**3GPP TSG-SA WG4 Meeting #124 S4-230825**

**Berlin, Germany, 22 – 26 May 2023**

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| **pseudo CHANGE REQUEST** |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network |  |

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| ***Title:***  | pCR on guidelines for marking PDU set importance  |
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| ***Source to WG:*** | InterDigital Communications, Samsung Electronics Co., Ltd., HUAWEI, KDDI, and Nokia Corporation |
| ***Source to TSG:*** | S4 |
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| ***Work item code:*** | 5G\_RTP |  | ***Date:*** | 16-05-2023 |
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| ***Category:*** | B |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** |  |
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| ***Summary of change:*** |  |
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| ***Consequences if not approved:*** |  |
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| ***Clauses affected:*** |  |
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|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** |  |
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| ***This CR's revision history:*** |  |

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#### 4.4.2.6 Guidelines for PDU Set Marking

##### 4.4.2.6.2 PDU Set Importance Field

4.4.2.6.2.1 General

The PDU sets that contain audio data shall be set with highest importance compared with other media PDU sets.

NOTE: PDU sets that carry immersive audio data are not set with highest importance compared with other media PDU sets. The importance 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 importance 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 and Broken Link Access (BLA) frames are very important in a video stream and shall be set with higher importance.

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 are used as reference pictures in the bitstream and are important for decoding the dependent frames.

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

4.4.2.6.2.2 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 Instantaneous Decoding Refresh (IDR) 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 should be set with higher importance value.

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 should be set with higher importance.

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

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

|F|NRI| Type |

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

*Figure 1.* *NAL unit type octet in an RTP packet payload*

The NAL unit type octet contains the NRI (nal\_ref\_idc) field highlighted in Figure 1. 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. The highest transport priority is 11, followed by 10, and then by 01; finally, 00 is the lowest.

PDU sets with an NRI field value 0x00 in the NAL Unit header of RTP packet are of lowest important. The importance value in the PDU set header extension for such PDU sets should be high. PDU sets with an NRI field value 0x11 in the NAL Unit header of RTP packet are of highest important. The importance value in the PDU set header extension for such PDU sets should be lower compared with PDU sets with other NRI field values.

The Type and NRI field in the NAL unit header indicate the relative transport priority. They can be used to set the PDU Set importance. The PDU set importance value assignmenet based on the Type and NRI field values is for further study.

4.4.2.6.2.3 HEVC Codec

Different from H.264 (AVC), H.265 (HEVC) NAL unit header is two bytes, contains a 6-bit Type field and no NRI field. NAL unit types 0–31 indicate Video Coding Layer (VCL) NAL unit types; 32–40 indicate non-VCL NAL unit types. NAL unit types 41–47 are reserved, and types 48–63 are unspecified.

All VCL NAL units of the same access unit must have the same value of NAL unit type and that value defines the type of the access unit and its coded picture. There are three basic classes of pictures in H.265 (HEVC): intra random access point (IRAP) pictures, leading pictures, and trailing pictures.

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. This includes IDR, CRA, and BLA picture types as well as types 22 and 23, which currently are reserved for future use.

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 should be set with higher importance value.

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) should be set with higher importance.

RFC 7798 specifies Aggregation Packets (APs) to enable the reduction of packetization overhead for small NAL units, such as most of the non-VCL NAL units, which are often only a few octets in size. An AP aggregates NAL units within one access unit. Each NAL unit to be carried in an AP is encapsulated in an aggregation unit. An AP consists of a payload header (denoted as PayloadHdr) followed by two or more aggregation units. In an AP, the Type field in the PayloadHdr MUST be equal to 48. APs are typically used to aggregate parameters sets (VPS, SPS, PPS) into a single packet.

When aggregation Packets (APs) are used, the sender should consider the NAL unit types of the aggregation units while assigning the importance value. For example, if the aggregation unit contains parameter sets, the PDU set importance value for such PDUs should be lower.

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

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

|F| Type | LayerId | TID |

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

*Figure 2.* *The Structure of the HEVC NAL Unit Header*

It could be that there are PDUs with different NAL unit types in a PDU set. For example, if the first PDU in PDU set is a prefix SEI message or Access Unit Delimiter (AUD), it would be misleading if the sender looked only at the first PDU of the PDU set to determine the importance value.

The sender should ignore the NAL units with non-VCL NAL unit types 35 and 39 and instead consider NAL unit types of the subsequent VCL NAL units while determining importance value for such PDUs.

A leading picture is a picture that follows a particular IRAP picture in decoding order and precedes it in output order. There are two types of leading pictures in H.265 (HEVC): Random access decodable leading (RADL) pictures and Random access skipped leading (RASL) pictures. A RADL picture is a leading picture that is guaranteed to be decodable when random access is performed at the associated IRAP picture. Therefore, RADL pictures are only allowed to reference the associated IRAP picture and other RADL pictures of the same IRAP picture A RASL picture is a leading picture that may not be decodable when random access is performed from the associated IRAP picture. Only other RASL pictures are allowed to be dependent on a RASL picture.

Hence, in HEVC bitstreams, RASL pictures can be discarded during random access. 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 that contain RADL pictures should be assigned an importance value higher than the importance value assigned to the IRAP pictures but lower than the importance value assigned to the RASL pictures in the bitstream.

PDU sets with Type field value equal to 6 or 7 (refer to Table 7.1 in HEVC specification [3]) in the NAL Unit header of RTP packet are RADL pictures and they are of lowest importance compared to the IRAP but higher importance compared to the RADL pictures. The importance value in the PDU set header extension for RADL picture PDU sets should be set with higher value compared to importance value of IRAP picture PDU sets.

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 of lowest importance compared to the IRAP and RADL pictures. The importance value in the PDU set header extension for such PDU sets should be set with higher value compared to importance value of IRAP and RADL picture PDU sets.

In H.265 (HEVC), each leading picture and trailing picture type has two type values. The even picture type numbers indicate sub-layer non-reference pictures and odd picture type numbers indicate sub-layer reference pictures. An encoder can use the sub-layer non-reference picture types for pictures that are not used for reference for prediction of any picture in the same temporal sub-layer. Note that a sub-layer non-reference picture may still be used as a reference picture for prediction of a picture in a higher temporal sub-layer.

PDU sets that contain sub-layer reference picture types should be assigned a lower PDU set importance value compared to the PDU sets with the corresponding sub-layer non-reference picture types.

Besides, PDU sets with TID value 1 (lowest possible value) as shown in Figure 2 should be set with higher importance. The importance value for such pictures should be lower for IRAP pictures and slightly higher for non-IRAP pictures compared to the pictures with higher TID values.

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 higher importance 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 importance. The importance value for such pictures should be set with highest value.

The Type and TID field in the NAL unit header indicates the relative transport priority. They can be used to be set the PDU Set importance. While they can also indicate different QoS requirements, which can be used to provide different protects against transmission losses, e.g. reliabilities (tolerable frame/slice error rate), priorities.

4.4.2.6.2.4 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 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 higher PDU sets are affected while higher values proportionally mean less 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. 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 importance value of a PDU Set in PDU set information RTP HE is set as follows

* The error propagation size is mapped to importance field value. The higher the error propagation size of a PDU set, that PDU set is more important, and it shall be assigned with the lower PDU set importance value. PDU sets with low error propagation are of less importance and the PDU set importance value for such PDU sets shall be higher compared to PDU sets with higher error propagation size.

4.4.2.6.2.5 Considerations for PSI mapping across bitstreams

Senders should consider that multiplexed RTP streams are treated as a single QoS flow and set the PSI field accordingly, i.e., the PSI field for one bitstream will affect the PDU sets in other multiplexed streams as well.

In some cases, dependencies may exist across bitstreams even when they are not multiplexed, particularly for XR services.

In case of such dependencies, it may not be enough to have PSI values based on codecs and media types alone. PSI values shall be set in this case based on the following, which are listed in an increasing order of importance.

* The PDU set is necessary for the processing of some PDU sets of the stream to which it belongs.
* The PDU set is necessary for the processing of all the other PDU sets of the stream to which it belongs.
* The PDU set is necessary for the processing of some PDU sets of the stream to which it belongs and also necessary for the processing of some PDU sets of some other streams to which it does not belong.
* The PDU set is necessary for the processing of all PDU sets of the stream to which it belongs and also of some other streams to which it does not belong.
* The PDU set is necessary for the processing of all PDU sets of all streams.

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# 2 References

1. H.264: Advanced video coding specification. https://www.itu.int/rec/T-REC-H.264-202108-I/en
2. H.265: High efficiency video coding specification. <https://www.itu.int/rec/T-REC-H.265-202108-I/en>

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