

ETSI TS 103 286-2 V1.2.1 (2017-08)



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

EBU
OPERATING EUROVISION

DVB[®]
Digital Video
Broadcasting



ReferenceRTS/JTC-DVB-374-2

Keywordsbroadcast, companion screen, DVB,
synchronization, TV**ETSI**650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
<http://www.etsi.org/standards-search>

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:
<https://portal.etsi.org/People/CommitteeSupportStaff.aspx>

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2017.

© European Broadcasting Union 2017.

All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members.

3GPP™ and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

oneM2M logo is protected for the benefit of its Members.

GSM® and the GSM logo are trademarks registered and owned by the GSM Association.

Contents

Intellectual Property Rights	9
Foreword.....	9
Modal verbs terminology.....	10
Introduction	10
1 Scope	14
2 References	14
2.1 Normative references	14
2.2 Informative references.....	16
3 Definitions and abbreviations.....	17
3.1 Definitions.....	17
3.2 Abbreviations	19
4 Overview	21
4.1 Interfaces	21
4.2 Architecture for identification and companion synchronization	21
4.2.1 General.....	21
4.2.2 Media synchronization architecture	24
4.2.3 Mapping of generic media synchronization architecture to Timeline Synchronization.....	26
4.2.4 Simplified scenario for the TV Device	28
4.3 Procedures	28
4.3.1 Introduction.....	28
4.3.2 Content Identification and other Information (CSS-CII)	29
4.3.3 Material Resolution Service (CSS-MRS)	30
4.3.4 Wall Clock (CSS-WC).....	31
4.3.5 Timeline Synchronization (CSS-TS)	32
4.3.6 Trigger Events interface (CSS-TE).....	34
5 Data model	36
5.1 Data model introduction	36
5.2 Content Identification.....	37
5.2.1 General.....	37
5.2.2 Content Identifier stem	38
5.2.3 DVB Broadcast and IPTV services.....	38
5.2.3.1 General	38
5.2.3.2 Net path for DVB broadcast services	39
5.2.3.3 Net path for DVB IPTV services	40
5.2.3.4 Event Constraint.....	40
5.2.3.5 Query.....	40
5.2.3.6 Progressive build-up of CIs for DVB Broadcast and IPTV services.....	41
5.2.3.6.1 Common	41
5.2.3.6.2 DVB Broadcast systems	42
5.2.3.6.3 DVB IPTV systems	42
5.2.4 DVB DASH services	43
5.2.5 Other types of service	43
5.3 Timelines.....	44
5.3.1 General.....	44
5.3.2 Tick rate and accuracy properties	44
5.3.3 Sources of Timelines and the Timeline Selector.....	46
5.3.4 MPEG-TS PTS: Presentation Time Stamp	47
5.3.5 ISOBMFF: composition time	47
5.3.6 TS Adaptation Packet	47
5.3.7 MPEG DASH: Period relative Timeline.....	47
5.3.7.1 General	47
5.3.7.2 Timeline Selector for a Period relative Timeline	48
5.3.7.3 Determining Time Values and Timestamps for a Period relative Timeline	48

5.4	Timeline correlation	49
5.5	Material Information	51
5.5.1	General.....	51
5.5.2	Material.....	52
5.5.3	Material Identifiers	53
5.5.4	Synchronization Timeline information	53
5.5.5	Timeline mappings	54
5.5.6	Correlation Timestamps.....	54
5.5.7	Trigger Event info.....	55
5.5.8	Process for determining which Materials are Active Materials	55
5.5.9	JSON syntax for representing Material Information.....	57
5.5.9.1	General.....	57
5.5.9.2	JSON for Material.....	58
5.5.9.3	JSON for Material Identifier	58
5.5.9.4	JSON for Synchronization Timeline information	58
5.5.9.5	JSON for Timeline properties	59
5.5.9.6	JSON for Timeline Mapping.....	59
5.5.9.7	JSON for Correlation Timestamp	60
5.5.9.8	Trigger Event Info.....	60
5.6	Content Identification and other Information (CII).....	61
5.6.1	General.....	61
5.6.2	Reporting the MRS URL	61
5.6.3	Reporting the Content Identifier	62
5.6.4	Status of presentation.....	62
5.6.5	Reporting Wall Clock, Timeline Synchronization and Trigger Event Notification service endpoint URLs.....	63
5.6.6	Reporting a list of timeline options.....	64
5.6.7	JSON Representation of Content Identification and other Information.....	64
5.7	Timestamps and Timeline Synchronization	65
5.7.1	General.....	65
5.7.2	Reference point for timestamping.....	66
5.7.3	Setup data.....	66
5.7.4	Actual, Earliest and Latest Presentation Timestamp.....	67
5.7.5	Control Timestamps.....	68
5.8	Trigger Events	69
5.8.1	General.....	69
5.8.2	Encoding Trigger Event locations	69
5.8.3	Reference point for Trigger Events.....	69
5.8.4	Trigger Event Sources	69
5.8.4.1	General.....	69
5.8.4.2	DSM-CC "do it now" Stream Events	70
5.8.4.2.1	Encoding in MPEG TS.....	70
5.8.4.2.2	Encoding the URI referencing the Trigger Event.....	70
5.8.4.2.3	Trigger Event data	70
5.8.4.2.4	Reference point.....	70
5.8.4.3	DASH Events.....	71
5.8.4.3.1	Encoding in the DASH Content	71
5.8.4.3.2	Encoding the URI referencing the event	71
5.8.4.3.3	Event Data	71
5.8.4.3.4	Reference Point	71
5.8.4.4	Other Event Sources.....	72
5.8.5	Messages.....	72
5.8.5.1	General.....	72
5.8.5.2	Trigger Event Session Setup (TESS) message.....	72
5.8.5.3	Trigger Event Subscription Management (TESM) messages	73
5.8.5.4	Trigger Event Notification (TEN) message	73
5.9	Private data.....	75
5.9.1	General.....	75
5.9.2	JSON for an item of private data	75
6	Content Identification and other Information (CSS-CII)	76
6.1	General	76

6.2	Protocol	76
6.3	Protocol transport	77
7	Material Resolution Service (CSS-MRS).....	78
7.1	General	78
7.2	Material resolution protocol	78
7.3	Material resolution protocol query	78
7.3.1	Material resolution protocol general requirements	78
7.3.2	Material resolution protocol URL.....	79
7.3.3	Material resolution protocol parameter.....	79
7.4	Material resolution protocol response	80
7.5	Material resolution protocol example (informative).....	81
7.6	MRS Update Protocols.....	82
7.6.1	General.....	82
7.6.2	JSON syntax for update array element	82
7.6.3	Update response JSON	83
7.6.3.1	Update response JSON types	83
7.6.3.2	Semantics of Material update responses	83
7.6.3.3	Semantics of Timeline Sync update responses.....	83
7.6.4	Long poll.....	84
7.6.5	WebSocket protocol.....	84
7.6.6	Server Sent Events protocol.....	84
7.6.7	BOSH/XMPP protocol	85
8	Wall Clock (CSS-WC)	85
8.1	General	85
8.2	Protocol overview.....	85
8.2.0	Protocol Introduction	85
8.2.1	Time values and estimating Wall Clock offset	86
8.2.2	Measurement precision	87
8.2.3	Maximum frequency error	87
8.3	Wall Clock protocol	88
8.4	Wall clock protocol transport.....	89
9	Timeline Synchronization (CSS-TS).....	90
9.1	General	90
9.2	Protocol	90
9.3	Protocol transport	92
10	Trigger Events (CSS-TE)	93
10.1	General	93
10.2	Protocol	93
10.3	Protocol Transport.....	94
11	Timelines in Transport Stream adaptation fields.....	95
11.1	General	95
11.2	Void.....	95
11.3	Timed External Media Information (TEMI)	95
11.3.1	General.....	95
11.3.2	Timeline Selector for an MPEG TEMI timeline.....	95
11.3.3	Interpretation of a temi_timeline_descriptor.....	95
11.3.4	Determining Disappearance of a TEMI timeline (informative).....	96
11.3.5	TEMI timelines and bitstream manipulation (informative)	96
12	Connection and playback session management	96
Annex A (informative): JSON representation		98
A.1	JSON Schemas	98
A.1.1	General	98
A.1.2	Core schema	98
A.1.3	Material Information (MI) schema.....	100
A.1.4	Content Identification and other Information (CII) schema	102
A.1.5	Setup-data schema	103

A.1.6	Control Timestamp schema.....	103
A.1.7	Actual, Earliest and Latest Presentation Timestamp schema	104
A.1.8	Trigger Event Session Setup (TESS) schema.....	104
A.1.9	Trigger Event Subscription Management (TESM) schema.....	105
A.1.10	Trigger Event Notification (TEN) schema	105
A.2	Example JSON representation (informative)	106
A.2.1	General	106
A.2.2	Examples of Material Information	106
A.2.2.1	Example response from the MRS	106
A.2.2.2	Example Materials update response from the MRS.....	108
A.2.2.3	Example Synchronization Timeline Information update response from the MRS	109
A.2.3	Example of Content Identification and other Information (CII).....	109
A.2.4	Example of Setup Data.....	110
A.2.5	Example of Control Timestamp	110
A.2.6	Example of Actual, Earliest and Latest Presentation Timestamp.....	110
A.2.7	Example of Trigger Event Session Setup	110
A.2.8	Example of Trigger Event Subscription Management	110
A.2.9	Trigger Event Notification	110

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.2.3	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

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<https://ipr.etsi.org/>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

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.

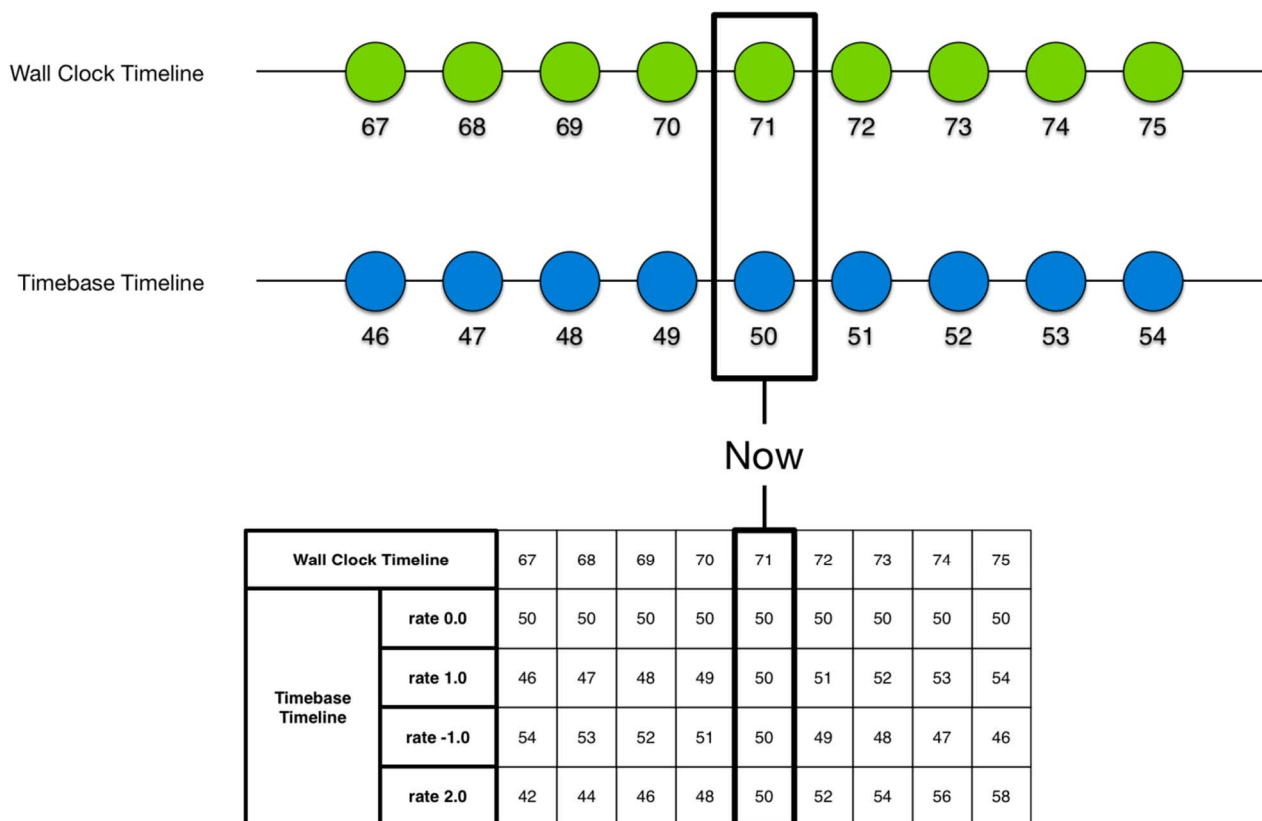


Figure 0.1: Basic model of time-controlled playback

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).

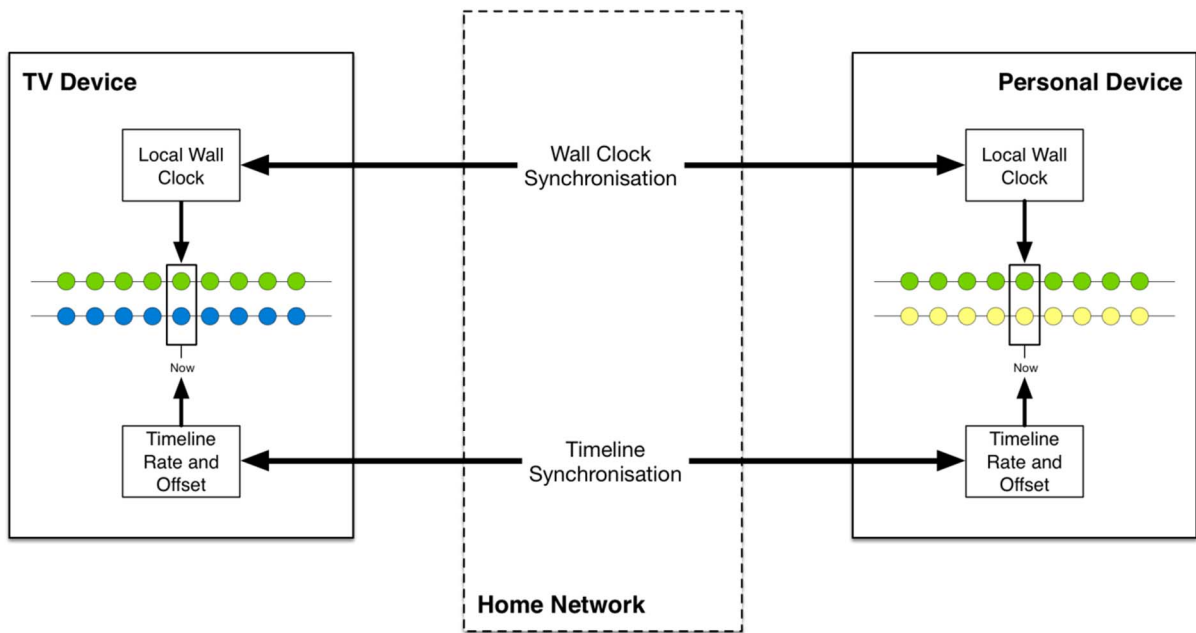


Figure 0.2: Basic model of synchronizing playback between devices

1 Scope

The present document specifies the architecture and protocols for content identification, Timeline Synchronization and Trigger Events for companion screens and streams.

The present document is applicable to:

- the interfaces between the TV Device and the Companion Screen Application:
 - interface for metadata exchange, including content identification;
 - interface for Wall Clock synchronization;
 - interface for Timeline Synchronization;
 - interface for Trigger Events;
- the interface between the Companion Screen Application and the Material Resolution Service (MRS).

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] IETF RFC 3986 (2005): "Uniform Resource Identifier (URI): Generic Syntax".

NOTE: Available at <http://www.ietf.org/rfc/rfc3986.txt>.

[2] ETSI TS 102 323 (V1.5.1): "Digital Video Broadcasting (DVB); Carriage and signalling of TV-Anytime information in DVB transport streams".

NOTE: Available at http://www.etsi.org/deliver/etsi_ts/102300_102399/102323/01.05.01_60/.

[3] ETSI TS 102 851 (V1.3.1): "Digital Video Broadcasting (DVB); Uniform Resource Identifiers (URI) for DVB Systems".

NOTE: Available at http://www.etsi.org/deliver/etsi_ts/102800_102899/102851/01.03.01_60/.

[4] IETF RFC 5234 (2008): "Augmented BNF for Syntax Specifications: ABNF".

NOTE: Available at <http://www.ietf.org/rfc/rfc5234.txt>.

[5] ETSI TS 102 034: "Digital Video Broadcasting (DVB); Transport of MPEG-2 TS Based DVB Services over IP Based Networks".

NOTE: Available at http://www.etsi.org/deliver/etsi_ts/102000_102099/102034/.

[6] ISO/IEC 13818-1:2015: "Information technology -- Generic coding of moving pictures and associated audio information -- Part 1: Systems".