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| *Title:* | **Proposal for definition of levels in HEVC** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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| *Source:* | Cable television laboratories, cable MSOs and vendors | | |

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# Abstract

This proposal is in alignment with the USNB comments related to this area, but expands on it by proposing starting numbers for Max Bitrate and Max CPB Size for the two tiers. It also proposes names for each tier: 1) Consumer (C), and High (H) for consideration.

This proposal suggests that the current one-table (e.g. “single-tier”) level structure for HEVC be modified to a two-tier level structure for levels four and higher, and that both tiers remain consistent for levels lower than level four. This contribution expands on earlier proposals JCT-VC I0455, JCT-VC I0472, and JCT-VC I0475 from the 9th meeting in Geneva. The first tier is a low bit rate tier labeled “Consumer” (C); the second tier is a high bit rate tier labeled “High” (H). Levels between the two tiers are not nested, **but within each tier, they are nested.** Such a structure could benefit the standard by aligning decoder complexities (based on maximum decoder performance) with the bitrate requirements of applications associated with “Consumer” and “High”. This aids in product compliance to the HEVC standard.

# Introduction

JCT-VC I0455, JCT-VC I0472, and JCT-VC I0475 each suggest that a non-nested level structure is required to support larger picture resolutions (when compared to those supported in a lower level) at a bitrate that is lower than the maximum bitrate required at the lower level. For example, in Table A-1 (replicated from JCT-VC I1003-d3; see below), Level 5, which supports the “lower” level max luma rate for 4Kp30, includes support for Level 4.3 (the “higher” level for 1080p60 requiring 50 max Mbps) and not strictly support for Level 4.2 (the “lower” level for 1080p60 requiring 30 max Mbps).   This forces Level 5 support to be higher than 50 Mbps to be consistent with level 4.3 (e.g. forcing Level 4.3 to not be higher to ensure Level 5 support is consistent) when different values may be more appropriate for the level definitions.

These contributions were discussed as reported in the 9th meeting’s meeting report available as JCTVC-I notes dD.doc. However, the nested level structure, as defined in previous drafts of the HEVC specification, was not changed, pending further study by the committee.

This proposal addresses the concerns raised in JCT-VC I0455, JCT-VC I0472, and JCT-VC I0475, i.e. that a non-nested tier approach (such as between the proposed two tier structure) is needed to align costs of decoders with performance expectations for low bitrate and high bitrate applications. A “Consumer” tier is proposed for decoders that need a low maximum performance limit that is more suitably in range of consumer performance expectations. It is important to note that within this tier, the levels are nested. This can greatly reduce the costs of consumer level decoders. A “High” tier is proposed for decoders that are used for contribution or production applications where the decoders need a higher level of performance and a higher set max performance. The increased performance between the two tiers justifies the increased costs of the decoder. It is believed that this separation is a natural division of the product market and will not cause artificial fragmentation of the market due to the differences between consumer applications contribution/production applications.

The proposal is described on the levels table (Table 1 & 2) ,respectively for each proposed tier, resulting from modifications to the existing levels table taken from the Committee Draft of the specification (Table A-1). In table 1, the consumer tier (“C”) replaces levels 4,5, and 6 with levels 4C, 5C, and 6C.

Resolutions in each level are changed to keep the Consumer tier and High tier levels in alignment. This information is only in the proposal and not proposed to be part of the permanent table. It is believed level 4 (both C and H) will handle existing HD resolutions. Level 5 will handle 4K resolutions (a natural product upgrade from HD in terms of services) at a lower bit rate level in both tiers. Lastly level 6will handle upto UHDTV with increased framerates to 120 fps and higher bit rate needs. Sublevels are created to indicate higher framerates (30, 60, 120) of the group level resolution.

Other changes on Table 1& 2 columns reflects adjustments due to resolution changes in accordance to Table A-4 picture sizes.

The proposal advocates a non-nested two tier approach for levels 4 and higher when within each tier levels are nested. It also proposesadjusted Max bitrate and Max CPBsize numbers for each level (4 above) for each respective tier..

Proposed Changes: (dropped levels:4.2, 5.2, 6.1) , 4=4C, 5=5C, 6=6C, 4.3=4U, 5.2=5U, 6.2= 6U, sublevels by framerate. Numbers suggested for the consumer and high tiers are in the proposed tables.

**Table 1: Levels Table with Consumer Tier**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **HEVC Working DraftLevel** | **Picture Resolution (information only)** | **Max luma pixel 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)** |
| **1** | QCIF or below | 552,960 | 36,864 | 128 | 2 | 6 | 350 |
| **2** | 352x240@30p  427x240@25p | 3,686,400 | 122,880 | 1,000 | 2 | 6 | 1,000 |
| **2.1&** | 640x360@30p | 6,912,000 | 230,400\* | 3,500 | 2 | 6 | 3,500 |
| **3&** | 720x480@30p,  720x576@25p, 854x480@30p,  960x544@30p | 16,588,800 | 552,960\*\* | 5,000 | 2 | 6 | 5,000 |
| **3.1** | 960x544@60p  1280x720@30p | 33,177,600 | 983,040 | 10,000 | 2 | 6 | 10,000 |
| **4C** | 1280x720@60p 1920x1088@30p  2048x1088@30p | 66,846,720 | 2,228,224\*\* | **12,000** | 4 | 6 | **12,000** |
| **4.1C** | 1920x1088@60p  2048x1088@60p | 133,693,440 | 2,228,224 | **20,000** | 4 | 6 | **20,000** |
| **5C** | 3840x2160@30p 4096x2160@30p | 267,386,880 | 8,912,896 | **20,000** | 6 | 6 | **20,000** |
| **5.1C** | 3840x2160@60p 4096x2160@60p | 534,773,760 | 8,912,896 | **40,000** | 6 | 6 | **40,000** |
| **5.2C** | 3840x2160@120p 4096x2160@120p | 1,069,547,520 | 8,912,896 | **60,000** | 6 | 6 | **60,000** |
| **6C** | 7680x4320@30p | 1,002,700,800 | 33,423,360 | **60,000** | 8 | 6 | **60,000** |
| **6.1C** | 7680x4320@60p | 2,005,401,600 | 33,423,360 | **120,000** | 8 | 6 | **120,000** |
| **6.2C** | 7680x4320@120p | 4,010,803,200 | 33,423,360 | **240,000** | 8 | 6 | **240,000** |

& Changes made from Geneva May 2012 JCT meeting

\*No A-4 Picture Size

\*\* Based upon new high resolution using table A-4 picture size (see current HEVC draft)

^ Framerates adjusted down to align 4H and 4C (HD and below) tiers

**Table 2: Levels Table with High Tier**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **HEVC Working DraftLevel** | **Picture Resolution (information only)** | **Max luma pixel 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)** |
| **1** | QCIF or below | 552,960 | 36,864 | 128 | 2 | 6 | 350 |
| **2** | 352x240@30p  427x240@25p | 3,686,400 | 122,880 | 1,000 | 2 | 6 | 1,000 |
| **2.1&** | 640x360@30p | 6,912,000 | 230,400\* | 3,500 | 2 | 6 | 3,500 |
| **3&** | 720x480@30p,  720x576@25p, 854x480@30p,  960x544@30p | 16,588,800 | 552,960\*\* | 5,000 | 2 | 6 | 5,000 |
| **3.1** | 960x544@60p  1280x720@30p | 33,177,600 | 983,040 | 10,000 | 2 | 6 | 10,000 |
| **4H^** | 1280x720@60p  1920x1088@30p  2048x1088@30p | 66,846,720 | 2,228,224 | **48,000** | 4 | 6 | **48,000** |
| **4.1H** | 1920x1088@60p  2048x1088@60p | 133,693,440 | 2,228,224 | **80,000** | 4 | 6 | **80,000** |
| **5H** | 3840x2160@30p 4096x2160@30p | 534,773,760 | 8,912,896 | **80,000** | 6 | 6 | **80,000** |
| **5.1H** | 3840x2160@60p 4096x2160@60p | 534,773,760 | 8,912,896 | **160,000** | 6 | 6 | **160,000** |
| **5.2H** | 3840x2160@120p 4096x2160@120p | 1,069,547,520 | 8,912,896 | **240,000** | 6 | 6 | **240,000** |
| **6H** | 7680x4320@30p | 1,002,700,800 | 33,423,360 | **240,000** | 8 | 6 | **240,000** |
| **6.1H** | 7680x4320@60p | 2,005,401,600 | 33,423,360 | **480,000** | 8 | 6 | **480,000** |
| **6.2H** | 7680x4320@120p | 4,010,803,200 | 33,423,360 | **960,000** | 8 | 6 | **960,000** |

& Changes made from Geneva May 2012 JCT meeting

\*No A-4 Picture Size

\*\* Based upon new high resolution using table A-4 picture size (see current HEVC draft)

^ Framerates adjusted down to align 4H and 4C (HD and below) tiers

**Table 2: Levels Table with High Tier**

Table A‑1 – Level limits (replicated from JCTVC-I1003\_d4)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **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)** |
| **1** | 552,960 | 36,864 | 128 | 2 | 6 | 350 |
| **2** | 3,686,400 | 122,880 | 1,000 | 2 | 6 | 1,000 |
| **3** | 13,762,560 | 458,752 | 5,000 | 2 | 6 | 5,000 |
| **3.1** | 33,177,600 | 983,040 | 9,000 | 2 | 6 | 9,000 |
| **4** | 62,668,800 | 2,088,960 | 15,000 | 4 | 6 | 15,000 |
| **4.1** | 62,668,800 | 2,088,960 | 30,000 | 4 | 6 | 30,000 |
| **4.2** | 133,693,440 | 2,228,224 | 30,000 | 4 | 6 | 30,000 |
| **4.3** | 133,693,440 | 2,228,224 | 50,000 | 4 | 6 | 50,000 |
| **5** | 267,386,880 | 8,912,896 | 50,000 | 6 | 6 | 50,000 |
| **5.1** | 267,386,880 | 8,912,896 | 100,000 | 8 | 6 | 100,000 |
| **5.2** | 534,773,760 | 8,912,896 | 150,000 | 8 | 6 | 150,000 |
| **6** | 1,002,700,800 | 33,423,360 | 300,000 | 8 | 6 | 300,000 |
| **6.1** | 2,005,401,600 | 33,423,360 | 500,000 | 8 | 6 | 500,000 |
| **6.2** | 4,010,803,200 | 33,423,360 | 800,000 | 6 | 6 | 800,000 |

# Patent rights declaration(s)

**Cable Television Laboratories 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).**

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