

JCTVC-I0108

High Bit Depth considerations in HEVC

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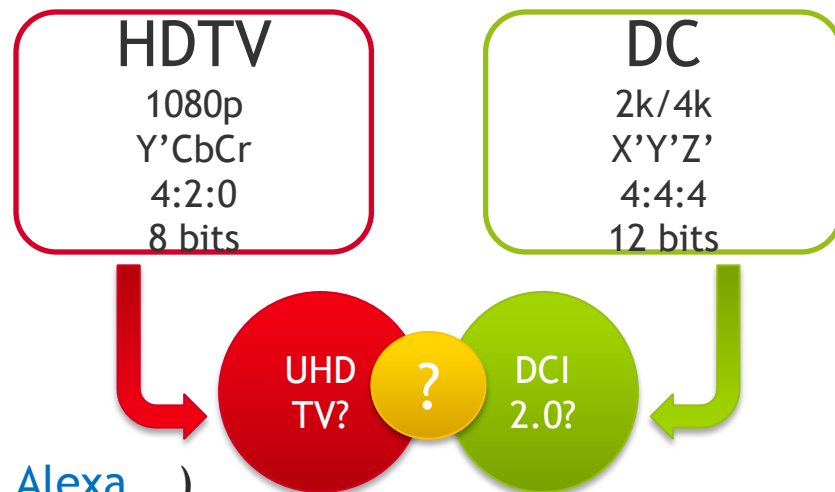
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High Bit Depth: rationale, market needs & facts

■ Convergence between broadcast & D-Cinema?

UHDTV draft	Parameter	Value
	Aspect Ratio	16x9
	Resolution	3840x2160 (4k) 7680x4320 (8k)
	Precision	10/12 bits



■ Needs for High accuracy production

- Acquisition ([Sony F65](#), [Red One 4k](#), [Arri Alexa...](#))
- Production workflow ([RAW 14/16 bits](#), and now pending IIF-ACES)

■ Needs for new distribution/contribution formats

- Prosumer encoding format (e.g. subsequent to “[AVC-Intra 10](#)”)
- Future broadcast (HDTV → full HDTV → 3DTV → **UHDTV?**)
- [HDMI 1.4a/DisplayPort support 4k 12 bits min./HDMI v2?](#) (HBD ULC profile?)
- Non-linear distribution ([Blu-ray](#), [VoD...](#))

■ Needs for High Quality rendering

- **UHDTV** ([LCD](#), [OLED...](#)), D-Cinema ([Laser vp](#))
- [10/12 bits flat panels](#)

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HEVC High Bit Depth WD/code maturity considerations

CD stage: Reference Software (HM6.0) and WD (JCT-VC-H1003_dK) are being stabilized

- High Level Syntax from H.264/AVC + PCM case
 - SPS
- Motion compensation process compliant with up to 14 bits (F537)
 - Inverse Quantization
 - Inverse Transform and Scaling
 - Interpolation
- QP wrapping and *cu_qp_delta* binarization: OK (H0053+H0736)
- SAO takes into account bitdepth larger than 8 bits
- When bit depth and its limit are considered then limit = 14 bits (AVC-legacy)
 - Weighted Prediction
 - Intra from luma prediction
 - Interpolation process
 - MC
 - ...
- Further study, influence on:
 - Deblocking?
 - ALF?
 - ...

Experiment: JM18.3 vs HM6.0 - 8/10/12/14 bits

Test material

■ 6 SVT sequences, 250 frames

- ftp://vqeg.its.blrdoc.gov/HDTV/SVT_MultiFormat/1080p50_CgrLevels_Master_SVTdec05_/
- 4K scan linear RGB → 1080p R'G'B' sgi16 (FR) → **1080p Y'CbCr 4:2:0 n bits**
 - Lanczos-3 downsampling
 - Truncate 16 bits → n bits with $n = \{8, 10, 12, 14\}$
 - **Rec. BT.709/Rec. BT.1361**

Test Conditions

- JM18.3: « HM-like » RA and AI configuration files
 - Same as in *H0360/I0409*
- HM6.0: RA, AI HE10 common conditions adapted configuration files
 - SAO, ALF, AMP, NSQT, LMChroma, RDOQ...
- BD-rate (4 QP)

Test material: SVT sequences - Class B

CrowdRun

difficult



Cplx motion
Texture
Colour
Noise

DucksTakeOff

difficult



High motion
Colour
Local texture

InToTree

easy



Slow motion
Zoom
Texture
Noise

OldTownCross

easy



Slow motion
Very textured
Noise

Seeking

Medium



High/cplx motion
Texture
Contrast

ParkJoy

difficult



High motion
Pan
Texture
Contrast

Experiment: Results

Reference: JM18.3

Tested: HM6.0

Bitdepth/ GoP	8			10			12			14		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
AI-HE	-18.3	-29.6	-23.3	-17.7	-28.4	-20.9	-17.4	-28.3	-21.0	-13.0	-21.5	-12.4
RA-HE	-33.2	-51.1	-40.1	-33.0	-47.7	-32.4	-31.4	-47.2	-32.6	x	x	x

- *x: JM18.3 issues for 5 out of 6 sequences for RA-HE 14 bit test conditions*

Comments

- 8 bits results quite consistent with I0409 (a bit below)
- Coherency between 8, 10, 12 bits comparative tests
- Performances regress for 14 bits AI but results are still encouraging
- JM18.3: Issues with RA 14 bits configuration

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Experiment: Notes

PSNR calculation

■ JM18.3

- $\text{format->max_value}[0] = (1 \ll \text{format->bit_depth}[0]) - 1;$

■ HM6.0

- $\text{maxval} = 255 * (1 \ll (\text{g_uiBitDepth} + \text{g_uiBitIncrement} - 8));$

→ We propose to harmonize with JM (full range PSNR)

JM18.3 issues

- Proposed a fix for an issue with integer promotion on 32-bit platform
- Issues RA 14 bits high QP (pending work)

Conclusion

Current High Bit Depth support in HM6.0

- Big analysis work to be performed but:
 - many modules seem to take bit depth into account
 - first results encouraging
- Stalling for AI 14 bits

Suggested actions

- Further study:
 - Market needs in terms of bit depth limit
 - « Stabilized » modules study
 - Test LowDelay cases
 - Require new test material for new classes
 - PSNR computation should be harmonized with JM
- Synchronization with:
 - Software coordinator: branch?
 - «AhG 14: chroma format support» chair: merging, extension of mandates?
- **AhG to prepare HBD support in HEVC?**