SMPTE STANDARD

Professional Media Over Managed IP Networks: Constant Bit-Rate Compressed Video

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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 32NF.

This revision updates the original 2019 publication. The requirements for traffic shaping and delivery timing are clarified, and the option for a description of "Type N" is added. The option to signal the SMPTE Standard Number (SSN) is also added. References have been updated and some further clarifications and corrections have been made.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

1 Scope

This Standard specifies parameters for the real-time, RTP-based transport of constant bit-rate compressed video over IP networks, referenced to a common reference clock.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; then formal languages; then figures; and then any other language forms.

3   Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 2110-10:2022 Professional Media over Managed IP Networks: System Timing and Definitions

SMPTE ST 2110-21:2022 Professional Media Over Managed IP Networks: Traffic Shaping and Delivery Timing for Video

Internet Engineering Task Force (IETF) RFC 4566 SDP: Session Description Protocol [online, viewed 2018-01-25] Available at https://tools.ietf.org/html/rfc4566

Internet Engineering Task Force (IETF) RFC 4855 Media Type Registration of RTP Payload Formats [online, viewed 2018-01-25] Available at https://tools.ietf.org/html/rfc4855

4   Video Compression and Packetization

The video compression or the packetization of the video compression shall produce a constant number of bytes per frame. The packetization shall produce a constant number of RTP packets per frame.

Note: The packetization can add padding bytes to achieve a constant number of bytes per frame.

5   RTP Transport

5.1   General

The network interface requirements and system timing model shall be in accordance with the provisions of SMPTE ST 2110-10.

5.2   RTP Timestamp Clock

The RTP Timestamp Clock rate shall be 90 kHz.

5.3 Traffic Shaping and Delivery Timing

The traffic shaping and delivery timing shall be in accordance with the Network Compatibility Model compliance definitions specified in SMPTE ST 2110-21 for either Narrow (Type N), Narrow Linear (Type NL) or Wide (Type W) Senders. The session description shall include a format-specific parameter of either `TP=2110TPN`, `TP=2110TPNL` or `TP=2110TPW` to indicate compliance with Type N, NL or W respectively.

Note 1: The Virtual Receiver Buffer Model compliance definitions of ST 2110-21 do not apply and therefore there is no requirement regarding "gapped" or "linear" transmission. The only difference between Type NL and Type N is that the C_{MAX} limit is adjusted by the factor R_{ACTIVE}.

Note 2: Receiver buffer management is left to individual compressed transport standards to specify because requirements are likely to differ, depending on the compressed format.

6 RTP Payload Format

6.1 Registration

The RTP payload format shall be registered in accordance with RFC 4855.

6.2 Media Type and Subtype

The media type name shall be "video". The subtype name shall be the name registered for the payload format.

6.3 Required parameters

A "rate" parameter, specifying the RTP timestamp clock rate is required. The value shall be 90000.

7 Session Description

7.1 General

A Session Description Protocol (SDP) object shall be created for each RTP stream and it shall be in accordance with the provisions of SMPTE ST 2110-10. The mapping of media parameters to SDP shall be in accordance with RFC 4855.

For example:

- The type name ("video") goes in SDP "`m=`" as the media name.
- The subtype name goes in SDP "`a=rtpmap`" as the encoding name, followed by a slash ("`/`") and the `rate` parameter.
- Any payload-format-specific parameters go in the SDP "`a=fmtp`" attribute.

7.2 Format-specific parameters

IETF RFC 4566 section "SDP Attributes" specifies the "`a=fmtp`" attribute as:

```
a=fmtp:<format> <format specific parameters>
```

The `<format specific parameters>` section shall consist of a sequence of parameter entries separated by a semicolon (";") character, with the semicolon optionally followed by a space character. There is no semicolon character after the last item.

Each parameter entry shall be constructed as either

- a `<name>=<value>` pair, with no whitespace within the name or value or between the name, equal sign, and value
- a `<name>` standalone declaration, with no whitespace within the name.

Note: A semicolon-separated list is the format suggested in RFC 4855 section 3.

The parameters shall include the required parameters defined for the media type and may include the optional parameters defined for the media type. Further parameters are specified below.

The SDP object shall include the format-specific parameters listed in Table 1 in the "`a=fmtp`" attribute.

Table 1 — Mandatory format-specific parameters.

Name	Value
`width`	Width of the image in pixels. Permitted values are integers between 1 and 32767 inclusive.
`height`	Height of the image in pixels. Permitted values are integers between 1 and 32767 inclusive.
`TP`	Either `2110TPN`, `2110TPNL` or `2110TPW` as specified in subsection 5.3

The SDP object may include the format-specific parameter listed in Table 2 in the "`a=fmtp`" attribute.

Table 2 — Optional format-specific parameter.

Name	Value
`CMAX`	As defined in SMPTE ST 2110-21
`SSN`	SMPTE Standard Number. If present, the value shall be either ST2110-22:2019 or ST2110-22:2022, depending on the version of the standard implemented.

7.3 Bit rate

The media-level section of the SDP object shall include the attribute listed in Table 3.

Table 3 — Bit rate attribute.

Syntax	Definition
`b=<brtype>:<brvalue>`	This attribute shall be as defined in RFC 4566. The `<brtype>` shall be AS (application specific). The `<brvalue>` shall be the average bit rate. Since the number of bits per frame is constrained by section 4 to be constant, the bit rate can be calculated as the number of bits in the coded representation of a frame divided by the frame period. It shall be expressed as an integer number of kilobits per second, where kilobit means 1000 bits, rounding up if necessary. The bit rate shall include the whole of each IP packet, i.e. IP headers and payload. The bit rate shall not include layers below IP (such as Ethernet).

7.4   Frame rate

The SDP object shall include an indication of frame rate via one of the mechanisms listed in Table 4.

Table 4 — Frame rate indication.

Type	Syntax	Definition
Attribute	`a=framerate:<frame rate>`	This attribute shall be as defined in RFC 4566. It gives the maximum frame rate in frames per second. Decimal representations using the notation `<integer>.<fraction>` are allowed.
Format-specific parameter for use in "`a=fmtp`" attribute	`exactframerate=<frame rate>`	The `<frame rate>` shall be the frame rate in frames per second. Integer rates shall be signaled as a single decimal number (e.g. "25") and non-integer rates shall be signaled as a ratio of two integer decimal numbers separated by a "forward-slash" character (e.g. "30000/1001"), utilizing the numerically smallest numerator value possible.

7.5   Example

```
v=0
o=- 1524820997 1524820997 IN IP4 sender.example.com
s=Example Session
t=0 0
m=video 5004 RTP/AVP 96
c=IN IP4 232.0.1.0/127
b=AS:216000
a=rtpmap:96 vc2/90000
a=ts-refclk:ptp=IEEE1588-2008:traceable
a=mediaclk:direct=0
a=framerate:25
a=fmtp:96 profile=HQ; width=1920; height=1080; TP=2110TPW; SSN=ST2110-22:2022
```

Note: The `profile=HQ` parameter is included to illustrate that there might be required parameters arising from the Media Type specification.