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S T A N D A R D S

Digital Video Subcommittee

SCTE OPERATIONAL PRACTICE

SCTE 248 2018

Operational Practice on Multiple Audio Signaling

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1. Introduction

1.1. Executive Summary

Cable operators, many program networks, and local broadcast affiliates routinely support up to two audio streams for programs they distribute. The first audio stream contains the main or primary audio for the program, typically in English; the second audio stream contains the audio description or a second language (typically Spanish). However, this legacy two-stream model can conflict with the desire to offer additional languages, video description service (VDS), emergency information and other audio services simultaneously. Newer equipment, including set-top boxes, and IP delivered content can support this capability; advanced audio technologies, such as object-based audio, will allow the consumer more choice of what they hear. This document provides guidance and recommendations to cable operators and program providers on distributing multiple audio streams, languages and services while supporting legacy requirements.

1.1.1. Background

The technical capability to offer more than one audio service was born of a desire to provide stereo audio in analog television channels to consumers. The method chosen to do this also allowed for a lower bandwidth Second Audio Program (SAP) channel. The cable industry embraced this capability and began delivering a second language in analog channels via the SAP feature, part of the Multichannel Television Sound (MTS) standard developed by the National Television Systems Committee (NTSC). This method of delivering program audio in English as well as in a second language was carried forward and replicated in the digital delivery of video services provided today.

In 2011, pursuant to the Twenty-First Century Communications and Video Accessibility Act of 2010, (CVAA), the Federal Communications Commission (FCC) reinstated video description rules requiring MVPDs serving 50,000 or more subscribers to provide 50 hours of video-described prime time or children's programming per calendar quarter on each of the top five non-broadcast networks -- currently USA, TNT, TBS, History, and Disney Channel. In July 2017 the FCC increased the total number of required video-described hours by 75%, up to 87.5 hours per calendar quarter, as of the calendar quarter beginning July 1, 2018.¹

Also pursuant to the CVAA, in April 2013 the FCC adopted revised "emergency information" rules that make emergency information provided in non-news video programming accessible to individuals who are blind or visually impaired. Cable operators retransmitting emergency information audio, typically from broadcast stations, must pass through that audio in the secondary audio stream to customers. Emergency information audio supersedes all other programming on the secondary audio stream, including VDS and second language.

The regulatory requirement to carry an increasing number of hours of video described programming, emergency information, and the business interest in supporting second language audio must now be considered when planning the delivery of audio service to customers.

¹ The list of top five networks is updated every three years, with the next update occurring on July 1, 2018. Broadcast stations affiliated with ABC, CBS, Fox, or NBC located in the top 60 TV markets are subject to the same hours requirement.

1.2. Scope

This document describes methods and practices for distributing multiple audio streams, languages and services within cable and program provider systems, while continuing to support legacy equipment requirements.

1.3. Benefits

Under current practice, the second audio stream can become oversubscribed. The guidance and recommendations provided in this operational practice document will help cable operators and program providers address this concern and improve the delivery of audio services to the consumer.

1.4. Intended Audience

Program providers (especially producers and engineers involved with content creation and operation of program distribution technologies) and multi-channel video programming distributors (MVPDs) (especially technicians and engineers responsible for receiving and processing program content for distribution to their customers) comprise the intended audience for this operational practice. It *may* also benefit vendors involved in the design, development and manufacturing of equipment and software for content distribution.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- No normative references are applicable.

2.2. Standards from Other Organizations

- No normative references are applicable.

2.3. Published Materials

- No normative references are applicable.

3. Informative References

3.1. SCTE References

- ANSI/SCTE 30 2017, Digital Program Insertion Splicing API
- ANSI/SCTE 35 2017, Digital Program Insertion Cueing Message for Cable
- ANSI/SCTE 54, Digital Video Service Multiplex and Transport System Standard for Cable Television
- ANSI/SCTE 224 2015, Event Scheduling and Notification Interface (ESNI)
- SCTE 236 2017, Content Metadata
- SCTE 243-1 Next Generation Audio Carriage Constraints for Cable Systems: Part 1 – Common Transport Signaling
- OC-SP-CEP3.0-C01-161026 Content Encoding Profiles 3.0

3.2. Standards from Other Organizations

- ATSC A/53, Part 1:2013, Digital Television System
- ATSC A/53, Part 3:2013, Service Multiplex and Transport Subsystem Characteristics
- ATSC A/53, Part 5:2014, AC-3 Audio System Characteristics
- ATSC A/53, Part 6:2013, Enhanced AC-3 Audio System Characteristics
- ATSC A/52:2015, Digital Audio Compression (AC-3) (E-AC-3) Standard
- ATSC A/85:2015, Digital Audio
- ATSC TG1-1013r1 ATSC Technology Group Report: ATSC Audio Language Signaling
- ATSC A/342 Parts 1-3 Audio
- OC-SP-CEP3.0 Content Encoding Profiles 3.0 Specification
<https://apps.cablelabs.com/specification/content-encoding-profiles-3-0-specification>
- ISO 639-1, Code for the representation of Names of Languages - Part 1: Alpha-2 code
- ISO 639-2, Code for the representation of Names of Languages - Part 2: Alpha-3 code
- ISO/IEC 23000-19:2018, Information technology – Multimedia application format (MPEG-A) – Part 19: Common media application format (CMAF) for segmented media
- IETF RFC 8216, HTTP Live Streaming <https://tools.ietf.org/html/draft-pantos-http-live-streaming-23>

3.3. Published Materials

- Video Description: Implementation of the Twenty-First Century Communications and Video Accessibility Act of 2010, Report and Order, FCC 17-88
(<https://docs.fcc.gov/public/attachments/FCC-17-88A1.pdf>), MB Docket No. 11-43 (rel. July 12, 2017).
- Video Description: Implementation of the Twenty-First Century Communications and Video Accessibility Act of 2010, Report and Order, FCC 11-126
(<https://docs.fcc.gov/public/attachments/FCC-11-126A1.pdf>), MB Docket No. 11-43 (rel. August 25, 2011).
- Video Description. (2016, November 16). Retrieved August 24, 2017, from <https://www.fcc.gov/general/video-description>
- Codes for the Representation of Names of Languages Part 2: Alpha-3 Code. (2011, April 8). Retrieved August 24, 2017, from <http://www.loc.gov/standards/iso639-2/langhome.html>

4. Compliance Notation

<i>shall</i>	This word or the adjective “ <i>required</i> ” means that the item is an absolute requirement of this document.
<i>shall not</i>	This phrase means that the item is an absolute prohibition of this document.
<i>forbidden</i>	This word means the value specified shall never be used.
<i>should</i>	This word or the adjective “ <i>recommended</i> ” means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
<i>should not</i>	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
<i>may</i>	This word or the adjective “ <i>optional</i> ” means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
<i>deprecated</i>	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

ATSC	Advanced Television Systems Committee
ASI	asynchronous serial interface
AVC	advanced video coding
CMAF	common media application format
DVS	Descriptive Video Services (see VDS, below)
FCC	Federal Communications Commission
HD	high definition
HEVC	high efficiency video coding
IP	Internet Protocol
MVPD	multichannel video programming distributor
NPRM	Notice of Proposed Rule Making
SAP	Secondary Audio Program
SCTE	Society of Cable Telecommunications Engineers
SD	standard definition
SDI	serial digital interface

TVE	TV Everywhere
VOD	video on demand
VDS	Video Description Service

5.2. Definitions

Cx	Term used to describe VOD playback within a measurement window that is typically 3 (C3) or 7 (C7) days.
Descriptive Video Service	Sometimes used in place of Video Description Service
Video Description Service	The insertion of audio narrated descriptions of a television program's key visual elements into natural pauses between the program's dialogue.

6. Applicable Standards for Audio Language Signaling

6.1. Introduction

The two relevant standards for signaling the language of an audio stream are ATSC A/53 Part 3 for television broadcast stations and SCTE 54 for cable television systems. These are transport layer specifications that tell how and where to carry the relevant signaling structures that describe the audio. The relevant signaling structures are the AC-3 audio descriptor (which is defined in ATSC A/52) and the ISO 639-2 language descriptor (which is defined in ISO/IEC 13818-1 Section 2.6.18).

6.2. ATSC A/53

ATSC A/53 Part 3 Section 5.8.1 requires that the AC-3 audio descriptor be carried in the ATSC broadcast stream and *may* optionally indicate language by including the ISO 639-2 language bytes within the AC-3 audio descriptor. Carriage of the ISO 639-2 language codes to indicate language is optional but recommended to support legacy devices such as cable set top boxes that *may* rely on it for language selection.

If the ISO 639-2 language descriptor is present for a given AC-3 audio elementary stream and, if the language code is present in the corresponding AC-3 audio descriptor, the language code in the ISO 639-2 language descriptor is set to the language code value present in the AC-3 audio descriptor.

The AC-3 audio descriptor contains a field named *bsmod* (Bit Stream Mode) that is used to indicate whether an audio stream has a service type of “main audio service: complete main” (*bsmod*=0), “associated service: visually impaired” (*bsmod*=2), or some other type.

6.3. SCTE 54

SCTE 54 Section 5.9.3.1 requires the AC-3 audio descriptor be carried and the audio language is set using the language field of the AC-3 audio descriptor. The language *may* also be indicated using the ISO 639-2 language descriptor. However, some cable programming services do not carry the AC-3 audio descriptor and carry only the ISO 639-2 language descriptor.

Section 6 of SCTE 54 provides additional details regarding the signaling of VDS audio (called Video Description audio in SCTE 54). It permits using different language values in the ISO 639-2 and AC-3 descriptors. This approach recognizes that some “legacy” set top boxes use audio language information derived from ISO 639, while newer set top boxes use audio language information from the AC-3 audio descriptor. It provides for the ISO 639-2 language descriptor to continue to label the second audio stream

as Spanish, even when it carries VDS audio. But the AC-3 audio descriptor would signal the VDS audio as English and as VDS (bsmod value 2).

This approach would require the AC-3 audio descriptor to change throughout the day, depending on whether the current program's second audio stream was Spanish or VDS. The approach does not appear to have been implemented by MVPDs or programmers, or their respective technology vendors.

7. Audio distribution ecosystem From Studio to Consumer

This chapter is intended to help the reader track multiple audio channels from the studio to the consumer. It also attempts to identify areas where the appropriate metadata describing the audio feed is generated and how it is distributed. Some of the solutions for supporting multiple audio streams may require obtaining the content with a different set of audio tracks than is commonly obtained today.

7.1. In Studio

Studios that create content with multiple languages or VDS applied typically have to keep multiple audio tracks for:

- 1) Music
- 2) Effects
- 3) English dialog
- 4) Spanish or other dialog
- 5) English VDS
- 6) Additional languages for dialog or VDS

There are occasionally issues with the effects track. Some sound effects are recorded live with the dialog and must be separated out if additional languages are to be created.

The actual VDS track can be created in two ways. One method is to create a complete English audio track with dialog and VDS combined. The second method is to create an additional track with just the VDS audio that needs to be mixed with the dialog track. The second method will be preferred for future object audio methods as this track is mostly silent and can be compressed easily to save bandwidth.

Studio systems *may* have limits on the number of tracks that can exist depending on their master format. There are some methods of increasing the available tracks such as Dolby E. Some newer technologies such as reflected in SMPTE 2110 allow for virtually unlimited number of perfectly synced audio tracks.

7.2. Studio to Content Originator

Content originators, typically cable or broadcast networks, order content from the studios with a particular audio configuration. Almost all content today is delivered digitally. Studios and programmers are moving towards the nascent SMPTE/NABA/DPP interoperable media format (IMF) that is in the process of standardization by SMPTE.

The Internet Advertising Bureau is also developing a specification on a common mezzanine format for delivering advertisements. This is an area that *may* require more work in moving toward using IMF and also for adding additional languages and VDS to advertisements.

7.3. Content Originator storage/playout

The arriving content is typically received in a digital format. This content goes through an ingest and quality assurance process to feed it and all the necessary metadata in to the media asset management system. The interoperable master format mentioned previously is aimed to help the ingest process and minimize additional quality assurance steps.

Content originators typically store all of their content digitally and use a media asset management system to retrieve the content needed for playout. Content is usually “Ordered” from the playout or scheduling system and the various languages required for a particular airing are selected. The content is then transferred to a playout server and prepared for air. Most systems are designed for playing out a main and secondary audio and will require changes if they are to play out additional languages, VDS, or object based audio (e.g. Dolby ATMOS or MPEG-H). Some of the newer systems always deliver all possible audio streams to the playout server and allow the automation system to use what is available.

Alternatively if certain tracks do not exist in the incoming content, sometimes the asset management system has rules to duplicate tracks. For example, if Spanish 2.0 is not present, then the system will copy the English 2.0 on to those tracks.

7.4. Content Originator to MVPD

Typically, the delivery of content from the programmer to MVPD is done using audio and video data compression (e.g. Dolby AC-3 and AVC) via satellite or terrestrial means. This is encapsulated in an MPEG-2 transport stream (TS) with individual program map table (PMT) for each program in the TS. Satellite delivery today uses a multiple program transport stream (MPTS). The MVPD usually decides what type of receiver is used in order to output the audio and video in the required format. Some typical outputs that MVPDs will require include; baseband audio and video, HD-SDI with embedded Audio; compressed audio/video that they use or transcode.

An Integrated Receiver Transcoder (IRT) can also be used if the MVPD requires a video format that is different than the programmer delivers. With some programmers moving to HEVC this may be required for AVC in addition to MPEG2 video output. Some of the techniques that *may* assist with the transition to more audio streams would leverage a new version of IRT that can switch and/or transcode the audio as well as the video. Signaling of which audio to present on the decoded outputs would need to be present in the stream and some possible methods for signaling are in section 9.1.

For VOD asset distribution a package is created with an SPTS audio/video file and various metadata files. The SPTS has static Packet Identifiers (PIDs) in a common format matching the Cablelabs CEP specification. The Main audio is on PID 0x1E1, SAP is on 0x1E2. Where extra audio streams exist beyond SAP on PID 0x1E2, the sequence simply continues (e.g., if VDS was available, that would be on 0x1E3).

Some programmers are working on making their Adaptive Bit Rate (ABR) files available off of the origin server or content distribution network (CDN). These files are typically encrypted so the keys must be shared securely in order for an MVPD to use the same files. They can use a Federated Rights Management (FRM) architecture to provide the keys to the MVPD or in a pass through mode directly to the subscriber. These files that can then be used to deliver programming to legacy cable QAM and newer internet-delivered services. These files are moving to a new MPEG standard format called CMAF that is a fragmented MP4 format that can have multiple audio streams associated with it. While there are some concerns about this approach for video quality of service (QOS), the appropriate audio streams that are available will be known in the CMAF file and a SAP feed could be reconstructed as well as separate VDS and any alternate language tracks.

7.5. MVPD Processing

Typically, minimal audio processing is performed to ensure audio is ready for legacy set tops. Where necessary, audio levels are set to an agreed loudness in LKFS for ensuring consistent levels. For classic set tops, typically anything beyond a second audio channel is ignored (or not found by the set top) and not available to the consumer. For over the top (OTT) applications, the audio is often transcoded to the Advanced Audio Coding (AAC) codec (many hand-held devices lack proper support for other more common set top audio codecs).

Most MVPDs do not deliver the programmer MPTS to the subscriber. The reasons for this include:

- 1) The MPTS may be of the wrong bandwidth.
- 2) The MVPD uses a switched digital architecture that requires constant bit rate SPTS streams.
- 3) They desire to fill their QAM channels differently for various reasons including optimizing the statistical multiplex, channel change time or other technical issues.

In order to create a stream that can be delivered to subscribers on the MVPD network, the MVPD either re-encodes / transcodes the original network or performs a re-(statistical)-multiplex. Either method allows the MVPD to change the audio descriptors as is needed for their subscribers and devices. In this case, the programmer just needs to deliver all of the required audio streams and enough signaling information so that the MVPD can appropriately reprocess the feed.

The main concern around legacy systems in the operational practice is for legacy operators that either deliver analog video and MTS audio or put the IRD/IRT output directly onto their plant.

7.6. MVPD to Legacy Set Top

Older but still widely deployed set top box architecture is based on a two audio only system with no capability to select a 3rd audio, since the legacy set top does not support discovery of more than a pair of audio options. Some of the earliest digital set tops do not look at any descriptors and the first audio PID they find in the PMT is the main audio and the second is the SAP channel. The audio is delivered in a multi-audio channelization format with stereo or mono for the first audio and stereo or mono for the second audio channel. Currently, when VDS audio is required, the content of the SAP (e.g., ISO 'spa') channel is changed from an alternate language to the VDS track by the programmer, and the PMT, the version number, and descriptors are unchanged.

Where the MVPD can deliver more than two audio streams, (e.g., HD) there are usually additional limits such as four hard coded languages (eng, spa, fre, por). For this reason, some programmers deliver VDS audio signaled as 'por', so a visually impaired user can make a one-time choice of 'por' in their set top box and receive VDS when available, with English fill when VDS is not available.

Legacy set tops still allow the presence of a 3rd audio carrying dedicated VDS + English fill (e.g., ISO 'por') *may* exist within transport. Creating an alternate virtual channel with the 3rd audio in PMT would allow a one-time selection of VDS for VDS subscribers with legacy set top boxes that can recognize the ISO 'por' language notation and can offer it to consumers as a menu selection. The inverse of Spanish being offered in a similar remapping could also exist. As we move towards HD only distribution, first from programmers to distributors, then from distributors to consumers, this method would support continuing use of legacy set top boxes with subscriber opt-in for their desired language choice.

Current state-of-art set tops can support more audio streams and have specific configurations that can be selected. This usually brings up an issue of the software and firmware running on the set top box and what

subscriber selections are provided; even though the box may be capable of handling many audio streams, they *may* not be able to be selected due to limitations in the set top software.

Newly designed set tops may be able to support next generation audio object-oriented standard. This would allow many audio streams to be selected along with VDS content in multiple languages if provided by the programmer.

7.7. MVPD to IP

In legacy versions of streaming protocols, the audio is muxed-in with the video, and the addition of extra channels of audio could cause a decrease in the fidelity of the video delivered as the individual segments may be too large for a single profile. As individual audio tracks are typically available for delivery, the extra audio streams can be encoded and available via package options.

The move from HLS/TS to HLS or DASH with CMAF fragmented files should allow current apps to support more audio choices and VDS.

If the MVPD is transcoding the content into the adaptive bitrate CMAF format, they can create whatever signaling or control metadata is required for their players. All they require is that all of the audio streams are available from the programmer and signaled correctly.

There are two ways an MVPD might use programmer ABR content directly; one. One is to deep link to the origin/CDN and the second is to use the programmer's embed player. With the embed player being provided by the programmer, there would be no audio issues, assuming the programmer handles audio correctly. With the deep linking approach there *may* be some need for standardization of how the audio tracks are created and what metadata is needed to describe how to play them back.

7.8. User Interface Issues

Since there is no VDS language descriptor, set top software has typically used 'por', 'men' (ISO notation for Middle English) or a separate configuration switch to indicate the user would like VDS audio if available. Or in legacy analog the user would simply select the SAP channel. VOD guides have created separate categories and navigation for different language programming.

Some TVE apps include logic for selection of VDS or SAP, but do not allow for a specific language to be selected. It is unclear if or how the logic interprets a combined SAP/VDS audio delivered by a programmer, or of its usefulness to the subscriber.

Another issue is to have the guide data indicate which shows have which languages available. Currently VDS program discovery is problematic. Also, some programs that were available in Spanish may switch to VDS and Spanish will no longer be available. This topic is discussed further in Section 12.

Dedicated audio paths for English, Spanish, and VDS with mapping to support one-time selection of the main audio of their choice addresses consumer navigation issues.

New set tops that support object-based audio formats require a menu that usually allows for the language and VDS components to be selected. They can offer other personalization components such as home and away announcers, increased dialog level for intelligibility or to turn components such as background music on or off.

7.9. Live to VOD consideration

CableLabs created a VOD Content Encoding Profile document that allowed for multiple audio streams, with a certain bandwidth allocated for the main video plus one audio. Currently MVPDs have no way of knowing what languages actually exist in the live programming on a given audio track. As mentioned in other sections, some networks that have a language other than English as a primary language still send it out as English as that is the default on most playback equipment.

There are issues with recording the live programming for Startover™ or Cx playback as exactly what audio is being carried is not known. SCTE 224, as discussed in Section 12 [Program Language Metadata](#), may help to solve this issue. Another possibility would be to add SCTE 35 signaling that can be acted upon in a dynamic fashion signaling what languages are actually present on each Program_Start segmentation message.

Some MVPDs are moving to IP delivery of all VOD content. This content may be delivered from locally transcoded sources or directly from the programmer origin with CMAF. This strategy is capable of supporting multiple audio streams and should be implemented to allow the subscriber to utilize them.

8. Currently deployed practices

8.1. Single Audio Channel Networks

Networks with only a single audio comprise a simple case of making sure to label the audio feed correctly. These programmers do not fall under the FCC VDS rules so do not require any other signaling to be done. They typically use appropriate Program Map Table (PMT) descriptors to signal the actual language as a Complete Main service in whatever audio channel format (2.0, 5.1) is actually on air.

8.2. TV Broadcast Station Usage

Most terrestrial TV broadcasters that deliver two audio streams designate one as the primary audio, signaled as a Complete Main service, with the correct language in the AC-3 and ISO 639 descriptors. In the United States the primary audio stream is usually English language, with audio signaled as English language. The second audio stream is usually signaled as Spanish language, but from time to time may actually be VDS audio or Spanish audio or emergency information audio. This continues the analog television tradition of designating the second audio program stream as SAP.

While all broadcasters carry the AC-3 audio descriptor, not all broadcasters correctly populate the values for language and audio service on the second audio stream. Rather, some broadcasters set those values to match the language and service in the ISO 639-2 language descriptor. In this case, the second audio stream is labeled as Spanish language Complete Main (bsmod value 0) even when the second audio stream is actually English language and Video Description audio (bsmod value 2).

However, some Spanish language TV stations found that when their main language was Spanish and they signaled it as Spanish in the AC-3 and ISO 639-2 descriptors, they got calls reporting no audio (when there was nothing on the secondary audio) or the wrong audio (getting the secondary audio stream when they wanted the main audio). Consequently, these stations now carry the Spanish language audio but signal it as English and carry English on the second audio stream but signal it as Spanish. Depending on the MVPDs set tops and infrastructure, they *may* be required to re-map the audio streams to work correctly in a system where labels correspond correctly with audio stream content.

For most broadcasters, the values in the AC-3 audio descriptor are "fixed" and do not change throughout the day rather than "dynamic," even when the type of service in the second audio stream is not fixed and

changes from one program to another. Consequently, even when the second audio changes from Spanish to VDS audio at a program boundary, those broadcasters continue to signal VDS audio as Spanish Complete Main in the AC-3 audio descriptor.

There are a number of stations that switch language frequently or carry simultaneous programs in a variety of languages. For example, in the San Francisco Bay Area there is a station running three services, all directed to non-English speaking audiences. This station signals its languages in the AC-3 descriptor as “multiple” when the actual language of a program might be Korean, Mandarin, Cantonese, Farsi or Hindi.

8.3. Video Description using POR or MEN

Some networks broadcast an audio stream that has VDS audio on it, when available, and switch back to the default language when not available. Since there is no ISO 639 language code for VDS, ‘por’ (Portuguese) is commonly used to identify this track. ‘por’ is used since many legacy set top boxes have four available languages, ‘eng’, ‘spa’, ‘fre’, ‘por’ and in North America the first three are the most commonly used. Some MVPDs request that the VDS content is labeled ‘men’ (Middle English) although that is typically done for VOD purposes and is not industry standard. The VOD feed is typically reprocessed anyway to create a VDS version of the feed that most likely uses English complete main in its signaling.

9. Possible Transition Accommodations for Content Originators

Unfortunately, most transition plans will require additional equipment or bandwidth or in some cases both. Depending on where the programmer is in their technology transition plans, satellite transponder renewals, desire for new services or languages, etc., finding the best transition plans will vary among programmers and may not be a simple process.

Most of the larger MVPDs can handle almost any language feed input as they usually only have a few receive sites and tend to transcode and re-multiplex the feeds that they deliver to their subscribers. As such they can customize their feeds and create multiple feeds if necessary to manage both their legacy and current set top boxes and other devices. As previously mentioned, all they require is to have the audio streams properly signaled so that they know what the streams are.

Much of this recommendation is meant to handle smaller MVPDs that need to be able to use the broadcast feed as output by the receiver.

9.1. Recommended Cable Content Originator Signaling

9.1.1. PMT issues

Changing the PMT on a live stream is not possible with current broadcast encoder/mux technology. Also, many equipment paths in the MVPD chain do not regularly look for PMT changes. For this reason, we do not recommend an active PMT to indicate audio options.

9.1.2. ISO Audio Signaling

The ISO 639 standard has 6 parts although part 6 has been withdrawn. VOD metadata typically uses the two alpha language descriptors (ISO 639-1) while live video typically uses the 3 alpha (ISO 639-2) version. There are newer versions that may allow additional signals such as indicating a descriptive video

track, but these are not supported by legacy equipment. There is no language descriptor for VDS audio as the language is usually English and with ISO descriptors there is no way to differentiate VDS English from the complete main English. Some legacy standards do not allow multiple audio streams with the same ISO language descriptor.

9.1.3. AC-3 Audio Signaling

The AC-3 audio descriptor is not always used by MVPDs and according to ATSC A/53 it is required to indicate the same language as the ISO language descriptor. The AC-3 descriptor does have the option to set the bsmode value to 2 to indicate that this track contains VDS audio, which allows a set top to differentiate a complete main English from a VDS English audio stream. The issue is that many legacy set tops cannot read this descriptor and ones that can do not have the guide programmed to use this. This can be used if the programmer can allow this feed to be output only to MVPDs that request it and have the infrastructure to handle it.

9.1.4. Object Based Signaling

See SCTE 243 (Next Generation Audio Carriage Constraints for Cable Systems) Part 1 Section 7.1.2 which discusses the audio preselection_descriptor. This descriptor, which is defined for AC-4 and MPEG-H audio technology, is designed for use by the TV or set top to allow the viewer to decide what they would like to listen to without having to ask for a mix of audio streams by themselves. It can also be used by a transcoder to decode/mix/re-encode audio to be delivered to legacy set tops.

9.1.5. SCTE 35 messages

Since changing the PAT/PMT to signal new audio streams does not work in most distributor headends and is not implemented on most encoder/mux systems that operators currently use, an alternative would be to signal audio changes with SCTE-35.

Many operators have implemented SCTE 35 segmentation for program start/end signals. This is typically driven by the automation system that also controls an audio switch to create the SAP or VDS streams. Having a signal create a downstream SAP channel while maintaining both an alternate language and VDS would be a customer experience improvement while saving bandwidth. One possible option for programmers that use Program Start/End messages to signal content would be to add ISO or AC-3 (preferable as it has a VDS mode) descriptors to that message to indicate which audio feeds are actually active with which languages. Alternatively, one could use a more recent ISO or a new descriptor that allows for language and type only

This information could then be used by an Integrated Receiver Descrambler/Transcoder to switch/remap PIDs to the output based on the affiliate and what types of audio they can process. It could create a SAP audio without having to broadcast a separate feed. This would require an update to the receivers to remap PIDs if needed on a Program Start message but depending on the receiver if it has re-mux capabilities this should be implementable.

This would also allow content that is being captured for Startover™, Cx or TVE delivery to be properly processed by the affiliate and present the correct languages available to the subscriber.

SCTE 35 is currently under revision and an audio_descriptor() is proposed to allow the splicer to know which audios are actually present in the feed.

9.2. Transmit SAP and additional languages and services

For programmers that can deliver four audio streams, this document recommends that the four audio streams should be an English complete main, a SAP channel (that is VDS when available, Spanish when VDS is not available but Spanish is available, and English otherwise), a Spanish (or other language) complete main, and an English VDS. The SAP audio supports legacy two-channel set tops. Instead of Spanish, other languages such as French or Korean might be provided as a second language. As described in the following section, English should always be provided as “fill” when VDS and the desired language is not available.

Most satellite transmission vendors allow the programmer to create virtual channels that are a subset of the available program elements (Video, Audios, signaling). The programmer can use these abilities to only allow the appropriate elements through depending on what the distributor requires.

Some programmers do not have four audio capability or capacity on their delivery systems. They would continue to deliver two audio streams (English main and SAP) as they do today.

9.2.1. Description of a Sample Program Audio Lineup

This alternative has the cable programmer delivering four channels of audio at all times. Some old set tops select audios in PMT order so the following order should be enforced. The first audio PID is the main audio and the second audio PID is the SAP audio. These set tops do not read any PMT descriptors. For delivery using MPEG Transport Streams, the following recommendations apply:

Audio 1 - English Complete Main audio. This should be signaled as (language = “eng”, bsmode = 0, along with the appropriate 2.0 or 5.1 information) in the AC-3 audio descriptor and eng in the ISO 639 language descriptor. For broadcasters who have a main language other than English, they will need to decide if they can label the audio correctly. For many programmers, this is also a 5.1 surround sound signal.

Audio 2 - SAP audio, which contains Video Description audio when that exists, Spanish (or other second audio language) when Video Description does not exist but the alternate language does, and English complete main when neither Video Description nor the alternate language exists. It should have no PMT ISO or AC-3 descriptors.

Audio 3 - Spanish (or other alternate language) Complete Main audio, which is backfilled with the English complete main audio when Spanish audio is not available. This should be signaled as (language = “spa”, bsmode = 0) in the AC-3 audio descriptor and spa in the ISO 639 language descriptor.

Audio 4 - English Video Description audio, which is backfilled with the English complete main audio when Video Description audio is not available. This should be signaled as (language = “eng”, bsmode = 2) in the AC-3 audio descriptor and not contain an ISO639 language descriptor. Some SD set tops use SPA to select this and some use POR. It is suggested that the ISO 639 and AC-3 descriptor should match; POR is the suggested designation for such

Of course, there are other broadcasters that may have additional audio streams for many other languages and may use additional tracks that are similarly described.

9.3. Object based audio

This design would make sense if the operator was planning a major distribution upgrade such as a transition to HEVC encoding or ATSC 3.0. With appropriate signaling, a device could be constructed in the receiver or as an add-on box that could render the audio from an object-based format to the legacy AC-3 formats that are required for the distributor. The unit could also switch in different objects, or other audio elements, for VDS or additional languages if required. The distributor could also use the full object stream to deliver advanced capabilities to devices that support it.

As an example, the following elements could be encoded along with metadata to describe when they are active and how they are mixed.

- 1) Music + Effects
- 2) English
- 3) Spanish
- 4) VDS

The receiver could decode, possibly downconvert 5.1(4) to stereo and mix these objects, then re-encode to whatever format is required by the Affiliate. Most receivers today can contain video transcoders and are moving to software-based implementations, so this addition may not be very difficult.

Some items to consider are that Object based systems can combine the main language with the VDS feed in the receiver if the VDS only contains the VDS content. In contrast, most of the VDS audio produced today is typically the program audio with the VDS overlay. It may be possible to save significant bandwidth if the VDS is then encoded as mono and only active when selected.

One could also look at this process in the receiver to insert watermarks for industry standard measurement systems to save additional bandwidth instead of having to transmit all of the audio streams multiple times.

This method would also make additional languages and additional VDS tracks simple to add in the future.

9.4. Use of both ISO and AC-3 descriptors to signal VDS

Some MVPDs have tested using an ISO descriptor of 'por' and an AC-3 descriptor that has bsmod=2 and language as 'eng'. While this contravenes requirements specified in ATSC A/53, it seems to work with the legacy set top boxes and software. Most encoder vendors however do not allow this setting as ATSC A/53 disallows it but will usually allow you to insert any descriptor that you pre-configure.

Signaling of VDS might be materially improved if broadcasters and program providers were to provide the VDS audio track with two labels: both an ISO 639-2 language descriptor (defined in ISO/IEC 13818-1) and an AC-3 audio descriptor (defined in ATSC A/52:2015). For example, an AC-3 audio stream (stream_type 0x81) containing VDS in a MPEG-2 PMT could be constructed as follows:

1. In the ISO_639_language_descriptor(), the ISO_639_language_code field would be set to 'spa' (Spanish).
2. In the AC-3_audio_stream_descriptor(), the bsmod field would be set to '010' to signal visually impaired (VI).
3. In the AC-3_audio_stream_descriptor(), the language field would be set to the correct ISO 3-character language identifier as defined in ISO 639-2. In other words, if the actual language of the VDS track is English, the language field shall be set to 'eng'.

It is expected that legacy receivers will use the ISO 639-2 language descriptor, which follows current practice and ignores the AC-3 audio descriptor. It is expected that newer receivers will ignore the ISO 639-2 language descriptor and use the AC-3 audio descriptor.

10. Recommended Distributor practices

10.1. SD Distribution

For Systems that have deployed HD digital set tops with multi-audio capability, a plausible solution is to provide those multi-audio set tops to Visually Impaired subscribers for opt-in language selection. Doing so would deliver a positive experience to subscribers who are visually impaired.

If deploying multi-audio set tops is not a possibility for the MVPD, then either the MVPD or programmer would need to deliver a SAP channel. If the programmer still has SD distribution, then this is usually not a problem as most legacy SD delivery only includes two audio streams. If the MVPD wants to downconvert an HD programmer's signal that only has a second language and separate VDS tracks, they would most likely have to use VDS as the second language.

10.2. HD Distribution

With delivery of multiple channels of discrete audio, MVPDs will be able to detect and ingest the desired audio streams using the AC-3 audio descriptor. The MVPDs' program guides should be capable of allowing the viewer to pick the VDS or second audio language as the preferred audio.

Non-linear assets created by transcoding the ingested video and multi-channel audio file allow the MVPD to format and offer subscriber choice for their desired audio that is compatible with legacy 2-channel set tops. Only the desired single audio is delivered.

If the programmer starts delivery of an object-based audio format, then that can be delivered to the newest set tops, or downconverted using the embedded signaling in the format for older HD and legacy SD set tops.

10.3. TVE/OTT Distribution

IP delivered services should have the guide capability and the bandwidth to allow for one of multiple audio tracks to be selected. File standards such as CMAF support multiple audio tracks. The MVPD can use a metadata feed such as SCTE 224 or embedded SCTE 35 signaling to know which tracks are actually active with the chosen audio.

11. Advertising Implications

While not the primary issue being discussed, how ad or content replacement is done when the content has multiple languages or video description available is of concern as it will impact how the viewer watches the program. It could also be used to detect where the program / ad boundaries are.

11.1. Issues with current practice

When digital ad insertion was developed, the common practice was to match audio streams using ISO 639-2 identifiers. If the ad / replacement content did not contain all the audio streams, the splicer would typically duplicate the first or main audio in to the missing elements.

If VDS is being delivered on the SAP channel that is labeled as Spanish, the current practice would be for the ad splicer using SCTE 30 would most likely put Spanish over the audio instead of VDS if Spanish was available in the ad.

11.2. Use the current audio for ad selection

The current practice for legacy splicing using hardware splicers is to match audio streams and have the splicer duplicate the base audio in to audio tracks missing from the ad content.

There are currently few IP (TVE or OTT) implementations that support multiple audio streams and ad insertion. As IP ad insertion is done by replacing or inserting new segments in to the stream, it is not known how all of the potential players will react to having a different set of audio tracks available in the various ads vs the program content.

11.3. How to use signaling for proper language insertion

SCTE 35 signaling could be used to indicate which additional language tracks actually contain the appropriate audio tracks as signaled in the PMT. SCTE 35 is currently under revision and an audio_descriptor() is proposed to allow the splicer to know which audio streams are actually present in the feed.

12. Program Language Metadata

12.1. SCTE 224 / SCTE 236

SCTE 224 ("Event Scheduling and Notification Interface") should be used to indicate what audio streams exist in a program. This can be used for VOD live capture to save only audio tracks that contain the expected language. It also could be used for additional guide enhancements to indicate what languages are available for a given program.

An example Media section (**highlighted in yellow below**) from an SCTE 224 file using SCTE 236 metadata section which has the audio language descriptors to indicate that on the second and third audio feeds are English Video Descriptive Services. This standard used the ISO 639-1 2 Alpha language identifier instead of the MPEG 3 Alpha language identifier.

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<AltID>http://doi.org/10.5239/6BCD-37E0</AltID>
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<Provider>TBS</Provider>
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<Ext>
<App_Data Name="Season_Number" Value="8"/>
<App_Data Name="Episode_Number" Value="165"/>
<App_Data Name="Series_Name" Value="The Big Bang Theory"/>
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</Ext>
</Media>
```

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```
<title:LocalizableTitle xml:lang="en">
<title>TitleMedium>The Expedition Approximation</title>TitleMedium>
<title>TitleLong>The Expedition Approximation</title>TitleLong>
<title:SummaryShort>
Sheldon and Raj undertake an underground research expedition that turns into a test of how long before they get under each other's skin. Meanwhile, Leonard
and Penny argue about money.
</title:SummaryShort>
<title:ActorDisplay>Johnny Galecki,Kaley Cuoco,Jim Parsons</title:ActorDisplay>
<title:Actor firstName="Johnny" lastName="Galecki" sortableName="Galecki,Johnny" fullName="Johnny Galecki"/>
<title:Actor firstName="Kaley" lastName="Cuoco" sortableName="Cuoco,Kaley" fullName="Kaley Cuoco"/>
<title:Actor firstName="Jim" lastName="Parsons" sortableName="Parsons,Jim" fullName="Jim Parsons"/>
<title:EpisodeName>The Expedition Approximation</title:EpisodeName>
</title:LocalizableTitle>
<title:Rating ratingSystem="TV">TV-PG</title:Rating>
<title:IsClosedCaptioning>true</title:IsClosedCaptioning>
<title:DisplayRunTime>00:30</title:DisplayRunTime>
<title:Year>2014</title:Year>
<title>ShowType>Series</title>ShowType>
</Asset>
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<Provider>TBS</Provider>
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SCTE 248 2018

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</Assert>
<Assert>
/SpliceInfoSection/SegmentationDescriptor/SegmentationUpid[text()='719444632']
</Assert>
<Assert>
/SpliceInfoSection/SegmentationDescriptor[@segmentationType = 17 or @segmentationType = 18]
</Assert>
</MatchSignal>
</MediaPoint>
</Media>
```