SMPTE RP 2110-23:2019

SMPTE RECOMMENDED PRACTICE

Single Video Essence Transport over Multiple ST 2110-20 Streams

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Approved December 13, 2019

Foreword

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Introduction

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

The introduction of video over IP enables sending multiple signals over a single port interface. Unfortunately, there are situations where the capacity of a the interface is not enough to carry a complete video signal. Examples include the transport of 2160-line (or higher framerate) camera images over a 10GbE connection, the transport of 4320-line camera images over a 25GbE connection and the transport of high framerate video signals, such as generated by supermotion cameras.

Whereas the straightforward answer is upgrading the entire IP switch infrastructure. A solution compatible with existing infrastructure is needed, similar to what has been done for SDI, where 2160-line signals can be carried over 4 HD SDI connections, and where supermotion camera signals are transported as “phases” over different SDI connections.

1 Scope

This document proposes a methodology to (i) split high bandwidth single video essence streams into several lower bandwidth SMPTE ST 2110-20 tributary streams , and (ii) to describe the appropriate grouping and signaling of these multiple SMPTE ST 2110-20 streams (SDP declarations, addressing conventions, RTP time stamp constraints, …). This RP does not intend to define new decomposition methods, but refers to existing approaches.

Lower bandwidth streams can be made according to

- The 2SI and Square Division (SD) decomposition mechanisms for UHD content
- Temporally decomposing the video into lower framerate streams

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.

Internet Engineering Task Force (IETF) RFC 4566 SDP: Session Description Protocol [online, viewed 2018-10-11] Available at https://www.ietf.org/rfc/rfc4566.txt"

SMPTE ST 425-5 Image Format and Ancillary Data Mapping for the Quad Link 3 Gb/s Serial Interface

SMPTE ST 435-1:2012 10 Gb/s Serial Signal / Data Interface – Part 1: Basic Stream Derivation

SMPTE ST 2110-10:2017 Professional Media over Managed IP Networks: System Timing and Definitions

SMPTE ST 2110-20:2017 Professional Media over IP Networks: Uncompressed Active Video

SMPTE ST 2110-21:2017 Professional Media over Managed IP Networks: Traffic Shaping and Delivery Timing for Uncompressed Active Video

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 SDP

Session Description Protocol, according to IETF RFC 4566 SDP.

4.2 supermotion camera

A supermotion camera is a high framerate camera that is used for slow motion replays. The camera generates multiple video feeds, each at a submultiple of the high framerate. These feeds are called "phases" and are currently transferred over physically different SDI connections.

5 Transport of high bandwidth video signals as multiple lower bandwidth SMPTE ST 2110-20 signals

5.1 Concept

A high resolution and/or high framerate signal, which needs a high bandwidth SMPTE ST 2110 signal, is split into several lower bandwidth SMPTE ST 2110-20 signals. The high resolution/high framerate signal is split into sub images or lower framerate signals (such as different phases of a supermotion content), that are transmitted as multiple lower bandwidth SMPTE ST 2110-20 signals.

For reasons of compatibility with existing SMPTE ST 2110 infrastructures, the different lower bandwidth streams shall each be valid SMPTE ST 2110-20 / 21 streams.

5.2 Decomposing the high-bandwidth signal

5.2.1 General

Three methods of decomposition are defined in this RP: Phased, Multi-2SI and Multi-SD. These are described in 5.2.2, 5.2.3 and 5.2.4.

5.2.2 Phased decomposition

A high framerate stream, such as coming from a supermotion camera, is split into different streams, each containing a unique phase, each with a lower framerate. These streams shall be interleaved on frame boundaries. The different composing streams shall all have an equal framerate and equal sampling parameters.

The different constituent streams are numbered 1 to <number_of_phases>.

5.2.3 2-sample interleave decomposition

A 3840 x 2160 signal shall be split into 4 signals as per SMPTE ST 425-5, as shown in Figure 2. The different constituent streams are numbered 1 to 4.

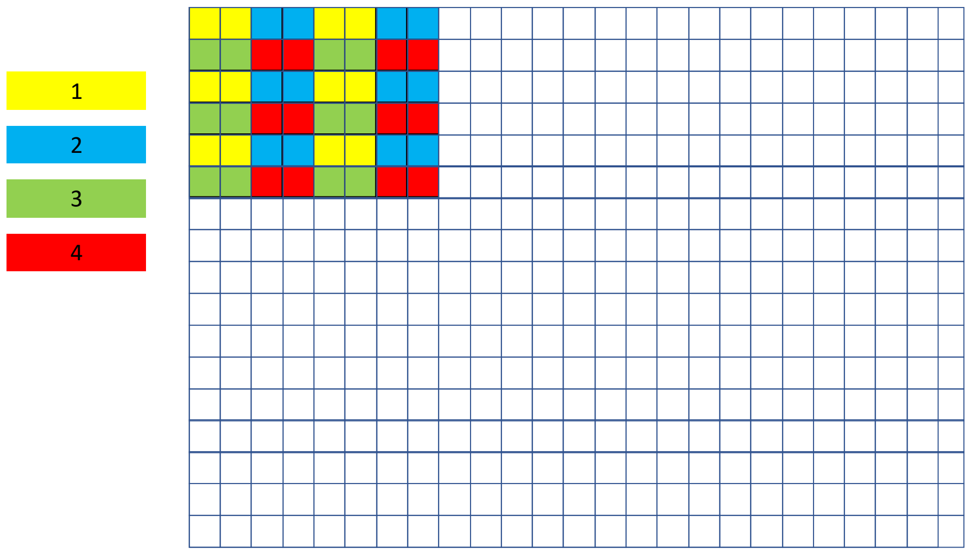

Figure 1 - 2SI split of a 2160-linesignal into 4 constituent streams

A 4320-line image can be split into 4 2160-line signals as per SMPTE ST 2082-12. The different constituent streams are numbered 1 to 4.

In the case of splitting into 16 signals to transport a 4320-line image, the 2-sample-interleave sub-division is applied multiple times as described in SMPTE ST 2082-12. The 4320-line image shall be divided into four 2160-line intermediate sub images and each 2160-line intermediate sub image shall then be divided into four 1080-line sub images as shown in Figure 2. The different constituent streams are ordered 1 to 16.

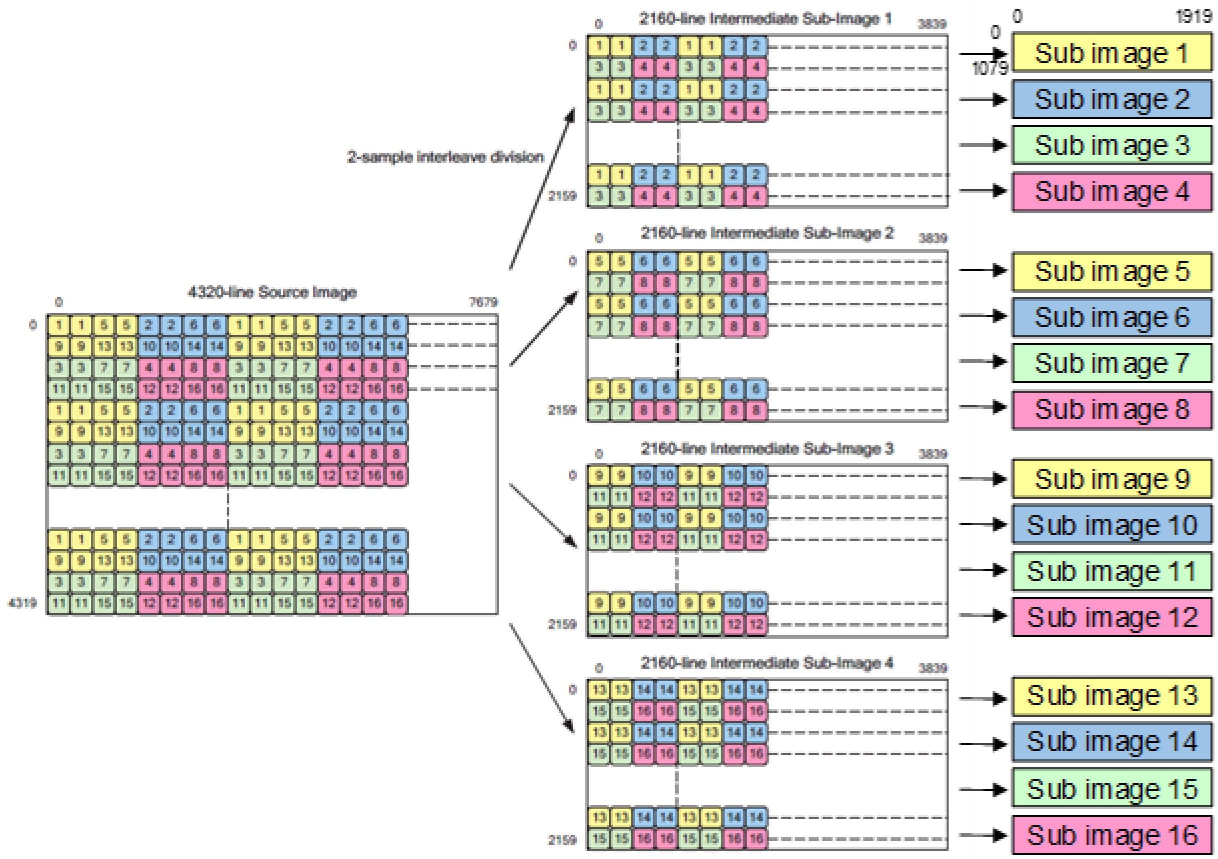

Figure 2 - 4SI split of a 4320-line signal into 16 constituent streams

5.2.4 Square Division decomposition

This decomposition technique has been deprecated and should not be used in new designs. If a signal is encountered which has been decomposed using square division it should use the session descriptors defined in section 5.3

A 3840 x 2160 signal shall be split into 4 signals according to the Square Division approach, as per SMPTE ST 435-1, as shown in Figure 4. The different constituent streams are numbered 1 to 4.

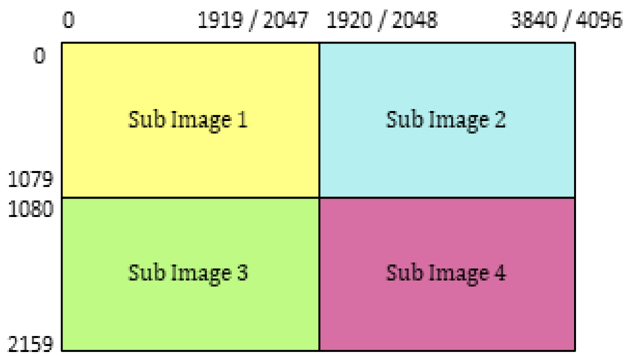

Figure 3 - Square Division split of a 2160-line image into 4 constituent streams.

A 4320-line image can be split into 4 2160-line signals according to the Square Division approach, as per SMPTE ST 435-1. The different constituent streams are numbered 1 to 4.

In the case of splitting into 16 signals to transport a 4320-line image, the Square Division process is applied to each Sub Image. The 4320-line image shall be divided into four 2160-line intermediate sub images and each 2160-line intermediate sub image shall then be divided into four 1080-line sub images as shown in figure 5.

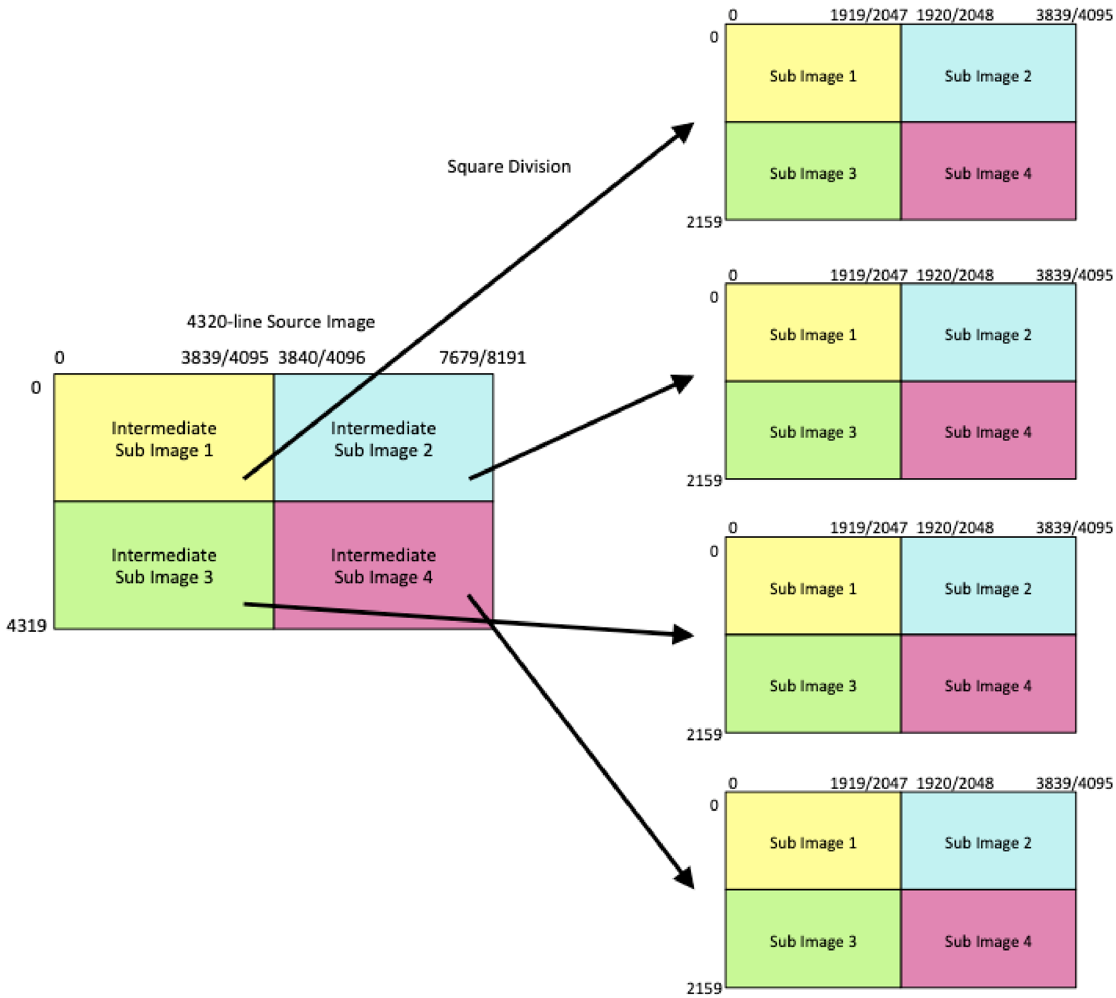

Figure 4 - squared split of a 2160-line image into 16 constituent streams.

The different constituent streams are numbered as indicated in figure 6:

1	2	5	6
3	4	7	8
9	10	13	14
11	12	15	16

Figure 5 - numbering of the 16 constituent streams to transport a 4320-line images in Square Division.

5.3 Session Description

An SDP object for each RTP stream shall be constructed in accordance with the provisions of SMPTE ST 2110-10. In addition, an SDP object which describes all the constituent streams shall be constructed as specified below.

Figure 6 defines the different sections of the SDP file

- Firstly, an indication of the group of signals using the “a=group” semantic.
- For each constituent stream a section shall be described in the SDP file with its associated parameters as defined in the SMPTE ST 2110-20 standard, using `a=mid:<flow identifier>` to end the section.

“`a=group`” statement defines the type of decomposition and the number of constituent flows

Complete description of the first constituent flow.

“`a=mid:1`” statement marks the end of the section in the SDP file that describes the first constituent flow

Complete description of the second constituent flow.

“`a=mid:2`” statement marks the end of the section in the SDP file that describes the 2nd constituent flow

.
.
.

Complete description of the last constituent flow.

“`a=mid:N`” statement marks the end of the section in the SDP file that describes the last constituent flow

Figure 6 - different sections and constituent streams in the SDP file.

The group of signals making a high bandwidth signal, shall be represented by an SDP file using the SDP "a=group" semantic for which three new parameters are defined: PHASED, MULTI-2SI and MULTI-SD

```
a=group:PHASED 1 2 3 … <number_of_phases>

a=group:MULTI-2SI 1 2 3 4 [5 6 7 8 9 10 11 12 13 14 15 16]

a=group:MULTI-SD 1 2 3 4 [5 6 7 8 9 10 11 12 13 14 15 16]
```

The `a=group:PHASED, MULTI-2SI and MULTI-SD` semantic defines a number of constituent streams, each identified by an identifier (1, 2, 3, …) . Each shall be described in the SDP file with its associated parameters as defined in the SMPTE ST 2110-20 standard.

In order to identify the definition of each stream in the SDP file, the `a=mid:<flow identifier>` is used at the end of each stream description, where `<stream identifier>` is the identifier of the stream as specified in the `a=group` statement.

The PHASED parameter shall be used when the Phased decomposition method is used. The statement "a=group:PHASED 1 2 3 … <number_of_phases>" shall be used before the first media-level section starting with "m=" line.. The identifiers 1, 2, 3 … shall correspond to the 1st, 2nd, 3rd, … phase of the supermotion camera (or equivalent split stream from any high framerate camera).

The MULTI-2SI parameter shall be used when the 2-sample interleave decomposition method is used. The "a=group: MULTI-2SI 1 2 3 4" shall be used before the first media-level section starting with "m=" line. The identifiers 1, 2, 3, 4 correspond to the 4 parts of a 2SI signal.

In the case of splitting into 16 signals, the "a=group: MULTI-2SI 1 2 3 4 … 16" shall be used before the first media-level section starting with "m=" line. The identifiers 1, 2, 3, 4, … 16 correspond to the 16 parts of 2SI signals.

The MULTI-SD parameter shall be used when the Square Division decomposition method is used. The "a=group: MULTI-SD 1 2 3 4" shall be used before the first media-level section starting with "m=" line. The identifiers 1, 2, 3, 4 correspond to the 4 Sub Images of a Square Division signal.

In the case of splitting into 16 signals as shown in figure 6, the "a=group: MULTI-SD 1 2 3 4 … 16" shall be used before the first media-level section starting with "m=" line. The identifiers 1, 2, 3, 4, … 16 correspond to the 16 parts of the Square Division signals.

The examples in annex A, B, C, D and E show complete SDP files.

5.4 Including redundancy (SMPTE ST 2022-7) in this method

In order to introduce redundancy, with a Primary and a Secondary signal, the "a=group:[PHASED|MULTI-2SI|MULTI-SD" statement shall be duplicated. The SDP file shall include a primary "a=group:[PHASED|MULTI-2SI|MULTI-SD]" statement where the identifiers 1, 2, 3 … are indicated as 1P, 2P, 3P, … The SDP file shall include a secondary "a=group:[PHASED|MULTI-2SI|MULTI-SD]" statement where the identifiers 1, 2, 3 … are indicated as 1S, 2S, 3S, …

An example is given below

```
a=group:PHASED 1P 2P 3P 4P 5P 6P

a=group:PHASED 1S 2S 3S 4S 5S 6S
```

The “a=group:DUP” semantics are used to indicate the pairings between the primary and secondary redundant stream as per RFC 7104. The SDP file shall include a “a=group:DUP <identifier_1> <identifier_2>” statement for each lower bandwidth stream where <identifier_1> and <identifier_2> correspond to the identifiers in the “a=group:[PHASED|MULTI-2SI|MULTI-SD]” statements. <identifier_1> shall correspond to the primary group, <identifier_2> shall correspond to the secondary group.

An example is given below

```
a=group:DUP 1P 1S

a=group:DUP 2P 2S

a=group:DUP 3P 3S

a=group:DUP 4P 4S

a=group:DUP 5P 5S

a=group:DUP 6P 6S
```

Either all of the constituent streams, or none of the streams shall be protected using the -7 mechanism.

The primary and duplicate stream shall not have different time offsets.

The examples in annex C and D shows a complete SDP file.

5.5 RTP Time Stamps

Each constituent RTP stream shall be in accordance with SMPTE ST 2110-20.

When 2-sample interleave decomposition or square division decomposition is used, the RTP timestamps for each constituent image shall be the same and the TRoffset values (as defined in SMPTE ST 2110-21) shall be the same.

When phased decomposition is used, the different phases should use different RTP timestamps corresponding to the temporal relationship between the phases. The TRoffset values for the different phases should be the same.

5.6 IP addressing

When using multicast, each constituent SMPTE ST 2110-20 stream shall have a different IP multicast destination address but need not have a different UDP destination port number.

Annex A Example 1 (Informative)

This example describes a 720p300 high-speed camera signal (6x, system frame rate/format = 720p50)

```
v=0

o=- 0 0 IN IP4 10.200.8.2

s=Video 1


a=group:PHASED 1 2 3 4 5 6


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:1


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.1

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:2


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.2

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”
```

```
a=mid:3


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:4


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.4

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:5


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.5

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:6
```

Annex B Example 2 (Informative)

In this example, a 2160p59.94 UHD (SDR) signal is sent as four separate 2SI streams

```
v=0

o=- 0 0 IN IP4 10.200.8.2

s=Video 1



a=group:MULTI-2SI 1 2 3 4



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:1



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.1

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:2


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.2

a=rtpmap:112 raw/90000
```

```
a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:3



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:4
```

Annex C Example 3 (Informative)

This example describes a 720p300 high-speed camera signal (6x, system frame rate/format = 720p50) with redundant SMPTE ST 2022-7 streams

```
v=0

o=- 0 0 IN IP4 10.200.8.2

s=Video 1


a=group:PHASED 1P 2P 3P 4P 5P 6P

a=group:PHASED 1S 2S 3S 4S 5S 6S

a=group:DUP 1P 1S

a=group:DUP 2P 2S

a=group:DUP 3P 3S

a=group:DUP 4P 4S

a=group:DUP 5P 5S

a=group:DUP 6P 6S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:1P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.1

a=rtpmap:112 raw/90000
```

```
a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN="ST2110-20:2017"

a=mid:2P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.2

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN="ST2110-20:2017"

a=mid:3P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN="ST2110-20:2017"

a=mid:4P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.4

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN="ST2110-20:2017"

a=mid:5P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.5

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN="ST2110-20:2017"
```

```
a=mid:6P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:1S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.1

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:2S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.2

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:3S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:4S
```

```
m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.4

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:5S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.5

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1280; height=720; exactframerate=50;
depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM; SSN=”ST2110-20:2017”

a=mid:6S
```

Annex D Example 4 (Informative)

In this example, a 2160p59.94 UHD (SDR) signal is sent as four separate Square Division streams with redundant SMPTE ST 2022-7 streams

```
v=0

o=- 0 0 IN IP4 10.200.8.2

s=Video 1


a=group:MULTI-SD 1P 2P 3P 4P

a=group:MULTI-SD 1S 2S 3S 4S

a=group:DUP 1P 1S

a=group:DUP 2P 2S

a=group:DUP 3P 3S

a=group:DUP 4P 4S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:1P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.1
```

```
a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:2P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.2

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:3P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:4P


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:1S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.1
```

```
a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:2S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.2

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:3S


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.1.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:4S
```

Annex E Example 5 (Informative)

In this example, a 4320p59.94 UHD (SDR) signal is sent as sixteen separate 2SI streams

```
v=0

o=- 0 0 IN IP4 10.200.8.2

s=Video 1


a=group:MULTI-2SI 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.0

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:1


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.1

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:2


m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.2

a=rtpmap:112 raw/90000
```

```
a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:3



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.3

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:4



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.4

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:5



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.5

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:6



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.6
```

```
a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:7



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.7

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:8



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.8

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:9



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.9

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:10



m=video 30000 RTP/AVP 112
```

```
c=IN IP4 239.252.0.10

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:11



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.11

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:12



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.12

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:13



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.13

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN="ST2110-20:2017"

a=mid:14
```

```
m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.14

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:15



m=video 30000 RTP/AVP 112

c=IN IP4 239.252.0.15

a=rtpmap:112 raw/90000

a=fmtp:112 sampling=YCbCr-4:2:2; width=1920; height=1080;
exactframerate=60000/1001; depth=10; TCS=SDR; colorimetry=BT709; PM=2110GPM;
SSN=”ST2110-20:2017”

a=mid:16
```

Bibliography (Informative)

SMPTE ST 2022-7 Seamless Protection Switching

SMPTE ST 2082-12 4320-line and 2160-line Source Image and Ancillary Data Mapping for Quad-link 12G-SDI