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Digital Video Broadcasting (DVB);
Dynamic substitution of content in linear broadcast;
Part 1: Carriage and signalling of placement opportunity information in DVB Transport Streams

EBU DVB®

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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.

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The DVB Project is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulators and others from around the world committed to designing open, interoperable technical specifications for the global delivery of digital media and broadcast services. DVB specifications 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.

The present document is part 1 of a multi-part deliverable covering the dynamic substitution of content in linear broadcast, as identified below:

ETSI TS 103 752-1: "Carriage and signalling of placement opportunity information in DVB Transport Streams";

ETSI TR 103 752-2: "Interfacing to an advert decisioning service and optimal preparation of media".

Full details of the entire series can be found in the present document (see clause 4).

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

For broadcasters who wish to dynamically substitute advertising in a linear broadcast, or for platform operators who wish to enable the functionality for broadcasters, the present document specifies broadcast signalling used by receivers to identify placement opportunities within a service in a DVB Transport Stream. The signalling described in the present document may also be applied to dynamic substitution of programme content.

1 Scope

The present document specifies broadcast signalling for DVB Dynamic Advertisement Substitution.

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 https://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] ANSI/SCTE 35 2019r1: "Digital Program Insertion Cueing Message for Cable".

[2] ANSI/SCTE 104 2019r1: "Automation System to Compression System Communications Applications Program Interface (API)".

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

[4] IETF RFC 4648: "The Base16, Base32, and Base64 Data Encodings".

[5] ETSI TS 101 162: "Digital Video Broadcasting (DVB); Allocation of identifiers and codes for Digital Video Broadcasting (DVB) systems".

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

[7] ETSI TS 103 286-2: "Digital Video Broadcasting (DVB); Companion Screens and Streams; Part 2: Content Identification and Media Synchronization".

[8] ISO/IEC 13818-1:2023: "Information technology - Generic coding of moving pictures and associated audio information - Part 1: Systems".

[9] ETSI TS 102 809: "Digital Video Broadcasting (DVB); Signalling and carriage of interactive applications and services in Hybrid broadcast/broadband environments".

[10] ATSC A/335: "ATSC Standard: Video Watermark Emission".

2.2 Informative 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.

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 not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 103 752-2: "Digital Video Broadcasting (DVB); Dynamic substitution of content in linear broadcast; Part 2: Interfacing to an advert decisioning service and optimal preparation of media".

[i.2] Media Perspectives: "Event Triggering Distribution Specification (ETDS)".

[i.3] ETSI TS 102 796: "Hybrid Broadcast Broadband TV".

[i.4] ETSI TS 103 464: "Hybrid Broadcast Broadband TV; Application Discovery over Broadband".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

1X Data Rate Video Watermark: As defined in ATSC A/335 [10].

2X Data Rate Video Watermark: As defined in ATSC A/335 [10].

advert: See advertisement.

advertisement: audio-visual presentation aimed at communicating the benefits of a product or brand

NOTE: An advertisement is an individual, self-contained Commercial, Sponsorship, Promotional (Promo), Bumper or similar item.

advert media: particular combination of audio-visual encoding and packaging used by a receiver to render an advert

NOTE: An advert response may reference several versions of advert media.

advert producer: organization, often a creative agency, responsible for supplying source media for an advertising campaign to an advert server

advert request: resource locator, which when resolved communicates the context of a placement opportunity to an advert server

advert response: response delivered in reply to an advert request, encapsulating all information related to a particular instance of an advert e.g. identifiers and resource locators for the advert's media and tracking

advert server: trusted web service that is used to decision advert opportunities and which receives advert requests and returns advert responses

break: complete block of one or more advertisements in advance of, interrupting, or following a programme

broadcaster: entity responsible for compiling and disseminating audio-visual programme content as a TV channel on a linear broadcast stream

bumper: specific type of advertisement, acting as channel identification and/or demarcation between different types of segments

NOTE: A bumper usually takes the form of a promotion of the broadcaster's channel brand and may be present going into a break and again coming out of it. Also referred to as a 'sting', 'ident', 'opener' or 'closer'.

chapter: part of a program followed by one or more advertisements or by the chapter of another programme

commercial: specific type of advertisement containing inducements to buy a product or attract customers

DAS app: software application to perform DAS on the receiver via the API exposed by the receiver's capabilities

Dynamic Advert Substitution (DAS): operation by which a certain broadcast advert is substituted by a targeted advert (delivered over internet protocol in most cases), chosen specifically for a given individual receiver

NOTE: The substitution is managed by an advert server, which will effectuate the DAS operation in compliance with the business rules set by the broadcaster or platform operator.

frame-accurate advert substitution: substitution of a linear advert that is perfectly spliced into a linear broadcast stream to exacting broadcast standards

General Data Protection Regulation (GDPR): single set of rules by which all companies operating within the European Union are required to abide by

horizontal deployment: deployment where one or more broadcasters output TV channels independently of each other and independently of the suppliers of the receiver hardware needed to view the TV channels

macro substitution: substitution method available to advert servers enabling run-time substitution of variables, typically URL parameters, within an advert response

network operator: entity responsible for the distribution of TV channels as linear broadcast streams

placement opportunity: section of broadcast TV content that may be replaced, typically a delineation of segments such as a block of one or more advertisements

NOTE: This concept generalizes the distributor placement opportunity (traditionally known as "Avail") and the provider placement opportunity.

platform operator: entity responsible for packaging and distributing TV channels as linear broadcast streams as well as the hardware receivers needed to view them

programme: individual, self-contained editorial grouping of content produced for TV broadcast, not being an advertisement

EXAMPLES: A movie, a news show, or an episode of a TV show.

promo: See promotional.

promotional: specific type of advertisement drawing attention to a future programme or event provided or organized by the broadcaster

receiver: device capable of receiving and rendering the audio-visual content of a linear broadcast stream, usually a television or set top box

seamless advert substitution: substitution of a linear broadcast advert which has no discernible visual or audible degradation to the viewer

NOTE: For a seamless advert substitution, the viewer cannot notice that the advert has been substituted without a comparative reference. This differs from frame-accurate substitution in that frames of black or freeze frames may have been introduced to visually improve a transition to the substitute advert.

segment: uniquely identifiable broadcast playlist element such as a program, a chapter or an advertisement

sponsorship: specific type of advertisement pointing out that the broadcasting of the previous, current or next programme was made possible thanks to a certain company or brand

spot: time-bound section of a break dedicated to a single advert

substitute advert: advert that is presented instead of the underlying broadcast advert

substituted advert: underlying broadcast advert that is omitted for the substitute advert

time shift: mode of viewing a linear broadcast stream so that it is presented to a viewer delayed from the live broadcast

tracking: resource locator that is resolved at run-time in order to count and measure advert delivery

trick play: pause, rewind or fast-forward of a linear broadcast stream

trusted advert gateway: server that provides receivers with substitution adverts based on decisions made elsewhere, but may provide restrictions or constraints for the decisioning process

vertical deployment: deployment where the end-to-end chain of broadcast-to-receiver infrastructure is the responsibility of a sole entity, e.g. a platform operator

NOTE: In a vertical deployment, the packages of TV channels are broadcast by the sole-entity and the receiver hardware and/or software needed to view the packages are supplied into the market by the same entity.

watermarking: technology for the delivery of signalling data associated with content wherein data is embedded within the media essence (i.e. in the audio and/or video signals) in such a way as to enable its recovery even after the application of transcoding, decoding or other operations that do not preserve ancillary metadata multiplexed with the essence

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

A/V	Audio Video
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
CAS	Conditional Access System
CEC	Consumer Electronics Control
DA	Distributor Advertisement
DAS	Dynamic Advertisement Substitution
DPO	Distributor Placement Opportunity
DSM-CC	Digital Storage Media - Command and Control
EDID	Extended Display Identification Data
EPG	Electronic Program Guide
FQDN	Fully Qualified Domain Name
GPI	General Purpose Interface
HbbTV®	Hybrid broadcast broadband TV
HDMI	High Definition Multimedia Interface
IP	Internet Protocol
IR	Infra Red
LSB	Least Significant Bit
PA	Provider Advertisement
PES	Packetized Elementary Stream
PID	Packet IDentifier
PO	Placement Opportunity
PPO	Provider Placement Opportunity
PTS	Presentation Time Stamp
SCTE	Society of Cable Telecommunications Engineers
SDI	Serial Digital Interface
STB	Set-Top Box
TA	Targeted Advertising
TEMI	Timed External Media Information
TS	Transport Stream
TV	TeleVision
UHD	Ultra High Definition
UI	User Interface
UPID	Unique Programme IDentifier
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UTC	Universal Time Coordinated
UUID	Universally Unique IDentifier
VANC	Vertical ANCilliary data

WMT Watermark Media Timeline

4 Overview

4.1 Introduction

Linear broadcast television has been established over many years as a reliable marketing channel for delivering brand awareness to a mass audience. Mass market penetration of internet connected TVs presents the opportunity for broadcast TV to support features commonly available in digital advertising.

In response to this, there is a desire from broadcasters and platform operators to evolve the capabilities available in a connected linear broadcast TV environment to include features commonly found in online/digital advertising as this is increasingly required by advertisers and agencies.

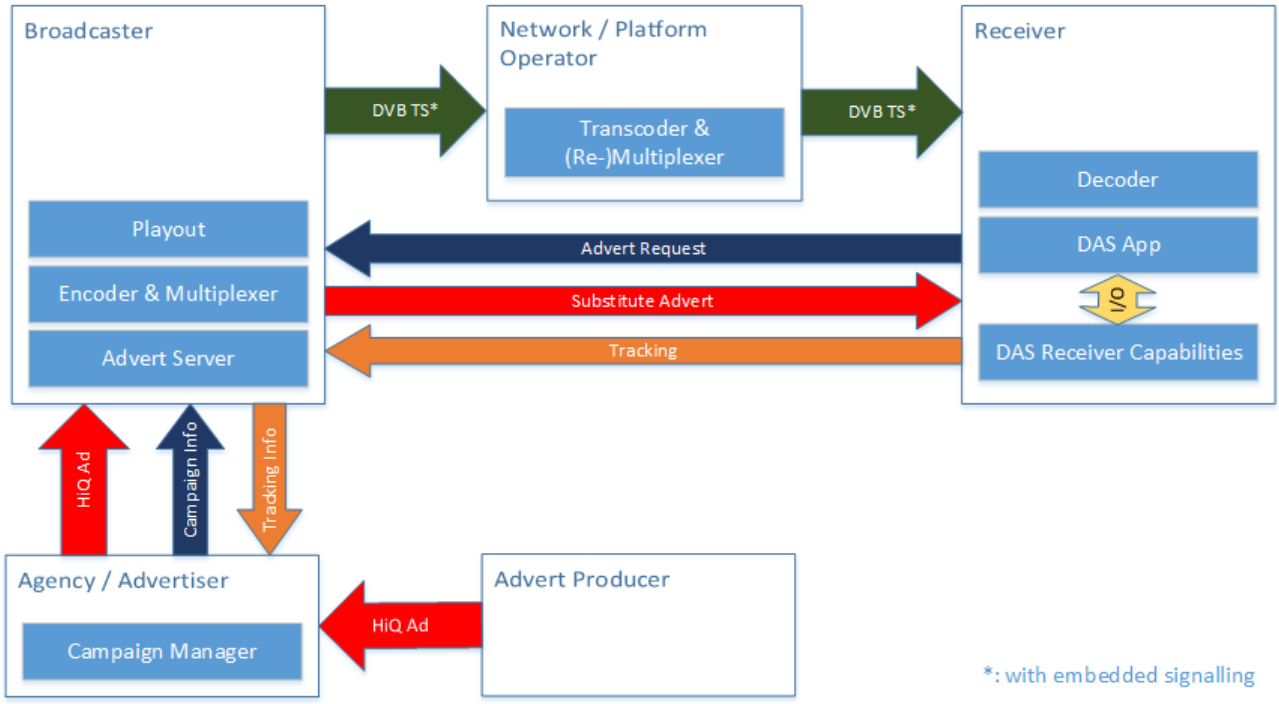


Figure 1: Logical components of the DVB-TA system

Figure 1 above illustrates the logical components found in the technology framework proposed by DVB to enable Targeted Advertising (DVB-TA), which means the substitution of an advert from a linear broadcast with an advert chosen by an advert decisioning service based on criteria such as viewer profile, viewing behaviour, environmental or contextual factors.

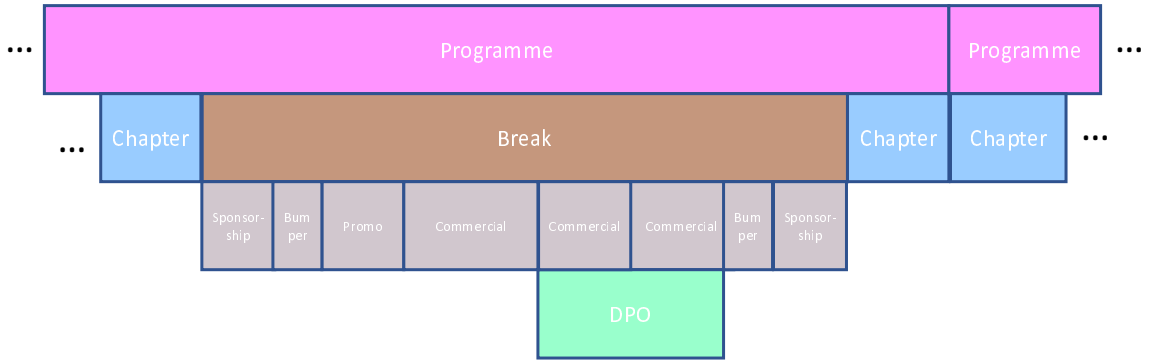
The DVB-TA technology framework addresses the following four areas:

- Signalling
- Seamless advert Splicing at the Connected Receiver
- Measurement & Reporting
- Integration with Existing Advert-Decisioning Systems

ETSI TR 103 752-2 [i.1] provides guidance for points 3 and 4 and gives advice for the preparation of streams and media to aid point 2. The present document covers the first point, and describes how to use SCTE 35 [1] and the related SCTE 104 [2] signalling to convey frame accurate information on where replacement of advertisements (or content) may take place. In addition to this, it describes how SCTE signalling can be used to convey frame accurate information on the location of the various segments in the content stream. This additional information enables more advanced ways of ad replacement. It also enables other use cases such as 'start-again', preventing ad-skipping (in time-shift/recordings) and automated editing.

The terminology in the present document often refers to the primary use-case of both the content being replaced and the replacement content being advertisements. The signalling described in the present document is also applicable to other content replacement scenarios, (e.g. regional content, alternate language content, or accessibility content) and these are not precluded.

Figure 2 displays the usual relations between the segments such as programmes, chapters, breaks and advertisements that are defined in clause 3.1. A Programme typically consists of chapters and breaks, with a break consisting of various advertisements (including bumpers, sponsorships, promos and the actual commercials). The definitions in clause 3 do not imply mandatory signalling behaviour for the various segments. For example, a broadcaster may decide that a Sponsorship is not part of the break, or that a break consists only of commercials. the choice where to define and signal the boundaries of a break is up to the broadcaster to decide.



NOTE: The presence of the DPO indicates that the second and third commercial in the break are eligible for replacement.

Figure 2: Typical relation between programs, chapters, breaks and advertisements

According to the SCTE 104 [2] and SCTE 35 [1] standards, broadcast events such as programmes, chapters, breaks, advertisements and many more can be signalled in a frame-accurate manner by using time_signal() messages, decorated with the appropriate segmentation_descriptors. In addition, opportunities for ad-replacement or content replacement can be signalled by the same method, using the 'Placement Opportunity' (DPO or PPO) segmentation_descriptors. This provides a homogeneous and future-proof signalling mechanism for targeted advertising and for other use cases, such as described above (see [i.2] for further examples). Advertisement segments are used to indicate opportunities for replacement of an individual advertisement, when nested signalling is required, see clause 5.3.3.

An alternative for signalling placement opportunities is to use the splice_insert() method, which is more widely supported in equipment at the time of writing of the present document. The splice_insert() method for signalling placement opportunities may be combined with time_signal() messages for signalling other broadcast events such as programmes and chapters.

4.2 Optionality of signalling methodologies

The present document specifies several different methods for signalling placement opportunities for content substitution.

While none of the methods individually are mandatory, content substitution deployments shall implement at least one of these methods in order to be considered DVB-TA compliant. It is anticipated that there will be deployments that will implement more than one of the methods.

Normative instructions for each method apply should they be implemented.

5 Contribution signalling

5.1 Introduction

The contribution signalling described in this clause is relevant to the interface between Broadcaster and Network/Platform Operator shown in Figure 1.

5.2 Use of SCTE 104

SCTE 104 [2] specifies an API between an automation system and an encoder that allows the encoder to generate a SCTE 35 message. SCTE 104 is closely linked to SCTE 35 [1]. SCTE 104 messages specify a point in time with a "baseband timing" reference. When SCTE 104 data is translated into SCTE 35 messages, most of the metadata are passed through while timings are translated into PTS.

SCTE 104 timings are based on the following principle: the time indicated by the SCTE 104 command is the moment when the encoder takes into account the SCTE 104 message plus the pre-roll time in the pre-roll parameter included in the SCTE 104 message. There are two methods for an encoder to take into account a SCTE 104 message: immediately, or when an event occurs (according to the time_type parameter). Three events are specified in the standard: a given timecode (which is the most used mode), a given UTC time, a GPI. The choice between such time_type modes to achieve the required accuracy depends on the automation and encoding equipment implementations.

In SCTE 104 messages, the DPI_PID_Index can be used to route a given message to a specific encoding channel/PID. The use of multiple SCTE 35 streams with different PIDs is recommended where there are multiple types of downstream devices consuming the SCTE 35 messages, and where each type only has an interest in a subset of the messages. Each downstream device is then configured to consume a SCTE 35 message stream using one of the PID values in order to filter the relevant messages.

5.3 Use of SCTE 35 with PTS

5.3.1 Overview

Signalling for placement opportunities shall use one of the two following methods:

- Method A: Sending SCTE time_signal() structures combined with Placement Opportunity segmentation_descriptors to signal the Start/End boundaries of the PO as well as its duration. To support partial replacement of a PO, the boundaries and duration of the individually replaceable segments within the PO shall be signalled via segmentation_descriptors as well (see clause 5.3.3.2).

- Method B: Sending SCTE splice_insert() structures. To support partial replacement of a PO, the starts and durations of the individually replaceable segments within the PO shall be signalled also by splice_insert() structures referencing the time periods of the individually replaceable segments within the PO (see clause 5.3.3.3).

An implementation shall select one of the methods and shall not mix the use of the two methods for signalling placement opportunities.

The Placement Opportunity and Advertisement segmentation_descriptors may be of type "Provider" or "Distributor". The present document does not distinguish between these types. An implementation may have further private semantics for the two types to enable the selection of relevant placement opportunities in an implementation-specific manner.

5.3.2 Additional segmentation information

For both methods A and B described in clause 5.3.1, additional segmentation information may be signalled, describing content boundaries and associated context data. If signalled, this information shall be sent via the time_signal() structure enriched with appropriate segmentation_descriptors. The most important examples of segmentation_descriptors to be sent have the following segmentation_type_ids:

- Programme Start/End

- Chapter Start/End
- Break Start/End

Downstream applications shall not be adversely affected by any additional received data that is compliant with the SCTE 35 standard [1].

The following constraints and interpretations apply to Placement Opportunities:

- Placement opportunities can be signalled without additional content segments being signalled. The required signalling only needs to identify the replaceable content segments.
- When breaks and/or chapters are being signalled, any placement opportunity should be fully within either a break or a chapter.

5.3.3 Partial replacement of a PO

5.3.3.1 Signalling for partial replacement of a PO

Signalling a PO (either via method A or B) is sufficient to support the basic scenario where all the content in the PO is to be replaced. For more advanced scenarios (e.g. replacement of consecutive versus non-consecutive ads) partial replacement is needed, i.e. it is needed to replace only some of the individually replaceable segments within a PO. In particular, it might be necessary to enable downstream applications to select either full or partial replacement, depending e.g. on technical and commercial conditions.

5.3.3.2 Partial Replacement of a PO using time_signal() structures

To support partial replacement scenarios using time_signal() structures, it is necessary to signal the start/end boundaries of the individually replaceable segments within the PO. For the case of ad replacement, this shall be done by sending Advertisement Start/End segmentation_descriptors in a time_signal() structure.

An example situation can be seen in Figure 2, where the PO contains two ads. To enable partial replacement for this case, the boundaries of each of the two individual commercials shall be signalled using Advertisement Start/End segmentation_descriptors.

5.3.3.3 Partial Replacement of a PO using splice_insert() structures

To support partial replacement scenarios using splice_insert() structures, starts and durations of the individually replaceable segments within the PO are also signalled using splice_insert() structures.

For the example situation in Figure 2, to enable replacement of the entire PO or individual replacement of the two commercials within the PO, three splice_insert() structures are signalled, one for the whole PO, and one for each of the commercials within the PO.

5.3.4 SCTE 35 section structure

5.3.4.1 Section encryption

SCTE 35 sections may be encrypted (encrypted_packet = 1) or unencrypted (encrypted_packet = 0). If encrypted, the encryption algorithm is specified in SCTE 35 [1], Table 27.

A decryption key, if needed, is delivered via the associated DAS application, and so is out of scope of the present document.

If the service is protected by a Conditional Access System (CAS), then the TS packets carrying SCTE 35 messages may be protected by this CAS.

5.3.4.2 Maximum section length

SCTE 35 [1] constrains SCTE 35 sections to start at the beginning of the payload of an MPEG TS packet. SCTE 35 sections for DVB DAS may be up to 4 096 bytes long, as specified in SCTE 35, and so can span multiple TS packets. The maximum length is reduced if the section is subsequently encapsulated in DSM-CC stream events, as described in clauses 6.3 and 7.2.

5.3.4.3 PTS adjustment field

The pts_adjustment field may be used in SCTE 35 message generation and re-multiplexing equipment. The value of this field shall be added to the times specified in pts_time fields to give the correct time reference.

5.3.5 SCTE 35 segmentation_descriptor() and splice_insert() contents

5.3.5.1 Introduction

The following constraints apply for the two methods for signalling advertisement (or content) replacement opportunities. Where appropriate, the differing field names for the same function are given. The segmentation_descriptor may be of any of the following types: DPO, PPO, distributor advertisement, provider advertisement.

5.3.5.2 Segmentation_event_id or splice_event_id

These fields provide an identifier for the signalled point in time which can be used by the DAS application.

5.3.5.3 Segmentation_event_cancel_indicator or splice_event_cancel_indicator

These fields shall be set to '0', i.e. cancellation of events is not permitted for DVB DAS.

5.3.5.4 DPO or PPO start and end segmentation messages or out_of_network_indicator

Using the DPO or PPO segmentation_descriptor, both start and end messages should be signalled in accordance with SCTE 35 [1]. For the DAS function, the end message conveys no additional information as the signalled end time shall be equal to the value given by start time + duration. The applicable segmentation_type_id values for POs are 0x34, 0x35, 0x36, and 0x37.

A splice_insert() with out_of_network_indicator = 1 is equivalent to a PPO/DPO start segmentation message. For splice_insert() messages, it is recommended that only messages with out_of_network_indicator set to '1' are used.

5.3.5.5 Segmentation_duration_flag or duration_flag

These flags shall be set to '1' indicating that the duration is specified (not applicable to End segmentation messages).

5.3.5.6 Splice_immediate_flag (splice_insert() only)

The flag shall be set to '0' indicating that the splice immediate mode is not permitted for DVB DAS.

5.3.5.7 Time_specified_flag

The flag in the splice_time() structure shall be set to '1', indicating that the time is always specified for DVB DAS.

5.3.5.8 pts_time

The pts_time in the splice_time() structure shall contain a PTS value to provide frame accurate information on the boundary between the segments/opportunities that are being signalled. This boundary is located immediately prior to the presentation unit whose presentation time most closely matches the signalled PTS value, where the signalled PTS value equals the signalled pts_time as modified by the pts_adjustment.

NOTE: For a Start message the PTS refers to the first frame of the segment, and for an End message the PTS refers to the first frame after the segment. This convention is aligned with how In Points and Out Points are defined in SCTE 35 [1].

5.3.5.9 Auto_return (splice_insert() only)

The field shall be set to '1' indicating that a splice_insert() command with out_of_network_indicator set to '0' is not required at the end of the placement opportunity.

5.3.5.10 Segmentation_upid_type (segmentation_descriptor() only)

To ensure interoperability of the Placement Opportunity signalling with downstream consumers such as DVB DAS applications, the segmentation_upid_type shall be set to '0x0F' indicating that the segmentation_upid() contains a Universal Resource Identifier (see IETF RFC 3986 [3]).

5.3.5.11 Unique_program_id or segmentation_upid()

These fields identify the specific instance of content such as a Programme or an Advertisement, or delineation of a collection of Segments such as a Break or a Placement. These fields can be used by the DAS application. The unique_program_id in the splice_insert() structure is a 16-bit field, whereas the segmentation_upid in the segmentation_descriptor() is a variable length field, further specified by segmentation_upid_type.

The Unique Programme Identifier (UPID) in the segmentation_upid() field shall conform to URI format (see IETF RFC 3986 [3]), with the following structure:

- urn: <reverse domain name of broadcaster>: <identifier>

The use of the reverse domain name ensures that there is no overlap of UPIDs from different broadcasters. The <identifier> field is defined by the broadcaster. Unless specific requirements exist for another format, it is recommended that the <identifier> field contains an Airing ID represented as 16 hexadecimal characters.

EXAMPLE: urn:com.broadcaster:112210F47DE98115

(<identifier> is an Airing ID)

urn:tv.acme:B637643-50A9-4C2D-BC7B-09FD8312190F

(<identifier> is a UUID according to application-specific requirements)

The time period over which the signalling is unique should be sufficient to prevent misinterpretation by the DAS system and needs to be managed accordingly by each broadcaster.

5.3.5.12 Sub_segment_num and sub_segments_expected for PPO/DPO

These fields can be used to convey the position of the placement opportunity and the number of placement opportunities expected within the break being described. These fields can be used by the DAS application.

5.3.5.13 Segment_num and segments_expected for PA/DA

These fields can be used to convey the position of the advertisement and the number of advertisements expected within the break being described. These fields can be used by the DAS application.

5.3.5.14 Avail_num and avails_expected for splice_insert

These fields can be used to convey the position of the placement opportunity and the number of placement opportunities expected within the break being described. These fields can be used by the DAS application.

5.3.5.15 Segment_num and segments_expected for DPO/PPO

These fields can be used to convey the number of the break within a programme and the total number of breaks expected within the programme. These fields can be used by the DAS application. There is no equivalent for splice_insert() defined by SCTE 35.

5.3.5.16 DVB DAS descriptor

For full equivalence between splice_insert() and segmentation_descriptor methods, a DVB descriptor is defined which can be optionally included within a splice_insert() command. See Table 1.

Table 1: DVB DAS descriptor

Syntax	No. of Bits	Mnemonic
DVB_DAS_descriptor() {		
splice_descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
identifier	32	uimsbf
break_num	8	uimsbf
breaks_expected	8	uimsbf
reserved	8	uimsbf
equivalent_segmentation_type	4	uimsbf
upid	4	bslbf
}	N*8	uimsbf

Semantics for the DVB DAS descriptor()

splice_descriptor_tag: This 8-bit number defines the syntax for the private bytes that make up the body of this descriptor. The splice_descriptor_tag shall have a value of 0xF0.

descriptor_length: This 8-bit number gives the length, in bytes, of the descriptor following this field.

identifier: This 32-bit number is used to identify the owner of the descriptor. The identifier shall have a value of 0x4456425F (ASCII "DVB_").

break_num: This 8-bit number identifies the position of the break within the programme. The field is set to '0' if it is not being used.

breaks_expected: This 8-bit number identifies the number of breaks expected within the programme. The field is set to '0' if it is not being used.

Equivalent_segmentation_type: This 4-bit number identifies the segmentation_type that would be used for the equivalent segmentation_descriptor in a time_signal() command.

Table 2: Equivalent Segmentation Type

Value	Meaning
0x0	no equivalent
0x1	Distributor Placement Opportunity
0x2	Provider Placement Opportunity
0x3	Distributor Advertisement
0x4	Provider Advertisement
0x5 to 0xF	reserved for future use

upid: This variable length field identifies the specific placement opportunity by a Unique Programme Identifier (UPID), and conforms to the URI format described in clause 5.3.5.11.

6 Distribution signalling

6.1 Introduction

The distribution signalling described in this clause is relevant to the interface between network/platform operator and the consumer receiver shown in Figure 1.

6.2 Use of SCTE 35 with PTS

SCTE 35 messages with PTS as described and profiled in clause 5.3 of the present document for contribution may also be used directly for distribution. In this case, any distribution re-multiplexer passes through the SCTE 35 messages from the contribution feed.

The signalling required by a specific platform might be a subset of the various SCTE 35 messages generated by the broadcaster. It is recommended for the contribution signalling to separate messages for different uses by generating the SCTE 35 messages on multiple PIDs, such that a single PID can be selected for a particular downstream usage, such as for distribution signalling. Other methods for filtering SCTE 35 messages include:

- Selection from the UPID value
- Use of a private_descriptor
- Private semantics defining different applications for "Provider" and "Distributor" segmentation types

SCTE 35 [1] allows the table payload to be encrypted; this can be used by broadcasters to prevent information mining by competitors, and to prevent ad-replacement-blockers for consumer devices.

Some processing operations, e.g. video transcoding, in the network/platform operator's distribution network could involve modification of PTS values. After such operations, the SCTE 35 message will need to be updated to reflect the modified PTS value. The modification is facilitated by the pts_adjustment field in the SCTE 35 message. This field is in a fixed position relative to the start of an SCTE 35 section, and remains unencrypted in the message encryption scheme described in SCTE 35 [1].

NOTE: A transcoding operation will need to be implemented in a manner to preserve or re-introduce any stream conditioning required to facilitate content replacement.

6.3 Use of DSM-CC stream events

6.3.1 DSM-CC stream event payload format and carriage

The SCTE 35 message section may be carried either directly in a DSM-CC stream event, or in a DSM-CC object carousel file, referenced by the DSM-CC stream event. In the former method, the maximum SCTE 35 section length is limited to 180 bytes when referencing PTS, or 178 bytes if a TEMI timeline is used (maximum values of the section_length field in splice_info_section() are 177 and 175 respectively). The latter method of referencing a DSM-CC carousel object enables the carriage of larger SCTE 35 sections.

The payload of a DSM-CC stream event for Targeted Advertising signalling of POs is initially generated in a binary form as described in Table 3 using the binary SCTE 35 message section.

The DSM-CC_stream_event_payload_binary() structure shall be base-64 encoded prior to being encapsulated by a DSM-CC stream event. The base-64 encoding shall be carried out according to IETF RFC 4648 [4].

Table 3: Binary version of DSM-CC stream event payload

Syntax	No. of Bits	Mnemonic
DSM-CC_stream_event_payload_binary() {		
DVB_data_length	8	uimsbf
reserved_zero_future_use	3	bslbf
event_type	1	bslbf
timeline_type	4	uimsbf
if (timeline_type == 0x2) {		
temi_component_tag	8	uimsbf
temi_timeline_id	8	uimsbf
}		
reserved_zero_future_use		
private_data_length	N*8	bslbf
if (private_data_length > 0) {		
private_data_specifier	8	uimsbf
for(i=0;i<private_data_length-4;i++) {		
private_data_byte	32	uimsbf
}		
}	8	uimsbf
if (event_type == 1) {		
carousel_object_name_length		
for(i=0;i<carousel_object_name_length;i++) {		
char		
}	8	uimsbf
}	8	uimsbf
If (event_type == 0) {		
SCTE_35_section()		
}		
}		

Semantics for the binary version of DSM-CC stream event payload

DVB_data_length: This 8-bit number gives the length, in bytes, of the fields following the DVB_data_length field prior to the private_data_length field.

reserved_zero_future_use: Use of these fields may be defined by ETSI in future versions of the present document.

NOTE: All "reserved_zero_future_use" bits are set to "0".

event_type: This 1-bit field, when set to "1" indicates that this DSM-CC stream event contains a reference to a DSM-CC carousel object conveying the SCTE 35 message section. When set to "0", it indicates that the SCTE 35 message section is conveyed within this DSM-CC stream event.

timeline_type: This 4-bit number identifies the timeline being referenced by PTS values in the SCTE 35 section.

Table 4: Timeline Type

Value	Meaning
0x0	no timeline used
0x1	PTS in SCTE 35 message references video PTS
0x2	PTS in SCTE 35 message references the time in a TEMI timeline associated with the service
0x2 to 0xF	reserved for future use

temi_component_tag: This 8-bit number is the component_tag of the TEMI timeline being referenced by PTS values in the SCTE 35 message. This field is only present when timeline_type is 0x2.

temi_timeline_id: This 8-bit number is the timeline_id of the TEMI timeline being referenced by PTS values in the SCTE 35 message. This field is only present when timeline_type is 0x2.

private_data_length: This 8-bit field specifies the length in bytes of the following private data.

private_data_specifier: The assignment of values for this field is given in ETSI TS 101 162 [5].

private_data_byte: This is an 8-bit field, the value of which is privately defined.

carousel_object_name_length: This is an 8-bit field conveying the length of the DVB URI [6] of the carousel object containing the SCTE 35 message.

char: This is an 8-bit field, a sequence of which conveys the DVB URI [6] of a DSM-CC carousel object containing the SCTE 35 message.

SCTE_35_section: The entire SCTE 35 splice_info_section() structure commencing with table_id and finishing with CRC_32. The splice_info_section() syntax is defined in Table 5 of SCTE 35 [1].

6.3.2 Use of DSM-CC stream events with PTS

The timeline_type is set to '0x1' to indicate that the PTS in the SCTE 35 message references the video PTS for the service. The SCTE 35 message conforms to clause 5.3.

Some processing operations, e.g. video transcoding, in the Network/Platform Operator's network could involve modification of PTS values. After such operations, the DSM-CC stream event payload will need to be updated to reflect the modified PTS value, e.g. by changing the value of the pts_adjustment field in the SCTE_35_section().

NOTE: A transcoding operation will need to be implemented in a manner to preserve or re-introduce any stream conditioning required to facilitate content replacement.

6.3.3 Use of DSM-CC stream events with TEMI

The timeline_type is set to '0x2' to indicate that the PTS in the SCTE 35 message references a TEMI timeline associated with the service.

NOTE 1: For comparison between TEMI timeline and pts_field value, the time on the timeline is first converted to a 90 kHz value, and then the 33 LSBs of the result are compared with the pts_field value.

ETSI TS 103 286-2 [7] defines support in a receiver for the decoding of TEMI timeline descriptors in the adaptation field of Transport Stream packets carrying Packetized Elementary Streams (PESs). A TEMI timeline referenced in the manner described in clause 6.3.1 shall be carried in adaptation fields of:

- any audio, video or subtitle component; or
- any component with stream_type 6 (private PES and stream _id 1011 1101 for "private_stream_1") in the PES packet header, including, but not limited to components where the PES packet payloads are empty.

TEMI timeline_descriptors for a TEMI timeline shall occur sufficiently frequently that the delta between successive timeline timestamp values does not exceed 1 second.

NOTE 2: A timeline discontinuity may cause an exception to the maximum delta value.

The temi_timeline_component_tag is the component_tag of the component carrying the timeline and the temi_timeline_id is the timeline_id found within the TEMI timeline_descriptor of the timeline. The SCTE 35 message conforms to clause 5.3 except that for clause 5.3.4.3, the pts_adjustment field is not modified in re-multiplexing operations.

Propagation of a TEMI timeline through a Network/Platform Operator's network will require the network equipment to preserve the TEMI. Where a component carrying TEMI is passed through, it is sufficient to correct the PTS as would normally be done for any other passed-through component containing PES. For operations (such as transcoding) that discard existing transport stream packets but preserve or transform the media essence, the TEMI timeline_descriptors can be passed through unmodified and included in the adaptation fields of the new Transport Stream packets, while preserving the timing relationship to the media essence.

NOTE 3: The timing relationship between TEMI and PES payloads containing media essence is defined by which TS packet the timeline_descriptor is carried in relative to the start of PES payloads. This is defined in clause U.3.6 of ISO/IEC 13818-1 [8].

NOTE 4: Timestamps contained in the TEMI timeline descriptor as well as the payload of the DSM-CC stream events are not modified.

NOTE 5: A transcoding operation will need to be implemented in a manner to preserve or re-introduce any stream conditioning required to facilitate content replacement.

6.4 Timing of Signalling

The DVB-TA signalling shall allow the pre-announcement of placement opportunities sufficiently far in advance to allow the decision to be made about what ad to insert and for DAS to be performed.

The DAS application can obtain advance knowledge of the approximate time for a placement opportunity by on-line communications with the relevant DAS servers, such that sufficient time for both ad decision and ad download is available ahead of the placement opportunity.

Additionally, broadcast SCTE 35 messages and their equivalent DSM-CC stream events signal the position of a placement opportunity ahead of the opportunity. There is no limit in the SCTE 35 [1] specification as to how far in advance the signalling can be, so that the SCTE 35 message and the equivalent DSM-CC stream event can potentially provide a pre-announcement function. If the SCTE 35 message is generated from a SCTE 104 message, there is a maximum of 65,535 seconds for the pre-roll_time field, potentially allowing pre-announcement up to slightly more than one minute before the opportunity.

NOTE: The maximum pre-roll time may be limited in implementations by the amount of buffering available in the encoding system for pending messages. Also, some encoding system implementations may delay the issue of SCTE 35 messages generated from an SCTE 104 [2] message such that the SCTE 104 pre-roll time does not directly determine the SCTE 35 pre-announcement timing.

SCTE 35 messages and their equivalent DSM-CC stream events may be sent more than once for a given placement opportunity.

A private_descriptor within the SCTE 35 message, as mentioned in clause 6.2, may be used to distinguish between messages for pre-announcement and messages that are close to the time of a placement opportunity.

Other mechanisms for pre-announcement of placement opportunities (e.g. a dedicated pre-announcement message) are for further study.

7 Converting contribution signalling to distribution signalling

7.1 Converting from SCTE 35 with PTS to SCTE 35 with PTS

No conversion is necessary in this case, as the same format is used in both contribution and distribution.

If and when PTS values are modified by distribution network processing, the pts_adjustment field shall be set or modified as described in clause 6.2.

7.2 Converting from SCTE 35 with PTS to DSM-CC stream events with PTS

The term 'converter' in this clause refers to apparatus (which can be implemented in hardware, software or a combination thereof) capable of converting from SCTE 35 with PTS to DSM-CC stream events with PTS.

SCTE 35 messages to be converted shall be provided using a dedicated PID, so that the relevant packets can be selected by PID value as the input stream to the converter. The converter can either remove the input stream from the TS or forward the input stream to downstream devices.

For signalling POs by means of DSM-CC stream events, the same PID used for delivering any other "do-it-now" stream events to the DAS application shall be used by the converter for delivering the DSM-CC sections contained in TS packets. The converter will need to multiplex the data carried on the PID so that contents of different sections are not interleaved. If there are no other "do-it-now" stream events, a new dedicated PID shall be used by the converter for the DSM-CC stream events providing the PO signalling.

The converter performs the following steps (in the given order):

1) Create the binary payload for the DSM-CC stream event as specified in clause 6.3.1 for the DSM-CC stream event payload. In the present case the timeline_type field shall be set to "1" in order to identify PTS as the referenced timeline.

2) Apply base-64 encoding according to IETF RFC 4648 [4] to DSM-CC_stream_event_payload_binary() structure.

3) Insert the base-64 encoded payload for the DSM-CC stream event as private data to the privateDataByte field of a stream event descriptor of a "do it now" event in compliance with ETSI TS 102 809 [9].

4) Transmit the DSM-CC stream event (i.e. the "do it now" event) immediately.

NOTE 1: There is a maximum of 245 bytes of payload per DSM-CC stream event as specified in ETSI TS 102 809 [9]. The base-64 encoding increases the message size from its binary form in the ratio 4:3. The maximum section payload size and effect of base-64 encoding needs to be taken into account when creating DSM-CC stream events from SCTE 35 messages. If the binary SCTE 35 message section exceeds 180 bytes (i.e. section_length field greater than 177), then the method described in clause 6.3.1 of conveying the SCTE 35 section in a DSM-CC carousel object needs to be used.

NOTE 2: When signalling a PO by means of DSM-CC stream events, receivers are likely to require some advance notice. SCTE 35 requires a minimum advance timing of 4 seconds for an SCTE 35 message. For the DSM-CC stream events, this will be reduced by the converter processing time. If required by the combination of the target receiver population and the converter, the SCTE 35 message can be sent further in advance than the minimum 4 seconds. If the DSM-CC stream event is referencing a carousel object, further consideration needs to be given to the SCTE 35 message timing to accommodate the synchronization with the carousel object and the receiver acquisition and processing time.

If and when PTS values are modified by the converter, the pts_adjustment field shall be set or modified as described in clause 6.2 before embedding the SCTE_35_section in the DSM-CC stream event.

7.3 Converting from SCTE 35 with PTS to DSM-CC stream events with TEMI

The term 'converter' in this clause refers to apparatus (which can be implemented in hardware, software or a combination thereof) capable of converting from SCTE 35 with PTS to DSM-CC stream events with TEMI. The changes made by a converter to a transport stream shall be compliant with the requirements in clause 6.3.1 for how SCTE 35 messages are to be packaged as DSM-CC stream events and clause 6.3.3 for the carriage of a TEMI timeline.

SCTE 35 messages to be converted shall be provided using a dedicated PID, so that the relevant packets can be selected by PID value as the input stream to the converter. The converter can either remove the input stream from the TS or forward the input stream to downstream devices.

For signalling POs by means of DSM-CC stream events, the same PID used for delivering any other "do-it-now" stream events to the DAS application shall be used by the converter for delivering the DSM-CC sections contained in TS packets. The converter will need to multiplex the data carried on the PID so that contents of different sections are not interleaved. If there are no other "do-it-now" stream events, a new dedicated PID shall be used by the converter for the DSM-CC stream events providing the PO signalling.

The converter performs the following steps (in the given order):

1) Create the binary payload for the DSM-CC stream event as specified in clause 6.3.1. In the present case the timeline_type field shall be set to "2" in order to identify TEMI as the referenced timeline. The fields temi_component_tag and temi_timeline_id shall be present in the DSM-CC stream event payload.

2) Apply base-64 encoding according to IETF RFC 4648 [4] to the DSM-CC_stream_event_payload_binary() structure.

3) Insert the base-64 encoded payload for the DSM-CC stream event as private data to the privateDataByte field of a stream event descriptor of a "do it now" event in compliance with ETSI TS 102 809 [9].

4) Transmit the DSM-CC stream event (i.e. the "do it now" event) immediately.

NOTE 1: There is a maximum of 245 bytes of payload per DSM-CC stream event as specified in ETSI TS 102 809 [9]. The base-64 encoding increases the message size from its binary form in the ratio 4:3. The maximum section payload size and effect of base-64 encoding needs to be taken into account when creating DSM-CC stream events from SCTE 35 messages. If the binary SCTE 35 message section exceeds 178 bytes (i.e. section_length field greater than 175), then the method described in clause 6.3.1 of conveying the SCTE 35 section in a DSM-CC carousel object needs to be used.

NOTE 2: When signalling a PO by means of DSM-CC stream events, receivers are likely to require some advance notice. SCTE 35 requires a minimum advance timing of 4 seconds for an SCTE 35 message. For the DSM-CC stream events, this will be reduced by the converter processing time. If required by the combination of the target receiver population and the converter, the SCTE 35 message can be sent further in advance than the minimum 4 seconds. If the DSM-CC stream event is referencing a carousel object, further consideration needs to be given to the SCTE 35 message timing to accommodate the synchronization with the carousel object and the receiver acquisition and processing time.

Where the converter is acting on a MPEG-2 Transport Stream for a service with an existing TEMI timeline, PTS values in the SCTE 35 messages are adjusted to correspond to times on that existing TEMI timeline prior to embedding in the DSM-CC stream events. The adjustment can be performed by replacing the value in the pts_time field of the SCTE 35 message, altering the value of the pts_adjustment field of the SCTE 35 message, or a combination of both.

NOTE 3: If the SCTE 35 messages are encrypted according to the encryption scheme specified in SCTE 35, the pts_time field will be encrypted, but the pts_adjustment field remains unencrypted, facilitating modification of the latter field without requiring decryption of the SCTE 35 messages within the converter.

Alternatively, if there is no suitable existing TEMI timeline in the Transport Stream, a new TEMI timeline can be generated by the converter that meets the requirements defined in clause 6.3.3.

A simple example approach to generating and using a TEMI timeline is described below:

- Derive the TEMI timeline directly from PTS as follows:
  - generate a separate component using a dedicated PID with stream_type 6 to carry the TEMI timeline_descriptors occurring with a frequency no greater than the video frame rate and no lower than once per second;
  - give the timeline a timescale (tickrate) of 90 000; and
  - use 32-bit TEMI media_timestamps whose value is the least significant 32 bits of the PTS value.
- Clear the most significant bit of pts_time fields in the SCTE 35 message and preserve the remaining 32 least significant bits.

NOTE 4: Using a 32-bit (instead of 64-bit) media_timestamp for the TEMI timestamps ensures that the timeline wraps cleanly with an interval of just over half a day. Clearing the top bit of the pts_time field ensures that the field value represents a time on this timeline.

The timing relationship between TEMI timestamps (carried in TEMI timeline_descriptors) and PTS (carried in the header of PES payloads) is defined in clause U.3.6 of ISO/IEC 13818-1 [8]. It is not required for there to be a TEMI timeline descriptor for every instance of PTS. In these situations, the TEMI timestamp corresponding to a PTS value can be extrapolated from the most recent (in presentation order) occurrence of a TEMI timestamp and its corresponding PTS value.

NOTE 5: The extrapolation involves calculating a difference between these two PTS values. Care needs to be taken to ensure this works correctly at the point where PTS values wrap.

7.4 Converting from SCTE 104 to SCTE 35 with PTS

SCTE 104 provides a standard interface for controlling SCTE 35 message generation, as described in clause 5.2. If the contribution feed is provided in an uncompressed form, then it should be accompanied by SCTE 104 signalling so that the content encoding and SCTE 35 message generation can both be performed by the distribution platform.

8 Watermark signalling

8.1 Introduction

Watermarking provides an optional alternative method for delivery of DVB-TA signalling from Broadcasters to Receivers. Watermarking is particularly applicable to use cases where a linear broadcast service is delivered to a television Receiver from a Set-Top Box (STB) via HDMI.

Watermarking is relevant to both the interface between the Broadcaster and Network/Platform Operator interface as well as the interface between the Network/Platform Operator and Receiver shown in Figure 1. Because it resides in the media essence and persists through transcoding and multiplexing, it can be embedded by the Broadcaster and delivered to the Receiver without any need for specialized handling at the Network/Platform Operator. It can pass through Network/Platform Operator systems seamlessly.

Clause 8.2 describes an architecture for introduction of watermark signalling equipment into broadcast origination environments as an alternative or supplement to transport-stream DVB-TA signalling. Clause 8.3 specifies an alternative compact format for carriage of DVB-TA signalling messages in watermarking environments with limited data capacity. Clause 8.4 provides guidance specific to the use of ATSC watermarking technologies in the DVB-TA context.

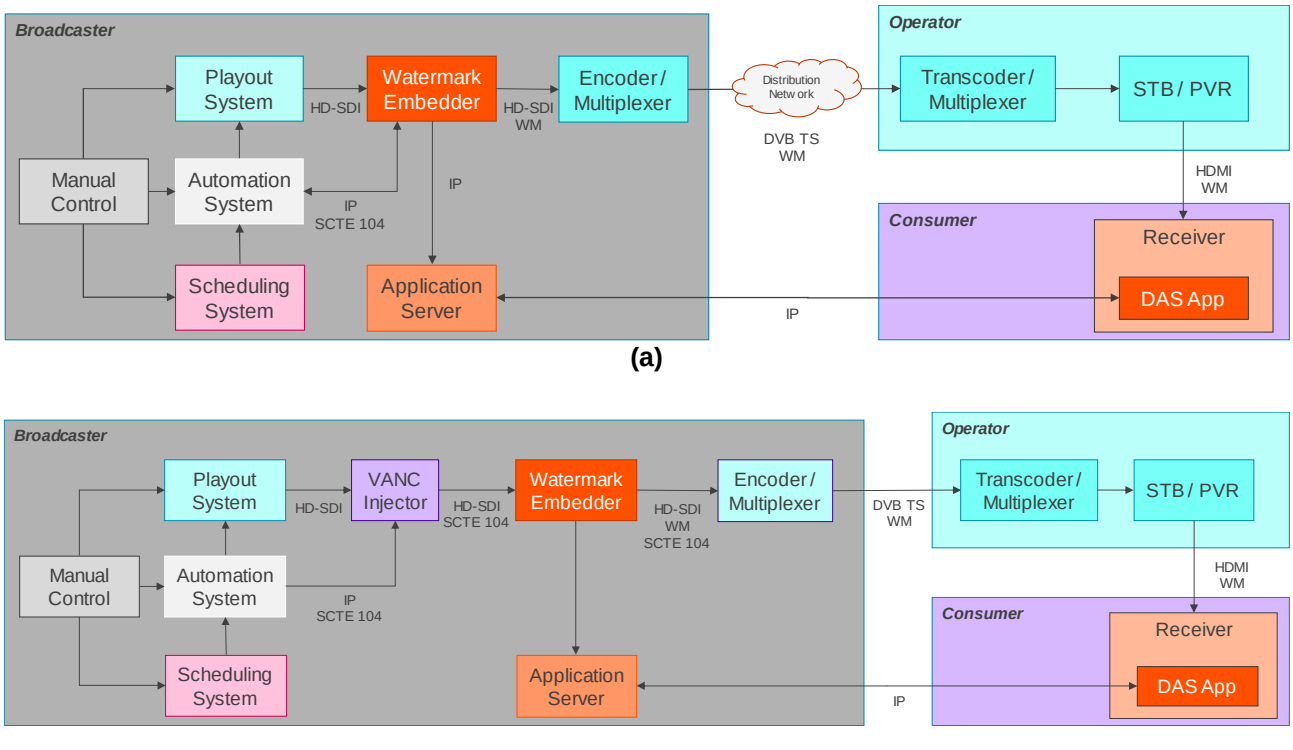
NOTE: DVB-TA signalling formats are agnostic of the watermark technology used for their carriage. Broadcasters are not prohibited under the present document from conveying DVB-TA signalling using watermark technologies other than those currently specified in the present document as needed to achieve compatibility with watermark detectors in televisions deployed in their markets.

Annex A provides supplemental specifications related to the use of watermark signalling for DVB-TA in the context of specific target platforms. Annex B includes a discussion of particular user experience issues that can arise when watermark signalling is employed and provides informative guidance on mitigation approaches.

8.2 Broadcaster Interface

The SCTE 104 APIs that are used to interface automation systems with SCTE 35 encoders at the Broadcaster as discussed in clause 4 can also be employed to interface automation systems with watermark embedders that convey DVB-TA signalling.

Two alternate arrangements for use of SCTE 104 with the use of watermarking for DVB-TA signalling are illustrated in Figure 3. Both arrangements employ SCTE 104 interfaces consistent with use cases defined in SCTE 104 specification. Figure 3(a) illustrates the use of a SCTE 104 IP interface for connection of a watermark embedder device to an automation system. In this arrangement, the watermark embedder acts as an injector, translating SCTE 104 messages received over IP into DVB-TA signalling messages transmitted via the watermark. Figure 3(b) illustrates an alternate approach in which a VANC injector is used to translate messages received from an automation system via SCTE 104 IP interface into the VANC area of an SDI signal for communication to a watermark embedder. The two arrangements enable equivalent functionality from the watermark embedder but the latter case also enables use of the SCTE 104 messages in SDI by an Encoder for use by the Network/Platform Operator.



(a) Watermark embedder receives SCTE 104 messages via IP interface.
(b) Watermark embedder receives SCTE 104 messages via SDI interface.

Figure 3: Typical arrangements for delivery of DVB-TA signalling from Broadcasters to Receivers using watermarking

The guidance regarding use of SCTE 104 given in clause 5.2 is applicable to watermark signalling. One or more DPI_PID_Index values can be associated with the watermark signalling path and indicated in SCTE 104 messages issued by the automation system. The watermark embedder equipment can be configured to transmit only SCTE 104 messages directed to those channel/PIDs via watermarking and to ignore other messages, which may be intended for carriage using other signalling methods.

In environments where a broadcast service is distributed across multiple distribution paths or across heterogenous operator networks, for the signalling to reach all addressable receivers it may be necessary for the emission to convey TA signalling using both watermarking and transport stream signalling simultaneously. It is important in such cases that the signalling provided through each method be properly coordinated to ensure that devices responding to the different types of signalling do not behave in conflicting ways. For example, if a particular viewer household included a STB capable of responding to TA signalling in the transport stream that is connected to a television running a DAS app capable of responding to TA signalling in a watermark, it is desirable that the two devices do not duplicate or interrupt each other's TA operations.

This can be reliably achieved so long as broadcasters ensure that no PO is signalled to begin via transport stream following an insertion point signalled via watermarking and during that watermark-signalled PO. This avoids the possibility that a TA replacement based on transport stream signalling performed by a STB or other device would interrupt an ongoing TA replacement based on watermark signalling that is being performed by a downstream television with a DAS App. Figure 4 provides examples of transport stream and watermark signalled PO arrangements that are safe and unsafe in this respect. Note that the straightforward approach of signalling the same insertion points and durations for POs using both transport stream and watermark signalling is a safe arrangement.

Insertion points are aligned (safe). (a)

TS-signalled insertion point precedes watermark-signalled PO (safe). (b)

TS-signalled insertion point follows watermark-signalled PO (unsafe). (c)

TS-signalled insertion point falls within watermark-signalled PO (unsafe). (d)

Figure 4: Illustrated examples of safe and unsafe timing of POs signalled using watermarking and transport stream signalling simultaneously

NOTE: Broadcasters are advised of the possibility that some devices that perform TA replacement based on transport stream or watermark signalling may do so with imprecise timing such that signalling emitted in a safe manner is acted on in an unsafe manner. In such cases, small timing errors in acting on the signalling may be mitigated by conditioning broadcast and replacement content with black frames prior or subsequent to placement opportunities in order that these errors are not noticeable to the end user. The need for and duration of such conditioning may also depend on local market regulations regarding advertisement presentation. Larger timing errors may require the inclusion of logic in DAS Apps that apply corrections that may go so far as not attempting substitution on devices incapable of ensuring an acceptable user experience.

8.3 Messages

8.3.1 Introduction

When watermark signalling is optionally employed, DVB-TA signalling messages are conveyed using watermark messages for transport.

8.3.2 Standard Encoding Format

DVB-TA signalling may be transmitted via watermark messages using the SCTE 35 message profile specified in clause 5.3.

8.3.3 Compact SCTE 35 Encoding Format

Watermark technologies may provide reduced data carrying capacity in comparison with encoded bitstreams. To facilitate more efficient transmission of important SCTE 35 messages via watermark messages, an optional alternative compact encoding format for conveyance of certain SCTE 35 messages in accordance with the methods and constraints specified in clause 5.3 is also provided. This format is specified in Tables 5 to 7.

Table 5: Compact encoding format of SCTE 35 messages

Syntax	No. of Bits	Mnemonic

`compact_SCTE_35() {`
`  message_type`
`  if (message_type == 0x00) {`
`  compact_time_signal()`
`  }`
`  else if (message_type == 0x01) {`
`  compact_ splice_insert()`
`  }`
`}`
	8	uimsbf

Semantics for the compact_SCTE_35()

message_type: This 8-bit number identifies the type and syntax of the compact SCTE 35 message encoded in the subsequent bits of the message. The value 0x00 indicates a message of type compact_time_signal() as defined in Table 6. The value 0x01 indicates a message of type compact_splice_insert() as defined in Table 8. All other values of the message_type field are reserved for future use.

Table 6: Compact encoding of the time_signal message

Syntax	No. of Bits	Mnemonic
compact time_signal() {		
encrypted_packet	1	bslbf
encryption_algorithm	6	uimsbf
cw_index	8	uimsbf
pts_time	33	uimsbf
segmentation_event_id	32	uimsbf
segmentation_duration	40	uimsbf
segmentation_type_id	8	uimsbf
segmentation_upid_length (N)	8	uimsbf
segmentation_upid	N*8	uimsbf
segments_num	8	uimsbf
segments_expected	8	uimsbf
if (encrypted_packet) {		
E_CRC_32	8	uimsbf
}		
}	8	rpchof

Semantics for the compact_time_signal()

Unless otherwise noted, all fields of the compact_time_signal() shall have the same semantic as the corresponding field in the time_signal() as specified in the SCTE 35 specification subject to the constraints given in clause 5.3.

SCTE 35 time_signal() message fields that are not explicitly conveyed in the compact encoding format shall be presumed to have the values specified in clause 5.3. These fields, and their implied values are listed in Table 7.

Table 7: Implied value for segmentation_descriptor fields in the compact_time_signal message

Field	Value
segmentation_event_cancel_indicator	0
segmentation_duration_flag	1
time_specified_flag	1
segmentation_upid_type	0x0F
program_segmentation_flag	1
segment_delivery_not_restricted_flag	1

Table 8: Compact encoding of the splice_insert message

Syntax	No. of Bits	Mnemonic
compact_splice_insert() {		
encrypted_packet	1	bslbf
encryption_algorithm	6	uimsbf
cw_index	8	uimsbf
pts_time	33	uimsbf
splice_event_id	32	uimsbf
duration	33	uimsbf
unique_program_id	16	uimsbf
avail_num	8	uimsbf
avails_expected	8	uimsbf
DAS_descriptor_flag	1	bslbf
reserved	6	bslbf
if (DAS_descriptor_flag) {		
descriptor_length (N)	8	uimsbf
break_num	8	uimsbf
breaks_expected	8	uimsbf
equivalent_segmentation_type	8	uimsbf
reserved	4	uimsbf
upid()	4	bslbf
}	(N-3)*8	uimsbf
if (encrypted_packet) {		
E_CRC_32	32	rpchof
}		
}		

Semantics for the compact_splice_insert()

pts_time: This 33-bit number conveys the media time of the splice event on the timeline of the watermark technology in which the message is conveyed.

upid: This ASCII-encoded variable-length field conveys either: (a) an 8-byte Airing ID, in which case the associated domain name is determined in a watermark technology-specific manner; or (b) a reverse domain name with ":" separated fields followed by "/" and a UUID. For case (a), the Airing ID has the format given in clause 5.3. For case (b), no prefix is included (the implied prefix is "urn:") and the UUID has the format given in clause 5.3.

Unless otherwise noted, all fields of the compact_splice_insert() shall have the same semantic as the corresponding field in the splice_insert() as specified in the SCTE 35 specification and the DVB_DAS_descriptor subject to the constraints given in clause 5.3.

SCTE 35 segmentation_descriptor() and DVB_DAS_descriptor() message fields that are not explicitly conveyed in the compact encoding format shall be presumed to have the values specified in clause 5.3. These fields, and their implied values are listed in Tables 9 and 10.

Table 9: Implied value for segmentation_descriptor fields in the compact_splice_insert message

Field	Value
splice_event_cancel_indicator	0
out_of_network_indicator	1
duration_flag	1
splice_immediate_flag	0
time_specified_flag	1
segmentation_upid_type	0x0F
auto_return	1
program_splice_flag	1

Table 10: Implied value for DVB_DAS_descriptor fields in the compact_splice_insert message

Field	Value
splice_descriptor_tag	0xF0
identifier	0x4456425F ("DVB_")

8.4 Use of ATSC A/335

8.4.1 Use of ATSC A/335 in DVB Markets (informative)

Clause 8.4 provides one possible watermarking solution for carrying signalling from the Broadcaster to the Receiver, other watermarking technologies are possible.

ATSC A/335 [10] specifies a technology for delivery of broadcast signalling in video watermarks and is a technology referenced for use with the HbbTV® interactive television platform (see clause A.2). The compact formats of SCTE 35 messages specified in clause 8.3.1 can be transmitted as stream event messages using the ATSC A/335 [10] video watermark in as little as 2 video frames, enabling delivery of DVB-TA signalling to DAS Apps with very low latency. Additionally, the presence of the ATSC A/335 video watermark in portions of broadcast content that constitutes a PPO facilitates adherence to the recommendations included in Annex B for avoiding undesirable interactions between the TV and an upstream set-top box.

ATSC A/335 [10] encodes data in the luma value of video pixels on the top two horizontal lines of video. The specification permits usage of the watermark in a manner that could be visible or obtrusive to the viewer in certain conditions. In particular, the ATSC A/335 watermark could degrade video quality if the watermark is embedded using pixel values that are brighter than adjacent video lines, if the television does not "overscan", and if the television is not capable of detecting and masking the presence of the watermark. This issue is particularly salient for a significant number of UHD TVs that are known to have been sold into DVB markets with "overscan" inactive by default and that do not include video watermark detection capabilities.

8.4.2 Usage Rules for ATSC A/335 Video Watermarks

To minimize the likelihood of viewers observing the video watermark broadcasters are advised to take perceptual quality into account when selecting and configuring A/335 video watermark embedding equipment and to use the watermark such that the visual impact is reduced as much as possible. To achieve this, the following Usage Rules shall be followed:

- Broadcasters shall not employ the 2X Data Rate Video Watermark.
- When the 1X Data Rate Video Watermark is employed, luma values for the Encoded Data value of "1" shall be set to either: (a) the lowest permitted luma value; or (b) a level that is materially invisible to the viewer when displayed together with the video content.
- ATSC A/335 video watermarking applied in accordance with all requirements of the present clause 8.4.2 may be included during and within the landing zones immediately adjacent to advertising and other content that constitutes a PPO.
- ATSC A/335 video watermarking that is materially invisible to the viewer when displayed together with the video content may be included in any broadcast content.

NOTE: "Materially invisible" means not degrading the quality of the content to typical viewers under normal viewing conditions.

Annex A (informative): Deployment Scenarios for Watermarking

A.1 Introduction

DVB-TA is a platform-agnostic specification and is intended to facilitate activation of POs across the broadest possible range of horizontal and vertical markets.

Some DVB markets employ known platforms with capabilities related to enablement of DVB-TA using watermark signalling. Clause A.2 provides specific guidance regarding the HbbTV® platform [i.3]. Guidance regarding additional platforms may be included in future revisions of the present document.

A.2 HbbTV

A.2.1 Introduction

The use of watermarking technologies to perform DAS app discovery and lifecycle management with ETSI TS 102 796 [i.3] is specified in ETSI TS 103 464 [i.4]. It further supports delivery of a Watermark Media Timeline ("WMT") that enables precise synchronization of DAS app actions with the content and multiple methods for delivery of broadcast signalling messages.

A.2.2 HbbTV ADB2 watermarking for DAS Apps

Audio watermarking is used in ETSI TS 103 464 [i.4] to enable DAS app discovery, DAS app lifecycle management, WMT access, audio component identification, and the detection of the presence of interruption or modification of the audio component of the received broadcast content. It is necessary that broadcast services that perform advertisement substitution on HbbTV ADB2-capable televisions include an HbbTV ADB2-specified audio watermarking technology for at least the duration of broadcast program segments that utilize DVB-TA.

Video watermarking is used in HbbTV ADB2 to enable WMT synchronization, video component identification, and detection of the presence of interruption or modification of the video component of the received broadcast content. It is desirable that broadcast services that perform advertisement substitution on HbbTV ADB2-capable televisions include HbbTV-specified video watermarking for at least the duration of placement opportunity.

A.2.3 DVB-TA Signalling Delivery with HbbTV ADB2

A.2.3.0 Overview

HbbTV ADB2 provides multiple methods for synchronized delivery of DVB-TA signalling from broadcasters to receivers.

The method with the lowest latency is carriage of the DVB-TA signalling in the video watermark as HbbTV video watermark event messages. This approach is described in clause A.2.3.1. Alternately, DVB-TA signalling may be delivered to receivers over broadband via an Application Server (see Figure 3). Methods using this approach are described in clause A.2.3.2.

A.2.3.1 DVB-TA signalling via Video Watermark Event Messages

HbbTV ADB2 supports delivery of video watermark event messages to deliver DVB-TA signalling to DAS apps in the same manner as DSM-CC stream events. Broadcast services that perform advertisement substitution on HbbTV ADB2-capable televisions can transmit DVB-TA signalling as HbbTV video watermark event messages.

A.2.3.2 DVB-TA signalling via Broadband

HbbTV ADB2 supports two alternative methods for the delivery of DVB-TA signalling to receivers over broadband via the Application Server.

The first of these methods employs the WMT synchronize delivery of DVB-TA signalling messages from the Application Server to the DAS App. The WMT capability of HbbTV ADB2 enables the DAS App to establish the current playback position in the service, which can differ from wall-clock time as a result of distribution path latency or time-shift. The DAS App can provide the current playback position to the Application Server using a transaction protocol selected by the broadcaster and receive, in turn, DVB-TA signalling messages associated with upcoming POs. A sequence diagram illustrating this arrangement is provided in Figure A.1.

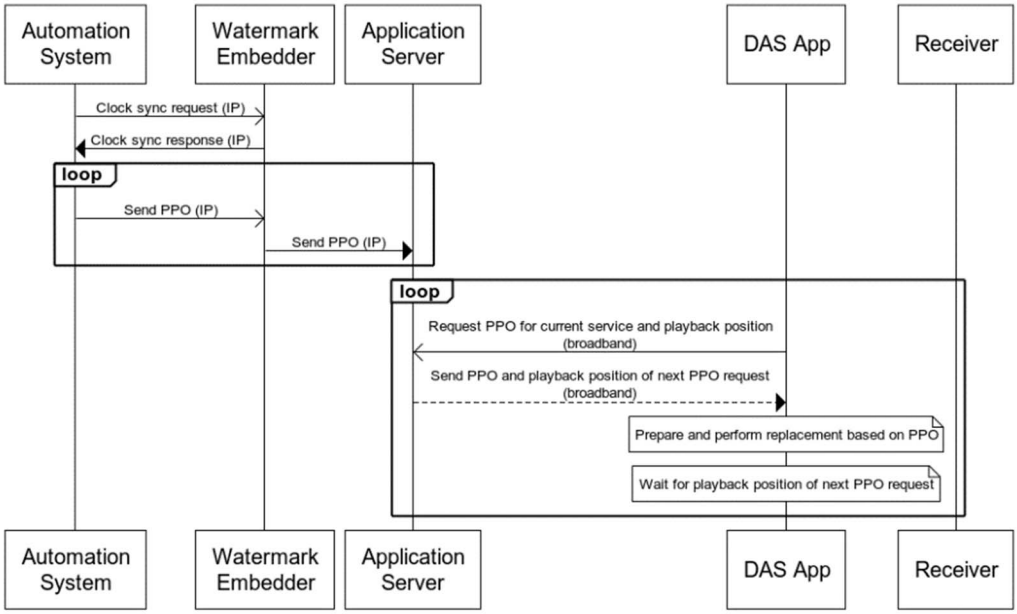


Figure A.1: Sequence diagram illustrating a method for delivering DVB-TA signalling to a DAS App in a receiver that supports HbbTV ADB2 over broadband via an Application Server using the Watermark Media Timeline for synchronization of signalling delivery

The second of these methods employs the query flag feature of HbbTV ADB2 to synchronize delivery of DVB-TA signalling messages from the Application Server to the DAS App. The query flag is a watermark data field that can be toggled at broadcaster-specified times on the media timeline and will deliver a "push notification" to receivers and DAS Apps when their current playback position reaches that time. This feature enables the broadcaster to efficiently deliver an unscheduled notification to receivers of the availability of DVB-TA signalling messages (e.g. a live-scheduled PO) at the Application Server. A sequence diagram illustrating this arrangement is provided in Figure A.2.

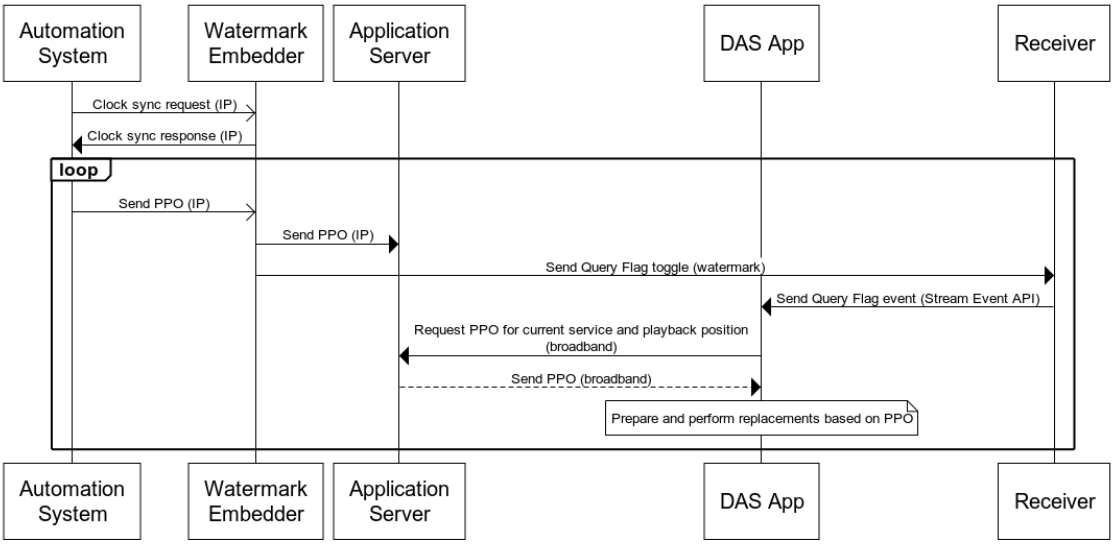


Figure A.2: Sequence diagram illustrating a method for delivering DVB-TA signalling to a DAS App in a receiver that support HbbTV ADB2 over broadband via an Application Server using the Query Flag for synchronization of signalling delivery

A.2.4 Use of pts_time field

HbbTV ADB2 supports a WMT with 54 bits of resolution and 1 millisecond ticks.

HbbTV ADB2 watermark media time values should be conveyed as pts_time values in DVB-TA signalling using binary truncation of this watermark media time representation to the 33 least-significant bits.

A.2.5 Use of upid field

When a compact SCTE 35 representation is used with HbbTV ADB2, the implied domain name associated with an Airing ID conveyed in a upid is the Authoritative FQDN associated with the watermark segment in which the message is conveyed, as specified in clause 5.5 of ETSI TS 103 464 [i.4].

Annex B (informative): User Experience Considerations for Watermarking

B.1 Introduction

This annex is aimed to provide some information about the way a generic watermark-based TA approach is designed. It is also aimed to help the organization implementing it to be aware about possible issues depending on how the solution is implemented but also offers some hints about the way to mitigate them as much as possible.

B.2 Video replacement

The approach described in the present document is aimed to enable TVs to replace the output signal of a STB, delivered through the HDMI link, by an advertising spot received by the TV over its broadband connection. During this replacement, the HDMI incoming signal from the STB is not shown by the TV anymore. This is triggered by a watermarked signal embedded in the video and in the audio of some TV channels that reach the TV through the STB.

This approach of having the TV replacing the STB's HDMI by another from the broadband TV during an advert can in some circumstances create possible confusion for the user. For example, when a user presses a button on the STB remote control, they would expect the result of their action to appear immediately on the TV screen. If the TV remains unaware of the action taken on the STB and continues with unmodified playback of the replacement ad, the STB response to the user action could be delayed until the end of the advertising spot when the display is given back to the STB by the TV. Faced with this, the user may think that their remote control or STB is not operating correctly when the cause lies in their TV.

It is therefore important that DAS apps and the terminals on which they operate are designed to detect such STB actions and conform the presentation of replacement advertisements to reflect any resulting changes in the STB output and to avoid negatively impacting users experience to the maximum extent practical.

When the following modifications of the broadcast content are performed upstream from the TV (e.g. by a STB), user expectations are believed to be best met if such changes are quickly detectable by the TV and if the TA presentation is modified by conforming, forgoing, or abandoning its presentation as specified in table B.1.

Table B.1: Conforming, forgoing or abandoning TA presentation

Content Modification	Desired behaviour if modification occurs while a TA presentation is pending	Desired behaviour if modification occurs while a TA presentation is ongoing
Channel Change	Do not present TA	End TA presentation
Pause	Do not present TA	Pause TA presentation
Speed change ("trick play")	Do not present TA *or* Present TA synchronized to media time in STB output	Present TA synchronized to media time in STB output
Skip forward/back ("cue")	Do not present TA *or* Present TA synchronized to media time in STB output	Present TA synchronized to media time in STB output
Full-screen UI (e.g. EPG)	Do not begin TA presentation *or* Present TA with audio only for duration of STB action	Present TA with audio only for duration of STB action
Mute	Do not begin TA presentation *or* Present TA with audio muted for duration of STB action	Present TA with audio muted for duration of STB action

Generally, it is desirable to minimize any additional delay in the response time of a user action on the upstream device.

When a STB is presenting a composite of broadcast content and STB-generated content (e.g. broadcast video with a partial-screen overlay, such as an information or notification banner), the ideal behaviour of the watermarking solution is to conform the TA presentation to the STB presentation by compositing the STB-generated content with the TA content.

It is understood, however, that the size and location of the composition may be widely varying in location, size, and geometry (e.g. top banner, bottom banner, side banner, L-banner, centred box, rounded or square corners, etc.) and is entirely dependent on the specific STB model/firmware and the interface being presented. In this case, detecting the presence of the composition in the STB presentation and conforming the TA presentation to it at the TV would likely require a pixel-accurate watermarking solution.

A practical approach to this scenario is for DAS apps to support user notification and control of TA presentations, as is commonly done in digital video advertising (e.g. web or app). This empowers a user to access a STB feature (e.g. banner overlay) that cannot be presented together with TA on request and may provide a better user experience than automatic abandonment of the TA by the TV which will cause an unexpected and potentially confusing change from the TA content to the broadcast content.

The detailed specification of such an approach is outside the scope of the present document, however it might include one or more of:

a) displaying an on-screen user notification while a TA presentation is occurring;

b) accepting a user input that terminates a TA presentation while it is occurring;

c) accepting a user input that configures a TV to not perform TA presentations anymore;

d) displaying an on-screen user notification prior to any TA presentation that informs the user about capabilities a) - c) listed above.

B.3 Audio levels

The approach described in the present document enables replacement of content received from the HDMI input of a TV. However, the audio level of the replacement advert is expected by the viewer to be at the same audio level as the one of the adjacent content. It is important that implementers of the present document ensure that this expectation is met across the full range of possible home entertainment system configurations.

For example, it is not uncommon for users using a STB connected to a TV to leave the TV volume level set to the maximum desired volume and to adjust the current listening volume using the STB remote. Different STB providers implement this scenario in different ways. Some example approaches include:

- The STB modifies the amplitude of the audio signal.
- The remote control is configured so the volume up/down buttons generate the IR codes used by the TV to control volume.
- The STB identifies the TV using information in the HDMI EDID and configures the remote control to generate the IR codes used by the TV to control volume.
- The STB tells the TV to adjust the volume using HDMI CEC.

In each of the scenarios listed above, it is important to avoid a situation where the TA audio level when streamed from broadband is rendered higher in perception than the one experience by the user when watching the content from the STB. The DAS application is expected to be able to determine this and decide not to do a substitution in scenarios where this requirement cannot be met.

TVs that perform content replacement over HDMI are also expected to properly support the configuration of a STB connected to a TV through an A/V receiver. In particular, they need to be able to avoid a scenario where the TV is playing the streamed advert on the TV (with video and audio) while the STB is still having its audio played out, at the same time, by the A/V receiver. Example A/V receiver configurations that avoid this issue include those that playback of all audio on the TV speakers and those that use of an audio return channel to play back all audio on the A/V receiver. In any case, it is also important in such scenarios that audio levels remain consistent between replacement content and adjacent broadcast content as discussed above if content replacement is performed.

History

Document history		
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