Versatile Video Coding (VVC)
on the final stretch

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Versatile Video Coding (VVC)
Joint ITU-T (VCEG) and ISO/IEC (MPEG) project

**Coding Efficiency**
- 50% over H.265/HEVC
- HD / UHD / 8K resolutions
- 10bit / HDR

**Versatility**
- Screen content
- Adaptive resolution change
- Independent sub-pictures
VVC – Coding Efficiency

History of Video Coding Standards

Bit-rate Reduction: 50%

H.265 / MPEG-HEVC (2013)


H.261 (1991)

JPEG (1990)
VVC – Coding Efficiency

History of Video Coding Standards

Do we need more efficient video coding?
"The efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource."
VVC – Coding Efficiency

Target for the final VVC standard

Bit-rate Reduction Target: 50%
VVC – Timeline

2015 Oct. – Exploration Phase

• Joint Video Exploration Team (JVET) of ITU-T VCEG and ISO/IEC MPEG established October ’15 in Geneva
• Joint Video Exploration Model (JEM) as software playground to explore new coding tools
• 34% bitrate savings for JEM relative to HEVC provided evidence to start a new joint standardization activity with a…

2017 Oct. – Joint Call for Proposals (CfP)

• Submit bitstreams and decoded video for proposed video coding technology
• Compare submission with HEVC anchor for given sequences, bitrates and coding conditions

2018 Apr. – Development Phase

• Subjective evaluation results of submitted CfP responses and HEVC anchor
• Lean initial starting point of standard development

2020 Jul. – Final Standard
VVC – Call for Proposals

Results

- JVET received submissions from 32 organizations.
- 40% or more bitrate savings in terms of PSNR over HEVC were shown.
- All submissions were superior in terms of subjective quality than...
  - HEVC (in most test cases).
  - JEM (in a relevant number of test cases).
VVC – Call for Proposals

Subjective testing result example

HEVC anchor

JEM

Best performing
(for this sequence)

SunsetBeach (UHD, HLG)

Mean Opinion Score (MOS)

JVET-J0080: “Results of Subjective Testing of Responses to the Joint CfP on Video Compression Technology with Capability beyond HEVC”, 10th JVET Meeting, San Diego, April 2018
VVC – Development

Draft 1 and First Test Model (VTM-1.0)

• Start off with a clean slate
• Add quadtree plus multi-type tree block partitioning (QT+MTT)
  • Fundamental impact on all coding tools to be added
  • Most common partitioning scheme among all CfP submissions
• VVC Test Model (VTM) as reference implementation of VVC specification draft
• Test promising coding tools from CfP on that lean basis (efficiency / complexity aspects)
• Agree on adding tested coding tools until sufficient bitrate reduction is achieved
VVC – Development

Draft 6 and VTM-6.1 - New coding tools for coding efficiency

- Flexible Block Partitioning with Multi-type Tree (MTT)
- Bi-prediction with CU weights (BCW)
- Separate Tree for Luma and Chroma (CST)
- Decoder-side motion vector refinement (DMVR)
- Dependent Quantization (DQ)
- Symmetric motion vector difference (SMVD)
- Joint coding of chrominance residuals (JCCR)
- Sub-block transform (SBT)

Many incremental improvements of
classic hybrid video coding design

- Affine Motion Compensation
- Intra sub-partitioning (ISP)
- Subblock-based Temporal Merging Candidates
- Matrix based intra prediction (MIP)
- Adaptive motion vector resolution (AMVR)
- Cross-component Linear Model (CCLM)
- Triangular partition mode (TPM)
- Luma mapping with chroma scaling (LMCS)
- Bi-directional optical flow (BDOF)
- Transform Skip Residual Coding (TSRC)
- Merge with MVD (MMVD)
- Quantized residual DPCM …
VVC – Coding Efficiency

VVC reference software (VTM) vs. HEVC reference software (HM)

Same ball park as HEVC vs. AVC

Subjective gains expected to be higher (to be confirmed)
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Done!

Versatility
Screen content
Adaptive resolution change
Independent sub-pictures
VVC – Versatility

Screen content coding (SCC)

• **Application:** new emerging content
  - Gaming
  - Screen sharing / remote desktop
  - ...

• **Problem:** Video codecs typically optimized for natural video (different signal characteristic)

• **Solution:** Special screen content coding tools

  HEVC v4 SCC extensions -> not in main profile!

  VVC supports SCC already in v1
VVC – Versatility

Reference picture resampling (RPR)

• **Application:** Adaptive streaming with resolution switching

• **Problem:** Pictures with different resolutions cannot reference each other in inter-picture prediction -> reduces coding efficiency

• **Solution:** Resample reference picture in case of different resolutions

VVC supports reference picture resampling

More efficient resampling filters currently under investigation

RPR as **enabler for spatial scalability** in VVC v1 (exact design under investigation)
VVC – Versatility

Independent sub-pictures

- **Application**: Tiled streaming of 360-degree videos

- **Problem**: Managing a decoder pixel budget dynamically post-encoding
  -> throwing 24K video (parts) at a 4K decoder

- **Solution**: More efficient coding of independent sub-pictures (in-picture padding)
  Flexible block addressing for easier extraction and merging of sub-pictures
  HLS design to avoid slice header rewriting
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Done!

Versatility
- Screen content
- Adaptive resolution change
- Independent sub-pictures

Almost Done!
Versatile Video Coding (VVC)

Summary

- **Coding Efficiency** – VVC Test Model 6.1 over HEVC (HM)
  - 38% PSNR-based bitrate reduction for HD and UHD
  - 8.9x encoder and 1.6x decoder runtime

- **Versatility** – enabled by:
  - Screen content coding tools (gaming, screen sharing, …)
  - Reference picture resampling (adaptive streaming)
  - Potential spatial scalability using RPR filters
  - Independent sub-pictures (360 video, ROI)

- Final Standard by July 2020
Thank you very much!

Further Information:

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