protocol Mapping

MHEG-5 entity	*Mapping needed*	*Semantics*

OpenConnection, CloseConnection	Mapping to connection management	• In OpenConnection:
		  • Protocol: one of the two strings: “PSTN” or “ISDN”.
		  • Address: E.164 NSAP. This is the address of the network service access point and the internet address of the service gateway to attach to. For the encapsulation of the internet address, the ATM forum specification is used. For an example see Annex N of this specification.

RemoteProgram objects	Mapping to RemoteProgram call protocol in the application domain (see clause 9.6)	• In Call and Fork:
		  • Name
		  • Parameters
		  • ProgramConnectionTag

Application name space	Mapping to name space of the application domain	• ObjectReference (see 9.9.3) • ContentReference (see 9.9.4)
Application name space in case a TransitionTo action uses the ConnectionTag parameter	Mapping to the name space of the application domain	• ObjectReference (see 9.9.3) • ContentReference (see 9.9.4)
Persistent storage name space	Mapping to the name space of the persistent storage	• In StorePersistent and ReadPersistent: • InFileName, OutFileName Flat name space. Names may be anything from one to 64 characters long.

Stream actions	Mapping to the stream interface of the application domain	• In Stream
		  • Speed
		  • CounterPosition (see 9.9.1)
		• In Audio, Video, RTGraphics
		  • ComponentTag

Stream events	Mapping to stream states and stream events in the application domain	• In Stream
		  • StreamPlaying, StreamStopped (mapping to application-domain stream state machine)
		  • CounterPosition
		  • StreamEventTag (see 9.9.1)

9.3 Mapping of MHEG-5 Elements to DSM-CC U-U

9.3.1 Stream Events and Normal Play Time Mapping

The DSM-CC StreamEvent interface provides the possibility to carry private data in the data structure for the event, in the form of the PrivateDataByte field. These bytes shall be mapped one-to-one on the StreamEventTag of the MHEG-5 event StreamEvent.

The MHEG-5 internal attribute CounterPosition of the Stream class shall also be mapped on the value of the DSM-CC Normal Play Time of the corresponding stream. The counter position shall represent a millisecond precision. Mapping from Normal Play Time to CounterPosition shall take place by rounding the value to the nearest millisecond.

9.3.2 Namespace Mapping

In figure 9-15, an example of a DSM-CC file structure is given, showing a diagram of a logical DSM-CC file structure along with the object references for an application object file, a scene object file and content data files. Below is a code fragment for accessing the different objects depicted in figure 9-15.

```
{:application
      ("App1/startup" 0)}
{:scene
      ("App1/Scene1/scene1.mheg" 0)
      :Items (
      {:bitmap 1
            (:content "App1/Scene1/bitmap.graphics") ...}
      {:audio 2
            (:content "App1/Scene1/audio1.aiff") ...}
      {:video 3
            (:content "App1/Scene1/video1.mpeg") ...}
...)
```

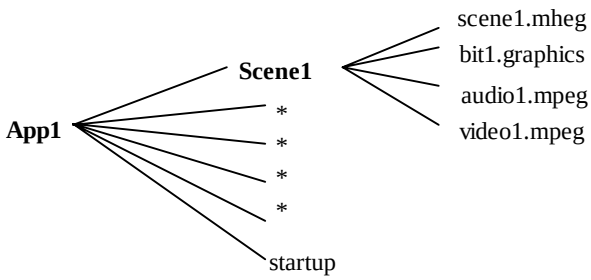


Figure 9-15. Searching and extracting a sub-string within a string.

When an application starts, it is assumed that a service gateway has been located and attached to, so that there is exactly one name space within which the application objects are located. Within that name space, a service has also been located. That service is a DSM-CC directory; within it, there can be other directories, files, and streams.

Furthermore, it is assumed that each object belongs to exactly one application. This assumption is necessary to allow for unambiguous object references.

The high-level API differentiates between three types of retrieved data:

- objects that comply to the high-level API definition,
- the content (such as bitmaps or text) of those objects, and
- streams (such as video and audio).

For accessing the various objects of an application 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 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.

9.3.3 MHEG-5 Object References

MHEG-5 objects can be exchanged in two ways: either the object is exchanged as a DSM-CC file object or within another high-level API object. The former method is used for Applications and Scenes, the latter for all other objects contained in a scene or application 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 DSM-CC, the following additional rules are defined:

1. Each Application and Scene object shall have in its GroupIdentifier a byte string which maps on the name of the DSM-CC file which contains that object. These objects shall have their ObjectNumber set to 0.
2. Each application shall have exactly one Application object. That object shall be contained in a DSM-CC File object with the name ‘startup’. Only one Application object shall be contained in each such file.
3. Ingredient Objects other than Application and Scene objects may
   - either leave out the GroupIdentifier, in which case it is assumed to be a string which maps on the name of a DSM-CC file which contains the object (Application or Scene) of which this object is a part,
   - or fill in the GroupIdentifier with such a string.
4. Such objects shall have their ObjectNumber set to a value which is unique within that Scene.
5. For the GroupIdentifier, the mapping rules defined in the following Clause apply.

9.3.3.1 Mapping Rules for GroupIdentifier

All GroupIdentifiers are ASCII strings. They are composed of four components:

Source	Path Origin	Path	Filename

The Source component is optional, and specifies the data source to be used to retrieve the data. Each source identification is terminated with a “:”. The default source identification is “DSM:” (in upper case). DAVIC 1.4.1 does not specify any further data sources, but the use of other source identifications is permitted.

9.3.3.1.1 Explicitly specified data source

The semantics defined in this clause apply in the case that the data source is defined explicitly. If the source is not explicitly defined, the semantics as described in clause 9.3.3.1.2 apply.

The Path Origin is either ‘//’ or ‘/’. If the path origin is ‘//’ then the following path and filename are to be interpreted as an absolute path starting from the root of the current service gateway to which the runtime is attached. If the path origin is ‘/’ then the following path and filename is to be interpreted as a relative path, starting from the directory that contains the current Application object.

The Path component is a (possibly empty) sequence of directory names, each followed by a ‘/’ character. Each directory name is to be used to delimit directory references (of the depth type).

The Filename component identifies the DSMCC object within the directory that is identified by the preceding Source, Path Origin and Path components.

For instance, if the GroupIdentifier is ‘DSM://apps/otherAppl’, it is mapped on the DSM-CC name ‘otherAppl’ in the directory ‘apps’ of the service gateway to which the runtime has attached. If the GroupIdentifier is ‘DSM:/scenes/myScene’, it is mapped on the DSM-CC name ‘myScene’ in the directory ‘scenes’ of the directory where the Application object was found.

9.3.3.1.2 Shorthand Notation when data source is not explicitly defined

In cases where the data source is not explicitly defined, the following shorthand notations may be used for references to objects accessible from the default Data Source. In DAVIC 1.4.1 the default Data Source is a DSM-CC service

gateway. The rationale behind the shorthand notation is compatibility with previous versions of the DAVIC specification.

There are two abbreviations allowed. The first abbreviation is '~/' (standard ASCII tilde + slash), which may be used to specify the default Data Source and a relative Path Origin; use in DAVIC 1.4.1 means 'DSM:' for the Data Source and '/' for Path Origin. This abbreviation can therefore be used to refer to objects relative to the current application.

The other abbreviation is '/' (standard ASCII slash), which may be used to specify the default Data Source and an absolute Path Origin; use in DAVIC 1.4.1 means 'DSM:' for the Source and '//' for Path Origin. This abbreviation can therefore be used to refer to objects with an absolute path from the root of the current service gateway to which the runtime is attached.

For instance, an object, referred to as 'DSM:/scenes/myScene' may be referred to as '~/scenes/myScene', while the object referred to as 'DSM://apps/otherAppl' may be referred to as '/apps/otherAppl'. Thus if no source is explicitly specified, then '/' represents an absolute path name and not a relative one as would be the case if the source was defined explicitly (see clause 9.3.3.1.1).

9.3.3.1.3 Other Service Gateways

It is possible to refer to objects in another service gateway, as DSMCC objects have built-in indirection to the actual location of the data. An object with the path "DSM://Mheg5/Banking/Welcome" can refer to a DSMCC object whose actual data is only accessible from another service gateway. Normal access to such an object will result in a 'service transfer exception', which will be followed by an attempt to attach to that service gateway.

9.3.4 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. The ContentReference consists of an optional PublicIdentifier followed by a SystemIdentifier, which is a byte string. The following rule shall apply.

For the SystemIdentifier, the exact same mapping shall be used as for the GroupIdentifier above. The PublicIdentifier shall not be used.

9.3.4.1 DSMCC Stream Objects

Note that the mapping of ContentReference and GroupIdentifier allow references to both DSMCC File and DSMCC Stream objects. Although this is possible, applications shall not refer to DSMCC Stream objects using a GroupIdentifier. GroupIdentifiers are always expected to refer to DSMCC File objects.

ContentReferences of content of MHEG-5 Stream objects may refer to both DSMCC File and DSMCC Stream objects. If such a ContentReference refers to a DSMCC File object, the MHEG-5 Stream object shall have its Storage attribute set to 'memory'. If the ContentReference refers to a DSMCC Stream object, the MHEG-5 Stream object shall have its Storage attribute set to 'stream'.

ContentReferences of content of MHEG-5 Ingredients, other than Stream objects must always refer to a DSMCC File object.

9.3.5 Mapping of MHEG-5 ComponentTag to DSM-CC and DVB-SI

The MHEG-5 ComponentTag is mapped to the least significant byte of the association_tag as defined by ISO/IEC 13818-6. The most significant byte of the association_tag may take any value (0xXX). The value encoded in the lower significant byte (LSB) of the association_tag shall be equal to the MHEG-5 ComponentTag value. In addition, the value of the component_tag defined in the stream_identifier_descriptor specified by DVB shall also take the same value as the MHEG-5 ComponentTag. A stream_identifier_descriptor in the descriptor loop of a PID is equivalent with an association_tag_descriptor for that PID with an association_tag value of MSB=0xXX and LSB=<component_tag> and a use value of 0x0100.

9.3.6 Java class File Names

In addition to the interworking provisions specified by ISO/IEC 13522-6, the DSM-CC to MHEG-5 name mapping rules specified in the above subclauses shall apply to the class file names interchanged in the ContentData attribute of

an MHEG-5 InterchangedProgram object, whenever this ContentData attribute is of the ReferencedContent type, and therefore used to identify a set of files that contain the referenced Java classes.

9.4 Core set of Java APIs

Depending on contours and micro-profiling, a selection from the following set of APIs will available to be used by Java VM code to express access to basic functions of the STU in an interoperable way.

- the java.lang package;
- the java.util package;
- the java.io package;
- the iso.mheg5 package;
- the org.davic.mpeg.sections package;
- the org.davic.resources package;
- the org.davic.mpeg package.
- the org.davic.awt package;
- the org.davic.net package and sub-packages;
- the java.awt package and sub-packages
- the java.applet package
- the java.net package
- the javax.media package and sub-packages

9.4.1 java.lang

The java.lang package, as defined by the Java API documentation, consists of the minimal set of Java VM classes needed to run Java VM code, supporting the following functionality: basic data types, object, mathematic operations, security, thread management, string manipulation, exception handling.

The methods load(), loadLibrary(), exec(), traceInstructions() and traceMethodCalls() in the java.lang.Runtime class and the java.lang.Process class must be implemented to some extent but their use is not standardised in a DAVIC system and hence applications using them will not be fully inter-operable.

The core Java class java.lang.System includes three references to java.io being java.lang.System.in, java.lang.System.out, java.lang.System.err. For java.lang.System.in, if there is no default system input device then attempts to read from this stream shall return '-1' to indicate 'end of stream' as defined in the Java reference documents. For java.lang.System.out and java.lang.System.err, if there is no default system output device then the method call shall return immediately without any negative results. It must be possible for DAVIC applications to make method calls such as "System.out.println()" without any negative effects (e.g. unforeseen exceptions, blocking or terminating) on STUs where there is no suitable output device for that call to use.

9.4.2 java.util

The java.util package, as defined by the Java API documentation, consists of Java VM classes supporting a number of utility features common to all Java VM programs.

9.4.3 java.io

The java.io package, as defined by the Java API documentation, consists of Java VM classes supporting a basic model for input and output of non real time streams of data.

All interfaces, classes and methods defined in the reference documents for java.io shall be implemented in a STU. The classes File, FileInputStream, FileOutputStream, RandomAccessFile and FileDescriptor are required to support access to files that are defined within the DSM.CC object domain using the DSM.CC File and Directory interfaces. The name space used to reference these shall be the same name space as specified for use with MHEG-5/6 in part 9, section 9.5.

9.4.4 iso.mheg5

The iso.mheg5 package, as defined by ISO/IEC 13522-6, provides Java VM code with access to and manipulation of the MHEG-5 multimedia presentation and interaction objects, i.e. access to the dynamic attributes of MHEG-5 objects and invocation of elementary actions on MHEG-5 objects.

9.4.5 The DSM-CC User to User API

DAVIC supports the org.davic.net.dsmcc.uu package, as defined in ETS 300 777-2. This package enables Java VM code to use the DSM-CC U-U interface objects for network data access.

The org.davic.net.dsmcc.uu package implements a subset of the DSM-CC U-U API defined by ISO/IEC 13818-6. Access to the following Core consumer services is provided:

- interface Base: operations Close and Destroy;
- interface File: operations Read and Write;
- interface Directory: operations Open, Close and Get;
- interface ServiceGateway: operations Attach and Detach;
- interface stream: operations Resume, Pause, Status, Reset, Play and Jump;
- interface CosNaming::NamingContext: operations List and Resolve;
- interface CosNaming::BindingIterator: operations Next_One and Next_N.

9.4.6 The Service Information (SI) API

The objective of this API is to allow inter-operable applications to access service information data from MPEG-2 streams. One example of such applications would be electronic program guides. This API is a relatively high level API allowing applications to access information from the SI tables in a clean and efficient way. The specification of this API is defined by ETSI DI /MTA-01074, entitled Application Program Interface (API) for DAVIC Service Information.

9.4.7 The MPEG-2 Section Filter API

The objective of this API (org.davic.mpeg.sections) is to provide a general mechanism allowing access to data held in MPEG-2 private sections. This will provide a mechanism for inter-operable access to data which is too specialized to be supported by the high level DVB-SI API or which is not actually related to service information.

The definition of the MPEG-2 section filter API is in Annex E of this specification. The API definition does not specify the lengths of the section filtering patterns. For those methods which do not specify an offset, the length of the section filtering pattern arrays shall be 8 with their mapping on to the section header as described in the last section of Annex E. For those methods which include an offset, the length of the section filtering pattern arrays shall be 7.

The API definition below does not specify the efficiency or effectiveness of the section filtering process. If filtering is happening with filters set beyond the 10th byte of the total section, filtering throughputs must be supported as in DAVIC part 10, section 115.3 with the restriction that support for filtered throughputs of more than 2 Mbits/second is not mandatory.

9.4.8 The Resource Notification API

The section filter API uses a resource notification API in the org.davic.resources package. This API provides a standard mechanism for applications to register interest in scarce resources and to be notified of changes in those resources or removal of those resources by the environment. The description of this API is in Annex F of this specification.

9.4.9 The MPEG Component API

Various MPEG related APIs use an MPEG component API in the org.davic.mpeg.sections package. This API provides a standard way of referring to standard MPEG features. The definition of the MPEG component API is in Annex G of this specification.

9.4.10 The Tuning API

The objective of this API is to tune a network interface of some kind between different transport streams. The specification for this API is contained in Annex H of this specification.

9.4.11 The Conditional Access API

The objective of this API is to provide limited access to the conditional access system in an STU. The specification for this API is contained in Annex I of this specification.

9.4.12 The java.awt package and User Interface API Extensions

The java.awt package as defined by the Java API specification provides a user interface API to allow applications written in Java to generate graphical output and receive user input events.

It is expected that this package as used in DAVIC will be aligned with the subset of java.awt defined in the PersonalJava specification. Classes and methods which are optional or non-supported in that specification shall have the same status in this specification.

The drawing model of AWT does not support transparency and blending with background video. This feature is usually supported by set-top box hardware. Annex K of this specification defines a user interface API extension which provides this feature.

The org.davic.awt.Color class is compatible with the java.awt.Color class, which means that the AWT components may receive either java.awt.Color or org.davic.awt.Color as a parameter for methods setForeground and setBackground. In a DAVIC system, if org.davic.awt.Color is received, the implementation of the component shall take the new color into account and make the component (partly) transparent. If java.awt.Color is used, the used colors are opaque. The selection between opaque and transparent drawing, as well as implementation of transparent drawing shall be kept inside the implementation of the component.

Similarly, the method setColor of java.awt.Graphics should accept both color classes.

9.4.13 The java.applet package

The java.applet package as defined in the Java API specification defines how that part of an application expressed in Java may be integrated into a larger application which initially has control of the full display of the STU.

In the DAVIC digital broadcast contours, this package can only be used together with the optional MHEG-6 class “Applet”. When combined with the java.applet package, this allows clean delegation of user interface graphical output and event input from the MHEG-5 engine to code running in the Java virtual machine.

9.4.14 The java.net package

The java.net package as defined in the Java API specification provides defines how that part of an application expressed in Java may access a network based on the IP transport protocols. Its presence does not imply the existence of such a network in any particular DAVIC STU.

9.4.15 The Java Media Framework and the Media Player API

The Java Media Framework as defined by the JMF specification and player guide provides a high level abstract way for that part of an application expressed in Java to manipulate real time media. It provides a level of flexibility beyond what can be achieved using the stream classes of MHEG-5 and manipulating those through the iso.mheg5 API. Annex L describes requirements, additional features and semantics for using this with broadcast data. Should a DAVIC STU

support internet access as well as broadcast, the additional features and semantics in Annex L should only apply to media accessed via the broadcast interface.

9.4.16 The DSM-CC User to Network API

The DSM-CC User-to-Network API as defined by DAVIC enables Web Browsers access to DAVIC services and contents. The specification of the DSM-CC User-to-Network API is contained in Annex N. For access to DAVIC services and contents see also Clause 9.7.

9.4.17 The OpenCard API

For the use of smartcards DAVIC 1.5.1 adopts the OpenCard API, that is the OCF version 1.1 specification as defined by the OpenCard Consortium (www.opencard.org). Opencard is intended for use as the primary smartcard interface in the EDB and IDB contour for applications communicating with non-CA smartcards. The OpenCard Framework provides a high level abstract way for applications to use smartcards. The framework allows independence of the application from a) the card reader device, b) the card operating system, c) the card layout to a maximum extent. The Opencard Framework does not specify any particular smartcards nor Javacards, nor does it specify security mechanisms.

The Opencard API fulfills the following requirements:

1. The API shall support devices which are equipped with one or multiple smartcard slots.
2. The API shall support access of concurrent applications to the same smartcard.
3. The API shall be extensible.
4. The API shall not be tailored to specific application domains, but should be tailorable to these domains.
5. The API shall be useable in meaningful subsets as well as a whole.
6. The API shall enable portability of the application by shielding it from smartcard-specific details, reader-specific details, and issuer-specific details.
7. The API shall enable activation of corresponding software components in dependence of the recognized card or of detected card-resident applications.
8. The API shall not restrict the type or number of cryptographic algorithms to be used
9. The API shall enable the support of SAMs (Secure Access Modules)
10. The API shall support ISO 7816-compliant smartcards, JavaCards, EMV cards, and memory cards.
11. The API shall allow for compatibility with PC/SC and VISA Open Platform cards.

Annex O contains background information about the OpenCard API as well as possible usage scenarios.

9.5 URL Format for Access to Broadcast Services

9.5.1 Introduction

DAVIC defines a specific Uniform Resource Locator (URL) format to access broadcast services. This URL format provides a general addressing mechanism intended to access broadcast services from e.g. JAVA and HTML. Note that URLs are commonly used in JAVA for addressing resources and other objects.

DAVIC broadcast networks carry the Service Information (SI) which contains globally unique parameters for locating the services in the broadcast networks. The URL format defined by DAVIC to access such services is based on these parameters as they provide an addressing mechanism in a physical network independent way. The same services may be carried simultaneously in many physical networks, but the parameters in the SI will remain the same and thus they can be used by the clients to locate the services regardless of the actual physical network.

DAVIC defined the following general format of the URLs :

<protocol>://<“server”>/<dir1>/.../<file>

The protocol (scene) part of the URL identifies that it is a broadcast service. The “server” part of the URL points to the service as the services are the basic element that is carried in the broadcast networks. The rest of the URL specifies the individual component inside a service. The format of the last part is dependent on the type of the service (this part is not needed if the URL points to the whole service).

9.5.2 Specification of the extended DAVIC DVB URL format

The format of the DAVIC DVB URL shown in an informal notation is as follows.

dvb://<original_network_id>.[<transport_stream_id>][.<service_id>[.<component_tag>{&<component_tag>}][;<event_id>]]{/<path_segments>}

A more formal specification of the expressed in BNF as used in RFC 2396 is as follows. (In case there is any inconsistency between the informal notation shown above and the BNF definition below, the BNF specification forms the normative definition of the DAVIC DVB URL.)

```
dvb_url           = dvb_scheme “:” dvb_hier_part
dvb_hier_part     = dvb_net_path | dvb_abs_path
dvb_net_path      = “//” dvb_entity [ dvb_abs_path ]
dvb_entity  = dvb_transport_stream | dvb_service |
              dvb_service_component
dvb_transport_stream = original_network_id “.” transport_stream_id
dvb_service =                        original_network_id                    “.”
                        [     transport_stream_id     ]     “.”     service_id
                        [ dvb_event_constraint ]
dvb_service_component       =      dvb_service      “.”      component_tag_set
                          [ dvb_event_constraint ]
component_tag_set     = component_tag *( “&” component_tag )
dvb_event_constraint = “;” event_id
original_network_id   = hex_string
transport_stream_id   = hex_string
service_id  = hex_string
component_tag     = hex_string
event_id    = hex_string
hex_string  = 1*hex
hex   =   digit   |   “A”   |   “B”   |   “C”   |   “D”   |   “E”   |   “F”
                          | “a” | “b” | “c” | “d” | “e” | “f”
digit       =   “0”   |   “1”   |   “2”   |   “3”   |   “4”   |   “5”   |   “6”   |
                      “7” | “8” | “9”
dvb_abs_path      = “/” path_segments
(path_segements as defined in RFC 2396)
```

It should be noted that this syntax is fully compliant with the generic syntax of URIs as specified in IETF RFC 2396 and uses the registry-based naming authority version of that. Furthermore, all generic definitions specified in RFC 2396 shall be valid for the DVB URL as well (e.g. escaping of special characters within file names, etc.).

When a path is present in a URL where the dvb_entity part identifies a DVB service, the path references an object in an object carousel within the service. If there are multiple object carousels within the same service, the rule on how to select the “default” one is to be defined.

When a path is present in a URL where the dvb_entity part identifies one component of a DVB service and that component carries an object carousel stream, the path references an object in an object carousel whose “root” (i.e. DSI message) is sent within that component. Note that the referenced object itself is not necessarily carried in the component identified in the URL, but the component in the URL identifies only the component carrying the root of the object carousel in which the referenced object is carried.

The semantics when the path is present in the URL and where the dvb_entity part identifies something else than the two cases described above is not defined in this specification and is reserved for future use.

When the dvb_net_path part is missing and only the dvb_abs_path is present, the URL refers to a file in a default object carousel within the current service. The “current” service is dependent on the usage context.

9.5.3 Examples of Usage

The table below gives shows example URLs and their sematics.

Table 16: DVB URL Examples

URL	Refers to
`dvb://e9e.f5ad`	DVB transport stream
`dvb://5f.8ec.6df1`	DVB service
`dvb://5f.8ec.6df1.1&2`	Two components of a DVB service, e.g. the primary video and audio components
`dvb://5f.8ec.6df1;23`	Specified event within a DVB service
`dvb://5f.8ec.6df1/logo.gif`	File in the root directory of the default Object Carousel within the DVB service
`dvb://e9e.f5ad.ff3a.c1/docs/manual.doc`	File in a subdirectory of an Object Carousel within a specified component of the DVB service
`dvb:/logo.gif`	File in the root directory of the default Object Carousel within the current DVB service

9.6 Run-time execution environment

9.6.1 Application execution

The STU run-time environment shall include the following component:

- the MHEG-5 run-time engine, as defined by ISO/IEC 13522-5; the MHEG-5 run-time engine may be extended by supporting MHEG-5/Java VM interworking provisions as defined by ISO/IEC 13522-6.

In addition, the STU run-time environment may include the following components:

- implementation of the Java virtual machine, as specified by the Java Virtual machine specification;
- implementation of the core set of Java API packages as defined in Clause 9.4 of this Specification.

The MHEG-5 run-time engine shall fully support the MHEG-5 instantiation defined by part 9 of this Specification.

9.6.2 User Input Events

The use of InputEventRegisters is defined in Clause 9.2.6 of this Specification. Each register has a number, which is exchanged as one of the parameters of a Scene object. The contents of a UserInputEventRegister (which is not exchanged) is a set of numbers (representing UserInputEventTags) and a name. The name/number pairs bind a specific UserInputEventTag to a logical input event. It is the task of the engine implementor to bind the logical input event to one or more physical input events. Table 9-4 in Clause 9.2.6 specifies the mandatory user input events that have to be generated by the user device for DAVIC 1.4 STUs.

9.6.3 IDL definition for RTE run remote call

MHEG-5 RemoteProgram objects invoke a stub at the client side. That stub then sends a DAVIC-defined message to the server, using the remote procedure call protocol defined in Part 7 of this Specification. The IDL definition of the stubs is as follows:

```
module DAV
{
	enum parType {boolPar, intPar, octStringPar, objRefPar, contRefPar};
	typedef sequence<octet> octString;
	typedef struct oR {
		octString groupIdentifier;
		long objectNumber;
	} objRef;
	typedef octString contRef;
	union par switch (parType)
	{
		case boolPar: boolean aBoolean;
		case intPar: long anInt;
		case octStringPar: octString aString;
		case objRefPar: objRef anObjRef;
		case contRefPar: contRef aContRef;
	};
	typedef sequence<par> pars;
	interface MHEG {
		void call(
			in octString programName,
			inout pars somePars
		);
		void fork(
			in octString programName,
			inout pars somePars
		);
	};
};
```

The mapping of the parameters of the MHEG-5 actions Call and Fork is intuitive. It is the responsibility of the MHEG engine to set the MHEG-5 parameters ForkSucceeded and CallSucceeded, respectively, to indicate the success or failure of the RPC operation.

9.6.4 Mapping of High-Level API Actions on DSM-CC Primitives

It is the responsibility of the STU to map the actions in the high-level API to DSM-CC primitives. To provide some indication of how DSM-CC primitives can be used to implement an MHEG-5 runtime engine, table 9-16 provides an example of a possible DSM-CC mapping to the high level API.

Table 9-17. Examples of mapping of high-level API actions to DSM-CC primitives

MHEG-5 behavior	*MHEG-5 Object Type*	*DSM-CC U-U Function*
Launch/Spawn	Application	DirectoryOpen(app.fileid) -> FileObRef FileRead(FileObRef)
Prepare	Scene, Content Object and Stream	DirectoryOpen(scene.fileid) -> FileObRef FileRead (FileObRef)
Run	Video and Audio	DirectoryOpen(stream.file) ->StreamObRef StreamResume(StreamObRef, startTime, 1/1)
Stop	Stream	StreamPause(StreamObRef, x80000)
StreamMarker	Stream	StreamSubscribe (StreamObRef, marker) StreamNotify (StreamObRef, marker, call back function) StreamUnSubscribe (StreamObRef, marker)
StreamTimer	Stream	StreamStatus -> Gets normal playtime
FreezeFrame	Stream	StreamPause(StreamObRef, x80000) StreamStatus -> Gets stoptime StreamResume(StreamObRef, stoptime, 1/1) Note: In linear broadcast mode, freeze frame is a client function only
RunAsynchronous and RunSynchronous	Application	RPC - UNO
OpenConnection	Application	Attach (ID)

9.7 Access to DAVIC Services and Contents from Web Browsers

9.7.1 Background and system architecture

To refer to DAVIC Contents and Applications from HTML pages the following system architecture is considered.

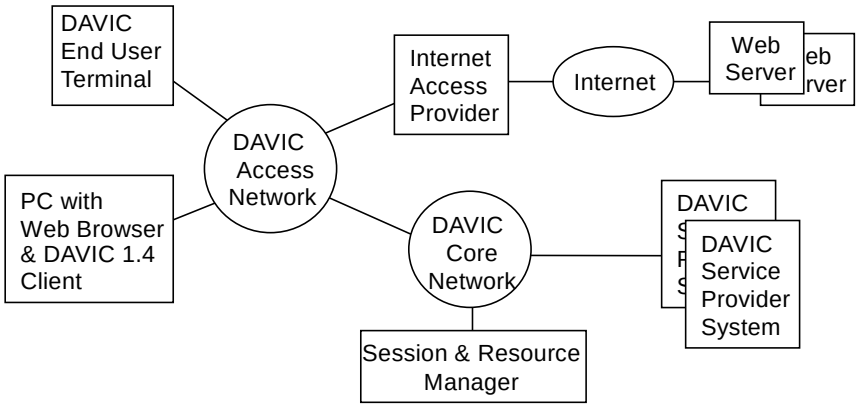


Figure 9-18. System architecture for DAVIC Access from a Web browser

On a browser, HTML pages are downloaded from HTTP servers. When an HTML page contains a reference to a DAVIC Content or Application, the HTML browser activates a local application (e.g. JMF Manager, plug-in, helper, etc.) and passes the information about content protocol and content coding to this application. These kinds of information are expressed in MIME-type. This operation is represented on the following figure.

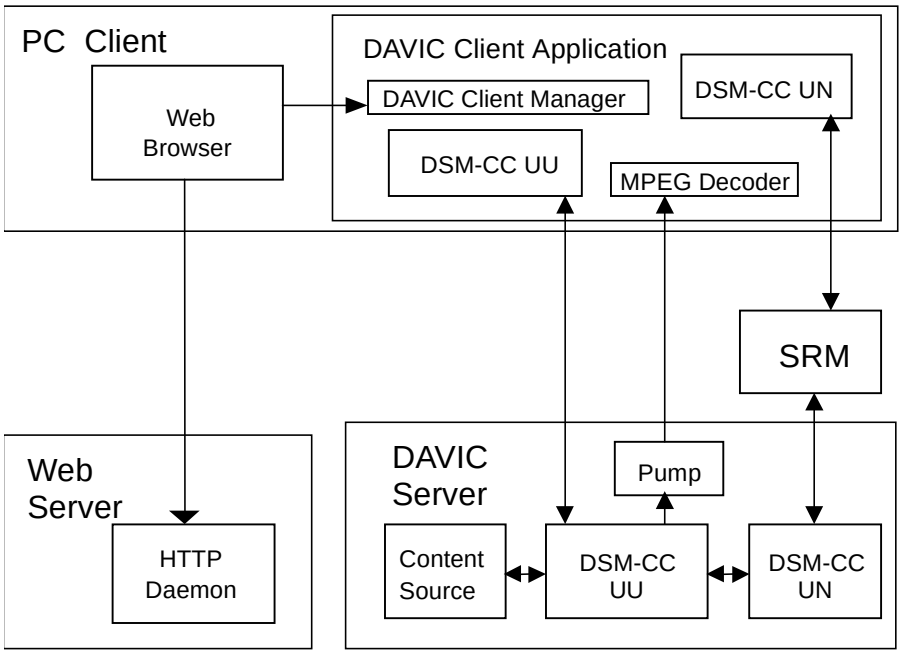


Figure 9-19. Block diagram for access to DAVIC content from a Web browser

9.7.1.1 URLs and MIME Types

URLs and MIME Types are specified so that the activated local application can use URLs and MIME-types to decide which package should be used for each content and protocol.

9.7.1.2 URLs(Informative)

URLs for DSMCC will be registered in IETF.

URL for DAVIC DSM-CC:

"org.davic.dsmcc://<Server-ID>/<Directory name>/<Directory name>/…/<Object Name>"

Examples of DSM CC URL for reference to DAVIC Content:

org.davic.dsmcc://<Server-ID>/<Directory name>/<Directory name>/…/movie1.mpg

org.davic.dsmcc://<Server-ID>/<Directory name>/<Directory name>/…/picture1.jpg

org.davic.dsmcc://<Server-ID>/<Directory name>/<Directory name>/…/page1.htm

Example of DSM CC URL for reference to DAVIC Service (reference to the file which contains the description of the first application scene):

org.davic.dsmcc://<Server-ID>/<Directory name>/<Directory name>/…/startup

9.7.1.3 MIME Types

The specification and examples of MIME Type are given below.

MIME Type for DAVIC Contents:

"dsmcc-<DSM Object Type>/<Content Type>"

Examples of MIME Types for DAVIC Contents:

DSMCC Stream (MPEG2 SPTS) : dsmcc-stream/mpeg2-ts

DSMCC File (MPEG2 PS) : dsmcc-file/mpeg2-ps

DSMCC File (HTML) : dsmcc-file/html

DSMCC Download (JPEG Image) : dsmcc-download/jpeg

9.7.2 JMF Architecture and APIs to access DAVIC contents

An implementation of the access to DAVIC Contents from a Web Browser is presented here using the JMF Architecture. However other implementations are possible. In JMF architecture, by the MIME-type JMF manager can decide which package should be used. The corresponding DataSource and Player are created and they access with the package. Then the DataSource requests multi media data from a server. The Player can get the data and play it.

In this section, it is assumed that JMF is used for a DAVIC stream client in a Web browser because JMF satisfies most requirements for it. But it doesn't have enough methods to get information about session events and resource allocations. So some extensions of JMF for DAVIC services are defined in this document.

9.7.2.1 Architecture

The next Figure shows an architecture of a DAVIC client for a Web browser and API reference points. The architecture is compliant to Java Media Framework (JMF) Specification 1.0.

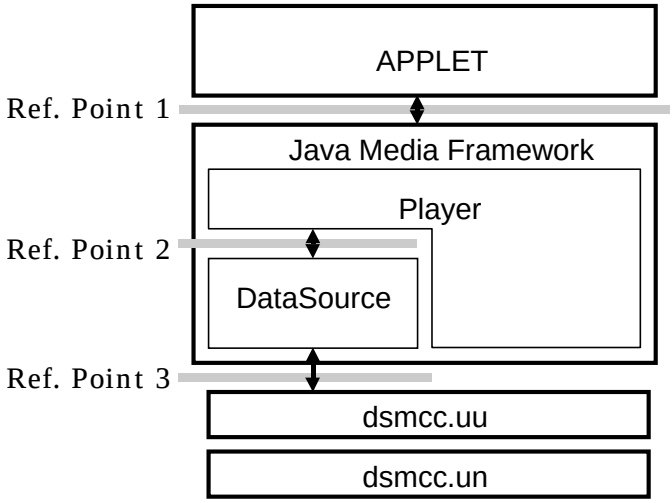


Figure 9-20. Architecture of a DAVIC client using JMF

Reference point 1 is the highest level API for applet designers. It is fully compliant to Java Media Player APIs. Applet designers do not have to worry about any DAVIC specific procedures. Reference point 2 is the internal API in the Java Media Framework. The interface between the Player and the DataSource are specified, because the DataSource's (…media.protocol package) vender is not always same as the Player's (…media package) vender. Reference point 3 is the lowest level API for Java Media Player Package providers. This API provides interfaces to DSM-CC UU (org.davic.net.dsmcc.uu) packages. For the DSM-CC UN API see clause 9.4.16.

10. DAVIC Reference Model for Contents Decoding

10.1 Scope

DAVIC 1.4.1 defines a Normative Reference Decoding Model, RDM. The RDM specifies normative semantic constraint on DAVIC content. in particular for delivery, handling and decoding of contents. The RDM is not a guideline for the design of actual decoders; the RDM does not describe any specific STU architecture. The major problem addressed by the RDM is to ensure interoperability of the memory size and behaviour between content and STUs, and to do so without specifying the internal design and behaviour of the STU.

The Reference Decoder Model provides a virtual STU platform of which the performance is defined in mathematical terms. The RDM provides models for (1) data delivery, (2) memory usage for code and content objects and (3) timing for object handling and instruction execution. In addition the RDM provides rules and constraints for applications for avoiding application failures.

Each DAVIC compliant application is required to run on the RDM without any violation of the RDM requirements. In addition each DAVIC compliant STU is also required to meet the RDM requirements. Therefore the RDM is the DAVIC tool that ensures that each single DAVIC compliant application runs on all DAVIC compliant STUs without any application failure, and without porting the application to each specific STU implementation.

DAVIC application developers use the RDM as the virtual platform for application development and as the tool for verification of application correctness, without requiring any application testing at each specific STU implementation of the DAVIC specification. Developers of DAVIC compliant STUs use the RDM as the reference model for their implementation, thereby compensating for the differences between the theoretical performance of the RDM and the practical performance of their implementation; e.g. different timing characteristics may result in the need for compensation in buffer sizes. By serving as a platform and application independent interface between application and STU developers, the RDM provides a mechanism for independent development of applications and STUs.

10.2 Reference Decoder Model

The RDM is based on the MPEG-2 Systems (ISO/IEC 13818-1) Transport System Target Decoder (T-STD). The RDM incorporates the T-STD in its entirety, and adds additional virtual buffers and decoders to support graphics, text, linear audio and both real-time streams and stored objects. ISO/IEC 13818-1 (MPEG-2 Systems) contains the complete specification of the T-STD. The RDM specifies completely the times at which all objects enter and leave each of the various buffers, in terms of the timing model provided by MPEG Systems.

Within the RDM applications are executed by the run-time engine. The RDM provides three storage elements for the execution of applications; these storage elements are defined from application perspective, in a way independent of the implementation of the run-time environment. The three elements are :

1. Buffer Bcontents to store coded objects containing raw contents for use by applications.
2. Buffer Bcode to store MHEG-5 objects in the interchange format; however, included contents are not stored in Bcode, but in Bcontents instead. In addition, JAVA VM byte code is stored in Bcode in the interchange format.
3. Buffer Bexecute which is the dynamic memory available for run-time execution of the application (stack, heap, scratch-pad, etc.)

In addition to these three storage elements, the RDM adds the following to the T-STD:

4. Run-time engine, which executes the code contained in Bcode, using Bexecute as dynamic memory for application execution. The run-time engine controls the time at which contents are decoded and presented and controls the time at which contents are removed from Bcontents. By executing appropriate application code, the run-time engine can control the presentation processor.
5. Graphics/text decoder capable to decode stored objects from Bcontent and real-time graphic streams.
6. Linear audio decoder capable to decode linear audio objects from the object memory.
7. Presentation processor capable to perform operations on the audio and video outputs of the various decoders as required by the application, under control by application code executed in the run-time engine. Examples of such operations are an audio mix and a video wipe.
8. Transport buffers TBn to deliver real-time graphic streams to buffer Bn for graphics and to deliver objects to either buffer Bcontents or buffer Bcode.

9. Data paths to carry data as needed between buffers and decoders.

The RDM is shown in the following figure.

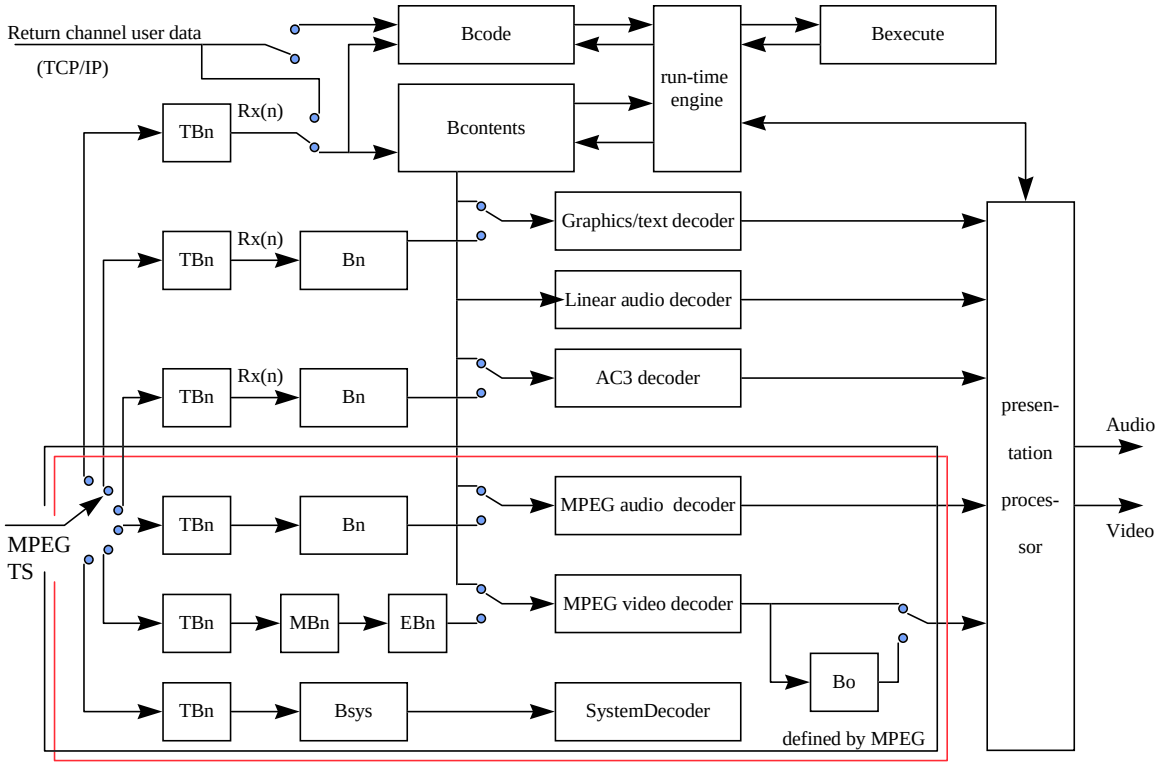


Figure 10-1. The DAVIC Reference Decoder Model

Data enters the RDM via an MPEG-2 Transport Stream or as user data via a return channel. A real-time stream can only be delivered via the MPEG-2 Transport Stream, while for delivery of stored objects both delivery mechanisms can be exploited.When delivered over an MPEG-2 TS, stored objects as well as application code are contained in a DSM-CC User to User Object Carousel carried within MPEG-2 sections. Service Information is delivered while meeting the constraints specified in ETS 300 468. For the delivery and decoding of real-time streams carrying compressed graphics the decoder model and constraints defined in ETS 300 743 apply.

Contents are contained in memory in its coded representation. Contents either contained in a stored objects or in a real-time stream consists of a sequence of one or more entire Access Units. In the case of compressed video, still pictures and compressed audio Access Units consist of one picture or one audio frame respectively, as defined in ISO/IEC 11172 and ISO/IEC 13818. In the case of linear audio, an Access Unit equals one mono audio sample or one pair of stereo audio samples. In the case of AC-3, an audio Access Unit consists of one audio frame as defined in ATSC A/52, Annex A. The size of buffer Bn for AC-3 audio is equal to the size of Bn for MPEG audio (which is specified in ISO/IEC 13818-1). In the case of graphics and text, an Access Unit consists of an entire graphical or text object respectively.

At decode time, as indicated by a PTS or DTS, Access Units are decoded instantaneously. In the case of a real-time stream each Access Unit is removed from buffer Bn instantaneously at decode time. In the case of Access Units stored in Bcontents or Bcode, removal of the objects is controlled by the Run Time Engine, RTE. When the RTE destroys an object, the object is removed instantaneously from the buffer in which it is stored. All RTE processing, including code execution and object handling are instantaneous.

The size of buffer Bn and the leak rate of Rx(n) for graphics depends on the maximum number of colours and the maximum full screen resolution applied in an application at any time. These values are mandatorily provided by each compliant DAVIC application. In DAVIC 1.4.1 the following options are allowed :

maximum number of colours at any time :	4 colours,	(2 bits per pixel)
	16 colours,	(4 bits per pixel)

256 colours or (8 bits per pixel)

65536 colours. (16 bits per pixel)

maximum full screen resolution at any time : 360 pixels by 288 lines (CIF)

720 pixels by 288 lines (601 hor, CIF vert)

720 pixels by 576 lines (601 hor and vert)

1280 pixels by 720 lines

1920 pixels by 1080 lines

Note that the maximum number of colours may be defined in multiple ways, e.g. by one CLUT table with a number of entries equal to the maximum number of colours, or by multiple CLUT tables with less entries, that use in total no more than the maximum number of colours.

Based on these options, 14 different colour and resolution combinations can be made. These combinations can be classified in multiple quality levels, using the required number of bits to store a full screen picture as qualifier. This results in 8 different quality levels, with one, two or three colour / resolution combinations with the same value of the qualifier per quality level. See Table 10-2.

Table 10-2. Quality Levels

quality level	maximum horizontal resolution at any time	maximum vertical resolution at any time	maximum number of colours at any time
1	CIF	CIF	4
2	CIF	CIF	16
	601	CIF	4
3	CIF	CIF	256
	601	CIF	16
	601	601	4
4	CIF	CIF	65536
	601	CIF	256
	601	601	16
5	601	CIF	65536
	601	601	256
6	601	601	65536
7	1280	720	65536
8	1920	1080	65536

For graphics the size of Bn and the value of the leak rate Rx(n) are defined per quality level. Note that these figures apply to a real-time graphics stream. The buffer size corresponds to a storage capacity equal to about 1.2 times one full screen uncompressed picture. The rates correspond to the constant delivery rate needed to fully load an empty Bn buffer in 2.5 seconds. See Table 10-3.

Table 10-3. Size of Bn and value of Rx(n) for graphics per Quality Level

quality level	size of buffer Bn for graphics (x 1 000 000 bits)	leakrate Rx(n) for graphics (x 1 000 000 bits/sec)
1	0.25	0.1

2	0.5	0.2
3	1.0	0.4
4	2.0	0.8
5	4.0	1.6
6	8.0	3.2
7	17.0	7.1
8	40.0	16.0

The TB buffers operate exactly as in the T-STD. They are 512 bytes in size; they receive data from the Transport stream on the S1 interface at the schedule encoded in the transport stream; data leaves them and enters Bn at rates specifies according to the elementary stream type. The leak rate of TB for graphics and text is defined in Table 10-3.

Buffer Bcontents contains stored objects in their coded representation. The DAVIC 1.4.1 coded objects which are accepted and stored in Bcontents are:

1. Graphics/text coded objects
2. Linear audio coded objects
3. MPEG video coded objects, including still pictures
4. MPEG audio coded objects.
5. AC-3 audio coded objects

Bcode contains MHEG-5 objects in interchange format (without included contents) and JAVA VM byte code.

The minimum size of buffers Bcontents and Bcode required to run an application are mandatorily provided by each compliant DAVIC application. In addition the application mandatorily provides the value of the leak rate Rx(n) applied by the application. Two options are available : 1 000 000 and 5 000 000 bits per second.

The RDM constrains all contents and its delivery such that when the contents its delivery is verified using the RDM the buffers shall not overflow. The RDM constraints include the constraints specified by the MPEG-2 Systems standard.

10.3 DAVIC Application Resource Descriptor

To inform the STU about the minimum requirements the run-time environment needs to support in order to successfully execute a specific application, the DAVIC application resource descriptor is defined, providing information about required memory resources, the resolution and number of colours applied in the application, and which leak rate Rx(n) is used for transfer of data from TB(n) to Bcontents and Bcode. Each compliant DAVIC application is mandatorily required to provide the DAVIC application resource descriptor. In future DAVIC may extend the descriptor by adding trailing bytes to the descriptor. The descriptor is carried by the MHEG-5 application. The required resources shall be specified for each application and may be specified for each scene within that application. The DAVIC application resource descriptor for an application or a scene is carried within the ObjectInformation attribute of the application or scene.

Table 10-4. DAVIC application resource descriptor

Syntax	No of bits	Mnemonic
DAVIC_application_descriptor(){		
Bcontents_size	16	uimsbf
Bcode_size	16	uimsbf
Bexecute_size	16	uimsbf
maximum_graphics_resolution	4	bslbf
maximum_number_colours_in_graphics	4	bslbf

	leak_rate_Rx(n)_for_objects	4	bslbf
	reserved	4	bslbf
	maximum_MPEG_video_coded_picture_size	16	uimsbf
}			

Bcontents_size : a 16 bit unsigned integer specifying the required size of Bcontents for this DAVIC application. The size is specified in units of 16384 Bytes.

Bcode_size : a 16 bit unsigned integer specifying the required size of Bcode for this DAVIC application. The size is specified in units of 16384 Bytes.

Bexecute_size : a 16 bit unsigned integer specifying the required size of Bexecute for this DAVIC application. The size is specified in units of 16384 Bytes.

maximum_graphics_resolution : a 4 bit field that indicates the maximum full screen resolution used at any time during this entire application, corresponding to the following table.

Table 10-5. Maximum full screen resolution applied in application.

Value	Meaning
‘0000’	reserved
‘0001’	360 pixels by 288 lines (CIF)
‘0010’	720 pixels by 288 lines
‘0011’	720 pixels by 576 lines (ITU-R601)
‘0100’	1280 pixels by 720 lines
‘0110’	1920 pixels by 1080 lines
‘0111’ - ‘1111’	reserved

maximum_number_colours_in_graphics : a 4 bit field that indicates the maximum number of different colours used throughout this entire application, corresponding to the following table.

Table 10-6. Maximum number of colours in application

Value	Meaning
‘0000’	4
‘0001’	16
‘0010’	256
‘0011’	65536
‘0100’ - ‘1111’	reserved

leak_rate_Rx(n)_for_objects : a 4 bit field that specifies the leak rate Rx(n) applied in this application to transfer objects to either Bcontents or Bcode, corresponding to the following table.

Table 10-7. Leak rate Rx(n) for objects

Value	Meaning
‘0000’	reserved
‘0001’	1 000 000 bits per second
‘0010’	5 000 000 bits per second
‘0011’ - ‘1111’	reserved

maximum_MPEG_video_coded_picture_size : a 16 bit field that specifies the maximum size of MPEG Video pictures used at any time in this application in units of macroblocks (256 pixels, equivalent to 16 pixels by 16 lines). A value of zero indicates that no MPEG Video is used in this application. Note that in that case MPEG Still Pictures may be used.

10.4 Minimum DAVIC 1.4.1 STU requirements

Each compliant DAVIC 1.4.1 STU is mandatorily required to implement Bcontents, Bcode and Bexecute of a size that is at least equal to the value specified in table 10-8. Note that these sizes are defined in terms of the RDM. Practical implementations of these buffers may have different sizes, while meeting the minimum requirements defined in Table 10-8.

Table 10-8. Minimum buffer sizes required in DAVIC 1.4.1 STUs

	Minimum size
Bcode	128 kByte (= 131 072 Bytes)
Bcontents	512 kByte (= 524 288 Bytes
Bexecute	128 kByte (= 131 072 Bytes)

10.5 Support for Graphics in STUs

DAVIC 1.4.1 STUs shall support graphics in relation to MPEG Video as specified in table 10-9. When MPEG Video is not used in an application, or when MPEG Still Picture is used in an application, then full screen graphics shall be supported at each graphics quality level. Note that MPEG Video and MPEG Still Pictures are mutually exclusive functions within DAVIC 1.4.1.

Table 10-9. Minimum requirement for the support of graphics in DAVIC 1.4.1 STUs

graphics quality level	graphic picture size	MPEG Video coded picture size
1-3	full screen	full screen ITU-R 601 / 50 Hz
4	<= 0.6 * full screen	(720*576 pixels by lines,
5	<= 0.3 * full screen	equivalent to 1620 macroblocks)
6	<= 0.15 * full screen	
1-4	full screen	full screen ITU-R 601 / 59.94 Hz
5	<= 0.6 * full screen	(720*480 pixels by lines,
6	<= 0.3 * full screen	equivalent to 1350 macroblocks)
4	full screen	<= 1440 macroblocks
5	full screen	<= 1080 macroblocks
6	full screen	<= 312 macroblocks
7	full screen	full screen (1280*720 pixels by lines, progressive)
8	full screen	full screen (1920*1080 pixels by lines, interlace)

10.6 Persistent Memory

Persistent memory is not explicitly defined in the RDM. DAVIC 1.4.1 STUs may contain persistent memory, as an optional resource for the convenience of applications. However, the availability of persistent memory is not a requirement for DAVIC 1.4.1 STUs. For DAVIC 1.4.1 applications the availability of persistent memory shall not be a condition for successful execution of the application.

11. Content Packaging and Metadata

This section describes how media content is packaged for delivery from a Content Provider to a Service Provider over the A10 interface. In addition, it describes the ancillary data (metadata) which relates to media content.

Other aspects of the content loading process are described in other parts of the DAVIC Specifications. Specifically:

Part 1 describes the basic functionalities required by the content loading process.

Part 3 describes the Content Transfer A10 Architecture from the perspective of the Service Provider System (SPS).

Part 7 describes the mid-layer protocols/APIs for content loading.

The way in which content is packaged for delivery is independent of the from the way in which media content data is delivered to the SPS (it may be delivered to a Service Provider either on physical media or over a transmission system).

All programming content is represented in the DAVIC system as multimedia components. Multimedia components comprise one or more monomedia components coupled with the logical relationships between the monomedia components. The multimedia components will be created by content providers for input to the servers. The multimedia components will be accessed by the STU's using the delivery system.

11.1 Content Package Structure

The scope of the content package structure is to support content transfer across the A10 interface, and content handling at the content provider system side and at the service provider system side. Among the important objectives for such a structure are (no priority in the listing):

- Random access to individual content item elements, e.g. for transfer, updating, deletion and adding.
- Extensibility of elements, i.e. adding new attributes must be possible with backward compatibility.
- Global referencing possibilities in and out of packages.

11.1.1 Content Item Elements

A content item element (CIE) is the smallest (and indivisible) content component. A CIE can be part of one or more content items. Examples of such elements are still pictures and video clips.

11.1.2 Content Item

A content item (CI) is a collection of content item elements that will form a complete application or a complete programme. Different content items may share one or more content item elements. A content item could contain another content item. Examples of content items are movies and home shopping applications.

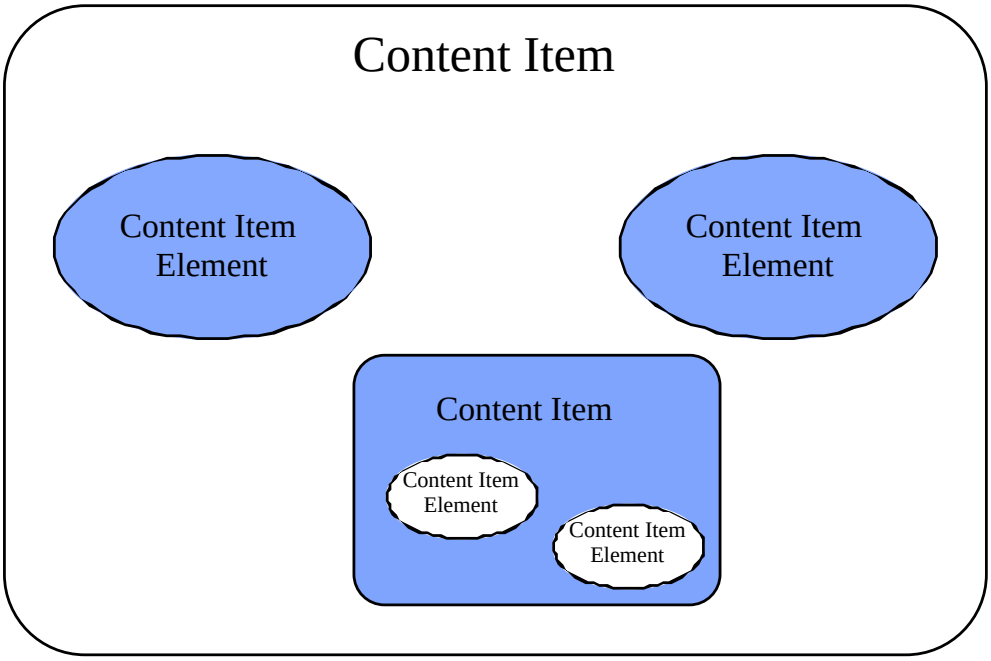


Figure 11-1. Illustration of a Content Item

11.1.3 Content Package

A content package is a set of content item elements and/or content items. Examples of use is delivery a intermediate storage.

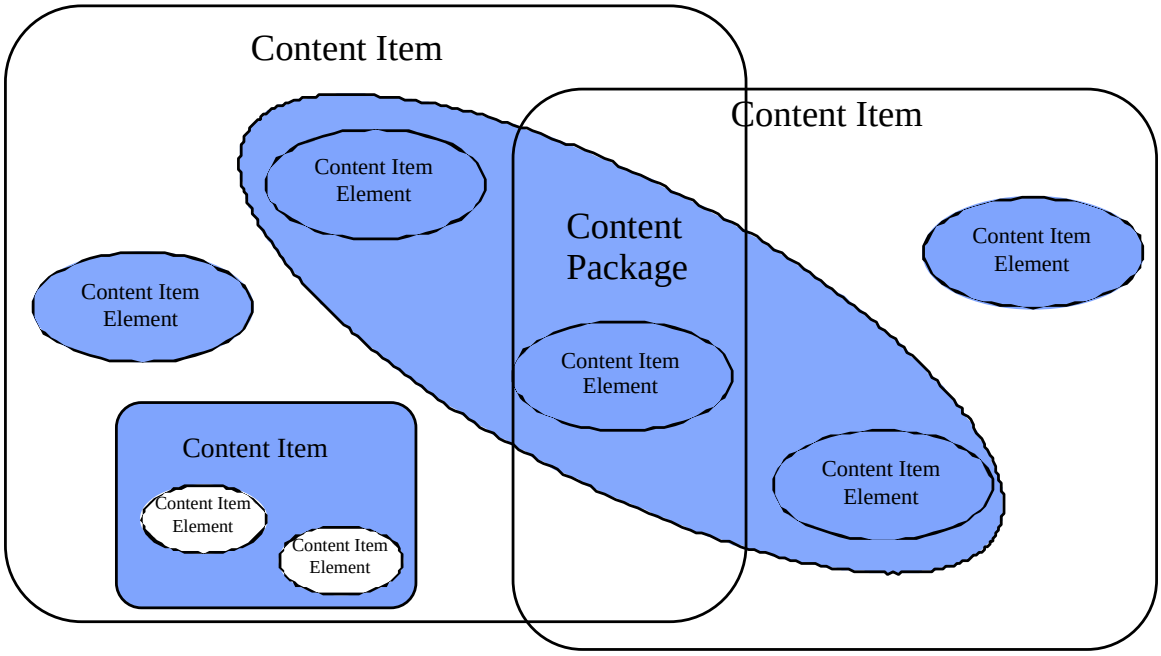


Figure 11-2. The relationships between the items, item elements and packages.

As an example, a movie show would typically contain the featured movie, a sequence of trailers and a number advertisements. Using the DAVIC content package structure the move show, the trailer sequence and t advertisement could be content items. Each trailer and each advertisement could be a content item element. Tl trailers could be assembled from a package of a large number of trailers delivered by some film company.

11.2 Content Metadata

Content items transferred by a Content Provider to a Content Server consist of both media content elements (video, audio, stills, etc.) and associated descriptive and control elements–refered to here as “content metadata”. Note that these descriptive elements can be (pointers to) media elements.

We divide content metadata into two categories: Content Management and Navigational. Content management refers to metadata that allows the content data to be managed within an SPS. Content management metadata is used for content transfer and loading, version control, and content verification. Navigational metadata is used to enable use of the server content, as controlled by the client and server applications. This may include navigation, embargo and deletion control, copyright management, and user access control.

A core set of metadata items are required to be provided with each content item. This small core set provides for the basic management of server items.

11.2.1 Types

The metadata types listed here are given as guidelines to express the general format of the information. Types will be more specifically defined for the content packaging tool chosen to encode content packages.

ISO 639.2	24-bit language code, as defined in ISO 639 Part 2 (/B and /T can be used), with each character coded into 8 bits according to ISO 8859-1 (see, for example, explanation in ETS 300 468 section 6.2.3)
bmp/ISO 10646-1	Coded byte pairs for international character representation, as per the Basic Multilingual Plane of ISO 10646-1 (see, for example, the European subset informatively stated in ETSI ETS 300 468 Annex A)
UTC/MJD	Global date/time: Modified Julian Day/Coordinated Universal Time (see ETSI ETS 300 468 Annex C)
UTC/rel	Time period, 24 bits coded as 6 digits in 4-bit Binary Coded Decimal (BCD), for example 12h 45m 01s is coded as “124501”.
char_sequence	Set of characters, coded to ISO 8859-1.
content_type	Restricted set of char_sequence (see above) to define the type of the CIE, the defined set being: {preview, main, logo, synopsis, poster_image}
country_code	24-bit field identifying a country using the 3-character code as specified in ISO 3166. Each character is coded into 8-bits according to ISO 8859-1 and inserted into the 24-bit field. In the case that the 3 characters represent a number in the range 900 to 999, then country_code specifies an ETSI-defined group of countries. These allocations are found in ETR 162
dimension_name	char_sequence (see above) defining dimension of content rating being considered, specific for the given region defined, for example violence or language rating for USA
text_rating	set of bmp/ISO 10646-1 symbols defining the actual rating given for the defined rating dimension for the defined country
rating_body	set of bmp/ISO 10646-1 symbols defining the recognised body within the given country that awarded the content item the given age_rating or text_rating
role_char	restricted, but extensible, char_sequence (see above) defining the role of the person or entity which will be stated in the role-description. The initial set to be defined as {director, actor, movie_house, producer, composer, author, book_title, musician, production_studio, location}
telephone_descriptor	a multi-part type, containing country_prefix_char, international_area_code_char, national_area_code_char, core_number_char:
country_prefix_char	a set of 8-bit characters, coded in accordance with ISO 8859-1, the set of alphanumeric characters which make up the country prefix.

international_area_code_char	a set of 8-bit characters, coded in accordance with ISO 8859-1, the set of alphanumeric characters which make up the international area code.
national_area_code_char	a set of 8-bit characters, coded in accordance with ISO 8859-1, the set of alphanumeric characters which make up the national area code.
core_number_char	a set of 8-bit characters, coded in accordance with ISO 8859-1, the set of alphanumeric characters which make up the core number.
age_rating	8-bit integer of recommended minimum age in years of end user, where minimum age = rating + 3 years (e.g., 04 implies that end users should be at least 7 years old), with a max value 0F.
content_descriptor	single byte, consisting of two nibbles, as defined in ETS 300 468 section 6.2.4 table 18, providing classification information for the content.
bslbf	bit sequence, left bit first
fpvsbf	floating point, value sign bit first
uimsbf	unsigned integer, most significant bit first

11.2.2 Semantics of the Loading Commands

The content loader in the SPS executes the loading commands attached to a content element. The following loading commands are available.

11.2.2.1 DSM-CC Directory Primitives

Directory primitives, as described in ISO/IEC 13818-6, allow the content item elements to be manipulated on loading as follows:

Table 11-3. DSM-CC Directory Primitives

Inherited from NamingContext:	
list	Return a list of all the bindings to object references in the context.
resolve	Return the object reference bound to a given name.
bind	Bind an object reference to a name.
bind_context	Bind a naming context to a name.
rebind	Bind an object reference to a name, overwriting any previous binding.
rebind_context	Bind a context to a name, overwriting any previous binding.
unbind	Remove a binding for a name.
new_context	Create a new naming context.
bind_new_context	Create a new naming context and bind it to the given name.
destroy	Destroy the naming context.

Defined in Directory:	
DSM Directory open	Resolve the objects associated with names in the given path.
DSM Directory close	Close a reference to a Directory.
DSM Directory get	Return the values bound to names in a given path.
DSM Directory put	Bind names in a given path to values, overwriting any previous bindings.

11.2.2.2 Execute

The content element gets executed. This is especially suited for “setup” procedures.

11.2.2.3 Priority

CIE loading instructions take precedence over CI loading instructions if they differ.

11.2.3 Mapping

The lists and definitions given below are not exhaustive. However, it is mandatory that if a type is used, that the definitions given are followed. The navigational data defined is inevitably aimed at the most open applications, such as movies or TV programmes on demand, but are not exclusive to those applications.

The following figure shows the inheritance of monomedia components from the Content Item Elements for metadata attributes. The monomedia components shown are as defined in the DAVIC 1.4.1 Specification Part 9. The monomedia components do not inherit attributes from Content Packages or Content Items.

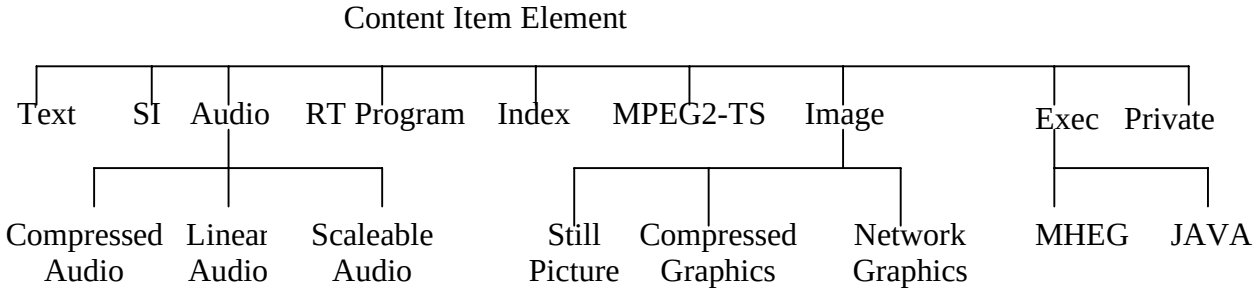


Figure 11-4. Inheritance from Content Item Element

In the descriptions below the following assumptions apply:

- All names are COS Naming Service compound names, based on the binding of an object to a name in a name space. This implies that the CIE and CI names may change upon loading, based on the binding of the referenced objects to a new naming context when loading.
- It is possible to add new attributes for a CIE while on SPS, but it isn’t allowed change any existing attributes value except for the CIE_path and CIE_assoc_CI list, where one is allowed to add associations to other CI’s.
- Changes and additions to the CI attributes while on the SPS are allowed in all attributes except for the CI_path, CI_guid, CI_owner, CI_ permission, and the CI_title.
- Optional attributes for the CIE and the CI means that it may not always be used , not that it may not be supported in a tool. All metadata marked as optional and mandatory must be supported by the tools.
- Private attributes may be added to any Content Package, Content Item, Content Item Element, or Monomedia Component. Definitions for such attributes are outside the scope of this specification.

11.2.3.1 Content Package Metadata

Attribute	*Type*	*Description*	*M/O*[7]
CP_name	CosNaming::name	COS Naming Service compound name	M
CP_path	char_sequence	Physical location of the CP metadata	M
CP_TOC	set of {{CIE_guid, CIE_name}, {CI_guid, CI_name}}	List of CIE names and IDs, and CI names and IDs, in the package	M

11.2.3.2 Content Item Metadata

Attribute	*Type*	*Description*	*M/O*
CI_ permission	TBD	Permissions for use that apply to the CI; different users will have different permissions	M
CI_guid	char_sequence	Global unique identifier of the Content Item	M
CI_name	CosNaming::name	COS Naming Service compound name	M
CI_owner	char_sequence	ID of the owner of the content item (Content Provider or SP)	M
CI_path	char_sequence	Physical location of the CI metadata	M
CI_title	char_sequence	Title of the CI	M
CI_TOC	set of {{CIE_guid, CIE_name}, CI_guid, CI_name}}	List of CIE names and IDs and CI names and IDs in the CI	M
CI_version	bslbf	Version of the CI (major and minor)	M
Award.date_received	UTC/MJD	Date awarded	O
Award.description	char_sequence	Award description	O
Award.name	bmp/ISO 10646-1	Award name	O
CI_abbr_title	char_sequence	Abbreviated CI title	O
CI_date_available	UTC/MJD	Date available to customers	O
CI_delete_date	UTC/MJD	Date to delete from the SPS	O
CI_episode_name	bmp/ISO 10646-1	Particular episode name	O
CI_expiration_date	UTC/MJD	Date content became unavailable to customers	O
CI_price_unit.price	TBD/fpvsbf	Price of content package from the CP to the SP, in appropriate units	O
CI_price_unit.user_price	TBD/fpvsbfFixed.2	CP suggested price of content package from the SP to the user, in appropriate units	O
CI_Provider.address	bmp/ISO 10646-1	Address of content provider	O
CI_Provider.contact_name	bmp/ISO 10646-1	Contact name	O

[7] Mandatory/Optional

CI_Provider.contact_phone	telephone_descriptor	Contact phone number	O
CI_Provider.ID[8]	char_sequence	Global unique ID for the Content Item provider	O
CI_Provider.name	bmp/ISO 10646-1	Name of content provider	O
CI_provider_ref	char_sequence	Local ID of the CI to the Service Provider	O
CI_Restriction.Country.Dimension.Rating	dimension_name.text_rating	Rating in given country according to a given system (or dimension) by agreed text (e.g. in USA, Warnings, Language, or UK, BBFC, Uc) three-dimensional	O
CI_Restriction.Country.Rating_Body.Overall_Age_Rating	country_code.rating_body.age_rating	Rating in given country by minimum age by given rating body (e.g., 15 years in UK by BVA) three-dimensional	O
Review.critic_name	bmp/ISO 10646-1	Name of critic	O
Review.description	bmp/ISO 10646-1	Description of review	O
Review.language	ISO 639.2	Language in which review is written	O
Review.org	bmp/ISO 10646-1	Organisation that gave the review	O
Review.quote	bmp/ISO 10646-1	Quote out of review	O
Review.rating	char_sequence	Rating on a specific scale (1-4 stars,...)	O
Review.text	bmp/ISO 10646-1	Text of review	O
Role.description	bmp/ISO 10646-1	Description or name of person/people taking that role	O
Role.name	role_char	Name of role	O
Schedule.channelno	char_sequence	logical channel number	O
Schedule.length	UTC/rel	length of program	O
Schedule.startdate	UTC/MJD	Starting date of program	O
Schedule.starttime	UTC/MJD	Starting time of program	O

11.2.3.3 Content Item Element Metadata

Attribute	*Type*	*Description*	*M/O*
CIE_ permission	TBD	Permissions for use that apply to the CIE; different users will have different permission	M
CIE_assoc_CI	set of char_sequence	Associated applications	M
CIE_comp	enumeration of { RT_program Text Index SI Compressed Audio	Content Item Element monomedia component type	M

[8] CI_Provider.ID will likely not be used at the same time as the other CI_Provider attributes.

	Linear Audio Compressed Video Still Picture Graphics Java, MHEG-5 Private }		
CIE_guid	char_sequence	Global unique identifier	M
CIE_loading	set of {DSM Directory, execute}	List of loading commands to be executed at loading time.	M
CIE_name	CosNaming::name	COS Naming Service compound name	M
CIE_owner	char_sequence	Global unique identifier of legal owner	M
CIE_path	char_sequence, char_sequence	Physical location of the CIE metadata and monomedia component data	M
CIE_size	uimsbf	size in bytes of the content part of the element	M
CIE_version	bslbf	version number (major, minor)	M
CIE_virus_checked	UTC/MJD	Date and Time the CIE was last virus checked	M
CIE _prov_ref	char_sequence	Local ID of the CI to the Service Provider	O
CIE_index_start	DSM-CC_appNPT	Index information to reference specific frames of the content (assumes MPEG-2 TS)	O
CIE_index_stop	DSM-CC_appNPT	Index information to reference specific frames of the content (assumes MPEG-2 TS)	O
CIE_mult_lang	list of lang	Languages available in the CIE	O
CIE_Provider.address	bmp/ISO 10646-1	Address of content provider	O
CIE_Provider.contact_name	bmp/ISO 10646-1	Contact name	O
CIE_Provider.contact_phone	telephone_descriptor	Contact phone number	O
CIE_Provider.ID[9]	char_sequence	Global unique ID for the Content Item Element provider	O
CIE_segment_table[10]	Ordered list of {CIE_name}	List of the CIE segments for a multi-file CIE, in order.	O
CIE_type	content _type	Type of content unit (preview, main, logo)	O
EncoderProvider.address	bmp/ISO 10646-1	Address of encoder provider	O
EncoderProvider.contact_name	bmp/ISO 10646-1	Contact name	O
EncoderProvider.contact_phone	telephone_descriptor	Contact phone number	O

[9] CIE_Provider.ID will likely not be used at the same time as the other CIE_Provider attributes.

[10] The CIE_segment_table attribute need to be included in the CIE metadata for each segment to which it applies.

EncoderProvider.name	bmp/ISO 10646-1	Name of encoder provider	O

11.2.3.4 Real Time Program Metadata

Attribute	*Type*	*Description*	*M/O*
RT_prog_comp	list of CIE_name	List of CIEs pointed to by the RT Program (MPEG-2 TS and Index only)	M

11.2.3.5 MPEG-2 TS Metadata

Attribute	*Type*	*Description*	*M/O*
bitrate	uimsbf	bit rate in bits per second	M
aspect_ratio	bslbf	aspect ratio of the intended display	O
frame_rate	fpvsbf	video frame rate in Hz	O
horizontal_size	uimsbf	Number of pixels of the frame in the horizontal direction	O
level_profile	bslbf	level and profile used for video encoding, as specified by ISO/IEC 13818-2	O
mult_lang_audio	set of ISO 639.2	list of one or more language identifiers for the audio tracks in the TS	O
mult_lang_text	set of ISO 639.2	list of one or more language identifiers for the text tracks (e.g., subtitles) in the TS	O
PES_comp	setof {CIE_comp, uimsbf)	The component monomedia that has been mapped to the TS via the PES structure, and location (PID)	O
ratio	uimsbf	Amount of speed up for the Fast forward or Fast Rewind streams	O
TS_comp	set of {CIE_comp, uimsbf)	The component monomedia that has been mapped to the TS via the TS private section, and location (PID)	O
TS_mode	bslbf	Indication of whether the TS is the standard, the fast forward or the fast rewind stream	O
vertical_size	uimsbf	Number of pixels of the frame in the vertical direction	O
video_comp_type	enumeration of {MPEG-1, MPEG-2}	Type of video encoding	O

11.2.3.6 Index Metadata

Attribute	*Type*	*Description*	*M/O*
Index_mode	bslbf	Indication of whether the Index file applies to the standard, the fast forward or the fast rewind stream	O

11.2.3.7 Text Metadata

Attribute	*Type*	*Description*	*M/O*
starting corner	uimsbf, uimsbf	location (in pixels) of the starting corner on the screen in terms of (# horizontal pixels, # vertical pixels), and where (0,0) is the upper left-hand corner.	O
text_flow	bslbf	Direction of the text flow (l-r, or r-l)	O

11.2.3.8 System Information Metadata

Attribute	*Type*	*Description*	*M/O*
SI_tables	char_sequence	The type of DVB SI table	M

11.2.3.9 Compressed Audio Metadata

Attribute	*Type*	*Description*	*M/O*
bitrate	uimsbf	The playback bitrate of the audio stream	M
audio_type	bslbf	The type of audio encoding - MPEG-1 Layer I, MPEG-1 Layer II, AC-3, or MPEG-2 Layer II.	O
channel_format	enumeration of {sing_chan, dual_chan, joint_stereo, stereo}	The type of channels included in the audio stream	O
sample_rate	fpvsbf	The sample frequency of the encoded data	O
sample_size	uimsbf	the number of bits per audio sample	O

11.2.3.10 Linear Audio Metadata

Attribute	*Type*	*Description*	*M/O*
num_channels	uimsbf	Whether one (mono) or two (stereo) channels are included in the audio stream	O
num_sample_frames	uimsbf	Number of sample frames	O
sample_rate	fpvsbf	The sample frequency of the encoded data	O
sample_size	uimsbf	the number of bits per audio sample	O

11.2.3.11 Still Picture Metadata

Attribute	*Type*	*Description*	*M/O*
aspect_ratio	bslbf	aspect ratio of the intended display	O
horizontal_size	uimsbf	Number of pixels of the frame in the horizontal direction	O
level_profile	bslbf	level and profile used for video encoding, as specified by ISO/IEC 13818-2	O
vertical_size	uimsbf	Number of pixels of the frame in the vertical direction	O

11.2.3.12 Graphics Metadata

Attribute	*Type*	*Description*	*M/O*
coding_type	bslbf	Coding type for still graphic - RGB16, CLUT8, CLUT4, or CLUT2	O
dithering_pref	bslbf	preference of whether or not to dither	O
horizontal_position	uimsbf	Horizontal offset between the top left corner of the object and the top left corner of the grid	O
horizontal_size	uimsbf	Number of pixels of the frame in the horizontal direction	O
object_scalability	bslbf	describes minimum CLUT format for the object on display	O
pixel_aspect_ratio	bslbf	aspect ration of a pixel	O
resolution_ind	bslbf	resolution of the graphical object based on screen size - half frame resolution in both horizontal and vertical, vertical only, horizontal only	O
scaling_pref	bslbf	preference for scaling if object ratio does not match display ratio	O
target_background_grid	bslbf	Target background grid	
vertical_position	uimsbf	Vertical offset between the top left corner of the object and the top left corner of the grid	O
vertical_size	uimsbf	Number of pixels of the frame in the vertical direction	O

11.2.3.13 Java Metadata

Attribute	*Type*	*Description*	*M/O*
client_server	bslbf	Indication of whether the Java executable represents client or server code.	M

11.2.3.14 MHEG-5 Metadata

None

11.2.3.15 Private Metadata

Attribute	*Type*	*Description*	*M/O*
private_data	unspecified	User-defined data	O

11.3 Content Packaging Format

11.3.1 Bento

The Bento data model fits very well to the object model of DAVIC. We shall choose Bento as a base file format for content packaging, and describe the definition of DAVIC Objects in this chapter.

11.3.2 Bento definition of DAVIC Objects

Bento allows for extension through the definition of new objects, properties, and data types. The DAVIC Objects could be newly defined. Each DAVIC object should have a globally unique ID. The attributes specified in DAVIC1.4.1 part 9 clause 11.2 will map onto Bento properties. Additional properties may be added by the content loading tool set and will be specified at an appropriate time. Using Bento representation, the DAVIC Objects could be defined as below.

11.3.2.1 Content Package Object

Property	*Type*	*Value*
ObjID	ObjClass	Content Package Object
CPID	ObjRef	A globally unique ID and Version number
CP_name	CosNaming::name	COS Naming Service compound name
CP_path	char_sequence	Physical location of the CP metadata
CP_TOC	set of {{CIE_guid, CIE_name}, {CI_guid, CI_name}}	List of CIE names and IDs, and CI names and IDs, in the package

11.3.2.2 Content Item Object

Property	*Type*	*Value*
ObjID	ObjClass	Content Item Object
CPID	ObjRef	A globally unique ID indicating the Content Provider
PackageID	String	An ASCII character string, unique within the domain of the Content Provider, indicating the Package ID
CI_ permission	TBD	Permissions for use that apply to the CI; different users will have different permissions
CI_guid	char_sequence	Global unique identifier of the Content Item
CI_name	CosNaming::name	COS Naming Service compound name
CI_owner	char_sequence	ID of the owner of the content item (Content Provider or SP)
CI_path	char_sequence	Physical location of the CI metadata
CI_title	char_sequence	Title of the CI
CI_TOC	set of {{CIE_guid, CIE_name}, CI_guid, CI_name}}	List of CIE names and IDs and CI names and IDs in the CI

CI_version	bslbf	Version of the CI (major and minor)
Award.date_received	UTC/MJD	Date awarded
Award.description	char_sequence	Award description
Award.name	bmp/ISO 10646-1	Award name
CI_abbr_title	char_sequence	Abbreviated CI title
CI_date_available	UTC/MJD	Date available to customers
CI_delete_date	UTC/MJD	Date to delete from the SPS
CI_episode_name	bmp/ISO 10646-1	Particular episode name
CI_expiration_date	UTC/MJD	Date content became unavailable to customers
CI_price_unit.price	TBD/fpvsbf	Price of content from the CP to the SP, in appropriate units
CI_price_unit.user_price	TBD/fpvsbfFixed.2	CP suggested price of content package from the SP to the user, in appropriate units
CI_Provider.address	bmp/ISO 10646-1	Address of content provider
CI_Provider.contact_name	bmp/ISO 10646-1	Contact name
CI_Provider.contact_phone	telephone_descriptor	Contact phone number
CI_Provider.ID[11]	char_sequence	Global unique ID for the Content Item provider
CI_Provider.name	bmp/ISO 10646-1	Name of content provider
CI_provider_ref	char_sequence	Local ID of the CI to the Service Provider
CI_Restriction.Country.Dimension.Rating	dimension_name.text_rating	Rating in given country according to a given system (or dimension) by agreed text (e.g. in USA, Warnings, Language, or UK, BBFC, Uc) three-dimensional
CI_Restriction.Country.Rating_Body.Overall_Age_Rating	country_code.rating_body.age_rating	Rating in given country by minimum age by given rating body (e.g., 15 years in UK by BVA) three-dimensional
Review.critic_name	bmp/ISO 10646-1	Name of critic
Review.description	bmp/ISO 10646-1	Description of review
Review.language	ISO 639.2	Language in which review is written
Review.org	bmp/ISO 10646-1	Organisation that gave the review
Review.quote	bmp/ISO 10646-1	Quote out of review
Review.rating	char_sequence	Rating on a specific scale (1-4 stars,...)
Review.text	bmp/ISO 10646-1	Text of review
Role.description	bmp/ISO 10646-1	Description or name of person/people taking that role
Role.name	role_char	Name of role
Schedule.channelno	char_sequence	logical channel number
Schedule.length	UTC/rel	length of program

[11] CI_Provider.ID will likely not be used at the same time as the other CI_Provider attributes.

Schedule.startdate	UTC/MJD	Starting date of program
Schedule.starttime	UTC/MJD	Starting time of program

11.3.2.3 Content Item Element Object

Property	*Type*	*Value*
ObjID	ObjClass	Content Item Element Object
CPID	ObjRef	A globally unique ID indicating the Content Provider
PackageID	String	An ASCII character string, unique within the domain of the Content Provider, indicating the Package ID
CIE_ permission	TBD	Permissions for use that apply to the CIE; different users will have different permission
CIE_assoc_CI	set of char_sequence	Associated applications
CIE_comp	enumeration of { RT_program Text Index SI Compressed Audio Linear Audio Compressed Video Still Picture Graphics Java, MHEG-5 Private }	Content monomedia component type
CIE_guid	char_sequence	Global unique identifier
CIE_loading	set of {DSM Directory, execute}	List of loading commands to be executed at loading time.
CIE_name	CosNaming::name	COS Naming Service compound name
CIE_owner	char_sequence	Global unique identifier of legal owner
CIE_path	char_sequence, char_sequence	Physical location of the CIE metadata and monomedia component data
CIE_size	uimsbf	size in bytes of the content part of the element
CIE_version	bslbf	version number (major, minor)
CIE_virus_checked	UTC/MJD	Date and Time the CIE was last virus checked
CIE _prov_ref	char_sequence	Local ID of the CI to the Service Provider
CIE_index_start	DSM-CC_appNPT	Index information to reference specific frames of the content (assumes MPEG-2 TS)
CIE_index_stop	DSM-CC_appNPT	Index information to reference specific frames of the content (assumes MPEG-2 TS)

CIE_mult_lang	list of lang	Languages available in the CIE
CIE_Provider.address	bmp/ISO 10646-1	Address of content provider
CIE_Provider.contact_name	bmp/ISO 10646-1	Contact name
CIE_Provider.contact_phone	telephone_descriptor	Contact phone number
CIE_Provider.ID[12]	char_sequence	Global unique ID for the Content Item provider
CIE_segment_table[13]	Ordered list of {CIE_name}	List of the CIE segments for a multi-file CIE, in order.
CIE_type	content _type	Type of content unit (preview, main, logo)
EncoderProvider.address	bmp/ISO 10646-1	Address of encoder provider
EncoderProvider.contact_name	bmp/ISO 10646-1	Contact name
EncoderProvider.contact_phone	telephone_descriptor	Contact phone number
EncoderProvider.name	bmp/ISO 10646-1	Name of encoder provider

11.3.2.4 Real Time Program Object

Property	*Type*	*Value*
ObjID	ObjClass	Real Time Program Object
Length	long	The length of the Real Time Program object, in bytes
Bitrate	uimsbf	Real Time Program bitrate in bits per second
Form	MediaTag	Recording format
RT_prog_comp	List of CIE_name	List of CIEs pointed to by the RT Program (MPEG-2 TS and Index only)
RTPData	ObjRef	Real Time Program data file

11.3.2.5 MPEG-2 TS Object

Property	*Type*	*Value*
ObjID	ObjClass	MPEG-TS Object
Length	long	The length of the MPEG2-TS object, in bytes
Bitrate	uimsbf	TS bitrate in bits per second
aspect_ratio	bslbf	Aspect ratio of the intended display
frame_rate	Fpvsbf	video frame rate in Hz
Horizontal_size	uimsbf	Number of pixels of the frame in the horizontal direction
level_profile	bslbf	level and profile used for video encoding, as specified by ISO/IEC 13818-2

[12] CIE_Provider.ID will likely not be used at the same time as the other CIE_Provider attributes.

[13] The CIE_segment_table attribute need to be included in the CIE metadata for each segment to which it applies.

mult_lang_audio	Set of ISO 639.2	list of one or more language identifiers for the audio tracks in the TS
mult_lang_text	Set of ISO 639.2	list of one or more language identifiers for the text tracks (e.g., subtitles) in the TS
PES_comp	Setof {CIE_comp, uimsbf)	The component monomedia that has been mapped to the TS via the PES structure, and location (PID)
Ratio	uimsbf	Amount of speed up for the Fast forward or Fast Rewind streams
TS_comp	Set of {CIE_comp, uimsbf)	The component monomedia that has been mapped to the TS via the TS private section, and location (PID)
TS_mode	bslbf	Indication of whether the TS is the standard, the fast forward or the fast rewind stream
vertical_size	uimsbf	Number of pixels of the frame in the vertical direction
video_comp_type	enumeration of {MPEG-1, MPEG-2}	Type of video encoding
MPEGData	ObjRef	MPEG2-TS data file

11.3.2.6 Index Object

Property	*Type*	*Value*
ObjID	ObjClass	Index Object
Length	long	The length of Index object, in bytes
Index_mode	bslbf	Indication of whether the Index file applies to the standard, the fast forward or the fast rewind stream
IndexData	ObjRef	Index data file

11.3.2.7 Text Object

Property	*Type*	*Value*
ObjID	ObjClass	Text Object
Length	long	The length of the Text object, in bytes
starting_corner	uimsbf	Location (in pixels) of the starting corner on the screen in terms of (# horizontal pixels, # vertical pixels), and where (0,0) is the upper left –hand corner
Text _flow	bslbf	Direction of the text flow (l-r, or r-l)
TextData	ObjRef	Text data file

11.3.2.8 System Information Object

Property	*Type*	*Value*
ObjID	ObjClass	System Information Object
Length	Long	The length of System Information object, in bytes

SI_tables	char_sequence	The type of DVB SI table
SIData	ObjRef	System Information data file

11.3.2.9 Compressed Audio Object

Property	*Type*	*Value*
ObjID	ObjClass	Compressed Audio Object
Length	Long	The length of the Compressed Audio object, in bytes
Bitrate	Uimsbf	The playback bitrate of the audio stream
audio_type	Bslbf	The type of audio encoding - MPEG-1 Layer I, MPEG-1 Layer II, AC-3, or MPEG-2 Layer II.
channel_format	enumeration of {sing_chan, dual_chan, joint_stereo, stereo}	The type of channels included in the audio stream
audio_type	Bslbf	The type of audio encoding - MPEG-1 Layer I, MPEG-1 Layer II, or AC-3.
channel_format	enumeration of {sing_chan, dual_chan, joint_stereo, stereo}	The type of channels included in the audio stream
CAData	ObjRef	Compressed Audio data file

11.3.2.10 Linear Audio Object

Property	*Type*	*Value*
ObjID	ObjClass	Linear Audio Object
Length	Long	The length of the Linear Audio object, in bytes
Bitrate	Uimsbf	The playback bitrate of the audio stream
num_channels	Uimsbf	Whether one (mono) or two (stereo) channels are included in the audio stream
num_sample_frames	Uimsbf	Number of sample frames
sample_rate	Fpvsbf	The sample frequency of the encoded data
sample_size	Uimsbf	the number of bits per audio sample
LAData	ObjRef	Compressed Audio data file

11.3.2.11 Still Picture Object

Property	*Type*	*Value*
ObjID	ObjClass	Still Picture Object
Length	Long	The length of the Still Picture object, in bytes
aspect_ratio	Bslbf	aspect ratio of the intended display
Horizontal_size	Uimsbf	Number of pixels of the frame in the horizontal direction

level_profile	Bslbf	level and profile used for video encoding, as specified by ISO/IEC 13818-2
vertical_size	Uimsbf	Number of pixels of the frame in the vertical direction
SPData	ObjRef	Still Picture data file

11.3.2.12 Graphics Object

Property	*Type*	*Value*
ObjID	ObjClass	Graphics Object
Length	Long	The length of the Graphics object, in bytes
coding_type	Bslbf	Coding type for still graphic - RGB16, CLUT8, CLUT4, or CLUT2
dithering_pref	Bslbf	preference of whether or not to dither
Horizontal_position	Uimsbf	Horizontal offset between the top left corner of the object and the top left corner of the grid
Horizontal_size	Uimsbf	Number of pixels of the frame in the horizontal direction
object_scalability	Bslbf	describes minimum CLUT format for the object on display
pixel_aspect_ratio	Bslbf	aspect ration of a pixel
Resolution_ind	Bslbf	resolution of the graphical object based on screen size - half frame resolution in both horizontal and vertical, vertical only, horizontal only
scaling_pref	Bslbf	preference for scaling if object ratio does not match display ratio
target_background_grid	Bslbf	Target background grid
vertical_position	Uimsbf	Vertical offset between the top left corner of the object and the top left corner of the grid
vertical_size	Uimsbf	Number of pixels of the frame in the vertical direction
GraphicData	ObjRef	Graphics data file

11.3.2.13 Java Object

Property	*Type*	*Value*
ObjID	ObjClass	Java Object
Length	long	The length of the Java object, in bytes
Client_server	bslbf	Indication of whether the Java executable represents client or server code
JavaData	ObjRef	Java data file

11.3.2.14 MHEG-5 Object

Property	*Type*	*Value*
ObjID	ObjClass	MHEG-5 Object
Length	Long	The length of the MHEG-5 object, in bytes
MHEGData	ObjRef	MHEG-5 data file

11.3.2.15 Private Object

Property	*Type*	*Value*
ObjID	ObjClass	Private Object
Length	Long	The length of the Private object, in bytes
private_data	Unspecified	User-defined data

11.4 Content Loading Toolset

11.4.1 Scope

This chapter describes the requirements and desired features for content loading from a Content Provider to a Service Provider over the A10 interface. To meet these conditions, we shall choose CMSL (Content Metadata Specification Language) as the content loading toolset, and describe the specification in this chapter.

11.4.2 Toolset requirements

The requirements for the toolset are listed below.

1. Ability to create new CI/CIE Metadata objects based on the Bento Format.
2. Ability to specify the set of Metadata attributes (Bento properties) associated with a particular CI/CIE type (e.g. Text object).
3. Must be Available and complete.
4. Ability to transfer content packages from a Content Provider to a Service Provider over A10 interface.

11.4.3 Toolset features

These are non-essential features of a toolset but should be used as a guide to the sort of functionality required of a toolset for packaging metadata and monomedia components into content packages.

The features can be used as a means of assessing tools against each other. The features are listed in priority order.

1. Support for the toolset.
2. Ability to extend the standard set of attributes defined in DAVIC 1.4.1 to include private attributes.
3. Lightweight content packages (minimum redundant information).
4. Intelligent file transfer mechanism (e.g. doesn't send files twice for different CIs)
5. Platform independent.
6. The components within the toolset should have simple, open and well defined interfaces so that they may interoperate.
7. Easy to use.

8. Metadata batch input function (e.g. creating new CI/CIE Metadata objects by extracting metadata from legacy databases).
9. Metadata validation (e.g. List of Values).
10. Ability to test the content (metadata and monomedia components) for completeness (against the specified set) and correctness of attribute values.

11.4.4 Toolset Specifications

A content specification is essentially a template from which instances of a particular CI or CIE type can be built, both in terms of its physical characteristics and its metadata requirements. For example, there may exist a specification for a Movie offering and an instance of it would be the 'Star Wars' movie. Only when specific values are assigned, is an instance of a content specification created. In this respect it is similar to a class in Object Oriented Technology, however, the specifications have additional parameters to define default values, constraints etc.

11.4.4.1 CI/CIE Relationships and Components

Relationships identify and define the links between a CI or CIE and its components. For example a Movie CI type may have an 'Actors' attribute assigned to it which could take several values i.e. there is a one to many relationship between the CI and its 'Actors' attribute. Alternatively a Movie package may contain several 'Movie' offerings for which there would be a one to many relationship. Some of these relationships may be mandatory and others optional.

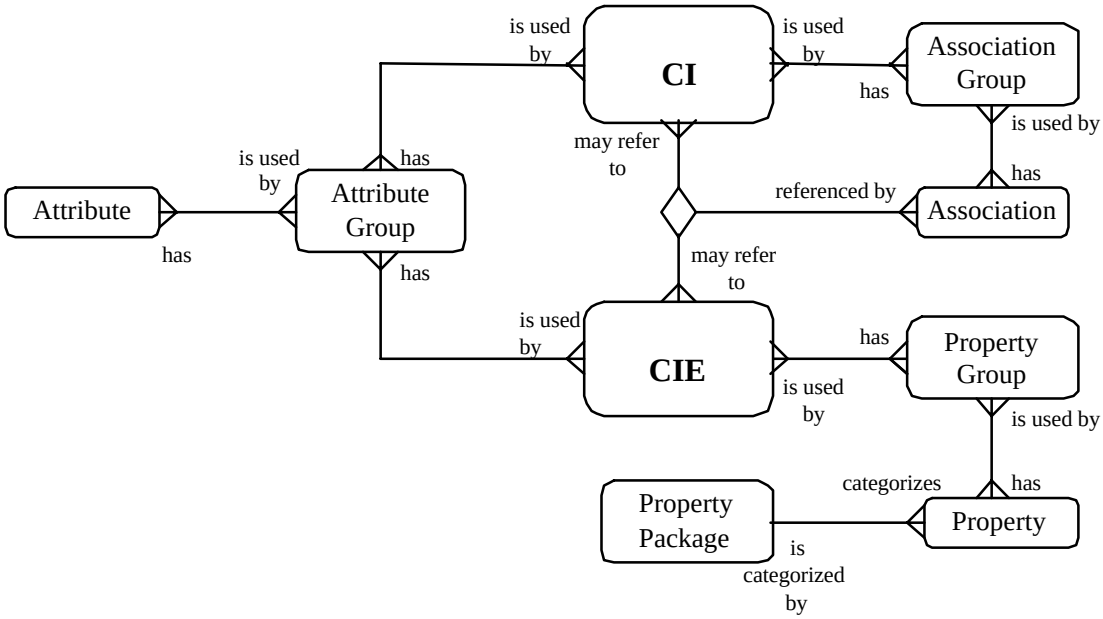


Figure 11-5. Entity Relationship Diagram

The diagram in Figure 11.5 shows the different relationship types required to specify CI/CIE's in the toolset.

Attributes - These are used to describe characteristics of a specific CI/CIE metadata. For example a 'Movie' offering may use 'Actor', 'Rating' and 'Genre' attributes. Alternatively a home shopping application may include a 'Shoes' offering which may use a 'Style' attribute. Within a CI or CIE , attributes are generic, mandatory or optional. The complete list of mandatory and optional attributes can be found in Part 9, Section 11.2.3.2 and 11.2.3.3. Private attributes can also be defined.

Properties - Physical media is built to a set of media properties e.g. a JPEG image must be built with a size of 200x200. Properties are not required as metadata by a target Service. They are for use by the CP only.

Attribute Groups - These are used to group together related metadata attributes. By default, all attributes declared in the group must be considered mandatory unless stated otherwise.

Property Groups - These are used to declare media property values from a set of media properties declared in a Property Package.

Property Packages - These are sets of properties that can be used in a property group. A property package declares all the properties that may be used within a property group. A property group always contains a subset of the properties held in a property package.

Association - A CI or CIE may be a required or optional component of a CI. In some cases the context of the relationship may be important as e.g. “help”, “background”, “reference”, etc.

Association Groups - A Relationship between a CI and CIE (or another CI) is declared in an Association Group.

CIE - This defines the specification that the actual physical CIE media should be built to by the included set of Property Groups. Any metadata required by the CIE is defined by the included set Attribute Groups.

CI - This defines any associated CIs and CIEs by the included set of Association Groups. Any attributes required by the CI are defined by the included set of Attribute Groups.

11.4.4.2 Specifying Relationships and Components using CMSL

Content Metadata Specification Language (CMSL) is a means of defining media and metadata specifications in an open and standardised language format, offering complete re-usability, flexibility and portability. The CMSL language consists of a number of major syntactic constructs, each of which is enclosed with its own unique keyword and common end marker e.g. :

CI_SPEC

…

END

Within the bounds of a keyword / End marker, other CMSL constructs and keywords can be declared in accordance with the syntactic rules of the language. In some cases parameters can be added to define maximum / minimum values, default values, optional values, number of duplicate occurrences, etc.

As in many languages comments may be included in the code by preceding them with two forward slashes ‘//’.

11.4.4.3 CMSL Language Specification

The full specification of the CMSL language, using Backus-Naur Format (BNF), can be found in Part 9 Annex O. CMSL is currently at Draft Version 2.0. It is anticipated that a new Version 3.0 will be produced this year which will have a modified entity-relationship model. These modifications will be small but nevertheless significant. A CMSL Example used to define a simple Movie Offering can be found in Part 9 Annex P.

11.4.5 Content Loading by CMSL

A CI/CIE CMSL specification must not be thought of as an instance of an actual CI/CIE. It defines the attribute names and associations of the CI/CIE together with any value constraints, not the actual values. However, using the same entity-relationship model as CMSL a set of generic class definitions can be defined, based on the same major constructs in CMSL but requiring additional elements for instantiation. So, by interpreting a CI/CIE CMSL specification, a CI/CIE object of a particular type can be created and then populated with (meaningful) metadata.

Instantiated CI/CIE’s cannot be loaded directly into a Bento file container. They must first of all be encoded into Bento Object format using the Bento API. Similarly, they can only be extracted from the Bento container after decoding.

Annex A
Coding of Outline Fonts

(This annex forms an integral part of this Specification.)

A.1 Font Format Specification

The scaleable outline format representation will be referred to as a Portable font resource (PFR) that can be stored statically in ROM or hard disks, or moved dynamically within a DAVIC network. This dynamic aspect is the reason the font resource is often referred to as portable. The file representation of the PFR is designed with two, sometimes conflicting, goals in mind. One is to minimize the size of the file representation; the other is to provide the information in a way that optimizes rendering performance even if the amount of memory is limited at playback time.

A Portable Font Resource consists of the following sections in order:

PFR header

Logical font directory

Logical font section

Physical font section

Glyph program strings

PFR trailer

The PFR header contains global information about the PFR and the fonts contained within it.

The logical font directory consists of a table of pointers to the logical fonts contained within the PFR.

The logical font section contains the logical font records themselves. Each logical font record defines the transformation (size, oblique effect, condense, expand) to be applied to a physical font. It therefore represents an instance of a physical font.

The physical font section consists of a set of physical font records. Each physical font records contains information about one physical font contained within the PFR including a table of character codes defined for that physical font. A physical font record may optionally be immediately followed by bitmap size and bitmap character table records associated with that physical font.

The glyph program strings section contains the definition of the shapes of each of the characters defined within the font. Both outline and bitmap image shapes are defined by glyph program strings. Glyph program strings are shared across all physical fonts within a PFR

All integers are written most significant bit first.

All offsets except those in glyph program strings are relative to the first byte of the portable font resource.

All offsets within glyph program strings are relative to the first byte of the first glyph program string.

Many of the concepts used in this specification are based on the Adobe Type 1 font format version 1.1 (Addison-Wesley Publishing Company, Inc. 1991).

A.2 PFR Header

The PFR header is the first block of data in a Portable Font Resource. It contains global information about the PFR and its constituent fonts.

The size of the PFR header is a fixed 58 bytes. Its structure is as follows:

Table A-1. PFR Header

Syntax	Number of bits	Mnemonic
`pfrHeader() {`		

```
pfrHeaderSig                                    32      bslbf
pfrVersion              16                    uimsbf
pfrHeaderSig2                                   16      bslbf
pfrHeaderSize                                   16     uimsbf
logFontDirSize                                  16     uimsbf
logFontDirOffset                                16     uimsbf
logFontMaxSize                                  16     uimsbf
logFontSectionSize                              24     uimsbf
logFontSectionOffset                            24     uimsbf
physFontMaxSize         16                    uimsbf
physFontSectionSize                             24     uimsbf
physFontSectionOffset                           24     uimsbf
gpsMaxSize              16                    uimsbf
gpsSectionSize                                  24     uimsbf
gpsSectionOffset                                24     uimsbf
maxBlueValues                                    8     uimsbf
maxXorus                8                     uimsbf
maxYorus                8                     uimsbf
physFontMaxSizeHighByte 8                     uimsbf
zeros                   6                      bslbf
pfrInvertBitmap                                  1      bslbf
pfrBlackPixel                                    1      bslbf
bctMaxSize              24                    uimsbf
bctSetMaxSize                                   24     uimsbf
pftBctSetMaxSize        24                    uimsbf
nPhysFonts              16                    uimsbf
maxStemSnapVsize        8                     uimsbf
maxStemSnapHsize        8                     uimsbf
maxChars                16                    uimsbf
}
```

pfrHeaderSig: A byte string which indicates the file type and format. This field shall be set to the constant value 0x50465230 representing the ASCII string “PFR0”.

pfrVersion: An unsigned integer indicating the PFR format version number. This field shall be set to the value 4.

pfrHeaderSig2: A byte string which further confirms the integrity of the PFR. This field shall be set to the constant value 0x0d0a representing the ASCII characters carriage return and line feed.

pfrHeaderSize: An unsigned integer indicating the number of bytes in the PFR header. This field shall be set to the constant value 58.

logFontDirSize: An unsigned integer indicating the total size of the logical font directory in bytes.

logFontDirOffset: An unsigned integer indicating the byte offset of the first byte of the logical font directory relative to the first byte of the PFR header.

logFontMaxSize: An unsigned integer indicating the size in bytes of the largest logical font record. This may be used to allocate a buffer capable of holding any logical font record.

logFontSectionSize: An unsigned integer indicating the size in bytes of the entire set of logical font records. This may be used to allocate a buffer capable of holding the entire logical font section.

logFontSectionOffset: An unsigned integer indicating the byte offset of the first byte of the first logical font record in the logical font section. The offset is relative to the first byte of the PFR header.

physFontMaxSize: An unsigned integer indicating the size in bytes of the largest physical font record. This may be used to allocate a buffer capable of holding any physical font record.

physFontSectionSize: An unsigned integer indicating the size in bytes of the entire set of physical font records. This may be used to allocate a buffer capable of holding the entire physical font section.

physFontSectionOffset: An unsigned integer indicating the byte offset of the first byte of the first physical font in the physical font section. The offset is relative to the first byte of the PFR header.

gpsMaxSize: An unsigned integer indicating the size in bytes of the largest glyph program string. In the case of compound glyphs, the size must include the total size of its component glyphs. This may be used to allocate a buffer capable of holding any glyph program string.

gpsSectionSize: An unsigned integer indicating the size in bytes of the entire set of glyph program strings. This may be used to allocate a buffer capable of holding the entire set of glyph program strings.

gpsSectionOffset: An unsigned integer indicating the byte offset to the first byte of the first glyph program string in the glyph program string section. The offset is relative to the first byte of the PFR header.

maxBlueValues: An unsigned integer indicating the maximum number of vertical alignment zones defined in any physical font record.

maxXorus: An unsigned integer indicating the maximum number of controlled X coordinates in any glyph program string. The number of controlled X coordinates in a glyph program string includes primary stroke edges, secondary stroke edges and secondary edges.

maxYorus: An unsigned integer indicating the maximum number of controlled Y coordinates in any glyph program string. The number of controlled Y coordinates in a glyph program string includes primary stroke edges, secondary stroke edges and secondary edges.

physFontMaxSizeHighByte: An unsigned number indicating the number of times 65536 should be added to the specified value of physFontMaxSize. This provides a means of handling physical font records whose size exceeds 64K bytes.

zeros: A concatenation of bits that shall all be set to zero.

pfrInvertBitmap: A bit flag that indicates, if set, that image data in bitmap glyph program strings is stored in decreasing order of Y value.

pfrBlackPixel: A bit flag that indicates the bit value used to represent black in image data contained in bitmap glyph program strings.

bctMaxSize: An unsigned integer that indicates the maximum size in bytes of any bitmap character table in any physical font record. This may be used to allocate a buffer capable of holding any bitmap character table.

bctSetMaxSize: An unsigned integer that indicates the maximum size in bytes of any complete set of bitmap character tables in any physical font. This may be used to allocate a buffer capable of holding the set of bitmap character tables for any physical font.

pftBctSetMaxSize: An unsigned integer that indicates the maximum size in bytes of any physical font record together with all of the bitmap character tables associated with it. This may be used to allocate a buffer capable of holding any physical font record and its associated bitmap character tables.

nPhysFonts: An unsigned integer that indicates the number of physical font records in the physical font section.

maxStemSnapVsize: An unsigned integer that indicates the number of values contained in the largest vertical stem snap table in any physical font record.

maxStemSnapHsize: An unsigned integer that indicates the number of values contained in the largest horizontal stem snap table in any physical font record.

maxChars: An unsigned integer that indicates the maximum number of characters in any of the physical font records.

A.3 Logical font directory

The logical font directory consists of a table of pointers to all of the logical font records contained with the PFR. The table is indexed by the logical font code. The structure of the logical font directory is as follows.

Table A-2. Logical Font Directory

Syntax	Number of bits	Mnemonic
logFontDir() {		
nLogFonts 16		uimsbf
for (i = 0; i < nLogFonts; i++){		
logFontSize 16		uimsbf
logFontOffset 24		uimsbf
}		
}		

nLogFonts: An unsigned integer indicating the total number of logical fonts contained in the logical font directory.

logFontSize: An unsigned integer indicating the size in bytes of one logical font record.

logFontOffset: An unsigned integer indicating the byte offset to the first byte of that logical font record. The offset is relative to the first byte of the PFR header.

A.4 Logical font section

The logical font section consists of zero or more logical font records. Each logical record contains information about one logical font. It is accessed via the logFontOffset value in the appropriate entry in the logical font directory. The structure of the logical font section is as follows.

Table A-3. Logical Font Section

Syntax	Number of bits	Mnemonic
logFontSection() {		
for (i = 0; i < nLogFonts; i++){		
logFontRecord()		
}		
}		

The structure of each logical font record is as follows.

Table A-4. Logical Font Record

Syntax	Number of bits	Mnemonic
logFontRecord() {		
fontMatrix[0]	24	tcimsbf
fontMatrix[1]	24	tcimsbf
fontMatrix[2]	24	tcimsbf
fontMatrix[3]	24	tcimsbf
zero 1	bslbf	
extraItemsPresent	1	bslbf
twoByteBoldThicknessValue	1	bslbf
boldFlag	1	bslbf
twoByteStrokeThicknessValue	1	bslbf
strokeFlag 1	bslbf	
lineJoinType	2	bslbf
if (strokeFlag){		
if (twoByteStrokeThicknessValue)		
strokeThickness 16 tcimsbf		
else		
strokeThickness 8 uimsbf		
if (lineJoinType == MITERLINEJOIN)		
miterLimit 24 tcimsbf		
}		
else if (boldFlag){		
if (twoByteBoldThicknessValue)		
boldThickness 16 tcimsbf		
else		
boldThickness 8 uimsbf		
}		
if (extraItemsPresent){		
nExtraItems 8 uimsbf		
for (i = 0; i < nExtraItems; i++){		
extraItemSize 8 uimsbf		
extraItemType 8 uimsbf		
for (j = 0; j < extraItemSize; j++){		
extraItemData 8 uimsbf		
}		
}		
}		
physFontSize	16	uimsbf
physFontOffset	24	uimsbf
if (pfrHeader.physFontMaxSizeHighByte){		

```
physFontSizeIncrement   8                                   uimsbf
}
}
```

fontMatrix[]: An array of four signed integers representing the coefficients of the transformation matrix (in units of 1/256) from the font's coordinate system to the document coordinate system. The defined transformation is:

x' = (fontMatrix[0] * x + fontMatrix[2] * y) / (256 * outlineResolution)

y' = (fontMatrix[1] * x + fontMatrix[3] * y) / (256 * outlineResolution)

where (x, y) is a point in the character outline resolution unit coordinate system, outlineResolution is the resolution of the associated physical font and (x', y') is the corresponding point in the (scaled) logical font.

zero: A bit flag that shall be set to zero.

extraItemsPresent: A bit flag that indicates that the logical font contains extra data items. This should be set to zero for the current version as no extra item types are defined for logical font records.

twoByteBoldThicknessValue: A bit flag that indicates that the bold thickness value is expressed as a signed 16-bit integer rather than as an unsigned 8-bit integer.

boldFlag: A bit flag that indicates that emboldening should be enabled when rendering this logical font.

twoByteStrokeThicknessValue: A bit flag that indicates that the stroke thickness value is expressed as a signed 16-bit integer rather than as an unsigned 8-bit integer.

strokeFlag: A bit flag that indicates that this logical font should be rendered by drawing a stroke with the specified thickness around the outline rather than by conventionally filling the interior of the outline. Note that if this flag is set, it overrides the bold flag.

lineJoinType: A two-bit field that indicates how convex corners should be handled during stroked rendering. Its values are the standard PostScript definitions:

0: MITER_LINE_JOIN

1: ROUND_LINE_JOIN

2: BEVEL_LINE_JOIN

3: Undefined

strokeThickness: This is a signed integer that indicates the thickness of the stroke to be used to render the character in stroke mode. The units are character coordinates (outline resolution units). If twoByteStrokeThicknessValue is equal to zero, this value is represented by an unsigned 8-bit field. If twoByteStrokeThicknessValue is equal to one, this value is represented by an signed 16-bit field. The effect of using a negative value for stroke thickness is undefined.

miterLimit: A signed integer representing the limit beyond which mitered corners should be rendered as beveled corners. It is represented by the standard PostScript value for miterLimit. The value represents the maximum value of the miter ratio for any mitered corner in units of 1/65536. The miter ratio is the distance of the mitered corner from the outline corner divided by half the bold or stroke thickness.

boldThickness: This is a signed integer that indicates the total amount by which rendered characters should be emboldened. The units are character coordinates (outline resolution units). Thus, for example, a 100 by 200 square emboldened by 10 units would be rendered as if the square were 110 by 210 character units. If twoByteBoldThicknessValue is equal to zero, this value is represented by an unsigned 8-bit field. If twoByteBoldThicknessValue is equal to one, this value is represented by an signed 16-bit field. A negative value for boldThickness may be used to specify a reduced boldness for a character. This should be used with caution as an excessively negative value for boldThickness can cause thin parts of a character shape to turn inside out.

nExtraItems: An unsigned integer that indicates the number of extra data items present. Extra data items added to a logical font contain data that will be ignored by earlier versions of the PFR interpreter and used by later versions of the PFR interpreter.

extraItemSize: An unsigned integer indicating the size in bytes of one extra data item. The size includes only the extra item data following the extraItemType field.

extraItemType: An unsigned integer indicating the type of extra item data present. No extra data item types have been defined for logical font records at this time.

extraItemData: One byte of extra item data. This data is interpreted in accordance with the extraItemType defined for logical font records. All undefined extra item types will be ignored.

physFontSize: An unsigned integer that defines the size in bytes of the associated physical font record.

physFontOffset: An unsigned integer that defines the offset in bytes of the first byte of the associated physical font record. The offset is relative to the first byte of the PFR header.

physFontSizeIncrement: An unsigned integer that allows physical font sizes in excess of 64K bytes to be supported. If the physFontMaxSizeHighByte field in the PFR header is non-zero, the value of physFontSizeIncrement is multiplied by 65535 and added to physFontSize. In other words, it provides a high byte for the physical font size.

A.5 Physical font record

The physical font section contains information about each of the physical fonts contained in the PFR. Each physical font is represented by a physical font record containing information about one physical font. It is accessed via the physFontOffset value in the parent logical font record. In the case that bitmaps are associated with a physical font, the bitmap size records and bitmap character tables appear immediately following the parent physical font. The structure of the physical font section is as follows.

Table A-5. Physical Font Section

Syntax	Number of bits	Mnemonic
physFontSection() {		
for (i = 0; i < nPhysFonts; i++)		
{		
physFontRecord()		
}		
}		

The structure of each physical font record in the physical font section is as follows.

Table A-6. Physical Font Record

Syntax	Number of bits	Mnemonic
physFontRecord() {		
fontRefNumber	16	uimsbf
outlineResolution	16	uimsbf
metricsResolution	16	uimsbf
xMin	16	tcimsbf
yMin	16	tcimsbf
xMax	16	tcimsbf
yMax	16	tcimsbf
extraItemsPresent	1	bslbf
zero	1	bslbf
threeByteGpsOffset	1	bslbf
twoByteGpsSize	1	bslbf
asciiCodeSpecified	1	bslbf
proportionalEscapement	1	bslbf
twoByteCharCode	1	bslbf
verticalEscapement	1	bslbf
if (!proportionalEscapement)		
standardSetWidth	16	tcimsbf
if (extraItemsPresent){		
nExtraItems	8	uimsbf
for (i = 0; i < nExtraItems; i++){		
extraItemSize	8	uimsbf
extraItemType	8	uimsbf
switch(extraItemType){		
case 1:		
bitmapInfo()		
break;		
case 2:		
fontID()		

```
break;
case 3:
stemSnapTables()
break;
default:
for (j = 0; j < extraItemSize; j++){
extraItemData     8     uimsbf
}
break;
}
}
}
nAuxBytes                              24                uimsbf
for(I=0; I<nAuxBytes; I++)
{
auxData                                8                 uimsbf
}
nBlueValues                            8                 uimsbf
for(i = 0; i < nBlueValues; i++)
{
blueValue[i]                           16               tcimsbf
}
blueFuzz                               8                 uimsbf
blueScale                              8                 uimsbf
stdVW                                  16                uimsbf
stdHW                                  16                uimsbf
nCharacters                            16                uimsbf
for (i = 0; i < nCharacters; i++)
{
charRecord()
}
```

fontRefNumber: An unsigned integer that uniquely defines the physical font record within the PFR. Conventionally, physical fonts are numbered in sequence starting at 0.

outlineResolution: A signed integer that defines the resolution of the coordinate system of the character outlines. The value represents the number of units in one em.

metricsResolution; A signed integer that defines the resolution of the coordinate system of the character set width values. The value represents the number of units in one em.

xMin: A signed integer whose value is the smallest value of any X-coordinate of any point in the outline representation of any character in the physical font.

yMin: A signed integer whose value is the smallest value of any Y-coordinate of any point in the outline representation of any character in the physical font.

xMax: A signed integer whose value is the largest value of any X-coordinate of any point in the outline representation of any character in the physical font.

yMax: A signed integer whose value is the largest value of any Y-coordinate of any point in the outline representation of any character in the physical font.

extraItemsPresent: A bit flag that indicates that the physical font contains extra data items. This field is normally set to one because the fontID extra item is required to be present.

zero: A bit flag that shall be set to zero.

threeByteGpsOffset: A bit flag that indicates that the value of gpsOffset is represented by a three-byte rather than by a two-byte integer.

twoByteGpsSize: A bit flag that indicates that the value of gpsSize is represented by a two-byte rather than by a single-byte integer.

asciiCodeSpecified: Obsolete; set to zero.

proportionalEscapement: A bit flag that indicates that the set width is specified for each character rather than for all characters.

twoByteCharCode: A bit flag that indicates that the value of charCode is represented by a two-byte rather than by a single byte integer.

verticalEscapement: A bit flag that indicates that set width value should be interpreted as a vertical rather than horizontal escapement value.

standardSetWidth: A signed integer whose value is the set width of all characters in the font.

nExtraItems: An unsigned integer that indicates the number of extra data items present. Extra data items added to a logical font contain data that will be ignored by earlier versions of the PFR interpreter and used by later versions of the PFR interpreter. This field normally has a value of at least one because the fontID extra item is required in the current version.

extraItemSize: An unsigned integer indicating the size in bytes of one extra data item. The size includes only the extra item data following the extraItemType field.

extraItemType: An unsigned integer indicating the type of extra item data present. Three extra data item types (values 1 - 3) have been defined for physical font records.

extraItemData: One byte of extra item data. This data is interpreted in accordance with the values of extraItemType defined for physical font records. All undefined extra item types will be ignored.

nAuxBytes: An unsigned integer defining the number of bytes of auxiliary data that follow.

auxData: nAuxBytes bytes of arbitrary data.

nBlueValues: An unsigned integer defining the number of vertical alignment edges. The number of alignment edges shall always be an even number.

blueValue: A signed integer defining the Y-coordinate of one edge of a blue zone. The contained blue values must be in ascending order. Each succeeding pair of blue values defines one blue zone. See the Adobe Type 1 Font Format specification for details on the effect of defining blue zones.

blueFuzz: An unsigned integer defining the value of blueFuzz. See the Adobe Type 1 Font Format specification for details on the effect of this value.

blueScale: An unsigned integer defining the value of blueScale See the Adobe Type 1 Font Format specification for details on the effect of this value.

stdVW: An unsigned integer defining the value of stdVW See the Adobe Type 1 Font Format specification for details on the effect of this value.

stdHW: An unsigned integer defining the value of stdHW See the Adobe Type 1 Font Format specification for details on the effect of this value.

nCharacters: An unsigned integer defining the number of character records present. Character records following this field must be in ascending order of charCode.

The format of each character record is as follows.

Table A-7. Character Record

Syntax	Number of bits	Mnemonic
charRecord() {		
if (twoByteCharCode)		
charCode	16	uimsbf
else		
charCode	8	uimsbf
if (proportionalEscapement)		
charSetWidth	16	tcimsbf
if (asciiCodeSpecified)		
asciiCodeValue	8	uimsbf
if (twoByteGpsSize)		
gpsSize	16	uimsbf
else		
gpsSize	8	uimsbf
if (threeByteGpsOffset)		
gpsOffset	24	uimsbf
else		

```
gpsOffset                16uimsbf
}
```

charCode: An unsigned integer defining the character code value.

charSetWidth: A signed integer defining the set width of the character. This determines the horizontal or vertical distance from the origin of the current character to the origin of the immediately following character.

asciiCodeValue: This field if present should be ignored.

gpsSize: An unsigned integer indicating the size in bytes of the glyph program string containing the outline representation of the character.

gpsOffset: An unsigned integer indicating the byte offset of the first byte of the glyph program string containing the outline representation of the character. The offset is relative to the first byte of the first glyph program string in the glyph program string section of the PFR.

A.5.1 Bitmap Information

Optional bitmap information, contained in one or more extra data items in a physical font record, associates a set of bitmap character tables with that physical font record. These bitmap character tables must be written immediately following the parent physical font record. As these bitmap character tables are individually accessed via bitmap size records their order is arbitrary. Each bitmap character table contains bitmap character records for a single bitmap size. Bitmap size is measured in pixels per em. The horizontal size of a bitmap image may be different from its vertical size. The bitmap information record consists of a header followed by one or more bitmap size records. The structure of the bitmap information record is as follows.

Table A-8. Bitmap Information Extra Data Item

Syntax	Number of bits	Mnemonic
bitmapInfo() {		
fontBctSize 24	tcimsbf	
zeros 3	bslbf	
twoByteNBmapChars 1	bslbf	
threeByteBctOffset	1	bslbf
threeByteBctSize	1	bslbf
twoByteYppm 1	bslbf	
twoByteXppm 1	bslbf	
nBitmapSizes	8	uimsbf
for (i = 0; i < nBitmapSizes; i++){		
bmapSizeRecord()		
}		
}		

fontBctSize: A signed integer that represents the total size in bytes of all bitmap character tables associated with this physical font record. Note that if there are multiple bitmap information records associated with a physical font record, all must have the same value of fontBctSize.

zeros: A concatenation of bits that shall all be set to zero.

twoByteNBmapChars: A bit flag that is set to indicate that the nBmapChars field in each bitmap size record within this bitmap information record is represented by two bytes rather than by a single byte field.

threeByteBctOffset: A bit flag that is set to indicate that the bctOffset field in each bitmap size record within this bitmap information record is represented by three bytes rather than by a two byte field.

threeByteBctSize: A bit flag that is set to indicate that the bctSize field in each bitmap size record within this bitmap information record is represented by three bytes rather than by a two byte field.

twoByteYppm: A bit flag that is set to indicate that the yppm field in each bitmap size record within this bitmap information record is represented by two bytes rather than by a single byte field.

twoByteXppm: A bit flag that is set to indicate that the xppm field in each bitmap size record within this bitmap information record is represented by a two bytes rather than by a single byte field.

nBitmapSizes: An unsigned integer indicating the number of bitmap size records that appear in the remainder of the bitmap information record.

The number of bitmap size records that can fit in one extra data item is limited by the 256 byte limit on the total size of any extra data item. Multiple extra data items may be used to get around this limitation. Each bitmap size record contains information about one bitmap character table. Within each extra data item, bitmap size records must be in ascending order of Y pixels per em (X pixels per em is a secondary sort key in the event of duplicate values of Y pixels per em). The format of each bitmap size record is as follows.

Table A-9. Bitmap Size Record

Syntax		Number of bits	Mnemonic
bmapSizeRecord() {			
if (twoByteXppm)			
xppm	16uimsbf		
else			
xppm	8uimsbf		
if (twoByteYppm)			
yppm	16uimsbf		
else			
yppm	8uimsbf		
zeros	5	bslbf	
threeByteGpsOffset		1	bslbf
twoByteGpsSize		1	bslbf
twoByteCharCode	1	bslbf	
if (threeByteBctSize)			
bctSize	24	uimsbf	
else			
bctsize	16	uimsbf	
if (threeByteBctOffset)			
bctOffset	24uimsbf		
else			
bctOffset	16uimsbf		
if (twoByteNBmapChars)			
nBmapChars	16uimsbf		
else			
nBmapChars	8uimsbf		
}			

xppm: An unsigned integer that represents the number of pixels per em in the X dimension

yppm: An unsigned integer that represents the number of pixels per em in the Y dimension

zeros: A concatenation of bits that shall all be set to zero.

threeByteGpsOffset: A bit flag that is set to indicate that the value of gpsOffset is represented by a three-byte rather than by a two-byte integer.

twoByteGpsSize: A bit flag that is set to indicate that the value of gpsSize is represented by a two-byte integer rather than by a single-byte integer.

twoByteCharCode: A bit flag that is set to indicate that the value of charCode is represented by a two-byte flag rather than by a single-byte flag.

bctSize: An unsigned integer that represents the total size in bytes of the bitmap character table for the specified values of xppm and yppm.

bctOffset: An unsigned integer that represents the offset in bytes of the first byte of the bitmap character table for the specified values of xppm and yppm. The offset is relative to the first byte of the parent physical font record.

nBmapChars: An unsigned integer indicating the number of bitmap character records provided in the bitmap character table.

A.5.2 Font ID

The font ID provides a means of uniquely identifying the physical font. It is structured as a type 2 extra data item for physical font records. Its data consists of 1 to 254 non-null bytes followed by a null byte. This extra data item must be present.

The structure of the fontID record is as follows:

Table A-10. Font ID Extra Data Item

Syntax	Number of bits	Mnemonic
fontID() {		
for (i = 0; ; i++){		
character[i]	8	uimsbf
if (character[i] == 0)		
break		
}		
}		

character[]: An unsigned integer representing each character in the name of the physical font. Although the preferred coding system is ASCII, any 8-bit coding system can be used as long as it is consistent with the manner in which the font is referred to.

A.5.3 Stem snap tables

Stem snap tables may be specified to enhance stem weight consistency during rendering by providing values of secondary stem weights (other than the primary values of stdVW and stdHW) which can be used for dynamic stem weight regularization. See the Adobe Type 1 font format specification for details on the behavior of stem snap tables. The vertical stem snap table contains zero or more values of vertical stem sizes measured in character outline resolution units. The horizontal stem snap table contains zero or more values of horizontal stem sizes measured in character outline resolution units. Stem snap tables are structured as a type 3 extra data item for a physical font. The format of the stem snap table data is as follows.

Table A-11. Stem Snap Tables

Syntax	Number of bits	Mnemonic
stemSnapTables() {		
sshSize	4	uimsbf
ssvSize	4	uimsbf
for (i = 0; i < ssvSize; i++){		
stemSnapV[i]	16	tcimsbf
}		
for (i = 0; i < sshSize; i++){		
stemSnapH[i]	16	tcimsbf
}		
}		

The values in each of the stem snap tables (vertical and horizontal) must be in ascending order.

sshSize: An unsigned integer indicating the number of horizontal stem snap values provided.

ssvSize: An unsigned integer indicating the number of vertical stem snap values provided.

stemSnapV: A signed integer representing one secondary vertical stem weight in character outline units.

stemSnapH: A signed integer representing one secondary horizontal stem weight in character outline units.

A.5.4 Bitmap character tables

Bitmap character tables provide a means of finding an optional bitmap image associated with a character code. A bitmap character table consists of a list of character codes and for each character code a pointer to the bitmap glyph program string containing the character image.

Bitmap character tables are written immediately following the physical font record with which they are associated. Each bitmap character table consists of one or more bitmap character records arranged in increasing order of character code.

The format of each bitmap character record in a bitmap character table is as follows.

Table A-12. Bitmap Character Record

Syntax	Number of bits	Mnemonic
bmapCharRecord() {		
if (twoByteCharCode)		
charCode 16uimsbf		
else		
charCode 8uimsbf		
if (twoByteGpsSize)		
gpsSize 16	uimsbf	
else		
gpsSize 8	uimsbf	
if (ThreeByteGpsOffset)		
gpsOffset 24uimsbf		
else		
gpsOffset 16uimsbf		
}		

Note that because twoByteCharCode, twoByteGpsSize and ThreeByteGpsOffset are defined in the parent bitmap size record, they apply to all bitmap character records in a given bitmap character table. This ensures that the size in bytes of every record in a bitmap character table is the same.

charCode: An unsigned integer defining the bitmap character code value.

gpsSize: An unsigned integer indicating the size of the glyph program string containing the bitmap image of the character.

gpsOffset: An unsigned integer indicating the byte offset of the first byte of the glyph program string containing the bitmap image of the character. The offset is relative to the first byte of the first glyph program string in the glyph program string section of the PFR.

A.6 Glyph program strings

Glyph program strings define character shapes and images. There are three kinds of glyph program strings supported:

Simple glyph program strings that encode a scaleable glyph shape

Compound glyph program strings that define a scaleable glyph in terms of one or more simple glyph program strings.

Bitmap glyph program strings that encode a bitmap image.

A.7 Simple glyph program strings

A simple glyph program string defines the shape of a character as zero or more outline contours. The points defining the outline are in character outline resolution units based on the value of outlineResolution in the parent physical font record. The structure of a glyph program string is as follows.

Table A-13. Simple Glyph Program String

Syntax	Number of bits	Mnemonic
simpleGps() {		
isCompoundGlyph 1	bslbf	
zeros 3	bslbf	
extraItemsPresent	1	bslbf
oneByteXYCoordCount	1	bslbf
controlledYCoords 1	bslbf	
controlledXCoords 1	bslbf	
if (oneByteXYCoordCount)		
{		

```
nYorus                          4                       uimsbf
nXorus                          4                       uimsbf
}
else
{
if (controlledXCoords)
{
nXorus                  8uimsbf
}
if (controlledYCoords)
{
nYorus                  8uimsbf
}
}
for (i = 0; i < (nXorus + nYorus); i++)
{
if (i & 7 == 0)
{
twoByteCoord[7]         1bslbf
twoByteCoord[6]         1bslbf
twoByteCoord[5]         1bslbf
twoByteCoord[4]         1bslbf
twoByteCoord[3]         1bslbf
twoByteCoord[2]         1bslbf
twoByteCoord[1]         1bslbf
twoByteCoord[0]         1bslbf
}
if (twoByteCoord[i & 7])
oruValue          16    tcimsbf
else
oruValue          8     uimsbf
}
if (extraItemsPresent)
{
nExtraItems             8uimsbf
for (i = 0; i < nExtraItems; i++){
extraItemSize           8uimsbf
extraItemType           8uimsbf
switch(extraItemType){
case 1:
secondaryStrokeInfo()
break;
case 2:
secondaryEdgeInfo()
break;
default:
for (j = 0; j < extraItemSize, j++){
extraItemData     8     uimsbf
}
break;
}
}
}
do
{
glyphOutlineRecord()
} while (!endGlyph)
}
```

isCompoundGlyph: A bit flag that indicates that the glyph is compound. This flag is always clear for a simple glyph program string.

zeros: A concatenation of bits that shall all be set to zero.

extraItemsPresent: A bit flag that indicates extra data items are present.

oneByteXYCoordCount: A bit flag indicating that the values of nXorus and nYorus are packed into a single byte.

controlledYCoords: A bit flag indicating that there are one or more controlled Y coordinates.

controlledXCoords: A bit flag indicating that there are one or more controlled X coordinates.

nXorus: An unsigned integer indicating the number of controlled X coordinates

nYorus: An unsigned integer indicating the number of controlled Y coordinates.

twoByteCoord[]: A bit flag indicating the format and method of interpreting a controlled coordinate value. If this bit flag is clear, the controlled coordinate value is represented by one byte which is interpreted as an unsigned coordinate value in outline resolution units relative to the preceding coordinate value. In the case of the first controlled coordinate value, the preceding value is deemed to be at the origin. If this bit flag is set, the controlled coordinate value is represented by two bytes whose integer value is interpreted as an absolute signed coordinate value in outline resolution units.

oruValue: A signed integer representing a controlled coordinate value in X or Y. Controlled coordinate values must be in ascending order within each dimension. Controlled X coordinates are listed first, controlled Y coordinates are listed second.

nExtraItems: An unsigned integer that indicates the number of extra data items present. Extra data items added to a simple glyph program string contain data that will be ignored by earlier versions of the PFR interpreter and used by later versions of the PFR interpreter.

extraItemSize: An unsigned integer indicating the size in bytes of one extra data item. The size includes only the extra item data following the extraItemType field.

extraItemType: An unsigned integer indicating the type of extra item data present. Two extra data item types (values 1 - 2) have been defined for simple glyph program strings at this time.

extraItemData: One byte of extra item data. This data is interpreted in accordance with the values of extraItemType defined for simple glyph program strings. All undefined extra item types will be ignored.

secondaryStrokeInfo(): A block of data representing one or more secondary stroke definitions.

secondaryEdgeInfo(): A block of data representing one or more secondary edge definitions.

glyphOutlineRecord(): A block of data representing one segment of an outline definition. Four types of glyph outline records are defined:

moveTo()

lineTo()

curveTo()

endGlyph()

The first glyph record must be a moveTo record. This defines the start point of the first contour. The shape of a contour is defined by a sequence of lineTo and curveTo records in any order. The outline shape defining a contour should not be self-intersecting. Each successive moveTo record terminates the preceding contour and starts a new one. If the end point of the previous contour is not coincident with its start point, the contour is closed as if a lineTo record back to the start point of the contour had been included. The last contour must be terminated by an endGlyph record.

Glyph outline records make use of the concept of an argument format that defines one of four possible formats for specifying an X or Y coordinate. Argument formats have the following meaning:

Table A-14. X - Coordinate Argument Format

Syntax	Number of bits	Mnemonic
xArg(xArgFormat) {		
switch (xArgFormat){		
case 0: xIndex	8	uimsbf
break		
case 1: xValue	16	tcimsbf
break		
case 2: xIncrement	8	tcimsbf
break		
case 3:		

```
}
}
```

xIndex: An unsigned integer representing the index in the controlled X coordinate table at which the value is found. Note that only controlled coordinates representing the edges of primary strokes may be used in this manner.

xValue: A signed integer representing the X coordinate of the point.

xIncrement: A signed integer representing the change in the X coordinate value relative to the X coordinate of the preceding point.

Table A-15. Y - Coordinate Argument Format

Syntax	Number of bits	Mnemonic
yArg(yArgFormat) {		
switch (yArgFormat){		
case 0: yIndex		8
uimsbf		
break		
case 1: yValue		16
tcimsbf		
break		
case 2: yIncrement	8	tcimsbf
break		
case 3:		
}		
}		

yIndex: An unsigned integer representing the index in the controlled Y coordinate table at which the value of the Y coordinate may be found. Note that only controlled coordinates representing the edges of primary horizontal strokes may be used in this manner.

yValue: A signed integer representing the Y coordinate of the point.

yIncrement: A signed integer representing the change in the Y coordinate value relative to the Y coordinate of the preceding point.

A.7.1 MoveTo glyph record

The moveTo glyph record starts a new contour at a specified point.

Its structure is:

Table A-16. Move To Glyph Record

Syntax	Number of bits	Mnemonic
moveTo() {		
moveOp	3	uimsbf
isOutsideContour	1	bslbf
yArgFormat	2	uimsbf
xArgFormat	2	uimsbf
xArg(xArgFormat)		
yArg(yArgFormat)		
}		

moveOp: An unsigned integer constant with value 2; this field provides, together with the subsequent isOutsideContour field, a unique identification of a moveTo glyph record.

isOutsideContour: A bit flag that is set to indicate that the contour is an outside contour whose direction is counterclockwise

yArgFormat: An unsigned integer that defines the encoding format of a Y coordinate value. In the case of the first move in a glyph program string, the preceding Y coordinate value is deemed to have a value of 0.

xArgFormat: An unsigned integer that defines the encoding format of a X coordinate value. In the case of the first move in a glyph program string, the preceding X coordinate value is deemed to have a value of 0.

xArg: The X coordinate of the start point of the contour as defined above.

yArg: The Y coordinate of the start point of the contour as defined above.

A.7.2 LineTo glyph record

The lineTo glyph record continues a contour from the current point in a straight line to a specified point. Its structure is as follows.

Table A-17. Line To Glyph Record

Syntax		Number of bits	Mnemonic
lineTo() {			
lineOp		4	uimsbf
yArgFormat	2	uimsbf	
xArgFormat	2	uimsbf	
xArg(xArgFormat)			
yArg(yArgFormat)			
}			

lineOp: An unsigned integer constant with value 1

yArgFormat: An unsigned integer that defines the encoding format of a Y coordinate value.

xArgFormat: An unsigned integer that defines the encoding format of a X coordinate value.

xArg: The X coordinate of the end point of the line as defined above.

yArg: The Y coordinate of the end point of the line as defined above.

A.7.3 CurveTo glyph record

The curveTo glyph record continues a contour from the current point in a curved outline to a specified point. The shape of the intervening curve is a cubic bezier and is defined by a pair of curve control points. Its structure is as follows.

Table A-18. Curve To Glyph Record

Syntax		Number of bits	Mnemonic
curveTo() {			
curveOp		1	uimsbf
curveDepth	3	uimsbf	
y1ArgFormat	2	uimsbf	
x1ArgFormat	2	uimsbf	
xArg(x1ArgFormat)			
yArg(y1ArgFormat)			
y3ArgFormat	2	uimsbf	
x3ArgFormat	2	uimsbf	
y2ArgFormat	2	uimsbf	
x1ArgFormat	2	uimsbf	
xArg(x2ArgFormat)			
yArg(y2ArgFormat)			
xArg(x3ArgFormat)			
yArg(y3ArgFormat)			
}			

curveOp: An unsigned integer constant with value 1; this field provides, together with the subsequent curveDepth field, a unique identification of a curveTo glyph record.

curveDepth: An unsigned integer indicating the number of recursive subdivisions required to result in a polygonal representation with an error less than one half of an outline resolution unit.

y1ArgFormat: An unsigned integer that defines the encoding format of the Y coordinate of the first curve control point.

x1ArgFormat: An unsigned integer that defines the encoding format of the X coordinate of the first curve control point.

xArg(x1ArgFormat): The X coordinate of the first curve control point.

yArg(y1ArgFormat): The Y coordinate of the first curve control point.

y3ArgFormat: An unsigned integer that defines the encoding format of the Y coordinate of the curve end point.

x3ArgFormat: An unsigned integer that defines the encoding format of the X coordinate of the curve end point.

y2ArgFormat: An unsigned integer that defines the encoding format of the Y coordinate of the second curve control point.

x2ArgFormat: An unsigned integer that defines the encoding format of the X coordinate of the second curve control point.

xArg(x2ArgFormat): The X coordinate of the second curve control point.

yArg(y2ArgFormat): The Y coordinate of the second curve control point.

xArg(x3ArgFormat): The X coordinate of the curve end point.

yArg(y3ArgFormat): The Y coordinate of the curve end point.

A.7.4 EndGlyph record

The endGlyph record terminates a contour with a line back to the start point of the contour. Its structure is as follows.

Table A-19. End Glyph Record

Syntax	Number of bits	Mnemonic
endGlyph() {		
endGlyphOp	8	uimsbf
}		

endGlyphOp: An unsigned integer constant with value 0

A.7.5 Short-form glyph records

In addition to these standard glyph outline records, there are several special-case versions to provide more compact representations of common shapes:

A.7.6 hLineTo glyph record

For horizontal straight lines that end on a X controlled coordinate, the hLineTo glyph outline record is provided. Its structure is as follows.

Table A-20. Horizontal Line To Glyph Outline Record

Syntax	Number of bits	Mnemonic
hLineTo() {		
hLineOp	4	uimsbf
xIndex	4	uimsbf
}		

hLineop: an unsigned integer constant with value 2.

xIndex: an unsigned integer indicating the index into the table of controlled X coordinates at which the X coordinate of the end point of the line is found. The first entry of this table has index value zero.

A.7.7 vLineTo glyph record

For vertical straight lines that end on a controlled X coordinate, the vLineTo glyph outline record is provided. Its structure is as follows.

Table A-21. Vertical Line To Glyph Outline Record

Syntax	Number of bits	Mnemonic
vLineTo() {		
vLineOp	4	uimsbf
yIndex	4	uimsbf
}		

vLineOp: an unsigned integer constant with value 3.

yIndex: an unsigned integer indicating the index into the table of controlled Y coordinates at which the Y coordinate of the end point of the line is found. The first entry of this table has index value zero.

A.7.8 hvCurveTo glyph record

For curves that start in a horizontal direction and end in a vertical direction along a controlled X coordinate, the hvCurveTo glyph outline record is provided. Its structure is as follows.

Table A-22. Horizontal to Vertical Curve Glyph Outline Record

Syntax		Number of bits	Mnemonic
hvCurveTo() {			
hvCurveOp	4	uimsbf	
zero	1	bslbf	
curveDepth	3	uimsbf	
x1Increment	8	tcimsbf	
xIndex		4	uimsbf
y2Increment	8	tcimsbf	
y3Increment	8	tcimsbf	
}			

hvCurveOp: an unsigned integer constant with value 6

zero: A bit flag that shall be set to zero.

curveDepth: An unsigned integer indicating the number of recursive subdivisions required to result in a polygonal representation with an error less than one half of an outline resolution unit.

x1Increment: A signed integer representing the X coordinate of the first curve control point relative to the start point of the curve.

xIndex: an unsigned integer indicating the index into the table of controlled X coordinates at which the X coordinate of the second control point and the end point of the curve is found. The first entry of this table has index value zero.

y2Increment: A signed integer representing the Y coordinate of the second curve control point relative to the first curve control point.

y3Increment: A signed integer representing the Y coordinate of the end point of the curve relative to the second curve control point.

A.7.9 vhCurveTo glyph record

For curves that start in a vertical direction and end in a horizontal direction along a controlled Y coordinate, the vhCurveTo glyph outline record is provided. Its structure is as follows.

Table A-23. Vertical to Horizontal Curve Glyph Outline Record

Syntax	Number of bits	Mnemonic
vhCurveTo() {		

vhCurveOp	4	uimsbf	
zero	1	bslbf	
curveDepth	3	uimsbf	
y1Increment	8	tcimsbf	
x2Increment	8	tcimsbf	
yIndex		4	uimsbf
x3Increment	8	tcimsbf	
}			

vhCurveOp: an unsigned integer constant with value 7.

zero: A bit flag that shall be set to zero.

curveDepth: An unsigned integer indicating the number of recursive subdivisions required to result in a polygonal representation with an error less than one half of an outline resolution unit.

y1Increment: A signed integer representing the Y coordinate of the first curve control point relative to the start point of the curve.

x2Increment: A signed integer representing the X coordinate of the second curve control point relative to the first curve control point.

yIndex: an unsigned integer indicating the index into the table of controlled Y coordinates at which the Y coordinate of the second control point and the end point of the curve is found.

x3Increment: A signed integer representing the X coordinate of the end point of the curve relative to the second curve control point.

A.7.10 Secondary stroke definitions

Primary strokes cannot be mutually overlapping. Secondary strokes that overlap primary strokes may be other secondary strokes that are encoded into secondary stroke information. Secondary strokes that overlap a primary stroke are positioned relative to the primary stroke after the primary stroke has been positioned. Secondary stroke information is structured as a type 1 extra data item. The format for a secondary stroke information is as follows.

Table A-24. Secondary Stroke Information Extra Data Item

Syntax	Number of bits	Mnemonic
secondaryStrokeInfo() {		
nVertSecStrokes	8	uimsbf
for (i = 0; i < nVertSecStrokes; i++){		
leftEdge[i]	16tcimsbf	
rightEdge[i]	16	tcimsbf
}		
nHorizSecStrokes	8	uimsbf
for (i = 0; i < nHorizSecStrokes; i++)		
{		
bottomEdge[i]	16	tcimsbf
topEdge[i]	16tcimsbf	
}		
}		

nVertSecStrokes: An unsigned integer representing the number of secondary vertical strokes defined for the current simple glyph.

leftEdge[]: A signed integer representing the X coordinate of the left edge of a secondary vertical stroke in outline resolution units.

rightEdge[]: A signed integer representing the X coordinate of the right edge of a secondary vertical stroke in outline resolution units.

nHorizSecStrokes: An unsigned integer representing the number of secondary horizontal strokes defined for the current simple glyph.

bottomEdge[]: A signed integer representing the Y coordinate of the lower edge of a secondary horizontal stroke in outline resolution units.

topEdge[]: A signed integer representing the Y coordinate of the upper edge of a secondary horizontal stroke in outline resolution units.

Because the maximum size of a secondary stroke definition item is 255 bytes, the maximum number of secondary strokes that may be defined in one extra data item is 63. Secondary vertical strokes must be in increasing order of their left edge. Secondary horizontal strokes must be in increasing order of their lower edge.

A.7.11 Secondary edge definitions

When the edge of a stroke is represented by a shallow curve or other irregularity, it is often desirable to straighten the outline at small sizes and low resolutions. A secondary edge may be defined relative to any stroke edge (its parent). At small sizes and low resolutions, the secondary edge is snapped to the position of its parent. This has the effect of squeezing outline points between the parent edge and the secondary edge onto the primary edge thus resulting in a locally straightened outline. Either edge of any primary or secondary stroke may have one or two secondary edges associated with it. Two edges allow the squeezing operation to take place from both sides of the parent edge. A secondary edge is a generalization of the flex mechanism used in Type 1 fonts which is restricted to certain specific curve structures. Secondary edges may be used with any shape that should be flattened at small sizes. Secondary edge information is structured as a type 2 extra data item. The format for secondary edge information is as follows.

Table A-25. Secondary Edge Information Extra Data Item

Syntax	Number of bits	Mnemonic
secondaryEdgeInfo() {		
nVertSecEdges	8	uimsbf
for (i = 0; i < nVertSecEdges; i++){		
secEdgeDef()		
}		
nHorizSecEdges	8	uimsbf
for (i = 0; i < nHorizSecEdges; i++){		
secEdgeDef()		
}		
}		

nVertSecEdges: An unsigned integer indicating the number of vertical secondary edge definitions provided.

nHorizSecEdges: An unsigned integer indicating the number of horizontal secondary edge definitions provided.

The briefest format for a secondary edge definition (either horizontal or vertical) is as follows.

Table A-26. Simplified Secondary Edge Definition

Syntax	Number of bits	Mnemonic
secEdgeDef() {		
secEdgeFormat	1	bslbf
deltaIndex 3	uimsbf	
deltaOrus 4	tcimsbf	
}		

secEdgeFormat: A bit flag with a constant value of 0

deltaIndex: An unsigned integer in the range 0 to 7 representing the index of the parent edge relative to the index of the parent edge of the immediately preceding secondary edge. In the case of the first edge in each dimension, deltaIndex is interpreted absolutely as the index of the parent edge.

deltaOrus: A signed integer in the range -8 to +7 representing the position of the secondary edge relative to its parent edge in units of character outline resolution units.

In this format, a standard secondary edge snap threshold of 1 pixel is assumed.

A more general (and longer) format for a secondary edge definition is as follows.

Table A-27. General Secondary Edge Definition

Syntax	Number of bits	Mnemonic
secEdgeDef() {		
secEdgeFormat	1	bslbf
threshFlag	1	bslbf
index	6	uimsbf
if (threshFlag == 0)		
thresh	8	uimsbf
deltaOrus	8	tcimsbf
if (deltaOrus == 0)		
deltaOrus	16	tcimsbf
}		

secEdgeFormat: A bit flag with a constant value of 1

threshFlag: A bit flag that indicates how the threshold value is represented. If set, a standard threshold value of 1 pixel is assumed. If clear, an explicit value is provided.

index: An unsigned integer in the range 0 to 63. A value of zero indicates that the index of the parent coordinate is explicitly specified. Any other value indicates that the index of the parent coordinate is index - 1.

thresh: An unsigned integer representing the threshold at which the secondary edge should be snapped to its parent. The units are 1/16 pixel.

deltaOrus: A signed integer representing the position of the secondary edge relative to its parent in units of character outline resolution units.

A.8 Compound glyph program strings

A compound glyph program string is constructed out of one or more simple glyph program strings. Each of the elements may be independently scaled and positioned in the process of constructing the compound glyph.

The structure of a compound glyph program string is as follows.

Table A-28. Compound Glyph Program String

Syntax	Number of bits	Mnemonic
compoundGps() {		
isCompoundGlyph	1	bslbf
extraItemsPresent	1	bslbf
nElements	6	uimsbf
if (extraItemsPresent)		
{		
nExtraItems	8	uimsbf
for (i = 0; i < nExtraItems; i++)		
{		
extraItemSize	8	uimsbf
extraItemType	8	uimsbf
switch(extraItemType){		
default:		
for (j = 0; j < extraItemSize; j++){		
extraItemData	8	uimsbf
}		
break;		
}		
}		
for (i = 0; i < nElements; i++){		
threeByteGpsOffset	1	bslbf
twoByteGpsSize	1	bslbf
yScalePresent	1	bslbf
xScalePresent	1	bslbf
yPosFormat	2	uimsbf
xPosFormat	2	uimsbf
if (xScalePresent)		

```
xScale                  16    tcimsbf
if (yScalePresent)
yScale                  16    tcimsbf
switch(xPosFormat)
{
case 1: xPos                  16    tcimsbf
break
case 2: xPos                  8     tcimsbf
break
}
switch(yPosFormat)
{
case 1: yPos                  16    tcimsbf
break
case 2: yPos                  8     tcimsbf
break
}
if (twoByteGpsSize)
gpsSize                 16    uimsbf
else
gpsSize                 8     uimsbf
if (threeByteGpsOffset)
gpsOffset         24    uimsbf
else
gpsOffset         16    uimsbf
}
}
}
```

isCompoundGlyph: A bit flag with a constant value to 1 to indicate that the glyph program string should be interpreted as a compound glyph program string.

extraItemsPresent: A bit flag that indicates extra data items are present. This should be set to zero for the current version.

nElements: An unsigned integer indicating the number of elements in the compound character.

nExtraItems: An unsigned integer that indicates the number of extra data items present. Extra data items added to a compound glyph program string contain data that will be ignored by earlier versions of the PFR interpreter and may be used by later versions of the PFR interpreter.

extraItemSize: An unsigned integer indicating the size in bytes of one extra data item. The size includes only the extra item data following the extraItemType field.

extraItemType: An unsigned integer indicating the type of extra item data present. No extra data item types have been defined for compound glyph program strings at this time

extraItemData: One byte of extra item data. This data is interpreted in accordance with the values of extraItemType defined for compound glyph program strings. All undefined extra item types will be ignored.

threeByteGpsOffset: A bit flag that indicates, if set, that the gpsOffset value is defined as a 3-byte integer rather than by 2-byte integer

twoByteGpsSize: A bit flag that indicates, if set, that the value of gpsSize is defined as a 2-byte integer rather than as a single-byte integer.

yScalePresent: A bit flag that indicates, if set, that an explicit value of xScale is defined.

xScalePresent: A bit flag that indicates, if set, that an explicit value of yScale is defined.

yPosFormat: An unsigned integer that indicates how the value of yPos is defined. A value of 1 indicates that it is defined as a 2-byte absolute value; a value of 2 indicates that it is defined as a single-byte value relative to the previous value of yPos; a value of 3 indicates that it is identical to the previous value of yPos.

xPosFormat: An unsigned integer that indicates how the value of xPos is defined. A value of 1 indicates that it is defined as a 2-byte absolute value; a value of 2 indicates that it is defined as a single-byte value relative to the previous value of xPos; a value of 3 indicates that it is identical to the previous value of xPos.

xScale: A signed integer representing the scale factor to be applied to the glyph element in the X dimension. This field is in units of 1/4096.

yScale: A signed integer representing the scale factor to be applied to the glyph element in the Y dimension. This field is in units of 1/4096.

xPos: A signed integer representing the amount by which the glyph element should be shifted in the X dimension. This field is in units of character outline resolution units.

yPos: A signed integer representing the amount by which the glyph element should be shifted in the Y dimension. This field is in units of character outline resolution units.

gpsSize: An unsigned integer representing the size in bytes of the glyph program string defining the glyph element.

gpsOffset: An unsigned integer representing the byte offset of the first byte of the glyph program string that defines the glyph element. The offset is relative to the first byte of the first glyph program string in the glyph program string section.

A.8.1 Bitmap glyph program string

A bitmap glyph program string defines the image of a glyph in the form of a bitmap. Its structure is as follows.

Table A-29. Bitmap Glyph Program String

Syntax			Number of bits	Mnemonic
bitmapGps() {				
imageFormat	2		uimsbf	
escapementFormat	2		uimsbf	
sizeFormat	2		uimsbf	
positionFormat			2	uimsbf
switch(positionFormat)				
{				
case 0:				
xPos	4	tcimsbf		
yPos	4	tcimsbf		
break				
case 1:				
xPos	8	tcimsbf		
yPos	8	tcimsbf		
break				
case 2:				
xPos	16	tcimsbf		
yPos	16	tcimsbf		
break				
case 3:				
xPos	24	tcimsbf		
yPos	24	tcimsbf		
break				
}				
switch(sizeFormat)				
{				
case 0:				
break				
case 1:				
xSize	4	uimsbf		
ySize	4	uimsbf		
break;				
case 2:				
xSize	8	uimsbf		
ySize	8	uimsbf		
break;				
case 3:				
xSize	16	uimsbf		
ySize	16	uimsbf		
break;				
}				

```
switch(escapementFormat)
{
case 0:
break:
case 1:
setWidth          8     tcimsbf
break;
case 2:
setWidth          16    tcimsbf
break;
case 3:
setWidth          24    tcimsbf
break;
}
imageData               variable
}
```

imageFormat: An unsigned integer that indicates how the bitmap image is represented.

A value of 0 indicates that the image is stored directly as a bitmap fully packed with no padding between rows.

A value of 1 indicates that the image is run-length encoded in which each byte specifies the unsigned number of white bits in the most significant 4 bits and the unsigned number of following black bits in the least significant 4 bits. A run of more than 15 bits of the same color is handled by multiple bytes Adjacent rows are encoded together without regard to the end of each row. Trailing white bits must be encoded.

A value of 2 indicates that the image is run-length encoded in which each pair of bytes specifies the unsigned number of white bits in the first byte and the unsigned number of following black bits in the second byte. A run of more than 255 bits of the same color is handled by multiple pairs of bytes. Adjacent rows are encoded together without regard to the end of each row. Trailing white bits must be encoded.

A value of 3 is undefined.

escapementFormat: An unsigned integer that indicates how the escapement value is represented.

A value of 0 indicates that no bitmap escapement data is included and that the linearly scaled outline width should be used without rounding.

A value of 1 indicates that the bitmap escapement is represented by a signed single-byte value in units of whole pixels.

A value of 2 indicates that the bitmap escapement is represented by a signed 2-byte value in units of 1/256 pixels.

A value of 3 indicates that the bitmap escapement is represented by a signed 3-byte value in units of 1/256 pixels.

sizeFormat: An unsigned integer that indicates how the dimensions of the bitmap image are represented.

A value of 0 indicates that that bitmap image is blank and no image data is present.

A value of 1 indicates that the width and the height of the bitmap image are each represented by an unsigned 4-bit value in units of whole pixels.

A value of 2 indicates that the width and the height of the bitmap image are each represented by an unsigned 8-bit value in units of whole pixels.

A value of 3 indicates that the width and the height of the bitmap image are each represented by an unsigned 2-byte value in units of whole pixels.

positionFormat: An unsigned integer that indicates how the (x, y) position of the first pixel in the bitmap image is represented.

A value of 0 indicates that the X and the Y coordinates are each represented by a signed 4-bit value in units of whole pixels.

A value of 1 indicates that the X and the Y coordinates are each represented by a signed single-byte value in units of whole pixels.

A value of 2 indicates that the X and the Y coordinates are each represented by a signed 2-byte value in units of 1/256 pixels.

A value of 3 indicates that the X and the Y coordinates are each represented by a signed 3-byte value in units of 1/256 pixels.

xPos: A signed integer representing the X position of the first pixel in each row of the image. The position is in units of pixels and is relative to the character origin.

yPos: A signed integer representing the Y position of the first row of the image. If the value of pfrInvertBitmap in the PFR header is 0, the position refers to the start of the lowest row of pixels in the character image. If the value of pfrInvertBitmap in the PFR header is 1, the position refers to the start of the highest row of pixels in the character image.

xSize: An unsigned integer representing the width of the bitmap image in pixels.

ySize: An unsigned integer representing the height of the bitmap image in pixels.

setWidth: A signed integer representing the distance in pixels (or 1/256 pixels depending upon the value of escapementFormat) the current rendering position should be moved by prior to imaging the next character. If the value of verticalEscapement in the parent physical font record is 1, the direction of the escapement vector is vertical. Otherwise, it is horizontal.

imageData: This data is interpreted depending upon the value of imageFormat.

A.9 Portable font resource trailer

The PFR trailer block shall be the last block of data in the Portable Font Resource. Its primary use it to facilitate the location of the start of a PFR that ends at the end of a file. Its structure is:

Table A-30. PorTable Font Resource Trailer

Syntax	Number of bits	Mnemonic
pfrTrailer() {		
pfrSize	24	uimsbf
pfrTrailerSig	40	bslbf
}		

pfrSize: An unsigned integer representing the total size of the PFR in bytes.

pfrTrailerSig: A bit pattern used as a PFR trailer signature. It shall have the constant value 0x2450465224 representing the string “PFR”.

A.10 Kerning data

Kerning data for a physical font is stored as one or more extra data items attached to the physical font for which the kerning data applies. Track and pair kerning data are stored in separate ExtraItem types.

A.10.1 Pair Kerning Data

The format of a pair kerning data block is as follows:

Table A-31. Pair Kerning Data

Syntax	Number of bits	Mnemonic

```
pairKernData() {
extraItemSize          8                                uimsbf
extraItemType          8                                uimsbf
nKernPairs             8                                uimsbf
baseAdjustment         16                              tcimsbf
zeros                  6                                 bslbf
twoByteAdjValues       1                                 bslbf
twoByteCharCodes       1                                 bslbf
for (i = 0; i < nKernPairs; i++){
if (twoByteCharCodes) {
charCode1   16    uimsbf
      charCode2   16    uimsbf
}
else {
charCode1   8     uimsbf
charCode2   8     uimsbf
}
if (twoByteAdjustment)
adjustment  16    tcimsbf
else
adjustment  8     uimsbf
}
}
```

extraItemSize: This is the number bytes of data in the extra data item. This does not include the two bytes for the extraItemSize and extraItemType.

extraItemType: This is a constant with a value of 4. It identifies the extra data item as kerning pair data.

nKernPairs: The number of kerning pairs included in the table.

baseAdjustment: The base value of the adjustment, in metrics resolution units, relative to which all adjustment values are encoded. It is primarily intended to facilitate compaction from the use of the single byte adjustment values. A positive value indicates an increased spacing, a negative value a reduced spacing.

zeros: a concatenation of 6 bits all set to zero.

twoByteAdjValues: a bit flag defining how all kerning adjustment values are encoded. A zero indicates that every kerning adjustment value is encoded as a one byte unsigned integer relative to the base adjustment. A one indicates that every kerning adjustment value is encoded as a 2-byte two-complement integer relative to the base adjustment.

twoByteCharCodes: a bit flag defining how all character codes are encoded. A zero indicates that each character code is encoded as an unsigned byte. A one indicates that each character code is encoded as 2-byte unsigned integer.

charCode1: the character code for the left character of each kerning pair.

charCode2: the character code for the right character of each kerning pair.

adjustment: the amount by which the escapement is to be adjusted between the left and right characters of the kerning pair in metrics resolution units. The adjustment is positive to increase the spacing, negative to reduce the spacing. The adjustment is relative to the value of baseAdjustment for the block of kerning data.

The order of the kerning pair records is required to be in increasing order of charCode1. Groups of records with a common value of charCode1 are required to be in increasing order of charCode2.

Because the maximum number of bytes in an extra data item is limited to 255, there is a limit on the number of kerning pairs that may be included in one extra data item. Multiple extra data items may be used to overcome this limit. The order of such multiple items must be in ascending order of character pair codes. This allows the search for a specific character code pair to scan the first entry in each type 4 extra data item to determine which block contains the pair.

A.10.2 Track Kerning Data

The format of a track kerning data block is as follows:

Table A-32. Track Kerning Data

Syntax	Number of bits	Mnemonic
trackKernData() {		
extraItemSize	8	uimsbf
extraItemType	8	uimsbf
nKernTracks	8	uimsbffor (I = 0; i < nKernTracks; i++){
degree	16	uimsbf
minPointSize	16	uimsbf
minAdjust	16	tcimsbf
maxPointSize	16	uimsbf
maxAdjust	16	tcimsbf
}		
}		

extraItemSize: This is the number bytes of data in the extra data item. This does not include the two bytes for the extraItemSize and extraItemType.

extraItemType: This is a constant with a value of 5. It identifies the extra data item as kerning track data.

nKernTracks: The number of track kerning entries.

degree: This identifies the amount of track kerning. Standard values are 1 for light kerning, 2 for medium kerning and 3 for tight kerning. All other values are reserved.

minPointSize: This is the minimum point size at which the track kerning takes place for the current track. Its value is in units of points.

minAdjust: This is the spacing adjustment to be applied between each pair of characters at the minimum point size. Its value is in metrics resolution units. A positive value indicates an increase in spacing; a negative value indicates a decrease in spacing.

maxPointSize: This is the maximum point size at which the track kerning takes place for the current track. Its value is in units of points.

maxAdjust: This is the spacing adjustment to be applied between each pair of characters at the maximum point size. Its value is in metrics resolution units. A positive value indicates an increase in spacing; a negative value indicates a decrease in spacing.

Note : The 255 byte limit on the size of an extra data item is not significant as this allows about 25 kerning tracks to be included.

Annex B
Coding of Linear Audio

(This annex forms an integral part of this Specification.)

B.1 Coding format for Linear Audio

The coding of linear audio in DAVIC 1.4.1 is based on the AIFF-C format. DAVIC 1.4.1 applies the commonly used, more restrictive but AIFF-C compliant format as specified in this Annex. For DAVIC 1.4.1 the Form chunk, Format Version chunk, Extended Common chunk, and the Sound Data chunk shall each appear only once and in the order shown below in a linear audio sample. Any Private chunks shall appear after the required chunks and are not restricted.

Table B-1. Linear audio

Syntax	*Number of bits*	*Mnemonic*
Linear_audio (){		
ckID_FC	32	bslbf
ckSize_FC	32	uimsbf
formType_FC	32	bslbf
Format_Version_Chunk ()		
Extended_Common_Chunk ()		
Sound_Data_Chunk ()		
for (i=N; i<ckSize_FC; i++) {		
Private_Chunk ()		
}		
}		
Format_Version_Chunk(){		
ckID_FVC	32	bslbf
ckSize_FVC	32	uimsbf
version_date	32	uimsbf
}		
Extended_Commom_Chunk(){		
ckID_ECC	32	bslbf
ckSize_ECC	32	uimsbf
numChannels	16	uimsbf
numSampleFrames	32	uimsbf
sampleSize	16	uimsbf

sampleRate	80	fpvsbf
compressionType	32	bslbf
compNameLength	8	uimsbf
compressionName	compNameLength*8	bslbf
if ((compNameLength % 2) == 0){		
compNamePadbyte	8	bslbf
}		
}		
Sound_Data_Chunk(){		
ckID_SDC	32	bslbf
ckSize_SDC	32	uimsbf
offset	32	uimsbf
blockSize	32	uimsbf
for (i=0; i<numSampleFrames; i++){		
for (j=0; j<numChannels; j++){		
sound_data	sampleSize	uimsbf
}		
}		
if (((numChannels % 2)==1) &&		
((numSampleFrames % 2)==1) &&		
(sampleSize==8)){		
pad_byte	8	uimsbf
}		
}		
Private_Chunk (){		
ckID_PC	32	bslbf
ckSize_PC	32	uimsbf
for(i=0; i<ckSize_PC; i++){		
reserved	8	uimsbf
}		
}		

ckID_FC: A byte string which specifies the chunk type as the Form chunk. It is used as a header for the entire linear audio sample. It shall be set to the constant value 0x464F524D, which is the ASCII value for ‘FORM’.

ckSize_FC: An unsigned integer indicating the size (in bytes) of the entire linear audio file after the ckSize_FC field.

formType_FC: A byte string which defines the format of the linear audio file as an AIFF-C file format. This field shall be set to the constant value 0x41494643, which is the ASCII value for ‘AIFC’.

ckID_FVC: A byte string which specifies the chunk type as the Format Version chunk. This field shall be set to the constant value 0x46564552, which is the ASCII value for ‘FVER’.

ckSize_FVC: An unsigned integer indicating the size (in bytes) of the Format Version chunk. This field shall be set to the constant value 0x00000004.

version_date: An unsigned integer indicating the creation date of the AIFF-C version used to code this linear audio file. This field shall be set to the constant value 0xA2805140, which represents the date May 23, 1990, 2:40 PM.

ckID_ECC: A byte string which specifies the chunk type as the Extended Common chunk. This field shall be set to the constant value 0x434F4D4D, which is the ASCII value for ‘COMM’.

ckSize_ECC: An unsigned integer indicating the size (in bytes) of the Extended Common chunk. For DAVIC 1.4.1, this field shall be set to the constant value 0x00000026.

numChannels: An unsigned integer indicating the number of audio channels used in the linear audio sample. This field is restricted to values of 1 or 2 indicating mono or stereo audio, respectively, for DAVIC 1.4.1.

numSampleFrames: An unsigned integer indicating the number of sample frames in the linear audio sample. The total number of sample points is figured numChannels * numSampleFrames.

sampleSize: An unsigned integer indicating the number of bits in each sample point. This field can contain any integer from 1 to 32, but is restricted to values of 8 or 16 for DAVIC 1.4.1.

sampleRate: An 80-bit floating point value indicating the rate at which the sound was sampled. The format of the floating point value is double-extended precision floating point, which includes one sign bit, 15-bit exponent, and 64-bit mantissa according to the IEEE 96-bit floating point representation (using only 15 bits instead of 31 for the exponent). For DAVIC 1.4.1, the only valid sample rates are show in the table below.

Table B-2. Sample rate assignments

Sample Rate	*Hex Representation*
16.000 kHz	0x400CFA00000000000000
22.050 kHz	0x400DAC44000000000000
24.000 kHz	0x400DBB80000000000000
32.000 kHz	0x400DFA00000000000000
44.100 kHz	0x400EAC44000000000000
48.000 kHz	0x400EBB80000000000000

The value is represented with sign bit first. [‘fpvsbf’ stands for ‘floating point value sign bit first’.]

compressionType: A byte string which indicates the type of compression algorithm, if any, used on the sound data. Compression is not used for DAVIC 1.4.1, so this field shall be set to the constant value 0x4E4F4E45, which is the ASCII value for ‘NONE’.

compNameLength: An unsigned integer which indicates the number of ASCII characters used in compressionName.

compressionName: A byte string which contains the compression algorithm ID specified in the compressionType field. Since compression is not used in DAVIC 1.4.1, this field shall be set to the constant value 0x6E6F7420636F70726573736564, which is the ASCII value for ‘not compressed’.

compNamePadbyte: The constant value 0x00 which is inserted if the value of compNameLength is even. DAVIC 1.4.1 requires the pad byte.

ckID_SDC: A byte string which specifies the chunk type as the Sound Data chunk. This field shall be set to the constant value 0x53534E44, which is the ASCII value for ‘SSND’.

ckSize_SDC: An unsigned integer indicating the size (in bytes) of the Sound Data chunk excluding the pad_byte, if included. This value will equal numChannels*numSampleFrames*(sampleSize/8) + 8.

offset: An unsigned integer indicating the offset (in bytes) to the beginning of the first sample frame in the chunk data. For DAVIC 1.4.1, this field shall be set to 0x00000000.

blockSize: An unsigned integer indicating the size (in bytes) of the blocks to which the sound data is aligned. This field is used in conjunction with the offset field for aligning sound data to blocks. For DAVIC 1.4.1, this field shall be set to 0x00000000.

sound_data: A variable bit field representing a linear audio sample point. The width of this field is equal to sampleSize in the Extended_Commom_Chunk. For two channel audio, the sample points are interleaved left channel first, then right.

pad_byte: An unsigned integer with the fixed value of 0x00. A pad_byte shall be included if the number of sound data bytes is odd.

ckID_PC: A byte string which specifies the chunk type as a Private chunk. This field can assume any 4 ASCII characters in the range ‘ ‘ (space character) through ‘~’ (i.e. 0x20 through 0x7E) other than those specified for ckID_FC, ckID_FVC, ckID_ECC, and ckID_SDC. Space (ASCII 0x20) cannot precede printing characters, but trailing spaces are allowed.

ckSize_PC: An unsigned integer indicating the size (in bytes) of the Private chunk.

Note : Support of Linear Audio as a real-time stream in future versions of the DAVIC specifications may require concatenation of objects containing linear audio with a play back duration of up to 0.7 second each.

Annex C
Default CLUT for single bitmaps with compressed graphics

(This annex forms an integral part of this Specification.)

C.1 Default CLUT specification

Table C-1. Default CLUT entries

Transparency Level	Default CLUT entry definition Format : clut[n] = [R, G, B], where n denotes the clut entry, and R,G and B denote the values of the Red, Green and Blue components associated to clut entry		
0 % (fully opaque)	clut[0] = [0, 0, 0]	clut[45] = [63,191, 0]	clut[90] = [191, 95, 0]
	clut[1] = [0, 0,127]	clut[46] = [63,191,127]	clut[91] = [191, 95,127]
	clut[2] = [0, 0,255]	clut[47] = [63,191,255]	clut[92] = [191, 95,255]
	clut[3] = [0, 31, 0]	clut[48] = [63,223, 0]	clut[93] = [191,127, 0]
	clut[4] = [0, 31,127]	clut[49] = [63,223,127]	clut[94] = [191,127,127]
	clut[5] = [0, 31,255]	clut[50] = [63,223,255]	clut[95] = [191,127,255]
	clut[6] = [0, 63, 0]	clut[51] = [63,255, 0]	clut[96] = [191,159, 0]
	clut[7] = [0, 63,127]	clut[52] = [63,255,127]	clut[97] = [191,159,127]
	clut[8] = [0, 63,255]	clut[53] = [63,255,255]	clut[98] = [191,159,255]
	clut[9] = [0, 95, 0]	clut[54] = [127, 0, 0]	clut[99] = [191,191, 0]
	clut[10] = [0, 95,127]	clut[55] = [127, 0,127]	clut[100] = [191,191,127]
	clut[11] = [0, 95,255]	clut[56] = [127, 0,255]	clut[101] = [191,191,255]
	clut[12] = [0,127, 0]	clut[57] = [127, 31, 0]	clut[102] = [191,223, 0]
	clut[13] = [0,127,127]	clut[58] = [127, 31,127]	clut[103] = [191,223,127]
	clut[14] = [0,127,255]	clut[59] = [127, 31,255]	clut[104] = [191,223,255]
	clut[15] = [0,159, 0]	clut[60] = [127, 63, 0]	clut[105] = [191,255, 0]
	clut[16] = [0,159,127]	clut[61] = [127, 63,127]	clut[106] = [191,255,127]
	clut[17] = [0,159,255]	clut[62] = [127, 63,255]	clut[107] = [191,255,255]
	clut[18] = [0,191, 0]	clut[63] = [127, 95, 0]	clut[108] = [255, 0, 0]
	clut[19] = [0,191,127]	clut[64] = [127, 95,127]	clut[109] = [255, 0,127]

	clut[20] = [0,191,255]	clut[65] = [127, 95,255]	clut[110] = [255, 0,255]
	clut[21] = [0,223, 0]	clut[66] = [127,127, 0]	clut[111] = [255, 31, 0]
	clut[22] = [0,223,127]	clut[67] = [127,127,127]	clut[112] = [255, 31,127]
	clut[23] = [0,223,255]	clut[68] = [127,127,255]	clut[113] = [255, 31,255]
	clut[24] = [0,255, 0]	clut[69] = [127,159, 0]	clut[114] = [255, 63, 0]
	clut[25] = [0,255,127]	clut[70] = [127,159,127]	clut[115] = [255, 63,127]
	clut[26] = [0,255,255]	clut[71] = [127,159,255]	clut[116] = [255, 63,255]
	clut[27] = [63, 0, 0]	clut[72] = [127,191, 0]	clut[117] = [255, 95, 0]
	clut[28] = [63, 0,127]	clut[73] = [127,191,127]	clut[118] = [255, 95,127]
	clut[29] = [63, 0,255]	clut[74] = [127,191,255]	clut[119] = [255, 95,255]
	clut[30] = [63, 31, 0]	clut[75] = [127,223, 0]	clut[120] = [255,127, 0]
	clut[31] = [63, 31,127]	clut[76] = [127,223,127]	clut[121] = [255,127,127]
	clut[32] = [63, 31,255]	clut[77] = [127,223,255]	clut[122] = [255,127,255]
	clut[33] = [63, 63, 0]	clut[78] = [127,255, 0]	clut[123] = [255,159, 0]
	clut[34] = [63, 63,127]	clut[79] = [127,255,127]	clut[124] = [255,159,127]
	clut[35] = [63, 63,255]	clut[80] = [127,255,255]	clut[125] = [255,159,255]
	clut[36] = [63, 95, 0]	clut[81] = [191, 0, 0]	clut[126] = [255,191, 0]
	clut[37] = [63, 95,127]	clut[82] = [191, 0,127]	clut[127] = [255,191,127]
	clut[38] = [63, 95,255]	clut[83] = [191, 0,255]	clut[128] = [255,191,255]
	clut[39] = [63,127, 0]	clut[84] = [191, 31, 0]	clut[129] = [255,223, 0]
	clut[40] = [63,127,127]	clut[85] = [191, 31,127]	clut[130] = [255,223,127]
	clut[41] = [63,127,255]	clut[86] = [191, 31,255]	clut[131] = [255,223,255]
	clut[42] = [63,159, 0]	clut[87] = [191, 63, 0]	clut[132] = [255,255, 0]
	clut[43] = [63,159,127]	clut[88] = [191, 63,127]	clut[133] = [255,255,127]
	clut[44] = [63,159,255]	clut[89] = [191, 63,255]	clut[134] = [255,255,255]

Transparency Level	Default CLUT entry definition Format : clut[n] = [R, G, B], where n denotes the clut entry, and R, G and B denote the values of the Red, Green and Blue components associated to clut entry		
25 %	clut[135] = [0, 0, 0]	clut[154] = [85, 85,255]	clut[173] = [170,212, 0]
	clut[136] = [0, 0,255]	clut[155] = [85,127, 0]	clut[174] = [170,212,255]
	clut[137] = [0, 42, 0]	clut[156] = [85,127,255]	clut[175] = [170,255, 0]
	clut[138] = [0, 42,255]	clut[157] = [85,170, 0]	clut[176] = [170,255,255]
	clut[139] = [0, 85, 0]	clut[158] = [85,170,255]	clut[177] = [255, 0, 0]
	clut[140] = [0, 85,255]	clut[159] = [85,212, 0]	clut[178] = [255, 0,255]
	clut[141] = [0,127, 0]	clut[160] = [85,212,255]	clut[179] = [255, 42, 0]
	clut[142] = [0,127,255]	clut[161] = [85,255, 0]	clut[180] = [255, 42,255]
	clut[143] = [0,170, 0]	clut[162] = [85,255,255]	clut[181] = [255, 85, 0]
	clut[144] = [0,170,255]	clut[163] = [170, 0, 0]	clut[182] = [255, 85,255]
	clut[145] = [0,212, 0]	clut[164] = [170, 0,255]	clut[183] = [255,127, 0]
	clut[146] = [0,212,255]	clut[165] = [170, 42, 0]	clut[184] = [255,127,255]
	clut[147] = [0,255, 0]	clut[166] = [170, 42,255]	clut[185] = [255,170, 0]
	clut[148] = [0,255,255]	clut[167] = [170, 85, 0]	clut[186] = [255,170,255]
	clut[149] = [85, 0, 0]	clut[168] = [170, 85,255]	clut[187] = [255,212, 0]
	clut[150] = [85, 0,255]	clut[169] = [170,127, 0]	clut[188] = [255,212,255]
	clut[151] = [85, 42, 0]	clut[170] = [170,127,255]	clut[189] = [255,255, 0]
	clut[152] = [85, 42,255]	clut[171] = [170,170, 0]	clut[190] = [255,255,255]
	clut[153] = [85, 85, 0]	clut[172] = [170,170,255]	
50 %	clut[191] = [0, 0, 0]	clut[203] = [127, 0, 0]	clut[215] = [255, 0, 0]
	clut[192] = [0, 0,255]	clut[204] = [127, 0,255]	clut[216] = [255, 0,255]
	clut[193] = [0, 51, 0]	clut[205] = [127, 51, 0]	clut[217] = [255, 51, 0]
	clut[194] = [0, 51,255]	clut[206] = [127, 51,255]	clut[218] = [255, 51,255]
	clut[195] = [0,102, 0]	clut[207] = [127,102, 0]	clut[219] = [255,102, 0]
	clut[196] = [0,102,255]	clut[208] = [127,102,255]	clut[220] = [255,102,255]
	clut[197] = [0,153, 0]	clut[209] = [127,153, 0]	clut[221] = [255,153, 0]
	clut[198] = [0,153,255]	clut[210] = [127,153,255]	clut[222] = [255,153,255]
	clut[199] = [0,204, 0]	clut[211] = [127,204, 0]	clut[223] = [255,204, 0]
	clut[200] = [0,204,255]	clut[212] = [127,204,255]	clut[224] = [255,204,255]
	clut[201] = [0,255, 0]	clut[213] = [127,255, 0]	clut[225] = [255,255, 0]
	clut[202] = [0,255,255]	clut[214] = [127,255,255]	clut[226] = [255,255,255]
75 %	clut[227] = [0, 0, 0]	clut[233] = [0,255, 0]	clut[238] = [255, 85,255]

	clut[228] = [0, 0,255] clut[229] = [0, 85, 0] clut[230] = [0, 85,255] clut[231] = [0,170, 0] clut[232] = [0,170,255]	clut[234] = [0,255,255] clut[235] = [255, 0, 0] clut[236] = [255, 0,255] clut[237] = [255, 85, 0]	clut[239] = [255,170, 0] clut[240] = [255,170,255] clut[241] = [255,255, 0] clut[242] = [255,255,255]
100 % (fully transparent)	clut[243] = [x, x, x], where x indicates “don’t care”.		
privately definable	clut[244] : reserved for private use clut[245] : reserved for private use clut[246] : reserved for private use clut[247] : reserved for private use clut[248] : reserved for private use clut[249] : reserved for private use	clut[250] : reserved for private use clut[251] : reserved for private use clut[252] : reserved for private use clut[253] : reserved for private use clut[254] : reserved for private use clut[255] : reserved for private use	

Annex D
Packetization of DAVIC defined Monomedia Components in PES Packets

(This annex forms an integral part of this Specification.)

D.1 Packetization into PES packets

Each monomedia object such as DAVIC defined linear audio is packetized in PES packets.

The following constraints apply for such packetization, in addition to the constraints defined in Clause 7-3 of this specification.

In the case of linear audio, an encoded PTS shall refer to the presentation time of the first audio sample contained in the payload of the packet in which the PTS is coded.

A PTS shall be encoded in the PES packet that contains the first byte of the elementary object. In each composite object the PTS of the elementary object that is presented first, shall be encoded with a value zero. A PTS is encoded in the PES packet that contains the first byte of the elementary object. In each composite object the PTS of the elementary object that is presented first, shall be encoded with a value zero.

the trick_mode_flag shall be encoded with a value ‘0’.

the stream_id field in the PES header shall be coded with a value equal to ‘1011 1101’, indicating a private stream 1.

A DTS shall be not be encoded.

To allow PES packets of private stream 1 to contain multiple monomedia components, the syntax of such PES packets is extended, corresponding to the structure defined below.

Table D-1. Extended PES Packet Header of Type Private Stream 1

Syntax	*Number of bits*	*Mnemonic*
Private_stream_1_PES_packet() {		
private_stream_1_PES_packet_header()		
data_identifier	8	bslbf
private_stream_id	8	bslbf
private_PES_packet_data ()		
}		

Private_stream_1_PES_packet_header(): A PES packet header that complies to ISO/IEC 13818-1 with the stream_id set to a value of ‘1011 1101’, indicating “private_stream_1”.

data_identifier: A byte indicating the type of data contained in this PES packet, corresponding to the following table.

Table D-2. Data Identifier Assignments

Value	*Meaning*
0x00 - 0x0F	reserved for use by DAVIC
0x10 - 0x1F	user-private
0x20	forbidden (used for DVB subtitling)
0x21 - 0x2F	user-private
0x30	objects with a coding format defined in DAVIC 1.4.1
0x31 - 0x7F	reserved for use by DAVIC

0x80 - 0xFF	user-private

private_stream_id: A byte indicating the type of private stream. DAVIC only specifies the coding of this field if the data_identifier field is coded with a value that is reserved for use by DAVIC. If the data_identifier field is encoded with the value 0x30, indicating an objects with a coding format defined in DAVIC, then the private_stream_id shall be coded corresponding to the following table.

Table D-3. Private Stream Id Assignments for Objects with a Coding Format Defined in DAVIC 1.4.1

Value	*Meaning*
0x00 - 0x0F	reserved
0x10 - 0x1F	linear audio
0x20 - 0xDF	reserved
0xE0 - 0xFF	user private

private_PES_packet_data() : A field containing data from a monomedia object. The objects are aligned with the extended PES packet header, i.e. the first byte of the object is the first byte of the PES packet data. The data from each object may be stored in multiple PES packets, all of which include the extended header syntax defined in this Clause. DAVIC will not specify data contained in the private_PES_packet_data field of user private PES packets.

Annex E
MPEG-2 Section Filter API

(This annex forms an integral part of this Specification)

E.1 Objective

The objective of this API is to provide a general mechanism allowing access to data held in MPEG-2 private sections. This will provide a mechanism for inter-operable access to data which is too specialized to be supported by the high level DVB-SI API or which is not actually related to service information.

E.2 Requirements

E.2.1 Non-Functional Requirements

Openness

The interfaces should be specified in such a way that they can be used also in the implementation of other interfaces.

Abstraction

However, the interface should not expose its implementation, making it possible to implement it for instance in native code.

Memory and CPU power

The random-access memory requirements of a typical implementation should not substantially add to the requirements of the underlying native services.

The CPU cycle budget of a typical implementation should not substantially add to the budget of a similar service in a native implementation. Specifically, where native applications takes advantage of hardware support to carry out a certain function, the interface specification must allow re-use of that feature.

Response times should not be substantially higher than the response times of the underlying native services.

Some resource handling functionality should be defined to control scarce resources. All interfaces using scarce resources should use this functionality.

The interface should allow everything in the range from a complete software implementation to an almost complete hardware implementation. The interface should hide all aspects of the software/hardware trade-off from the implementation..

The system must be flexible and easily extendible to be future proof.

Maximal use should be made of the object-oriented paradigm of Java to allow sub-typing in new packages or in the application.

The interfaces should have a Java look and feel.

E.2.2 Functional Requirements

The basic functional requirement on org.davic.mpeg.sections is to provide convenient application-level access to any data transported in MPEG sections independent of transmission scheme.

The section filter should be associated with one transport stream and, if possible, also one transport stream source.

The API should support the following section types ([MPEG], §2.4.4.10) :-

Both “long header syntax” and “short header syntax”

Both 4k and 1k sections.

It should be possible to indicate the buffer size for desired sections at filter creation time.

There should be an ability to filter on bytes 0, 3-9 of a section.

There should be an efficient mechanism to monitor change in sections.

After a filter has been started, it must be possible to terminate the operation without any data having arrived.

The package should enable the application to be notified in the event that filtering resources are not sufficient to honor a request including cases where a filter becomes not available.

The package should allow parsing of header data as defined by MPEG-2, table 2.30 of ISO/IEC 13818-1.

There should be an ability to notify the user of the API when a complete section has arrived.

NOTE It is a desirable feature that the package supports at least two different priority levels of filters (for background filtering) and also avoid double buffering/copying.

E.3 Overview of Specification

This section presents the specification of the org.davic.mpeg.sections package. The specification is given using the OMT method.

The aim is to provide a platform-neutral interface which allows access to the MPEG2 sections present in a MPEG2 Transport Stream. For readers not familiar with the MPEG2 system layer and the use of the section format, see the MPEG2 system layer specification [MPEG2].

The package allows an application to create section filters, to connect section filters to a section source (Transport Stream) and to manage connecting and disconnecting of resources.

E.3.1 Object diagram

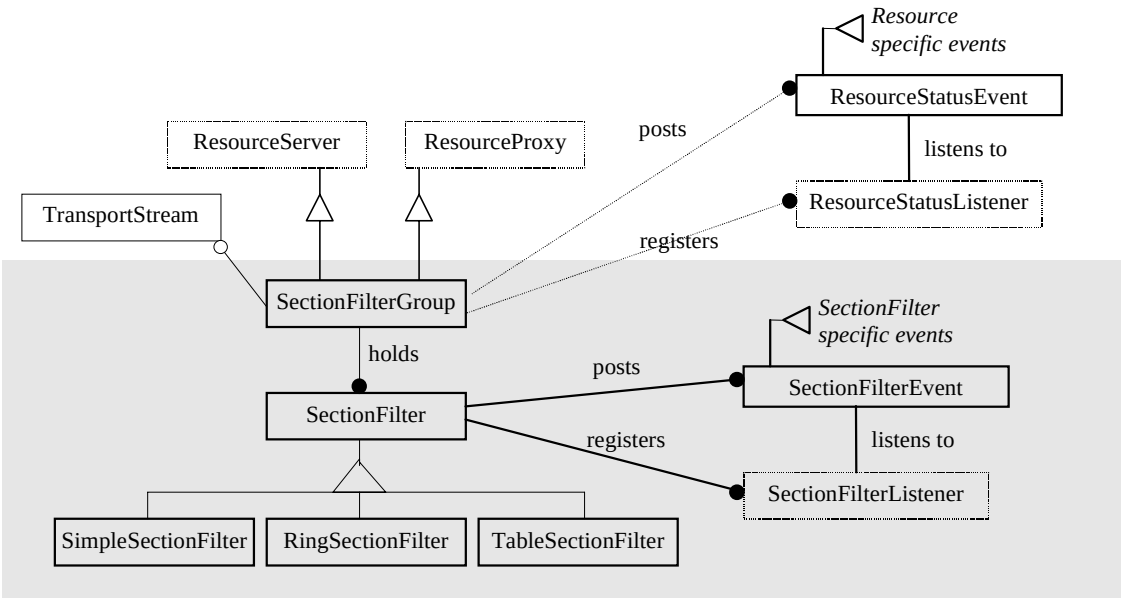


Figure E-1 Object diagram

In Figure E-1 the total object diagram of the package is presented. In this diagram interfaces are presented with dotted boxes and classes with straight boxes. The classes and interfaces part of the section filtering API are presented within the gray area. The classes and interfaces outside this area are defined in the Resource Notification API and MPEG component API.

In this picture the relations between the following section filtering classes are defined:

SectionFilterGroup, the class responsible for creating SectionFilter objects and maintaining the connection with a TransportStream. This class uses the ResourceProxy and ResourceServer interface the manage the section filter resources.

SectionFilter, the abstract super class of all section filter classes. This class provides the methods to start and stop section filters.

Section, this class contains the sections filtered from a Transport Stream by a SectionFilter instance.

SectionFilterListener, an interface used to ‘listen’ to events happening in a SectionFilter instance.

SectionFilterEvent, the main class of the SectionFilterGroup events.

SimpleSectionFilter, a subclass of SectionFilter providing basic filter functionality to filter one section.

RingSectionFilter, a subclass of SectionFilter to filter a continuous stream of MPEG-2 sections.

TableSectionFilter, a subclass of SectionFilter filtering a table of MPEG-2 sections.

E.3.2 Interclass relations

Before SectionFilter can be created first a SectionFilterGroup has to be found. A SectionFilterGroup is created with the maximum number of section filters to be used and a priority indication.

The created SectionFilterGroup is responsible for:

the creation of SectionFilters

the connection with a TransportStream

the managing and control of the resources needed for section filtering.

Before filtering can commence a connection with a TransportStream has to be made.

The SectionFilterGroup has to attach itself to the TransportStream. This mechanism is controlled by the resource mechanism.

The activity of the SectionFilterGroup can be monitored by implementing the ResourceStatusEventListener interface. Classes of this type registered with a SectionFilterGroup receive ResourceStatusEvents each time something noteworthy has happened in that SectionFilterGroup. A complete list of ResourceStatusEvents is given later on.

From the SectionFilterGroup the required SectionFilters can be obtained. Three different SectionFilter classes exist. At any one time any number of SectionFilter objects may be associated with this SectionFilterGroup, but only the number of section filters of this SectionFilterGroup can be active.

A SectionFilterGroup is responsible for maintaining the connection with a TransportStream, a SectionFilter is responsible for the actual filtering. The objects of the SectionFilter class allow a user to start a filter with filter parameters and read any filtered section from the Transport Stream.

Similar to the SectionFilterGroup the SectionFilter objects allow clients to register SectionFilterListeners to which SectionFilterEvents are sent. The registered SectionFilterListeners receive events every time a section arrives and when the filter starts and stops.

E.3.3 Event mechanism

The event mechanism allows the application to respond to the different processes and changes in the lifecycle of the different objects. They are used to signal errors and important state changes.

The SectionFilter and SectionFilterGroup both use an event mechanism. The class diagram of the events in this interface is given in Figure E-2.

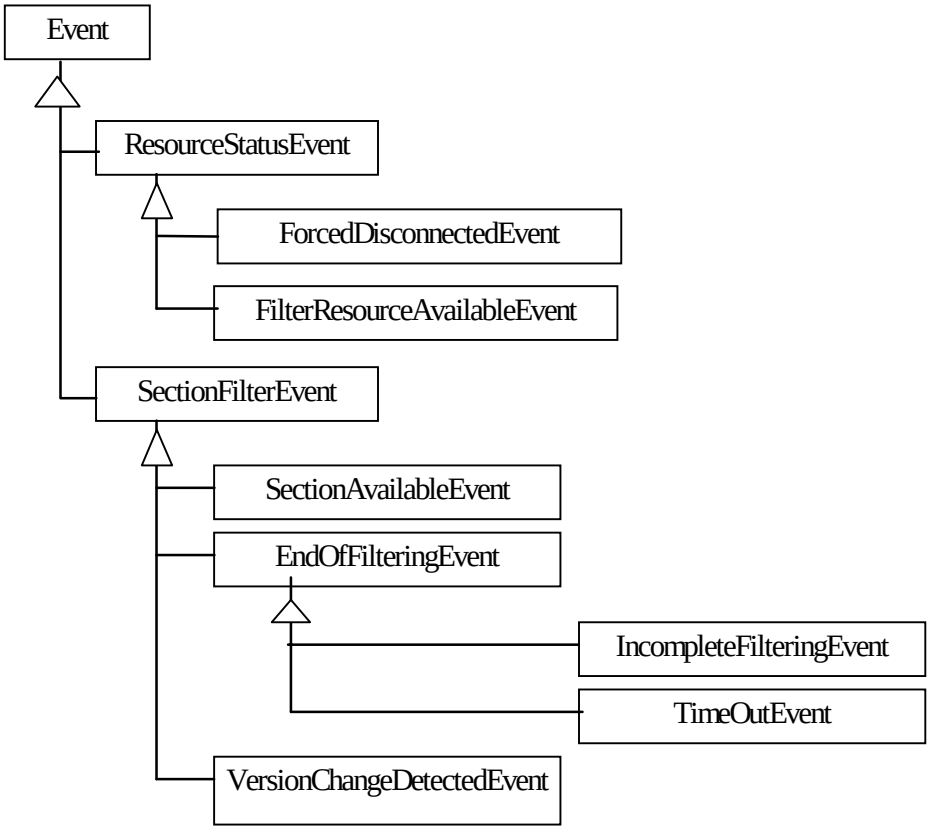


Figure E-2 Class diagram of events generated by the SectionFilterGroup and the SectionFilter

Events generated by the SectionFilterGroup are :

ResourceStatusEvent, a general event generated when the status of a resource changes.

ForcedDisconnectedEvent, this event is generated when the SectionFilterGroup is detached by the underlying system.

Events generated by the Section Filter are :

SectionAvailableEvent, indication of the SectionFilter to the user that a new section has been filtered and can be read.

EndOfFilteringEvent, the filter process was stopped because it was completed or for some other reason. It is not used to signal a call to stopFiltering

IncompleteFilteringEvent, the filter process for a TableSectionFilter was stopped because the filter parameters have been incompletely defined, resulting in a blocking filter or a non MPEG-2 compliant result

TimeOutEvent, the SectionFilter has timed out.

VersionChangeDetectedEvent, indication of the TableSectionFilter to the user that a section has been encountered that contained a different version_number from earlier sections that were filtered.

All events are sent asynchronously. A consequence of this is that events originating from a filtering actions can still come in when a new filtering action has already been started. It is the responsibility of the application to check if the event is still relevant.

E.3.4 SectionFilterGroups

The SectionFilterGroup is responsible for:

the creation of SectionFilters

the connection with a TransportStream

the managing and control of the resources needed for section filtering

The behaviour of the connection between TransportStream and SectionFilterGroup is defined by a finite state machine; see Figure E-3.

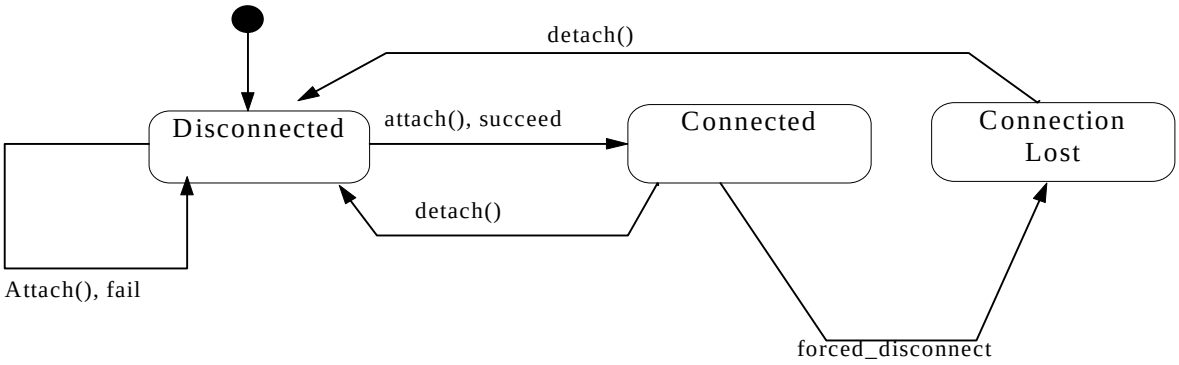


Figure E-3 Finite State Machine for connection between TransportStream and SectionFilterGroup

In Figure E-3, method calls are indicated with a ().

In this finite state machine the states Disconnected and Connected occur:

Disconnected, the state the SectionFilterGroup starts in. In this state no connection is made with a TransportStream and no resources are claimed by the SectionFilterGroup. In this state calls to startFiltering() methods are effectively queued until the SectionFilterGroup enters the Connected state.

Connected, the SectionFilterGroup is connected to a TransportStream and has the number of section filter resources indicated when created. All active SectionFilters are filtering data. In this state calls to startFiltering() methods cause filtering to start upto the limit of available section filters.

ConnectionLost, the SectionFilterGroup has stopped filtering due to the loss of a connection or of a resource. In this case, calls to startFiltering() methods always throw exceptions.

The following events occur:

attach(), fail, an attempt was made to connect the SectionFilterGroup to a TransportStream and failed due to a incorrect TransportStream or not enough resources are available.

attach(),succeed, the SectionFilterGroup was successfully connected to a TransportStream and claimed the number of section filter resources indicated when created. All active SectionFilters start filtering.

detach(), the user has disconnected the SectionFilterGroup from the TransportStream. All section filter resources are released and all filtering is stopped.

force_disconnect, the system has reclaimed the section filter resources of this SectionFilterGroup or the transport stream is no longer available. When this happens, all SectionFilter objects in this SectionFilterGroup are stopped as if the application had called the stopFiltering() method for each such object.

E.3.5 SectionFilters

The objects of the SectionFilter class represent the actual section filter functionality. Three different SectionFilter classes exist:

SimpleSectionFilter, to filter one section

TableSectionFilter, to filter an MPEG2 section table

RingSectionFilter, for continuous filtering.

All SectionFilter objects use the same methods to set a filter. A SectionFilter claims a section filter resource from its SectionFilterGroup when startFiltering is called.

A SectionFilterGroup knows the number of section filter resources it holds. This is the maximum number of active SectionFilters connected to this SectionFilterGroup. The number of active SectionFilters connected to a SectionFilterGroup is independent of the state of the SectionFilterGroup. This allows a user to set a number of SectionFilters and start and stop them with the attach and detach method of SectionFilterGroup.

E.4 Interfaces

E.4.1 SectionFilterListener

public interface SectionFilterListener

The SectionFilterListener interface is implemented by classes which wish to be informed about events relating to section filters.

Methods

sectionFilterUpdate

```
public abstract void sectionFilterUpdate(SectionFilterEvent event)
```

When a section filter event happens, the sectionFilterUpdate method of all listeners connected to the originating object will be called.

E.5 Classes

E.5.1 SectionFilterGroup

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterGroup
```

public class SectionFilterGroup

extends Object

implements ResourceProxy, ResourceServer

This class represents a group of MPEG-2 section filters to be activated and de-activated as an atomic operation. The purpose of this class is to minimize the potential for resource deadlock between independent pieces of application(s).

Constructors

```
public SectionFilterGroup(int numberOfFilters)
```

Creates a section filter group object with an associated number of section filters needed to be reserved when the object is to be connected to an active source of MPEG-2 sections. The object will have a default high resource priority should the number of section filters available to the package become insufficient.

Parameters:

numberOfFilters - the number of section filters needed for the object.

```
public SectionFilterGroup(int numberOfFilters,
                          boolean resourcePriority)
```

Creates a section filter group object with an associated number of section filters needed to be reserved when the object is to be connected to an active source of MPEG-2 sections.

Parameters:

numberOfFilters - the number of section filters needed for the object

resourcePriority - the resource priority of the object should the number of section filters available to the package become insufficient. High priority is indicated by true and low priority by false.

Methods

newSimpleSectionFilter

```
public SimpleSectionFilter newSimpleSectionFilter()
```

Creates a new simple section filter object within the parent section filter group. On activation (succesfull startFiltering) the SimpleSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created. The section filter object will have a buffer suitable to hold a default long section.

newSimpleSectionFilter

```
public SimpleSectionFilter newSimpleSectionFilter(int sectionSize)
```

Creates a new simple section filter object within the parent section filter group. On activation (succesfull startFiltering) the SimpleSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created.

Parameters:

sectionSize - specifies the size in bytes of the buffer to be created to hold data captured by the SectionFilter. If sections are filtered which are larger than this then the extra data will be dropped and filtering continue without any notification to the application.

newRingSectionFilter

```
public RingSectionFilter newRingSectionFilter(int ringSize)
```

Creates a new ring section filter within the parent section filter group. On activation (succesfull startFiltering) the new RingSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created.

Parameters:

ringSize - the number of Section objects to be created for use in the ring.

newRingSectionFilter

```
public RingSectionFilter newRingSectionFilter(int ringSize,
                                              int sectionSize)
```

Creates a new ring section filter within the parent section filter group. On activation (succesfull startFiltering) the new RingSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created.

Parameters:

ringSize - the number of Section objects to be created for use in the ring.

sectionSize - the size in bytes of the buffer for each Section object. If sections are filtered which are larger than this then the extra data will be dropped and filtering continue without any notification to the application.

newTableSectionFilter

```
public TableSectionFilter newTableSectionFilter()
```

Creates a new table section filter object within the parent section filter group. On activation (succesfull startFiltering) the new TableSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created. Each Section created for the table section filter object will have a buffer suitable to hold a default long section.

newTableSectionFilter

```
public TableSectionFilter newTableSectionFilter(int sectionSize)
```

Creates a new table section filter object within the parent section filter group. On activation (succesfull startFiltering) the new TableSectionFilter object will use section filters from the total specified when the parent SectionFilterGroup was created.

Parameters:

sectionSize - specifies the size in bytes of the buffer to be created to hold data captured by the SectionFilter. When the first section has been captured and the total number of sections in the table known, each Section created will have a buffer of this size. If sections are filtered which are larger than this then the extra data will be dropped and filtering continue without any notification to the application.

attach

```
public void attach(TransportStream stream, ResourceClient client,
       Object requestData) throws FilterResourceException,
       InvalidSourceException, TuningException
```

Connects a SectionFilterGroup to an MPEG-2 transport stream. The SectionFilterGroup will attempt to acquire the number of section filters specified when it was created. Any SectionFilter objects which are part of the group concerned and whose filtering has been started will become active and start filtering the source for sections matching the specified patterns. A call to attach on a attached SectionFilterGroup will be treated as a detach followed by the new attach.

Parameters:

stream- specifies the source of MPEG-2 sections for filtering

client - specifies an object to be notified if the section filters acquired during this method are later removed by the environment for any reason.

requestData - application specific data for use by the resource notification API

Throws: FilterResourceException

if reserving the specified section filters fails.

Throws: InvalidSourceException

if the source is not a valid source of MPEG-2 sections.

Throws: TuningException

if the source is not currently tuned to

detach

```
public void detach()
```

Returns a SectionFilterGroup to the disconnected state. When called for a SectionFilterGroup in the connected state, it disconnects a SectionFilterGroup from a source of MPEG-2 sections. The section filters held by the SectionFilterGroup will be released back to the environment. Any running filtering operations will be terminated. This method will have no effect for SectionFilterGroups already in the disconnected state.

getSource

```
public TransportStream getSource()
```

Returns the MPEG-2 transport stream to which a SectionFilterGroup is currently connected. If the SectionFilterGroup is not connected to a transport stream then the method will return null.

getClient

```
public ResourceClient getClient()
```

Returns the ResourceClient object specified in the last call to the attach() method as to be notified in the case that the section filters acquired by the SectionFilterGroup during that call to attach() are removed by the environment for any reason. If the SectionFilterGroup is not connected to a source then the method will return null.

addResourceStatusEventListener

```
public void addResourceStatusEventListener(ResourceStatusListener listener)
```

Specifies an object to be notified of changes in the status of resources related to a SectionFilterGroup object. If this call is made more than once, each specified listener will be notified of each change in resource status.

Parameters:

listener - the object to be notified

removeResourceStatusEventListener

```
public void removeResourceStatusEventListener(ResourceStatusListener
listener)
```

Indicates that an object is no longer to be notified of changes in the status of resources as setup by addResourceStatusEventListener. If an object was not specified as to be notified then this method will be have no effect.

Parameters:

listener - the object no longer to be notified

E.5.2 SectionFilter

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilter
```

public abstract class SectionFilter

extends Object

This class is the base class for a set of classes describing section filters with different characteristics of life cycle and buffering.

Methods

startFiltering

```
public void startFiltering(Object appData,
                           int pid) throws FilterResourceException,
NotAuthorizedException, IllegalFilterDefinitionException,
ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID. If the parent SectionFilterGroup

is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: IllegalFilterDefinitionException

if called for a TableSectionFilter.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

startFiltering

```
 public void startFiltering(Object appData,
                            int pid,
                            int table_id) throws FilterResourceException,
NotAuthorizedException, ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID and table_id. If the parent SectionFilterGroup is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections

table_id - the value of the table_id to filter for in incoming sections

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

startFiltering

```
 public void startFiltering(Object appData,
                            int pid,
                            int table_id,
                            byte posFilterDef[],
                            byte posFilterMask[]) throws
FilterResourceException, IllegalFilterDefinitionException,
NotAuthorizedException, ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID and table_id, and where contents of the section match the specified filter pattern. The first byte of each array corresponds to the third byte of the section. If the parent SectionFilterGroup is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections.

table_id - the value of the table_id field to filter for in incoming sections

posFilterDef - defines values to match for bits in the section, as defined in clause H7.

posFilterMask - defines which bits in the section are to be compared against the values specified in the posFilterDef parameter, as defined in clause H7.

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: IllegalFilterDefinitionException

the filter definition specified is illegal either because the posFilterDef and posFilterMask arrays are of different sizes or because their length is beyond the filtering capacity of the system.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

startFiltering

```
 public void startFiltering(Object appData,
                            int pid,
                            int table_id,
                            int offset,
                            byte posFilterDef[],
                            byte posFilterMask[]) throws
FilterResourceException, IllegalFilterDefinitionException,
NotAuthorizedException, ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID and table_id, and where contents of the section match the specified filter pattern. If the parent SectionFilterGroup is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections.

table_id - the value of the table_id field to filter for in incoming sections

offset - defines the offset within the section which the first byte of the posFilterDef and posFilterMask arrays is intended to match. The offset must be less than 31 as described in DAVIC part 10, section 115.3. The offset must be equal to or greater than 3.

posFilterDef - defines values to match for bits in the section, as defined in clause H7.

posFilterMask - defines which bits in the section are to be compared against the values specified in the posFilterDef parameter, as defined in clause H7.

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: IllegalFilterDefinitionException

the filter definition specified is illegal either because the posFilterDef and posFilterMask arrays are not the same size or because their length is beyond the filtering capacity of the system or because the specified offset is too large.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

startFiltering

```
 public void startFiltering(Object appData,
                            int pid,
                            int table_id,
                            byte posFilterDef[],
                            byte posFilterMask[],
                            byte negFilterDef[],
                            byte negFilterMask[]) throws
FilterResourceException, IllegalFilterDefinitionException,
NotAuthorizedException, ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID and table_id, and where contents of the section match the specified filter pattern. The first byte of each array corresponds to the third byte of the section. If the parent SectionFilterGroup is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections.

table_id - the value of the table_id field to filter for in incoming sections

posFilterDef - defines values to match for bits in the section, as defined in clause H7.

posFilterMask - defines which bits in the section are to be compared against the values specified in the posFilterDef parameter, as defined in clause H7.

negFilterDef - defines values to match for bits in the section, as defined in clause H7.

negFilterMask - defines which bits in the section are to be compared against the values specified in the negFilterDef parameter, as defined in clause H7.

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: IllegalFilterDefinitionException

the filter definition specified is illegal either because the arrays posFilterDef, posFilterMask, negFilterDef, negFilterMask are not all the same size or because their length is beyond the filtering capacity of the system.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

startFiltering

```
 public void startFiltering(Object appData,
                            int pid,
                            int table_id,
                            int offset,
                            byte posFilterDef[],
                            byte posFilterMask[],
                            byte negFilterDef[],
                            byte negFilterMask[]) throws
FilterResourceException, IllegalFilterDefinitionException,
NotAuthorizedException, ConnectionLostException
```

Defines a SectionFilter object as filtering only for sections matching a specific PID and table_id, and where contents of the section match the specified filter pattern. If the parent SectionFilterGroup is attached to a TransportStream then filtering will start immediately.

Parameters:

appData - An object supplied by the application. This object will be delivered to the subscribed section filter listener as part of all SectionFilterEvents that will be generated because of this method call. The application can use this object for internal communication purposes. If the application does not need any application data, the parameter can be null.

pid - the value of the PID to filter for in incoming sections.

table_id - the value of the table_id field to filter for in incoming sections

offset - defines the offset within the section which the first byte of the posFilterDef, posFilterMask, negFilterDef and negFilterMask arrays is intended to match. The offset must be less than 31 as described in DAVIC part 10, section 115.3. The offset must be equal to or greater than 3.

posFilterDef - defines values to match for bits in the section, as defined in clause H7.

posFilterMask - defines which bits in the section are to be compared against the values specified in the posFilterDef parameter, as defined in clause H7.

negFilterDef - defines values to match for bits in the section, as defined in clause H7.

negFilterMask - defines which bits in the section are to be compared against the values specified in the negFilterDef parameter, as defined in clause H7.

Throws: FilterResourceException

if all the number of started SectionFilters for the parent SectionFilterGroup is already equal to the number of section filters associated with the SectionFilterGroup when it was created.

Throws: IllegalFilterDefinitionException

the filter definition specified is illegal either because the posFilterDef, posFilterMask, negFilterDef, negFilterMask arrays are not all the same size or because their length is beyond the filtering capacity of the system or because the specified offset is too large.

Throws: NotAuthorizedException

if the information requested is scrambled and permission to descramble it is refused.

Throws: ConnectionLostException

if the parent SectionFilterGroup is in the ConnectionLost state and hence is unable to satisfy the method call due to absence of resources or absence of sections to filter.

stopFiltering

```
public void stopFiltering()
```

If the parent SectionFilterGroup is attached to a TransportStream then filtering for sections matching this SectionFilter object will stop. If the parent is not attached then should it become attached, filtering for sections matching this SectionFilter object will not start.

setTimeOut

```
public void setTimeOut(long milliseconds) throws IllegalArgumentException
```

Sets the time-out for this section filter. When the time-out happens, a TimeOutEvent will be generated and sent to the SectionFilter object and filtering stops. For a SimpleSectionFilter this will be generated if no sections arrive within the specified period. For a TableSectionFilter, this will be generated if the complete table does not arrive within the specified time. For a RingSectionFilter, this will be generated if the specified time has elapsed since the arrival of the last section being successfully filtered. Setting a time-out of 0 milliseconds has the effect of removing a possible time-out. A set time-out only applies to subsequent filter activations, not to a possible filter activation that is currently in progress when the call to this method is made. The default time-out value is 0.

Parameters:

milliseconds - the time out period

Throws: IllegalArgumentException

if the 'milliseconds' parameter is negative

addSectionFilterListener

```
public void addSectionFilterListener(SectionFilterListener listener)
```

Specifies an object to be notified of events relating to this SectionFilter object.

Parameters:

listener - the object to be notified of events

removeSectionFilterListener

```
public void removeSectionFilterListener(SectionFilterListener listener)
```

Indicates that an object is no longer to be notified of events relating to this SectionFilter object. If the object was not specified as to be notified then this method has no effect.

Parameters:

listener - the object no longer to be notified of events

E.5.3 SimpleSectionFilter

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilter
           |
           +----org.davic.mpeg.sections.SimpleSectionFilter
```

public class SimpleSectionFilter

extends SectionFilter

This class defines a simple section filter intended to be used to capture a single section once only. When a section matching the specified filter pattern is found, SimpleSectionFilter objects will stop filtering as if the stopFiltering method had been called.

Methods

getSection

```
public Section getSection() throws FilteringInterruptedException
```

This method retrieves a Section object describing the last MPEG-2 section which matched the specified filter characteristics. If the SimpleSectionFilter object is currently filtering, this method will block until filtering stops. Repeated calls to this method will return the same Section object, provided that no new calls to startFiltering have been made in the interim. Each time a new filtering operation is started, a new Section object will be created. All references except any in the application to the previous Section object will be removed. All data accessing methods on the previous Section object will throw a NoDataAvailableException.

Throws: FilteringInterruptedException

if filtering stops before a matching section is found

E.5.4 RingSectionFilter

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilter
           |
           +----org.davic.mpeg.sections.RingSectionFilter
```

public class RingSectionFilter

extends SectionFilter

This class defines a section filter intended to be used to capture a continuous stream of MPEG-2 sections without needing to stop and re-arm a filter. A RingSectionFilter object has a pre-defined number of Section objects as part of it. Incoming sections are loaded sequentially into these Section objects. Filtering proceeds while empty Section objects remain. Applications wishing filtering to proceed indefinitely must use the setEmpty method of the Section

object to mark Section objects as empty before the filling process reaches them. If the filtering process reaches a non-empty Section object, it will terminate at that point. On each occasion when startFiltering is called, the sections will be captured starting from the beginning of the array.

Methods

getSections

```
public Section[] getSections()
```

This method returns the Section objects of the RingSectionFilter in an array. The array will be fully populated at all times, it is the responsibility of the application to check which of these contain valid data. Repeated calls to this method will always return the same result.

E.5.5 TableSectionFilter

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilter
            |
            +----org.davic.mpeg.sections.TableSectionFilter
```

public class TableSectionFilter

extends SectionFilter

This class defines a section filter operation optimized to capture entire tables with minimum intervention required from the application. When filtering is started, first one section matching the specified pattern will be filtered. Once that section has been found, the last_section_number field will be used to determine the number of Section objects required to hold the entire table. This number of objects will be created and filtering re-started to capture all the sections of the table. The SectionAvailableEvent will be generated each time a Section is captured. The EndOfFilteringEvent will be generated when the complete table has been captured. The version_number of all sections of the table will be the same. If a section is captured with a version_number that differs from the version_number of the section first captured, a VersionChangeDetectedEvent will be generated. The newly captured section will be ignored and filtering will continue on the table with the version number of the first captured section. Only one VersionChangeDetectedEvent will be sent per filtering action. Care should be taking in setting the filter parameters, a too restrictive filter will never stop automatically and a too wide filter can produce inconsistent results (e.g. filtering short sections using a TableSectionFilter) When the API detects a filtering situation where the filter parameters have been incompletely defined, resulting in a blocking filter or a non MPEG-2 compliant result, an InCompleteFilteringEvent is sent and filtering is stopped.

Methods

getSections

```
public Section[] getSections() throws FilteringInterruptedException
```

This method returns an array of Section objects corresponding to the sections of the table. The sections in the array will be ordered according to their section_number. Any sections which have not yet been filtered from the source will have the corresponding entry in the array set to null. If no sections have been filtered then this method will block until at least one section is available or filtering stops. Repeated calls to this method will return the same array, provided that no new calls to startFiltering have been made in the interim. Each time a new filtering operation is started, a new array of Section objects will be created. All references except any in the application to the previous array and Section objects will be removed. All data accessing methods on the previous Section objects will throw a NoDataAvailableException.

Throws: FilteringInterruptedException

if filtering stops before one section is available

E.5.6 Section

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.Section
```

public class Section

extends Object

implements Cloneable

This class describes a single section as filtered from an MPEG transport stream. A cloned Section object is a new and separate object. It is unaffected by changes in the state of the original Section object or restarting of the SectionFilter the source Section object originated from. The clone method must be implemented without declaring exceptions.

Methods

getData

```
public byte[] getData() throws NoDataAvailableException
```

This method returns all data from the filtered section in the Section object, including the section header. Each call to this method results in a new a copy of the section data (everything after the length field, not including a CRC check).

Throws: NoDataAvailableException

if no valid data is available.

getData

```
public byte[] getData(int index,
                      int length) throws NoDataAvailableException,
IndexOutOfBoundsException
```

This method returns the specified part of the filtered data. Each call to this method results in a new a copy of the section data (everything after the length field, not including a CRC check).

Parameters:

index - defines within the filtered section the index of the first byte of the data to be retrieved. The first byte of the section (the table_id field) has index 1.

length - defines the number of consecutive bytes from the filtered section to be retrieved.

Throws: NoDataAvailableException

if no valid data is available.

Throws: IndexOutOfBoundsException

if any part of the filtered data requested would be outside the range of data in the section.

getByteAt

```
public byte getByteAt(int index) throws NoDataAvailableException,
IndexOutOfBoundsException
```

This method returns one byte from the filtered data.

Parameters:

index - defines within the filtered section the index of the byte to be retrieved. The first byte of the section (the table_id field) has index 1.

Throws: NoDataAvailableException

if no valid data is available.

Throws: IndexOutOfBoundsException

if the byte requested would be outside the range of data in the section.

table_id

```
public int table_id() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

section_syntax_indicator

```
public boolean section_syntax_indicator() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

private_indicator

```
public boolean private_indicator() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

section_length

```
public int section_length() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

table_id_extension

```
public int table_id_extension() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

version_number

```
public short version_number() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

current_next_indicator

```
public boolean current_next_indicator() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

section_number

```
public int section_number() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

last_section_number

```
public int last_section_number() throws NoDataAvailableException
```

This method returns the value of the corresponding field from an MPEG-2 section header.

Throws: NoDataAvailableException

thrown if no valid data is available

getFullStatus

```
public boolean getFullStatus()
```

This method reads whether a Section object contains valid data.

setEmpty

```
public void setEmpty()
```

This method sets a Section object such that any data contained within it is no longer valid. This is intended to be used with RingSectionFilters to indicate that the particular object can be re-used.

E.6 Events

E.6.1 SectionFilterEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
```

public class SectionFilterEvent

extends Object

This class is the base class for Events in the section filter API.

Constructors

```
public SectionFilterEvent (SectionFilter f, Object appData)
```

This constructs a SectionFilterEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilter object which was the source of the event.

getAppData

```
public Object getAppData()
```

Returns the application data that was passed to the startFiltering method

Returns:

the application data

E.6.2 SectionAvailableEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
            |
            +----org.davic.mpeg.sections.SectionAvailableEvent
```

public class SectionAvailableEvent

extends SectionFilterEvent

This class is used to report a complete section being filtered. It is generated by SimpleSectionFilter, TableSectionFilter and RingSectionFilter objects when a section matching the filtering pattern is successfully filtered from the transport stream.

Constructors

```
public SectionAvailableEvent (SectionFilter f, Object appData)
```

This constructs a SectionAvailableEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilter object which filtered the data.

Overrides:

getSource in class SectionFilterEvent

E.6.3 EndOfFilteringEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
           |
           +----org.davic.mpeg.sections.EndOfFilteringEvent
```

public class EndOfFilteringEvent

extends SectionFilterEvent

This class is used to report the end of a filtering operation with one exception: It is not generated when filtering stops for a SimpleSectionFilter under normal circumstances (i.e. after one section has successfully been filtered).

Constructors

```
public EndOfFilteringEvent (SectionFilter f, Object appData)
```

This constructs an EndOfFilteringEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilter object which filtered the data.

Overrides:

getSource in class SectionFilterEvent

E.6.4 ForcedDisconnectedEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.mpeg.sections.ForcedDisconnectedEvent
```

public class ForcedDisconnectedEvent

extends ResourceStatusEvent

This class is used to report when a TransportStream which was available becomes no longer available or if the section filter resources are removed from a connected SectionFilterGroup. In this second case, the notifyRelease() method of the ResourceClient will also be called in addition to this event being generated.

Constructors

```
public ForcedDisconnectedEvent (SectionFilterGroup f)
```

This constructs a ForcedDisconnectedEvent for the specified SectionFilterGroup object.

Parameters:

f - the SectionFilter object where the event originated

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilterGroup object which filtered the data.

Overrides:

getSource in class ResourceStatusEvent

E.6.5 VersionChangeDetectedEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
           |
           +----org.davic.mpeg.sections.VersionChangeDetectedEvent
```

public class VersionChangeDetectedEvent

extends SectionFilterEvent

This class is used by TableSectionFilter to report that a section has been encountered which has a different version_number from earlier sections. It is generated only once per filtering action. The section with a different version_number is ignored.

Constructors

```
public VersionChangeDetectedEvent (SectionFilter f, Object appData)
```

This constructs a VersionChangeDetectedEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilter object which filtered the data.

Overrides:

getSource in class SectionFilterEvent

getOriginalVersion

```
public int getOriginalVersion()
```

This returns the original version number of the table.

getNewVersion

```
public int getNewVersion()
```

This returns the version number of the new table.

E.6.6 IncompleteFilteringEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
           |
           +----org.davic.mpeg.sections.EndOfFilteringEvent
                   |
                   +----org.davic.mpeg.sections.IncompleteFilteringEvent
```

public class IncompleteFilteringEvent

extends EndofFilteringEvent

This class is used to report the end of a filtering operation started by TableSectionFilter. This event is generated when the API detects a filtering situation where the filter parameters have been incompletely defined, resulting in a blocking filter or a non MPEG-2 compliant result.

Constructors

```
public IncompleteFilteringEvent (SectionFilter f, Object appData)
```

This constructs an IncompleteFilteringEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilter object which filtered the data.

Overrides:

getSource in class EndOfFilteringEvent

E.6.7 TimeOutEvent

```
java.lang.Object
   |
   +----org.davic.mpeg.sections.SectionFilterEvent
           |
           +----org.davic.mpeg.sections.EndOfFilteringEvent
                   |
                   +----org.davic.mpeg.sections.TimeOutEvent
```

public class TimeOutEvent

extends EndOfFilteringEvent

This event is generated if section filter operations time out within the period specified by the setTimeOut() method. For a SimpleSectionFilter it will be generated if no sections arrive within the specified period. For a TableSectionFilter, it will be generated if the complete table does not arrive within the specified time. For a RingSectionFilter, it will be generated if the specified time has elapsed since the arrival of the last section being successfully filtered.

Constructors

```
public TimeOutEvent (SectionFilter f, Object appData)
```

This constructs a TimeOutEvent for the specified SectionFilterObject.

Parameters:

f - the SectionFilter object where the event originated

appData - application data that was passed to the startFiltering method

E.6.8 FilterResourcesAvailableEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.mpeg.sections.FilterResourcesAvailableEvent
```

public class FilterResourcesAvailableEvent

extends ResourceStatusEvent

This event signals that enough section filter resources for the corresponding section filter group were available at the time this event was generated. For example, if a section filter group was created with 4 filters, then this event indicates that at least 4 filters were available at the time this event was generated. Note that these filters may no longer be available at the time the application tries to attach the section filter group again. This event is a hint to the application that it is useful to try to attach the section filter group again. This event is only generated after a ForcedDisconnectedEvent has been generated and before the application has successfully attached the section filter group again.

Constructors

```
public FilterResourcesAvailableEvent(SectionFilterGroup f)
```

This constructs a FilterResourcesAvailableEvent for the specified SectionFilterGroup object.

Parameters:

f - the SectionFilterGroup

Methods

getSource

```
public Object getSource()
```

This returns the SectionFilterGroup object for which enough filter resources were available at the time this event was generated.

Overrides:

getSource in class ResourceStatusEvent

E.7 Exceptions

E.7.1 SectionFilterException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.sections.SectionFilterException
```

public class SectionFilterException

extends Exception

This is the base class for exceptions in the section filter API.

Constructors

```
public SectionFilterException()
```

Constructs a SectionFilterException with no detail message

```
public SectionFilterException(String s)
```

Constructs a SectionFilterException with the specified detail message

Parameters:

s - the detail message

E.7.2 FilterResourceException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.sections.SectionFilterException
                           |
                           +----
org.davic.mpeg.sections.FilterResourceException
```

public class FilterResourceException

extends SectionFilterException

Signals that inadequate resources are available to support the requested operation when a SectionFilterGroup is in the connected or disconnected states.

Constructors

```
public FilterResourceException()
```

Constructs a resource Exception.

```
public FilterResourceException(String s)
```

Constructs a FilterResourceException with the specified detail message

Parameters:

s - the detail message

E.7.3 ConnectionLostException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.mpeg.sections.SectionFilterException
                              |
                              +----
org.davic.mpeg.sections.ConnectionLostException
```

public class ConnectionLostException

extends SectionFilterException

Signals that a SectionFilterGroup has lost its connection or resources and hence is unable to satisfy a call to a startFiltering method. It is only generated for SectionFilterGroups which are in the ConnectionLost state.

Constructors

```
public ConnectionLostException()
```

Constructs an exception.

```
public ConnectionLostException(String s)
```

Constructs a ConnectionLostException with the specified detail message

Parameters:

s - the detail message

E.7.4 InvalidSourceException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.mpeg.sections.SectionFilterException
                              |
                              +----org.davic.mpeg.sections.InvalidSourceException
```

public class InvalidSourceException

extends SectionFilterException

Signals that the section source specified is not valid for some reason.

Constructors

```
public InvalidSourceException()
```

Constructs an InvalidSourceException with no detail message.

```
public InvalidSourceException(String detail)
```

Constructs an InvalidSourceException with the specified detail message.

Parameters:

detail - the detail message

E.7.5 NoDataAvailableException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.sections.SectionFilterException
                           |
                           +----
org.davic.mpeg.sections.NoDataAvailableException
```

public class NoDataAvailableException

extends SectionFilterException

Signals that no data is available from a Section object.

Constructors

```
public NoDataAvailableException()
```

Constructs a NoDataAvailableException.

```
public NoDataAvailableException(String s)
```

Constructs a NoDataAvailableException with the specified detail message

Parameters:

s - the detail message

E.7.6 IllegalFilterDefinitionException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.sections.SectionFilterException
                           |
                           +----
org.davic.mpeg.sections.IllegalFilterDefinitionException
```

public class IllegalFilterDefinitionException

extends SectionFilterException

Signals that a requested filter definition is not valid.

Constructors

```
public IllegalFilterDefinitionException()
```

Constructs an IllegalFilterDefinitionException.

```
public IllegalFilterDefinitionException(String s)
```

Constructs a IllegalFilterDefinitionException with the specified detail message

Parameters:

s - the detail message

E.7.7 FilteringInterruptedException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.mpeg.sections.SectionFilterException
                              |
                              +----
org.davic.mpeg.sections.FilteringInterruptedException
```

public class FilteringInterruptedException

extends SectionFilterException

Signals that a filtering operation was interrupted before any data had been filtered.

Constructors

```
public FilteringInterruptedException()
```

Constructs an FilteringInterruptedException.

```
public FilteringInterruptedException(String s)
```

Constructs a FilteringInterruptedException with the specified detail message

Parameters:

s - the detail message

E.8 Section filtering

Most high level modules use the org.davic.mpeg.sections module. This module filters sections from an MPEG-2 Transport Stream. A section is a data package format commonly used to send data in an MPEG-2 TS.

E.8.1 Filter options

The interfaces as presented in this document provide three kinds of interfaces:

pure PID filtering

PID filtering with a Positive filter

PID filtering with a Negative and a Positive filter

When the sections are filtered in the pure PID filtering method all sections sent within a certain PID trigger this filter:

TS_PID = SF_PID

In this equation TS_PID is the value of the PID field of the TS-packets, the SF_PID is the PID value as defined in the section filter parameters.

The second filter provides the option to filter on the PID and on the header of the section. The filtering on the section header is done using a mask and a value parameter. The mask defines which bits are filtered on. The value holds the value these bits should have. If all the bits in the header set in the mask equal the value as set in the value parameter the filter is triggered. This kind of filter is called a Positive Filter

So this Positive Filter is triggered when the following situation occurs:

$$\text{Value} \,\&\, \text{Mask} = \text{SectionHeader} \,\&\, \text{Mask}$$

The third and final option adds another step to the filter process. In many situations it is needed to trigger a filter when a part of the header changes. For example when of a certain section such as the version_number field changes. To be able to do this another filter step is necessary. This filter is called a Negative Filter.

The Negative Filter also uses the mask and value parameters, but the Negative Filter triggers when:

$$\text{value} \,\&\, \text{mask} \neq \text{header} \,\&\, \text{mask}$$

E.8.2 MPEG2 section format (informative)

The format of long headers of MPEG-2 sections is presented in Figure E-4.

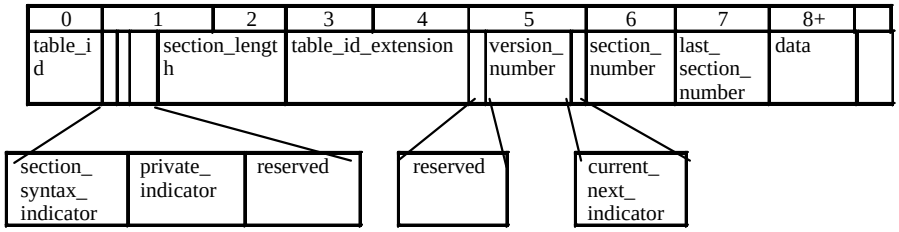


Figure E-4 Format of long header of MPEG-2 section

The first row represents the byte order, the second row the most important fields. The length of the header equals 8 bytes. Of these 8 bytes, byte 0 holds the table_id and byte 1 and 2 hold no critical filter information. So a section filter with length 7, excluding the first three bytes, covers the complete section header and gives some freedom to the user for additional filter fields (for example CA uses datafield 1 as address).

This means for mask and value of length 7 the mapping as given in Figure E-5 is used:

Table E-5 Mapping of Mask and Value on Section Header

Mask or Value array	Section header byte
0	3
1	4
2	5
3	6
4	7
5	8
6	9
7	10

Annex F
Resource Notification API

(This annex forms an integral part of this Specification)

F.1 Objective

Any system with limited resources needs some way of managing those resources and ensuring that any contention is resolved fairly and without an adverse impact on application reliability. This applies even more in a set-top box where resources can be very limited and where application robustness is of vital importance. If such a system can run multiple applications (either interoperable or native, or a combination of the two), then some form of resource management is essential.

The API (org.davic.resources) described here provides a Java interface to either an existing resource manager or any resource management functionality implemented in the DAVIC environment. For this reason, the scope of this API is limited to those applications which have a Java component.

Many necessary methods are left undefined because the security requirements for those methods cannot be met by methods defined in a Java interface, or because the exact format of these methods and their parameters is best specified in any API using the resource notification API.

F.2 Interfaces

F.2.1 ResourceProxy

public interface ResourceProxy

The resource proxy interface is implemented by objects which represent a scarce resource to an application but where the actual scarce resource may be a lower level object to which the application does not have direct access. The indirection provided by ResourceProxy allows the retaining of state regardless of availability of the actual resource. Objects implementing the ResourceProxy interface are created by the application program and may have a lifetime longer than the time a resource is actually held by the application. A resource may be acquired and released multiple times using the same ResourceProxy object. All interaction between applications and objects abstracting over the resources themselves is carried out via an object implementing the ResourceProxy interface.

Methods

getClient

```
public abstract ResourceClient getClient()
```

Returns:

the object which asked to be notified about withdrawal of the underlying physical resource from a resource proxy.

F.2.2 ResourceServer

public interface ResourceServer

The resource server interface is implemented by objects which manage low level scarce resources and inform applications of changes in their status which may have happened due to factors beyond the control of the application. Any application wishing to use a resource controlled by an object implementing the ResourceServer interface must request access to that resource via an object implementing the ResourceProxy interface, and should release the resource via the same object when exclusive access to the resource is no longer needed.

Methods

addResourceStatusEventListener

```
public abstract void addResourceStatusEventListener(ResourceStatusListener
listener)
```

This method informs a resource server that a particular object should be informed of changes in the state of the resources managed by that server.

Parameters:

listener - the object to be informed of state changes

removeResourceStatusEventListener

```
public abstract void removeResourceStatusEventListener(ResourceStatusListener
listener)
```

This method informs a resource server that a particular object is no longer interested in being informed about changes in state of resources managed by that server. If the object had not registered it's interest initially then this method has no effect.

Parameters:

listener - the object which is no longer interested

F.2.3 ResourceStatusListener

public interface ResourceStatusListener

This interface should be implemented by objects wishing to be informed about changes in status of particular resources.

Methods

statusChanged

```
public abstract void statusChanged(ResourceStatusEvent event)
```

This method is called by a ResourceServer when a resource changes status.

Parameters:

event - the change in status which happened.

F.2.4 ResourceClient

public interface ResourceClient

This interface should be implemented by objects that use a scarce resource.

Methods

requestRelease

```
public abstract boolean requestRelease(ResourceProxy proxy,
                                       Object requestData)
```

A call to this operation informs the ResourceClient that another application has requested the resource accessed via the proxy parameter. If the ResourceClient decides to give up the resource as a result of this, it should terminate its usage of proxy and return True, otherwise False. requestData may be used to pass more data to the ResourceClient so

that it can decide whether or not to give up the resource, using semantics specified outside this framework; for conformance to this framework, requestData can be ignored by the ResourceClient.

Parameters:

proxy - the ResourceProxy representing the scarce resource to the application

requestData - application specific data

Returns:

If the ResourceClient decides to give up the resource following this call, it should terminate its usage of proxy and return True, otherwise False.

release

```
public abstract void release(ResourceProxy proxy)
```

A call to this operation informs the ResourceClient that proxy is about to lose access to a resource. The ResourceClient shall complete any clean-up that is needed before the resource is lost before it returns from this operation. This operation is not guaranteed to be allowed to complete before notifyRelease() is called.

Parameters:

proxy - the ResourceProxy representing the scarce resource to the application

notifyRelease

```
public abstract void notifyRelease(ResourceProxy proxy)
```

A call to this operation notifies the ResourceClient that proxy has lost access to a resource. This can happen for two reasons: either the resource is unavailable for some reason beyond the control of the environment (e.g. hardware failure) or because the client has been too long in dealing with a ResourceClient.release() call.

Parameters:

proxy - the ResourceProxy representing the scarce resource to the application

F.3 Classes

F.3.1 ResourceStatusEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
```

public class ResourceStatusEvent

extends Object

This class is the parent class for events reporting changes in the status of resources.

Constructors

```
public ResourceStatusEvent(Object source)
```

This constructs a resource status event relating to the specified resource. The precise class of the object will depend on the individual API using the resource notification API.

Parameters:

source - the object (resource) whose status changed

Methods

getSource

```
public Object getSource()
```

Returns:

the object whose status changed

Annex G
MPEG Component API

(This annex forms an integral part of this Specification)

G.1 Objective

There are various basic MPEG concepts which need to be common between various APIs relating to MPEG. The classes in this API represent these. The API comprises two Java packages, org.davic.mpeg for most of the classes and org.davic.mpeg.dvb for two classes which provide access to DVB specific information.

G.2 Interfaces

G.2.1 NotAuthorizedInterface

public interface NotAuthorizedInterface

NotAuthorizedInterface shall be implemented by classes which can report failure to access broadcast content due to failure to descramble that content. The interface provides an ability for an application to find out some information about the reason for the failure.

Variables

POSSIBLE_UNDER_CONDITIONS

```
public static final int POSSIBLE_UNDER_CONDITIONS = 0
```

Major reason - access may be possible under certain conditions.

NOT_POSSIBLE

```
public static final int NOT_POSSIBLE = 1
```

Major reason - access not possible

COMMERCIAL_DIALOG

```
public static final int COMMERCIAL_DIALOG = 1
```

Minor reason for POSSIBLE_UNDER_CONDITIONS - user dialog needed for payment

MATURITY_RATING_DIALOG

```
public static final int MATURITY_RATING_DIALOG = 2
```

Minor reason for POSSIBLE_UNDER_CONDITIONS - user dialog needed for maturity

TECHNICAL_DIALOG

```
public static final int TECHNICAL_DIALOG = 3
```

Minor reason for POSSIBLE_UNDER_CONDITIONS - user dialog needed for technical purposes.

FREE_PREVIEW_DIALOG

```
public static final int FREE_PREVIEW_DIALOG = 4
```

Minor reason for POSSIBLE_UNDER_CONDITIONS - user dialog needed to explain about free preview.

NO_ENTITLEMENT

```
public static final int NO_ENTITLEMENT = 1
```

Minor reason for NOT_POSSIBLE - user does not have an entitlement

MATURITY_RATING

```
public static final int MATURITY_RATING = 2
```

Minor reason for NOT_POSSIBLE - user does not have suitable maturity

TECHNICAL

```
public static final int TECHNICAL = 3
```

Minor reason for NOT_POSSIBLE - a technical reason of some kind

GEOGRAPHICAL_BLACKOUT

```
public static final int GEOGRAPHICAL_BLACKOUT = 4
```

Minor reason for NOT_POSSIBLE - not allowed for geographical reasons

OTHER

```
public static final int OTHER = 5
```

Minor reason for both POSSIBLE_UNDER_CONDITIONS and NOT_POSSIBLE. Another reason.

SERVICE

```
public static final int SERVICE = 0
```

The component to which access was refused was a MPEG Program/DVB Service

See Also:

getType

ELEMENTARY_STREAM

```
public static final int ELEMENTARY_STREAM = 1
```

Access was refused to one or more elementary streams.

See Also:

getType

Methods

getType

```
public abstract int getType()
```

Returns:

SERVICE or ELEMENTARY_STREAM to indicate that either a service (MPEG program) or one or more elementary streams could not be descrambled.

getService

```
public abstract Service getService()
```

If getType() returns SERVICE, then this method returns the Service that could not be descrambled. Otherwise it returns null.

Returns:

either the Service that could not be descrambled or null

getElementaryStreams

```
public abstract ElementaryStream[] getElementaryStreams()
```

If getType() returns ELEMENTARY_STREAM, then this method returns the set of ElementaryStreams that could not be descrambled. Otherwise it returns null.

Returns:

either the set of ElementaryStreams that could not be descrambled or null

getReason

```
public abstract int[] getReason(int index) throws IndexOutOfBoundsException
```

Returns the reason(s) why descrambling was not possible.

Parameters:

index - If the component to which access failed is a Service, index shall be 0. Otherwise index shall refer to one stream in the set returned by getElementaryStreams().

Returns:

an array of length 2 where the first element of the array is the major reason and the second element of the array is the minor reason.

Throws: IndexOutOfBoundsException

If the component to which access failed is a Service, this exception will be thrown if index is non zero. If the component(s) to which access failed was a (set of) elementary streams then this exception will be thrown when index is not a valid index into the array returned by getElementaryStreams.

See Also:

getElementaryStreams

G.3 Classes

G.3.1 TransportStream

```
java.lang.Object
   |
   +----org.davic.mpeg.TransportStream
```

public abstract class TransportStream

extends Object

This class represents an MPEG-2 Transport Stream with its associated Service Information (SI) as known to a decoder.

A TransportStream object models a specific transport stream that can be accessed through a specific network interface. This implies that a Transport Stream object has implicitly a connection to a specific network interface. Thus, if two or more network interfaces can deliver the same transport stream, this will be modeled by two or more separate

TransportStream objects. A network interface does not need to be tuned to a transport stream if an application wants to use the corresponding TransportStream object.

If the corresponding network interface is currently tuned to the TransportStream, then an application can query the TransportStream for the services it contains, and the services for which elementary streams it contains. If the corresponding network interface is not currently tuned to the TransportStream, then the application can query the TransportStream for the services it contains. If the STB has cached the required information it can return it, otherwise it should return null. If an application queries a Service object for elementary stream information and the corresponding TransportStream is not currently tuned to, then the Service object should return null.

If an application has two references to a TransportStream object and those TransportStream objects model the same transport stream coming from the same network interface, then the equals() method (inherited from java.lang.Object) return true when comparing both TransportStream objects. The references themselves are not necessarily the same, although they may be.

Note: If an application wants to know to which network interface a TransportStream object is connected to, it should use the Tuning API if it is available.

Methods

getTransportStreamId

```
public int getTransportStreamId()
```

Returns:

the transport_stream_id of this transport stream.

retrieveService

```
public Service retrieveService(int serviceId)
```

Parameters:

serviceId - the id of the requested service within this transport stream

Returns:

a reference to the service object that represents the service from which this MPEG-2 TS is accessed. If the required information is not available or the indicated service does not exist, null is returned.

retrieveServices

```
public Service[] retrieveServices()
```

Returns:

the array of all service objects belonging to this transport stream. When the required information is not available null is returned.

G.3.2 Service

```
java.lang.Object
   |
   +----org.davic.mpeg.Service
```

public class Service

extends Object

This class is used to represent a Service within an MPEG Transport Stream.

Methods

getTransportStream

```
public TransportStream getTransportStream()
```

Returns:

a reference to the TransportStream object to which this Service belongs.

getServiceId

```
public int getServiceId()
```

Returns:

the service_id (or equivalently the program_number) of this service.

retrieveElementaryStream

```
public ElementaryStream retrieveElementaryStream(int pid)
```

Parameters:

pid - the value of MPEG-2 Transport Stream packets that carry the elementary stream.

Returns:

a reference to the ElementaryStream object that represents the Elementary Stream carried by packets with the specified PID. Null is returned if the specified PID is not present within this service or if no Elementary Stream is carried by the specified PID or if the required information is not available.

retrieveElementaryStreams

```
public ElementaryStream[] retrieveElementaryStreams()
```

Returns:

the array of all ElementaryStream objects present within this service. When the required information is not available null is returned.

G.3.3 ElementaryStream

```
java.lang.Object
   |
   +----org.davic.mpeg.ElementaryStream
```

public abstract class ElementaryStream

extends Object

This class represents one elementary stream within a transport stream. If an elementary stream belongs to multiple services then it will be represented by multiple instances one instance for each parent service.

Methods

getService

```
public Service getService()
```

Returns:

a reference to the Service object that represents the service in which this Elementary Stream is contained.

getPID

```
public int getPID()
```

Returns:

the PID value of MPEG-2 Transport Stream packets that carry this elementary stream.

getAssociationTag

```
public Integer getAssociationTag()
```

Returns:

the DSM-CC association tag of this elementary stream, or null if none is present.

G.3.4 ApplicationOrigin

```
java.lang.Object
   |
   +----org.davic.mpeg.ApplicationOrigin
```

public class ApplicationOrigin

extends Object

Methods

getService

```
public static Service getService()
```

Returns:

the service that contained the root object of the application, or null if the application was not contained in a service (e.g. in the case of a receiver-resident application).

G.4 DVB Specific Classes

G.4.1 DvbTransportStream

```
java.lang.Object
   |
   +----org.davic.mpeg.TransportStream
           |
           +----org.davic.mpeg.dvb.DvbTransportStream
```

public class DvbTransportStream

extends TransportStream

This class represents an MPEG-2 Transport Stream as used in DVB with its associated Service Information (SI) as known to a decoder.

Methods

getOriginalNetworkId

```
public int getOriginalNetworkId()
```

Returns:

the original_network_id of this transport stream.

getNetworkId

```
public int getNetworkId()
```

Returns:

the network_id of the network from which this MPEG-2 TS is accessed.

G.4.2 DvbElementaryStream

```
java.lang.Object
   |
   +----org.davic.mpeg.ElementaryStream
           |
           +----org.davic.mpeg.dvb.DvbElementaryStream
```

public class DvbElementaryStream

extends ElementaryStream

This class represents one elementary stream within a transport stream as used in DVB.

Methods

getComponentTag

```
public Integer getComponentTag()
```

Returns:

the DVB component tag of this elementary stream, or null if none is present.

G.4.3 DvbService

```
java.lang.Object
   |
   +----org.davic.mpeg.Service
           |
           +----org.davic.mpeg.dvb.DvbService
```

public class DvbService

extends Service

This class represents one service within a transport stream as used in DVB.

Methods

retrieveDvbElementaryStream

```
public DvbElementaryStream retrieveDvbElementaryStream(int componentTag)
```

Parameters:

componentTag - the value of the component tag that is associated with the elementary stream.

Returns:

a reference to the DvbElementaryStream object that represents the Elementary Stream that is associated with the provided component tag. Null is returned if the specified component tag is not present within this service or if the required information is not available.

G.5 Exceptions

G.5.1 NotAuthorizedException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.mpeg.NotAuthorizedException
```

public class NotAuthorizedException

extends Exception

implements NotAuthorizedInterface

This class is thrown by MPEG related APIs when access is requested to information which is scrambled and to which access is not permitted by the security system.

Constructors

```
public NotAuthorizedException()
```

Constructs a NotAuthorizedException with no detail message

```
public NotAuthorizedException(String s)
```

Constructs a NotAuthorizedException with the specified detail message

Parameters:

s - the detail message

G.5.2 TuningException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.mpeg.ResourceException
                              |
                              +----org.davic.mpeg.TuningException
```

public class TuningException

extends ResourceException

Constructors

```
public TuningException()
```

Constructs a TuningException with no detail message

```
public TuningException(String s)
```

Constructs a TuningException with the specified detail message

Parameters:

s - the detail message

Methods

getTransportStream

```
public TransportStream getTransportStream()
```

Returns:

a reference to the TransportStream object that represents the Transport Stream which could not be accessed.

G.5.3 ResourceException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.ResourceException
```

public class ResourceException

extends Exception

This exception must be thrown by MPEG related APIs when an operation could not be performed due to lack of resources.

Constructors

```
public ResourceException()
```

Constructs a ResourceException with no detail message

```
public ResourceException(String s)
```

Constructs a ResourceException with the specified detail message

Parameters:

s - the detail message

G.5.4 ObjectUnavailableException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.mpeg.ObjectUnavailableException
```

public class ObjectUnavailableException

extends Exception

This exception must be thrown by MPEG related APIs when an object is not available.

Constructors

```
public ObjectUnavailableException()
```

Constructs a ObjectUnavailableException with no detail message

```
public ObjectUnavailableException(String s)
```

Constructs a ObjectUnavailableException with the specified detail message

Parameters:

s - the detail message

Annex H
Tuning API

(This annex forms an integral part of this Specification)

H.1 Objective

The objective of this API is to provide a mechanism for inter-operable applications to select DAVIC services by tuning between different MPEG-2 transport streams.

H.2 Requirements

H.2.1 General Requirements

The API shall support selection of an MPEG-2 transport stream that is accessed through a network interface.

Support for multiple network interfaces.

Support for multiple simultaneous applications.

When access to a particular transport stream could be given via more than one network or input port, it shall be possible but not necessary for the application to specify which network or input port to use.

The application must have a possibility to attach to a transport stream which has been selected by another application.

Support for simultaneous reception of multiple transport streams from one or more network interfaces.

Ability to get information about existence, capabilities (e.g. type: cable/satellite/terrestrial) and availability of both local and remote tuners.

The API must be able to coexist with other APIs / protocols / features which are entitled to tune such as DSM-CC, MHEG-5 using DSM-CC, CA0 or a tuner server for other STUs on an in home network.

The API shall provide a mechanism to inform the application if the right to control the tuning/switching is revoked.

NOTE: switching is defined to be selection of a network interface

10. The API shall notify an application that requests tuning when the tuning operation has finished.

H.2.2 Functional Requirements

Local and Remote Tuners

The tuning API shall give access to all known transport streams that can be received by the set-top box via the NIUs at a certain time.

The tuning API shall provide a register of all such transport streams.

The tuning API shall allow for traversing that register in a convenient way, allowing for instance access per network interface.

The tuning API shall provide high level status information on the tuner such as whether it is currently tuned to a transport stream. Detailed access to error characteristics shall not be provided.

Remote Tuner Only

The API shall be extensible to allow an application to apply all its function to a tuning function which is in fact not located in the STB itself in a transparent way. More precisely:

locating the tuning device may involve knowledge about its location, but

controlling it shall be possible with complete location transparency.

H.2.3 Access to Physical Tuner Parameters

Access to physical parameters of the tuner is not required to be provided to inter-operable applications. Implementations may update the register of known transport streams by any method of their choosing.

H.3 General

The API supports multiple network interfaces, both local and remote, and allows the application to select the network interface to be used or leave the selection to the implementation of the API. However, currently the API only provides the application information about the delivery system type (satellite, cable, terrestrial) of the network interface and information whether it is a local or remote network interface. It is currently unknown if this information is sufficient for the application to do any meaningful selection of the network interface that should be used.

The tuning is normally based on the usage of Locator objects s that point to transport streams. However, the application has the option to browse the transport stream objects that are known to the receiver and tune to them directly.

The used tuning model is as follows. A tuner is a scarce resource and therefore this API uses the resource notification API, for the management of the tuner resource(s).

There are two kinds of tuning actions: explicit and implicit. Tuning is explicit when the application directly specifies which transport stream should be tuned to. Tuning is implicit when the application requests an action that implicitly requires tuning to another transport stream. Implicit tuning, for instance, can occur when the application asks the Java Media Framework to play a service and this service is part of another transport stream than the one(s) currently tuned to.

There are two types of implicit tuning. The first type is implicit tuning caused by a Java API controlled by the Java (part of the) application. The second type is implicit tuning that is not caused by such a Java API but required by the MHEG/Java application to run properly. Thus, this second type of implicit tuning is beyond the control of the Java (part of the) application. The implicit tuning example given above is an example of the first type of implicit tuning. An example of the second type of implicit tuning is a tuning action caused by DSM-CC, because the MHEG engine requires an object in another transport stream than the one(s) currently tuned to.

Explicit tuning:

The tuning API defined here supports explicit tuning. If an application wants to tune explicitly (by using this API), then it must first reserve a tuner resource. Explicit tuning is only allowed through a NetworkInterfaceController object that holds a tuner resource.

Implicit tuning when the application has not reserved an appropriate tuning resource:

An application does not need to explicitly reserve a tuner resource to do implicit tuning, because this would be awkward and because this tuning can also occur in configurations that do not have a Tuning API. When a tuner resource has not been explicitly reserved by an application, then it is up to the ‘system’ running the application to decide whether that application is allowed to do the implicit tuning action or not. This decision could for instance be based on the priority of the application, but the algorithm for this decision is currently outside the scope of this specification.

Implicit tuning in Java APIs when the application has reserved a required tuning resource:

In case the Java (part of the) application has reserved a tuning resource, then Java API implementations for which it is defined that they can cause implicit tuning, can use this tuning resource ‘under the surface’. The tuning resource will remain reserved by the application.

Implicit tuning not in Java APIs when the application has reserved a required tuning resource:

When an implicit tuning action is required that is beyond the control of the Java (part of the) application and the application has reserved a required tuning resource, then the Java (part of the) application will be notified that it has lost the resource and that the resource is no longer available. This enables the implicit tuning action to happen. When the tuning resource becomes available again later, this will be signaled to the Java (part of the) application.

(This policy prevents that the Java part of the application can block the MHEG engine to get its objects from a required transport stream. Tuning actions required by for instance CA0 can also not be blocked by the Java part of the application.)

H.3.1 The object model

The object model of the API is shown in Figure H-1, Figure H-2 and Figure H-3.

The class NetworkInterface is an abstraction of the tuner. This class has no public constructors. The implementation of the API keeps track of available network interfaces, creates the corresponding instances of the NetworkInterface class and registers them into the network interface manager.

If an application wants to be able to explicitly control a tuner, it must reserve a network interface exclusively for itself so that no other application can tune that network interface while it is reserved. However, some parts of the system software may still have a higher priority and the possibility to take over the network interface even if it has been reserved. The application will be notified of a possible withdrawal of the right to control a network interface through the ResourceClient interface.

Where one network interface has two physical inputs connected to it, this interface shall be represented as two NetworkInterface objects in this API. This is one case where reserving one network interface may result in another network interface appearing to be reserved.

An application always controls a network interface by means of a NetworkInterfaceController object. A single ResourceClient is always the owner of a NetworkInterfaceController object. The NetworkInterfaceController class implements the ResourceProxy interface.

The NetworkInterfaceManager class provides an interface that gives access to NetworkInterfaces and informs ResourceStatusListeners about any resource status changes.

An application has to implement the interfaces ResourceClient and ResourceStatusListener in order to register itself with the resource management system if it wants to use the exclusive reservation.

The StreamTable class is a database that holds information about known transport streams and their Locator`s.

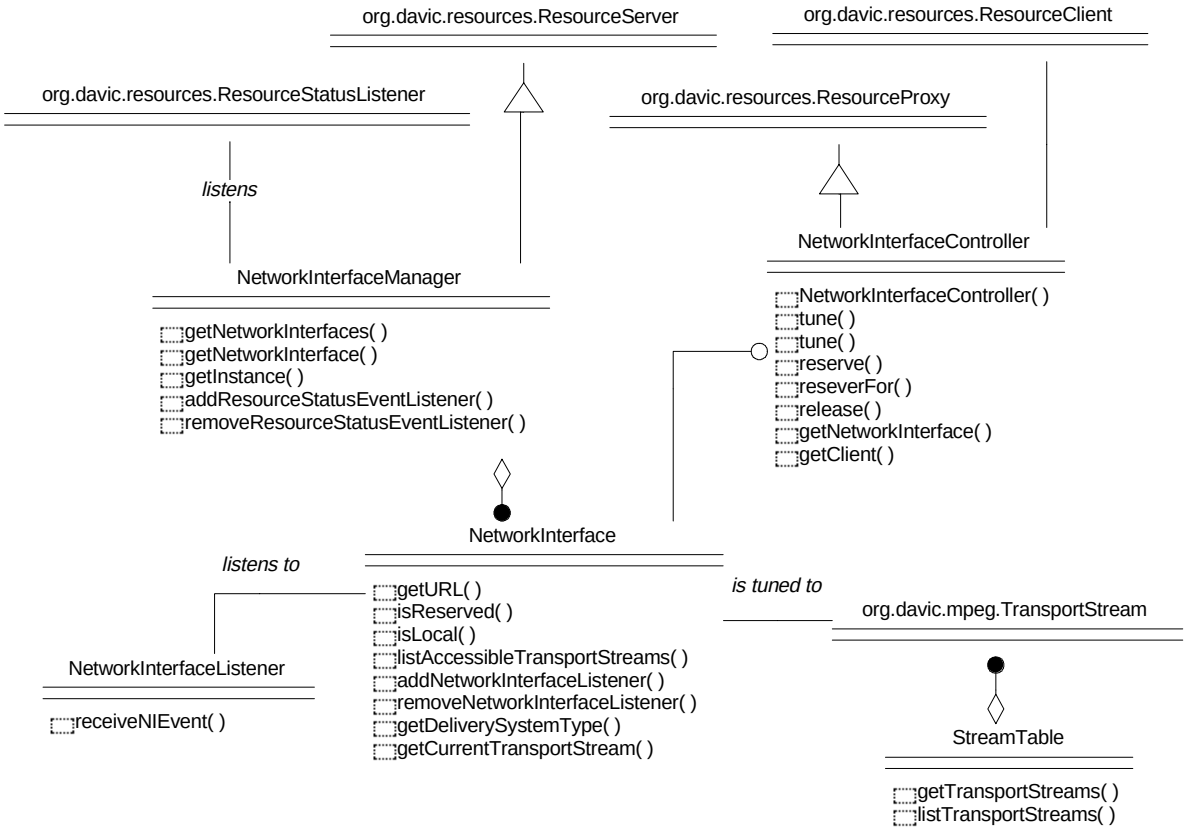


Figure H-1: Tuning API object model: Base classes.

All specified and used exceptions are shown in Figure 7.

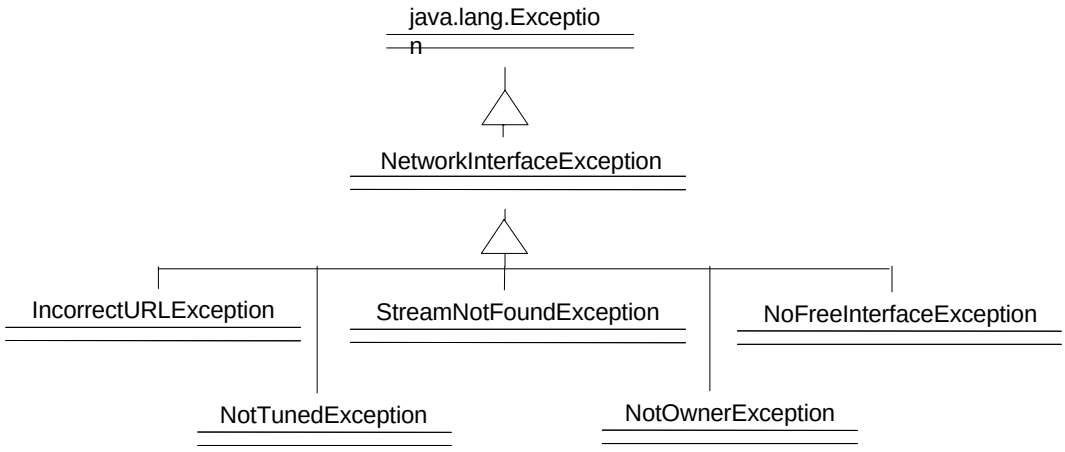


Figure H-2: Tuning API object model: Exceptions.

Classes needed to implement event listener model are shown in Figure 8.

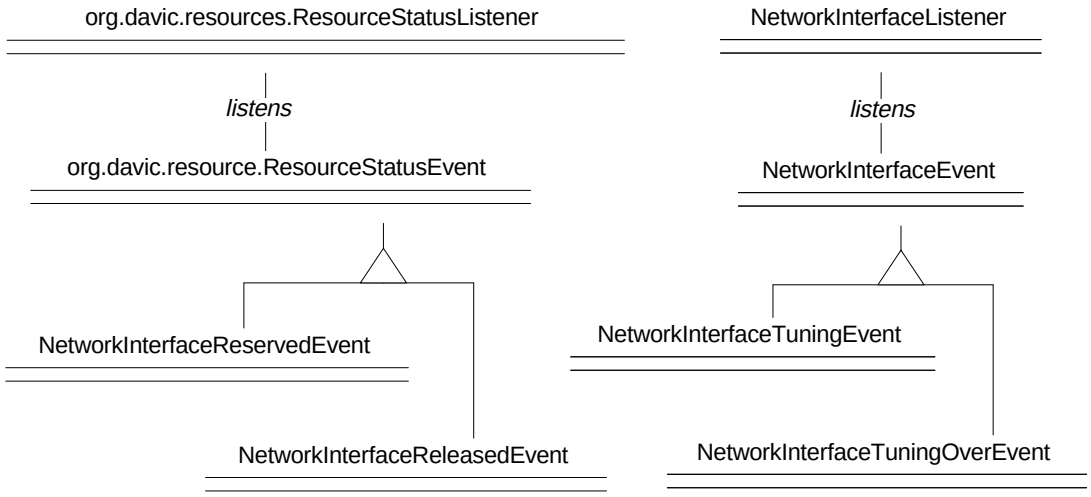


Figure H-3: Tuning API object model: Event Listener model.

NOTE: The event mechanism in this API has been defined to allow inheritance from the JDK 1.1 java.util.EventObject class and java.util.EventListener interface should this API be used on a system supporting these.

H.4 Supporting Classes API Specification

H.4.1 org.davic.net.Locator

```
java.lang.Object
   |
   +----org.davic.net.Locator
```

public abstract class Locator

extends Object

Locator that encapsulates an URL into an object

Constructors

```
public Locator()
```

```
public Locator(String url)
```

Constructor for the locator

Parameters:

url - URL string

Methods

toString

```
public String toString()
```

Returns the URL string representation

Returns:

a URL string

Overrides:

toString in class Object

hasMultipleTransformations

```
public boolean hasMultipleTransformations()
```

Indicates whether this locator maps to multiple transport dependent locators

Returns:

true, if and only if this locator maps to more than one transport dependent locator

toExternalForm

```
public String toExternalForm()
```

Returns a URL string corresponding to the locator

Returns:

a URL string

H.4.2 org.davic.net.dvb.DvbLocator

```
java.lang.Object
   |
   +----org.davic.net.Locator
            |
            +----org.davic.net.dvb.DvbLocator
```

public class DvbLocator

extends Locator

DVB Locator that encapsulates a DVB URL into an object

Constructors

```
public DvbLocator(String url) throws InvalidLocatorException
```

Constructor for the DVB locator

Parameters:

url - URL string

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid"

Parameters:

onid - original network identifier

tsid - transport stream identifier

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid,
                  int serviceid) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid.serviceid"

Parameters:

onid - original network identifier

tsid - transport stream identifier (if -1, the locator does not include a transport_stream_id)

serviceid - service identifier

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid,
                  int serviceid,
                  int eventid) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid.serviceid;eventid"

Parameters:

onid - original network identifier

tsid - transport stream identifier (if -1, the locator does not include a transport_stream_id)

serviceid - service identifier

eventid - event identifier

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid,
                  int serviceid,
                  int eventid,
                  int componenttag) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid.serviceid.componenttag;eventid " or "dvb://onid.tsid.serviceid.componenttag"

Parameters:

onid - original network identifier

tsid - transport stream identifier (if -1, the locator does not include a transport_stream_id)

serviceid - service identifier

eventid - event identifier (if -1, the locator does not include an event id)

componenttag - component tag

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid,
                  int serviceid,
                  int eventid,
                  int componenttag[]) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid.serviceid.componenttag{&componenttag};eventid" or "dvb://onid.tsid.serviceid.componenttag{&componenttag}"

Parameters:

onid - original network identifier

tsid - transport stream identifier (if -1, the locator does not include a transport_stream_id)

serviceid - service identifier

eventid - event identifier (if -1, the locator does not include an event id)

componenttags - an array of component tags

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

```
public DvbLocator(int onid,
                  int tsid,
                  int serviceid,
                  int eventid,
                  int componenttags[],
                  String filePath) throws InvalidLocatorException
```

Constructor for the DVB locator corresponding to the URL form "dvb://onid.tsid.serviceid.componenttag{&componenttag};eventid/filepath" or "dvb://onid.tsid.serviceid.componenttag{&componenttag}/filepath"

Parameters:

onid - original network identifier

tsid - transport stream identifier (if -1, the locator does not include a transport_stream_id)

serviceid - service identifier

eventid - event identifier (if -1, the locator does not include an event id)

componenttags - array of component tags (if null, the locator does not include any component tags)

the - file path string including the slash character in the beginning

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

Methods

getOriginalNetworkId

```
public int getOriginalNetworkId()
```

Returns the original_network_id

Returns:

original_network_id

getTransportStreamId

```
public int getTransportStreamId()
```

Returns the transport_stream_id

Returns:

transport_stream_id, -1 if not present

getServiceId

```
public int getServiceId()
```

Returns the service_id

Returns:

service_id, -1 if not present

getComponentTags

```
public int[] getComponentTags()
```

Returns an array of the component_tags

Returns:

an array containing the component_tags, the length of the array will be zero if the locator does not identify component_tags

getEventId

```
public int getEventId()
```

Returns the event_id

Returns:

event_id, -1 if not present

getFilePath

```
public String getFilePath()
```

Returns the file name path part of the locator

Returns:

the path string, including the slash character in the beginning. If the locator does not include a path string, this method will return null.

H.4.3 org.davic.net.dvb.NetworkBoundLocator

```
java.lang.Object
   |
   +----org.davic.net.Locator
            |
            +----org.davic.net.dvb.DvbLocator
                     |
                     +----org.davic.net.dvb.DvbNetworkBoundLocator
```

public class DvbNetworkBoundLocator

extends DvbLocator

implements TransportDependentLocator

DVB Locator that is bound to a network. An object of this type identifies uniquely a given entity and the delivery system in which it is carried.

For example, a service may be carried in both satellite and terrestrial networks and the DvbLocator identifying that service may be common, but both of them will have a different DvbNetworkBoundLocator.

Constructors

```
public DvbNetworkBoundLocator(DvbLocator unboundLocator,
                              int networkId) throws InvalidLocatorException
```

Constructor for a network bound locator

Parameters:

unboundLocator - an unbound DVB locator

networkId - network identifier of the network

Throws: InvalidLocatorException

when the parameters to construct the locator wouldn't specify a valid locator (e.g. a numeric identifier out of range)

Methods

getNetworkId

```
public int getNetworkId()
```

Returns the the network_id

Returns:

network_id

H.4.4 org.davic.net.TansportDependentLocator

public interface TransportDependentLocator

An interface implemented by Locators that identify entities that are dependent on the specific transport path they are carried in.

H.5 NetworkInterface API Specification

H.5.1 Exceptions

H.5.1.1 NetworkInterfaceException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
```

```
                    |
                    +----org.davic.net.tuning.NetworkInterfaceException
```

public class NetworkInterfaceException

extends Exception

Base class for the NetworkInterfaceExceptions

Constructors

```
public NetworkInterfaceException()
```

Default constructor for the exception

```
public NetworkInterfaceException(String reason)
```

Constructor for the network interface exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.1.2 NotTunedException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.tuning.NetworkInterfaceException
                           |
                           +----org.davic.net.tuning.NotTunedException
```

public class NotTunedException

extends NetworkInterfaceException

This exception is raised when a method that requires access to a transport stream is called on a network interface that is not tuned to any transport stream.

Constructors

```
public NotTunedException()
```

Default constructor for the exception

```
public NotTunedException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.1.3 StreamNotFoundException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
```

```
          +----java.lang.Exception
                  |
                  +----org.davic.net.tuning.NetworkInterfaceException
                          |
                          +----org.davic.net.tuning.StreamNotFoundException
```

public class StreamNotFoundException

extends NetworkInterfaceException

This exception is raised when a reference to a transport stream from a Locator can not be resolved because the transport stream does not exist in the database of known transport streams.

Constructors

```
public StreamNotFoundException()
```

Default constructor for the exception

```
public StreamNotFoundException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.1.4 NoFreeInterfaceException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.tuning.NetworkInterfaceException
                           |
                           +----org.davic.net.tuning.NoFreeInterfaceException
```

public class NoFreeInterfaceException

extends NetworkInterfaceException

This exception is raised when a NetworkInterface that could be reserved by the application, cannot be found.

Constructors

```
public NoFreeInterfaceException()
```

Default constructor for the exception

```
public NoFreeInterfaceException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.1.5 IncorrectLocatorException

```
java.lang.Object
```

```
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.tuning.NetworkInterfaceException
                           |
                           +----org.davic.net.tuning.IncorrectLocatorException
```

public class IncorrectLocatorException

extends NetworkInterfaceException

This exception is raised when a Locator given is of an inappropriate type.

Constructors

```
public IncorrectLocatorException()
```

Default constructor for the exception

```
public IncorrectLocatorException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.1.6 NotOwnerException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.tuning.NetworkInterfaceException
                           |
                           +----org.davic.net.tuning.NotOwnerException
```

public class NotOwnerException

extends NetworkInterfaceException

This exception is raised when the application calls a method and has no control over the corresponding NetworkInterface.

Constructors

```
public NotOwnerException()
```

Default constructor for the exception

```
public NotOwnerException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

H.5.2 Event-Listener model

H.5.2.1 NetworkInterfaceEvent

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterfaceEvent
```

public abstract class NetworkInterfaceEvent

extends Object

Base class for events related to network interfaces. Events that inherit from NetworkInterfaceEvent will be sent to all registered listeners, when they are sent.

Constructors

```
public NetworkInterfaceEvent(Object networkInterface)
```

The constructor for the event

Parameters:

networkInterface - the network interface which the event is generated for.

Methods

getSource

```
public Object getSource()
```

Returns the NetworkInterface that generated the event

H.5.2.2 NetworkInterfaceListener

public interface NetworkInterfaceListener

The listener used to receive NetworkInterface related events.

Methods

receiveNIEvent

```
public abstract void receiveNIEvent(NetworkInterfaceEvent anEvent)
```

This function is called to send an event to the listener

Parameters:

anEvent - event that is sent to the listener

H.5.2.3 NetworkInterfaceTuningEvent

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterfaceEvent
           |
           +----org.davic.net.tuning.NetworkInterfaceTuningEvent
```

public class NetworkInterfaceTuningEvent

extends NetworkInterfaceEvent

This event signals that a particular NetworkInterface has started to tune to another transport stream.

Constructors

```
public NetworkInterfaceTuningEvent(Object networkInterface)
```

Constructor for the event

Parameters:

networkInterface - the network interface which has started to tune.

H.5.2.4 NetworkInterfaceTuningOverEvent

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterfaceEvent
           |
           +----org.davic.net.tuning.NetworkInterfaceTuningOverEvent
```

public class NetworkInterfaceTuningOverEvent

extends NetworkInterfaceEvent

This event signals that a particular NetworkInterface has completed its tuning action.

Variables

SUCCEEDED

```
public static final int SUCCEEDED = 0
```

Constant for the status code that indicates that the Network Interface has been tuned to a new transport stream.

FAILED

```
public static final int FAILED = 1
```

Constant for the status code that indicates that the tuning action has failed.

Constructors

```
public NetworkInterfaceTuningOverEvent(Object networkInterface,
                                       int status)
```

Constructor for the event

Parameters:

networkInterface - the networkInterface which completed tuning

status - Status code which shows if the tuning action succeeded

Methods

getStatus

```
public int getStatus()
```

Returns the status code of the tuning action

Returns:

status code

H.5.3 Event-Listener model, resource status events

H.5.3.1 NetworkInterfaceReservedEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.net.tuning.NetworkInterfaceReservedEvent
```

public class NetworkInterfaceReservedEvent

extends ResourceStatusEvent

This event informs that a particular network interface has been reserved by an application or other entity in the system.

Constructors

```
public NetworkInterfaceReservedEvent(Object ni)
```

Constructor for the event

Parameters:

ni - the NetworkInterface object representing the network interface that has been reserved.

Methods

getSource

```
public Object getSource()
```

Returns the network interface that has been reserved

Returns:

the NetworkInterface object representing the network interface that has been reserved

Overrides:

getSource in class ResourceStatusEvent

H.5.3.2 NetworkInterfaceReleasedEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.net.tuning.NetworkInterfaceReleasedEvent
```

public class NetworkInterfaceReleasedEvent

extends ResourceStatusEvent

This event informs that the NetworkInterface returned by the getNetworkInterface method has been released by an application or other entity in the system.

Constructors

```
public NetworkInterfaceReleasedEvent(Object ni)
```

Constructor for the event

Parameters:

ni - the NetworkInterface object representing the network interface that has been released.

Methods

getSource

```
public Object getSource()
```

Returns the network interface that has been released

Returns:

the NetworkInterface object representing the network interface that has been released

Overrides:

getSource in class ResourceStatusEvent

H.5.4 NetworkInterface

H.5.4.1 NetworkInterfaceManager

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterfaceManager
```

public class NetworkInterfaceManager

extends Object

implements ResourceServer

A network interface manager is an object that keeps track of broadcast network interfaces that are connected to the receiver.

There is only one instance of the network interface manager in a receiver and this can be retrieved using the getInstance method.

Methods

getInstance

```
public static NetworkInterfaceManager getInstance()
```

Returns the instance of the NetworkInterfaceManager

Returns:

network interface manager

getNetworkInterfaces

```
public NetworkInterface[] getNetworkInterfaces()
```

Returns all network interfaces.

If there are no network interfaces, returns an array with the length of zero.

Returns:

an array containing all network interfaces

getNetworkInterface

```
public NetworkInterface getNetworkInterface(TransportStream ts)
```

Returns the NetworkInterface with which the specified TransportStream object is associated. It neither tunes nor reserves the NetworkInterface.

Parameters:

ts - Transport stream object

Returns:

network interface that is associated with the transport stream

addResourceStatusEventListener

```
public void addResourceStatusEventListener(ResourceStatusListener listener)
```

Registers a resource status listener to receive resource status events

Parameters:

listener - listener to be registered

removeResourceStatusEventListener

```
public void removeResourceStatusEventListener(ResourceStatusListener
listener)
```

Removes the registration of a registered listener so that it will not receive resource status events any more

Parameters:

listener - listener whose registration is to be removed

H.5.4.2 NetworkInterface

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterface
```

public class NetworkInterface

extends Object

Objects of this class represent physical network interfaces that can be used for receiving broadcast transport streams.

Methods

getCurrentTransportStream

```
public TransportStream getCurrentTransportStream()
```

Returns the transport stream to which the network Interface is currently tuned. Returns null if the network interface is

not currently tuned to a transport stream, e.g. because it is performing a tune action.

Returns:

Transport stream to which the network interface is currently tuned

getLocator

```
public Locator getLocator()
```

Returns the Locator of the transport stream to which the network interface is connected. Returns null if the network interface is not currently tuned to a transport stream.

Returns:

Locator of the transport stream to which the network interface is tuned

isReserved

```
public synchronized boolean isReserved()
```

Returns:

true, if the network interface is reserved, otherwise false

isLocal

```
public boolean isLocal()
```

Returns:

true, if the network interface is local (i.e. embedded in the receiver), otherwise false

listAccessibleTransportStreams

```
public TransportStream[] listAccessibleTransportStreams()
```

Lists the known transport streams that are accessible through this network interface. If there are no such streams, returns an array with length of zero.

Returns:

array of transport streams accassible through this network interface

getDeliverySystemType

```
public int getDeliverySystemType()
```

This method returns the type of the delivery system that this network interface is connected to.

Returns:

delivery system type

addNetworkInterfaceListener

```
public void addNetworkInterfaceListener(NetworkInterfaceListener listener)
```

Adds a listener for network interface events

Parameters:

listener - listener object to be registered to receive network interface events

removeNetworkInterfaceListener

```
public void removeNetworkInterfaceListener(NetworkInterfaceListener listener)
```

Removes a registered listener

Parameters:

listener - listener object to be removed so that it will not receive network interface events in future

H.5.4.3 NetworkInterfaceController

```
java.lang.Object
   |
   +----org.davic.net.tuning.NetworkInterfaceController
```

public class NetworkInterfaceController

extends Object

implements ResourceProxy

NetworkInterfaceController represents a controller that can be used for tuning a network interface. Applications may create a network interface controller object and use it to attempt to reserve the capability to tune a network interface.

The capability to tune a network interface is a resource and the network interface controller acts as a resource proxy for this resource.

Constructors

```
public NetworkInterfaceController(ResourceClient rc)
```

Creates a NetworkInterfaceController

Parameters:

rc - The ResourceClient that the controller is associated with

Methods

tune

```
public synchronized void tune(Locator locator) throws
NetworkInterfaceException
```

Tunes asynchronously to the given stream (specified by a Locator). This method causes the NetworkInterfaceTuningEvent and the NetworkInterfaceTuningOverEvent to be sent to the listeners of this NetworkInterface.

If tuning fails for one of the reasons which generate an exception, the status of the network interface will be unchanged and no events generated. If failure of tuning is reported by the event code of the NetworkInterfaceTuningOverEvent then the state of the network interface is not defined and it may be tuned to any transport stream or be left in a state where it is not tuned to any transport stream.

Parameters:

locator - The locator describing the transport stream to tune to

Throws: StreamNotFoundException

raised if the specified locator does not point to any known transport stream or the currently reserved NetworkInterface cannot tune to the specified transport stream

Throws: IncorrectLocatorException

raised if locator does not references a broadcast transport stream

Throws: NotOwnerException

raised if no network interface is reserved at the moment

tune

```
 public synchronized void tune(TransportStream ts) throws
NetworkInterfaceException
```

Tunes asynchronously to the given transport stream.

This method causes the NetworkInterfaceTuningEvent and the NetworkInterfaceTuningOverEvent to be sent to the listeners of this NetworkInterface. If tuning fails for one of the reasons which generate an exception, the status of the network interface will be unchanged and no events generated. If failure of tuning is reported by the event code of the NetworkInterfaceTuningOverEvent then the state of the network interface is not defined and it may be tuned to any transport stream or be left in a state where it is not tuned to any transport stream.

Parameters:

ts - Transport stream object to tune to

Throws: StreamNotFoundException

raised if the specified transport stream is not associated with the currently reserved network interface

Throws: NotOwnerException

raised if no network interface is reserved at the moment

reserve

```
 public synchronized void reserve(NetworkInterface ni,
                                  Object requestData) throws
NetworkInterfaceException
```

Tries to reserve exclusively the control over the specified network interface.

If the reservation succeeds, a NetworkInterfaceReservedEvent is sent to the listeners of the NetworkInterfaceManager. If this NetworkInterfaceController has already reserved another NetworkInterface, then it will either release that NetworkInterface and reserve the specified one, or throw an exception. If the specified NetworkInterface has already been reserved by this NetworkInterfaceController, then this method does nothing.

Parameters:

ni - Network Interface to be reserved

requestData - Used by the Resource Notification API in the requestRelease method of the ResourceClient interface. The usage of this parameter is optional and a null reference may be supplied.

Throws: NoFreeInterfaceException

raised if the requested network interface can not be raised

reserveFor

```
 public synchronized void reserveFor(Locator locator,
                                     Object requestData) throws
NetworkInterfaceException
```

Tries to reserve exclusively the control over a network interface that can receive the transport stream specified by the locator parameter.

The specific network interface is selected by the method implementation.

If the reservation succeeds, a NetworkInterfaceReservedEvent is sent to the listeners of the NetworkInterfaceManager. If this NetworkInterfaceController has already reserved another NetworkInterface, then it will either release that NetworkInterface and reserve an appropriate one, or throw an exception. If NetworkInterfaceController has already reserved a NetworkInterface that is able to tune to the specified transport stream, then this method does nothing.

Parameters:

locator - a Locator that points to a transport stream that the reserved network interface should be able to tune to

requestData - Used by the Resource Notification API in the requestRelease method of the ResourceClient interface. The usage of this parameter is optional and a null reference may be supplied.

Throws: NoFreeInterfaceException

raised if a network interface can not be reserved

Throws: StreamNotFoundException

raised if the specified locator does not point to any known transport stream

Throws: IncorrectLocatorException

raised if the locator does not references a broadcast transport stream

release

```
public synchronized void release() throws NetworkInterfaceException
```

Releases the tuner.

This method causes a NetworkInterfaceReleasedEvent to be sent to the listeners of the NetworkInterfaceManager.

Throws: NotOwnerException

raised if the controller does not currently have a network interface reserved

getNetworkInterface

```
public NetworkInterface getNetworkInterface()
```

Returns the network interface associated with this controller.

Returns:

the network interface associated with this controller or null if no network interface has been reserved.

getClient

```
public ResourceClient getClient()
```

Returns the resource client that is associated with this NetworkInterfaceController. This method implements getClient method of org.davic.resources.ResourceProxy.

Returns:

the resource client associated with this controller

H.5.4.4 DvbNetworkInterfaceSIUtil

```
java.lang.Object
   |
```

```
   +----org.davic.net.tuning.dvb.DvbNetworkInterfaceSIUtil
```

public class DvbNetworkInterfaceSIUtil

extends Object

Each SI database is associated with a network interface and vice versa. This class allows the application to query this association.

Methods

getSIDatabase

```
public static SIDatabase getSIDatabase(NetworkInterface ni)
```

Gets the SI database for a particular network interface.

Parameters:

ni - the network interface for which the associated SI database will be returned.

Returns:

the associated SI database

getNetworkInterface

```
public static NetworkInterface getNetworkInterface(SIDatabase sd)
```

Get the network interface for a particular SI database

Parameters:

sd - the SI database for which the associated network interface will be returned.

Returns:

the associated network interface

H.5.5 DeliverySystems

H.5.5.1 DeliverySystemType

public interface DeliverySystemType

An interface that defines constant values for delivery system types

Variables

SATELLITE_DELIVERY_SYSTEM

```
public static final int SATELLITE_DELIVERY_SYSTEM = 0;
```

Constant value for satellite delivery system

CABLE_DELIVERY_SYSTEM

```
public static final int CABLE_DELIVERY_SYSTEM = 1;
```

Constant value for cable delivery system

TERRESTRIAL_DELIVERY_SYSTEM

```
public static final int TERRESTRIAL_DELIVERY_SYSTEM = 2;
```

Constant value for terrestrial delivery system

H.5.6 StreamTable

```
java.lang.Object
   |
   +----org.davic.net.tuning.StreamTable
```

public class StreamTable

extends Object

A stream table containing information about transport streams known to the receiver

Methods

getTransportStreams

```
public static TransportStream[] getTransportStreams(Locator locator) throws
NetworkInterfaceException
```

Returns the transport streams that match the locator.

The locator must uniquely identify the transport stream (i.e. for DVB networks, it must specify the orig_network_id and the transport_stream_id). If the locator is more specific than just identifying the transport stream, any more specific part of it will be disregarded.

Since the same transport stream may be received via multiple networks and via multiple network interfaces, this function returns an array of all the possible transport stream objects that can be used for receiving this transport stream.

Parameters:

locator - A locator that points to a broadcast transport stream

Returns:

array of transport streams

Throws: IncorrectLocatorException

raised if the locator does not reference a broadcast transport stream

listTransportStreams

```
public static Locator[] listTransportStreams()
```

Returns all known transport streams on all network interfaces as an array of Locators

Returns:

array of Locators pointing to known transport streams

H.6 Example of using the Tuning API (informative)

An application using the Tuning API must define an object that implements the ResourceClient interface. This interface allows the Tuning API to notify the application about resource withdrawals.

If an application wants to tune it must create a NetworkInterfaceController object. This NetworkInterfaceController object must be connected to a real network interface (i.e. it must have reserved a NetworkInterface).

The example below uses the reserveFor method to reserve an appropriate network interface. Before doing a tune action, the application must subscribe to the NetworkInterfaceTuningOverEvent, so it gets notified when the tuning action completes.

This example uses the dummy object 'tuningSync' to synchronize the Tuner.tune method with the NetworkInterfaceTuningOverEvent.

Note that resource withdrawal notification methods of the ResourceClient interface are implemented rather simply, as it always directly releases the resource (i.e., the network interface).

The application can, however, continue to use the transport stream that a network interface is tuned to, even when it does not control (i.e. has not reserved) the network interface.

H.6.1 Code example

The following code is an example of how this API can be used:

```
import org.davic.mpeg.*;
import org.davic.net.Locator;
import org.davic.net.tuning.*;
import org.davic.resources.*;

class Tuner implements ResourceClient,
                           NetworkInterfaceListener {

          private NetworkInterface NIU = null;
          private NetworkInterfaceController NIUCtrl = null;
          private TransportStream ts = null;
          private Object tuningSync = new Object();
          private boolean tuningOver = false;

          public synchronized TransportStream tune(Locator locator)
                    throws NetworkInterfaceException {

            NetworkInterface NIUnew = null;

            NIUCtrl = new NetworkInterfaceController(this);
            NIUCtrl.reserveFor(locator, null);
            NIUnew = NIUCtrl.getNetworkInterface();
            if (NIUnew != NIU) {
              NIU.removeNetworkInterfaceListener(this);
              NIU = NUInew;
              NIU.addNetworkInterfaceListener(this);
            }

            synchronized(tuningSync) {
              tuningOver = false;
              NIUCtrl.tune(locator);
              try {
                while (!tuningOver) {
                  // Corresponding notify done in receiveNIEvent
                  // method.
                  tuningSync.wait();
                }
              }
              catch ( InterruptedException e )
```

```
            {
              throw new Error( “” + e );
            }
          }

          return NIU.getCurrentTransportStream();
        }

        /* This method implements ResourceClient.requestRelease
         * method   */
        public boolean requestRelease(ResourceProxy proxy,
                                      Object requestData) {

          // This version gives resource, if someone wants it
          if (proxy == NIUCtrl) {
            try {
              NIUCtrl.release();
            } catch (NetworkInterfaceException e) {
            }
          }
          return true;
        }

        /* This method implements ResourceClient.release method
         */
        public void release(ResourceProxy proxy) {
          if (proxy == NIUCtrl) {
            try {
              NIUCtrl.release();
            } catch (NetworkInterfaceException e) {
            }
          }
        }

        /* This method implements ResourceClient.notifyRelease
         * method   */
        public void notifyRelease(ResourceProxy proxy) {
          // Resource has been lost. No specific actions
          // are needed for this example.
        }

        /* Inherited from NetworkInterfaceListener
         */
        receiveNIEvent(NetworkInterfaceEvent e)
        {
          if ((e instanceof NetworkInterfaceTuningOverEvent) &&
               ((NetworkInterface)(e.getSource()) == NIU)) {
            synchronized(tuningSync) {
              tuningOver = true;
              tuningSync.notifyAll();
            }
          }
        }

...
}
```

Annex I
Conditional Access API

(This annex forms an integral part of this Specification)

I.1 Objective

This annex describes an interface between the application and the CA system. It provides the application a CA system independent interface to access some CA related functions needed, for example, in Electronic Program Guides (EPGs). This interface is intended as a high level interface for applications to access the CA systems. Actual low level CA functionality such as processing the ECM and EMM messages is performed by the CA system and is not visible to the applications. The high level interface specified in this document is hereafter referred to as the CA API.

I.2 Requirements

I.2.1 General Requirements

The interface shall support applications implementing high level MMI user dialogs but only when security has been dealt with in a proper way.

The interface must be implementable on DAVIC compliant CA interfaces.

I.2.2 CA System and Interface Requirements

The interface shall support CA modules which may be either DAVIC CA0 (DVB Common Interface [1]) or DAVIC CA1 compliant. Also mixed configurations (both CA0 and CA1 modules simultaneously) shall be supported. (In this document, the CA device is referred to as a module, even if in the case of CA1 it is actually only a smartcard.)

The interface shall provide generic support for proprietary CA system dependent extensions to DAVIC compliant CA systems.

The interface may contain CA system independent features which can be supported on some but not all DAVIC compliant CA interfaces.

The interface shall provide notification to applications about removal or installation of CA modules should that happen while that application is executing.

The interface shall allow an application to retrieve a list of CA systems supported in the STB identified by CA system ID.

The interface shall allow an application to determine some form of physical location of security modules if there are multiple slots for such modules.

If there are several CA systems in the STB, the interface shall allow an application to control which CA system is used to descramble a service. On the other hand, it shall also be possible for an application to indicate that this decision is to be taken by the implementation of the API.

The interface shall allow interoperable applications to pass messages to a security module and allow security modules to pass messages to interoperable applications. It shall allow for responses to be related back to the original message.

I.2.3 Scalability Requirements

The interface shall support STUs with multiple network interface units and multiple incoming transport streams. The support for this should not make the simple case of one network interface unit and one incoming transport stream essentially more complex.

The interface shall support one or more Conditional Access modules.

The interface shall allow multiple applications to initiate the descrambling of multiple services simultaneously if supported by the module.

I.2.4 Descrambling Requirements

The interface shall be able to coexist with implicit descrambling of services which are accessed at a high level.

The interface shall support starting and stopping the descrambling of services / components of a services which are accessed by low level APIs such as the DAVIC section filter API.

The interface shall be able to report if a transport stream with valid entitlements cannot be descrambled for technical reasons such as the absence of a path from an NIU to a security module or a mismatch in scrambling algorithms.

The interface shall support checking of the ability to descramble a specific service, or event where the module has enough information to do this. The service or event may be running or not. The interface should allow the CA system to impose access restrictions on this data. (e.g. for CA0, EN50221, Annex B, part 4, Event Enquiry Object).

The interface shall allow retrieval of a list of all entitlements of a user. The entitlements may be listed separately for each combination of CA system and security module. The API allows that the CA system imposes access restrictions on this data.

I.3 Introduction

I.3.1 The Object Model

The object model of the CA API is shown in Figure I-1, Figure I-2, Figure I-3, and Figure I-4.

The CAModule class is an abstraction of the physical CA module. The CA module provides functions for enquiring about entitlements and retrieving some CA module related information.

Class DescramblerProxy implements interface ResourceProxy for resource management ([2] annex I: Resource Notification API). A DescramblerProxy object provides functionality to descramble one service. (Note: Starting of the descrambling of a service is usually implicit for television services that are started using the media player API. Possibility to start explicitly the descrambling is mainly intended for some data services that the application accesses through the section filtering API.)

Classes TransportStream, Service and ElementaryStream from MPEG Components API [annex G] are used as parameters in methods of class CAModule and DescramblerProxy.

The CAModuleManager is an object that manages the CA modules and keeps track of the available modules in the STU. The implementation automatically creates an instance of the CAModule and registers it to the CAModuleManager when a module is inserted into the STU. Thus the class CAModule has no public constructor. Also, the CAModule object is automatically removed from the CAModuleManager when the module is removed from the STU.

Class CAModuleManager implements interface ResourceServer which gives access to DescramblerProxy and informs ResourceStatusListeners (Resource Notification API) about any resource status changes. If only implicit descrambling is used, the application does not have to implement ResourceClient and ResourceStatusListener. For such applications, APIs providing implicit descrambling may include facilities to notify them about withdrawal of resources. One example of this is the AccessDeniedEvent in the media player API.

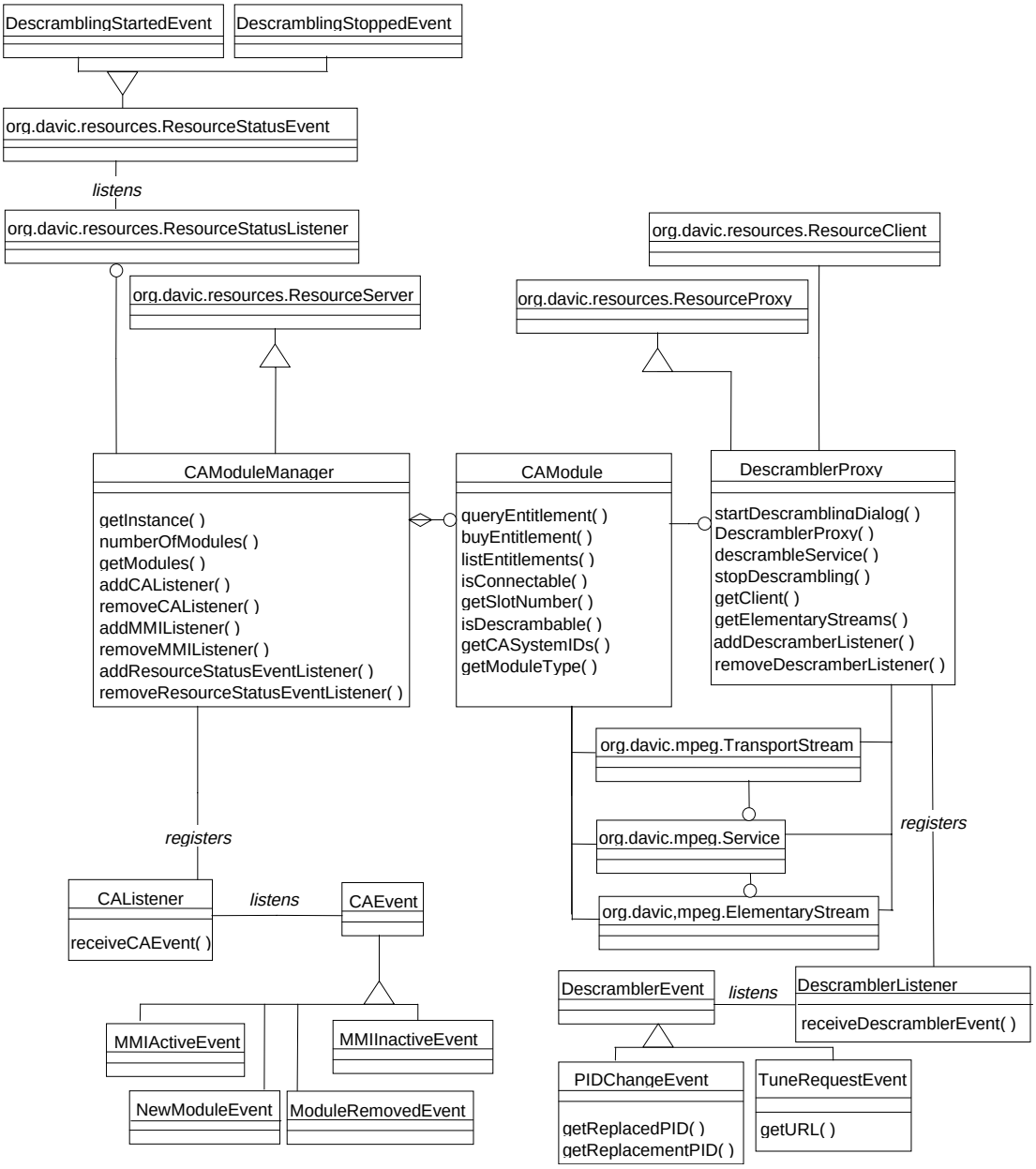


Figure I-1 : Main class diagram

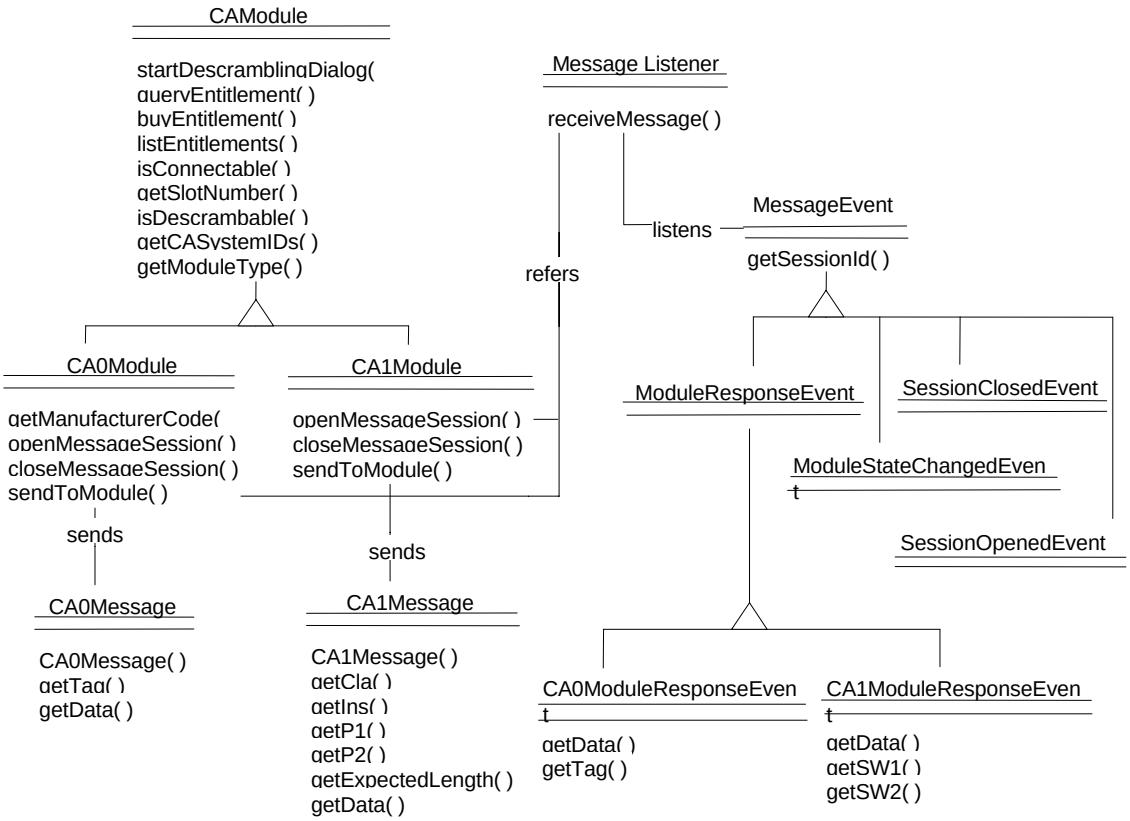


Figure I-2 : Message Passing

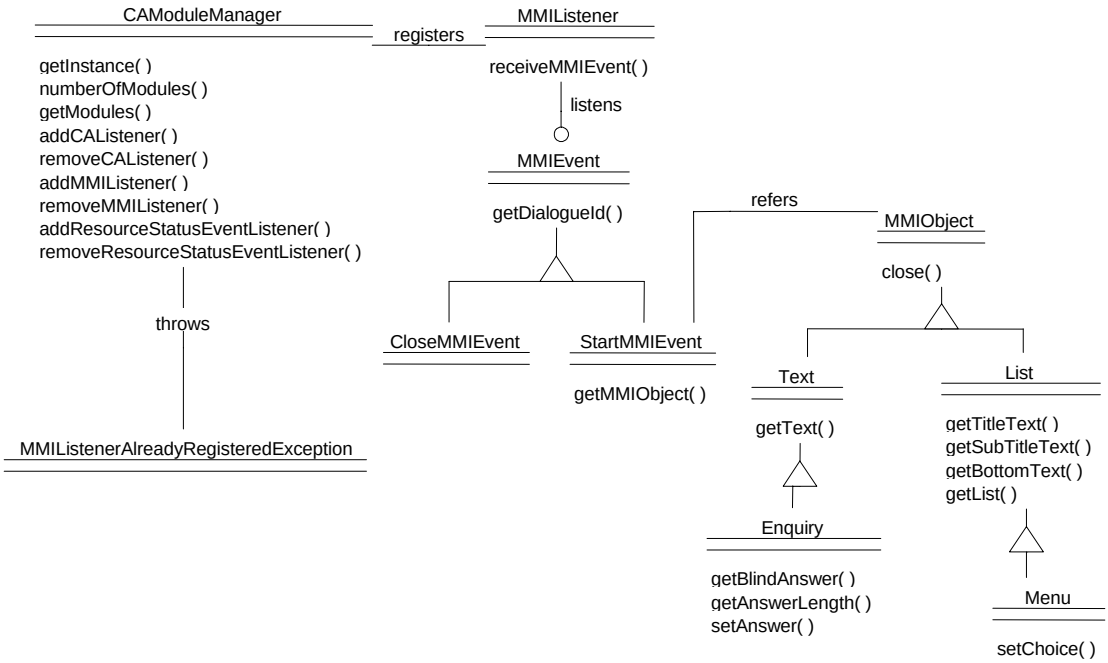


Figure I-3 : MMI

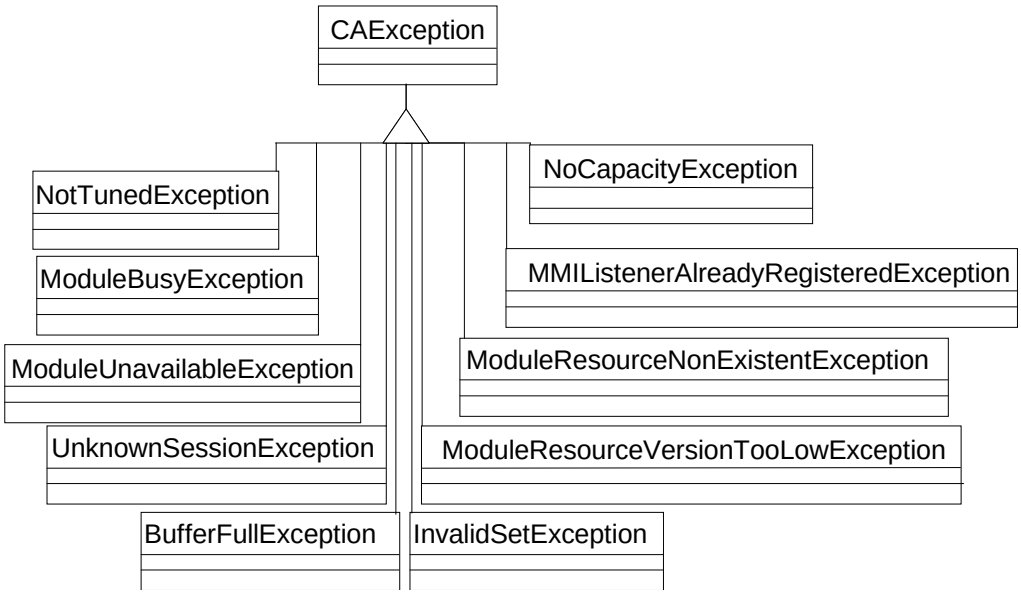


Figure I-1 : Exceptions

NOTE: The event mechanism in this API has been defined to allow inheritance from the JDK 1.1 java.util.EventObject class and java.util.EventListener interface should this API be used on a system supporting these.

I.3.2 State changes of the CA API

Figure I-4 describes the changes of the CA system. There are three states: no_descrambling, MMI_done and descrambling. The default state is no_descrambling. When the system (CAModule) is in this state, no descrambling is in execution. The state descrambling can be achieved using two different ways. The first one is to call method startDescrambling directly. After a call to this function, the process to start descrambling is carried out. This may

involve some user dialogs if the CA system requests them. If the descrambling is not possible, an exception is thrown. The second option is to call method startDescramblingDialog. That causes the CA system to start dialogue with the user if necessary and finally to enter state MMI_done. After that state descrambling can be achieved immediately by calling method startDescrambling.

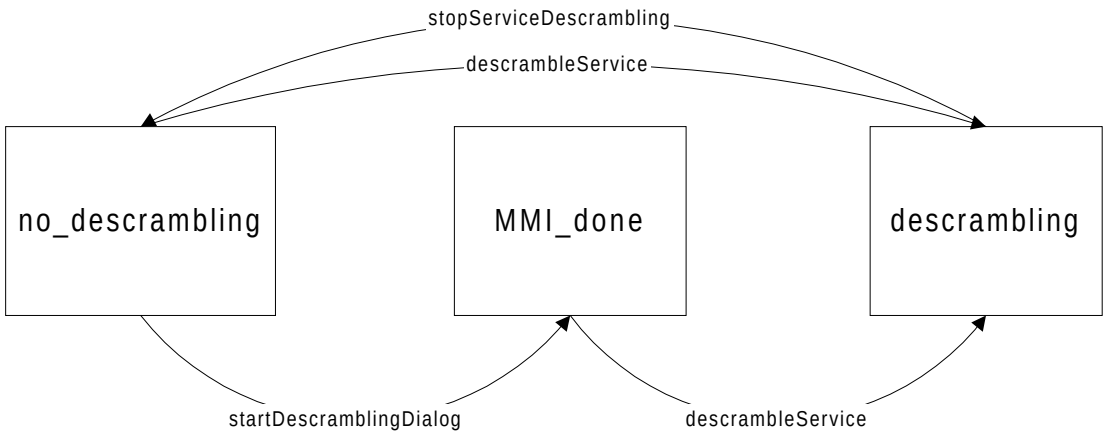


Figure I-4 : State changes of the CA system.

I.4 CA API

In API definitions is stub implementations present. Actual code shall replace those statements.

I.4.1 Exceptions

I.4.1.1 NotAuthorizedException

The following minor reasons shall be added to the definition of NotAuthorizedException in package org.davic.mpeg.

```
         /**
Reasons below are minor reasons for POSSIBLE_UNDER_CONDITIONS. */
         public final static int COMMERCIAL_DIALOG = 1;
         public final static int MATURITY_RATING_DIALOG = 2;
         public final static int TECHNICAL_DIALOG = 3;
         public final static int FREE_PREVIEW_DIALOG = 4;
         public final static int OTHER = 5;

         /**
         Reasons below are minor reasons for NOT_POSSIBLE. */
         public final static int NO_ENTITLEMENT = 1;
         public final static int MATURITY_RATING =2;
         public final static int TECHNICAL = 3;
         public final static int GEOGRAPHICAL_BLACKOUT = 4;
         public final static int OTHER = 5;
```

I.4.1.2 CAException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
```

public class CAException

extends Exception

Base class for exceptions in the CA API

Constructors

```
public CAException()
```

Default constructor for the exception

```
public CAException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.3 NoCapacityException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----org.davic.net.ca.NoCapacityException
```

public class NoCapacityException

extends CAException

This exception is raised when there isn't sufficient descrambling capacity available.

Constructors

```
public NoCapacityException()
```

Default constructor for the exception

```
public NoCapacityException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.4 NotTunedException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
```

```
                                  +----org.davic.net.ca.NotTunedException
```

public class NotTunedException

extends CAException

This exception is raised when the called method can not perform the action because the receiver is not tuned to the transport stream that carries the necessary information required to perform the action.

Constructors

```
public NotTunedException()
```

Default constructor for the exception

```
public NotTunedException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.5 MMIListenerAlreadyRegisteredException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----
org.davic.net.ca.MMIListenerAlreadyRegisteredException
```

public class MMIListenerAlreadyRegisteredException

extends CAException

This exception is raised if an application tries to register a listener for the MMI events and there is already a listener registered.

Constructors

```
public MMIListenerAlreadyRegisteredException()
```

Default constructor for the event

```
public MMIListenerAlreadyRegisteredException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.6 ModuleUnavailableException

```
java.lang.Object
   |
   +----java.lang.Throwable
```

```
          |
          +----java.lang.Exception
                  |
                  +----org.davic.net.ca.CAException
                          |
                          +----org.davic.net.ca.ModuleUnavailableException
```

public class ModuleUnavailableException

extends CAException

This exception is raised when a method is called and the module is no longer available

Constructors

```
public ModuleUnavailableException()
```

Default constructor for the exception

```
public ModuleUnavailableException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.7 ModuleBusyException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----org.davic.net.ca.ModuleBusyException
```

public class ModuleBusyException

extends CAException

This exception is raised when a method is called and the module is busy and can not perform the requested action.

Constructors

```
public ModuleBusyException()
```

Default constructor for the exception

```
public ModuleBusyException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.8 ModuleResourceNonExistentException

```
java.lang.Object
```

```
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.net.ca.CAException
                              |
                              +----
org.davic.net.ca.ModuleResourceNonExistentException
```

public class ModuleResourceNonExistentException

extends CAException

This exception is raised when the resource requested by the application in the message passing functions does not exist in the module.

Constructors

```
public ModuleResourceNonExistentException()
```

Default constructor for the exception

```
public ModuleResourceNonExistentException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.9 ModuleResourceVersionTooLowException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----org.davic.net.ca.CAException
                              |
                              +----
org.davic.net.ca.ModuleResourceVersionTooLowException
```

public class ModuleResourceVersionTooLowException

extends CAException

This exception is raised when the version of the resource requested by the application in the message passing functions is lower than what the application requested. This exception is based on table 7.7 of the common interface specification.

Constructors

```
public ModuleResourceVersionTooLowException()
```

Default constructor for the exception

```
public ModuleResourceVersionTooLowException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.10 UnknownSessionException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----org.davic.net.ca.UnknownSessionException
```

public class UnknownSessionException

extends CAException

This exception is raised when the application tries to close or send a message to an unknown session.

Constructors

```
public UnknownSessionException()
```

Default constructor for the event.

```
public UnknownSessionException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.11 InvalidSetException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----org.davic.net.ca.InvalidSetException
```

public class InvalidSetException

extends CAException

This exception is raised if an application tries to set an invalid response value in the MMI object methods or calls the methods to set the response more than once.

Constructors

```
public InvalidSetException()
```

Default constructor for the event

```
public InvalidSetException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.1.12 BufferFullException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----org.davic.net.ca.CAException
                           |
                           +----org.davic.net.ca.BufferFullException
```

public class BufferFullException

extends CAException

This exception is raised when sendToModule() is called when the message buffer is full.

Constructors

```
public BufferFullException()
```

Default constructor for the event.

```
public BufferFullException(String reason)
```

Constructor for the exception with a specified reason

Parameters:

reason - the reason why the exception was raised

I.4.2 Event-Listener model

I.4.2.1 CAEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.CAEvent
```

public abstract class CAEvent

extends Object

Base class for CA events

Methods

getSource

```
public Object getSource()
```

Returns the source of the event

I.4.2.2 DescramblerEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.DescramblerEvent
```

public abstract class DescramblerEvent

extends Object

Base class for events related to an on-going descrambling activity

Methods

getSource

```
public Object getSource()
```

Returns the source of the event

I.4.2.3 CAListener

public interface CAListener

This interface is implemented by an object in the application that can be registered to receive events related to CA

Methods

receiveCAEvent

```
public abstract void receiveCAEvent(CAEvent anEvent)
```

This method is called to send an event to the listener.

Parameters:

anEvent - event to be sent to the listener

I.4.2.4 DescramblerListener

public interface DescramblerListener

This interface is implemented by an object in the application that can be registered to receive events related to an on-going descrambling activity

Methods

receiveDescramblerEvent

```
public abstract void receiveDescramblerEvent(DescramblerEvent anEvent)
```

This method is called to send an event to the listener.

Parameters:

anEvent - event to be sent to the listener

I.4.2.5 PIDChangeEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.DescramblerEvent
           |
           +----org.davic.net.ca.PIDChangeEvent
```

public class PIDChangeEvent

extends DescramblerEvent

This event is generated as part of the Host Control functionality in the Common Interface / CA0 to signal that an elementary stream should be substituted with an other one. This event is intended for data services only. Television services that are presented using a high level media player API (whose implementation implicitly handles descrambling) will also have this event handled implicitly by that implementation.

Constructors

```
public PIDChangeEvent(short oldPid,
                      short newPid,
                      Object descramblerProxy)
```

Constructor for the event

Parameters:

oldPid - the PID to be replaced.

newPid - the new replacement PID.

descramblerProxy - the DescramblerProxy object representing the descrambling resource which is the source of the event.

Methods

getReplacedPID

```
public short getReplacedPID()
```

Returns the PID of the previous elementary stream.

Returns:

the previous PID

getReplacementPID

```
public short getReplacementPID()
```

Returns the PID of the new elementary stream that substitutes the previous one.

Returns:

the new PID to replace the previous one.

getSource

```
public Object getSource()
```

Returns the DescramberProxy that is the source of the event.

Overrides:

getSource in class DescramblerEvent

I.4.2.6 TuneRequestEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.DescramblerEvent
           |
           +----org.davic.net.ca.TuneRequestEvent
```

public class TuneRequestEvent

extends DescramblerEvent

This event is generated as part of the Host Control functionality in the Common Interface / CA0.

Constructors

```
public TuneRequestEvent(Locator locator,
                        Object descramblerProxy)
```

Constructor for the event

Parameters:

locator - a Locator pointing to the replacement broadcast service

descramblerProxy - the DescramblerProxy object representing descrambler resource which is the source of the event

Methods

getLocator

```
public Locator getLocator()
```

Returns a Locator pointing to the service to which the CA module requests to tune to

Returns:

a Locator pointing to a broadcast service

getSource

```
public Object getSource()
```

Returns the DescramblerProxy that is the source of the event

Overrides:

getSource in class DescramblerEvent

I.4.2.7 MMIActiveEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.CAEvent
           |
           +----org.davic.net.ca.MMIActiveEvent
```

public class MMIActiveEvent

extends CAEvent

This event informs that an MMI user dialog has been started

Constructors

```
public MMIActiveEvent(Object caModule)
```

Constructor for the event

Parameters:

caModule - the CAModule or CAModuleManager object representing the source of the event

Methods

getSource

```
public Object getSource()
```

Returns the CAModule or CAModuleManager that is the source of the event

Overrides:

getSource in class CAEvent

I.4.2.8 MMIInactiveEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.CAEvent
           |
           +----org.davic.net.ca.MMIInactiveEvent
```

public class MMIInactiveEvent

extends CAEvent

This event informs that an MMI user dialog has ended

Constructors

```
public MMIInactiveEvent(Object caModule)
```

Constructor for the event

Parameters:

caModule - the CAModule or CAModuleManager object representing the source of the event

Methods

getSource

```
public Object getSource()
```

Returns the CAModule or CAModuleManager that is the source of the event

Overrides:

getSource in class CAEvent

I.4.2.9 NewModuleEvent

```
java.lang.Object
   |
```

```
   +----org.davic.net.ca.CAEvent
           |
           +----org.davic.net.ca.NewModuleEvent
```

public class NewModuleEvent

extends CAEvent

This event informs that a new CA module has been added

Constructors

```
 public NewModuleEvent(CAModule caModule,
                       Object caModuleManager)
```

Constructor for the event

Parameters:

caModule - the CAModule object representing the new module

caModuleManager - the CAModuleManager object representing the module manager that is the source of the event

Methods

getModule

```
 public CAModule getModule()
```

Returns the CAModule object representing the new module

Returns:

the CAModule object representing the new module

getSource

```
 public Object getSource()
```

Returns the CAModuleManager that is the source of the event

Overrides:

getSource in class CAEvent

I.4.2.10 ModuleRemovedEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.CAEvent
           |
           +----org.davic.net.ca.ModuleRemovedEvent
```

public class ModuleRemovedEvent

extends CAEvent

This event informs that a CA module has been removed.

Constructors

```
 public ModuleRemovedEvent(int slotNumber,
                           Object caModuleManager)
```

Constructor for the event

Parameters:

slotNumber - the slot number

caModuleManager - the CAModuleManager object that is the source of the event

Methods

getSlotNumber

```
public int getSlotNumber()
```

Returns the slot number of the slot where the module was removed from

Returns:

the number of the slot from which the module was removed

getSource

```
public Object getSource()
```

Returns the CAModuleManager that is the source of the event

Overrides:

getSource in class CAEvent

I.4.2.11 DescramblingStartedEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.net.ca.DescramblingStartedEvent
```

public class DescramblingStartedEvent

extends ResourceStatusEvent

This event sent to the resource status event listeners when the descrambling of a service is started.

This event is generated only when the descrambling is actually started. If two applications are requesting to descramble the same service, this event is generated only when the first application first requests the descrambling and it actually starts.

Constructors

```
public DescramblingStartedEvent(Object caModule)
```

Constructor for the event

Parameters:

caModule - the CAModule object controlling the descrambling which has just started.

Methods

getServiceLocator

```
public Locator getServiceLocator()
```

Returns a Locator pointing to the service components of which are descrambled.

Returns:

a Locator pointing to a broadcast service

getSource

```
public Object getSource()
```

Returns the CAModule object controlling the descrambling which has just started.

Overrides:

getSource in class ResourceStatusEvent

I.4.2.12 DescramblingStoppedEvent

```
java.lang.Object
   |
   +----org.davic.resources.ResourceStatusEvent
           |
           +----org.davic.net.ca.DescramblingStoppedEvent
```

public class DescramblingStoppedEvent

extends ResourceStatusEvent

This event sent to the resource status event listeners when the descrambling is stopped because of the application itself stopping it or because the descrambling resources were revoked by some other part of the system.

This event is generated only when the descrambling is actually stopped. If two applications are requesting to descramble the same service, this event is generated only after both of them have requested to stop the descrambling and the descrambling actually stops.

Constructors

```
public DescramblingStoppedEvent(Object caModule)
```

Constructor for the event

Parameters:

caModule - the CAModule object controlling the descrambling which has just stopped.

Methods

getServiceLocator

```
public Locator getServiceLocator()
```

Returns a Locator pointing to the service components of which have been descrambled.

Returns:

a Locator pointing to a broadcast service

getSource

```
public Object getSource()
```

Returns the CAModule object controlling the descrambling which has just stopped.

Overrides:

getSource in class ResourceStatusEvent

I.4.2.13 ModuleRemovedEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.CAEvent
           |
           +----org.davic.net.ca.ModuleRemovedEvent
```

public class ModuleRemovedEvent

extends CAEvent

This event informs that a CA module has been removed.

Constructors

```
public ModuleRemovedEvent(int slotNumber,
                          Object caModuleManager)
```

Constructor for the event

Parameters:

slotNumber - the slot number

caModuleManager - the CAModuleManager object that is the source of the event

Methods

getSlotNumber

```
public int getSlotNumber()
```

Returns the slot number of the slot where the module was removed from

Returns:

the number of the slot from which the module was removed

getSource

```
public Object getSource()
```

Returns the CAModuleManager that is the source of the event

Overrides:

getSource in class CAEvent

I.4.3 Event-Listener model, MMI

I.4.3.1 MMIEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIEvent
```

public abstract class MMIEvent

extends Object

Base class for events related to MMI dialogs

Methods

getDialogueId

```
public int getDialogueId()
```

Returns the identifier of the dialogue.

Returns:

the identifier of the dialogue

getSource

```
public Object getSource()
```

Returns the CAModule or CAModuleManager that is the source of the event

I.4.3.2 StartMMIEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIEvent
           |
           +----org.davic.net.ca.StartMMIEvent
```

public class StartMMIEvent

extends MMIEvent

This event informs an application that an MMI dialogue has to be started.

Constructors

```
public StartMMIEvent(MMIObject mmiObject,
                     int dialogueId,
                     Object caModule)
```

Constructor for the event

Parameters:

mmiObject - the MMI object

dialogueId - a unique identifier for the dialogue

Methods

getMMIObject

```
public MMIObject getMMIObject()
```

Returns a reference to the object that describes the MMI.

Returns:

the MMI object describing the MMI dialogue to be presented

I.4.3.3 CloseMMIEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIEvent
            |
            +----org.davic.net.ca.CloseMMIEvent
```

public class CloseMMIEvent

extends MMIEvent

This event informs application(s) that an MMI dialogue has to be closed. During normal operation, an MMI dialogue is closed either after receiving a new StartMMIEvent or after receiving a CloseMMIEvent.

Constructors

```
public CloseMMIEvent(Object caModule,
                     int DialogueID)
```

Constructor for the event

Parameters:

caModule - the CAModule or CAModuleManager object representing the source of the event.

DialogueID - the dialogue which has been closed

I.4.3.4 MMIListener

public interface MMIListener

The object in the application that wants to register to receive events related to the MMI dialogues must implement this interface.

Methods

receiveMMIEvent

```
public abstract void receiveMMIEvent(MMIEvent event)
```

This method is called to send an event to the listener

Parameters:

event - the event to be sent

I.4.4 Event-Listener model, Message passing

I.4.4.1 MessageEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
```

public abstract class MessageEvent

extends Object

Base class of events related to message passing in the CA API

Methods

getSessionId

```
public int getSessionId()
```

Returns the session_id of the message session

Returns:

the session_id

getSource

```
public Object getSource()
```

Returns the source of the event

Returns:

the CAModule object representing the CA module that is the source of this event

I.4.4.2 SessionClosedEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.SessionClosedEvent
```

public class SessionClosedEvent

extends MessageEvent

Event to notify the application that a session has been closed.

Constructors

```
public SessionClosedEvent(int SessionID,
                          Object caModule)
```

Constructor for the event

Parameters:

SessionID - the sessionID of the session concerned

caModule - the CAModule object representing the module that is the source of the event

Methods

getSource

```
public Object getSource()
```

This method returns the CAModule that is the source of the event

Returns:

the CAModule object representing the CA module that is the source of the event

Overrides:

getSource in class MessageEvent

I.4.4.3 SessionOpenedEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.SessionOpenedEvent
```

public class SessionOpenedEvent

extends MessageEvent

Event to notify the application that a session has been opened. This is generated after the return from openMessageSession. For CA1, it will be delayed after the return from openMessageSession until the time when the session has actual access to the smart card.

Constructors

```
public SessionOpenedEvent(int SessionID,
                          Object caModule)
```

Constructor for the event

Parameters:

SessionID - the sessionID of the session concerned

caModule - the CAModule object representing the module that is the source of the event

Methods

getSource

```
public Object getSource()
```

This method returns the CAModule that is the source of the event

Returns:

the CAModule object representing the CA module that is the source of the event

Overrides:

getSource in class MessageEvent

I.4.4.4 ModuleStateChangedEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.ModuleStateChangedEvent
```

public class ModuleStateChangedEvent

extends MessageEvent

This event is sent for a specific session, at the moment that the state of the module (as far as relevant to that session) has changed. The module state may change due to events out of the scope of the session, e.g. when the module is accessed by other parts of the STB software.

Any messages sent by the application to the CA module in this session to which the CA module has not responded yet, may or may not have been delivered to the module and will not be responded to any more due to the state change.

Constructors

```
public ModuleStateChangedEvent(int SessionID,
                               Object caModule)
```

Constructor for the event

Parameters:

SessionID - the sessionID of the session concerned

caModule - the CAModule object representing the module that is the source of the event

Methods

getSource

```
public Object getSource()
```

Returns the CAModule that is the source of the event

Returns:

the CAModule object representing the CA module that is the source of the event

Overrides:

getSource in class MessageEvent

I.4.4.5 ModuleResponseEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.ModuleResponseEvent
```

public abstract class ModuleResponseEvent

extends MessageEvent

Base class for events that carry a message from the module

Methods

getSource

```
public Object getSource()
```

Returns the CAModule that is the source of the event

Overrides:

getSource in class MessageEvent

I.4.4.6 CA0ModuleResponseEvent

```
java.lang.Object
   |
```

```
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.ModuleResponseEvent
                   |
                   +----org.davic.net.ca.CA0ModuleResponseEvent
```

public class CA0ModuleResponseEvent

extends ModuleResponseEvent

Event that carries a message from a CA0 (Common Interface) module

Constructors

```
public CA0ModuleResponseEvent(byte data[],
                              int tag,
                              int SessionID,
                              Object caModule)
```

Constructor for the event

Parameters:

data - the data of the response

tag - the APDU tag

SessionID - the sessionID of the session concerned

caModule - the CAModule object representing the module that is the source of the event

Methods

getData

```
public byte[] getData()
```

Returns the data bytes of the response.

Returns:

the data bytes of the response

getTag

```
public int getTag()
```

Returns the APDU tag of the response

Returns:

the APDU tag

getSource

```
public Object getSource()
```

Returns the CAModule that is the source of the event

Returns:

the CAModule object representing the CA module that is the source of the event

Overrides:

getSource in class ModuleResponseEvent

I.4.4.7 CA1ModuleResponseEvent

```
java.lang.Object
   |
   +----org.davic.net.ca.MessageEvent
           |
           +----org.davic.net.ca.ModuleResponseEvent
                   |
                   +----org.davic.net.ca.CA1ModuleResponseEvent
```

public class CA1ModuleResponseEvent

extends ModuleResponseEvent

Event that carries a message from a CA1 module

Constructors

```
public CA1ModuleResponseEvent(byte data[],
                              byte sw1,
                              byte sw2,
                              int SessionID,
                              Object caModule)
```

Constructor for the event

Parameters:

data - the data of the response

sw1 - the SW1 byte

sw2 - the SW2 byte

SessionID - the sessionID of the session concerned

caModule - the CAModule object representing the module that is the source of the event

Methods

getData

```
public byte[] getData()
```

Returns the data bytes of the response.

Returns:

the data

getSW1

```
public byte getSW1()
```

Returns the smart card status word 1 of the response

Returns:

the sw1 byte

getSW2

```
public byte getSW2()
```

Returns the smart card status word 2 of the response

Returns:

the sw2 byte

getSource

```
public Object getSource()
```

Returns the CAModule that is the source of the event

Returns:

the CAModule object representing the CA module that is the source of the event

Overrides:

getSource in class ModuleResponseEvent

I.4.4.8 MessageListener

public interface MessageListener

Objects of the application that want to be registered to receive events related to message passing with CA modules must implement this interface.

Methods

receiveMessage

```
public abstract void receiveMessage(CAModule module,
                                    MessageEvent event)
```

This method is called to send a message to the listener.

Parameters:

module - the CA module that is the sender of the message

event - the message event to be sent

I.4.5 CAModuleManager

```
java.lang.Object
   |
   +----org.davic.net.ca.CAModuleManager
```

public class CAModuleManager

extends Object

implements ResourceServer

The CA module manager is an object that manages available CA modules.

There is only one instance of the CAModuleManager in a receiver and it can be retrieved using the getInstance method.

Methods

getInstance

```
public static CAModuleManager getInstance()
```

Returns the instance of the CAModuleManager class.

Returns:

the CA module manager object instance

numberOfModules

```
public int numberOfModules()
```

Returns the number of connected CA modules.

Returns:

number of connected CA modules

getModules

```
public CAModule[] getModules()
```

Returns all available CA modules.

If there are no available modules, returns an array whose length is 0.

Returns:

an array containing all available CA modules

getModules

```
public CAModule[] getModules(Service s)
```

Returns all available modules whose CASystemID matches with the CASystemID of a CA system used to scramble this service.

If there are no applicable modules, returns an array whose length is 0.

Parameters:

s - a service that is scrambled

Returns:

an array of CA modules

addCAListener

```
public void addCAListener(CAListener l)
```

Registers a new CA event listener to CAModuleManager.

Parameters:

l - the listener to be registered

removeCAListener

```
public void removeCAListener(CAListener l)
```

Removes a registered listener from CAModuleManager.

Parameters:

l - the listener to be removed

addMMIListener

```
public void addMMIListener(MMIListener listener) throws CAException
```

Registers a listener for the MMI related events. There can be only one MMI listener registered at a time.

Parameters:

listener - the listener to be registered

Throws: MMIListenerAlreadyRegisteredException

raised if there is already a listener registered

removeMMIListener

```
public void removeMMIListener(MMIListener listener)
```

Removes a registered listener for the MMI related events.

Parameters:

listener - the listener to be removed

addResourceStatusEventListener

```
public void addResourceStatusEventListener(ResourceStatusListener l)
```

Registers a listener for the resource status messages.

Parameters:

l - the listener to be registered

removeResourceStatusEventListener

```
public void removeResourceStatusEventListener(ResourceStatusListener l)
```

Removes a registered listener for the resource status messages.

Parameters:

l - the listener to be removed

I.4.6 CAModule

```
java.lang.Object
   |
   +----org.davic.net.ca.CAModule
```

public abstract class CAModule

extends Object

CAModule class represents a physical CA Module

Variables

CA0

```
public static final int CA0 = 0x00
```

Constant value for the CA0 (Common Interface) CA module type. Values from 0x02 to 0xFE are reserved for future use.

See Also:

getModuleType

CA1

```
public static final int CA1 = 0x01
```

Constant value for the CA1 (DAVIC specified smart card) CA module type. Values from 0x02 to 0xFE are reserved for future use.

See Also:

getModuleType

PROPRIETARY

```
public static final int PROPRIETARY = 0xFF
```

Constant value for the proprietary CA module types. Values from 0x02 to 0xFE are reserved for future use.

See Also:

getModuleType

ENTITLEMENT_UNKNOWN

```
public static final int ENTITLEMENT_UNKNOWN = 0x00
```

Constant value for a return value of queryEntitlement(). ENTITLEMENT_UNKNOWN shall be returned if all necessary information for returning a more specific answer is not available (e.g. because the STU is not tuned to the relevant transport stream).

See Also:

queryEntitlement

ENTITLEMENT_AVAILABLE

```
public static final int ENTITLEMENT_AVAILABLE = 0x01
```

Constant value for a return value of queryEntitlement(). ENTITLEMENT_AVAILABLE is returned when the entitlement is definitely available and all information needed to verify this is available.

See Also:

queryEntitlement

ENTITLEMENT_NOT_AVAILABLE

```
public static final int ENTITLEMENT_NOT_AVAILABLE = 0x02
```

Constant value for a return value of queryEntitlement(). ENTITLEMENT_NOT_AVAILABLE is returned when the entitlement is definitely not available and all information needed to verify this is available.

See Also:

queryEntitlement

MMI_DIALOGUE_REQUIRED

```
public static final int MMI_DIALOGUE_REQUIRED = 0x03
```

Constant value for a return value of queryEntitlement(). MMI_DIALOGUE_REQUIRED is returned when the entitlement may become available after an MMI dialogue (e.g. a purchase dialogue or a maturity rating verification dialogue).

See Also:

queryEntitlement

Methods

queryEntitlement

```
public int queryEntitlement(Locator locator) throws CAException
```

Returns if descrambling is possible for specified service or future event (specified by a Locator).

Return values are specified by constants in this class. In case of CA0 this maps onto event_query with event_cmd_id = query (Common Interface specification, section B.4.1.1).

Parameters:

locator - a Locator that points to a broadcast service or an event of a service

Returns:

descrambling status code

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

buyEntitlement

```
public int buyEntitlement(Locator locator) throws CAException
```

Initiates a purchase dialogue for specified service or future event (specified by a Locator).

Returns whether descrambling of the specified service or future event is possible after the user dialogue has been completed. Return values are specified by constants in this class. If a dialog is required to buy an entitlement, this dialog may be started. In case of CA0 this method maps onto event_query with event_cmd_id = mmi (Common Interface specification, section B.4.1.1).

Parameters:

locator - Locator that points to a broadcast service or an event of a service

Returns:

descrambling status code (similar as in queryEntitlement)

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

listEntitlements

```
public String[] listEntitlements() throws CAException
```

Returns the entitlements present in this module for display to the end-user. The strings returned are CA system dependent. The CA system and implementation of this API together should format these such that they can be presented to end users.

Returns:

array of entitlement strings

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

isConnectable

```
public boolean isConnectable(TransportStream ts) throws CAException
```

Returns true if the given transport stream can be connected to this module

Returns:

true, if the transport stream can be connected to this CA module, false otherwise

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

getSlotNumber

```
public int getSlotNumber() throws CAException
```

Returns the number of the slot where module is connected. The numbering of slots is dependent on the API implementation, but should be such that if the number is presented to the end user, he can identify which physical slot it is.

Returns:

slot number

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

isDescramblable

```
public boolean isDescramblable(Service s) throws CAException
```

Returns true if given service can be descrambled by this CAModule now. The difference between this function and the queryEntitlement is that this function returns whether this CA module can descramble this service now, i.e. if it has both the entitlement as well as resources to perform it. In case of CA0 this maps onto ca_pmt with ca_pmt_cmd_id = query (Common Interface specification, section 8.4.3.4).

Returns:

true, if descrambling of the service could be performed now, false otherwise

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

isDescramblable

```
public boolean isDescramblable(ElementaryStream streams[]) throws CAException
```

Returns true if the given array of elementary services (which are components of the same service) can be descrambled by this CAModule. The difference between this function and the queryEntitlement is that this function returns whether this CA module can descramble this service now, i.e. if it has both the entitlement as well as resources to perform it. In case of CA0 this maps onto ca_pmt with ca_pmt_cmd_id = query (Common interface specification, section 8.4.3.4).

Returns:

true, if descrambling of these elementary streams could be performed now, false otherwise

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

getCASystemIDs

```
public int[] getCASystemIDs() throws CAException
```

Returns all CASystemIDs of this CA module.

Returns:

array of CA system identifiers

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

getModuleType

```
public int getModuleType() throws CAException
```

Returns the type of this module. Constants for the possible return values are defined in this class

Returns:

module type

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

openMessageSession

```
public int openMessageSession(
                                MessageListener listener) throws CAException
```

This method allows an application to open a message session to this module. The return value of this method is the session_id that is a unique identification of the session within the module.

Parameters:

listener – the listener which will receive the messages related to this message session

Returns:

the session identifier

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: ModuleBusyException

raised if the module is busy and is not able to handle a message session at the moment

Throws: ModuleResourceNonExistentException

raised if the specified resource cannot be addressed. This includes situations where the resource is not present in the module as well as addressing what would be a public resource in a DAVIC CA0 / DVB-CI system.

Throws: ModuleResourceVersionTooLowException

raised if the version of the module resource is too low

closeMessageSession

```
public void closeMessageSession(int session_id) throws CAException
```

This method allows an application to close a session to this module. After this method has returned, no new messages will be accepted in this session. Messages that have already been submitted will however be answered. After the last 'ModuleResponseEvent' a 'SessionClosedEvent' will follow.

Parameters:

session_id - the session identifier returned by the openMessageSession method.

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: UnknownSessionException

raised if the specified session does not exist

sendToModule

```
public void sendToModule(int session_id,
```

```
CAMessage msg) throws CAException
```

Sends a message to this module. The sending of the message is asynchronous.

Parameters:

session_id - the session identifier returned by the openMessageSession method

msg - the message to be sent to the module

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: UnknownSessionException

raised if the specified session does not exist

Throws: BufferFullException

raised if the message buffer is full

I.4.7 DescramblerProxy

```
java.lang.Object
   |
   +----org.davic.net.ca.DescramblerProxy
```

public class DescramblerProxy

extends Object

implements ResourceProxy

The class DescramblerProxy is a proxy for the descrambling resources.

An application instantiates an object of this class to descramble a service or elementary streams of a single service. If an application wants to descramble multiple services simultaneously, it should instantiate multiple objects.

Constructors

```
public DescramblerProxy(ResourceClient c)
```

Constructor of a resource proxy for a specific resource client.

Parameters:

c - the resource client object representing the application as a client for the resource management

Methods

startDescramblingDialog

```
public void startDescramblingDialog(Service s) throws CAException,
NotAuthorizedException
```

Requests the CA system to perform any user dialogs needed before starting to descramble the service.

This version can be used for descrambling the whole service. In case of CA0 this maps onto ca_pmt with ca_pmt_cmd_id = ok_mmi (Common Interface specification, section 8.4.3.4). After successful execution, descrambling can be started with the startDescrambling method.

Parameters:

s - service to be descrambled after the dialogue

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

startDescramblingDialog

```
public void startDescramblingDialog(ElementaryStream streams[]) throws
CAException, NotAuthorizedException
```

Requests the CA system to perform any user dialogs needed before starting to descramble the service.

This version can be used for descrambling only specified subset of elementary streams of a service. The elementary streams given in the parameter array must belong to the same service. In case of CA0 this maps onto ca_pmt with ca_pmt_cmd_id = ok_mmi (Common Interface specification, section 8.4.3.4). After successful execution, descrambling can be started with the startDescrambling method.

Parameters:

streams - subset of elementary streams of a service to be descrambled after the dialogue

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

startDescrambling

```
public synchronized CAModule startDescrambling(Service s,
                                               Object requestData) throws
CAException, NotAuthorizedException
```

Stops all existing descrambling initiated by this DescramblerProxy instance and starts the descrambling of the specified service.

The module used for descrambling is returned. If descrambling is not possible, an exception is thrown. This method may start an MMI dialog.

Parameters:

s - service to be descrambled

requestData - Used by the ResourceNotification API in the requestRelease method of the ResourceClient interface. Usage of this parameter is optional and a null reference may be supplied.

Returns:

CA module used for descrambling

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

startDescrambling

```
public synchronized CAModule startDescrambling(ElementaryStream streams[],
                                               Object requestData) throws
CAException, NotAuthorizedException
```

Stops all existing descrambling initiated by this DescramblerProxy instance and starts the descrambling of the specified elementary streams (that shall be part of the same service).

The module used for descrambling is returned. If descrambling is not possible, an exception is thrown. This method may start an MMI dialog.

Parameters:

streams - subset of elementary streams of a service to be descrambled after the dialogue

requestData - Used by the ResourceNotification API in the requestRelease method of the ResourceClient interface. Usage of this parameter is optional and a null reference may be supplied.

Returns:

CA module used for descrambling

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

startDescrambling

```
public synchronized void startDescrambling(Service s,
                                           CAModule module,
                                           Object requestData) throws
CAException, NotAuthorizedException
```

Stops all existing descrambling initiated by this DescramblerProxy instance and starts the descrambling of the specified service.

The module to be used for descrambling is indicated as a parameter. If descrambling is not possible, an exception is thrown. This method may start an MMI dialog.

Parameters:

s - service to be descrambled

module - CA module to be used for descrambling

requestData - Used by the ResourceNotification API in the requestRelease method of the ResourceClient interface. Usage of this parameter is optional and a null reference may be supplied.

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

startDescrambling

```
public synchronized void startDescrambling(ElementaryStream streams[],
                                           CAModule module,
                                           Object requestData) throws
CAException, NotAuthorizedException
```

Stops all existing descrambling initiated by this DescramblerProxy instance and starts the descrambling of the specified elementary streams (that shall be part of the same service). The module to be used for descrambling is indicated as a parameter. If descrambling is not possible, an exception is thrown. This method may start an MMI dialog.

Parameters:

streams - subset of elementary streams of a service to be descrambled after the dialogue

module - CA module to be used for descrambling

requestData - Used by the ResourceNotification API in the requestRelease method of the ResourceClient interface. Usage of this parameter is optional and a null reference may be supplied.

Throws: NoFreeCapacityException

raised if the CAModule does not have available capacity to perform this action now

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: NotTunedException

raised if performing the action would require being tuned to the transport stream carrying the service and the receiver is not currently tuned to it

Throws: NotAuthorizedException

raised if the user is not authorized to perform this action

stopDescrambling

```
public void stopDescrambling() throws CAException
```

Stops descrambling of the service.

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

stopDescrambling

```
public void stopDescrambling(ElementaryStream streams[]) throws CAException
```

Stops descrambling of the specified elementary streams of the service.

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

addDescramblerListener

```
public void addDescramblerListener(DescramblerListener l)
```

Registers a new descrambler event listener.

Parameters:

l - the listener to be registered

removeDescramblerListener

```
public void removeDescramblerListener(DescramblerListener l)
```

Removes a registered descrambler event listener.

Parameters:

l - the listener to be removed

getCAModule

```
public CAModule getCAModule()
```

Returns the CA module that is associated with the current descrambling via this proxy.

If there is no descrambling being active via this proxy at the moment, this method returns null.

Returns:

CAModule object representing the CA module that is associated with the current descrambling activity.

getClient

```
public ResourceClient getClient()
```

Returns the resource client associated with this resource proxy. This method implements ResourceProxy.getClient method.

Returns:

resource client

getElementaryStreams

```
public ElementaryStream[] getElementaryStreams()
```

This method returns the elementary streams being descrambled via this proxy at the moment. If there is no descrambling, the method returns an empty array.

Returns:

s array of elementary stream being descrambled

I.4.8 CA0Module

```
java.lang.Object
   |
   +----org.davic.net.ca.CAModule
           |
           +----org.davic.net.ca.CA0Module
```

public class CA0Module

extends CAModule

Objects of this class represent CA sub-systems which can be addressed directly or indirectly using the semantics of the DAVIC CA0 / DVB Common Interface. This includes CA sub-systems using that physical interface. It also includes CA sub-systems using the common interface protocol with other physical interfaces (e.g. some embedded CA systems). It also may include other CA sub-systems not using any standardised protocol at all but where there is an easy mapping between the proprietary protocol and those parts of the common interface protocol exposed by this API.

Methods

getManufacturerCode

```
public int getManufacturerCode() throws CAException
```

Returns the manufacturer code of a Common Interface module (table 8.7 of the Common Interface specification).

Returns:

manufacturer code

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

openMessageSession

```
public int openMessageSession(byte resource_id[],
                              MessageListener listener) throws CAException
```

This method allows an application to open a message session to this module. The return value of this method is the session_id that is unique identification of the session within the module. The exceptions are based on Table 7.7 of the Common Interface specification.

Parameters:

resource_id - the resource in the module to which to communicate. The coding of this parameter is defined by Table 8.1 of the Common Interface specification.

listener - listener that will receive the messages related to this message session

Returns:

the session identifier

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: ModuleBusyException

raised if the module is busy and is not able to handle a message session at the moment

Throws: ModuleResourceNonExistentException

raised if the specified resource is not present in the module

Throws: ModuleResourceVersionTooLowException

raised if the version of the module resource is too low

closeMessageSession

```
public void closeMessageSession(int session_id) throws CAException
```

This method allows an application to close a session to this module. After this method has returned, no new messages will be accepted in this session. Messages that have already been submitted will however be answered. After the last 'ModuleResponseEvent' a 'SessionClosedEvent' will follow.

Parameters:

session_id - the session identifier returned by the openMessageSession method.

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: UnknownSessionException

raised if the specified session does not exist

sendToModule

```
public void sendToModule(int session_id,
                         CA0Message msg) throws CAException
```

Sends a message to a CA0 module. The sending of the message is asynchronous.

Parameters:

session_id - the session identifier returned by the openMessageSession method

msg - the message to be sent to the module

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: UnknownSessionException

raised if the specified session does not exist

Throws: BufferFullException

raised if the message buffer is full

I.4.9 CA1Module

```
java.lang.Object
   |
   +----org.davic.net.ca.CAModule
           |
           +----org.davic.net.ca.CA1Module
```

public class CA1Module

extends CAModule

This class represents a CA1 module

Methods

openMessageSession

```
public int openMessageSession(MessageListener listener) throws CAException
```

This method allows an application to open a message session to this module. The return value of this method is the session_id that is unique identification of the session within the module.

Parameters:

listener - listener that will receive the messages related to this message session

Returns:

session identifier

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: ModuleBusyException

raised if the module is busy and is not able to handle a message session at the moment

closeMessageSession

```
public void closeMessageSession(int session_id) throws CAException
```

This method allows an application to close a session to this module. After this method has returned, no new messages will be accepted in this session. Messages that have already been submitted will however be answered. After the last 'ModuleResponseEvent' a 'SessionClosedEvent' will follow.

Parameters:

session_id - session identifier returned by the openMessageSession method.

Throws: UnknownSessionException

raised if the specified session does not exist

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

sendToModule

```
public void sendToModule(int session_id,
                         CA1Message msg) throws CAException
```

Sends a command APDU to a CA1 module. The sending of the message is asynchronous. This command must describe the entire context of the command.

Parameters:

session_id - the session identifier returned by the openMessageSession method

msg - the message to be sent to the module

Throws: UnknownSessionException

raised if the specified session does not exist

Throws: ModuleUnavailableException

raised if the physical CA module has been removed and is not available any more

Throws: BufferFullException

raised if the message buffer is full

getHistoryBytes

```
public byte[] getHistoryBytes() throws CAException
```

Returns:

the historical characters of this CA module

Throws: ModuleUnavailableException

if the CA module is not available anymore

sendToModule

```
public void sendToModule(int session_id,
                         CA1Message msg[]) throws CAException
```

Sends a number of command APDUs to a CA1 module. The sending of the messages is asynchronous and will be handled as one atomic operation unless access to the smart card is pre-empted by a higher priority system function (e.g. the conditional access system). If access to the smart card is pre-empted in this way, a ModuleStateChangedEvent will be generated. A separate CA1ModuleResponseEvent will be generated for each command in the array.

Parameters:

session_id - the session identifier returned by the openMessageSession method

msg - the messages to be sent to the module

Throws: UnknownSessionException

if the specified session does not exist

Throws: ModuleUnavailableException

if the physical CA module is not available anymore

Throws: BufferFullException

is if the message buffer is full. None of the commands in the array will be sent to the module.

resetModule

```
public void resetModule() throws CAException
```

Resets the module. Like for all methods, a java.lang.SecurityException may be raised if this method is called and the application is not allowed to perform this operation.

Throws: ModuleUnavailableException

if the CA module is not available anymore.

I.4.10 MMI

This section describes the part of the CA API that relates to user dialogs. The implementation of the CA API may let an application display user-dialogs. In this way, the application can determine the look-and-feel of the dialogs. The mechanism is based on the high-level Man Machine Interface (MMI) of the Common Interface/CA0.

I.4.10.1 Text

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIObject
            |
            +----org.davic.net.ca.Text
```

public class Text

extends MMIObject

Class representing a text MMI object.

Methods

getText

```
public String getText()
```

Returns:

the text to be displayed

I.4.10.2 Enquiry

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIObject
            |
            +----org.davic.net.ca.Text
                     |
                     +----org.davic.net.ca.Enquiry
```

public class Enquiry

extends Text

Class representing an enquiry MMI object.

Methods

getBlindAnswer

```
public boolean getBlindAnswer()
```

Returns:

true if the answer should not be visible while being entered, otherwise false

getAnswerLength

```
public short getAnswerLength()
```

Returns:

the expected length of the answer in characters

setAnswer

```
public final void setAnswer(String answer) throws CAException
```

Submits the answer.

Parameters:

answer - The answer string. If null, it means that the user aborted the dialogue.

Throws: InvalidSetException

raised if the application calls this method with an invalid value or more than once

I.4.10.3 List

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIObject
           |
           +----org.davic.net.ca.List
```

public class List

extends MMIObject

Class representing a List MMI object.

Methods

getTitleText

```
public String getTitleText()
```

Returns the title text. An empty string is returned, if a title text does not exist.

Returns:

the title

getSubTitleText

```
public String getSubTitleText()
```

Returns the sub-title text. An empty string is returned, if a subtitle text does not exist.

Returns:

the sub-title

getBottomText

```
public String getBottomText()
```

Returns the bottom text. An empty string is returned, if a bottom text does not exist.

Returns:

the bottom text

getList

```
public String[] getList()
```

Returns the list. An empty array is returned, if a list does not exist.

Returns:

an array of strings containing the list items

I.4.10.4 Menu

```
java.lang.Object
   |
   +----org.davic.net.ca.MMIObject
            |
            +----org.davic.net.ca.List
                     |
                     +----org.davic.net.ca.Menu
```

public class Menu

extends List

Class representing a Menu MMI.

Methods

setChoice

```
public final void setChoice(short choice) throws CAException
```

Submit the user's choice from the menu.

Parameters:

choice - the number of the users choice. The first item in the list corresponds to value 1. Value 0 means that the user exited the menu without making a choice.

Throws: InvalidSetException

raised if the application calls this method with an invalid value or more than once

I.4.11 Message Passing

This is the specification for message passing from application to module.

NOTE: A SecurityException may be thrown by several methods related to message passing.

Within a session, the order of messages and responses is preserved.

I.4.11.1 org.davic.net.ca.CA0Message

```
java.lang.Object
   |
   +----org.davic.net.ca.CAMessage
            |
            +----org.davic.net.ca.CA0Message
```

public final class CA0Message

extends CAMessage

This class represents messages to CA0 modules.

The coding of the tag parameter is according to the CA0 specification on APDU tags.

Constructors

```
public CA0Message(int tag,
                  byte data[])
```

Constructor for the message

Parameters:

tag - APDU tag for the message

data - message data

Methods

getTag

```
public int getTag()
```

Returns:

the APDU tag

getData

```
public byte[] getData()
```

Returns:

the data of the message

I.4.11.2 org.davic.net.ca.CA1Message

```
java.lang.Object
   |
   +----org.davic.net.ca.CAMessage
            |
            +----org.davic.net.ca.CA1Message
```

public final class CA1Message

extends CAMessage

This class represents messages to CA1 modules.

Coding of the cla, ins, p1, and p2 parameters is according to the CA1 specification.

Constructors

```
public CA1Message(byte cla,
                  byte ins,
                  byte p1,
                  byte p2)
```

Constructor for a message with no data

Parameters:

cla - the CLA byte of the message

ins - the INS byte of the message

p1 - the P1 byte of the message

p2 - the P2 byte of the message

```
public CA1Message(byte cla,
                  byte ins,
                  byte p1,
                  byte p2,
                  byte data[])
```

Constructor for a message with data

Parameters:

cla - the CLA byte of the message

ins - the INS byte of the message

p1 - the P1 byte of the message

p2 - the P2 byte of the message

data - data of the message

```
public CA1Message(byte cla,
                  byte ins,
                  byte p1,
                  byte p2,
                  int expectedResponseLength)
```

Constructor for a message with expected response length and data

Parameters:

cla - the CLA byte of the message

ins - the INS byte of the message

p1 - the P1 byte of the message

p2 - the P2 byte of the message

expectedResponseLength - the expected length of the response message

```
public CA1Message(byte cla,
                  byte ins,
                  byte p1,
```

```
                    byte p2,
                    byte data[],
                    int expectedResponseLength)
```

Constructor for a message with expected response length and no data

Parameters:

cla - the CLA byte of the message

ins - the INS byte of the message

p1 - the P1 byte of the message

p2 - the P2 byte of the message

data - data of the message

expectedResponseLength - the expected length of the response message

Methods

getCla

```
public byte getCla()
```

Returns:

the CLA byte of the message

getIns

```
public byte getIns()
```

Returns:

the INS byte of the message

getP1

```
public byte getP1()
```

Returns:

the P1 byte of the message

getP2

```
public byte getP2()
```

Returns:

the P2 byte of the message

getExpectedLength

```
public int getExpectedLength()
```

Returns the expected length of the response message. Returns -1, if there is no expected length specified.

Returns:

the excepted length of the response

getData

```
public byte[] getData()
```

Returns the data of the message. Returns null, if the message does not contain the data part.

Returns:

the data of the message

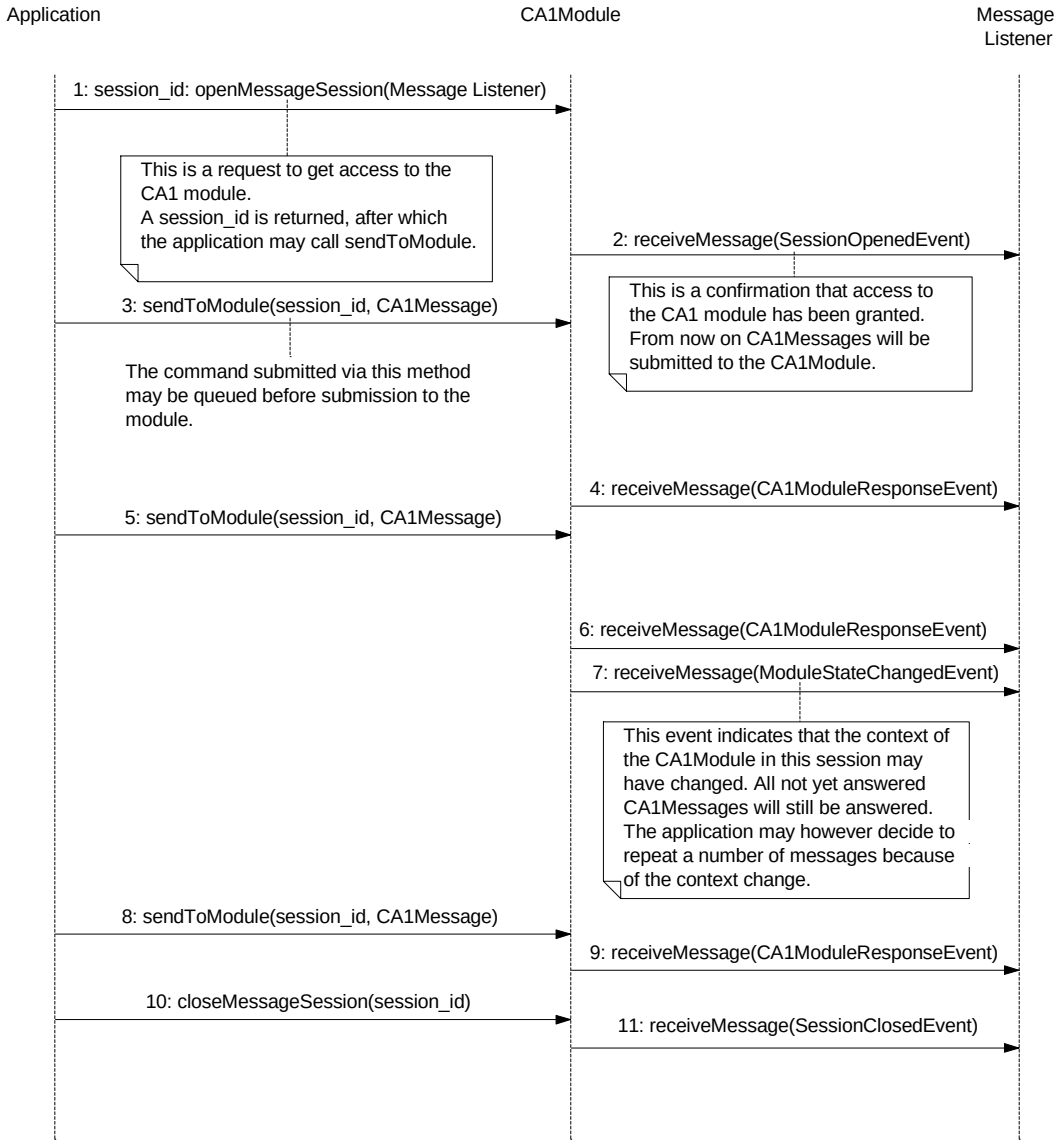
I.4.11.3 org.davic.net.ca.CAMessage

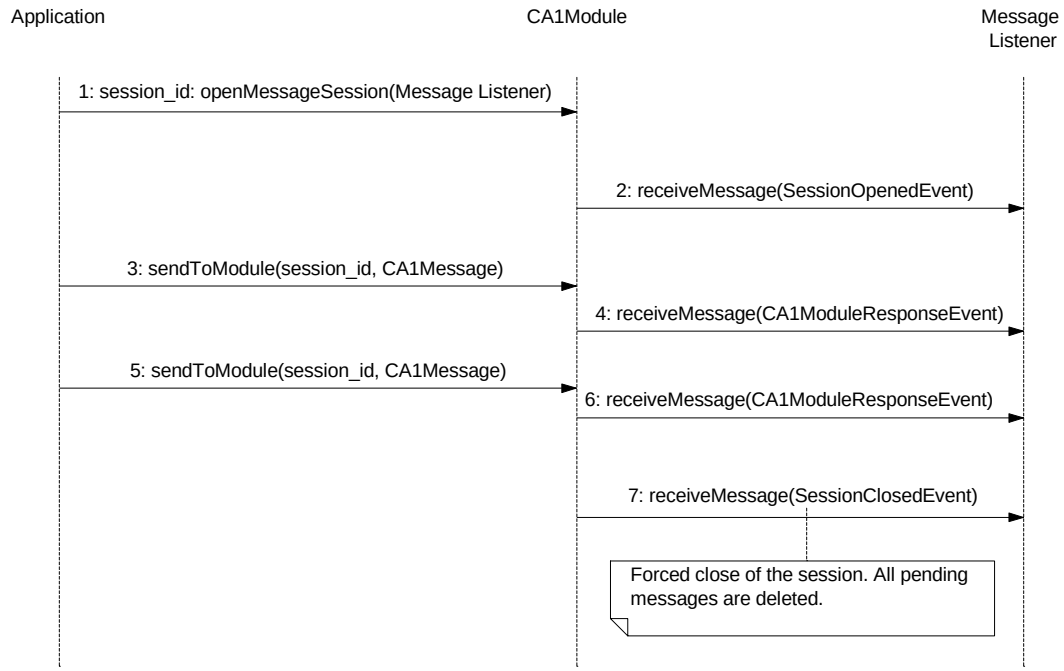
Erreur! Nom de fichier incorrect.

I.4.11.3 Erreur! Nom de fichier incorrect.

I.4.11.4 Message Passing in CA1 (informative)

The diagrams below explain the timing of generation of the messages involved in sending messages over the CA1 interface.




Application
CA1Module
Message Listener
1: session_id: openMessageSession(Message Listener)
2: receiveMessage(SessionOpenedEvent)
3: sendToModule(session_id, CA1Message)
4: receiveMessage(CA1ModuleResponseEvent)
5: sendToModule(session_id, CA1Message)
6: receiveMessage(CA1ModuleResponseEvent)
7: receiveMessage(SessionClosedEvent)
Forced close of the session. All pending messages are deleted.

Annex K :
User Interface API Extensions

(This annex forms an integral part of this Specification)

K.1 Objective

The objective of these extensions is to allow the use of the “java.awt” user interface API in DAVIC systems by providing extensions to be used with this API to support various user interface features required by DAVIC systems and applications but not found in java.awt itself.

K.2 API Definitions

K.2.1 Extended Colour Support

This specification defines an additional colour class that has a new field (alpha) for the transparency level. A zero value in this field indicates an opaque color. If the hardware does not support transparency, the proposed class shall still available, but all colors shall be opaque.

K.2.2 Color

```
java.lang.Object
   |
   +----java.awt.Color
            |
            +----org.davic.awt.Color
```

public class Color

extends Color

This is an additional colour class that provides support for transparency (alpha). DAVIC implementations of java.awt should accept objects of this class as well as java.awt.Color and take the alpha value (if any) into account.

Constructors

```
 public Color(int r,
              int g,
              int b,
              int a)
```

Creates a color with the specified red, green, blue, and alpha values in the range (0 - 255). The actual color used in rendering will depend on finding the best match given the color space available for a given output device.

Parameters:

r - the red component

g - the green component

b - the blue component

a - - the alpha (transparency) component.

```
 public Color(int r,
              int g,
              int b)
```

Creates a color with the specified red, green, and blue in the range (0 - 255). The alpha value defaults to 0.

Parameters:

r - the red component

g - the green component

b - the blue component

```
public Color(int rgba)
```

Creates a color with the specified combined RGB value consisting of the red component in bits 16-23, the green component in bits 8-15, the blue component in bits 0-7, and alpha (transparency) component in bits 24-31. The actual color used in rendering will depend on finding the best match given the color space available for a given output device.

Parameters:

rgba - the combined components

```
public Color(float r,
             float g,
             float b,
             float a)
```

Creates a color with the specified red, green, blue and transparency values in the range (0.0 - 1.0). The actual color used in rendering will depend on finding the best match given the color space available for a given output device.

Parameters:

r - the red component

g - the red component

b - the red component

a - the alpha (transparency) component

```
public Color(float r,
             float g,
             float b)
```

Creates a color with the specified red, green and blue values in the range (0.0 - 1.0). The transparency value defaults to 0.

Parameters:

r - the red component

g - the red component

b - the red component

Methods

getAlpha

```
public int getAlpha()
```

Returns:

the alpha component.

getNumberOfBlendingLevels

```
public static int getNumberOfBlendingLevels()
```

Returns:

the supported blending/transparency levels of the platform (excluding opaque). If the platform does not support transparency, 0 is returned.

Annex L
Media Player API

(This annex forms an integral part of this Specification)

L.1 Introduction

The Media Player API allows that part of a DAVIC application expressed in Java to initiate and control the playback of real time media with a high degree of flexibility and at a high level of abstraction. It is based upon the Java Media Framework (JMF) as defined by JavaSoft with additional restrictions, features and extensions.

L.2 Requirements

L.2.1 General Requirements

The concepts used in the player shall be similar to Java platform and familiar to Java programmers.

The player API shall control the player in high level of abstraction.

The player API shall not limit the format or source of the played content. One example of this being the playback of AIFF-C audio from memory.

When playing broadcast content, the player shall be able to play a service as well as a single elementary stream. If a request to play a service does not fully specify the service, the API should complete the non-specified information where possible.

It shall be possible to change the language of audio and sub-titling on-the-fly when playing broadcast services.

The API shall not require provision of access to media data for data types where it is inappropriate in a STU.

The API shall conform to the requirements for the JavaBeans model where possible without extra costs.

The Media player API shall not restrict the number of streams being decoded or controlled at one time.

The API shall co-operate with a general resource mechanism to allow different players to co-operate and share resources on a predictable and efficient way

When certain resources acquired by a player are revoked, there must be a mechanism to inform the application of this occurrence.

The application will be notified when the player has moved to the state where the audio-visual content is actually being presented to the end-user.

The API shall allow access to media whose playback was started before the application (e.g. the channel from which the application itself was downloaded).

The API shall allow implicit descrambling of scrambled services i.e. without application knowledge or intervention.

The API shall not exclude the possibilities of distributed functionality where possible, which means that there shall be no assumption about the location of specific functionality. The API shall be extendible to in principle co-operate with a mechanism that controls distributed functionality.

There shall be at least one state in which a media player does not hold any resources.

L.2.2 Synchronisation Requirements

The API shall provide for synchronising the playback of related and unrelated streams where possible e.g. synchronising audio from memory with broadcast video.

The API shall provide for notification of applications about synchronisation points such as passing a specified media time.

The API shall provide for notification of applications about synchronisation points which are included in the stream (e.g. by the content or service provider as defined in the DSMCC specification) and not set by the local application.

The API shall provide for the correct signaling of the DSMCC events, both with and without accompanying data.

For content where the application has limited control, the API shall provide for notification of changes in the status of that content e.g. in DVB, changes in the running status of an SI event.

The API shall provide for notification of changes in the composition of broadcast content.

L.2.3 Internet Compatibility

The application using the player should as similar as possible to a (desktop) player playing non-broadcast-content.

It should be as portable as possible between desktop and STU.

The same player API should be usable in both broadcast-only and Internet-enabled devices.

L.2.4 Playback Control Requirements

The API shall provide for starting, stopping, pausing (e.g. freeze frame) and resuming of the timeline (if appropriate to the type of stream).

The API shall provide for the positioning of the timeline (if appropriate to the type of stream).

The API shall provide for the setting of the play rate (if appropriate to the type of stream)

The API shall provide a mechanism for access to specific properties of decoders which are related to specific media types and for testing the existence of such properties. (e.g. for audio : gain, relationship between channels. for video switching between pan and scan/letterbox)

L.3 DAVIC Defined Extensions to JMF

L.3.1 HardwareDataSource

```
java.lang.Object
   |
   +----javax.media.protocol.DataSource
           |
           +----org.davic.media.HardwareDataSource
```

public class HardwareDataSource

extends DataSource

This class provides a Java Media Framework DataSource for use with data sources such as DAVIC network interfaces. This is required because some of the standard JMF data sources require implementations to provide access to the actual media data which is inappropriate in most DAVIC systems.

Applications are discouraged from invoking any of the methods defined in the DataSource. These methods are for internal use of the player only. The DataSource shall only be used for referencing content. Applications shall make no assumptions about the HardwareDataSource implementing certain interfaces nor may draw any conclusions from that. The content type returned by the HardwareDataSource does not indicate the actual content, it indicates the type of MediaHandler required for playing the content. This is required for an internal mechanism to find the appropriate hardware MediaHandler and not intended for application. The proposed types include "davic/service" for any davic-defined service (where URL refers to a service) and "davic/audio" for the davic-defined audio types (where URL refers to an audio component).

Methods

setLocator

```
public void setLocator(MediaLocator locator)
```

Overrides:

setLocator in class DataSource

getLocator

```
public MediaLocator getLocator()
```

Overrides:

getLocator in class DataSource

getContentType

```
public String getContentType()
```

Overrides:

getContentType in class DataSource

connect

```
public void connect() throws IOException
```

Overrides:

connect in class DataSource

disconnect

```
public void disconnect()
```

Overrides:

disconnect in class DataSource

start

```
public void start() throws IOException
```

Overrides:

start in class DataSource

stop

```
public void stop() throws IOException
```

Overrides:

stop in class DataSource

getControls

```
public Object[] getControls()
```

Overrides:

getControls in class DataSource

getControl

```
public Object getControl(String control)
```

Overrides:

getControl in class DataSource

getDuration

```
public Time getDuration()
```

Overrides:

getDuration in class DataSource

L.3.2 Time Based Synchronisation

In order to provide for synchronisation of code in an application to the time base of a media stream, the following classes and interfaces are defined as part of this specification.

L.3.2.1 MediaTimeEventControl

public interface MediaTimeEventControl

extends javax.media.Control

This interface describes methods for the application to associate events with the media time of the current stream.

Methods

notifyWhen

```
public abstract void notifyWhen(MediaTimeEventListener i,
                                long mediaTime,
                                int id)
```

This method allows the application to associate an event with the specified media time. The application can supply an identification that will be associated with this event.

Parameters:

i – the listener to notify when the event happens

mediaTime – the media time which will be associated with the event

id – an identification for application use

notifyWhen

```
public abstract void notifyWhen(MediaTimeEventListener i,
                                long mediaTime)
```

This method allows the application to associate an event with the specified media time. The identification that will be associated with this event always equals 0.

Parameters:

i – the listener to notify when the event happens

mediaTime – the media time which will be associated with the event

L.3.2.2 MediaTimeEvent

```
java.lang.Object
   |
   +----org.davic.media.MediaTimeEvent
```

public class MediaTimeEvent

extends Object

The MediaTimeEvent class describes events that are associated with the stream by the application. These events are posted whenever the Controller encounters a media position which has been associated with the stream by the local application. The event includes the associated media time encoded as a long and the event identification encoded as an int.

Constructors

```
public MediaTimeEvent(Object source,
                      long eventTime,
                      int ID)
```

Make an event

Parameters:

source - the object generating the event

eventTime - the media time at which the event fired

ID - the event identification

Methods

getEventTime

```
public long getEventTime()
```

Returns:

the time with which this event was associated

getEventId

```
public int getEventId()
```

Returns:

s the identification of this event

getSource

```
public Object getSource()
```

This method returns the source for the event. It may be inherited from sunw.util.EventObject or java.util.EventObject

Returns:

the source of the event

L.3.2.3 MediaTimeEventListener

public interface MediaTimeEventListener

This interface should be implemented by the application in order to receive the events associated to a media position by the application.

Methods

receiveMediaTimeEvent

```
public abstract void receiveMediaTimeEvent(MediaTimeEvent e)
```

This method is invoked to signal the occurrence of an application associated event. The application needs to implement this interface in order to receive the events.

L.3.3 Event Based Synchronisation

In order to provide for the synchronisation of code in an application to events embedded in a stream, this specification defines the following class and interfaces.

L.3.3.1 StreamEventControl

public interface StreamEventControl

extends javax.media.Control

This interface describes the methods to handle the Stream events.

Methods

subscribeStreamEvent

```
 public abstract int subscribeStreamEvent(StreamEventListener l,
                                          String eventName) throws
InvalidEventNameException
```

This method allows the application to subscribe itself to the stream events that are present in the current stream. The method requires an event name as input and will return the associated event identifier. The scope of the event identifier is at least the media stream.

Parameters:

l - the listener to be notified when stream events happen

eventName - the name of the event to listen for

Returns:

the associated event identifier

Throws: InvalidEventNameException

if the supplied event name cannot be resolved

subscribeStreamEvent

```
 public abstract void subscribeStreamEvent(StreamEventListener l,
                                           int eventId) throws
InvalidEventIDException
```

This method allows the application to subscribe itself to the stream events that are present in the current stream. The method requires an event id as input. The scope of the event identifier is at least the media stream.

Parameters:

l - the listener to be notified when stream events happen

eventId - the id of the event to listen for

Throws: InvalidEventIDException

if the supplied event id is invalid.

unsubscribeStreamEvent

```
 public abstract void unsubscribeStreamEvent(StreamEventListener l,
                                             int id) throws
InvalidEventIDException
```

This method allows the application to unsubscribe itself from stream events that are present in the current stream.

Parameters:

l - the listener to un-subscribe

id - the event id of the events that the listener is no longer interested in

Throws: InvalidEventIDException

If the supplied identification does not exist or the application has not subscribed to this event

getEventList

```
public abstract String[] getEventList()
```

This method allows the application to get a list of available stream event names.

Returns:

a list of available stream event names

L.3.3.2 StreamEvent

```
java.lang.Object
   |
   +----org.davic.media.StreamEvent
```

public class StreamEvent

extends Object

The StreamEvent class describes a stream event. This event is posted whenever the Controller encounters a stream event in the current stream. The event includes the media time of the stream event encoded as a long (nanoseconds) and the stream event identification encoded as an int. Optional the event also includes (references to) data associated with the event.

Constructors

```
public StreamEvent(Object source,
                   long eventTime,
                   int Id)
```

Construct a stream event

Parameters:

source - the source of the event

eventTime - the time the event happened encoded in nanoseconds

Id - the event identification

```
public StreamEvent(Object source,
                   long eventTime,
                   int Id,
                   byte data[])
```

Construct a stream event

Parameters:

source - the source of the event

eventTime - the time the event happened encoded in nanoseconds

Id - the event identification

data - associated data

Methods

getEventId

```
public int getEventId()
```

Returns:

the event identification

getEventTime

```
public long getEventTime()
```

Returns:

the event media time encoded as a long

getEventData

```
public byte[] getEventData()
```

Returns:

the associated event data or null if not present

getSource

```
public Object getSource()
```

This method returns the source for the event. It may be inherited from sunw.util.EventObject or java.util.EventObject

Returns:

the source of the event

L.3.3.3 StreamEventListener

public interface StreamEventListener

This interface should be implemented by application(s) wishing to receive stream events.

Methods

receiveStreamEvent

```
public abstract void receiveStreamEvent(StreamEvent e)
```

This method is invoked to signal a stream event

Parameters:

e - the event which happened

L.3.3.4 InvalidEventNameException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----javax.media.MediaException
                              |
                              +----org.davic.media.InvalidEventNameException
```

public class InvalidEventNameException

extends MediaException

This exception indicates that an invalid event name was supplied to the subscribe method of the stream event interface.

Constructors

```
public InvalidEventNameException()
```

The constructor of the exception.

```
public InvalidEventNameException(String reason)
```

The constructor of the exception.

Parameters:

reason - the reason why the exception was thrown

L.3.3.5 InvalidEventIDException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----javax.media.MediaException
                           |
                           +----org.davic.media.InvalidEventIDException
```

public class InvalidEventIDException

extends MediaException

This exception indicates that an invalid event identification was supplied to the unsubscribe method of the stream event interface.

Constructors

```
public InvalidEventIDException()
```

The constructor of the exception.

```
public InvalidEventIDException(String reason)
```

The constructor of the exception with a reason

Parameters:

reason - the reason why the exception was thrown

L.3.4 Referencing Content at Startup

When used for DAVIC AV services, the JMF shall support at least two forms of URL to define the source of the media data. The DVB URL as defined by DAVIC part 9, section 9.5 provides for referencing broadcast content transmitted using the DVB standards.

A ‘file:’ URL may be used to reference media content in files according to the mapping defined in DAVIC part 9 for the file system classes from the java.io package.

During the startup of a JMF player, any tuning required shall happen during the JMF prefetch phase. This is only the case when an application has detailed control over the state machine of a player and moves the player up to the

prefetched state. This has no implications on using the setSource method (which may require tuning) on a player that is in the playing state.

L.3.5 Referencing Content During Playback

In order to provide for the changing of languages during playback of media, this specification defines the following interfaces.

L.3.5.1 LanguageControl

public interface LanguageControl

extends Control

This interface is the base interface for both audio and subtitling language control. This interface should never be implemented in a control alone, but always either as audio or subtitling language control. If a language can not be selected because the user/application is not entitled to access it, the language is reset to that before the invocation of the method.

Methods

listAvailableLanguages

```
public abstract String[] listAvailableLanguages()
```

Provides the application a list of available languages. The returned strings contain three letter language codes according to ISO 639 standard. If there are no selectable languages, the method returns an array of length zero.

selectLanguage

```
public abstract void selectLanguage(String lang) throws
LanguageNotAvailableException, NotAuthorizedException
```

Changes the language to the language given in the parameter.

Parameters:

lang - the desired language code according to the ISO 639 standard.

Throws: LanguageNotAvailableException

if the language given in the parameter is not available,

Throws: NotAuthorizedException

if access to the required language is not permitted

getCurrentLanguage

```
public abstract String getCurrentLanguage()
```

Returns the language code of the currently selected language. If this information is not available, a String of length zero is returned.

selectDefaultLanguage

```
public abstract String selectDefaultLanguage() throws NotAuthorizedException
```

Returns :

the language code of the default language

Throws: NotAuthorizedException

if access to the default language is not permitted

L.3.5.2 AudioLanguageControl

public interface AudioLanguageControl

extends LanguageControl

Audio language control

L.3.5.3 SubtitlingLanguageControl

public interface SubtitlingLanguageControl

extends LanguageControl

Subtitling language control

Methods

isSubtitlingOn

```
public abstract boolean isSubtitlingOn()
```

Returns:

true if the subtitling is currently being presented, otherwise returns false

setSubtitling

```
public abstract boolean setSubtitling(boolean new_value)
```

Changes the subtitling on or off depending on the value of the parameter

Parameters:

new_value - true = subtitles on, false = subtitles off.

Returns:

the previous state.

L.3.5.4 LanguageNotAvailableException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----javax.media.MediaException
                           |
                           +----org.davic.media.LanguageNotAvailableException
```

public class LanguageNotAvailableException

extends MediaException

This exception indicates that a requested language was not available

Constructors

```
public LanguageNotAvailableException()
```

The constructor of the exception.

```
public LanguageNotAvailableException(String reason)
```

The constructor of the exception with a reason

Parameters:

reason - the reason why the exception was thrown

L.3.6 Switching Content in a Player

The setSource() method on the javax.media.MediaHandler interface shall be interpreted as allowing applications to change the media content being played by a JMF player without releasing any resources held by that player and with the minimum possible disruption visible to the end user.

The setSource method can be invoked in any state of the player. It does not interfere with the state machine of the player. If the required resources for rendering the new content are not available the ResourceIOMediaException is thrown. If there is no authorisation to have access to the content, the NotAuthorizedMediaException is thrown.

If the new DataSource references content that is beyond the scope of the current player an IncompatibleSourceException is thrown (e.g. a “davic/audio” player can not be connected to a DataSource providing “davic/service” as its content type).

If an exception has been thrown, the player continues to reference the content that was referenced before the invocation of this method.

The applicability of certain controls provided by a Controller may depend on the content that is actually being referenced. Thus the application should assume that if the new DataSource is used that all the controls are no longer valid and should re-invoke getControl or getControls to acquire the new controls that are applicable with reference to the new content. If the application does not follow this procedure, the behaviour of the controls is not specified.

The following additional exceptions are defined which the setSource() method may throw.

L.3.6.1 NotAuthorizedException

```
java.lang.Object
   |
   +----java.lang.Throwable
            |
            +----java.lang.Exception
                     |
                     +----java.io.IOException
                              |
                              +----org.davic.media.NotAuthorizedException
```

public class NotAuthorizedException

extends IOException

This exception indicates that the source can not be accessed in order to reference the new content, the source has not been accepted.

Constructors

```
public NotAuthorizedException()
```

Constructor without reason

```
public NotAuthorizedException(String reason)
```

Constructor with reason

Parameters:

reason - the reason why the exception was thrown

L.3.6.2 NotAuthorizedMediaException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----java.io.IOException
                           |
                           +----
org.davic.media.NotAuthorizedException
   |
   +----org.davic.media.NotAuthorizedMediaException
```

public class NotAuthorizedMediaException

extends NotAuthorizedException

implements NotAuthorizedInterface

This exception indicates that the source can not be accessed in order to reference the new content, the source has not been accepted.

Constructors

```
public NotAuthorizedMediaException()
```

Constructor without reason

```
public NotAuthorizedMediaException(String reason)
```

Constructor with reason

Parameters:

reason - the reason why the exception was thrown

Methods

getType

```
public int getType()
```

Returns:

SERVICE or ELEMENTARY_STREAM to indicate that either a service (MPEG program) or one or more elementary streams could not be descrambled. Implements method from org.davic.mpeg.NotAuthorizedInterface.

getService

```
public Service getService()
```

If getType() returns SERVICE, then this method returns the Service that could not be descrambled. Otherwise it returns null. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Returns:

either the Service that could not be descrambled or null

getElementaryStreams

```
public ElementaryStream[] getElementaryStreams()
```

If getType() returns ELEMENTARY_STREAM, then this method returns the set of ElementaryStreams that could not be descrambled. Otherwise it returns null. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Returns:

either the set of ElementaryStreams that could not be descrambled or null

getReason

```
public int[] getReason(int index) throws IndexOutOfBoundsException
```

Returns the reason(s) why descrambling was not possible. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Parameters:

index - If the component to which access failed is a Service, index shall be 0. Otherwise index shall refer to one stream in the set returned by getElementaryStreams().

Returns:

an array of length 2 where the first element of the array is the major reason and the second element of the array is the minor reason.

Throws: IndexOutOfBoundsException

If the component to which access failed is a Service, this exception will be thrown if index is non zero. If the component(s) to which access failed was a (set of) elementary streams then this exception will be thrown where index is beyond the size of the array returned by getElementaryStreams.

See Also:

getElementaryStreams

L.3.6.3 ResourceIOMediaException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----java.io.IOException
                           |
                           +----org.davic.media.ResourceIOMediaException
```

public class ResourceIOMediaException

extends IOException

This exception indicates that the source can not be accessed since there are IO problems (the resources are not available).

Constructors

```
public ResourceIOMediaException()
```

The constructor of the exception.

```
public ResourceIOMediaException(String reason)
```

The constructor of the exception with a reason code

Parameters:

reason - the reason why the exception was thrown

L.3.7 Resource Handling

Below are defined two additional events to be supported for resource handling. These are indicative events only. An implementation of a player is allowed to perform a state transition (upon request of the application) even if not all the required resources, for the target state, are available. The implementation then posts the ResourceWithdrawnEvent before the event indicating the state transition. If a certain resource is not available and will not become available, the player may post the ResourceUnavailableEvent (upon the state transition request).

L.3.7.1 ResourceWithdrawnEvent

```
java.lang.Object
   |
   +----java.util.EventObject
           |
           +----javax.media.ControllerEvent
                   |
                   +----org.davic.media.ResourceWithdrawnEvent
```

public class ResourceWithdrawnEvent

extends ControllerEvent

Generated if a Player has some or all of the resources used withdrawn for some reason. The Player remains in a potentially usable condition unlike javax.media.ResourceUnavailableEvent. The posting of this event does not interfere with the state machine of the player, it does not change state as a result of this event. If the player is in the playing state it still may be (partially) rendering the content. This indicative event is only posted once before the accompanying ResourceReturnedEvent is posted (even if sequentially different resources are lost at different points in time).

Constructors

```
public ResourceWithdrawnEvent(Controller controller)
```

Build an event

Parameters:

controller - the controller which generates the event

L.3.7.2 ResourceReturnedEvent

```
java.lang.Object
   |
   +----java.util.EventObject
           |
           +----javax.media.ControllerEvent
```

```
                    |
                    +----org.davic.media.ResourceReturnedEvent
```

public class ResourceReturnedEvent

extends ControllerEvent

Generated if a Player which was stopped due to having its resources withdrawn has had those resources returned to it. The posting of this event does not interfere with the state machine of the player, it does not change state as a result of this event. This indicative event is only posted once after all the resources required for the current state of the player have become available again and it is performing as is expected in the current state. This event is only posted as a result of an earlier ResourceWithDrawnEvent.

Constructors

```
public ResourceReturnedEvent(Controller controller)
```

Build an event

Parameters:

controller - the which generates the event

L.3.8 AccessDeniedEvent

```
java.lang.Object
   |
   +----java.util.EventObject
           |
           +----javax.media.ControllerEvent
                   |
                   +----org.davic.media.AccessDeniedEvent
```

public class AccessDeniedEvent

extends ControllerEvent

implements NotAuthorizedInterface

Posted by the Controller if a Player is refused access to the specified media data. This event may be posted either when a Player is starting if access to the data is not permitted or should access to the data be revoked at some arbitrary point while that data is being played (e.g. the end of a free preview period)

Constructors

```
public AccessDeniedEvent(Controller source)
```

Parameters:

source - the controller access to whose data has been refused

Methods

getType

```
public int getType()
```

Returns:

SERVICE or ELEMENTARY_STREAM to indicate that either a service (MPEG program) or one or more elementary streams could not be descrambled. Implements method from org.davic.mpeg.NotAuthorizedInterface.

getService

```
public Service getService()
```

If getType() returns SERVICE, then this method returns the Service that could not be descrambled. Otherwise it returns null. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Returns:

either the Service that could not be descrambled or null

getElementaryStreams

```
public ElementaryStream[] getElementaryStreams()
```

If getType() returns ELEMENTARY_STREAM, then this method returns the set of ElementaryStreams that could not be descrambled. Otherwise it returns null. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Returns:

either the set of ElementaryStreams that could not be descrambled or null

getReason

```
public int[] getReason(int index) throws IndexOutOfBoundsException
```

Returns the reason(s) why descrambling was not possible. Implements method from org.davic.mpeg.NotAuthorizedInterface.

Parameters:

index - If the component to which access failed is a Service, index shall be 0. Otherwise index shall refer to one stream in the set returned by getElementaryStreams().

Returns:

an array of length 2 where the first element of the array is the major reason and the second element of the array is the minor reason.

Throws: IndexOutOfBoundsException

If the component to which access failed is a Service, this exception will be thrown if index is non zero. If the component(s) to which access failed was a (set of) elementary streams then this exception will be thrown where index is beyond the size of the array returned by getElementaryStreams.

See Also:

getElementaryStreams

L.3.9 Visual Controls

Applications should note that in an STU it is very unlikely that the getControlComponent method will return a visual component.

L.3.10 Control of Positioning Media in Time

In order to allow an application to control the positioning of media in time, the following additional interface and class are defined.

L.3.10.1 MediaTimePositionControl

public interface MediaTimePositionControl

extends Control

This interface should be implemented to enable the application to position the media position in time (timeline control). The method getControl and getControls return the object implementing this interface if it is supported. For an ordinary broadcast player it is unlikely that this control is supported.

Methods

setMediaTimePosition

```
public abstract Time setMediaTimePosition(Time mediaTime)
```

Invocation of this method repositions the media time position as closely as possible to the requested media time (with as little disruption as possible if the player is playing). The time positions are specified as a javax.media.time.

Parameters:

mediaTime - the required media time position

Returns:

the position in time that was actually set.

getMediaTimePosition

```
public abstract Time getMediaTimePosition()
```

Returns:

the current media time.

L.3.10.2 MediaTimePositionChangedEvent

```
java.lang.Object
   |
   +----java.util.EventObject
           |
           +----javax.media.ControllerEvent
                   |
                   +----javax.media.TransitionEvent
                           |
                           +----javax.media.StopEvent
                                   |
                                   +----javax.media.RestartingEvent
                                           |
                                           +----
org.davic.media.MediaTimePositionChangedEvent
```

public class MediaTimePositionChangedEvent

extends RestartingEvent

This event is generated whenever the media position is changed (when the invocation of the setMediaPosition resulted in a change in the media position).

Constructors

```
public MediaTimePositionChangedEvent(Controller source)
```

Parameters:

source - the controller whose media position was changed

L.3.11 Application Origin

When a Java component of a DAVIC application is to be started, the Java VM needs to be started in order to run the Java application. It is assumed that at this moment there is already a stream being decoded and displayed (the origin of the application). It does not make sense to stop such a stream before starting the application since this may result in a blank screen for an unspecified time (start-up of the VM and the application). It may be better to have the application stop the decoding of such a stream if required. This may depend on what stream is being decoded at that time (the application may run in the background and not use the display at all).

An extra static method Player[] getCurrentPlayer(), defined in the class StartUp, will be provided for this. If the application invokes this method before any player has been created it will return a player that is in the started state representing the stream currently being played. It is then the responsibility of the implementation to acquire the resources and return the player with as little perceptible interference as possible. If this method is invoked after a player has been created it returns all the players that have been created by the application up till then.

L.3.11.1 StartUp

```
java.lang.Object
   |
   +----org.davic.media.StartUp
```

public class StartUp

extends Object

Methods

getCurrentPlayers

```
public static Player[] getCurrentPlayers()
```

If the application invokes this method before any player has been created it will return a player that is in the started state representing the stream currently being played. If this method is invoked after a player has been created it returns all the players that have been created by the application up till then.

L.3.12 Freezing Playback of Media

In order to provide for freezing and resuming the playback of media, this specification defines an interface and an exception below. In this interface, the freeze and resume methods are both synchronous. The invocation of these methods does not interfere with the state machine of the player. Invoking freeze or resume will only be successful if the player is in the playing state.

L.3.12.1 FreezeControl

public interface FreezeControl

extends Control

Methods

freeze

```
public abstract void freeze() throws MediaFreezeException
```

Invocation of this method freezes the decoding of the media stream as soon as possible and leaves the last decoded frame visible to the end-user. The decoding of the audio is stopped. The actual timebase of the underlying media is however not altered.

Throws: MediaFreezeException

if the freeze is unsuccessful

resume

```
public abstract void resume() throws MediaFreezeException
```

Invocation of this method resumes the decoding of the media stream following a freeze operation. This should be a very low latency operation.

Throws: MediaFreezeException

if the resume is unsuccessful

L.3.12.2 MediaFreezeException

```
java.lang.Object
   |
   +----java.lang.Throwable
           |
           +----java.lang.Exception
                   |
                   +----javax.media.MediaException
                           |
                           +----org.davic.media.MediaFreezeException
```

public class MediaFreezeException

extends MediaException

This exception indicates that either the freeze method or the resume method was unsuccessful.

Constructors

```
public MediaFreezeException()
```

Construct an exception without a reason

```
public MediaFreezeException(String reason)
```

Construct an exception with a reason

Parameters:

reason - the reason why the exception was thrown

L.3.13 MediaLocator

```
java.lang.Object
   |
   +----javax.media.MediaLocator
           |
           +----org.davic.media.MediaLocator
```

public class MediaLocator

extends MediaLocator

Constructors

```
public MediaLocator(org.davic.net.Locator locator)
```

Constructor for a locator which can be used with the Java Media Framework based on a DAVIC locator

Parameters:

locator - the DAVIC locator

L.3.14 Enhanced State Transitions

The following additional event is defined by this specification for use in DAVIC STUs:-

L.3.14.1 MediaPresentedEvent

```
java.lang.Object
   |
   +----java.util.EventObject
           |
           +----javax.media.ControllerEvent
                   |
                   +----org.davic.media.MediaPresentedEvent
```

public class MediaPresentedEvent

extends ControllerEvent

Generated as soon as possible after new content is actually being presented to the user, regardless of whether a state change has taken place in the player or not.

Constructors

```
public MediaPresentedEvent(Controller source)
```

Parameters:

source - the controller concerned

L.3.15 Player LifeCycle

The application shall invoke the stop, deallocate and the close method before removing the reference to the player in case it no longer needs the player. It is an error if a reference to a player is removed and the player is not closed as described above.

L.3.16 Mapping to JDK 1.0.2

The following classes and interfaces are part of this specification in order to allow the new event model introduced as part of version 1.1 of the Java specification to be supported on implementations based on the previous version of the specification which is the case for DAVIC

```
/*
In order to support the Java Beans event model an implementation of MediaEvent
is required to sub-class java.util.EventObject. If an implementation is
designed to support the 1.0.2 JDK then it may alternatively sub-class
sunw.util.EventObject to provide the appropriate support. Any class that
subclasses MediaEvent must resolve to either java.util.EventObject or
sunw.util.EventObject.
*/
package sunw.io;
public interface Serializable {
}

package sunw.util;
public class EventObject implements Serializable {
```

```
          public EventObject(Object source) {
            this.source = source;
          }
          public Object getSource() {
            return source;
          }

          private Object source;
}

package sunw.util;
public interface EventListener {
}
```

.

The class MediaEvent inherits from sunw.util.EventObject in case of a 1.0.2 implementation and inherits from java.util.EventObject in case of a 1.1.x implementation. The interface ControllerListener inherits from sunw.util.EventListener in case of a 1.0.2 implementation and inherits from java.util.EventListener in case of a 1.1.x implementation.

The applications written to use the JMF, subtype the MediaEvent and the ControllerListener. As a result they do not depend on either 1.0.2 or 1.1.x. This will allow the usage of the JMF with 1.0.2.

Annex M
Application Level Software Architecture

(This annex does not form an integral part of this Specification)

M.1 Introduction

The definition of an Application Level Software Architecture has been introduced to clarify the role of the different APIs specified in DAVIC 1.3 and further extended in DAVIC 1.4 to support implementations of applications related to e.g. the Enhanced Digital Broadcast (EDB) and Interactive Digital Broadcast (IDB) DAVIC contours.

The APIs presented here and structured in the following modular Application Level Reference Architecture offer flexibility in terms of application sophistication and platform complexity

Common elements with the Internet have been used where possible, e.g. bitmap image formats, usage of Java, etc. The Internet is considered very important and integration between the broadcast environment and the Internet will be enhanced through appropriate solutions.

All the elements have been specified to allow the implementation of EDB and IDB inter-operable platforms on which applications like the navigator, the EPG (Electronic Program Guide), and others, can run respecting their respective look and feel using a common language and set of functions. Information data necessary to enrich the application will be collected transparently from various sources including local storage devices.

Furthermore, the following Application Level Reference Architecture follows a stable but evolutionary approach based on open standards assuring scaleability and backward compatibility. It is future proof and the range of possible applications will grow as a function of the availability of affordable hardware of rising complexity.

This approach leaves room for competition in hardware and software implementation as required by a market led approach which should benefit from the modularity of this system to migrate smoothly from existing proprietary solutions towards the DAVIC architecture. DAVIC specification part 14 contains a list of possible profiling options to cover the whole range of devices from low-end set-top-boxes to high-end systems like multimedia PCs.

M.2 API structure

M.2.1 API Reference Model

A conceptual reference model of the DAVIC API is shown in Figure M-1. As shown in the figure, DAVIC applications shall be exchanged using the MHEG-5 final form interchange format. This format defines both the semantics and the encoding of the multimedia objects. In addition, to allow procedural applications to execute in STUs in an interoperable way, applications shall use the MHEG-5 InterchangedProgram class to encapsulate Java Virtual Machine (VM) code, in accordance with the MHEG-6 specification. In order to further enhance the capabilities of MHEG-6, DAVIC has defined a number of Java packages (the dotted arrows in Figure M-1) providing Java Interchanged programs access to DVB Service Information, MPEG-2 sections, the DSM-CC U-U Interface, tuning, and basic interfacing with CA systems. Also, a mapping of the Java Media Framework to the broadcast environment is specified by DAVIC to be used in high-level set-top-boxes.

The DAVIC API is intended for downloaded interoperable applications. Resident applications that are stored in the receiver as part of the basic receiver platform may use native platform dependent interfaces, although it is possible to use the DAVIC specified APIs also for these applications.

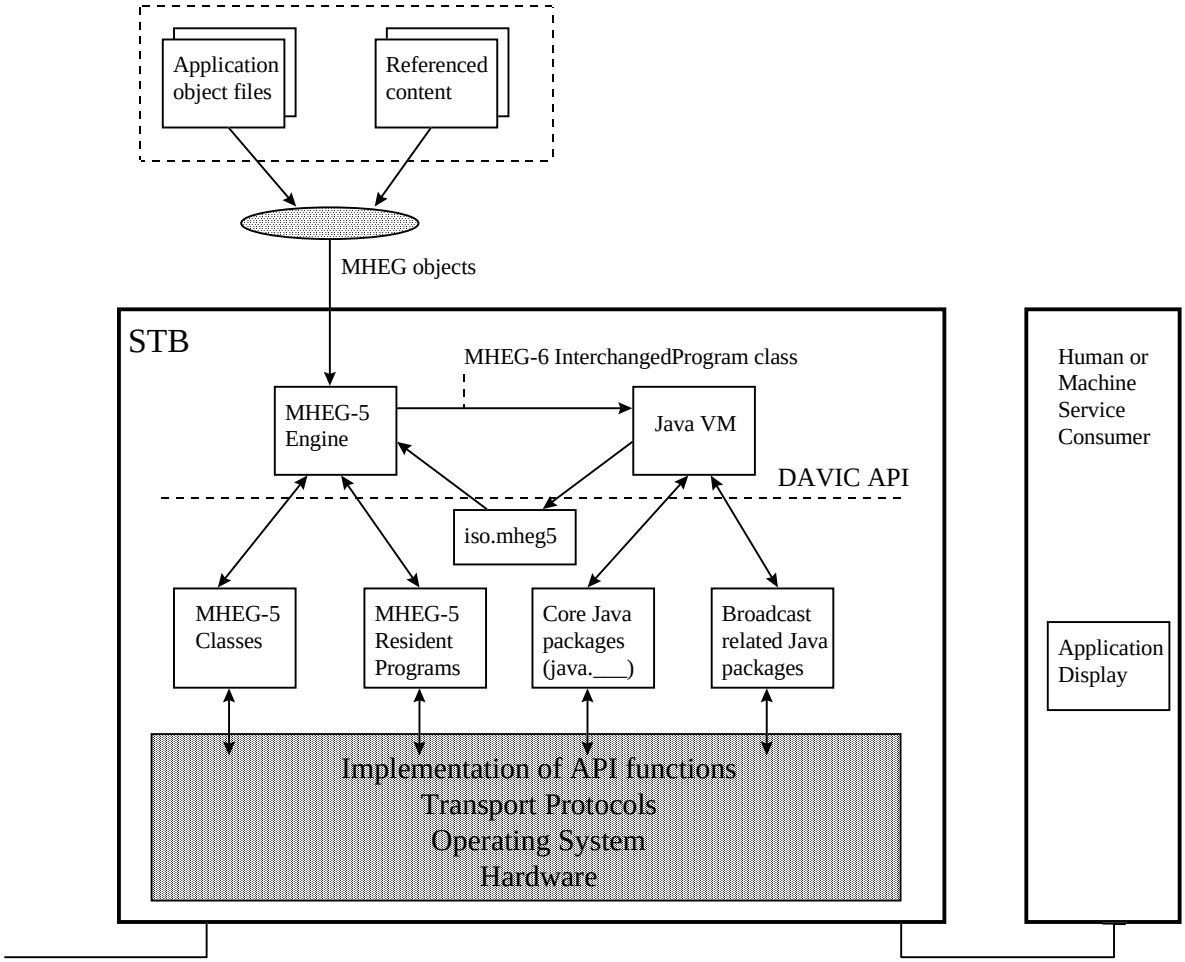


Figure M-1. API reference model

M.2.2 Reference Decoder Model

Predictability of applications and tools for ensuring the interoperability of applications and different decoder implementations has been one of the primary goals in the design of the DAVIC API. For this reason, DAVIC has defined a Reference Decoder Model for the decoders. The reference decoder model serves two purposes:

Defining the minimum characteristics of a compliant decoder in an implementation independent way. These characteristics include memory requirements, timing behaviour, etc.

A mechanism to verify that a given application will execute on all compliant decoders by analyzing that the application stays within the limits set by the reference decoder model

The reference decoder model has been defined for the MHEG-5 part and is currently being extended to cover also the Java parts.

The reference decoder model is an important tool in ensuring that applications will run on all compliant decoders without needing to test them on every different type of decoder in all possible scenarios. This approach provides a predictable environment for application authoring.

M.2.3 Use of MHEG and Java

MHEG-5 is used for providing static content such as text, bitmap images, links to broadcast video streams, etc. in a declarative format. This provides an easy mechanism for authoring presentation parts of the applications and assuring the predictability of the applications, i.e. to verify that a given application can be executed on every compliant decoder. Use of a static declarative content format such as MHEG has made the definition of a reference decoder model easier.

Code written in Java can be used for providing more dynamic features in applications. Java code can be used for tasks that require programming in the traditional sense, such as for complex calculations, information processing, retrieving data from broadcast streams, etc. An extensive set of Java APIs specifically designed for the broadcast environment is defined by DAVIC. Parts of an application that are written in Java can be integrated into MHEG applications

M.2.4 How MHEG and Java fit together

In DAVIC 1.4, the relationship between MHEG-5 and Java is similar to but simpler than the relationship between HTML and Java in the Internet. An application in DAVIC 1.4 must contain some MHEG objects. It may also contain some Java object code but the presence of Java is optional. MHEG-6 specifies the integration between MHEG-5 and Java.

If Java object code is present in a DAVIC 1.4 application, it must be connected with an MHEG-5 object of the "InterchangedProgram" class. This class from MHEG-5 is the only mechanism for loading Java object code into a Java virtual machine which is standardized by DAVIC.

In the same way that Java object code can only be loaded through MHEG-5, it can only start to run under the control of the MHEG-5 engine. This can be in response to two of the many MHEG-5 elementary actions, "call" and "fork" which are described in more detail below.

Once Java object code has started running in response to either of the above MHEG-5 actions, it can access many features of the MHEG-5 application which started it. Some examples of these features include:

modifying the values of MHEG-5 variables to return results of calculations or other operations.

reading the value from an MHEG-5 user input object such as a slider or text entry field.

changing the attributes of visible MHEG objects such as the text label of a button or the source file name of an image

MHEG-6 includes also an option called the Applet class that is similar to the applets found on HTML pages in the Internet. The applet class represents an area of the screen that is controlled by the Java code and drawing to that area is performed using the java.awt package.

M.2.5 Relationship between APIs and Transport Protocols

The MHEG applications in DAVIC are delivered in DSM-CC Object carousels in the broadcast stream. The DSM-CC User-to-User interface is used internally by the MHEG engine to retrieve the objects from the broadcast carousel. Some objects may not be broadcast but reside on a server that is accessed via an interaction channel. In this case, the DSM-CC User-to-User uses the OMG specified UNO RPC mechanism on top of a TCP/IP connection to access the objects. The DSM-CC User-to-User interface abstracts this from the higher layers and the MHEG engine does not need to care (or even know) whether a given object is retrieved from a broadcast carousel or via an interaction channel.

In MHEG applications, the MHEG engine takes care of retrieving the objects using the DSM-CC U-U API and the application author does not need to be aware of it. However, if the application author specifically wants to retrieve or manipulate some objects directly, this can be done by Java code in the application using the Java DSM-CC U-U API. Also, a mapping from the functions in the java.io package to DSM-CC U-U functions is defined so that it is possible to access some of the DSM-CC U-U functionality also through java.io.

M.2.6 Relationship between DAVIC and the Internet

The application environment that DAVIC has currently specified is designed specifically to meet the requirements of the broadcast television environment. Common elements with the Internet have been used where possible, e.g. bitmap image formats, usage of Java, etc. This makes it possible for manufacturers to use common components in implementations and it provides the content developers familiar environment to author content both for broadcast environment as well as for the Internet.

The television environment has, however, some requirements that are not present in the traditional computer environment such as relation with video and related real-time aspects, strict requirements for predictability, etc. For that reason, it has been necessary to define specific solutions to meet the specific requirements of this environment.

The Internet is considered very important and implementations that have both broadcast television as well as Internet access capabilities are probably important in the future. Using common elements in both environments makes it easier

to build this type of devices. Also, solutions that provide for making applications that integrate broadcast parts and Internet parts are being specified.

M.2.7 Contours and different configurations

DAVIC has defined a range of application level tools to be used in the Enhanced Digital Broadcast and Interactive Digital Broadcast contours. Since these contours cover a large market area with different requirements and different types of services, different configurations have been defined within these contours. DAVIC has defined four different configurations ranging from a low end broadcast receiver to a high end device supporting possibly also Internet services.

The different configurations are targeted for different types of devices that allow the user to access different types of services. The higher configurations provide more functionality and are able to run a wider range of possible applications and services. The higher configurations are not intended to provide alternative ways to make the same applications as for the low end configurations but to enable different types of services. Also, the configurations do not represent evolution in time, but are intended for different types of devices. It is expected that there will be different types of devices supporting the different configurations targeted at different markets and different types of usage.

M.3 MHEG

M.3.1 Overview of MHEG-5

The MHEG-5 (ISO/IEC 13522-5) specification provides a framework for distribution of interactive multimedia applications in a client/server architecture across platforms of different types and brands. The MHEG-5 specification defines the final-form interchange format of the MHEG object classes used to create the application.

An MHEG-5 application consists of an Application object, a number of Scene objects and objects that are common to all Scenes. A Scene object contains a group of objects, called Ingredients, used to present information (graphics, sound, video, etc.) or interactibles (buttons, sliders, etc.) along with localised behaviour based on event firing. The Scene is the smallest interchanged unit. At most one scene is active at any one time and navigation in an application is done by making transitions between scenes. The content data may either be included in the object or referenced and stored externally. An example of how the MHEG-5 objects may be used in a multimedia application is given in Figure .

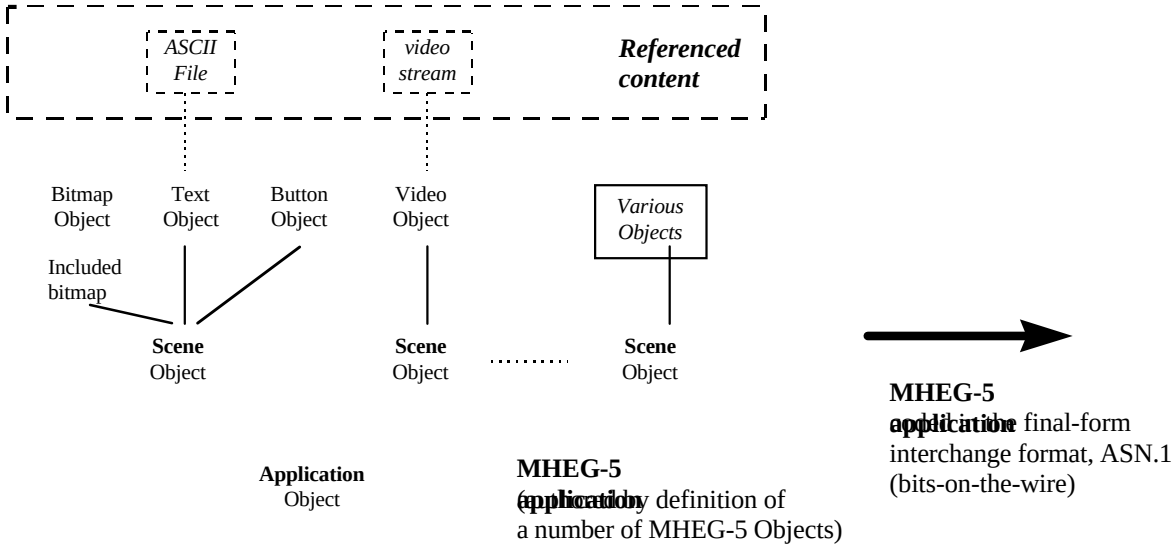


Figure M-2. Example of an MHEG-5 Application

The minimal MHEG-5 runtime environment has to provide an entity called MHEG engine that handles decoding of the MHEG data structures as well as parsing and interpreting the MHEG-5 objects. The engine also communicates

with the local presentation environment. It responds to the events initiated by the application or the user (for example timer events, or a press of a button) in the application specific way. A MHEG application is always event driven.

Since MHEG-5 is a generic ISO/IEC standard, DAVIC has, to ensure interoperability, made its own MHEG-5 profile (defined in Part 9 of the DAVIC specification). The MHEG-5 Profile defines a set of MHEG-5 classes which are mandatory in DAVIC together with content and attribute encoding that provides a mapping between the MHEG-5 objects (and their attributes) and the content format selected by DAVIC. The profile also defines a user input (e.g. remote control) mapping, semantic constraints, transition effect parameters and a set of resident programs (e.g. date/time functions and string manipulation functions). Finally the semantics in the mapping to transport protocols is defined.

M.3.2 Overview of MHEG-6

MHEG-6 (ISO/IEC 13522-6) is an extension to MHEG-5 that defines how the InterchangedProgram class of MHEG-5 is used to carry programs in the Java byte code format and all related issues.

MHEG objects of the InterchangedProgram class either directly contain Java byte code or can contain the name of a file (e.g. in the DSM-CC broadcast carousel) where the connected Java byte code can be found. This Java byte code consists of one or more Java classes as defined by the Java specifications. Java classes can be loaded into the virtual machine when the MHEG-5 scene to which they are connected is loaded or in response to the MHEG-5 "preload" action or before they are first needed. If a Java class is connected to an MHEG-5 object whose scope is restricted to one particular MHEG scene then when the MHEG engine leaves that scene, the class will become unavailable.

Classes which are connected to an MHEG-5 object whose scope is an entire application will be available for the whole duration of that application.

The "call" elementary action will cause the MHEG-5 engine to call out into Java object code and then wait for the Java code to finish before the MHEG-5 engine continues. Since the MHEG-5 engine is blocked while the Java code is executing, access from Java code to the features of the MHEG5 engine is limited in this case to a small subset, specifically reading attributes of MHEG-5 objects together with writing values of variables in order for the Java code to return results back to MHEG-5.

The "fork" elementary action will start Java object code executing and then the MHEG-5 engine will continue without waiting for the Java code to finish. Since in this case, the MHEG-5 engine is executing in parallel with the Java interpreter, the restrictions on access to MHEG-5 features do not apply. Java code started by this mechanism can be stopped before its normal completion using the MHEG-5 "stop" elementary action. If Java code started by this mechanism terminates normally, an event will be generated back into the MHEG-5 engine to inform the MHEG application of that termination.

Both the "call" and "fork" elementary actions require the application to specify which class to call of those within the InterchangedProgram object and which method of that class to call. In addition to these two parameters, applications may specify other parameters, which will be passed to the Java code in the order specified.

MHEG-6 specifies 4 Java packages, which must be available to applications. Three of these are from the Internet version of Java - java.lang, java.io, java.util. The fourth is the iso.mheg5 package. More detailed explanation of these packages is found in chapter 4. These four packages are only the minimum that must be available for MHEG-6 applications; DAVIC has defined also other packages that may be available in the DAVIC compliant environment.

M.3.3 Mapping to Transport Protocols

Another very important definition made by DAVIC to ensure interoperability, is the mapping of MHEG-5 elements to the DSM-CC User-to-User interface. The mapping of MHEG-5 to the DSM-CC U-U interface provides an abstraction so that the MHEG-5 application does not need to know how objects are obtained (e.g. from a broadband data carousel or from a narrowband interaction channel). In short the following have been defined by DAVIC:

a one to one mapping of stream events in DSM-CC to MHEG-5 stream events is defined, which allows applications to trigger application specific behavior between streams and other objects;

the mapping of the MHEG-5 objects into the DSM-CC objects;

the way referenced content in MHEG-5 are coded to refer to corresponding DSM-CC objects;

a mapping of the MHEG-5 ComponentTag to the association_tag of DSM-CC which enables mapping of MHEG-5 stream objects to the actual stream carried in the MPEG-2 Transport stream.

M.4 Java

M.4.1 Overview of the Java Virtual Machine

One of the key functions which Java provides in DAVIC is a virtual machine for the execution of procedural applications. This enables such procedural applications to be broadcast once only and then executed on all receivers regardless of the microprocessor used in the receiver. Without such a virtual machine, procedural applications would have to be broadcast at least once for each different microprocessor used in the target receiver population.

Two of the major architectural features designed into Java from the very start are robustness and security. Security issues are addressed below and it should be noted that many of them also increase application robustness. One of the major areas of robustness concerns memory allocation and de-allocation. In Java, applications do not deallocate memory, instead the VM detects objects which are no longer referenced and deallocates them automatically. This system avoids two common programming errors: where an application accesses an object which has been deleted, and where the application forgets to deallocate objects it no longer needs.

M.4.2 Java APIs and Packages

The concept of Java is more than just the virtual machine, it also includes APIs which allow code executing in the Java virtual machine to access the resources of the host system. These APIs known in Java as packages allow applications to be independent of receiver software implementations. For the packages, only the API is standardized — the way in which the packages are implemented and especially whether the implementation uses Java or native code to implement the functions is left entirely for the manufacturer to decide when implementing the packages.

Java packages are modular groupings of related classes addressing particular functional areas. A defined package structure provides the means to ensure that the classes can be uniquely named. The specifier of each package must take care that the classes within a package have unique names. The package names have a hierarchical structure that guarantees that packages have globally unique names. The packages defined by DAVIC have a org.davic prefix. Packages defined by other organizations have their own unique prefixes and package names.

M.4.3 Java Package Naming

The following package structure is used in naming the current and future DAVIC Java packages. This diagram does not describe any relationships between the packages, but just the hierarchical naming structure.

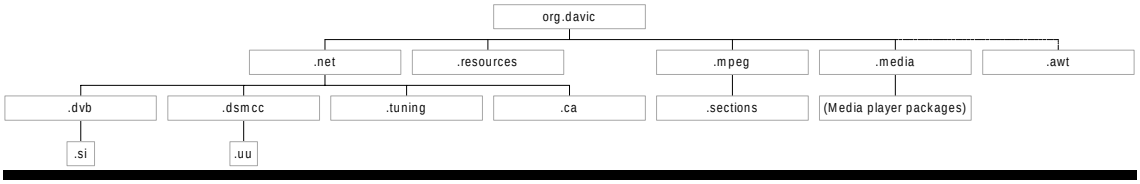


Figure M-3. Java package naming structure

M.4.4 Overview of Java Packages

Figure M-4 shows the available Java packages and dependencies between them. Solid line means that package on the top depends on the lower package. Dashed line means that the package on the top may be implemented so that it uses the lower package, but this is a choice of the implementor. The core Java packages (java.lang, java.util, java.io) are probably used by all the other packages and these dependencies are not shown in the figure.

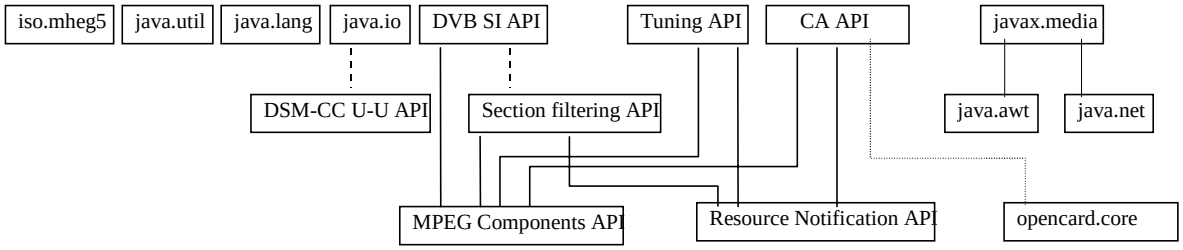


Figure M-4. Java APIs and dependencies between packages

Note : Solid line means that package on the top depends on the lower package. Dashed line means that the package on the top may be implemented so that it uses the lower package, but this is a choice of the implementor. The core Java packages (java.lang, java.util, java.io) are probably used by all the other packages and these dependencies are not shown in the Figure.

M.4.4.1 java.lang

The java.lang package defined by JavaSoft / Sun Microsystems contains the basic support to make Java applications. This includes basic data types and definition of the Object class that is a base class for all objects. Also, operations for processing basic data types such as mathematical operations for numerical data types and string manipulations for strings, definition of exception classes and thread management functions are included in this package.

M.4.4.2 java.util

The java.util package defined by JavaSoft / Sun Microsystems contains various utility functions that are commonly needed in various applications such as hash tables and vectors

M.4.4.3 java.io

The java.io package defined by JavaSoft / Sun Microsystems contains basic I/O related functions such as file system access, support for character streams, etc. A mapping from the functions in the java.io package to DSM-CC U-U functions is defined so that it is possible to access some of the DSM-CC U-U functionality also through java.io.

M.4.4.4 MHEG-5 API

The iso.mheg5 package defined in MHEG-6, provides the Java application means to interact with MHEG objects. It is based on a mapping of the MHEG-5 class hierarchy into Java. It includes one Java class corresponding to each MHEG-5 class. For each MHEG elementary action which controls display, interaction or synchronization, there is a corresponding Java method to allow Java byte code to send such an action to the MHEG-5 engine. There are also Java methods to read the value of each MHEG-5 dynamic attribute.

M.4.4.5 DSM-CC User-to-User API

The org.davic.net.dsmcc.uu package provides applications with a Java version of the standard DSM-CC User-to-User interface. This is used for accessing objects from a broadcast object carousel as well as for accessing objects via an interaction channel. Normally, the application just uses this API for accessing objects.

M.4.4.6 Resource Notification API

The Resource Notification API, org.davic.resources, is a framework for implementing resource management functions for informing applications about the status of allocated resources. It is not a stand-alone API, but definitions of interfaces that are implemented by other packages that need resource management.

M.4.4.7 MPEG Components API

The org.davic.mpeg package contains basic classes that represent common MPEG concepts such as transport stream, service, elementary stream, etc. These classes are used in the other APIs and packages that deal with MPEG related issues.

M.4.4.8 DVB Service Information API

The org.davic.net.dvb.si package, defined by DAVIC / ETSI provides access to the DVB Service Information (SI) in the broadcast network. The structure of DVB SI is modeled in an object oriented fashion and the package provides access to the various tables and descriptors.

This package is a high level API that allows for different types of implementations with regard to, for example, caching of the SI data. Also, as the SI data is carried in sections, it is possible to implement this package completely in Java using the section filtering API. Alternatively this package can be implemented using a native SI library. This choice is left to the manufacturer and the implementation method does not affect the applications.

M.4.4.9 MPEG Section Filtering API

The org.davic.mpeg.sections package provides a mechanism for filtering data transmitted in sections from the MPEG transport stream. It supports three different filtering types: for retrieving a single section once, retrieving a sub-table once and for continuous filtering of sections fulfilling the filtering criteria.

The API does not specify whether a hardware demultiplexer, software or combination of both performs the filtering. However, a minimum performance level is defined which a compliant implementation has to fulfill.

M.4.4.10 Tuning API

The org.davic.net.tuning package allows the application to tune the receiver to the transport streams in the broadcast network. The package is designed to support implementations with multiple tuners and multiple incoming transport streams from either local tuners or tuners connected to a home network.

As a single tuner can be tuned to a single transport stream at a time, the tuners are a very scarce resource. Management of the resources is handled using the org.davic.resources resource management framework.

The tuning API also provides access to a database of known transport streams in the broadcast network.

Note: This API has been specified in DAVIC 1.4, hence it is not found in the first version of the DAVIC standard as submitted to ISO/IEC.

M.4.4.11 Conditional Access API

The org.davic.net.ca package provides the application a basic interface to the CA system. This interface provides some basic functionality such as inquiring if the user is entitled to access a given service, etc. This API is independent of the type of the CA system, it just provides a way to access the basic CA functions provided by a CA module via the DAVIC CA0 (DVB Common Interface) or CA1 interface.

Note: This API has been specified in DAVIC 1.4, hence it is not found in the first version of the DAVIC standard as submitted to ISO/IEC.

M.4.4.12 java.net

The java.net package defined by JavaSoft / Sun Microsystems contains basic support for accessing data networks. Primarily, it contains support for normal socket type access to IP network as well as support for some commonly used protocols such as HTTP.

The java.net package will be included in the Internet Access contour when that is defined.

M.4.4.13 java.awt and extensions

A user interface / graphics API based on the java.awt package defined by JavaSoft / Sun Microsystems provides basic functions for graphics programming. DAVIC has defined extensions to the java.awt in package org.davic.awt to address details related to the television environment like transparency and blending.

M.4.4.14 java.applet

The java.applet package includes basic framework functions for applets, i.e. components embedded in a declarative format application such as HTML or MHEG. A part of the display of a declarative format application is reserved for the Java applet and control of that part of the display is handled entirely by the Java applet. The user interface / graphics API is needed in order to support this applet functionality.

This package will be included at least in the Internet Access contour when that is defined.

M.4.4.15 javax.media

The media playback API based on the Java Media Framework defined by JavaSoft / Sun Microsystems contains basic functions for starting and controlling the presentation of media streams – broadcast media streams, streams provided via an interactive service and streams stored in memory. The media playback API could be used, for example, to start the presentation of a television service and to control the presentation during playback.

Note: The usage of this API has been specified in DAVIC 1.4, hence it is not found in the first version of the DAVIC standard as submitted to ISO/IEC.

M.4.4.16 DSM-CC User-to-Network API

The DSM-CC User to Network packages provide applications with a Java interface to control DSM-CC U-N sessions.

M.4.4.17 OpenCard API

The core package of the OpenCard Framework (OCF) was defined by the Opencard Consortium (www.opencard.org) to ease development of portable applications using smartcards of any flavor and card readers of any make. The package consists of two main components: The CardTerminal package and the CardService package. The CardTerminal component contains abstractions for card readers. The CardService component provides the basic infrastructure to gain and share access to an actual smartcard. Both components provide means to plug-in proprietary implementations of card issuers and card reader manufacturers. Applications mainly interact with opencard.core though the SmartCard class, independently of card reader / smartcard implementation .

M.4.5 Security of the Java Virtual Machine

Security is designed in to the Java system architecture from the beginning. At the most fundamental level, the instruction set of the virtual machine is designed to enforce security. The best example of this concerns those instructions which allow access to memory. Unlike the instruction sets of conventional processors, Java VM instructions do not allow general access to memory at the byte level. Memory locations to be accessed are specified as fields of objects rather than addresses and the instructions to access those fields are strongly typed.

As well as at the instruction set level, Java virtual machine implementations include something called a byte code verifier. This is responsible for validating a Java class file before code from it can be executed. One of the tests required here is enforcing type checking on references to external variables and method calls. Another feature of the byte code verifier is checking the type consistency of the Java stack at each point in each method which can be reached by multiple paths through the method. Recent Java security scares have mostly been connected with errors in implementations of this.

An entity calls the security manager together with the class loader that is used for loading classes provides an security framework that determines which API functions an application is allowed to access. These decisions can be made for example based on the source of the application. An application from a totally unknown source executes probably in a sandbox that limits the accessible functions to only such that can not have any security risks.

M.5 Contours

M.5.1 Overview of the Different Contours

DAVIC defines a large number of tools, many of which are only applicable in different systems or products. In order to make this clearer, DAVIC 1.4 includes a concept called contours that define which tools are applicable for particular systems or environments.

The contours allow trade-offs between system component cost and service revenue since the exact details of this are deemed to be outside the scope of DAVIC. This requires that more detailed "micro-profiling" take place between the various parties involved in implementing a system.

Contours are defined as a set of tables of system functions. These are collections of DAVIC clauses which together realize a complete feature of the overall system. For each of the system functions the table indicates various information such as which DAVIC clause implements the function and which other system functions which shall be implemented if the function is implemented.

Part 14 of DAVIC 1.3 currently defines two contours, "enhanced digital broadcast" and "interactive digital broadcast". At the API level, there are two tables of system functions relating to APIs. The table describing the function P9DAPP describes declarative applications i.e. MHEG-5 ones and the table describing the function P9PAPP describes procedural applications i.e. MHEG-6 ones. Additional functions/tables will be added for as future versions of the DAVIC specifications add extra APIs. This split allows both MHEG-5 only and MHEG-5 + Java (i.e. MHEG-6) configurations depending on the results of micro-profiling as discussed above.

In DAVIC 1.4 new tables have been added describing the options for higher level profiles that include more Java APIs to allow more advanced applications.

M.5.2 The DAVIC range of configurations

At the application level, the technologies selected by DAVIC are mainly MHEG-5 for the representation and interchange of static multimedia presentation objects and Java for the representation and interchange of procedural program objects. Moreover, a set of Java APIs has been defined for the Java programs to access external resources.

It is not intended that all these technologies are always implemented in a terminal. Within the Enhanced Digital Broadcast (EDB) and Interactive Digital Broadcast (IDB) contours, DAVIC has defined four microprofiles, which correspond to four terminal configurations:

the low end terminal runs MHEG-5 only;

the medium- end terminal runs MHEG-6 that is complements MHEG-5 with Java in order to provide a procedural program functionality; however, that functionality is mainly for data processing and calculation type of use and there is very limited provision for those Java programs to access external information

the medium+ end terminal runs MHEG-6 plus a limited set of APIs which allow programs to access external information; however, the presentation aspects and the user interface is handled entirely through MHEG-5. There is a simple Java API for Java programs to manipulate the MHEG-5 presentation; the Java program can not access the display directly at all.

the high end terminal runs MHEG-6 plus an extended set of APIs. These APIs provide an extensive set of functions to communicate and retrieve information from external sources. Also, the Java application can, in addition to manipulating MHEG-5 object, also access the display directly. This configuration is very close to how Java is used in the Internet / World Wide Web.

The four configurations are presented in increasing order of functionality and thus of receiver complexity. They are more and more demanding with regard to processing power and memory size and this has of course an impact on the cost.

These different configurations are targeted for different types of devices that allow the user to access different services. The higher configurations provide more functionality and are able to run a wider range of possible applications and services. The higher configurations are not intended to provide alternative ways to make the same applications as for the low end configurations but to enable different types of services. Also, the configurations do not represent evolution in time, but are intended for different types of devices. It is expected that there will be different types of devices supporting the different configurations targeted at different markets and different types of usage.

M.5.2.1 The low-end configuration: MHEG-5 only

The low-end configuration runs MHEG-5 only and does not provide any Java support. Access to local operating system resources (date, string conversion, etc.) is provided through the use of a set of resident programs defined by DAVIC. Moreover, basic access to DVB-SI is provided though the use of an additional set of resident programs defined by DAVIC. These functions are intended to be used by e.g. downloadable Electronic Program Guides (EPGs) represented in MHEG-5.

NOTE: In that case the downloadable EPG may be made of 'empty' MHEG-5 objects: the actual contents are retrieved on the terminal side through the SI resident programs. Another way to make downloadable EPGs represented in MHEG-5 would be to include all the information in the MHEG-5 content. The latter approach however, does not allow applications to adapt to the set of services that the particular receiver is able to receive, e.g. services from another service providers than the one broadcasting the applications.

M.5.2.2 The medium- end configuration: MHEG-5 and basic MHEG-6

The medium- end terminal runs MHEG-6 that is complements MHEG-5 with Java in order to provide a procedural program functionality. Moreover, MHEG-6 includes the definition of an API which enable programs to control the MHEG-5 engine (package iso.mheg5) as well as the definition of utilities API (packages java.lang and java.util).

This configuration still corresponds to an MHEG-5 centric view where the main part of the application is expressed using MHEG-5 and where Java programs are called from times to times to deal with functionality that MHEG-5 does not provide or that are not easily expressed using MHEG-5 e.g. procedural control structure (if-then-else, while, for, etc.) or computation.

However, only very limited provision is given for the programs to access external information sources (this means, for example, that access to DVB-SI is still limited to the basic access available through resident programs). Also, Java programs can only deal with presentation aspects only through an interface to the MHEG-5 engine that controls the display (in that respect, MHEG-6 is used without its - optional - Applet class).

NOTE: Within MHEG-6, the part of the MHEG-5 API which deals with MHEG-5 Variable objects manipulation (get and set) is mandatory while the rest (manipulation of other MHEG-5 objects especially for presentation purposes) is optional.

NOTE: For upward compatibility purposes, this configuration has to implement the set of general purposes resident programs defined for the low end configuration even if it collides with the utilities packages.

M.5.2.3 The medium+ end configuration: MHEG-5, MHEG-6 and a limited set of Java APIs

The medium+ end terminal runs MHEG-6 plus a limited set of APIs which allow programs to access the outside world: Tuning API, Conditional Access API, DVB-SI API (optional), DSM-CC User-to-User API (optional), resource notification API, MPEG components API and a section filter API (optional).

In this configuration, Java programs can still deal with presentation aspects only through an interface to the MHEG-5 engine that controls the display (in that respect, MHEG-6 is used without its - optional - Applet class).

NOTE: For upward compatibility purposes, this configuration has to implement the basic SI resident programs defined for the low end configuration even if it partially collides with the org.davic.net.dvb.si package. Both of them, however, are probably just interfaces to a common SI library in an implementation.

M.5.2.4 The high-end configuration: MHEG-5, MHEG-6 and an extended set of Java APIs

The high end terminal runs MHEG-6 (including its Applet class) plus an extended set of APIs which allow programs to deal with presentation aspects (and thus to deal with World Wide Web contents) :

an API to provide basic GUI related functions (package java.awt) enhanced with some extensions dedicated to the television environment defined in package org.davic.awt;

an API to provide playback and control functions for streamed media (package javax.media);

an API to provide basic framework functions for applets (that is procedural programs controlling a part of the display) defined in package java.applet;

an API to provide basic support for accessing data networks over IP protocols (package java.net).

NOTE: In that configuration, MHEG-5 is used similarly as HTML in the Internet world : it is used to express the static / declarative part (that is, in most cases the main part) of applications.

M.5.2.5 Summary of configurations

The following table sums up the four configurations definition.

		Low	Medium-	Medium+	High
1	MHEG-5	✔	✔	✔	✔
2	MHEG-5 General Purposes Resident Programs	✔	✔	✔	✔
3	MHEG-5 SI Resident Programs	✔	✔	✔	✔
4	Java Virtual Machine		✔	✔	✔
5	java.lang		✔	✔	✔
6	java.util		✔	✔	✔
7	iso.mheg5 (core)		✔	✔	✔
8	iso.mheg5 (extension)		opt.	opt.	opt.
9	java.io		✔	✔	✔
10	org.davic.net.dvb.si			opt.[14]	opt.[15]
11	org.davic.net.dsmcc.uu			opt.	opt.
12	org.davic.net.tuning			opt.	opt.
13	org.davic.net.ca			opt.	opt.
14	org.davic.resources			opt.[16]	opt.[17]
15	org.davic.mpeg			✔	✔
16	org.davic.mpeg.sections			opt.[18][SM1]	opt.[19]
17	MHEG-6 Applet class				✔
18	java.applet				✔
19	java.net				✔
20	java.awt				✔
21	org.davic.awt				✔
22	javax.media				✔

M.5.3 Examples of Applications

The enhanced digital broadcast and interactive digital broadcast contours are both intended for the broadcast television environment. Typical applications in digital broadcast environment are:

Electronic Program Guides (EPGs)

enhanced teletext applications (broadcast information services with textual and still image content)

television program related applications (e.g. a game show where the viewer can play along with the contestants or sports events where the viewer can get additional information or select a view from multiple video streams via an application).

[14] it is mandatory to select either this item or item #16.

[15] it is mandatory to select either this item or item #16.

[16] mandatory if item #12, #13 or #16 is selected.

[17] mandatory if item #12, #13 or #16 is selected.

[18] it is mandatory to select either this item or item #10.

[19] it is mandatory to select either this item or item #10.

M.5.3.1 Example 1: Electronic Program Guide

An Electronic Program Guide (EPG) is a broadcast application provided by the broadcast service provider that gives the user information about the services and upcoming events, etc. The receiver has a resident Navigator that provides the user means to invoke an EPG of a selected service provider.

Using the DAVIC specified API, the EPG would be built as an MHEG application that is broadcast using a DSM-CC object carousel. The basic MHEG application can contain textual information as well as still images and other static content. The MHEG buttons and hotspots can be used for providing the user means to navigate through the different pages. Links to video streams provide a way for selecting the television service. The EPG may also use the scaling facilities of the MHEG video class to present the video of the service in small window on the screen while presenting the user information about the service or event.

Java components can be used where more dynamic procedural extensions are needed. An example is inquiring the CA system whether the user has entitlements for a given service or event and, depending on the result, displaying this information to the user in some form. Another example is retrieving some information from the DVB Service Information using the Java SI API.

Using the DAVIC specified APIs the service provider can provide information about the services and coming events in the services while having complete control over the look and feel of his own EPG. The design of the DAVIC APIs provides a robust and predictable environment that ensures that the EPG can be viewed on every compliant decoder.

M.6 Summary

The definition of an Application Level Software Architecture has been intended to clarify the role of the different APIs specified in DAVIC 1.3 and further extended in DAVIC 1.4 to support the implementations of applications related to e.g. the Enhanced Digital Broadcast (EDB) and Interactive Digital Broadcast (IDB) DAVIC contours.

The main features of each API are as follows:

MHEG-5 (ISO/IEC 13522-5) that provides an easy mechanism for authoring presentation parts of the applications, assuring the predictability of the applications, and provides a framework for distribution of interactive multimedia applications in a client/server architecture across platforms of different types and manufacturers. The MHEG-5 engine handles MHEG-5 objects.

The handling of the transport protocol via the mapping of MHEG-5 with DSM-CC U-U allows data from broadcast object carousels or from narrowband interaction channels to be transparently accessed by the application.

The Java Virtual Machine specified by JavaSoft / Sun Microsystems is used as a mechanism to run processor independent binary form (Java object code) procedural applications in a DAVIC system. MHEG-6 specifies the integration of Java with MHEG-5.

An extensive set of Java packages specifically designed for the digital broadcast environment include, for example, the DVB SI, MPEG section filtering, tuning, CA and media player API.

Conditional Access API providing high-level CA system independent interface for applications to access some CA system functions has been specified

The application environment that DAVIC has currently specified meets particularly well the requirements of the broadcast television environment. The APIs presented here and structured in the following modular Application Level Reference Architecture offer flexibility in terms of application sophistication and platform complexity. This is achieved by defining "microprofiles" at different levels of complexity (e.g. low-end microprofile may be defined containing only basic MHEG-5 with some resident programs and different levels of Java support may be part of higher microprofiles).

Common elements with the Internet have been used where possible, e.g. bitmap image formats, usage of Java, etc. The Internet is considered very important and integration between the broadcast environment and the Internet will be enhanced through appropriate solutions.

All the elements have been specified to allow the implementation of EDB and IDB inter-operable platforms on which applications like the navigator, the EPG (Electronic Program Guide), and others an run respecting their look and feel using a common language and set of functions. Information data necessary to enrich the application will be collected transparently from various sources including local storage devices.

Furthermore, the Application Level Reference Architecture follows a stable but evolutionary approach based on open standards assuring scaleability and backward compatibility. It is future proof and applications will grow as a function of the availability of affordable hardware of rising complexity.

This approach leaves room for competition in hardware and software implementation as required by a market led approach which should benefit from the modularity of this system to migrate smoothly from existing proprietary solutions towards the DAVIC architecture.

Annex N
DSM-CC User-to-Network API

(This annex does not form an integral part of this Specification.)

N.1 Objective

The objective of the DSM-CC User-to-Network API is to provide applications with a means to control DSM-CC User-to-Network sessions.

N.2 API Definitions

N.2.1 ResourceDescriptor

public class ResourceDescriptor

ResourceDescriptor is a descriptor of a network resource which is assigned by network (SRM). The format of this descriptor is defined in ISO 13818-6 DSM-CC U-N. This descriptor is used for initialization of network interface cards and/or video/audio decoders.

Variables

resourceDescriptorBytes

public byte[] resourceDescriptorBytes;

Contents of network resources.

Constructors

public ResourceDescriptor(byte[] resourceDescriptorBytes)

Parameters:

resourceDescriptorBytes - Contents of a network resources.

N.2.2 SessionEvent

public class SessionEvent

SessionEvent class is the base class for all Session related events generated by SessionHandler. These events are used by SessionEventlisteners.

Constructors

public SessionEvent(SessionHandler source)

Parameters:

source - An object of SessionHandler class which generates this SessionEvent

Methods

getSource

public SessionHandler getSource()

Returns the object which generated this SessionEvent.

Returns:

SessionHandler object which generated this SessionEvent.

N.2.3 SessionAddResourceEvent

public class SessionAddResourceEvent

extends SessionEvent

This event notifies the arrival of DSM-CC U-N AddResourceIndication message from the network(SRM).

Constructors

public SessionAddResourceEvent(SessionHandler source,
ResourceDescriptor rdsc)

Parameters:

source - An object which generates this SessionEvent.
rdsc - A ResourceDescriptor which is defined in ISO 13818-6 DSM-CC U-N messages.

Methods

getSource

public SessionHandler getSource()

Returns the object which generated this SessionEvent.

Returns:

The object which generated this SessionEvent.

getResourceDescs

public ResourceDescriptor[] getResourceDescs()

Returns ResourceDescriptors of network resources (such as ATM-VC, IP connection) which is added by this event

Returns:

ResourceDescriptors of network resources.

N.2.4 SessionDelResourceEvent

public class SessionDelResourceEvent

extends SessionEvent

This event notifies the arrival of DSM-CC U-N DelResourceIndication message from the network.

Constructors

public SessionDelResourceEvent(SessionHandler source,
ResourceDescriptor rdsc)

Parameters:

source - An object which generates this SessionEvent.

rdsc - A ResourceDescriptor which defined in ISO 13818-6 DSM-CC U-N messages.

Methods

getSource

public SessionHandler getSource()

Returns:

The object which generated this SessionEvent.

getResourceDescs

public ResourceDescriptor[] getResourceDescs()

Returns ResourceDescriptors of network resources which are deleted by an event.

Returns:

ResourceDescriptors of network resources.

N.2.5 SessionReleaseEvent

public class SessionReleaseEvent

extends SessionEvent

This event notifies the arrival of DSM-CC U-N SessionReleaseIndication message from the network.

Constructors

public SessionReleaseEvent(SessionHandler source)

parameters

source - An object which generates this SessionEvent.

Methods

getSorce

public SessionHandler getSource()

Returns the object which generated this SessionEvent.

Returns:

SessionHandler object which generated this SessionEvent.

N.2.6 Interface SessionEventListener

public interface SessionEventListener

SessionEventListener catches SessionEvents from the object which implements SessionHandler interface.

Methods

sessionEvent

public abstract void sessionEvent(SessionEvent ev);

Catches a SessionEvent from SessionHandler

Parameters:

ev – An object of session events which is to be passed.

N.2.7 SessionHandler

public interface SessionHandler

Methods

addSessionEventListener

public void addSessionEventListener(SessionEventListener l)

Add a listener for SessionEvents

Parameters:

l – A listener to be added.

delSessionEventListener

public void delSessionEventListener(SessionEventListener l)

Delete a listener for SessionEvents

Parameters:

l – A listener to be added.

N.2.8 DsmStreamStream

public interface DsmStreamStream

extends PushSourceStream, SessionEventListener

Methods

getResourceDescriptors

public abstract ResourceDescriptor[] getResourceDescriptors()

Returns ResourceDescriptors of network resources (e.g. A/V PIDs) associated with this Stream Object. Player objects will be able to initialize the decoder hardware using these ResourceDescriptors.

Returns:

ResourceDescriptors og network resources.

sessionEventListener

public abstract void sessionEvent(SessionEvent ev)

If the event is an instance of SessionAddResourceEvent, the ResourceDescriptor which is extracted from this event will be added to a resource list in this DsmStreamStream Object. If the event is an instance of SessionDelResourceEvent, the ResourceDesciptor will be deleted from the resource list.

Parameters:

ev – An object of session events which is to be passed.

N.3 Code examples (Informative)

N.3.1 Example of an applet

The following code is an example of how an applet for DAVIC client is made.

```
import java.applet.Applet;
import javax.media.MediaLocator;
import javax.media.ControllerListener;
import javax.media.ControllerEvent;
import javax.media.RealizeCompleteEvent;
import javax.media.Player;

public class DavicJMF extends Applet implements ControllerListener {
  private Player plyr = null;
  private MediaLocator locML;

  public void init() {
    locML = new MediaLocator( getParameter( "LocatorURL" ) );
  }

  public void start() {
    plyr = javax.media.Manager.createPlayer( locML );
    plyr.addControllerListener( this );
    plyr.realize();
  }

  public void stop() {
    plyr.close();
```

```
  }

  public void destroy() {
  }

  public void controllerUpdate( ControllerEvent ev ) {
    if( ev instanceof RealizeCompleteEvent ){
      plyr.start();
    }
  }
}
```

N.3.2 Example of code using API

The following code is an example of how this API can be used.

N.3.2.1 DataSource

The following code is a sample implementation of DataSource for DAVIC client. A function of DataSource is defined in JMF specification.

```
import javax.media.MediaLocator;

public class DataSource
    extends javax.media.protocol.PushDataSource, SessionEventListener {

  private MediaLocator locML;
  private SessionObj session;
  private String ServerId;
  private String DirName;
  private String ObjName;
  private org.davic.net.dsmcc.uu.CosNaming.NameComponent nc[]
          = new org.davic.net.dsmcc.uu.CosNaming.NameComponent[1];
  private org.davic.net.dsmcc.uu.ObjRefsHolder sgwRefs
  private org.davic.net.dsmcc.uu.ServiceGateway sgw;
  private org.davic.net.dsmcc.uu.Directory dir;
  private org.davic.net.dsmcc.uu.Stream ctrl;
  private DsmStreamStream streams[] new DsmStreamStream;
    // get server id from 'locML'
    nc[0] = new NameComponent( ServerId, "ServiceGateway" );
    session.attach( null, nc, sgwRefs );
    sgw = sgwRefs.value[0];
```

```
    dir = sgw.resolve( DirName );
    // 'resources' will be set in sessionEvent() at this time.
    ctrl = dir.resolve( ObjName );
    javax.media.protocol.ContentDescriptor cd =
      javax.media.protocol.ContentDescriptor( ... );
                                    // create ContentDescriptor
    streams[0] = new DsmStreamStreamObject(onAddResourceEvent )
{       resources = ( (SessionAddResourceEvent)ev ).getResourcesDescs();
    }
    else if( ev instanceof SessionDelResourceEvent ){
      resources = ( (SessionDelResourceEvent)ev ).getResourcesDescs();
      streams.sessionEvent( ev );
    }
  }

  ... // definition of other methods

}
```

N.3.2.2 Handler (Player)

The following code is a sample implementation of Player for DAVIC client. A function of Player is defined in JMF specification.

```
public class Handler implements javax.media.Player {

  private DataSource dsource;
  private DsmStreamStream stream;
  private ResourceDescriptor resource;
  private org.davic.net.dsmcc.uu.Stream ctrl;

  /*
   * constructor
   */
  public Handler() {
  }

  /*
   * defined from javax.media.Player
   */
```

```
  public void setSource( javax.media.protocol.DataSource dsrc ) {
    dsource = (DataSource)dsrc;
  }

  public void realize() {
    stream = dsource.getStreams()[0];
    resource =
      (org.davic.net.dsmcc.uu.Stream)stream.getResourceDescriptors();
    // initialize decoder and network interface using 'resoruce' here
    ctrl = (org.davic.net.dsmcc.uu.Stream)stream.getControl(
                              "org.davic.net.dsmcc.uu.Stream" );
    ctrl.reset();
  }

  public void start() {
    ctrl.resume( NOW, NORMAL );
  }

  public void close() {
    ctrl.pause( NOW );
    // close decoder and network interface here
    dsource.disconnect();
  }

  ... // definition of other methods

}
```

N.3.2.3 DsmStreamStreamObject class

DsnStreanStreamObject is a class which implements DsmStreamStream interface. DsmStreamStreamObject is an abstraction of a DAVIC stream.

```
import javax.media.protocol.ContentDescriptor;

public class DsmStreamStreamObject implements DsmStreamStream {

  private org.davic.net.dsmcc.uu.Stream ctrl;
  private ResourceDescriptor[] resources;
  private ContentDescriptor cd;
```

```
 /*
  * constructor
  */

 public DsmStreamStreamObject() {
 }

 public DsmStreamStreamObject( org.davic.net.dsmcc.uu.Stream ctrl,
                               ContentDescriptor cd,
                               RsourceDescriptor[] resources ) {
   this.ctrl = ctrl;
   this.cd = cd;
   this.resources = resources;
 }

 /*
  * defined in DsmStreamStream
  */

 public Object getControl( String controlname ) {
   if( controlname.equals( "org.davic.net.dsmcc.uu.Streeam" ) ) {
     return ctrl;
   }
   else {
     return null;
   }
 }

 public ContentDescriptor getContentDescriptor() {
   return cd;
 }

 public void sessionEvent( SessionEvent ev ) {
   if( ev instanceof SessionDelResourceEvent ) {
     resources = ( (SessionDelResourceEvent)ev ).getResourceDescs();
   }
 }

 public Resources getResourceDescriptors() {
   return resources;
```

```
  }

  ... // definition of other methods

}
```

N.3.2.4 SessionObj class

SessionObj is a class which implements SessionHandler interface. SessionObj is an abstraction of a session event source.

```
public class SessionObj implements SessionHandler {

  private java.util.Vector SessionEventListneres;
  private org.davic.net.dsmcc.uu.ServiceGateway sgw;

  /*
   * constructor
   */

  public SessionObj() {
  }

  /*
   * method for DSMCC UU
   */

  public void attach( byte saveContext,
                      java.lang.String serverId, NameComponent[] nc,
                      org.davic.net.dsmcc.uu.ObjRefsHolder resolveRefs ) {
    // initiate an UN message sequence, and set service gateway object
    // to 'resolveRefs' here
    return sgw;
  }

  public void detach() {
    // terminate an UN session here
  }

  /*
   * defined in SessionHandler
```

```
  */

 public void addSessionEventListener( SessionEventListener el ) {
   SessionEventListeners.addElement( el );
 }

 public void delSessionEventListener( SessionEventListener el ) {
   SessionEventListeners.removeElement( el );
 }

 /*
  * It is assumed that the next method will be called when getting a
  * UN message.
  */

 public void unEventUpdate( ... ) {
   if( ... ){ // if get a 'Add Resource' message
     SessionAddResourceEvent ev = (SessionAddResourceEvent)event;
     for( i = 0; i < SessionEventListeners.size(); i++ ){
       SessionEventListener el =
         (SessionEventListener)sessionEventListeners.elementAt( i );
       ResourceDescriptor rdsc = new ResourceDescriptor( ... );
       el.sessionEvent( new SessionAddResourceEvent( this, rdsc ) );
     }
   }
   else if( ... ){ // if get a 'Del Resource' message
     SessionDelResourceEvent ev = (SessionDelResourceEvent)event;
     for( i = 0; i < sessionEventListeners.size(); i++ ){
       SessionEventListener el =
         (SessionEventListener)sessionEventListeners.elementAt( i );
       ResourceDescriptor rdsc = new ResourceDescriptor( ... );
       el.sessionEvent( new SessionDelResourceEvent( this, rdsc ) );
     }
   }
   else if( ... ){ // if get a 'Session Release' message
     for( i = 0; i < sessionEventListeners.size(); i++ ){
       SessionEventListener el =
         (SessionEventListener)sessionEventListeners.elementAt( i );
       el.sessoinEvent( new SessionReleaseEvent( this ) );
     }
```

```
    }
  }

  ... // definition of other methods

}
```

Annex O
OpenCard API

(This annex does not form an integral part of this Specification.)

O.1 Objective

The purpose of the Opencard Framework API is to lower the cost of application programming by allowing those DAVIC-compliant applications which depend on smartcards to be written in a platform-independent way, and to ease the adaptation of these applications to further, yet unforeseen needs by provision of an extensible API. The framework API provides hooks for dynamic insertion of proprietary implementations.

The general objective of OCF is described in http://www.opencard.org/docs.

A smart card based system needs to take into account the following roles:

Application developers / service providers	card issuers	card terminal manufacturers	card / cardOS manufacturers

Applications consist of a card-resident part and a card-external part. The card-resident part typically depends on the organization of the data on the card and on the underlying card OS. The card-external part of an application, downloadable from the network, should be independent from the smartcard details. OCF shields the applications from the way an issuer chooses to organize the data on the card and from the underlying card operating system.

Conventional applications, which make use of smartcards, are typically a vertically integrated entity and written on APDU level. The OCF API raises the level of abstraction such that the application programmer does not need knowledge about APDU and card details.

O.1 Security Issues

This chapter is for informative reasons only. It contains one of many possible scenarios how to use OCF in a DAVIC service consumer system (SCS). Note that integrity, source, and freshness of downloaded card services is covered by the secure download protocol as defined in Part 10, clause 7.6.

O.1.1 Remarks to security options in OCF

The amount of security provided by an OCF implementation is determined by the service provider’s and the SCS manufacturer’s security policies.

The SCS manufacturer may tailor the CardServiceRegistry's implementation to suit his security requirements. For example, the Registry may be implemented in such a way that only CardServiceFactories with valid signatures are accepted.

The service provider can implement a CardServiceFactory in such a way that security mechanisms of his choice are used, for example DAVIC secure download or other protocols employing digital signatures and encryption. The following chapter discusses a scenario requiring a high level of security, based on OCF.

O.1.1 Case Study: Secure Card Services

O.1.1.1 Problem Statement

A service provider populated the market with his proprietary cards. To make these cards runnable in a OCF-conformant environment, he provides a matching card service as a downloadable unit. The service provider trusts his card only, and to a limited extend, also the terminal hosting. He wants to be sure that his card is not operated with a tampered card service. An OCF-compliant scenario is requested which provides the required security.

O.1.1.2 Solution approach

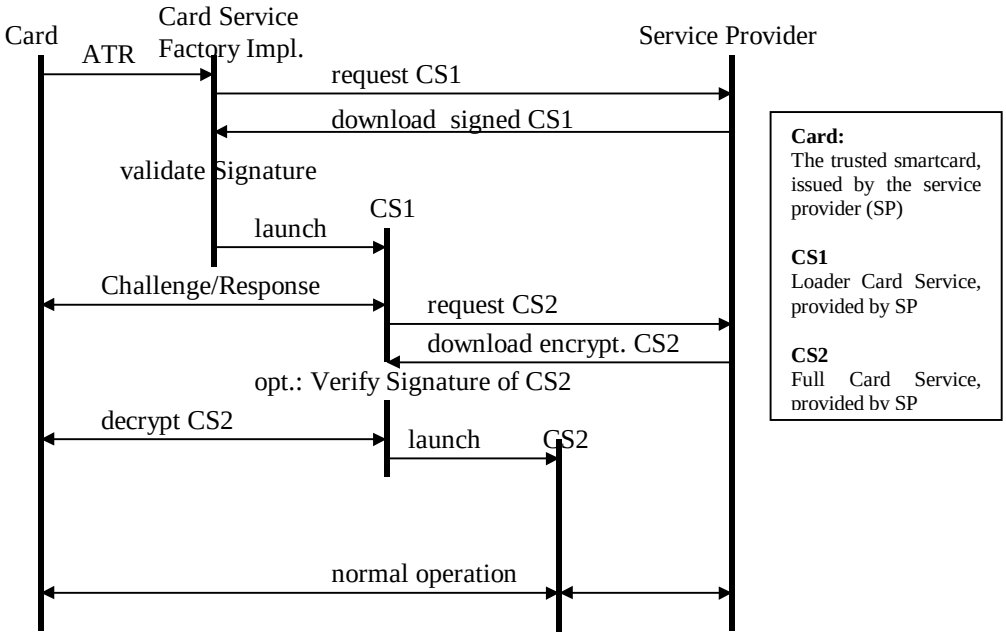
To verify that the downloaded card service is genuine, mutual authentication between the card and the card service is the practical way. However, for communication between card and card service, the card service must be already there and be active. This deadlock situation can be resolved by introducing a “loader” card service, which is capable of exchanging security information with the provider’s family of cards and knows how to download the “final” card service for a specific card.

The “loader” card service can be obtained either by downloaded through a card service factory implementation, as shown in the figure; or being resident in the consumer terminal. The latter alternative is technically simpler to realize, however limits flexibility of the service provider, who has to equip consumer terminals in advance with an appropriate “loader” card service.

In both cases, the consumer terminal needs to be equipped with the service provider’s card service factory implementation, which is able to locate and download the “loader” card service. For security reasons, this piece of software may be located in a trusted device (PC card, ROM).

Note, that the following scenario is an example only; OCF’s architecture allows a variety of different implementations without the need of modifying OCF itself.

A scenario for secure operation of downloaded card services is sketched below.



Description of the scenario

Assumption: When the card is inserted, there is no matching card service resident in the box.

OCF invokes the matching card service factory, resident in the terminal, on basis of the ATR.

The card service factory initiates secure download of the matching card service (CS1); the security requirements confidentiality, authentication, data integrity can be achieved either by the DAVIC-specified secure download, or, in case of internet-based systems, using a SSL implementation.

The signature of CS1 is validated and CS1 is activated (launched).

Mutual authentication between CS1 and the card takes place.

CS1 knows how to obtain the ‘final’ card service for this card and initiates download of CS2.

If CS2 is encrypted using a pair of public/private keys, CS2 might be signed to verify its authenticity; if CS2 is encrypted using private keys (DES) only, we assume that signing of CS2 is not necessary. Therefore, this step is marked as optional in the figure.

The box decrypts CS2 with the help of the smartcard

Once CS2 is decrypted, it is activated and the card can be used by the application.

Note: “requesting a card service” could also be realised using DVB carousels.

Annex P
Carriage of Private Data

(This annex does not form an integral part of this Specification.)

P.1 General Method for Inclusion of Private Data

Both the MHEG, ISO/IEC 13522-1, and MPEG, ISO/IEC-13818-1, standards used in this specification allow for carriage of private data. These mechanisms can be used without compromising compliance to this specification. An example of private data is Vertical Blanking Interval (VBI) Information for teletext as encoded according to ETS 300 472 and the coding of closed caption information according to ATSC standard A-53. STUs may be required to support the display of VBI information based on mandatory requirements by regional regulatory authorities.

Annex Q
Video Input Formats

(This annex does not form an integral part of this Specification)

While not required by this standard, there are certain television production standards, shown in Table Q-1, that define video formats that relate to compression formats specified in Table 6-7.

Table Q-1. Standardized Video Input Formats

Video standard	*Active lines*	*Active samples/ line*
ITU-R BT.601-4	483/576	720
ITU-R.BT.709-1	1035	1920
SMPTE 274M	1080	1920
SMPTE S17.392	720	1280

The compression formats may be derived from one or more appropriate video input formats. It may be anticipated that additional video production standards will be developed in the future that extend the number of possible input formats.

Annex S :
STU Video Display Capabilities

(This annex does not form an integral part of this Specification)

S.1 Background

While a DAVIC 1.4.1 higher quality video tool shall decode bitstreams of all of the resolutions specified in Table 6-7, the choice of a display format is left to the STU manufacturer. This flexibility permits manufacturers to offer a range of DAVIC 1.4.1 compliant products - each having a unique price/performance profile. Technologies to facilitate this flexibility (often called downconversion or “All-Format” decoders) allow decoding of all of the video formats contained within the DAVIC specifications (Revision 1.2 and beyond) for output to lower resolution displays.

S.2 Display Considerations

The choice of display format for a DAVIC STU involves consideration of many issues, including the following:

In general, larger display formats provide higher quality video reproduction.

Progressive display formats provide a high degree of compatibility with flat panel display technologies (PD, LCD, DMD, etc.) without the need for scan-conversion.

Progressive display formats are generally more compatible with computer applications and provide better representation of text and graphics.

S.3 Implementation Examples

The following examples illustrate three possible implementation scenarios, each with different targeted output displays. These three are shown as examples only and are not intended to suggest a preferred implementation; many other scenarios are possible.

S.3.1 Example 1

Figure S-1 shows an STU with the capability to fully decode all of the specified video formats for display on a multiple scan display. Lower formats are upconverted by the STU for display on the chosen display.

An STU of the type illustrated here preserves the full fidelity of all transmitted video material and requires a full MPEG-2 MP@HL decoder (with some constraints) and associated memory (12-16 MBytes).

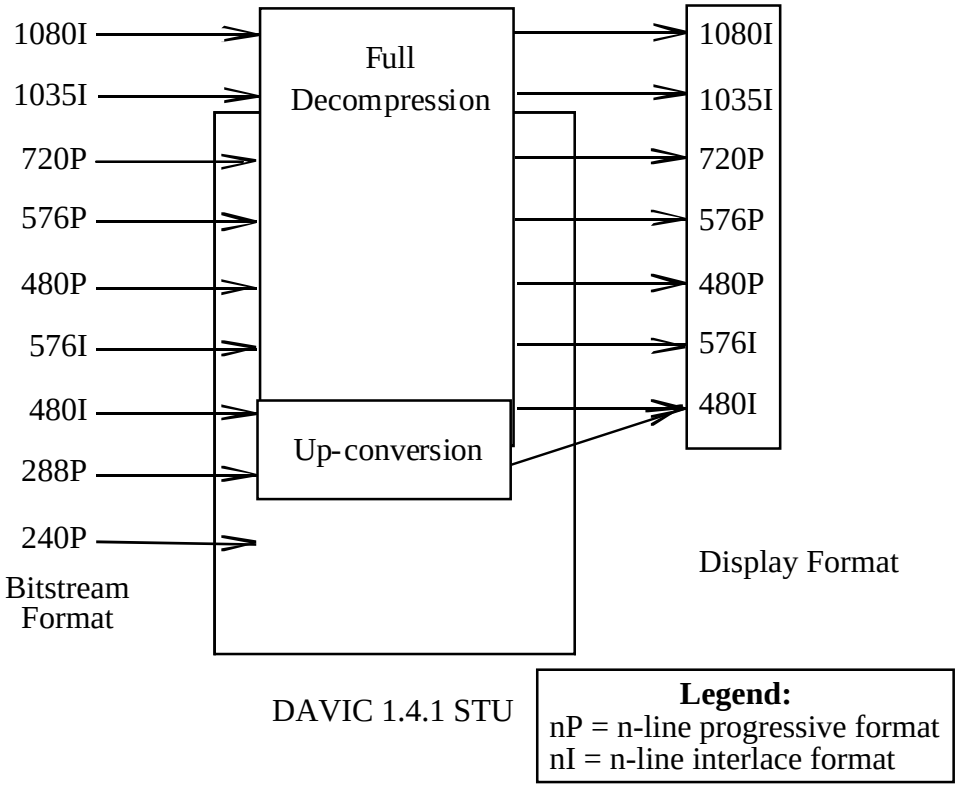


Figure S-1.

S.3.2 Example 2

Figure S-2 shows an STU with the capability to fully decode only those video formats up through the 480/576 line progressive format for display on a 480 or 576 line progressive/interlace display. Higher formats are downconverted and lower formats are upconverted by the STU for display on the chosen display.

An STU of the type illustrated here preserves the full fidelity of the transmitted video material only for those formats equal to or below the 480/576 line progressive format. This type of STU has display compatibility with 480/576 progressive and NTSC/PAL (interlace) displays. Use of a downconverting video decoder in this application will significantly reduce the cost of the video decoder and associated memory (2Mbytes) versus that used in example 1. Higher formats may be degraded somewhat by the downconversion process.

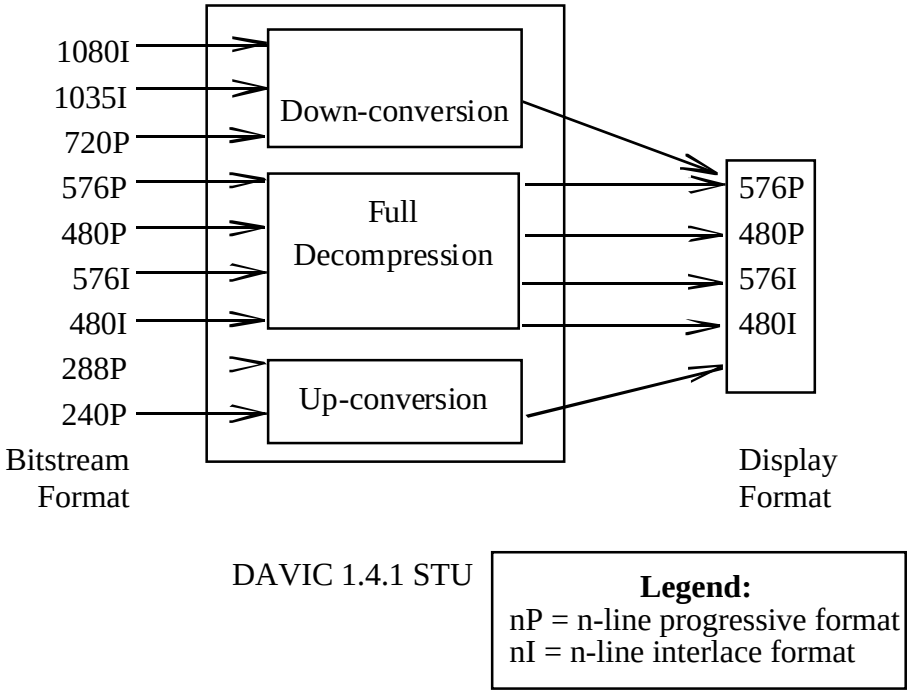


Figure S-2.

S.3.3 Example 3

Figure S-3 shows an STU with the capability to fully decode only those video formats up through the 480/576 interlace format for display on a 480 or 576 line interlace display. Higher formats are downconverted and lower formats are upconverted by the STU for display on the chosen display.

An STU of the type illustrated here preserves the full fidelity of the transmitted video material only for those formats equal to or below the 480/576 line interlace format. This type of STU preserves compatibility with 480/576 and NTSC/PAL (interlace) displays. Use of a downconverting video decoder in this application will slightly reduce the cost of the video decoder and associated memory (over example 2) due to lower processing speeds. Higher formats may be further degraded (over that of example 2) by the downconversion process.

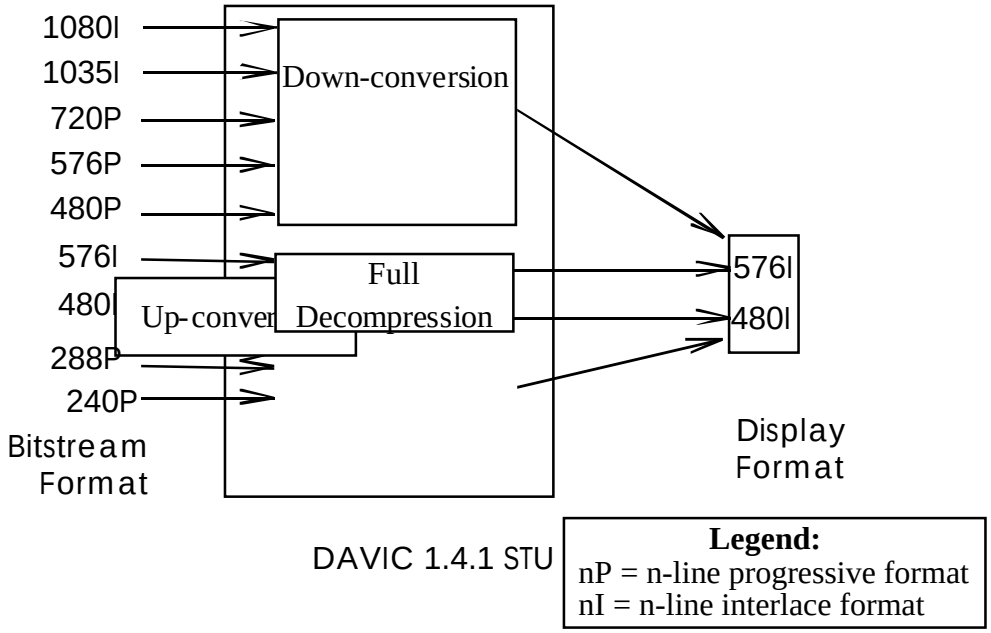


Figure S-3.

S.4. Encoder Constraints

While the use of an All-Format Decoder does not require special processing by a higher quality encoder, the resulting image quality is dependent on choices made by the encoder. The main source of degraded image quality of the downconverted video is prediction drift, a periodic pulsing of the image sharpness caused by degraded reference pictures in the decoder. Constraints to a higher quality encoder can reduce the prediction drift–yielding significant improvements in downconverted picture quality–with only minimal loss of higher quality coding efficiency. These constraints retain strict compliance with the MPEG-2 video coding standard. The encoder constraints, described in detail below, include choices for the distance between I frames and the distance between anchor frames, noise reduction prior to encoding, channel buffer fullness monitoring, and grid motion vector selection. Among these techniques, the greatest improvements in picture quality can be obtained through the use of grid motion vector selection.

The following sections describe four classes of constraints that may be used in the encoding of higher quality video which insure good video image quality in STUs which use an All-Format decoder.

S.4.1 Setting N and M

The severity of prediction drift depends on the encoding parameters “N” and “M”, where N is the distance between I frames, and M is the distance between anchor frames (I and P frames). More specifically, the ratio N/M (number of anchor frames in a "GOP") is directly proportional to the magnitude of the drift artifacts.

Ratios of N/M <= 5 have been found to produce good quality downconverted video. This is accomplished by using small values of N and/or large values of M.

Video coded with values of N as low as 9 have been shown to have negligible subjective difference to the same sequences coded with N = 15. Lower N also has the advantage of faster acquisition time.

For some video sequences, large values of M can help the coding of higher quality by using more B frames and fewer P frames while improving the downconverted image quality. This is especially true of sequences with relatively little complex motion.

Choosing M=1 (i.e. no B frames) and dual-prime prediction would be undesirable for downconverting, because of the high number of successive predictions.

S.4.2 Noise Reduction Prior to Encoding

For improved downconverted video quality, it is desirable to apply noise reduction to the source video prior to encoding.

S.4.3 Monitoring of Channel Buffer Fullness

The All-Format decoder uses a channel buffer size which may be considerably smaller than that specified for higher quality encoding. The All-Format decoder's pre-parser examines the incoming bit stream and discards less important coding elements, specifically high frequency DCT coefficients. The All-Format decoder pre-parser serves two functions. First, it discards run-length amplitude symbols, which allows for simpler real-time syntax parser and variable-length decoder units. Second, it discards data to allow a smaller channel buffer to be used without overflow and to allow reduction of the channel buffer bandwidth requirements.

If an incoming higher quality bit stream assumes a buffer size larger than the All-Format decoder's buffer size, the pre-parser may need to reduce the rate of the bit stream to avoid overflow. The pre-parser reduces the bit-rate by removing DCT coefficients, which may add to prediction drift and reduce downconverted image quality. It is preferable for downconversion if an encoder would restrict its buffer size (as indicated by the MPEG syntax element "vbv_buffer_size") to 4 Mbits or less. The encoder could minimize the range of the buffer usage, and should indicate, in the bit stream, the minimum vbv_buffer_size (and the related "vbv_delay") needed to process the bit stream.

S.4.4 Motion Vector Selection on a Grid

Allowing motion vectors with half-pel accuracy improves higher quality coding efficiency. However, applying motion vectors that are not on the downsampled grid contributes to prediction drift. The prediction drift can be significantly reduced by allowing only motion vectors that are on the downsampled grid.

For example, an All-Format decoder might use a 2 x 2 downsampling grid for a 1280 x 720 higher quality format; hence, motion vectors would be restricted to a 2 x 2 grid. For a 1920 x 1080 format, motion vectors might be constrained to a 3 horizontal by 2 vertical downsampling grid.

Restricting the motion vectors in the higher quality encoding to the coarser grid reduces the quality of predictions and hence hurts the higher quality coding efficiency. The penalty to the higher quality encoding can be significantly reduced by applying the motion vector restriction only to P frames and not to B frames. Since B frames are not used in prediction, the error caused by motion vector prediction mismatch in B frames does not propagate in the downconverted video.

In an encoder with a motion vector grid restriction or preference, P frames should be allocated relatively more bits than typically used to account for the statistically poorer prediction achieved with restricted motion vectors.

S.5 Bibliography

L. Pearlstein, J. Henderson and J. Boyce, "An SDTV Decoder With HDTV Capability: An All Format ATV Decoder", 137th SMPTE Proceedings, September 6-9, 1995, p. 422-434.

J. Boyce, L. Pearlstein, "Low-cost All Format ATV Decoding with Improved Quality", 30th SMPTE Advanced Motion Imaging Conference, Paper # 11, Delivery and Distribution, February

Annex T
Coding and Carriage of A/52 Audio in ATSC Systems

(This annex does not form an integral part of this Specification)

T.1 Coding and Carriage of A/52 Audio in ATSC Systems

The text of the ATSC A/52 (AC-3) audio specification defines and describes the AC-3 audio decoder and bit stream syntax. Descriptive information is also provided about the encoder; however, the AC-3 audio encoder is not defined by the ATSC A/52 audio specification and may take many forms.

ATSC A/52 Annex A specifies methods for carriage of one or more AC-3 audio elementary streams in an MPEG-2 “Transport Stream” or “Program Stream” (per ISO/IEC 13818-1). The detailed specification for carrying AC-3 in the MPEG-2 transport stream is found in ATSC A/53, Annex C.

ATSC A/52 Annex B specifies the methodology for carriage one or more AC-3 audio elementary streams and related time stamps in a single bit stream consistent with the physical and logical interface specifications of IEC60958 for non-PCM data. The IEC60958 standard defines a widely used method for interconnection of digital audio equipment which includes two channels of linear PCM audio. IEC61937 extends IEC60958 by defining the methodology for carriage of one or more bit rate reduced (coded) audio bit streams in a bit stream format consistent with the physical and logical interface specifications of IEC60958 for non-PCM data. Use of an IEC60958/61937 interface on DAVIC STUs can facilitate interconnection of a DAVIC STU with existing and future consumer A/V equipment (e.g. A/V receivers) which are already present in consumer home entertainment systems.

ATSC A/52 Annex C contains specifications for how karaoke aware and karaoke capable AC-3 audio decoders should reproduce karaoke AC-3 audio bit streams consistent with the functionality of DVD standards. A minimum level of functionality is defined which allows a karaoke aware decoder to produce an appropriate 2/0 or 3/0 (front/rear) default output when presented with a karaoke mode AC-3 audio bit stream. An additional level of functionality is defined for the karaoke capable decoder so that the listener may optionally control the reproduction of the karaoke bit stream. The AC-3 audio karaoke mode has been defined in order to allow a multichannel AC-3 audio bit stream to convey audio channels designated as L, R (e.g., 2-channel stereo music), M (e.g., guide melody), and V1, V2 (e.g., one or two vocal tracks). ATSC A/52 Annex C does not specify the contents of L, R, M, V1, and V2, but does specify the behavior of AC-3 audio decoding equipment when receiving a karaoke bit stream containing these channels.

Annex U
Transition Effects for Still Picture Compositions

(This annex does not form an integral part of this Specification)

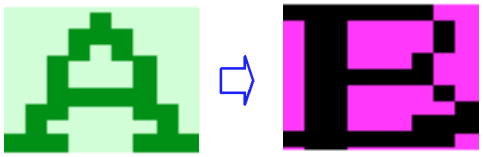
U.1 Scope

This annex describes the transition effects defined in Clause 9.2.11 and in Table 9-7 by means of graphics.

U.2 TransitionTo actions

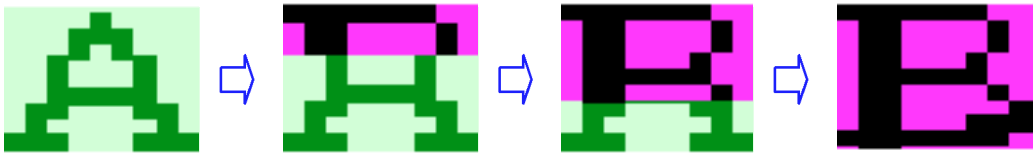
The Transition effect type and the actions are shown as graphic examples on a display. From left to right the graphics present the changes in the picture according to each effect command. For example, the 3rd effect, "Vertical wipe (top to bottom)," changes the picture from top to bottom, while the 25th command, the Roll from top to bottom, moves the subject from the top to the bottom of the picture, simulating the effect of tilting up a video camera.

1. Simple cut

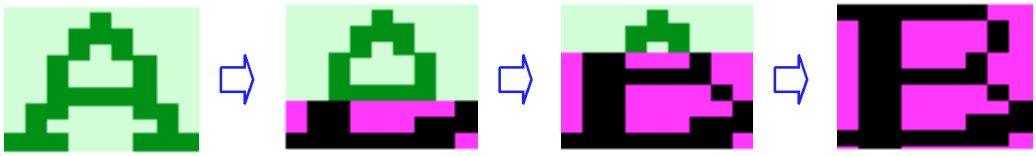


2 Dissolve

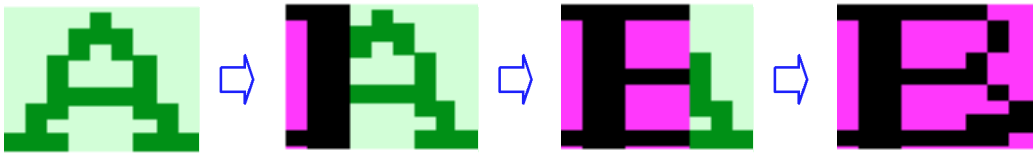
3 Vertical wipe (top to bottom)



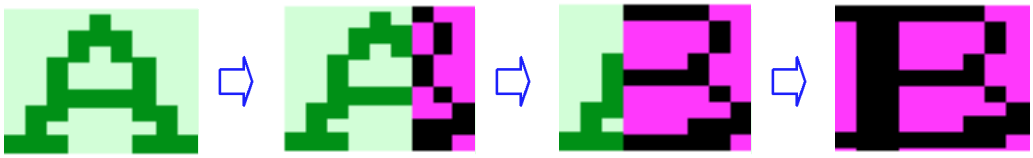
4 Vertical wipe (bottom to top)



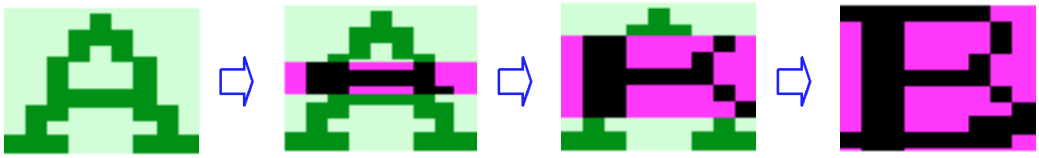
5 Horizontal wipe (left to right)



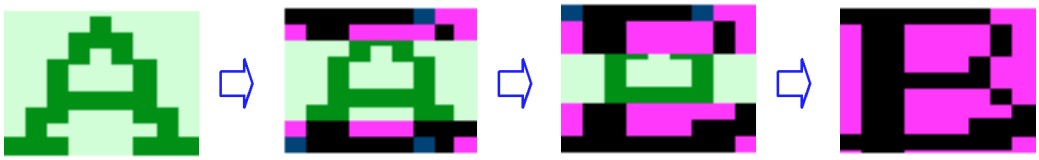
6 Horizontal wipe (right to left)



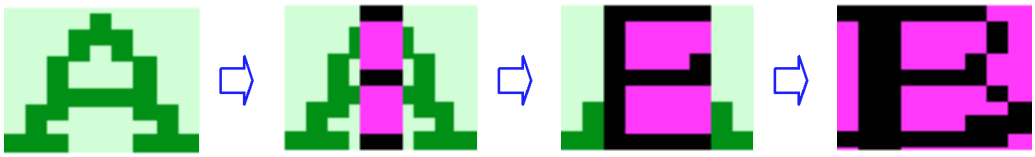
7 Wipe that vertically opens from the center



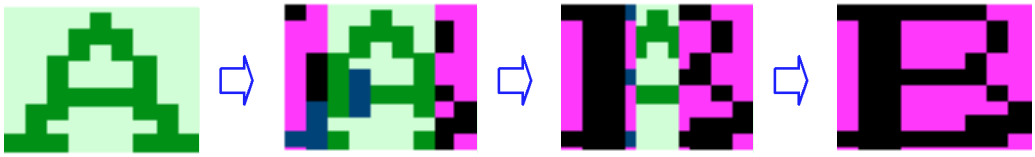
8 Wipe that vertically closes from both top and bottom



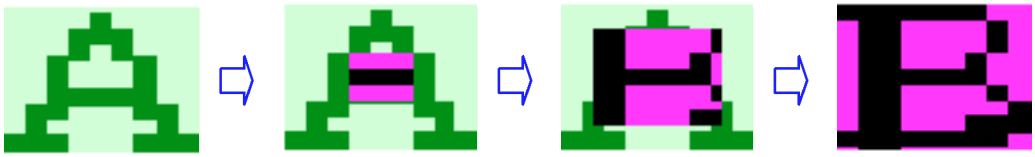
9 Wipe that horizontally opens from the center



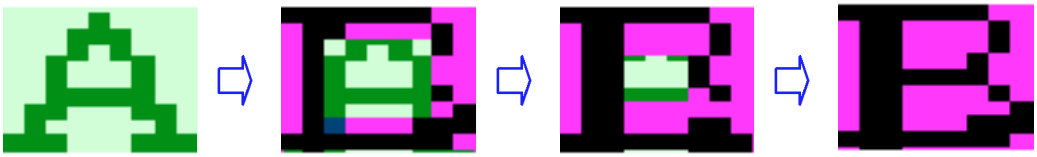
10 Wipe that horizontally closes from both left and right



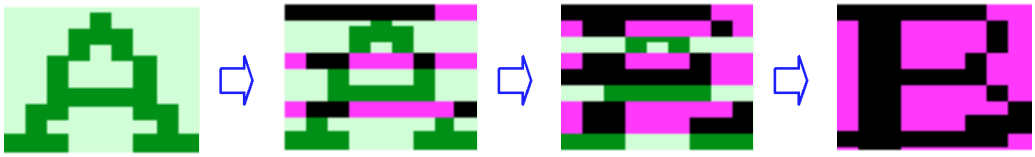
11 Square wipe (open)



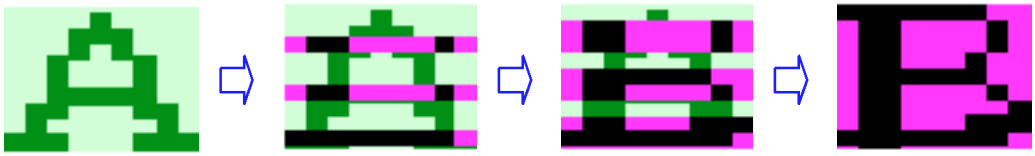
12 Square wipe (close)



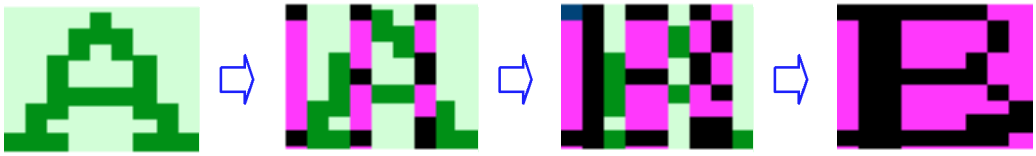
13 Vertical split wipe (top to bottom)



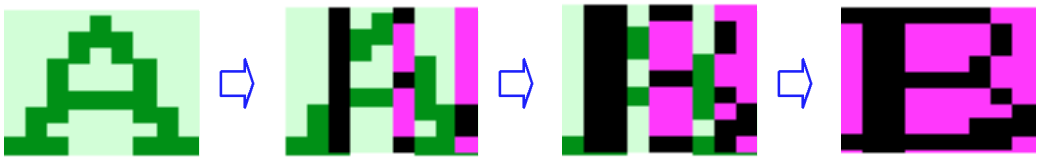
14 Vertical split wipe (bottom to top)



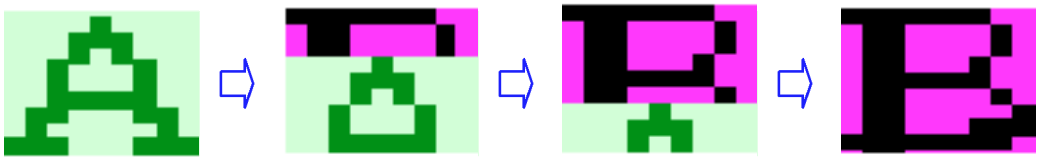
15 Horizontal split wipe (left to right)



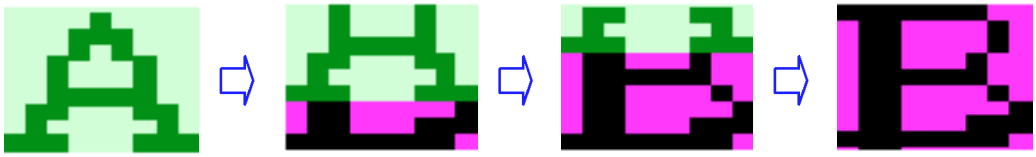
16 Horizontal split wipe (right to left)



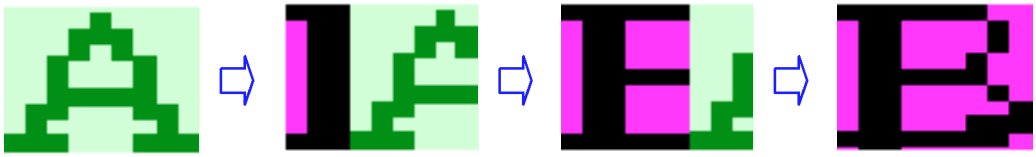
17 Vertical slide-out (top to bottom)



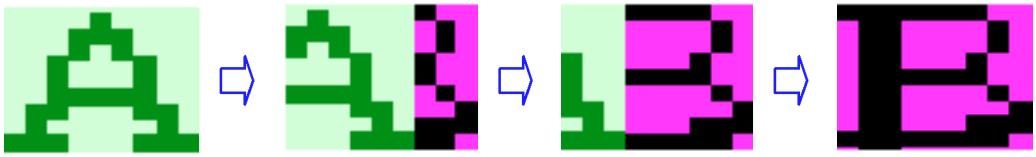
18 Vertical slide-out (bottom to top)



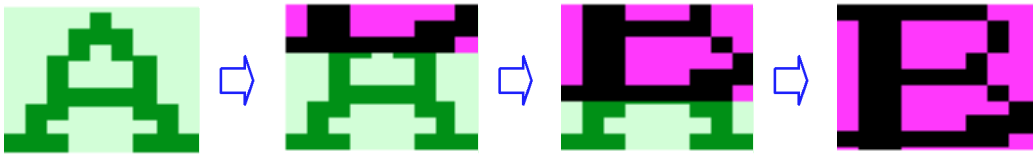
19 Horizontal slide-out (left to right)



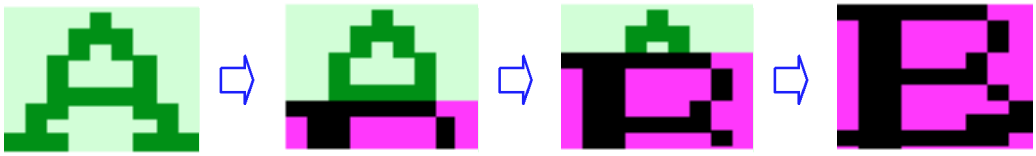
20 Horizontal slide-out (right to left)



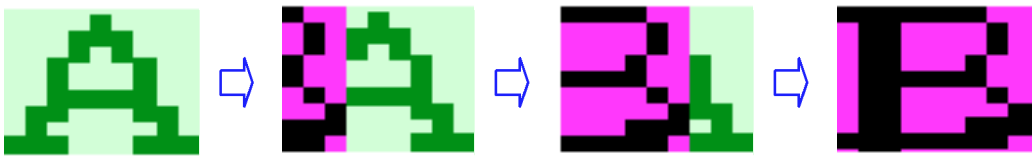
21 Vertical slide-in (top to bottom)



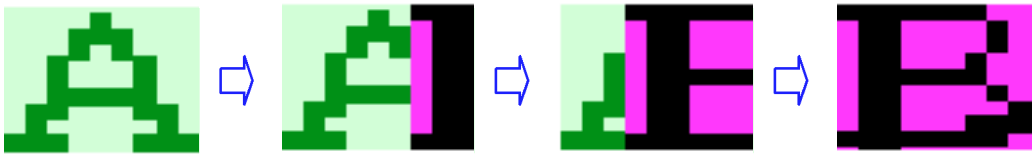
22 Vertical slide-in (bottom to top)



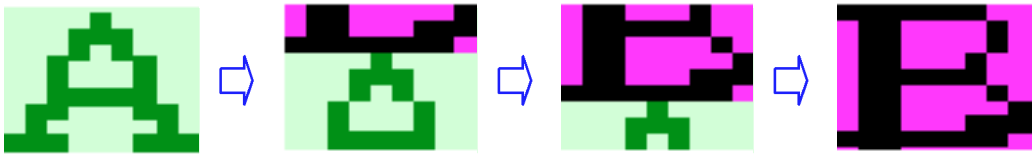
23 Horizontal slide-in (left to right)



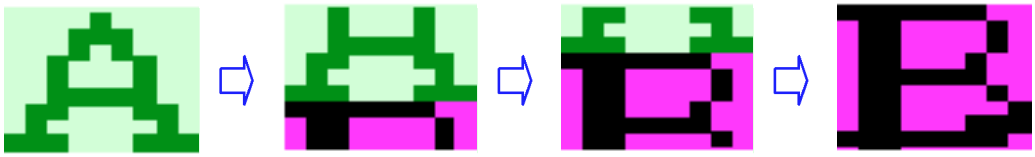
24 Horizontal slide-in (right to left)



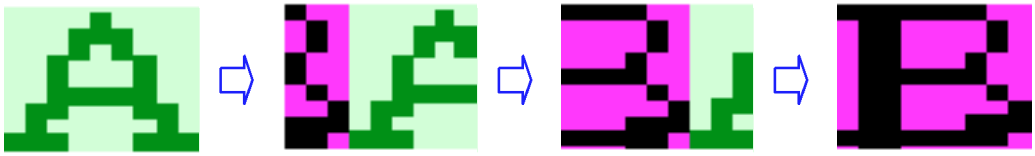
25 Vertical roll (top to bottom)



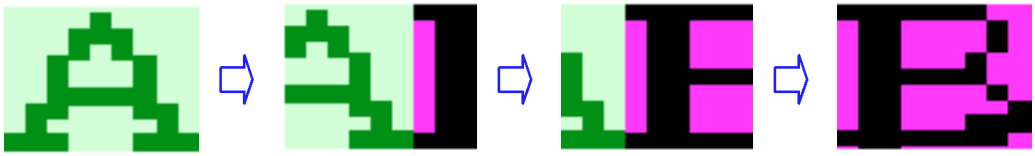
26 Vertical roll (bottom to top)



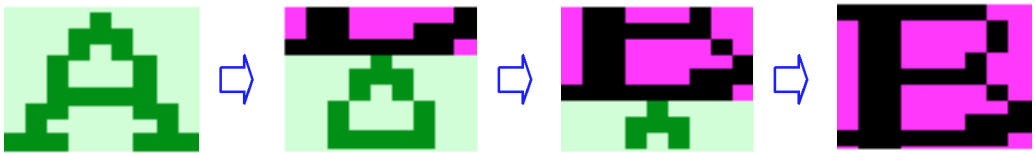
27 Horizontal roll (left to right)



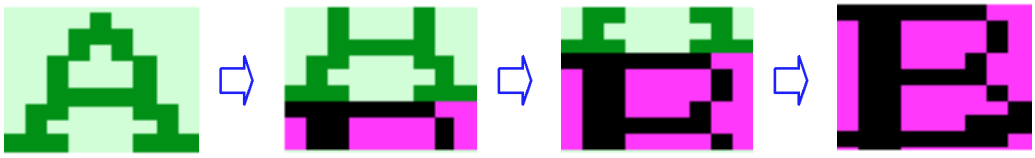
28 Horizontal roll (right to left)



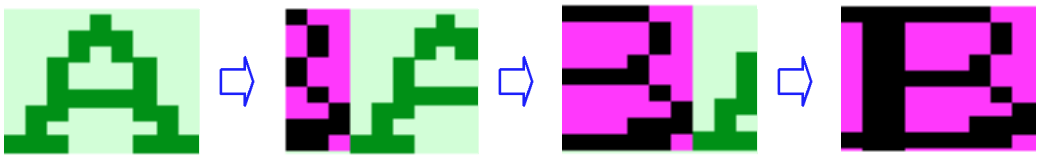
36 Half vertical roll (top to bottom)



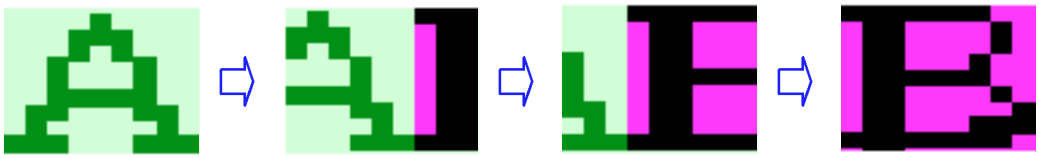
37 Half vertical roll (bottom to top)



38 Half horizontal roll (left to right)



39 Half horizontal roll(right to left)



Annex V
Example of an OSI NSAP Address Format

(This annex does not form an integral part of this Specification)

V.1 Purpose

The purpose of this annex is to describe a possible implementation for clientId and serverId, two User-to-Network message data fields used in many of the User-to-Network messages. The normative section of this specification defines these fields to be in the format of an OSI NSAP (Network Service Access Point) address. For more details on clientId and serverId, refer to the section on User-to-Network Messages in Part 7.

V.2 Introduction

ISO/IEC 8348 defines the OSI. The ATM Forum industry consortium uses a subset of these address formats -- named AESA (ATM End System Address) -- in the User-Network Interface (UNI) Specification. The example selected below is the E.164 NSAP.

Note: Any discrepancies between the OSI and ATM Forum specifications, and the address format described below represents an error in the format presented here.

V.3 E.164 NSAP

While any AFI is acceptable for DSM-CC (i.e., inter-networking is beyond the scope), an example is the E.164 version of the AESA address format. The characteristics of this format are as follows:

The generic OSI NSAP address consists of two domains:

1) Initial Domain Part (IDP), which consists of two sub-parts :

a) A 1-byte Authority and Format Identifier (AFI)

b) A variable-length Initial Domain Identifier (IDI), which depends on the value of the AFI.

2) Domain Specific Part (DSP), which depends on the value of the IDI.

The E.164 NSAP version is a fixed 20-byte OSI NSAP address and is formatted as given in the following table.

Table V-1. The E.164 NSAP version of the AESA address.

IDP		DSP		
AFI	IDI			
45 1-byte	E.164 address 8-byte	HO-DSP 4-byte	ESI 6-byte	SEL 1-byte

where

AFI: 45 (ISO/IEC 8348 registered)

IDI: 8-byte BCD-encoded E.164 address

DSP: Contains the Internet Protocol (IP) address in the 4-byte High Order-DSP (HO-DSP), the MAC address in the 6-byte End System Identifier (ESI), and a subscriber's identifier in the 1-byte Selector (SEL).

For example, the E.164 address in the IDI could identify a client’s ATM Baseband subscriber loop. The MAC address identifies the set-top terminal that is serviced by the drop. The SEL byte allows the set-top terminal to support up to 256 logical subscribers from one hardware platform, such as in a dormitory environment where one terminal may be shared by more than one roommate. For servers, the E.164 address identifies the ATM address of the server. The ESI identifies a service that runs in that server. IP addresses can be embedded within the above format to be used by the interactive multi-media applications between the Client and Server (User-to-User communication).

Annex W
Content Metadata Specification Language

(This annex does not form an integral part of this Specification)

W.1 CMSL Low Level Representations

Identifiers, Integers, strings, etc. are defined thus :

<alphanumeric> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z|

a|b|c|d|e|f|g|h|i|j|k|l|m|n|o|p|q|r|s|t|u|v|w|x|y|z|

_|-|.|%|£|$|&|!|?|+|=|*|,|'|#|

0|1|2|3|4|5|6|7|8|9

<character>	::=	<alphanumeric>| space
<identifier>	::=	<alphanumeric>+
<string>	::=	"<null>|<character>+"
<digit>	::=	0|1|2|3|4|5|6|7|8|9+
<integer>	::=	<digit>+
<boolean>	::=	TRUE | FALSE
<eol>	::=	carriage return and line feed
<comment>	::=	//{<character>} <eol>
<max_min_eq>	::=	MAX|MIN|EQ

W.2 Attribute / Property Types

Six types of Attributes and Properties can be defined in CMSL. These are Integer, String, Boolean, Date, Price and Floating Point. Each type has its own requirement parameters which must be specified in CMSL e.g. A Boolean can only be set to true or false, an Integer has a maximum and minimum range of values, etc. The syntactic constructs governing the definition of these parameters is shown below.

<Min Integer Range> ::= <Integer> | NO_MIN

NO_MIN is specified when a minimum Integer is not applicable to range or size

<Max Integer Range> ::= <Integer> | NO_MAX

NO_MAX is specified when a maximum Integer is not applicable to range or size

<Integer Type> ::=

INTEGER<eol>

[RANGE <Min Integer Range>,<Max Integer Range><eol>]

[DEFAULT <Integer><eol>]

<String Type> ::=

STRING<eol>

[SIZE <Min Integer Range>,<Max Integer Range><eol>]

The minimum and maximum size of the string can be set up. If a fixed size

is required then both Integers should be set to the desired length

[FORMAT ALPHANUMERIC|ALPHA|NUMERIC|CUSTOM<string><eol>]

A custom format can be specified based upon the C Programming Standards for Print formatting e.g. %d,%s, etc.

[LANGUAGE <string><eol>]

Language names must be based on a known standard if specified e.g. ISO 639.2 eng = English

[DEFAULT <string><eol>]

[{STRING_ASSIGNMENT <string><eol>}*]

String Assignments allow a pre-defined range of string values to be associated

with this Attribute /Property Type

<Boolean Type> ::=

BOOLEAN<eol>

[DEFAULT <boolean><eol>]

<Date Type> ::=

DATE<eol>

[FORMAT <string><eol>]

Date Formats styles must be based on a known standard if specified e.g. UTC or MJD

[DEFAULT <string><eol>]

<Price Type> ::=

PRICE<eol>

CURRENCY <string><eol>

Currency names must be based on a known standard if specified e.g. £,$,YEN,DM,

FORMAT <string><eol>

Price formats must be based on a known standard if specified e.g. FIXED.2,FIXED.3

[DEFAULT <string><eol>]

<Floating Point Type> ::=

FLOATING_POINT<eol>

[DEFAULT <Integer>.<Integer><eol>]

W.3 Attributes

Attributes are used to describe characteristics of a specific CI/CIE. For example a ‘Movie’ offering may use ‘Actor’, ‘Rating’ and ‘Genre’ attributes. Alternatively a home shopping application may include a ‘Shoes’ offering which may use a ‘Style’ attribute. The basic structure of an attribute contains a title description, an attribute type (e.g. Integer, string, etc.) and some descriptive “help” text for inclusion in the interpreted CMSL specification to use in Content Creation Tools.

<Attribute> ::=

ATTRIBUTE <identifier><eol>

TITLE <string><eol>

TYPE {

<Integer Type> |

<String Type> |

<Boolean Type> |

<Date Type> |

<Price Type> |

<Floating Point Type>

}

[HELP <string><eol>]

END<eol>

W.3.1 Generic Attributes

Title', 'Description' and 'Every CI or CIE must contain string attributes for a 'Unique ID', 'Title', 'Abbreviated CI/CIE Construct Identifier'. These generic attributes are fixed and not specified in any CMSL source code . So a CMSL Interpreter must automatically include them in each CI or CIE it interprets or produces a mapping for.

These identifiers cannot be used for other attribute identifier names, although they can be used for other CMSL construct identifiers e.g. properties, attribute groups, etc.

W.4 Properties

Physical media is built to a set of properties e.g. A BMP image is built with a size of 200x200 and uses 256 colour palette. The structure is similar for the Attribute Construct except that Price and Date types are not valid property types

<Property> ::=

PROPERTY <identifier><eol>

TITLE <string><eol>

TYPE {

<Integer Type> |

<String Type> |

<Boolean Type> |

<Floating Point Type>

}

[HELP <string><eol>]

END<eol>

W.5 Attribute Groups

Content Item and Content Item Element constructs, specified later on, do not allow for attributes to be included directly. They can only be included by declaring them in an Attribute Group as the group provides the attribute's 'context' . An Attribute Group is used to group together related attributes. By default, all attributes declared in the group are considered mandatory i.e. before an instance of a Content Item or Content Item Element can be considered complete each attribute must have been set up with a value. Optional attributes are indicated by the OPTIONAL keyword. When the same attribute is required more than once in an Attribute Group the OCCURS keyword can be used to indicate the number of occurrences. An attribute identifier cannot be repeated in the same Attribute Group. However, when an Attribute Group inherits from other Attribute Groups a 'duplicate' attribute identifier may be found in one of the inherited groups. These 'duplicate' attributes are valid as they have a different context within their own group. Some descriptive "help" text may be included in the interpreted CMSL specification to use in Content Creation Tools.

<Attribute Group> ::=

ATTRIBUTE_GROUP <identifier>[INHERITS <identifier>]<eol>

[{<identifier> [OPTIONAL] [{OCCURS <Integer>,<Integer>}]}<eol>]*

[HELP <string><eol>]

END<eol>

W.6 Property Packages

A Property Package essentially acts like a properties template in which properties can be declared for values to be assigned to them in a Properties Group (See next Section). A property identifier cannot be repeated in the same Property Package. However, when a Property Package inherits from other Property Packages a 'duplicate' property identifier may be found in one of the inherited packages. These 'duplicate' properties are valid as they have a different context within their own package.

Some descriptive "help" text may be included in the interpreted CMSL specification to use in Content Creation Tools.

<Property Package> ::=

PROPERTY_PACKAGE<identifier>[INHERITS <identifier>]<eol>

[{<identifier> <eol>}]*

[HELP <string><eol>]

END<eol>

W.7 Property Groups

Property Groups are used to declare property values from the available list of properties declared in a specified Property Package. Only properties from the specified Property Package, and its inherited packages if any, can be used. Property Groups can inherit other Property Groups. They can also be inherited by other Property Groups in both abstract and non-abstract CIEs (See Section 2.10).

A property identifier cannot be repeated in the same Property Group. However, when a Property Group inherits from other Property Groups a 'duplicate' property identifier may be found in one of the inherited groups. Such 'duplicate' properties are valid but are ignored. The value of the property in the derived Property Group overrides the duplicate property of the inherited Property Group.

Some descriptive "help" text may be included in the interpreted CMSL specification to use in Content Creation Tools.

<Property Group> ::=

PROPERTY_GROUP <identifier>[INHERITS <identifier>]<eol>

PROPERTY_PACKAGE_USED <identifier>

[{<identifier> [VALUE <string><max_min_eq>] <eol>}]*

The value is given as a string be it a numeric or alphanumeric value

max_min_eq only has meaning if the value is numeric

[HELP <string><eol>]

END<eol>

W.8 Association groups

A Relationship between a Content Item and Content Item Element, or another Content Item, is declared in an Association Group. One-to-Many relationships can be set up using the OCCURS keyword to specify the minimum and maximum bounds of the relationship. In some cases the relationship must be put into some sort of usage context e.g. "help", "background", etc. By default all relationships are considered to be components that are needed to build a Content Item. In some cases though the relationship may simply be just a reference. This can be indicated using the REFERENCE Keyword. Association Groups cannot inherit from one another.

<Association Group> ::=

ASSOCIATION_GROUP <identifier><eol>

[{CI_ASS|CIE_ASS} {<identifier> [OPTIONAL]

[{OCCURS <Integer>,<Integer>}]

[USAGE <string>]

[REFERENCE|COMPONENT]

Defaults to COMPONENT if nothing specified

}

<eol>]*

[HELP <string><eol>]

END<eol>

W.9 Content Item Element

The CIE Construct defines the specification that the actual physical CIE media should be built to by the included set of Property Groups. Any metadata required by the CIE is defined by the included set Attribute Groups or inherited from the Attribute Groups in an inherited CIE. When a CIE inherits from another CIE it must not inherit another Attribute Group with the same identifier.

The ABSTRACT Keyword indicates that the CIE cannot exist in its own right i.e. It can only be inherited by other CIEs. In a non-abstract CIE the property groups used will contain property values for the properties declared in abstract property groups of inherited CIEs.

Some descriptive “help” text may be included in the interpreted CMSL specification to use in Content Creation Tools.

<CIE Specification> ::=

CIE [ABSTRACT] <identifier> [INHERITS <identifier>]<eol>

[ATTRIBUTE_GROUPS_USED <eol>

{<identifier><eol>}*

END<eol>]

[PROPERTY_GROUPS_USED <eol>

{<identifier><eol>}*

END<eol>]

[HELP <string><eol>]

END<eol>

W.10 Content Item

The CI Construct defines any associated CIs and CIEs by the included set of Association Groups, together with Association Groups from inherited CIs. Note that some associated CIs may not actually be ‘build components’ of the CI but simply ‘referenced’ by it.

Any attributes required by the CI are defined by the included set of Attribute Groups and those from inherited CIs. When a CI inherits from another CI it must not inherit another Association Group or Attribute Group with the same identifier.

The Abstract Keyword indicates that the CI cannot exist in its own right i.e. It can only be inherited by other CIs.

Some descriptive “help” text may be included in the interpreted CMSL specification to use in Content Creation Tools.

<CI Specification> ::=

CI [ABSTRACT] <identifier> [INHERITS <identifier>]<eol>

[ATTRIBUTE_GROUPS_USED <eol>

{<identifier><eol>}*

END<eol>]

[ASSOCIATION_GROUPS_USED <eol>

{<identifier><eol>}*

END<eol>]

[HELP <string><eol>]

END<eol>

W.11 CMSL Source Files

All CMSL source files should have the same extension name. It is recommended that ".cms" is used. A complete set of CMSL constructs for a given multimedia application do not have to be declared in a single source file. CMSL source files can be included in other CMSL files by using the 'INCLUDE' keyword as follows.

INCLUDE "filename.cms"

Any INCLUDE statements must precede all other CMSL constructs in a source file.

Unless the complete CMSL source is quite small it is recommended that the different types of CMSL constructs are split into separate files. This can be done in a number of ways, especially as identifiers do not have to be defined before they can be used. One possible way is to group constructs by type with a "build" file containing the include keywords e.g.

INCLUDE "PropertiesFile.cms"

INCLUDE "AttributesFile.cms"

INCLUDE "PropertyGroupsFile.cms"

INCLUDE "PropertyPackagesFile.cms"

INCLUDE "AttributeGroupsFile.cms"

INCLUDE "AssociationGroupsFile.cms"

INCLUDE "ContentItemElementsFile.cms"

INCLUDE "ContentItemsFile.cms"

Annex X
Example of Simple Movie Content Item

(This annex does not form an integral part of this Specification)

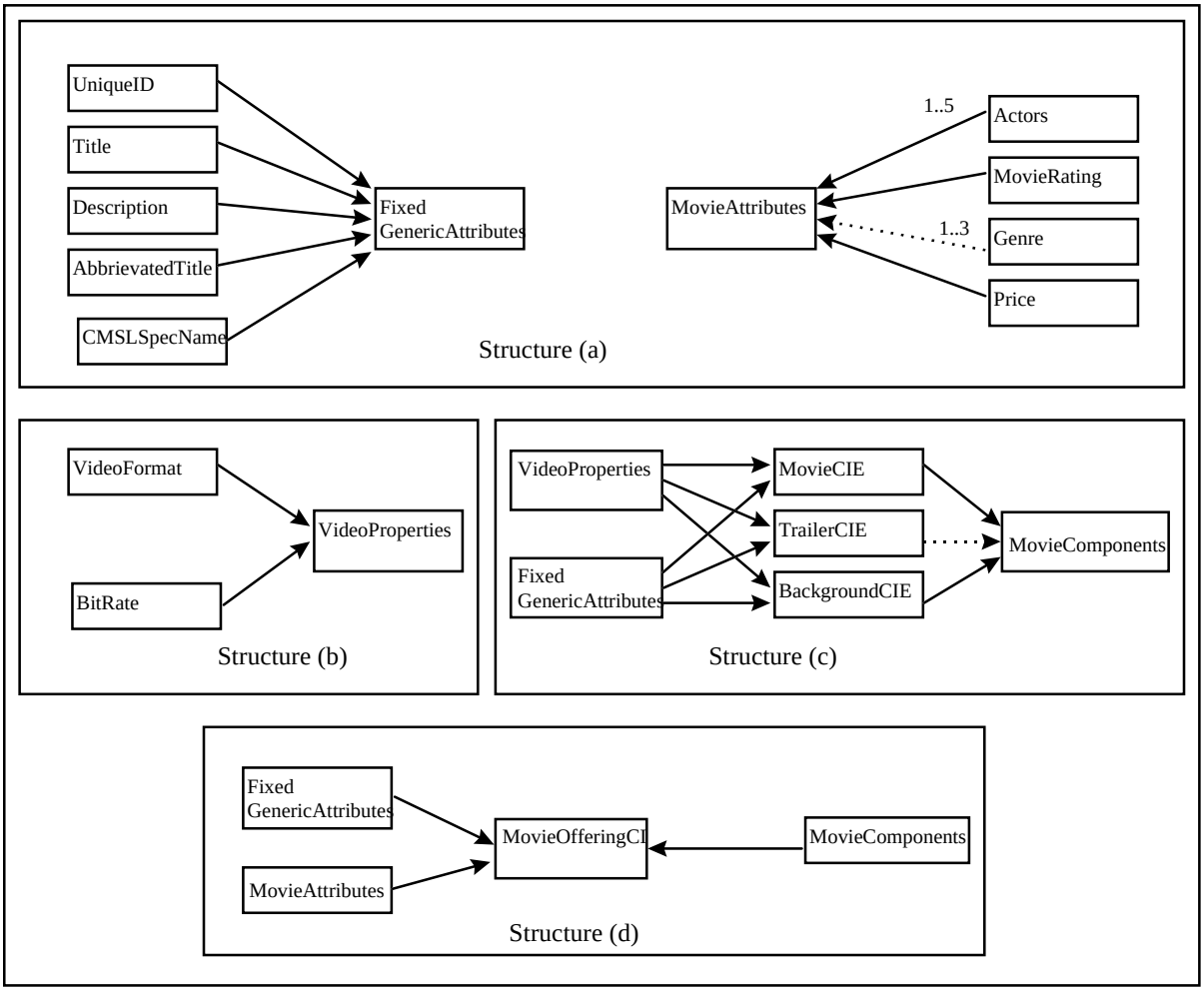


Figure X-1 Movie Offering CI/CIE Structures and Attributes.

Figure X-1 illustrates how a very simple movie type offering structure could be designed. Structure Parts (a), (b), (c) and (d) illustrate how the final structure is built up.

Structure (a) illustrates the grouping together of similar attributes for inclusion in CIs and CIEs. The 'MovieAttributes' group, consists of 'Actors', 'Genre', etc. The dashed line between 'Genre' and the 'MovieAttributes' group indicates that the attribute is optional within this group. The numbers by the 'Genre' relationship indicate that between one and three attributes of this kind can be included in the Group. Each CI or CIE must, by default, include a fixed set of 'Generic Attributes' for ID, Title, CMSL Spec Name, Description and Abbreviated title. Structure (b) illustrates the media content properties defined to ensure media is built in the correct format for the offering e.g. 'VideoBitRate', 'VideoFormat', etc. These are used to form a group of properties called 'VideoProperties'. Structure (c) shows the inclusion of the 'VideoProperties' and, by default, the 'GenericAttributes' into each CIE movie component. An associations group, 'MovieComponents', is set up with references to selected CIE movie components. In this case the 'TrailerCIE' component is optional in the group. Finally, Structure (d) shows the inclusion of the 'MovieAttributes' Group and, again by default, the 'GenericAttributes' into the 'MovieOfferingCI', together with the 'MovieComponents' associations group to indicate which CIE movie components are required to offer the movie. CMSL source code representing the structure parts described above is shown in Figure X-2.

Table X-2. Sample CMSL Source

```
ATTRIBUTE Genre
  TITLE "Genre Categories"
  TYPE STRING
  SIZE 0,40
END

ATTRIBUTE Actors
  TITLE "Actor Names"
  TYPE STRING
END

ATTRIBUTE MovieRating
  TITLE "Movie Rating Catagories"
  TYPE STRING
  DEFAULT "18"
  STRING_ASSIGNMENT "U "
  STRING_ASSIGNMENT "12"
  STRING_ASSIGNMENT "PG"
  STRING_ASSIGNMENT "18"
END

Other Attributes defined here.   Structure (a)
```

```
ASSOCIATION_GROUP MovieComponents
  CIE MovieCIE
  CIE TrailerCIE OPTIONAL
  CIE BackGroundCIE
END                                Structure (c)
```

```
CIE MovieCIE
  ATTRIBUTE_GROUPS_USED
    //GenericAttributes are implied
    //so they do not need declaring
  END
  PROPERTY_GROUPS_USED
    VideoProperties
  END
END                          Structure (c)
```

```
CI MovieOfferingCI
  ATTRIBUTE_GROUPS_USED
     MovieAttributes
     //GenericAttributes are implied
     //so they do not need declaring
END
  ASSOCIATION_GROUPS_USED
    MovieComponents
  END
END                          Structure (d)
```

```
PROPERTY VideoFormat
  TYPE STRING
  DEFAULT "MPEG"
  STRING_ASSIGNMENT "MPEG2"
  STRING_ASSIGNMENT "AVI"
  STRING_ASSIGNMENT "PFX"
END

PROPERTY BitRate
  TYPE NUMBER
END

Other Properties defined here

PROPERTY_PACKAGE VideoProps
    VideoFormat
  BitRate
END

Other Property Packages defined here.

PROPERTY_GROUP VideoProperties
  PROPERTY_PACKAGE_USED VideoProps
  VideoFormat MPEG
  BitRate  1600000 MAX
END

Other Property Groups defined here.   Structure (b)
```

```
ATTRIBUTE_GROUP GenericAttributes
  UniqueID
  Title
  Description
  AbbrieviatedTitle
  ContentProducerReference
END
ATTRIBUTE_GROUP MovieAttributes
  Actors  OCCURS 1,5
  MovieRating
  Genre  OPTIONAL OCCURS 1,3
  Price
END                                Structure (a)
```