

# **JCTVC-C405r1: Summary of HEVC working draft 1 and HEVC test model (HM)**

TK Tan, Gary J. Sullivan and Jens-Rainer Ohm

3<sup>rd</sup> JCTVC Meeting: Guangzhou, CN, 7-15 October, 2010

## HEVC Test Model Overview - High Efficiency and Low Complexity Configurations

Table 1: Structure of tools forming the high efficiency and low complexity configurations of the HM

High Efficiency	Low Complexity
Coding unit tree structure (8x8 up to 64x64 luma samples)	
Prediction units	
Transform unit tree structure (maximum of 3 levels)	Transform unit tree structure (maximum of 2 levels)
Transform block size of 4x4 to 32x32 samples (always square)	
Angular intra prediction (maximum of 34 directions)	
DCT-based interpolation filter for luma samples (1/4-sample, 12-tap)	Directional interpolation filter for luma samples (1/4-sample, 6-tap)
Bi-linear interpolation filter for chroma samples (1/8-sample)	
Advanced motion vector prediction	
Context adaptive binary arithmetic entropy coding	Low complexity entropy coding phase 2
Internal bit-depth increase (4 bits)	X
X	Transform precision extension (4 bits)
Deblocking filter	
Adaptive loop filter	X

# HEVC Test Model Overview – high level summary by category

- Coding Structure
  - Coding unit tree structure (CU)
  - Prediction unit (PU)
  - Transform unit tree structure / Residual quadtree (RQT)
- Intra Prediction
  - Angular intra prediction
- Inter Prediction
  - Luma interpolation filters
    - 1/4-sample, 12-tap DCT-based interpolation filter (DCT-IF) for high efficiency configuration (HE)
    - 1/4-sample, 6-tap directional interpolation filter (DIF) for low complexity configuration (LC)
  - Chroma interpolation filter
    - 1/8-sample, bi-linear interpolation filter for both HE and LC
  - Advanced motion vector prediction
  - CU merging + CU skip / direct
- Transforms
  - Transform block size of 4x4 to 32x32 transforms (always square)
- Entropy Coding
  - Context adaptive binary arithmetic coding (CABAC) for high efficiency configuration
  - Low complexity entropy coding (LCEC) phase 2 for low complexity configuration
- Loop Filter
  - Deblocking filter
  - Adaptive loop filter (ALF) for high efficiency configuration
- Others
  - Higher level syntax

# HEVC Test Model – Coding Structure

- Tools adopted in HM
  - Coding unit tree structure (CU)
  - CU splitting into PUs
  - Transform unit tree structure / RQT (JCTVC-C311, JCTVC-C319)
    - 3-level quadtree for high efficiency configuration
    - LCEC phase 2 + 2-level quadtree is equivalent to LCEC phase 2 with RQT off for low complexity configuration
      - Includes Qualcomm coded block pattern (CBP) flag
    - Encoder setting for fast intra encode as per JCTVC-C311
      - HHI\_RQT\_INTRA\_SPEEDUP = 1
      - HHI\_RQT\_INTRA\_SPEEDUP\_MOD = 0
      - (Slower search for Intra modes to remain in software)
    - Same maximum quadtree depth for luma and chroma
- TMuC features for further investigation (Not in the HM)
  - Asymmetric motion partitions (AMP)
  - Geometric partitioning

Note: Items in red are features that are currently not in the TMuC 0.8 software but shall be integrated in the TMuC 0.9 / HM1.0 software.

# HEVC Test Model – Intra Prediction

- Tools adopted in HM
  - Simplified unified intra prediction (JCTVC-C042)
  - Encoder modification for intra prediction search (JCTVC-C207)
  
- TMuC features for further investigation (Not in the HM)
  - Adaptive intra smoothing (AIS)
    - Note: For HM, AIS is turned off and DEFAULT\_IS is set to 0
  - Combined intra prediction (CIP)
  - Planar prediction
  - Edge base prediction

Note: Items in red are features that are currently not in the TMuC 0.8 software but shall be integrated in the TMuC 0.9 / HM1.0 software.

# HEVC Test Model – Inter Prediction

- Tools adopted in HM
  - Luma interpolation filters
    - 1/4-sample, 12-tap DCT-based interpolation filter (DCT-IF) for high efficiency configuration (HE)
    - 1/4-sample, 6-tap directional interpolation filter (DIF) for low complexity configuration (LC)
  - Chroma interpolation filter
    - 1/8-sample, bi-linear interpolation filter for both HE and LC (based on follow-up reflector email agreement 27 Oct.)
  - Bi-direction rounding control
    - Rounding offset for bi-predictive rounding is signalled. (0 or 1)
      - Enable this when internal bit depth increase (IBDI) is off and disable when IBDI is on.
    - Encoder only modifications for software speedup. (JCTVC-C253)
  - CU merging + CU skip / direct
  - Advanced motion vector prediction
  - Bi-directional prediction for temporal level 0 (JCTVC-C278, JCTVC-C285)
- TMuC features for further investigation (Not in the HM)
  - Interleaved motion vector prediction (IMVP)
  - Adaptive motion vector resolution (AMVRES)
  - Motion vector prediction scaling
  - PU merging + modified CU skip / direct
  - Partition based illumination compensation (PBIC).

Note: Items in red are features that are currently not in the TMuC 0.8 software but shall be integrated in the TMuC 0.9 / HM1.0 software.

# HEVC Test Model – Transforms

- Tools adopted in HM
  - Transform block size of 4x4 to 32x32 samples (always square)
  
- TMuC features for further investigation (Not in the HM)
  - Mode dependent directional transform (MDDT)
  - Rotational transform (ROT)
  - Transform block size of 64x64 samples

# HEVC Test Model – Entropy Coding

- Tools adopted in HM
  - Context adaptive binary arithmetic coding (CABAC) for high efficiency configuration
  - Low complexity entropy coding (LCEC) phase 2 for low complexity configuration
  - Coefficient sign PCP (JCTVC-B088 Section 3.2)
  - Coefficient level BinIdx 0 PCP (JCTVC-B088 Section 3.3)
  - Coded block flag signaling in VLC (JCTVC-C262)
  - Coded block flag redundancy removal (JCTVC-C277)
  - HHI transform coefficient coding
- TMuC features for further investigation (Not in the HM)
  - Probability interval partitioning entropy (PIPE) coding
  - Variable length to variable length (V2V) codes

Note: Items in red are features that are currently not in the TMuC 0.8 software but shall be integrated in the TMuC 0.9 / HM1.0 software.

# HEVC Test Model – Loop Filter

- Tools adopted in HM
  - Deblocking filter
  - Adaptive loop filter (ALF) for high efficiency configuration
  - Signaling ALF flag in slice header
  
- TMuC features for further investigation (Not in the HM)
  - 3-input ALF

# HEVC Test Model – Others

- Tools adopted in HM
  - Higher level syntax (as decided in Geneva, July 2010)
  - Internal bit depth increase (IBDI) with 4 bits added precision for 8-bit per sample decoding
  - Transform precision extension (TPE) with 4 bits added precision for 8-bit per sample decoding
  - Rate distortion optimized quantization (RDOQ) (encoder only)