OpenCable™ Specifications

Mezzanine Encoding Specification

OC-SP-MEZZANINE-C01-161026

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Key to Document Status Codes

Work in Progress	An incomplete document, designed to guide discussion and generate feedback that may include several alternative requirements for consideration.
Draft	A document in specification format considered largely complete, but lacking review by Members and vendors. Drafts are susceptible to substantial change during the review process.
Issued	A stable document, which has undergone rigorous member and vendor review and is suitable for product design and development, cross-vendor interoperability, and for certification testing.
Closed	A static document, reviewed, tested, validated, and closed to further engineering change requests to the specification through CableLabs.

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1 SCOPE

1.1 Introduction and Purpose

This document specifies the content and format of mezzanine content being provided to content recipients. This document defines a unified ingest specification for file-based content to be used across IP and QAM delivery platforms. The goal in all included scenarios is to deliver the highest quality video available based on the originally produced content type, bit rate and codec.

1.2 Purpose of Document

This specification has the goal of providing a consolidated set of requirements for content essence and related content from a Content Provider to a Processing Facility for subsequent delivery to a Content Delivery Network. The formats are defined so as to obtain the best resultant quality across a number of distribution methods.

Asset files should be self-contained, or otherwise logically or physically 'bundled' including all video, audio, text, cover images and associated metadata to ensure that all necessary components are available for processing. An example of physical bundling is a .tar file; examples of logical bundling are manifest files or folder nesting. This specification does not provide an explicit mechanism for the bundling. Although asset files must all be available for processing, this specification does not preclude that the elements may be externally referenced (for example, by a URL to an external file system). External references could permit, for example, third-party metadata to be used with locally stored (and properly referenced) video and audio files.

These elements will be carried through the content transformation process and packaged appropriately for the consuming device.

1.3 Organization of Document

Sections 1-4 present basic information, including references and acronyms.

Section 5 provides detailed requirements for audio and video content.

Section 6 provides detailed requirements regarding content-associated external metadata.

1.4 Scope

This document specifies contribution formats. This document covers file-based audio-video content and related components preparation for ingest. From the ingest point, content in this format can be used in multiple ways which are covered in other specifications.

This document does not specify operational processes such as notifications and content delivery. Where notifications are expected in this document, it is expected other process-oriented documents will address this.

All scenarios related to linear VoD are considered out of scope of the document. Linear VoD is defined as linear video intended for broadcast that is captured by the Content Delivery Network for time-shifted or future VoD playback.

1.5 Document Lifecycle

This document is expected to evolve as audio, video, metadata, and associated technologies evolve. Figure 1 shows the potential roadmap for this document based on upcoming technologies.

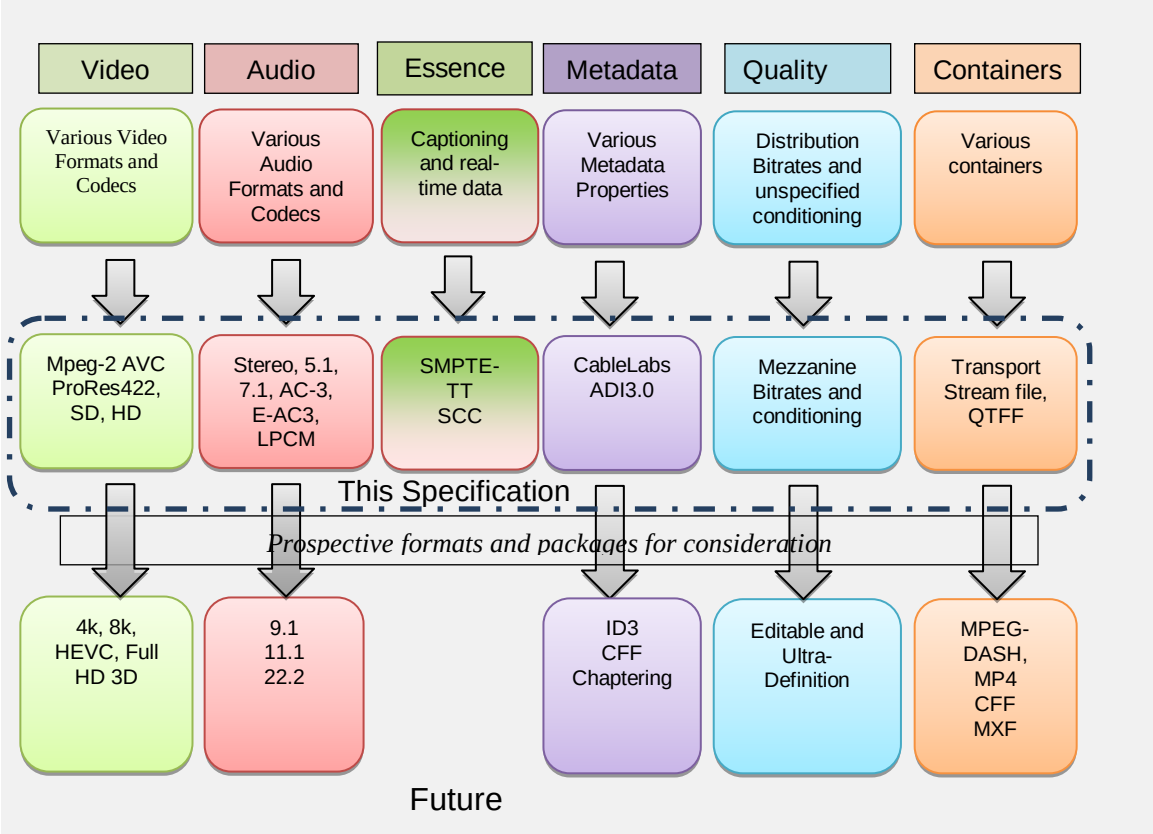

Figure 1 - Document Scope Lifecycle

Note: Captioning may also be embedded in the video.

1.6 Mezzanine File Reference Architecture

Figure 2 represents the high-level Mezzanine file creation and flow. This specification will address the desired and acceptable Mezzanine file content and format. Content encoding, packaging, and delivery are out of scope of this specification.

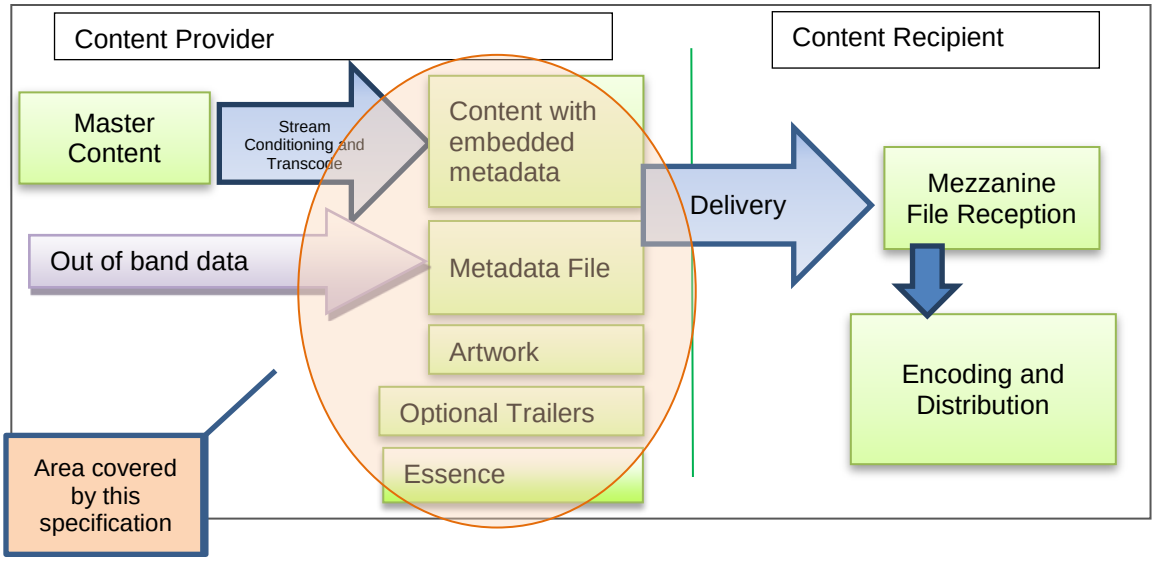

Figure 2 - Mezzanine File Reference Architecture

1.7 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word 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 weighed before choosing a different course.
"SHOULD NOT"	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.
"MAY"	This word 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.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

All references are subject to revision, and parties to agreement based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

[13818-1] ISO/IEC 13818-1:2013, Information technology - Generic coding of moving pictures and associated audio information: Systems.

[14496-10] ISO/IEC 14496-10:2012, Information technology - Coding of Audio-visual Objects. Part 10: Advanced Video Coding.

[A/52] ATSC A/52:2012: Digital Audio Compression (AC-3) (E-AC-3) Standard, December 17, 2012.

[A/53, Part3] ATSC A/53, Part 3:2009: Digital Television Standard Part 3 – Service Multiplex and Transport Subsystem Characteristics.

[A/53, Part4] ATSC A/53, Part 4:2009: Digital Television Standard Part 4 – MPEG-2 Video System Characteristics.

[A/85] ATSC A/85:2013: Recommended Practice: Techniques for Establishing and Maintaining Audio Loudness for Digital Television.

[CALM] FCC 11-84: Implementation of the Commercial Advertisement Loudness Mitigation (CALM) Act, May 27, 2011.

[CEA 608] ANSI/CEA-608-E: Line 21 Data Services, April 2008.

[CEA 708] CEA-708-E: Digital Television (DTV) Closed Captioning, June 2013.

[CEP 3.0] OC- SP-CEP3.0-C01-161026, Content Encoding Profiles 3.0 Specification, October 26, 2016, Cable Television Laboratories, Inc.

[CONTENT 3.0] MD-SP-CONTENTv3.0-C01-151104, CableLabs Content 3.0 Specification, November 4, 2015, Cable Television Laboratories, Inc.

[EIDR] EIDR System Version 1.2.1 – Data Fields Reference, May 23, 2013. http://eidr.org/documents/EIDR_1.2_Data_Fields.pdf

[ETV-AM] OC-SP-ETV-AM1.0-C01-161026, Enhanced TV Application Messaging Protocol 1.0, October 26, 2016, Cable Television Laboratories, Inc.

[ETV-BIF] OC-SP-ETV-BIF1.0.1-120614, Enhanced TV Binary Interchange Format 1.0.1, June 14, 2012, Cable Television Laboratories, Inc.

[ID3] ID3 Tagging System, February 3, 1999, http://www.id3.org/id3v2.3.0.

[ISO 639-2] ISO 639-2:1998, Codes for the Representation of Names of Languages - Part 2: Alpha-3 Code.

[LPCM] AES3-2009: AES Standard for Digital Audio Engineering – Serial Transmission Format for two-channel linearly represented digital audio data.

[ProRes] Apple ProRes Format Specifications: http://documentation.apple.com/en/finalcutpro/professionalformatsandworkflows/index.html#chapter=10%26section=4.

[QTFF] Apple Quick Time File Format: https://developer.apple.com/library/mac/#documentation/QuickTime/QTFF/qtff.pdf, August 14, 2012.

[SCTE 20] ANSI/SCTE 20 2012, Method for Carriage of Closed Captions and Non-Real Time Sampled Video.

[SCTE 35] ANSI/SCTE 35 2013, Digital Program Insertion Cueing Message for Cable.

[SCTE 104] ANSI/SCTE 104 2012, Automation System to Compression System Communications Applications Program Interface (API).

[SCTE 128-2] ANSI/SCTE 128-2 2013, AVC Video Constraints for Cable Television Part 2: Transport.

[SCTE 172] ANSI/SCTE 172 2011, Constraints on AVC Video Coding for Digital Program Insertion.

[SCTE 187-1] ANSI/SCTE 187-1 2012, Stereoscopic 3D Formatting and Coding for Cable.

[SMPTE-302] SMPTE ST 302:2007, For Television – Mapping of AES3 Data into an MPEG-2 Transport Stream.

[SMPTE-TT] SMPTE ST 2052-1:2010, Timed Text Format (SMPTE-TT).

2.2 Informative References

This specification uses the following informative references.

[47CFR79.1] Code of Federal Regulations 47CFR79.1, Closed Captioning of Video Programming.

2.3 Reference Acquisition

- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;
  Phone +1-303-661-9100; Fax +1-303-661-9199; www.cablelabs.com
- Internet Engineering Task Force (IETF), www.ietf.org
- Federal Communications Commission (FCC), www.fcc.gov
- Code of Federal Regulations (CFR), www.ecfr.gov
- International Organization for Standardization (ISO), www.iso.org
- Society of Cable Telecommunications Engineers (SCTE), www.scte.org
- Advanced Television Systems Committee (ATSC), www.atsc.org

3 TERMS AND DEFINITIONS

This specification uses the following terms:

AC-3	Dolby Digital Audio Codec.
Adaptive Content	Adaptive Content is an alternative approach for information delivery with the purpose of providing access of content to many types of devices and network conditions.
Advanced Audio Coding	Advanced Audio Coding (AAC) is a lossy compression and encoding scheme for digital audio.
Advanced Video Coding	Advanced Video Coding (AVC) is a standard for video compression (H.264/MPEG-4 Part 10).
Dialnorm	The metadata parameter that controls playback gain within the Dolby Laboratories Dolby Digital (AC-3) audio compression system.
Digital Rights Management	A coding system applied to digital content that manages the usage rights of that content.
Field Dominance	The method by which video fields are recorded into a file.
H.264	A standard for High Definition video compression. Can also be called AVC.
HTTP Live Streaming	A protocol for transferring unbounded streams of multimedia data. It specifies the data format of the files and the actions to be taken by the server (sender) and the clients (receivers) of the streams.
I-Picture	A picture type contained within a GOP. It is a reference picture, which represents a fixed image and which is independent of other picture types.
In Point	A point in the stream, suitable for entry, that lies on an elementary presentation unit boundary. An In Point is actually between two presentation units rather than being a presentation unit itself.
LPCM	Linear pulse-code modulation is a method of encoding audio content digitally.
Master	The original source of content prior to any copying or editing which could degrade quality.
Mezzanine	File-based content to be used across IP and QAM delivery platforms.
MPEG-2	A standard as defined by ISO/IEC 13818 for the generic coding of moving pictures and associated audio information.
NPT	Normal play time (NPT) indicates the stream absolute position relative to the beginning of the presentation. The timestamp consists of a decimal fraction. The part left of the decimal may be expressed in seconds or hours, minutes, and seconds. The part right of the decimal point measures fractions of a second.
Out Point	A point in the stream, suitable for exit, that lies on an elementary presentation unit boundary. An Out Point is actually between two presentation units rather than being a presentation unit itself.
Padding	Artificial bits added to a video in order to meet the minimum bit rate requirements defined within this specification.
ProRes	A high quality video compression format developed by Apple, Inc.
SCC	Scenarist Closed Caption, a file type developed by Sonic. SCC files (.scc) have become a popular format for many different applications of closed captions, and many editing programs have adopted the SCC file format.
Telecine	A process for transferring motion picture content into video format.

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations:

AAC Advanced Audio Coding
ADI Asset Distribution Interface
AFD Active Format Description
ATSC Advanced Television System Committee
AVC Advanced Video Coding
BP Baseline Profile
CABAC Context-Adaptive Binary Arithmetic Coding
CALM Commercial Advertisement Loudness Mitigation
CBR Constant Bit Rate
CDN Content Distribution Network
CCI Copy Control Information
CEA Consumer Electronics Association
CEP Content Encoding Profiles
DPI Digital Program Insertion
DRM Digital Rights Management
DTS Decoding Time Stamp
DVS Descriptive Video Service
EIDR Entertainment Identifier Registry
ETV Enhanced Television
FCC Federal Communications Commission
GOP Group of Pictures
HD High Definition
HP High Profile
HVS Human Visual System
IDR Instantaneous Decoding Refresh
IEC International Electrotechnical Commission
IP Internet Protocol
IRE Institute of Radio Engineers
ISO International Organization for Standards
ITU-R International Telecommunications Union – Radiocommunication
JPEG Joint Photographic Experts Group
LPCM Linear Pulse-Code Modulation
MBAFF Macroblock-Level Adaptive Frame/Field
MOS Mean Opinion Score
MP Main Profile
MPEG Moving Pictures Experts Group
NPT Normal Playback Time
PAFF Picture Adaptive Frame Field

PAT	Program Association Table
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Program Identifier or Packet Identifier per [13818-1]
PMT	Program Map Table
PSI	Program System Information
PTS	Presentation Time stamp
QoE	Quality of Experience
RT	Real Time Transcoding
SCC	Scenarist Closed Caption
SCTE	Society of Cable Telecommunication Engineers
SD	Standard Definition
SEI	Supplemental Enhancement Information
SMPTE	Society of Motion Picture and Television Engineers
SPTS	Single Program Transport Stream
TS	Transport Stream
T-STD	Transport Stream System Target Decoder
VANC	Vertical Ancillary Data Space
VBI	Vertical Blanking Interval
VBR	Variable Bit Rate
VMOS	Video Mean Opinion Score
VOD	Video On Demand
VOIP	Voice Over IP
XML	eXtensible Markup Language

5 MEDIA ENCODING

This section includes the requirements for the actual audio, video and directly related content, which is expected to be encoded for further distribution. As a reminder, the goal of this specification is to deliver the highest quality video available based on the content type, bit rate and codec, and provide a complete input format which should work well with encoders / transcoders.

5.1 Video

All mezzanine video encoding MUST be of one of the following codecs:

- AVC (H.264) as specified in [14496-10]
- MPEG-2 as specified in [13818-1]
- ProRes as specified in [ProRes]

Note: Codec names are also used as profile names within this document. Each profile will have further details specified based on unique characteristics of the profile.

All HD Content MUST be delivered with one of the following resolutions:

- 1920x1080
- 1280x720

High Definition (HD) video content with an original picture resolution at or above 1920x1080 MUST be delivered at 1920x1080.

High Definition (HD) video content with an original picture resolution between 1280x720 and 1920x1080 MUST be delivered at 1280x720.

Any Content with an original picture resolution less than 1280x720 MUST be delivered as SD content with one of the following resolutions:

- 720 x 480 for 4:3 content
- 720 x 480 or 854 x 480 for 16:9 content

All HD Content MUST be delivered with one of the following frame rates in frames per second (fps):

- 23.976 fps progressive
- 24.0 fps progressive
- 29.97 fps interlaced
- 29.97 fps progressive
- 59.94 fps progressive

All SD Content MUST be delivered with one of the following frame rates:

- 23.976 fps progressive
- 24.0 fps progressive
- 29.97 fps interlaced
- 29.97 fps progressive

All HD content MUST be provided with square pixels.

All content MUST have a black level of 0 IRE.

AVC (H.264) content SHOULD use CABAC Entropy Encoding.

All interlaced content compressed using the AVC codec MUST utilize interlaced compression tools (PAFF and/or MBAFF) if available.

ProRes Encoding MUST comply with profiles as defined by [ProRes].

Frame-rate converted (e.g., film content with 3:2 Telecine applied) content SHOULD NOT be provided unless it is the only format available.

Field dominance MUST be properly tagged (top field first, bottom field first, or progressive) per [13818-1].

Broken cadence SHOULD be avoided when using 3:2 pulldown. When broken cadence has been known to occur, metadata flags MAY be used to indicate that content SHOULD be kept at a 59.94 frame rate (for example) and de-telecine SHOULD NOT be attempted.

All video content MUST be encoded using parameters from Table 1.

Table 1 - Video Encoding Parameters

Profile	MPEG-2	AVC (H.264)	ProRes
Video Codec	MPEG-2	MPEG4 Part 10	ProRes 422
Chroma Sampling	4:2:0 (SD or HD), 4:2:2 (HD)	4:2:0, 4:2:2	4:2:2
Bit Depth	8 bit	8 bit, 10 bit	10 bit
GOP Structure	Long GOP (I, B, P pictures)	Long GOP (I, B, P pictures)	N/A
GOP Mode	Closed	Closed	N/A
Max GOP Size	90 Frames	90 Frames	N/A
Scene Change Detection	Yes	Yes	N/A

All VBR encoding SHOULD be multi-pass for the best quality.

The following video encoding parameters MUST be applied to all content originally produced in HD. They MAY be used as a guideline for older content originally produced in SD. It is recognized that some HD content could be produced at a lower bit rate than defined by the following requirements; however, in order to ensure the highest level of video quality is provided to content recipients, these parameters MUST be met. Padding to meet the following requirements SHOULD NOT be used.

All High Definition (HD) video content MUST be encoded using parameters from Table 2.

Table 2 - HD Video Content Encoding Parameters

Profile	MPEG-2	AVC	ProRes
Bit Rate (Peak)	50Mbps	50Mbps	-
Bit Rate (Minimum)	35Mbps	20Mbps	23.976 fps @ 117Mbps 29.97 fps @ 147 Mbps 59.94 fps @ 293 Mbps
Profile	High @ High Level	High @ L4.1 or above	N/A

All Standard Definition (SD) video content MUST be encoded using parameters from Table 3.

Table 3 - SD Video Content Encoding Bit Rates

Profile	MPEG-2	AVC	ProRes
Bit Rate (Peak)	35Mbps	35Mbps	
Bit Rate (Minimum)	25Mbps	15Mbps	24 fps @ 34Mbps 30 fps @ 42 Mbps

Profile	MPEG-2	AVC	ProRes
Profile	Main @ High Level	Main @ L3.1 or above	N/A

The encoded files MUST be delivered in the following file types:

Table 4 - Encoded File Types and Extensions

Profile	MPEG-2	AVC	ProRes
File Type	Transport Stream (.mpg)	Transport Stream (.ts)	QuickTime per [QTFF] (.mov)

The ProRes file MUST comply with Quicktime File Format as specified by [QTFF].

All visible VBI MUST be omitted from source content. If omitted, CC and XDS MUST be provided in another format as defined in [CEA 608]. Note, however, that CC and XDS must be regenerated and re-inserted for FCC compliance on some outputs.

All "entertainment" content MUST have three (3) seconds of black video with audio silence appended to the start and end (leader and trailer). Audio mode MUST be the same as the immediately following program (e.g., 5.1 or 2.0).

Any closed captioning (non-embedded) or time-sensitive metadata MUST take into account the actual program to accommodate the start and end of video indicators based on the appended video. (See Section 6.2.1 for concerns about maintenance of synchrony between program timeline and CC timing).

Note: Entertainment content includes movies, programs, and non-advertising content where a consumer is expected to start content from scratch that may have session-set-up or other latency that may up-cut the beginning of the content.

All advertising "ad content" MUST NOT have black video appended to the start and end.

Note: Ad content includes commercials and related content which are typically inserted into other programming.

Advertising Content SHOULD be within 4 frames of its stated length.

For AVC encoding, audio PES packets MUST NOT exist with a PTS in the content prior to the IDR (AVC) designated as NPT 0, as defined in Section 6.11 of [CEP 3.0].

For AVC encoding, the last byte of the payload of the transport packet transmitted prior to an Out Point MUST be the last byte of a video access unit and the last byte of a PES packet.

For AVC encoding where an exit at an Out Point is optional, the first picture in presentation order following an Out Point MUST have a PTS such that the presentation of this picture follows the presentation of the last picture presented prior to an Out Point at the proper time as determined by the video access unit duration.

Note: Requirements in this area are to handle certain business rules (e.g., Nielsen C3), where advertising content will be carried in the delivered asset for a period of time before being refreshed with other advertisements.

For AVC encoding where an exit at an Out Point is optional, the first picture in decode order following an Out Point MUST have a DTS such that the decoding of this picture follows the decoding of the last picture decoded prior to the Out Point at the proper time as determined by the access unit duration.

5.2 Transport Stream

5.2.1 Digital Program Insertion

For Digital Program Insertion enabled content, transport stream content MUST include In and Out Points embedded within the content.

Note: This is also referred to as signaling "in-band".

For MPEG-2 and AVC encoding, In and Out Points MUST comply with [SCTE 35].

ProRes In and Out Points for Digital Program Insertion MUST be provided in-band (VANC) and comply with [SCTE 104]. It MAY be provided out of band using the format specified in [CONTENT 3.0].

Non-embedded (out-of-band) In and Out Points MAY be provided using the format specified in [CONTENT 3.0].

5.2.2 Transport Stream Constraints

The transport stream MUST comply with the definition of a transport stream as specified in [13818-1].

Video content SHOULD use an Active Format Descriptor (AFD) per [A/53, Part4] for MPEG-2 and [14496-10] for AVC, where the width and height may not meet that of the active frame. When used, an AFD mode / setting should be valid for the entire asset and its value MUST NOT change during the asset.

HD content that will be subsequently distributed in SD format MUST include AFD to define the cropping window or instructions on how to process the content when converting to SD.

The video elementary stream MUST contain an integral number of access units.

3D content MUST be formatted as specified in [SCTE 187-1].

The transport stream MUST carry only a single program (SPTS).

The program in the transport stream MUST contain only a single video elementary stream.

The program in the transport stream MUST contain at least one audio elementary stream.

Default audio PID MUST contain data. For content that has no audio whatsoever, silent audio is acceptable, but at least one PID must have audio data on it at all times.

The transport stream MAY carry up to 14 audio elementary streams.

The transport stream MUST consist of 188-byte transport packets.

The first byte of the transport stream MUST be the first byte of a transport packet.

The transport stream MUST contain an integral number of transport packets.

The transport stream MUST NOT contain continuity_counter discontinuities.

The transport stream MUST contain exactly one system time-base discontinuity (PCR).

System time-base discontinuity MUST be signaled in the first PCR packet of the stream.

PCR continuity MUST be maintained in the case where one or more Out Points and/or In Points exist between two presentation units in the encoded content.

PCRs MUST have an accuracy of 5 ppm.

The first PCR packet of the stream MUST have the transport discontinuity_indicator flag set to '1'.

A PCR SHOULD be present in any transport packet containing the first byte of a video PES payload.

The audio T-STD MUST comply with section 3.6 of Annex A of [A/52].

The random_access_indicator MUST be set to '1' in any transport packet containing the first byte of a video PES payload that carries an I-Picture.

For Video In Point and Out Points, the transitions MUST maintain full compliance with the T-STD model.

When present, ETV content MUST be delivered as part of the transport stream as described in [ETV-AM] and [ETV-BIF].

A PID with ETV content MUST NOT exceed 200 kbps.

5.2.3 PSI Constraints

A complete Program Association Table (PAT) MUST occur in the transport stream before the first byte of a Program Map Table (PMT).

A PMT that contains a complete program definition MUST occur in the transport stream before the first transport packet with an elementary stream PID.

The time interval in the transport stream between successive occurrences of the PAT MUST be less than or equal to 250 milliseconds.

The time interval between successive occurrences of the PAT SHOULD be 125 milliseconds.

The time interval in the transport stream between successive occurrences of the PMT MUST be less than or equal to 250 milliseconds.

The time interval between successive occurrences of the PMT SHOULD be 125 milliseconds.

The stream_type value assigned in the PMT to the video elementary stream MUST be 0x02 or 0x80 for MPEG-2 video and 0x1B for AVC video.

The stream_type value assigned in the PMT to AC-3 and E-AC-3 audio elementary streams MUST be 0x81 [A/53, Part3].

5.2.4 PID Values

The program_map_PID for the program MUST have the value 0x1E0.

The elementary_PID assigned to the video elementary stream MUST have the value 0x1E1.

The PCR_PID of the program MUST have the value 0x1E1.

The elementary_PID assigned to the first, or primary, audio elementary stream listed in the PMT MUST have the value 0x1E2.

If more than one audio elementary stream is present, the elementary_PID value MUST increment sequentially using the range from 0x1E3 to 0x1EF.

If one or more data elementary streams are present in addition to one or more audio elementary streams, the elementary PID assigned to the data elementary streams listed in the PMT MUST have values higher than the last audio elementary stream.

5.3 Audio

If Nielsen audio watermarking is present, it MUST NOT be degraded during any audio conditioning processes.

Dialog Normalization (dialnorm) MUST be set per [A/85] recommended practice for audio loudness to conform with [CALM]. If the content provider has certified CALM compliance, then all processing or audio transcoding MUST be 'unity gain'. If the content provider has not certified CALM compliance, then this MUST be indicated in the metadata. In addition, the content recipient, in accordance with their policies and procedures, MAY process audio loudness.

Audio language descriptors MUST be included using 3-digit code per [ISO 639-2].

ISO 639 language descriptor audio_type as specified in [13818-1] section 2.6.19 MUST be set to 0x00 (undefined) per [A/53, Part3].

When an audio track with DVS content is present, an [A/53, Part3] AC3 (0x81) Visual Impaired (VI) bsmod value of 2 (010) MUST be set.

When an audio track with DVS content is present, the [A/53, Part3] AC3 'language' value MUST be populated with the [ISO 639-2] value matching the content's language.

Audio MUST meet format options from Table 5.

Table 5 - Audio Encoding Format Options

Audio Configuration	Encoded Audio Streams	Discrete Audio Channels
Stereo Mix only	1	2
5.1 Surround Mix only	1	6
5.1 Surround Mix + Stereo Mix	2	8
7.1 Surround Mix only	1	8
7.1 Surround Mix + Stereo Mix	2	10

Mono content MUST be provided as a Stereo Mix with mono content duplicated on left and right channels.

5.3.1 Transport Stream Audio Encoding

The source audio MUST be encoded as AC-3 up to 5.1 or Enhanced AC-3 (E-AC-3) up to 7.1 per [A/52].

Audio stream ordering MUST be per [A/52].

The first byte of the audio elementary stream MUST be the first byte of an audio access unit.

The audio elementary stream MUST contain an integral number of access units.

The last byte of the payload of the transport packet transmitted prior to an Out Point MUST be the last byte of an audio access unit and the last byte of a PES packet.

The first audio payload following an In Point MUST start with a PES header and the start of an audio access unit.

The values of PTS of the first audio access unit after an Out Point MUST be such that the presentation of this access unit follows the presentation of the last access unit transmitted prior to the Out Point at the proper time as determined by the audio access unit duration.

Based on format, audio (i.e., primary and all alternates) in Transport Stream files MUST meet bitrate requirements from Table 6.

Table 6 - TS Audio Format and Bitrate

Audio Format	Channels	Target Bit Rate	Sample Rate
E-AC-3 [A/52]	Stereo	192 kbps	48 kHz
E-AC-3 [A/52]	5.1	448 kbps	48 kHz
E-AC-3 [A/52]	7.1	960 kbps	48 kHz
AC-3 [A/52]	Stereo	192 kbps	48 kHz
AC-3 [A/52]	5.1	640 kbps	48 kHz

When transcoding within the Dolby "family" of formats, transcoding MUST be block-aligned.

5.3.2 LPCM Audio

The following external metadata formatted as [CONTENT 3.0] MUST be provided when LPCM audio is used:

- Audio track type
- Audio Language in ISO-639-2 format
- DVS signaling when present

LPCM audio included in an MPEG2-TS MUST comply with [SMPTE-302].

ProRes encoded content MUST use LPCM audio format as specified in [LPCM].

Based on format, LPCM audio MUST meet bitrate requirements from Table 7.

Table 7 - ProRes Audio Format and Sampling Rate

Audio Format	Channel Order	Minimum Sampling	Maximum Sampling
LPCM Surround	Left, Right, Center, Low Frequency Effects (LFE), Left Surround, Right Surround	16 bit at 48kHz	24 bit at 48kHz
LPCM Stereo	Left, Right	16 bit at 48kHz	24 bit at 48kHz

5.4 Trailers

Trailer content MAY be provided.

Trailer content SHOULD use the same format and codecs as the source content.

6 ASSOCIATED CONTENT

6.1 Program Metadata

6.1.1 CableLabs-Compliant Metadata

Applicable Program Metadata MUST be provided for all content.

Program Metadata MUST be CableLabs [CONTENT 3.0] compliant.

Program Metadata MUST be provided as a CONTENT 3.0-based XML file containing asset information.

Metadata MUST include all applicable ratings information based on [CONTENT 3.0] for applicable content.

The [CONTENT 3.0] compliant Metadata MUST include signaling and placement opportunity metadata.

Signaling metadata MUST use NPT.

NPT MUST be calculated per the NPT Usage section of [CEP 3.0].

If the content is registered through the Entertainment ID Registry [EIDR], it MUST include the EIDR ID inside the metadata XML file.

All content IDs MUST be unique across all types and across all assets.

Content IDs MUST be formed using the [CONTENT 3.0] compliant format of its provider ID and its Asset ID.

6.1.2 Other Metadata

Content MUST support inclusion of ID3 identification tags per [ID3].

6.2 Closed Captioning

In addition to embedded, out-of-band [SMPTE-TT] Closed Captioning information MAY be provided for transport stream content.

Out-of-band Closed Captioning data MUST be provided for ProRes content.

All ProRes content MUST have Closed Captioning information provided in a separate Scenarist Closed Caption (SCC) file, using .scc file extension.

ProRes content MAY have Closed Captioning information provided in [SMPTE-TT] format in a separate file.

SCC file captions MUST be 29.97 fps regardless of frame rate of the movie file. When final frame rate of the movie file does not remain 29.97, workflow MUST verify that proper CC timing is maintained after the frame rate conversion has occurred.

Closed captioning content MUST only contain Latin-based characters.

If closed captioning is not present for the content, content recipient MUST be notified.

6.2.1 Transport Stream Closed Captioning

To create SD and/or HD programs, the content MUST include elements necessary to generate SD versions with CEA 608 captions in [SCTE 20] format for MPEG2-TS and in [SCTE 128-2] format for AVC, as well as CEA 708 captions in ATSC A/53 format (which includes 608 compatibility bytes).

Content MAY have Closed Captioning information provided in [SMPTE-TT] format in a separate file. When captioning is separately supplied, the time reference MUST conform to the content start / end, including any prefix of black, etc., and match with embedded transport stream Closed Captioning (if present).

If a provided SMPTE-TT file is created through a translation from CEA 608 data to SMPTE-TT XML and includes tunnel data, the original CEA 608 data MUST be included as a tunnel in the same SMPTE-TT file, and the tunnel data MUST be used for any 608 (and CEA 708, if included) embedded CC in distribution content.

6.3 Poster Art

Poster Art MUST be delivered with each asset, unless otherwise agreed to with the content provider.

Note: All movies and similar entertainment content should have poster art.

Poster Art files MUST be JPEG or PNG format.

Poster Art MUST be available in all three aspect ratios or scaled to associated resolutions listed in Table 8 below, as a 'best available format' guideline.

Table 8 - Poster Art Formats

Aspect Ratio	Resolution
3:4	1536x2048
4:3	2048x1536
2:1	2048x1024
16:9	1920x1080

All JPEG poster art MUST be delivered with a ".jpg" extension.

All PNG format poster art MUST be delivered with a ".png" extension.

Appendix I Acknowledgements

We wish to thank the vendor participants contributing directly to this document:

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