**Agenda item:** 10.8

**Source:** InterDigital Communications and Samsung Electronics Co., Ltd.

**Title: [5G\_RTP] Signaling PDU set importance in RTP HE**

**Document for:** Discussion andAgreement

# Introduction

In S4aR230057 the RTC working group has agreed that the semantics of the importance/priority field needs to be defined based on the 3GPP codecs (existing and new ones that are included as part of Release 18 work in SA4) in an RTP header extension.

In this contribution, we discuss the syntax and semantics of PDU set importance field signaling in the RTP HE and the guidelines on how to set this field in the RTP HE at the application level.

# Introduction

SA4 agreed to work on the RTP HE for PDU set marking providing the following PDU set information as part of the RTP HE fields as:

* PDU set sequence number (PSSN)
* PDU sequence number (PSN) within a PDU set
* End PDU of a PDU set indication (E)
* PDU set importance (PSI)
* PDU end-of-data burst (EoB) indication
* Optionally, PDU set size (PSS) in bytes

S2-2303879 [1] defines PDU set importance as the relative importance of a PDU Set compared to other PDU Sets within a QoS Flow. The definition also includes a note that states “whether and how PDU Set Importance can span across QoS Flows is FFS”. RAN2 also agreed that it may use the priority or importance indication at a PDU set level for packet discarding in the presence of congestion.

# PDU set importance field

The PDU set importance can be signalled in the PDU Set information RTP header extension.

The syntax and semantics for the importance/priority field (4-bits in length) in the PDU Set information header extension is as follows:

* + 1. Syntax

 0 1 2 3

 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | 0xBE | 0xDE | length |

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | ID | L=6 |E|EOB | PRI | PSSN | PSN |

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | PSSize | Zero padding |

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

*Figure 1.* *RTP header extension using one-byte header format.*

 0 1 2 3

 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | 0x10 | 0x00 | length |

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | ID | L=6 |E|EOB | PRI | PSSN

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 | PSN | PSSize |

 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 *Figure 2.* *RTP header extension using two-byte header format.*

* + 1. Semantics

PRI (4-bits): Priority field indication. This field indicates the priority of a PDU set compared with other PDU sets with in the same stream. The lower the value of the priority field lower the importance. For example, a PDU set with priority value 0 is less important compared to a PDU set with priority value 1.

* + 1. Guidelines

The PDU sets that contain audio data are set with highest importance compared with other media PDU sets. PDU sets that belong to audio media are set with a priority value b1111.

NOTE: PDU sets that carry immersive audio data are not set with highest importance compared with other media PDU sets. The priority value of immersive audio PDU sets is FFS.

The PDU sets that contains the reference frames present in the video bitstream are set with higher priority compared with non-reference frames present in the video bitstream. The Intra Random Access Pictures (IRAP) pictures such as Instantaneous Decoder Refresh (IDR) frames, Clean Random Access (CRA) frames, Broken Link Access (BLA) frames and Gradual decoding refresh (GDR) frames are set very important in a video stream and are set with higher priority. The priority value for such pictures can be set to b1110.

In video coding, temporal scalability is the option to decode only some of the frames in a video stream instead of the whole stream. This enables a media server to reduce the bitrate sent towards viewers who doesn’t have enough bitrate or CPU to handle the whole stream. Pictures with lowest temporal identifier value as shown in Figure 3 are used as reference pictures in the bitstream and are important for decoding the dependent frames.

Hence PDU sets with TID value 1 (lowest possible value) are set with higher priority. The priority value for such pictures may be set to b1110 (for IRAP pictures) or b1101 (for non-IRAP pictures).

Pictures with highest TID value cannot be used as reference pictures and can be discarded at the network level when the throughput is not good, or network conditions are unstable. PDU sets with higher TID values in the NAL Unit header of RTP packet or with higher nuh\_temporal\_id\_plus1 value in the NAL unit header of the bitstream are set with lower priority value compared with the PDU sets with lower TID values.

PDU sets with the highest TID value in the NAL Unit header of RTP packet or with highest nuh\_temporal\_id\_plus1 value in the NAL unit header of the bitstream are set with lowest priority. The priority value for such pictures may be set to b0000

+---------------+---------------+

|0|1|2|3|4|5|6|7|0|1|2|3|4|5|6|7|

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

|F| Type | LayerId | TID |

+-------------+-----------------+

*Figure 3.* *The Structure of the HEVC NAL Unit Header*

The following clauses provides the guidelines on setting the priority field in a PDU set RTP header extension for various video codecs.

* + - 1. H.264 Codec

In an H.264 bitstream, NAL units with the nal\_unit\_type field assigned the value 5 (refer to Table 7.1 in AVC specification [2]) are Intra Random Access Pictures (IRAP) pictures. When the Type field value in the NAL Unit header of an RTP packet is 5, then the corresponding PDUs in that PDU set are set with higher priority value for example with b1110.

The parameter set NAL units such as Sequence Parameter Set (SPS) and Picture Parameter Set (PPS) are important for decoding the bitstream. Therefore, PDU sets with a payload Type field value equal to 7, 8, 13 or 15 (refer to Table 7.1 in AVC specification [2]) in the NAL Unit header of the RTP packet are set with higher priority. The priority value for such PDU sets is set to b1110.

 +---------------+

 |0|1|2|3|4|5|6|7|

 +-+-+-+-+-+-+-+-+

 |F|NRI| Type |

 +---------------+

*Figure 4.* *NAL unit type octet in an RTP packet payload*

The NAL unit type octet contains the NRI (nal\_ref\_idc) field highlighted in Figure 4. A value of b00 indicates that the content of the NAL unit is not used to reconstruct reference pictures for inter picture prediction. Such NAL units can be discarded without risking the integrity of the reference pictures. Values greater than b00 indicate that the decoding of the NAL unit is required to maintain the integrity of the reference pictures.

PDU sets with an NRI field value 0x00 in the NAL Unit header of RTP packet are of lowest important. The priority value in the PDU set header extension for such PDU sets is set to b0000.

* + - 1. HEVC Codec

In an HEVC bitstream, NAL units with the nal\_unit\_type field assigned a value in the rang 16 to 23 (inclusive) (refer to Table 7.1 in HEVC specification [3]) are Intra Random Access Pictures (IRAP) pictures. When the Type field value in the NAL Unit header of RTP packet is in the range 16 to 23 (inclusive), then the corresponding PDUs in that PDU set are set with higher priority value for example with b1110.

The parameter set NAL units such as Sequence Parameter Set (SPS), Picture Parameter Set (PPS), Video Parameter Set (VPS) are important for decoding the bitstream. Therefore, PDU sets with payload Type field value in the NAL Unit header of RTP packet in the range 32 to 34 (inclusive) are set with higher priority. The priority value for such PDU sets is set to b1110.

+---------------+---------------+

|0|1|2|3|4|5|6|7|0|1|2|3|4|5|6|7|

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 |F| Type | LayerId | TID |

+-------------+-----------------+

*Figure 5.* *The Structure of the HEVC NAL Unit Header*

In HEVC bitstreams, RASL pictures can be discarded. HEVC provides mechanisms to enable specifying the conformance of a bitstream wherein the originally present RASL pictures have been discarded. Consequently, system components can discard RASL pictures, when needed, without worrying about causing the bitstream to become non-compliant.

PDU sets with Type field value equal to 8 or 9 (refer to Table 7.1 in HEVC specification [3]) in the NAL Unit header of RTP packet are RASL pictures and they are not important. The priority value in the PDU set header extension for such PDU sets is set to true or b0000.

* + - 1. PDU set importance based on affected PDU sets

When the transport layer is forced to perform immediate dropping/discarding of a PDU set but has a freedom of selection among the PDU sets, the PDU set with smaller degrees of artifact would be the better choice in most cases. Dropping of a PDU set may corrupt the decoded output of itself and the other PDU sets though they may already be transmitted perfectly to the receiving end or yet in a queue waiting to be transmitted. The degrees of artifact can be explicitly transferred from the application layer to the transport layer as the number of affected frames which precedes/follows the PDU set, or can be implicitly transferred as the importance value where the lower value means the fewer PDU sets are affected while higher values proportionally mean higher number of PDU sets are affected for example. By considering such a quantization of various affected PDU sets can be translated into importance field, using 4 bits to represent 16 possible size ranges is recommended.

The information on the size of propagation error which caused by the dropping of each PDU set may be provided by the application layer to the transport layer. The information may present the size of error propagation implicitly with a proportional mapping of error propagation size to an index such as the importance of the PDU set in the media stream.

The priority value of a PDU Set in PDU set information RTP HE is set as follows

* The error propagation size is mapped to priority field value as exponent of 2. For e.g., priority value 0 means one PDU set (self) is affected, priority value 6 means 64~127 PDU sets are affected.

# Proposal

We propose to agree the proposed syntax, semantics, and guidelines for importance field indication to the PDU set information RTP header extension in 5G\_RTP permanent document.

# References

1. [S2-2303879](https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_155_Athens_2023-02/Docs/S2-2303879.zip), 23.501 CR3759R6 (Rel-18, 'B'): Support of XR and Media Services, Tencent, et al.
2. H.264: Advanced video coding specification. https://www.itu.int/rec/T-REC-H.264-202108-I/en
3. H.265: High efficiency video coding specification. https://www.itu.int/rec/T-REC-H.265-202108-I/en