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| *Title:* | **Study on HEVC profile and levels** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution studied the following issues in HEVC profile and level definitions, and proposes to change the current definition of profile and level.

* DPB size
* Num\_ref\_idx
* 2 table level definitions
* Max bitrate
* No constraint on max bit/bin at LCU level

# DPB size

In JCTVC-I1003, MaxDpbSize is set equal to 6 for all levels, including the current picture. However, the DpbSize of 6 frames is too large for higher resolution video such as4K. Thus the cost of supporting such huge memory is not feasible for consumer products. JCTVC-J0163 has done some investigation regarding the required DPB size- It reports that the coding loss is not significant by reducing the MaxDpbSize. from 6 to 5. It should be noted that number 5 is the same as AVC DPB size for level 4 and higher. An alternative way of expressing the DpbSize can also be considered in terms of total bytes rather than frame numbers If there is a demand to use a larger number of reference frames for DPB, the DPB size should be restricted at least for level 4 and higher (720@60p and larger picture) levels.. "In AVC, this maximum value was 16, but this contribution proposes to change this maximum value of num\_ref\_idx\_l0/l1\_default\_active\_minus1 from 15 to 7. (15 in I1003 must be error due to cut & paste from AVC spec).

# Constraint on max bit/bin at LCU level

In AVC, a constraint on the maximum bits per MB is defined. However this constraint increases the encoder complexity significantly. It is a common knowledge that this leads to multipath encoding and once video is encoded, CABAC can’t go back to the previous state and encoder needs therefore to store CABAC state information before encoding. Although this constraint is defined in AVC, in practice there are a lot of bitstreams which do not follow this constraint. . Such constraint will therefore impose extra burden on the encoder complexity. Accordingly, this contribution proposes not to define the constraint on max bit/bin at LCU level.

# 2 level definition with different bit rate

The current levels in HEVC are defined with an onion ring structure, and a higher level decoder needs to decode lower level bitstreams. Therefore, the bitrate at higher level must be equal to or higher than that at lower levels. However there could be a demand to send higher resolution video at low bitrates. For example, the high end HDTV authoring systems need to support higher bitrates, while 4K distribution or broadcast cannot use such high bit rates due to the bandwidth limitation. The following is an observation of the current level definitions.

* Since the standard specifies decoder spec, profile/levels should be defined based on the complexity of decoder. In cases wheredecoder complexity is not so different, it is better to maintain higher quality.
* For example, both level 4.2 and 4.3 support 1080@60p and bitrates are 30 Mbps and 50 Mbps, respectively. The complexity of entropy coder is not so different between 30Mbps and 50Mbps bitstreams. Also the complexity of CABAC in HEVC is not so high compared with AVC.
* Bit rate of the current level 4.1, 4.3, 5.1 are defined as 2/3 of AVC. This was proposed by JCTVC-H0168.
* It is not necessary to put upper bound of the quality by standard. Especially the bit rate constraints at which picture quality become lower than existing standard, e.g. AVC, should not be introduced.
* In AVC, HDTV format is the only one in which two bit rates are defined by level. Level 4.0 is for broadcasting and level 4.1 is for storage media, e.g. Blu-Ray Disc. However, the target bitrates for high end and affordable applications are overlapped for HDTV (30p/60p), 4K@30p in very near future.

The current HEVC level is defined by the following table A-1.

Table A‑ – Level limits

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Level** | **Max luma sample rate MaxLumaPR**  **(samples/sec)** | **Max luma picture size MaxLumaFS (samples)** | **Max bit rate MaxBR**  **(1000 bits/s)** | **Min Compression Ratio MinCR** | **MaxDpbSize (picture storage buffers)** | **Max CPB size**  **(1000 bits)** | **MaxDpbSize (bytes)** |
| **1** | 552,960 | 36,864 | 128 | 2 | 6 | 350 | 331,776 |
| **2** | 3,686,400 | 122,880 | 1,000 | 2 | 6 | 1,000 | 1,105,920 |
| **3** | 13,762,560 | 458,752 | 5,000 | 2 | 6 | 5,000 | 4,128,768 |
| **3.1** | 33,177,600 | 983,040 | 9,000 | 2 | 6 | 9,000 | 8,847,360 |
| **4** | 62,668,800 | 2,088,960 | 15,000 | 4 | 6 | 15,000 | 18,800,640 |
| **4.1** | 62,668,800 | 2,088,960 | 30,000 | 4 | 6 | 30,000 | 18,800,640 |
| **4.2** | 133,693,440 | 2,228,224 | 30,000 | 4 | 6 | 30,000 | 20,054,016 |
| **4.3** | 133,693,440 | 2,228,224 | 50,000 | 4 | 6 | 50,000 | 20,054,016 |
| **5** | 267,386,880 | 8,912,896 | 50,000 | 6 | 6 | 50,000 | 80,216,064 |
| **5.1** | 267,386,880 | 8,912,896 | 100,000 | 8 | 6 | 100,000 | 80,216,064 |
| **5.2** | 534,773,760 | 8,912,896 | 150,000 | 8 | 6 | 150,000 | 80,216,064 |
| **6** | 1,002,700,800 | 33,423,360 | 300,000 | 8 | 6 | 300,000 | 300,810,240 |
| **6.1** | 2,005,401,600 | 33,423,360 | 500,000 | 8 | 6 | 500,000 | 300,810,240 |
| **6.2** | 4,010,803,200 | 33,423,360 | 800,000 | 6 | 6 | 800,000 | 300,810,240 |

Based on this observation, it may be difficult to keep onion ring structure based on thebitrates. In JCTVC-I0475 a proposal was made to specify level by introduction of a "constrainted\_flag". For example, if this flag is equal to 1, it means bitarte is N/M of table A-1. This in turn will lead to simplification of table A-1. The example of the syntax change is shown in the following table.

|  |  |
| --- | --- |
| seq\_parameter\_set\_rbsp( ) { | Descriptor |
| **profile\_idc** | u(8) |
| **constraint\_bitrate\_flag** | u(1) |
| **reserved\_zero\_7bits** /\* equal to 0 \***/** | u(8) |
| **level\_idc** | u(8) |
| **seq\_parameter\_set\_id** | ue(v) |
| **chroma\_format\_idc** | ue(v) |
| if( chroma\_format\_idc = = 3 ) |  |
| **separate\_colour\_plane\_flag** | u(1) |
| **…** |  |

An alternative approach is to define two level tables, one for broadcast/streaming and the other for storage. This contribution proposes the following definitions.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Level** | **Max luma sample rate MaxLumaPR**  **(samples/sec)** | **Max luma picture size MaxLumaFS (samples)** | **Max bit rate MaxBR**  **(1000 bits/s)** | **Min Compression Ratio MinCR** | **MaxDpbSize (picture storage buffers)** | **Max CPB size**  **(1000 bits)** | **MaxDpbSize (bytes)** |
| **1** | 552,960 | 36,864 | 128 | 2 | 5 | 350 | 276,480 |
| **2** | 3,686,400 | 122,880 | 1,000 | 2 | 5 | 1,000 | 921,600 |
| **3** | 13,762,560 | 458,752 | 5,000 | 2 | 5 | 5,000 | 3,440,640 |
| **3.1** | 33,177,600 | 983,040 | 9,000 | 2 | 5 | 9,000 | 7,372,800 |
| **4** | 62,668,800 | 2,088,960 | 15,000 | 4 | 5 | 15,000 | 15,667,200 |
| **4.1** | 133,693,440 | 2,228,224 | 18,000 | 4 | 5 | 18,000 | 16,711,680 |
| **5** | 267,386,880 | 8,912,896 | 20,000 | 6 | 5 | 20,000 | 66,846,720 |
| **5.1** | 534,773,760 | 8,912,896 | 40,000 | 8 | 5 | 40,000 | 66,846,720 |

Table : Low Bitrate Definition

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Level** | **Max luma sample rate MaxLumaPR**  **(samples/sec)** | **Max luma picture size MaxLumaFS (samples)** | **Max bit rate MaxBR**  **(1000 bits/s)** | **Min Compression Ratio MinCR** | **MaxDpbSize (picture storage buffers)** | **Max CPB size**  **(1000 bits)** | **MaxDpbSize (bytes)** |
| **1** | 552,960 | 36,864 | 128 | 2 | 5 | 350 | 276,480 |
| **2** | 3,686,400 | 122,880 | 1,000 | 2 | 5 | 1,000 | 921,600 |
| **3** | 13,762,560 | 458,752 | 5,000 | 2 | 5 | 5,000 | 3,440,640 |
| **3.1** | 33,177,600 | 983,040 | 9,000 | 2 | 5 | 9,000 | 7,372,800 |
| **4** | 62,668,800 | 2,088,960 | 30,000 | 4 | 5 | 30,000 | 15,667,200 |
| **4.1** | 133,693,440 | 2,228,224 | 50,000 | 4 | 5 | 50,000 | 16,711,680 |
| **5** | 267,386,880 | 8,912,896 | 100,000 | 8 | 5 | 100,000 | 66,846,720 |
| **5.1** | 534,773,760 | 8,912,896 | 150,000 | 8 | 5 | 150,000 | 66,846,720 |
| **6** | 1,002,700,800 | 33,423,360 | 300,000 | 8 | 5 | 300,000 | 250,675,200 |
| **6.1** | 2,005,401,600 | 33,423,360 | 500,000 | 8 | 5 | 500,000 | 250,675,200 |
| **6.2** | 4,010,803,200 | 33,423,360 | 800,000 | 6 | 5 | 800,000 | 250,675,200 |

Table : High Bitrate Definition

# Conclusion

* Proposal has been made to define max. DPB size for higher resolution video,Num\_ref\_idx, 2 table level definitions, Max bitrate and No constraint on max bit/bin at LCU level.

## 

# Patent rights declaration(s)

**Sony Corporation may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**