Source	**Telecom ParisTech, INSA/IETR**
Status	**For consideration at the 105nd MPEG meeting**
Title	**Clarifications on HEVC VCL NALU order**
Authors	Jean Le Feuvre, Cyril Concolato, Mickael Raulet

1   Introduction

During our various experiments with the HEVC standard, in both decoding tests with OpenHEVC and transport with GPAC, we have investigated several topics such as independent tiles and slices transport and decoding as well as resilience to packet loss.

In all these tests, we manage to have an integrated decoder working fine but we had to tune the NAL processing in specific ways. More specifically, we ended up with issues with the following section from the standard: **7.4.2.4.5 Order of VCL NAL units and association to coded pictures.**

2   Problems

2.1   first_slice_segment_in_pic_flag

The first issue found was that in case of packet loss, a decoder cannot rely on the clause "The first VCL NAL unit of the coded picture shall have first_slice_segment_in_pic_flag equal to 1.", since the packet carrying the first slice segment could be lost. One way for a decoder to detect picture change is then analyzing the POC for cases, hoping no two IDR frames will follow each other. Each of theses method introduce an extra delay in the frame output, since at least one slice header from the next frame has to be parsed to detect frame change. The situation is even worse when the first slice segments of two consecutive IDR frames are lost. Usage of AU Delimiter NAL may help in some cases, but probability that this NALU is lost with the first slice segment is high, especially in MPEG-2 TS streams where the same TS packet would carry the NALUD and the beginning of the first slice segment (including its header).

We concluded that the only reliable, low-latency way of doing exact pic change detection in lossless or lossy environments is to rely on underlying transport signaling, which can signal AU boundaries to the decoder, as is the case in ISO BMFF or MPEG-2 TS.

2.2   Restrictions on Tiles

We then started to experiment with transport and decoding of tiles, and found out that a parallel HEVC decoder may not need to process the tiles in any specific order for a given picture:

typically the decoder will get the different independent tiles and dispatch them to different threads, without any particular knowledge of their respective order. The only constraint for the decoder is to be able to detect a picture change.

The **7.4.2.4.5** subclause specifies however:
"Let sliceSegAddrA and sliceSegAddrB be the slice_segment_address values of any two coded slice segment NAL units A and B within the same coded picture. When either of the following conditions is true, coded slice segment NAL unit A shall precede the coded slice segment NAL unit B:

- TileId[CtbAddrRsToTs[sliceSegAddrA]] is less than TileId[CtbAddrRsToTs[sliceSegAddrB]].
- TileId[CtbAddrRsToTs[sliceSegAddrA]]   is   equal   to   TileId[CtbAddrRsToTs[sliceSegAddrB]] and CtbAddrRsToTs[sliceSegAddrA] is less than CtbAddrRsToTs[sliceSegAddrB].
"

Theses conditions apply to any kind of slices, including independent ones. While this may not be very important for a decoder point of view, the constraint is very high for the overall chain: a parallel HEVC architecture may very well encode and produce independent tiles in various order for a given picture, and these should be transportable as soon as they are produced. Imposing a decoding order constraint in such case is likely to increase the latency of the chain, as reordering has to happen either at the sender or at the receiver side. We do not understand the purpose of this limitation, and would therefore like to remove these constraints.

3   Proposal

We propose to rewrite the clause **7.4.2.4.5** as follows:

"

This subclause specifies the order of VCL NAL units and association to coded pictures.

Each VCL NAL unit is part of a coded picture.

The order of the VCL NAL units within a coded picture is constrained as follows:

- If no Access Unit Delimiter NAL unit is present for a coded picture and no underlying transport mechanism provides information on AU boundaries, the first VCL NAL unit of the coded picture shall have first_slice_segment_in_pic_flag si equal to 1.

Let sliceSegAddrA and sliceSegAddrB be the slice_segment_address values of any two coded slice segment NAL units A and B within the same coded picture**, where B is a dependent slice segment of A**. When either of the following conditions is true, coded slice segment NAL unit A shall precede the coded slice segment NAL unit B:

- TileId[CtbAddrRsToTs[sliceSegAddrA]] is less than TileId[CtbAddrRsToTs[sliceSegAddrB]].
- TileId[CtbAddrRsToTs[sliceSegAddrA]]   is   equal   to   TileId[CtbAddrRsToTs[sliceSegAddrB]] and CtbAddrRsToTs[sliceSegAddrA] is less than CtbAddrRsToTs[sliceSegAddrB].
"

4   Conclusion

In this contribution, we have presented ongoing work related to HEVC decoder robustness and parallel processing of Tiles, and shown that the current specification could be clarified regarding processing order of VCL NALUs. We suggest JCTVC to include the proposed text in a COR to the specification.