

ENGINEERING REPORT

Interoperable Master Format — Business Requirements for DPP Technical Specifications



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All other inquiries in respect of this document, including inquiries as to intellectual property requirements, should be addressed to the SMPTE Business Requirements proponents identified below.

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Forward

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SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Technical Specification was prepared by The Digital Production Partnership and the North American Broadcasters Association.

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Introduction

The Digital Production Partnership and the North American Broadcasters Association have collaborated to define the Business Requirements for one of more SMPTE Technical Specifications based on the Interoperable Master Format. This document outlines the Business Requirements any Technical Specification aim to achieve.

1 Scope

The Business Requirements in this document can refer to more than one SMPTE Technical Specification proposal. Many of the parameters are identical however and in order to maintain consistency with the SMPTE ST 2067 suite of documents, each proposed SMPTE Technical Specification contains only one video codec.

2 Conformance Notation

All the content of this document is INFORMATIVE.

3 Business Requirements

Annex A details the Business Requirements for that apply to each SMPTE Technical Specification.

The DPP and NABA Business Requirements groups require proposed SMPTE Technical Specification(s) to -

1. Allow the use of ProRes, JPEG 2000 [and H.264¹] video codecs as detailed under “Codec Parameters” in Table 1 of Annex A (via a separate SMPTE Technical Specification for each codec).
2. Maintain high quality images by including minimum data rates requirements for each codec as detailed in Table 2 of Annex A.
3. Include the option to allow the use of interlaced for HD SDR only. Described under “Frame Structure” in Table 1 of Annex A.
4. Constrain image parameters described in ITU-R BT.2100 – “Image parameter values for high dynamic range television for use in production and international programme exchange”.
5. Include the option to allow the use of the legacy colour space defined as COLOR.3 in SMPTE ST 2067-20 Section 6.
6. Constrain image parameters of SMPTE RDD 45 and SMPTE ST 2067-21 to those referenced under “Video Parameters” in Table 1 of Annex A².
7. Constrain the audio parameters of SMPTE ST 2067-2 to those referenced under “Audio Parameters” in Table 1 of Annex A.
8. Enable the use of the following Access Service options described under “Access Service Requirements” in Table 1 of Annex A;
 - a. Captioning/subtitling – IMSC1.0.1, EBU-TT-D, EBU STL, CTA 608 and to update to IMSC1.1 when supported.
 - b. Audio Description (Described Video Service) – either fully rendered mix or dialogue plus a control channel, which can be a rendered audio track (left Dialogue, right Control).
 - c. Signing service – as an alternate fully rendered video track until alternative options are supported in the SMPTE ST 2067 suite.

¹ Included for potential future consideration

² The Business Requirements Group requires the inclusion of Hybrid Log-Gamma (HLG). It is noted that the proposed revision of SMPTE ST 2067-21 is intended to include HLG however this is required immediately.

9. Allow the inclusion (and use via OPL or other means) of AMWA AS-11 Descriptive metadata, other broadcaster³ specific metadata, SMPTE RDD 6 audio metadata and EBU.IO/QC template metadata as listed under “Metadata Requirements” in Table 1 of Annex A.
10. Carry CPL and OPL XML files such that all required editorial versions and technical delivery options can be fulfilled. (see notes in Annex B);
 - a. CPLs must reference SMPTE ST 2067-3:2016 (or later).
 - b. OPL’s must reference SMPTE ST 2067-101:2014 (or later).
 - c. OPL(s) to create AS-11 V1.1 and AS-11 X series delivery are desirable.
 - d. OPL(s) to create SMPTE ST 2067-21 delivery are desirable.
 - e. OPLs able to create a future proposed SMPTE TSP[J2K] and possible TSP [H.264] delivery are desirable.

Annex A details the individual Business Requirements and the location of the SMPTE Technical Specification option that fulfils them.

Annex B reproduces the notes the Business Requirements Group made during their preparation work for this document.

Annex C reproduces the glossary of terms the Business Requirements Group worked too.

³ This includes broadcast and online users.

Annex A Business Requirements Overview

Table 1 lists the Business Requirements agreed by the Business Requirements Group, that SMPTE Technical Specification document(s) aim to meet.

Each parameter has been given a level of importance

- 1 Essential – the parameter is required
- 2 Important – the parameter is important but can wait for relevant SMPTE 2067 support or references
- 3 Desired – the parameter is desired but may require revisions of the SMPTE Technical Specification(s).

Note: The proponents of these Business Requirements have included parameters in square brackets [] which indicate a desire for inclusion but recognise there is currently no current support within the current SMPTE ST 2067 suite or other established documentation. These parameters are included in the Business Requirements document as place holders for future revisions of any SMPTE Technical Specification(s).

Table 1: Business Requirements

Video				
Primacy Image Format	Requirement	Importance	SMPTE References	Notes
Codec Parameters				
Codec	J2k	1	ST 2067-2	
	ProRes	1	RDD 45	SMPTE TSP 2121-1:2018
	H.264	3	-	
Data Rate	See Table 2	-	-	
GoP	I-Frame only	1	ST 2067-2	
Video Parameters				
Image Size	1920 x 1080	1	ST 2067-21	
	3840 x 2160	1	ST 2067-21	
	[7680 x 4320]	3	Not Yet Supported	
Frame Rates (50Hz)	25	1	ST 2067-20/21	
	50	1	ST 2067-21	
	[100]	3	Not Yet Supported	
Frame Rates (60Hz)	24, 24/1.001	1	ST 2067-20/21	
	60, 60/1.001	1	ST 2067-21	
	[120, 120/1.001]	3	ST 2067-21	
Frame Structure	Interlace (HD SDR)			SMPTE ST 422:2013 P1, I1
	Progressive	1	ST 2067-20/21	Progressive only SMPTE TSP 2121-1:2018
Sampling	4:2:2	1	ST 2067-20/21	
	4:4:4	1	ST 2067-21	
Coding Range	Narrow	1	RDD 45/ ST 2067-21	QE.1 HLG and PQ
	Full	1	RDD 45/ ST 2067-21	QE.2 PQ ONLY
HDR	HLG	1	TSP 2121-1:2018	
	PQ	1	ST 2067-21	SMPTE ST 2084
HDR dynamic metadata	HLG Peak Luminance	3	Not Yet Supported	Not required for HLG in SMPTE TSP 2121-1:2018
	DMCVT Virtual Track	1	ST 2094 and ST 2067-200	
[Graphics/Overlays]	-	3	Revisited if included in ST 2067	Not Required this iteration
Audio Parameters				

Sound Fields per Track	1	1	ST 2067-2	
Audio Tracks	Up to 128	1	ST 2067-2	
Bit Depth	24	1	ST 2067-2	
Sample Rate	48kHz/96kHz	1	ST 2067-2	
Audio Labelling	Yes	1	ST 2067-2/8	
Access Services Requirements				
Captions/Subtitles				
Type	IMSC1.0.1	1	ST 2067-2	Requires further development Conversion required Not Required in this iteration
	EBU-TT-D	1	Option based on ST 2067-2	
	EBU STL	1		
	CTA 608	1	Options based on ST 2067-2	
	IMSC1.1	2	Not Yet Supported	
Audio Description/ Described Video Service				
Fully Rendered	Yes	2	ST 2067-2	Via additional Audio Track(s)
Dialogue & Control	Desired	2	TSP 2121-1:2018	
Signing				
Fully Rendered	Yes	2	Alternate Video	Via additional Video Track(s)
[Signer and Data]	Desired	3	Not Yet Supported	Not Required this iteration
Metadata Requirements				
Broadcaster ⁴ Specific	Yes	1	Via ST 2067-9	See relevant TSP for example
EBU QC Templates	Desired	1	Via ST 2067-9	See relevant TSP for example
RDD 6	Yes as Static	1	Via ST 2067-9	See relevant TSP for example

Table 2 details the Business Requirements Group’s proposed minimum data rates. The table assumes 10-bit 4:2:2 and 10-bit 4:4:4:4 progressive scan images. 10-bit HDR and 12-bit may increase the minimum data rates guidance. Data rates will reference the relevant SMPTE ST 2067 documentation.

Table 2 : Recommended Minimum Codec Data Rates (Mb/s)

Image Size	Frame Rate*	J2K (IMF level 5 or higher)		Importance	ProRes (IMF Profile)		Importance	
		4:2:2	4:4:4:4		422 HQ	4444 XQ		
1920 x 1080	24	170	380	1	176	396	1	
	25	180	400	1	184	413	1	
	50	350	800	1	367	826	1	
	60	430	960	1	440	990	1	
	(Indicative)	[100]	700	1600	3	736	1652	3
	(Indicative)	[120]	860	1920	3	880	1980	3
3840 x 2160	24	700	1560	1	707	1591	1	
	25	720	1610	1	737	1659	1	
	50	1440	3230	1	1475	3318	1	
	60	1728	3870	1	1768	3977	1	
	(Indicative)	[100]	2880	6460	3	2950	6636	3
	(Indicative)	[120]	3450	7740	3	3536	7954	3
7680 x 4320	24	2800	6270	3	2829	6366	3	
	25	2880	6450	3	2950	6637	3	
	50	5760	12900	3	5899	13274	3	
	60	6910	15480	3	7072	15912	3	
	(Indicative)	[100]	11520	25800	3	11798	26548	3
	(Indicative)	[120]	13820	30960	3	14144	31824	3

⁴ This includes broadcast and online users.

* Includes fractional rates when appropriate

Annex B Business Requirements - Additional Notes

These notes are comments made during the Business Requirements discussions and are included as background information only.

Codec Notes

J2K and ProRes are the proposed codecs for mastering. H.264 may be considered in the future

The bitrates detailed in Table 2 are the recommended minimum bitrates for the Mastering Media Files. Where further production processing may be required or the broadcaster defines higher specific mastering needs, higher bitrates may be requested. Lower bitrates may constrain the downstream copying of the material due to generation loss or concatenation. Future use should be considered in the definition of codec and bitrate

For Acquisition and Production requirements, reference should be made to the DPP technical documentation.

<https://www.digitalproductionpartnership.co.uk/what-we-do/technical-specifications/uhd-hd-sd-programmes/>

The use of lower bitrates may constrain the downstream copying of the material due to generation loss or concatenation. Future use should be a consideration in the definition of codec and bitrate.

CPL Notes

CPLs control the timeline and OPLs control the rendering of the asset cut defined by the CPL.

Examples include;

- One CPL might define the timeline for a pre-watershed version and a different CPL defines the post-watershed version. For each of those CPLs there might be one OPL for the 2.35:1 letterbox 5.1 rendering and another for the 16:9 stereo rendering. Each OPL is associated with exactly one CPL.
- **CPL (A) = Main Copy** CPL (A) + OPL (A) = Main 2.35 + 5.1 CPL (A) + OPL (B) = Main 16:9 + 2.0
- **CPL (B) = Pre Watershed** CPL (B) + OPL (A) = Pre Watershed 2.35 + 5.1 CPL (B) + OPL (B) = Pre Watershed 16:9 + 2.0

Currently there is no definition for frame rate adjustment. We recommend that this should be an OPL macro definition. The link to the audio is also missing, but should also be a macro either in the same (new) document or as an amendment to the existing audio mix macro (SMPTE ST 2067- 103:2016).

Currently the end user can determine a frame playback rate on transcode of the delivered asset.

Example: The CPL will state the master is 24/1.001 but the destination transcoder can manage the frames to play back at 25fps on output. The IMF File is decoded at the master frame rate and transcoded to the new playback timeline.

Annex C Glossary of Terms

Glossary

Air Master (Transmission Master)	Master asset for playout to destination (e.g. AS-11) – may be traditional linear playout or VOD encode.
AS-11	Defines the constrained media files used for the delivery of finished media assets (Air Master). DPP has an AS-11 specification for HD and UHD file delivery.
Audio Channel	A single stream of recorded sound with a location in a sound field (e.g. channel 1 = stereo left).
Audio Track	A single stream of recorded sound with no location in a sound field (e.g. track 1 = programme stereo).
BT.2100 (ITU-R BT.2100)	BT.2100 defines the HDR and colourspace formats used within the HD and UHD standards. (see https://www.itu.int/rec/R-REC-BT.2100).
BT.709 (ITU-R BT.709)	Defines the format of SDR HD programmes https://www.itu.int/rec/R-REC-BT.709).
CPL	<i>Composition Play List</i> – enables the playback of the correct timeline of the respective video and audio files within the IMF package.
EBU	<i>European Broadcasting Union</i> – an alliance of public service media organisations.
EBU QC	A team within the EBU working on guidelines for automated Quality Control – with a sub-group studying the application of IMF for broadcasters.
Essence	The pictures and sound that make up a programme.
H.264	Video codec based on the MPEG-4 (Part 10) Advanced Video Coding (AVC) profile
HDR	<i>High Dynamic Range</i> (see BT.2100).
IMF	<i>Interoperable Master Format</i> – a package containing video, audio, additional data essences (subtitles) and appropriate metadata to enable the respective playback of the files within (as defined in SMPTE ST-2067-2).
InterFrame	A type of codec that looks across time (temporal) and encodes the difference between frames.
IntraFrame	A type of codec that encodes each frame, one at a time.
J2K	<i>JPEG 2000</i> codec. Used by the movie studios as a high quality mezzanine format for distribution.
Library Master	Highest quality Master from which copies can be made with no loss of image and audio quality. Allows for editing and further rendering without any generation loss.

MXF	<i>Material eXchange Format</i> (MXF) is a container for video and audio essences.
NABA	<i>North American Broadcasters Association</i> – with members from the USA, Canada and Mexico.
OPL	<i>Output Profile List</i> – delivery playback format instructions.
ProRes	Video codec created by Apple and used in post production as a file format. ProRes 422HQ is noted as a master format.
RDD	<i>Registered Disclosure Document</i> – a document submitted by an entity to make a disclosure of technical information to the public via SMPTE's publication channels.
RDD44	RDD that describes technical aspects of the ProRes video codec created by Apple.
RDD6	RDD that describes technical aspects of multichannel audio metadata created by Dolby.
SMPTE	<i>Society of Motion Picture and Television Engineers</i> – defines standards, recommended practices and engineering guidelines.
Sound Field	Describes whether the sound mix is mono, stereo, or multichannel.
XML	<i>eXtensible Markup Language</i> (XML) is a flexible way to electronically share structured data.