ST SMPTE STANDARD

Professional Media over Managed IP Networks: Fast Metadata Framework

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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.

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.

Introduction

This clause is entirely informative and does not form an integral part of this Engineering Document.

In the SMPTE ST 2110 family of standards, specific payload formats are defined for video, audio, and ANC (SMPTE ST 291-1) payloads. This document defines a flexible payload framework that can be used for additional data items — either those associated tightly to a video or audio essence flow, or data items which might not be associated to video or audio at all.

1 Scope

This Standard defines a flexible RTP payload framework for data items. The framework can be used to transport data items which are tightly time-associated with video or audio RTP Streams, or those that are independent of any video or audio RTP streams. This framework defines a base RTP payload format, SDP signaling conventions, and an optional object segmentation method.

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 clause 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 2059-1:2021 SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications

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

Internet Engineering Task Force (IETF) RFC 3550 RTP: A Transport Protocol for Real-Time Applications [online] Available at https://www.ietf.org/rfc/rfc3550.txt

Internet Engineering Task Force (IETF) RFC 4566 SDP: Session Description Protocol [online] Available at https://www.ietf.org/rfc/rfc4566.txt

Internet Engineering Task Force (IETF) RFC 8285 A General Mechanism for RTP Header Extensions [online] Available at https://www.ietf.org/rfc/rfc8285.txt

4 Terms and Definitions

For the purposes of this document, the terms and definitions given in SMPTE ST 2110-10 apply.

5 RTP Payload Format Framework

5.1 General Provisions

RTP streams compliant with this specification contain a sequence of Data Item Packages, transported using the RTP payload format framework defined below. Each Data Item Package includes an identifier (Data Item Type). The syntax and semantics of the contents within each Data Item Package are outside the scope of this document; instead a public registry is used that associates the Data Item Type with its defining documents (for SMPTE or other public types) or contact information (for private types).

A single RTP stream may contain Data Item Packages with different Data Item Types, provided the RTP Clock rate, source, and RTP Timestamping meaning are compatible among the different types of Data Item Packages multiplexed within the same RTP stream.

Each RTP packet shall contain zero or more Data Item Packages.

Even if no Data Item Packages are transmitted, Senders shall transmit at least one RTP packet every 500 ms in order to allow for detection of transport loss. RTP packets with zero items may be used to fulfill this requirement.

RTP Streams compliant to this specification shall be compliant with the provisions of SMPTE ST 2110-10.

5.2 RTP Header

The RTP Packet Header is illustrated in Figure 1.

The fields of the RTP packet header and their order shall be as defined in IETF RFC 3550. The following additional constraints shall apply:

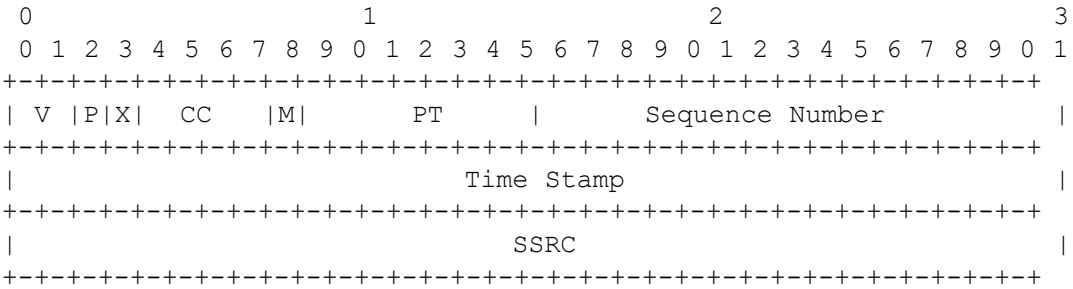

Figure 1 — RTP Header

Payload Type (PT): 7 bits	The Payload Type field shall refer to a dynamically allocated payload type chosen in the range of 96 through 127. The dynamically allocated value shall be signaled in the SDP in accordance with IETF RFC 4566.
Timestamp: 32 bits	The Timestamp field shall contain the RTP Timestamp as specified in this specification.
SSRC: 32 bits	The SSRC field shall be as specified in IETF RFC 3550.
Marker bit (M): 1 bit	The marker bit shall be set to 0 for all packets.
Sequence Number: 16 bits	The RTP header sequence number field shall contain a 16-bit packet sequence counter.

Extension bit (X): 1 bit — When this bit is set, an RTP header extension is present immediately following the SSRC field.

Any header extensions shall be compliant with IETF RFC 8285.

5.3 RTP Timestamps

The RTP Clock rate and RTP Timestamp requirements of each Data Item are defined in the document that specifies the Data Item Package Contents. In all cases, the RTP Clock rate shall be signaled in the SDP as specified in IETF RFC 4566.

For streams containing Data Item Packages that are time-associated with Video or Audio streams, these RTP timestamps may be used to implement the association. The specific methods of implementing or signaling such association are outside the scope of this document.

NOTE All Data Item Packages within a single RTP Packet share the same RTP Clock rate and RTP Timestamp.

5.4 RTP Payload Format

The RTP Payload shall consist of a sequence of zero or more Data Item Packages.

Each Data Item Package shall be completely contained with the RTP Payload of a single RTP Packet (no partial Data Item Packages). All Data Item Packages are a multiple of 32 bits in length, and any padding of the contents required to achieve such alignment is part of the Data Item Package and defined in the defining document for the Data Item Package. There is no padding or spacing between Data Item Packages.

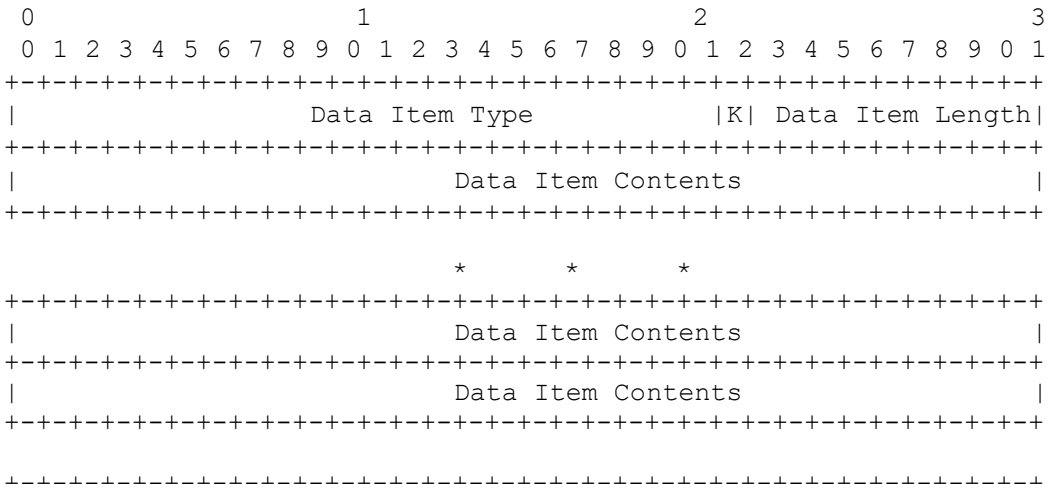

Figure 2 — Data Item Package Format

The Data Item Contents are the payload of the Data Item Package.

The total length of the UDP packet that encompasses each RTP Packet shall be less than or equal to the Standard UDP Size Limit defined in SMPTE ST 2110-10.

Figure 2 shows the format of each Data Item Package. Each Data Item Package shall contain a Data Item Type, Data Item K-bit, and Data Item Length field, followed by one or more 32-bit Data Item Contents elements.

Data Item Type: 22 bits	The Data Item Type field shall signal the Data Item Type corresponding to the contents of this Data Item Package.
Data Item K-bit: 1 bit	The K bit in Figure 2 shall be known as the Data Item K-bit. If the defining document for the Data Item Contents specifies that the Simple Object Segmentation Method defined in Annex A is used, then the K bit shall take the meaning specified in Annex A; otherwise its meaning is as specified by the document that defines the contents of the Data Item Package indicated by the Data Item Type value.
Data Item Length: 9 bits	Indicates the total number of 32-bit Data Item Contents elements that follow. This value shall not be equal to zero.

6 SDP Signaling

An SDP object shall be constructed as specified in IETF RFC 4566. The SDP shall comply with the requirements of SMPTE ST 2110-10.

The SDP may include additional clauses or format-specific media parameters specified in the defining documents for the specific Data Item Types, provided that these additional clauses do not contradict the requirements of this standard.

Senders shall signal the Format Specific Parameter `SSN` with the value `ST2110-41:2024` in the SDP.

Senders should signal the Format Specific Parameter `DIT` with a value containing a comma-separated list of hexadecimal values of the Data Item Types that might appear in the stream. The hexadecimal values shall not include the leading “0x” and any alphabetic characters shall be uppercase. Whitespace characters shall not appear in the comma-separated list of values. Listing of a type in the DIT list does not guarantee that the type will appear in every packet, nor that it will appear in the stream at all. Additionally, data types might appear in the stream which are not enumerated in the DIT list.

For example:

```
a=fmtp:117 SSN=ST2110-41:2024; DIT=100,2000A1,1013FC,3FFF00
```

7 Network Compatibility Model

RTP Streams compliant with this standard shall ensure that their sequence of actual packet transmission instants, as measured on their network egress interface, passes the Network Compatibility Model shown in Figure 3 at all times and in all operating configurations. The model is tested at the output of the Sender, prior to any network-induced delivery impairments.

Packets from the Sender shall enter a leaky bucket of finite capacity at the instant they are emitted from the Sender. The bucket drains a packet every T_{DRAIN} seconds, if a packet is available. For the purpose of accurate modeling, the specific instant of the bucket draining the packet is N * T_{DRAIN} seconds since the SMPTE Epoch as defined in SMPTE ST 2059-1. C_{INST} represents the instantaneous number of packets in the bucket at any time. The value of C_{INST} shall never exceed the C_{MAX} value specified below.

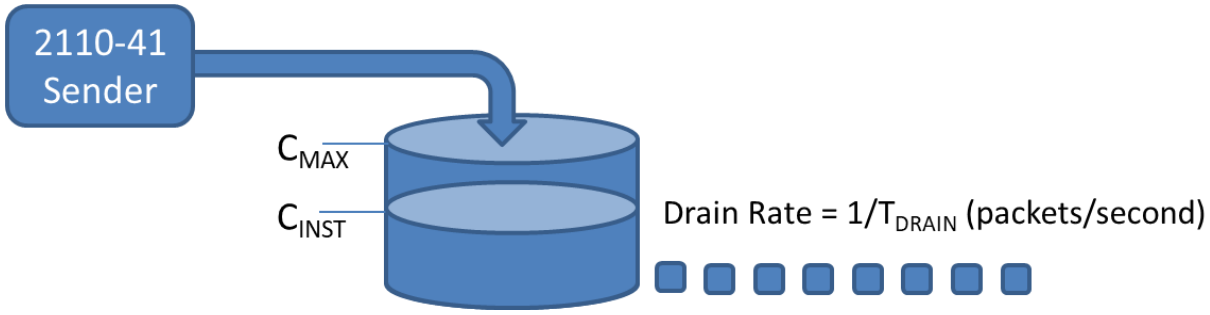

Figure 3 — Network Compatibility Model

The parameters of the Network Compatibility Model are as follows:

$R_{NOMINAL}$ The long-term average RTP packet rate generated by a Sender, in units of packets per second. For purposes of measurement, the average should be taken over at least 10 seconds.

β A scaling factor applied to $R_{NOMINAL}$.

T_{DRAIN} The time interval (in seconds) between packets being drained in the Network Compatibility buffer model.

C_{INST} The instantaneous fullness (in packets) of the bucket at any time.

For RTP Streams generated in accordance with this standard, the following values shall apply:

β = 1.1

$T_{DRAIN} = \left\lceil \frac{1}{MAX(800,\ (R_{NOMINAL} \times \beta))} \right\rceil$

$C_{MAX} = MAX\left(4,\ INT\left(\frac{R_{NOMINAL}}{43200}\right)\right)$

NOTE While this specification defines a single RTP Stream, implementers are cautioned to consider the systemic implications of the bursting and transmission timing of the aggregate traffic.

8 Data Item Type Allocation and Registration

8.1 Public Registry

SMPTE maintains a publicly accessible administrative register of Data Item Types. Allocation of entries in this registry is purely administrative and Data Item Type values shall be registered for any request containing all of the required information below. Each Request is for a single Data Item Type registration.

8.2 SMPTE Data Item Types

The Data Item Type range 0x000000 through 0x0FFFFF is reserved for allocation by SMPTE for Data Item Types associated with SMPTE technical documents. The Data Item syntax and semantics of such types shall be defined by a SMPTE technical document. The registration information for such a type shall include:

- the Data Item Type (number) allocated by SMPTE HQ
- brief textual description
- reference to the defining SMPTE technical document or clause thereof

8.3 Other User Organization Data Item Types

The Data Item Type range 0x100000 through 0x1FFFFF is reserved for allocation by SMPTE for Data Item Types requested by other user organizations. The registration information for such a type shall include:

- the Data Item Type (number) allocated by SMPTE HQ
- brief textual description
- reference to the defining technical document or section/clause thereof

Requests from other user organizations for allocation of ranges of contiguous values require the consent of the SMPTE Standards Vice President. Allocation of such a range does not relieve the requesting organization from the requirement to submit individual requests for registrations of values with the required information as they are needed.

8.4 Private Data Item Types

The Data Item Type range 0x200000 through 0x2FFFFF is reserved for allocation by SMPTE for Data Item Types requested by individuals and corporations. The public registration information for such a type shall include:

- the Data Item Type (number) allocated by SMPTE HQ
- brief textual description
- A contact name and email address for information purposes
- (Optional but highly encouraged) URL or other reference to a defining document

The registrant may provide a URL or other reference to a defining document, but is not required to do so.

8.5 Reserved Data Item Types

The Data Item Type range 0x300000 through 0x3FEFFF is reserved for future use.

8.6 Experimental Data Item Types

The Data Item Type range 0x3FF000 through 0x3FFFFF is for experimental use. These Data Item Types may be used on an experimental basis during the development of new formats and applications without the need to register. It is incumbent on the users of these values to ensure that their use does not interfere with other users.

9 IANA RTP Payload Format Registration Information

9.1 Overview

Clause 9 provides information to support the registration of the payload subtype name “ST2110-41” with the Internet Assigned Numbers Authority (IANA) in accordance with IETF RFC 4855. The template defined in IETF RFC 6838 is used.

9.2 Media Type Definition

9.2.1 Type and Subtype Names

Type Name: application

Subtype Name: ST2110-41

9.2.2 Required Parameters

`rate`: RTP timestamp clock rate, as specified in Clause 5.3 of this document. The `rate` parameter shall appear in the `rtpmap` clause of the SDP.

`SSN`: The full SMPTE standard number (including year) associated with the stream. `SSN=SMPTE2110-41:2024` for streams compliant to this specification.

9.2.3 Optional Parameters

`DIT`: The comma-separated list of Data Item Types, as specified in Clause 6 of this document.

This RTP payload format contains a multiplex of different application data elements. Some data element definition documents may specify additional format-specific media parameters, which if present, must be included in the `a=fmtp` clause of the SDP.

9.2.4 Encoding Considerations

This media type is framed and binary; see Section 4.8 of IETF RFC 6838.

9.2.5 Security Considerations

RTP packets using the payload format defined in this specification are subject to the same considerations as outlined in IETF RFC 3190 Section 9. Those considerations are incorporated here by reference.

9.2.6 Interoperability Considerations

Care was taken in the development of this payload specification to retain compatibility with existing Ravenna system implementation.

9.2.7 Published Specification

This document is the authoritative reference document for the registration of this media type and payload format.

9.2.8 Applications

This media type is used by professional equipment commonly found in the television production and distribution industry, for the transport and intercommunication of metadata about media streams.

9.2.9 Additional Information

Deprecated alias names for this type: N/A

Magic number(s): N/A

File Extension(s): N/A

Macintosh file type code(s): N/A

9.2.10 Contact Information

Comments or questions about this document can be addressed to the SMPTE Director of Standards, at standards-support@smpte.org.

9.2.11 Intended Usage and Restrictions

This media type is intended for common use. It is restricted to use within the context of RTP framing and is defined only for transfer via RTP as defined in IETF RFC 3550. Transport within other framing protocols is not defined.

9.2.12 Change Control

This document is change-controlled by the Society of Motion Picture and Television Engineers (SMPTE).

Annex A
(Normative)

Simple Object Segmentation Method

Many Data Items fit within the limited size available within a standard UDP packet, and thus do not require segmentation or reassembly.

This annex defines a method for fragmenting larger application objects into multiple Data Item Packages. Documents that define Data Item Package Contents may define segmentation methods specific to their application and need not use this method. This method is defined here as an example, and may be normatively referenced by Data Item definition documents that choose to use it.

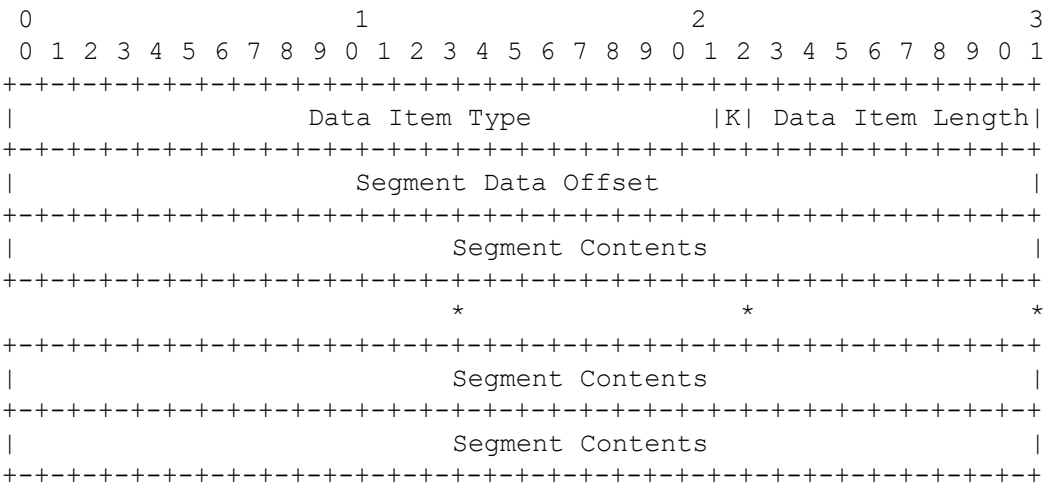

Figure A.1 — Reference Object Segmentation Method

Figure A.1 shows the internal structure of Data Item Packages using the Simple Object Segmentation Method.

Each successive Data Item Package of the same Data Item Type shall contain one segment of the larger application data object. The contents of the larger object shall be split into 32-bit words, and each segment shall consist of one or more successive 32-bit words. The size of the segments may be variable from Data Item Package to Data Item Package but each Data Item Package shall be smaller than the maximum size specified in Clause 5.4.

Each Data Item Package shall contain a 32-bit Segment Data Offset and one Segment of the length indicated by the Segment Data Offset.

When using the Simple Object Segmentation Method, the Data Item K-bit shall be set to 1 on the last segment of the application object, and set to zero otherwise.

Segment Data Offset: 32 bits — This shall indicate the location of the first 32-bit word of the Segment Contents within the larger application object. The units of the Segment Data Offset shall be 32-bit words.

Segment Contents: — Sequence of 32-bit words of the application object.

The number of Segment Contents words within each Data Item Package shall be determined by subtracting 2 from the Data Item Length field. There is no requirement for the Data Item Packages to be the same length.

The overall size of the application object is determined by the Segment Data Offset value and the number of Segment Contents words in the last packet. The last packet is marked by the Data Item K-bit.

If the application object length is not evenly divisible by 32 bits, then padding bytes of value 0T shall be added at the end of the application object during the encapsulation process in order to force the total length to be divisible by 32 bits.

NOTE The application is responsible for differentiating between the application object and any padding introduced during this encapsulation process.

Bibliography (Informative)

SMPTE ST 291-1:2011 Ancillary Data Packet and Space Formatting