Digital Video Broadcasting (DVB);
Companion Screens and Streams;
Part 2: Content Identification and Media Synchronization
5.4 Timeline correlation

5.5 Material Information

5.5.1 General

5.5.2 Material

5.5.3 Material Identifiers

5.5.4 Synchronization Timeline information

5.5.5 Timeline mappings

5.5.6 Correlation Timestamps

5.5.7 Trigger Event info

5.5.8 Process for determining which Materials are Active Materials

5.5.9 JSON syntax for representing Material Information

5.5.9.1 General

5.5.9.2 JSON for Material

5.5.9.3 JSON for Material Identifier

5.5.9.4 JSON for Synchronization Timeline information

5.5.9.5 JSON for Timeline properties

5.5.9.6 JSON for Timeline Mapping

5.5.9.7 JSON for Correlation Timestamp

5.5.9.8 Trigger Event Info

5.6 Content Identification and other Information (CII)

5.6.1 General

5.6.2 Reporting the MRS URL

5.6.3 Reporting the Content Identifier

5.6.4 Status of presentation

5.6.5 Reporting Wall Clock, Timeline Synchronization and Trigger Event Notification service endpoint URLs

5.6.6 Reporting a list of timeline options

5.6.7 JSON Representation of Content Identification and other Information

5.7 Timestamps and Timeline Synchronization

5.7.1 General

5.7.2 Reference point for timestamping

5.7.3 Setup data

5.7.4 Actual, Earliest and Latest Presentation Timestamp

5.7.5 Control Timestamps

5.8 Trigger Events

5.8.1 General

5.8.2 Encoding Trigger Event locations

5.8.3 Reference point for Trigger Events

5.8.4 Trigger Event Sources

5.8.4.1 General

5.8.4.2 DSM-CC “do it now” Stream Events

5.8.4.2.1 Encoding in MPEG TS

5.8.4.2.2 Encoding the URI referencing the Trigger Event

5.8.4.2.3 Trigger Event data

5.8.4.2.4 Reference point

5.8.4.3 DASH Events

5.8.4.3.1 Encoding in the DASH Content

5.8.4.3.2 Encoding the URI referencing the event

5.8.4.3.3 Event Data

5.8.4.3.4 Reference Point

5.8.4.4 Other Event Sources

5.8.5 Messages

5.8.5.1 General

5.8.5.2 Trigger Event Session Setup (TESS) message

5.8.5.3 Trigger Event Subscription Management (TESM) messages

5.8.5.4 Trigger Event Notification (TEN) message

5.9 Private data

5.9.1 General

5.9.2 JSON for an item of private data

6 Content Identification and other Information (CSS-CII)

6.1 General
A.2.7 Example of Trigger Event Session Setup .......................................................................................... 110
A.2.5 Example of Control Timestamp .................................................................................................. 110
A.2.4 Example of Setup Data ............................................................................................................. 110
A.2.3 Example of Content Identification and other Information (CII) ...................................................... 109
A.2.2 Example of Material Information .................................................................................................. 108
A.2.1 General ...................................................................................................................................... 106

Annex A .................................................................................................................................................. 106
A.1.10 Trigger Event Notification (TEN) schema .................................................................................. 105
A.1.9 Trigger Event Subscription Management (TESM) schema ........................................................... 105
A.1.8 Trigger Event Session Setup (TESS) schema ............................................................................. 104
A.1.7 Actual, Earliest and Latest Presentation Timestamp schema ........................................................ 104
A.1.6 Control Timestamp schema ........................................................................................................ 103

Annex B (informative): Implementation guidelines for broadcasters ................................................. 111

B.1 General ........................................................................................................................................... 111
B.2 Use of Material Information and Material Resolution ...................................................................... 111
B.2.1 General ...................................................................................................................................... 111
B.2.2 Material Information ................................................................................................................... 111
B.2.2.1 General .................................................................................................................................. 111
B.2.2.2 Hierarchical relationships .................................................................................................. 112
B.2.2.3 Use of Material Identifiers .................................................................................................. 112
B.2.2.4 Use of private data ................................................................................................................. 113
B.2.2.5 Ambiguities in timeline mappings .......................................................................................... 113
B.2.2.5.1 Example of Handling wrapping of a Synchronization Timeline ........................................ 113
B.2.2.5.2 A point on the Synchronization Timeline maps to multiple points on the Material Timeline .... 114
B.2.2.5.3 Ambiguities due to long duration Materials ...................................................................... 114
B.2.2.5.4 Ambiguities due to Synchronization Timeline discontinuities ............................................ 114
B.2.2.6 Precisely identifying the start and end of programmes on a DVB broadcast service ............... 115
B.2.4 Content Identification and regular wrapping of the Synchronization Timeline ............................ 116
B.3 Derivation of timelines from the broadcast chain ............................................................................ 116
B.3.1 General ...................................................................................................................................... 116
B.3.2 Time synchronization at playout ................................................................................................. 117
B.3.3 Coding and multiplexing ........................................................................................................... 118
B.3.4 Generation of Material Information ............................................................................................ 118
B.3.5 Handling non integer frame rates and dropped frame timecode .................................................. 119
B.4 Managing delay throughout distribution network ............................................................................. 119
B.5 Managing multiple content timelines .............................................................................................. 120
B.6 Generating Correlation Timestamps ................................................................................................ 120
B.7 Timelines in MPEG DASH streams ............................................................................................... 122
B.7.1 Handling xlink references ........................................................................................................ 122
B.7.2 Timeline wrapping ..................................................................................................................... 123

Annex C (informative): Implementation guidelines for TV Devices and Companion Screen Applications .............................................................................................................................. 124

C.1 General .......................................................................................................................................... 124
C.2 CI examples ................................................................................................................................... 124
C.2.1 Examples of correctly formed CIs ............................................................................................... 124
C.2.2 Examples of malformed CIs ........................................................................................................ 126
C.3 Handling dynamics of media synchronization by the Synchronization Client .................................. 127
C.4 Example calculations: Reference point for timestamping......................................................128
C.4.1 General ............................................................................................................................128
C.4.2 Actual Presentation Timestamp........................................................................................129
C.4.3 Earliest Presentation Timestamp ....................................................................................129
C.4.4 Latest Presentation Timestamp ......................................................................................130
C.4.5 Control Timestamp .........................................................................................................130
C.5 Example calculations: Where TV Device cannot vary the presentation time of content ..........131
C.5.1 General ............................................................................................................................131
C.5.2 SC elementary function in the TV device .........................................................................131
C.5.2.1 Calculation Explanation...............................................................................................131
C.5.2.2 Calculation Example....................................................................................................134
C.5.3 MSAS elementary function in the TV device ....................................................................135
C.5.3.1 Calculation Explanation...............................................................................................135
C.5.3.2 Calculation Example....................................................................................................135
C.6 Example calculations: Where TV Device can vary the presentation time of content ..............136
C.6.1 General ............................................................................................................................136
C.6.2 SC elementary function in the TV device .........................................................................136
C.6.2.1 Calculation Explanation...............................................................................................136
C.6.2.2 Calculation Example....................................................................................................140
C.6.3 MSAS elementary function in the TV device ....................................................................141
C.6.3.1 Calculation Explanation...............................................................................................141
C.6.3.2 Calculation Example....................................................................................................143
C.7 Example calculations: SC elementary function in the Companion Screen Application ..........145
C.7.1 General ............................................................................................................................145
C.7.2 SC elementary function in the CSA for media content ....................................................145
C.7.2.1 Calculation Explanation...............................................................................................145
C.7.2.2 Calculation Example....................................................................................................149
C.7.3 SC elementary function in the CSA for application generated content ..............................150
C.7.3.1 Calculation Explanation...............................................................................................150
C.7.3.2 Calculation Example....................................................................................................153
C.8 Wall Clock synchronization implementation guidance ................................................................154
C.8.1 General ............................................................................................................................154
C.8.2 TV Device and WC Server ..............................................................................................155
C.8.3 CSA and WC Client .........................................................................................................156
C.8.3.1 Process Overview .......................................................................................................156
C.8.3.2 Calculation of candidates and metrics from measurements ..........................................158
C.8.3.3 Measurement process ..................................................................................................160
C.8.3.4 Filtering process ...........................................................................................................161
C.8.3.5 Adjustment process .....................................................................................................161
C.9 Status of Presentation and behaviour of TV Device ................................................................162
C.9.1 Primary aspect of status of presentation and behaviour of TV Device ...............................162
C.9.2 Examples of extended aspects of status of presentation ..................................................163
C.10 Trigger Event Presentation Time (informative) ...................................................................164
C.10.0 Trigger Event Presentation Time Introduction ................................................................164
C.10.1 Calculation of presentation time by the TV Device .........................................................164
C.10.2 Calculation by the CSA to adjust for playback speed ......................................................165

Annex D (informative): Data model diagrams description..........................................................166
D.1 General ...............................................................................................................................166
D.2 Objects ...............................................................................................................................166
D.3 Links and associations ..........................................................................................................166
D.4 Aggregation ........................................................................................................................166

Annex E (normative): Signalling of MRS and CI ancillary data in DASH MPDs .........................168
E.1 General ...............................................................................................................................168
E.2 DASH MPD Schema Extensions ............................................................................................................. 168
E.2.1 XML Element Namespace ..................................................................................................................... 168
E.2.2 MRS URL ............................................................................................................................................. 168
E.2.3 CI Ancillary Data ................................................................................................................................. 168
E.2.4 Schema ............................................................................................................................................... 169
E.3 Example MPD ........................................................................................................................................... 169

Annex F (normative): Signalling of MRS and CI Ancillary data in DVB IPTV Service Discovery and Selection XML ........................................................................................................171
F.1 General .................................................................................................................................................. 171
F.2 XML Namespace ..................................................................................................................................... 171
F.3 MRS (URILinkage) .................................................................................................................................. 171
F.4 CI Ancillary Data ..................................................................................................................................... 171
F.5 Schema .................................................................................................................................................. 171

Annex G (informative): Change History ......................................................................................................... 172
History ............................................................................................................................................................ 174
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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation Electrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

**NOTE:** The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members’ activities in the technical, legal, programme-making and programme exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

European Broadcasting Union
CH-1218 GRAND SACONNEX (Geneva)
Switzerland
Tel: +41 22 717 21 11
Fax: +41 22 717 24 81

The Digital Video Broadcasting Project (DVB) is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulatory bodies, content owners and others committed to designing global standards for the delivery of digital television and data services. DVB fosters market driven solutions that meet the needs and economic circumstances of broadcast industry stakeholders and consumers. DVB standards cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. The consortium came together in 1993 to provide global standardization, interoperability and future proof specifications.

The present document is part 2 of a multi-part deliverable covering the DVB Companion Screens and Streams Specification, as identified below:

Part 1:  "Concepts, roles and overall architecture";

Part 2:  "Content Identification and Media Synchronization";

Part 3:  "Discovery".
Modal verbs terminology

In the present document "shall", "shall not", "should", "should not", "may", "need not", "will", "will not", "can" and "cannot" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"must" and "must not" are NOT allowed in ETSI deliverables except when used in direct citation.

Introduction

It is assumed that the reader is familiar with ETSI TS 103 286-1 [i.10] that provides background information on the concepts covered in the present document.

Personal, smart devices like tablet computers and smart phones enable new user experiences for broadcast service consumption. Many of these new experiences require synchronization between the broadcast content presented on the TV Device and the content presented on the personal device.

The present document enables the identification of, and synchronization with timed content and trigger events on TV devices (for example a Connected TV or STB) and related content presented by an application running on a personal device. Example use cases are:

- presenting a question and a choice of possible answers on a personal device, which are related to what is currently happening on a quiz show that is the current TV Programme;
- alternative audio intended to be consumed through the personal device (e.g. via connected headphones) and along with the broadcast video content on the TV device, such as an alternative commentary, an alternative language, clean audio for hearing impaired or audio descriptions for the visually impaired;
- seamlessly switching between different camera views on the personal device synchronously with a football game on the TV Device;
- presenting advertisements on the personal device which are related to the broadcast content, and in synchronization with the broadcast content (for example an advertisement for a product that is currently prominently visible in the broadcast video); and
- presenting a targeted advertisement to the user on the personal device at the time of presenting a generic interstitial in the broadcast content.

To enable such use cases, two functionalities are needed. The first functionality is the identification of broadcast content and finding of associated content for presentation on the personal device. The identification mechanisms defined in the present document are hence designed to take the following limiting factors into account:

- Different broadcast platforms may use different solutions to identify broadcast programmes.
- Synchronized transmission of broadcast and personal content through different transmission infrastructures is difficult.
- Broadcast platforms are bandwidth sensitive, and the amount of data needed for identification and synchronization should hence be kept to a minimum.
- Interactions of the personal device or the TV device with resources over broadband connections may take significant time. Furthermore, in a series of requests, the amount of time spent on each of them can vary largely and unpredictably.
- Applications presenting content on the personal device, and which are controlled by trigger events, need to identify of the content currently being presented by the TV device and determine the associated content for presentation on the personal device. In addition they also will need to subscribe to, and receive notifications of, any trigger event signalling in the broadcast service.
The second functionality is the synchronization of playback on the personal device with the playback on the TV device. Typically, an accuracy of at least 40 ms is required for frame-accurate synchronization between two video streams or lip sync between audio and video. The synchronicity between pieces of content is influenced by several factors:

- Propagation delays are different for different transmission networks and technologies, like terrestrial broadcast, satellite broadcast, IP multicast, and IP unicast; this can lead to arrival time differences of up to ten secs when transmitting through different paths.
- If the media is delivered via a Content Delivery Network (CDN), a significant amount of time (often 30 secs or more) is needed to ingest the content into the CDN before it becomes available for retrieval.
- Media processing function like transcoding can take up to several seconds of time which may limit their applicability to certain use cases.
- Streaming delivery through switched packet networks (for instance typical broadband Internet services) requires buffering for smooth presentation of media content. The size of the buffer depends on the technology used and the presence of any local post-processing for quality enhancement. This may lead to additional delays of up to 500 ms at the receiving device.

The present document provides an architectural framework for timeline synchronization between a presentation on one device and associated Timed Content on another, optionally using trigger events. The present document provides the protocol interfaces to provide this functionality given the limiting and influencing factors described above. These mechanisms are designed to take the following additional limiting factors into account:

- Related pieces of content may have different types of Timelines, with different tick rates and resolutions.
- The clocks of related pieces of content may exhibit different error properties (e.g. drift or jitter) if these clocks are not genlocked ("generator locked", i.e. synchronized at the source).
- As a consequence of processing during content production or distribution, timelines may be offset between different related pieces of content, even if they are of the same type and if clocks are genlocked.
- Timelines embedded into content (e.g. PTS for MPEG TS, or composition time of ISOBMFF) may be modified by the distribution network due to multiplexing, transcoding, and re-origination.
- Timelines transmitted along with content may be removed by distribution networks.
- Timelines can, and will, include discontinuities.
- Depending on the particular encoding of timestamps, some timelines will wrap around during presentation, as only a limited number of bits is available to express a Time Value on such Timeline.
- The system clocks of TV devices and personal devices run independently, and will hence exhibit different error behaviour (e.g. drift).

Figure 0.1 shows a basic, conceptual model for time-controlled playback. A local wall clock advances steadily, and the playback of the media streams is timed accordingly to achieve a smooth presentation. To enable this, the media streams are adorned with their own timebase timeline, which is compared to the wall clock timeline. During playback, whenever the wall clock timeline advances, the media player computes the corresponding point on the media's timebase timeline, and retrieves the associated chunk of media data for playback. To achieve time-controlled and smooth playback the media player will typically apply an offset to the media stream's timebase timeline and also adjust the playback rate of the media stream's timebase timeline in these computations. As the playback proceeds over time, media players will typically make dynamic re-adjustments of the offset and playback rate, to accommodate variations in the wall clock's progress, and in the delivery of the media stream.
Extending from this basic model, figure 0.2 shows how the playback of two independent media streams can be controlled on two independent media players in a coordinated fashion. To adapt the playback of the two media streams - for example to make the audio from one suitable for consumption with the video from the other - both the wall clocks and the media stream playback need to be coordinated between the two players. In the context of the present document, this happens by exchanging information between the two players across a home network. All mechanisms and solutions defined in the present document will build on and extend from this basic conceptual model. These solutions are not limited to audio-visual content but cover any type of timed content, for example subtitles, trigger events received in the broadcast and timed content generated locally by an application running on either of the devices (e.g. in the quiz show use case mentioned above).
Figure 0.2: Basic model of synchronizing playback between devices