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

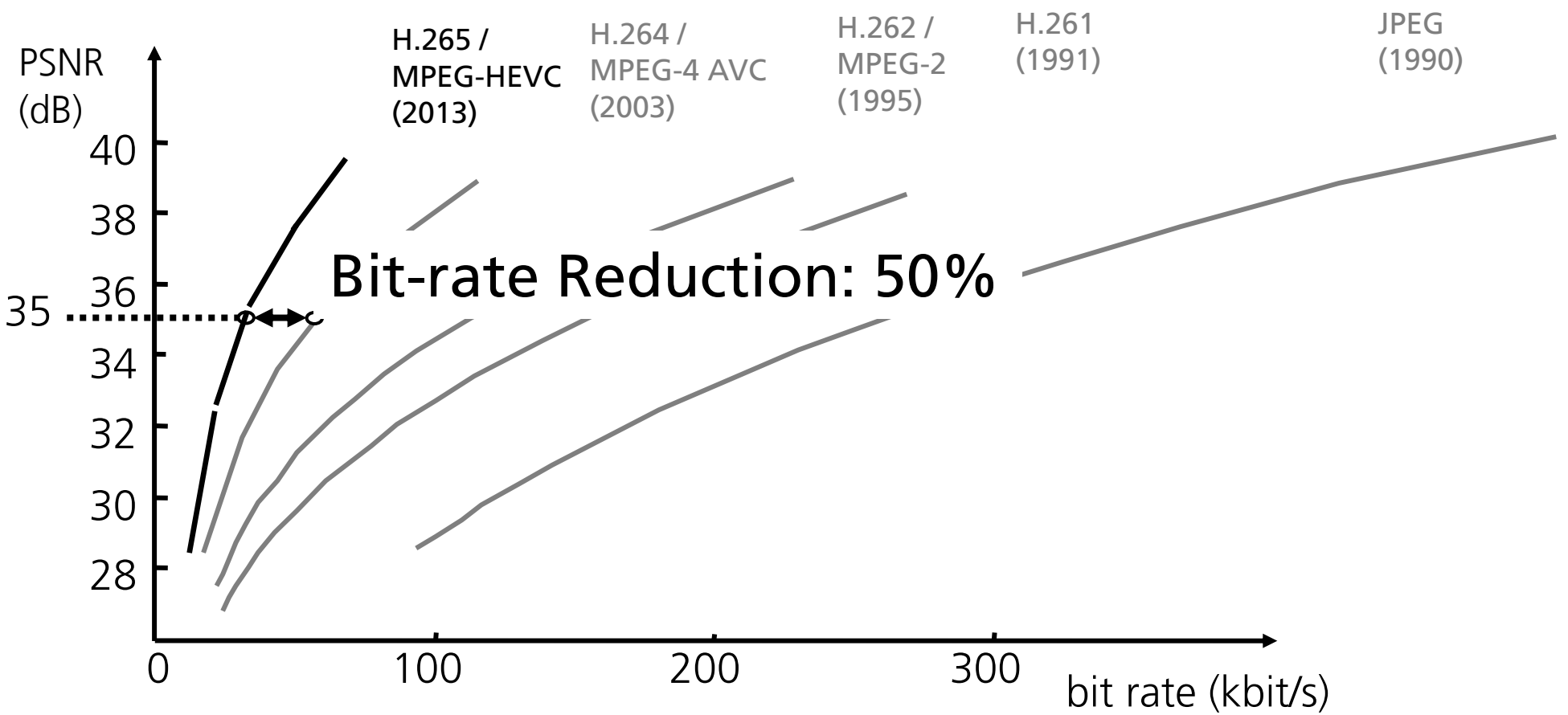
Adaptive resolution change

Scalability

Tile-based streaming

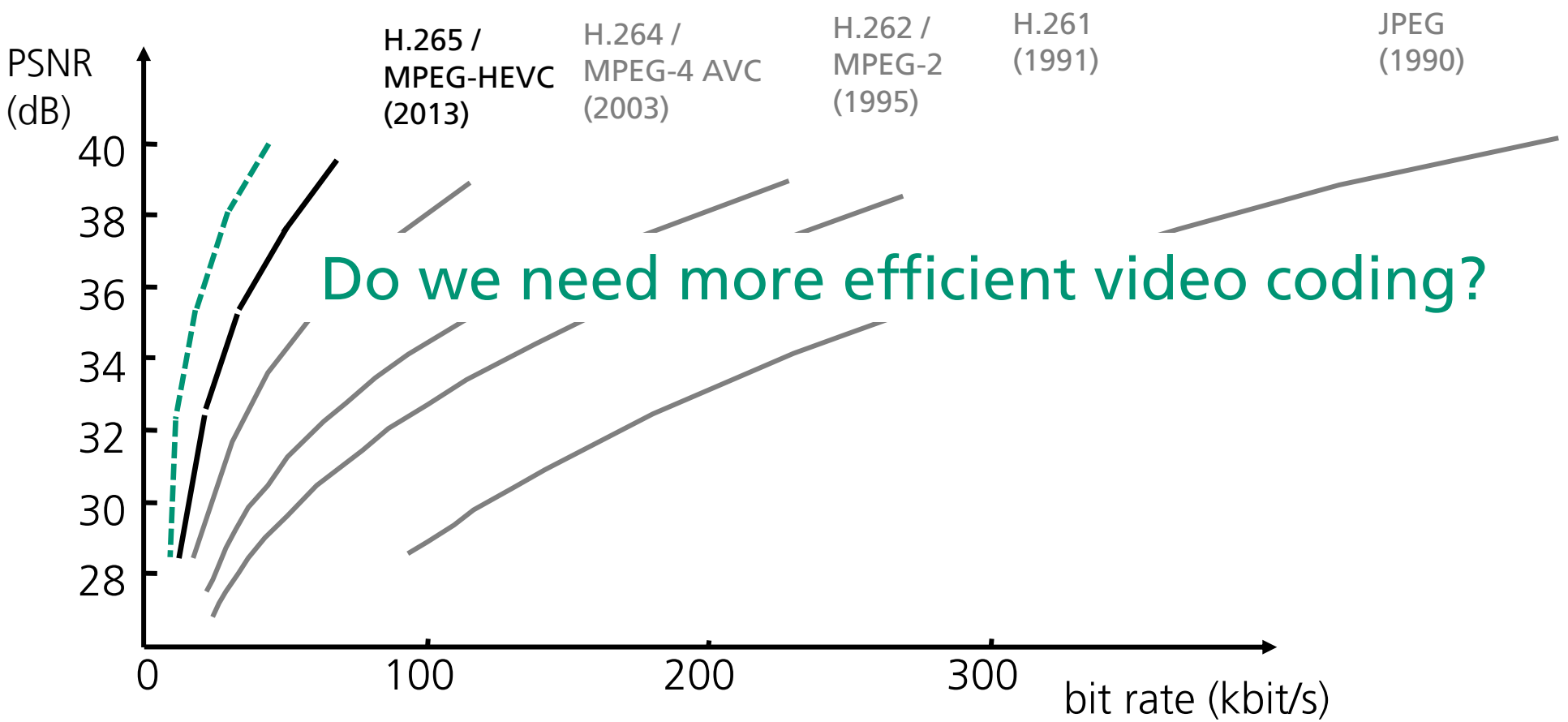
VVC – Coding Efficiency

History of Video Coding Standards



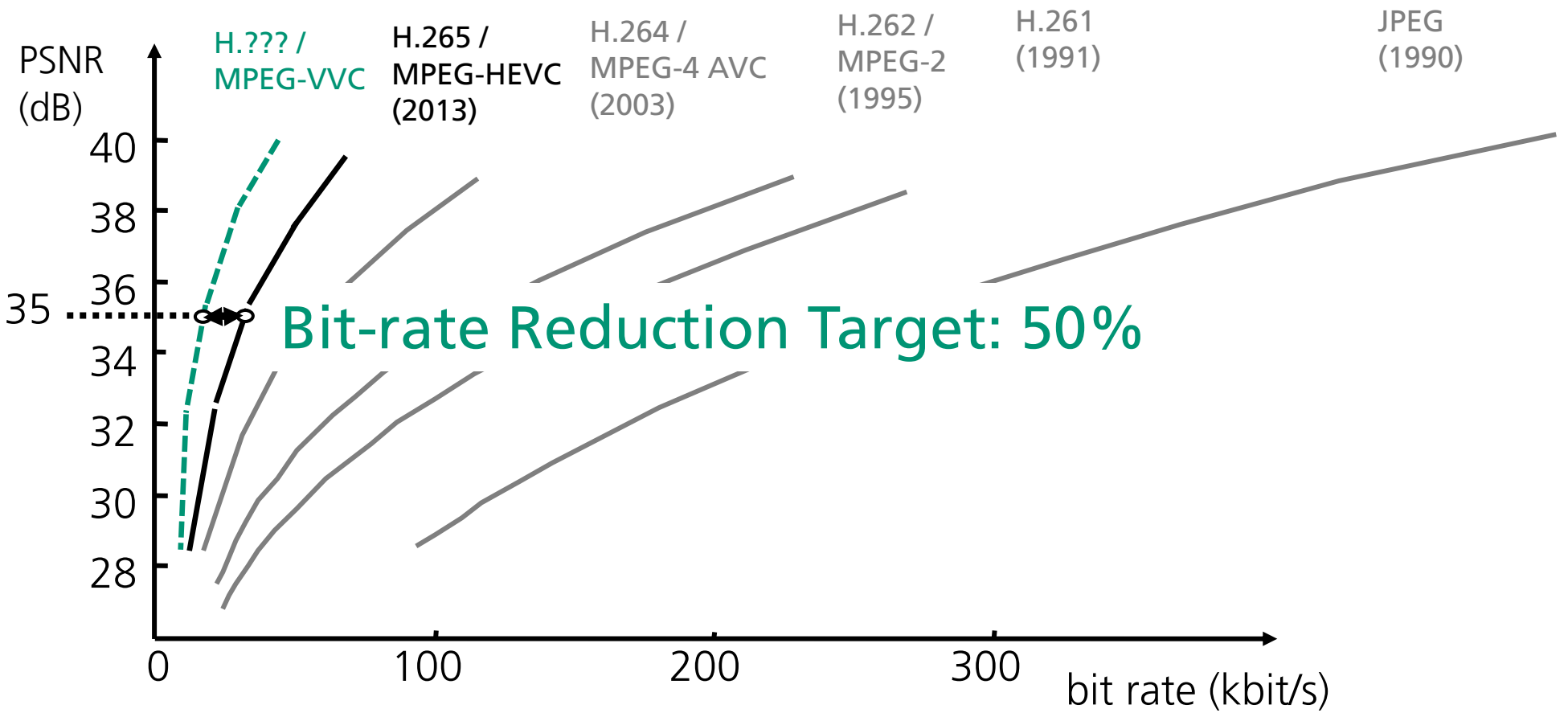
VVC – Coding Efficiency

History of Video Coding Standards



VVC – Coding Efficiency

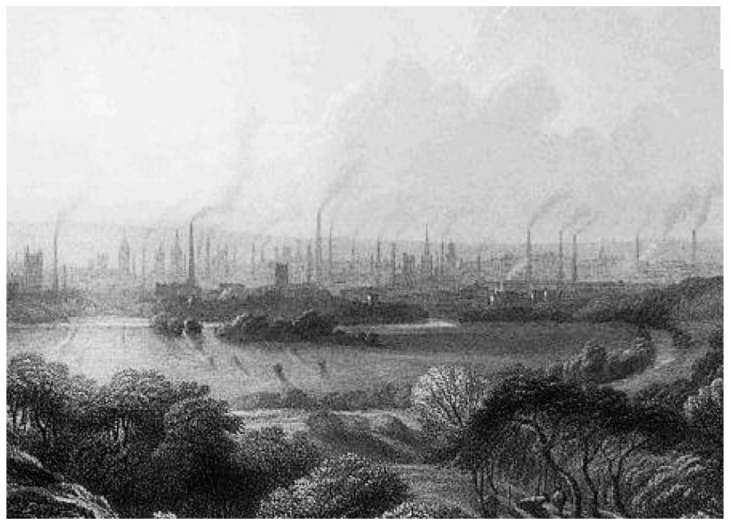
Target for the final VVC standard



VVC – Coding Efficiency

Jevons Paradox

"The efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource."



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

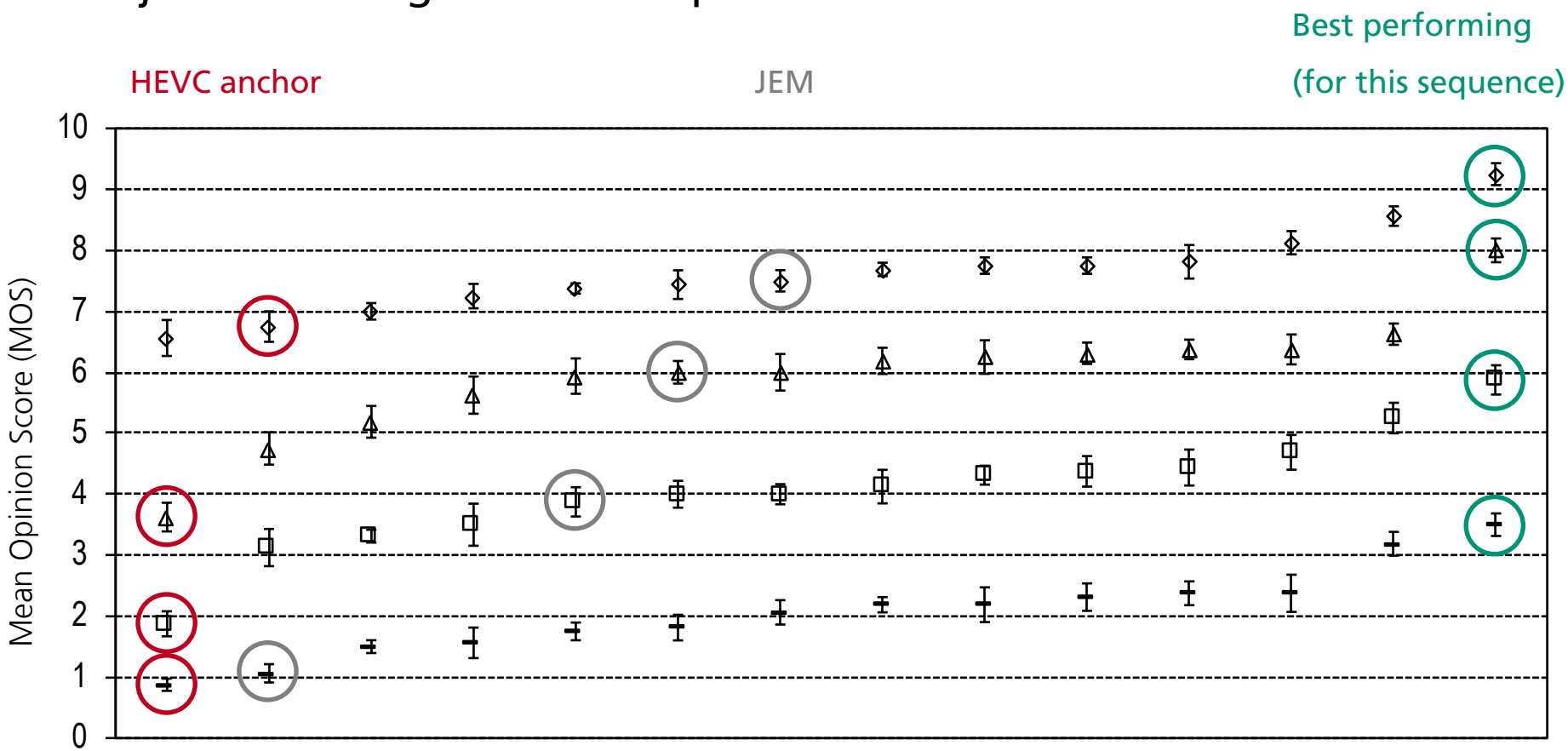
VVC – Call for Proposals

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



SunsetBeach (UHD, HLG)

◇ 10 Mbit/s

△ 6 Mbit/s

□ 3 Mbit/s

– 1.5 Mbit/s

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

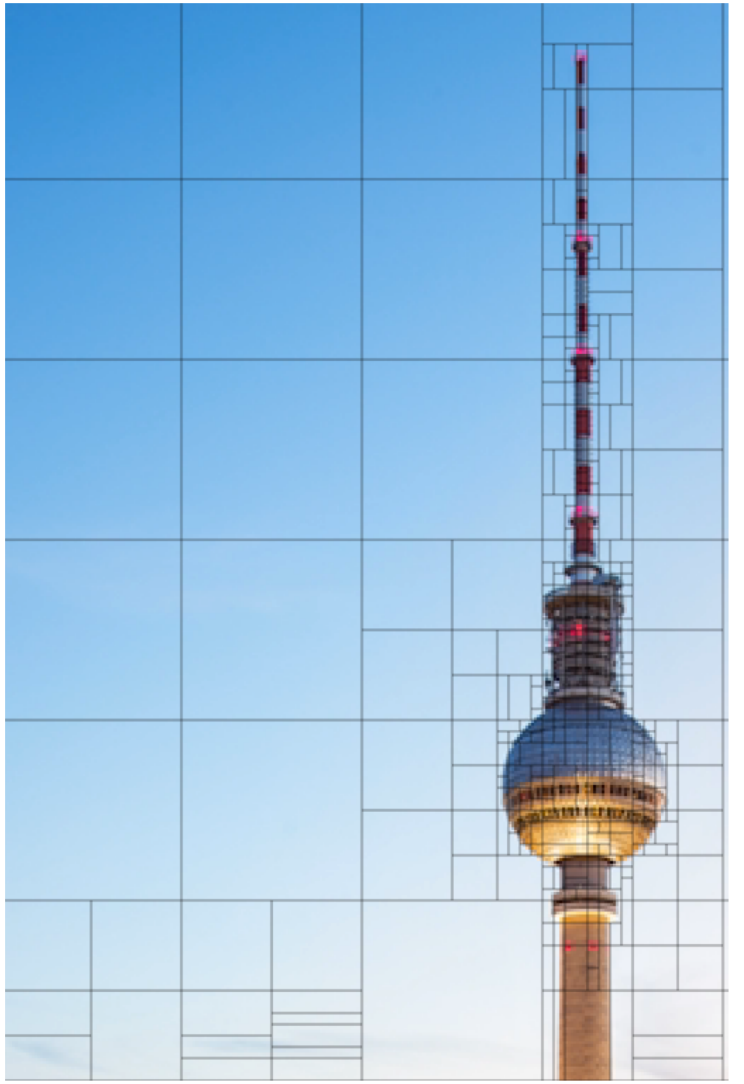
VVC – Development

Draft 7 and VTM-7 - New coding tools for coding efficiency

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

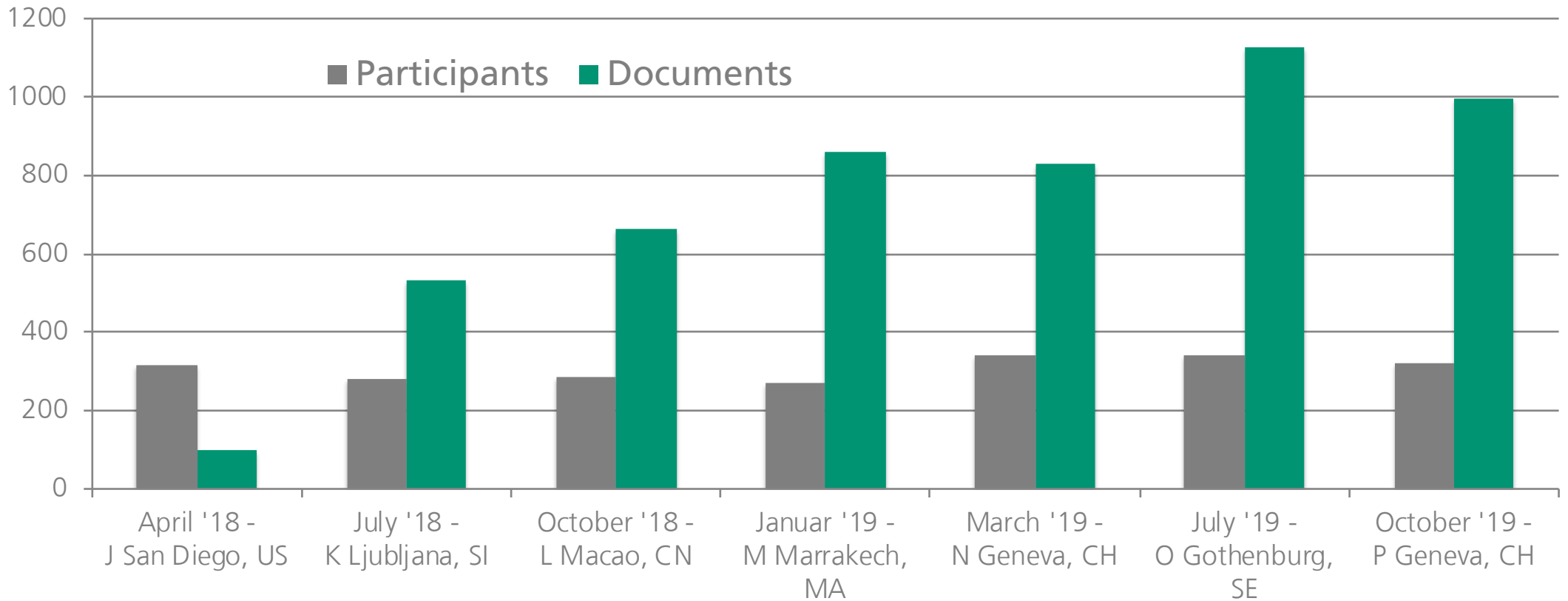
Many incremental improvements of classic hybrid video coding design

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



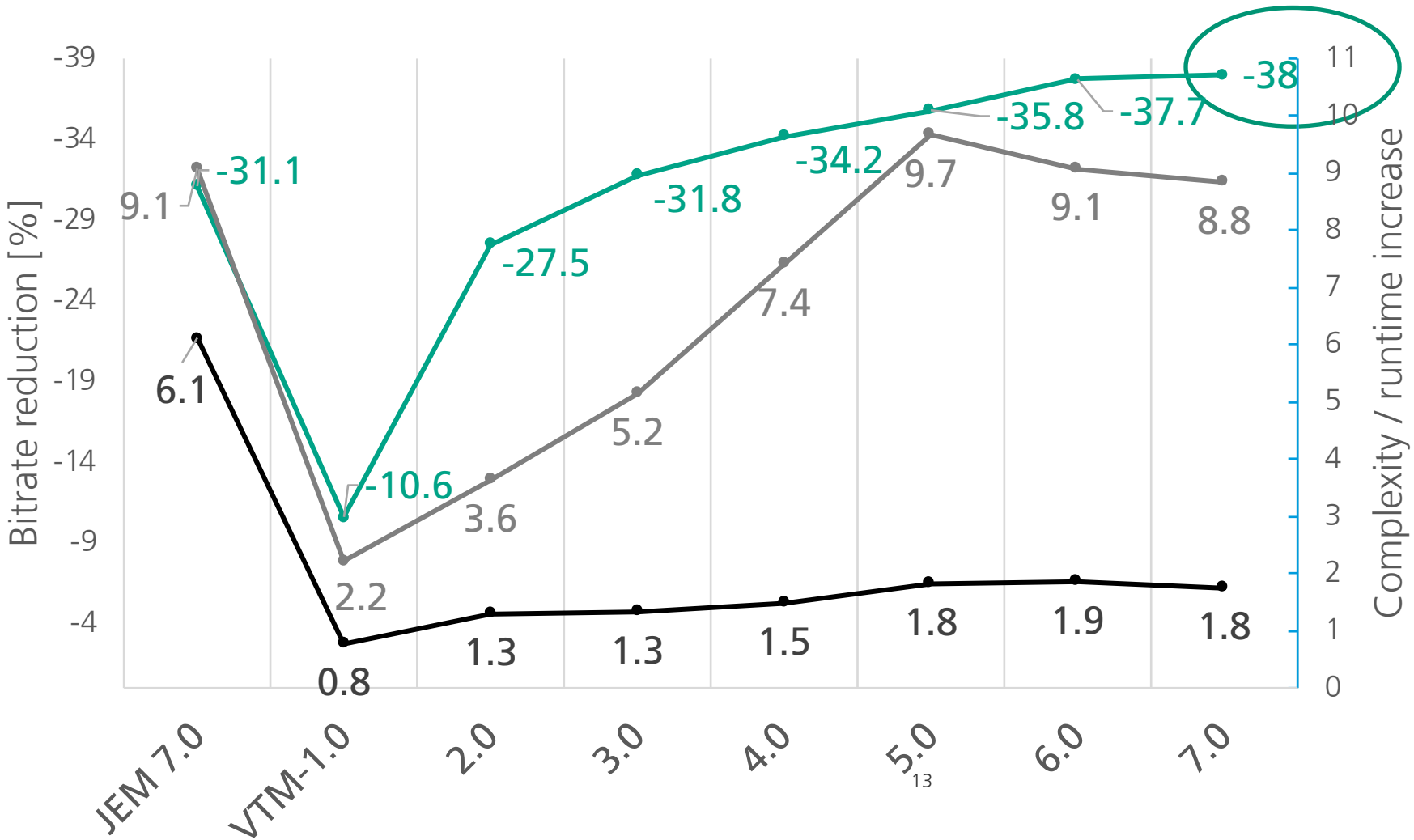
VVC – Development

JVET Meetings



VVC – Coding Efficiency

VVC reference software (VTM) vs. HEVC reference software (HM) – HD & UHD

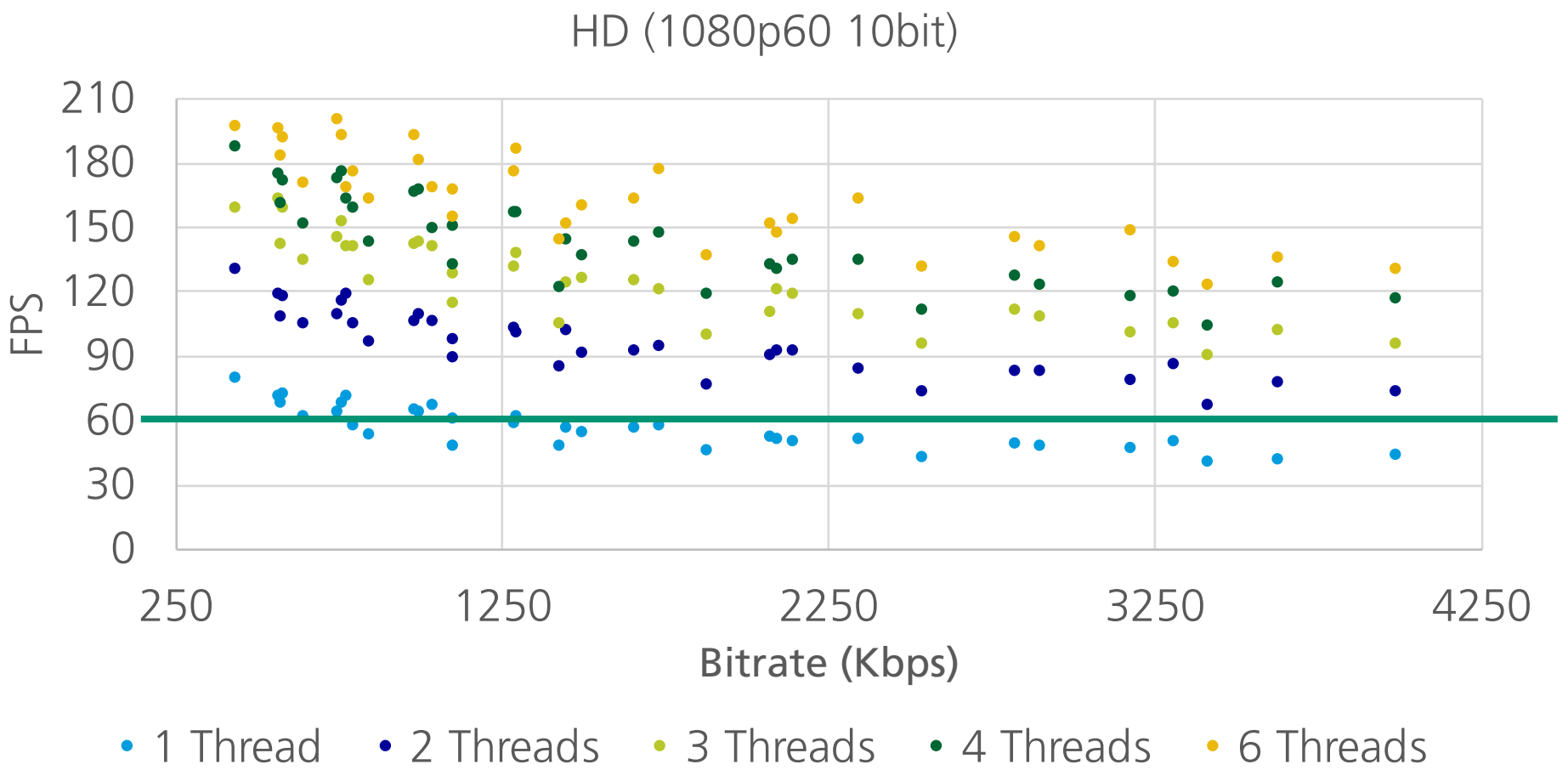


Same ball park as HEVC vs. AVC

Subjective gains expected to be higher (to be confirmed)

VVC – Coding Efficiency

Fraunhofer HHI live SW decoder on a laptop



Demo
@ IBC 2019
Fraunhofer
booth

2 threads
>60 fps

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Done!

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Versatility

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Adaptive resolution change

Scalability

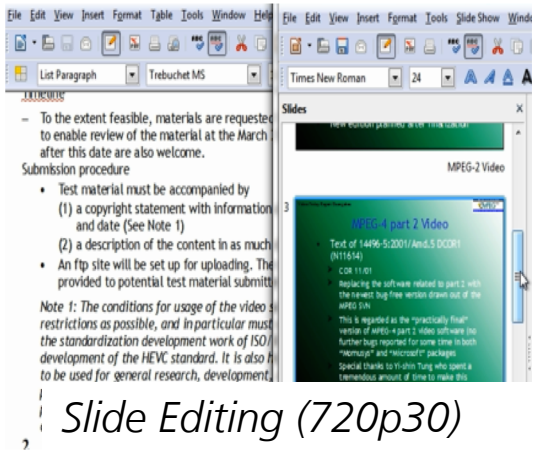
Tile-based streaming

VVC – Versatility

Screen content coding (SCC)

- Application: new emerging content
  - Gaming
  - Screen sharing / remote desktop
  - …

Arena of Valor (1080p60)



Slide Editing (720p30)

- 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

Adaptive resolution change

- 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 (RPR)

  Upsampling: Interpolation filters from regular motion compensation

  Downsampling: Two new filters for 1.5x and 2x downsampling

  RPR as enabler for spatial scalability in VVC v1

VVC – Versatility

Scalability

- Application: Scalable coding with a base + enhancement layer for low / high:
  - Framerate, e.g. 50fps | 100fps (temporal)
  - Resolution, e.g. HD | UHD (spatial)
  - Bitrate, e.g. 1 | 4 MBit/s (quality)
- Problem: Requires support for independent base + dependent enhancement layer
- Solution: Multi-layer Coding

VVC – Versatility

Tile-based streaming

- 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!

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Adaptive resolution change

Almost Done!

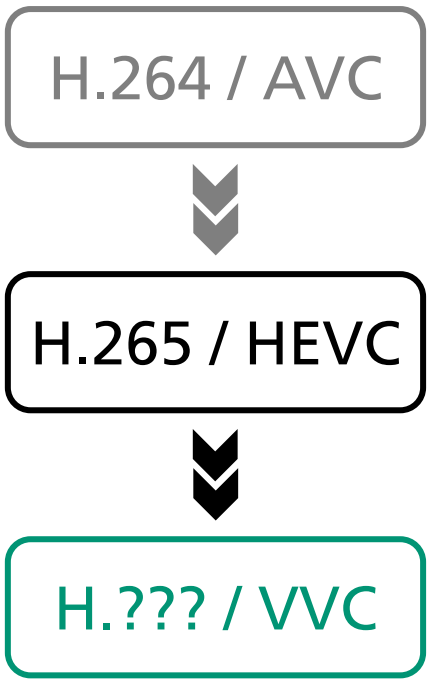
Scalability

Tile-based streaming

Versatile Video Coding (VVC)

Summary

- Coding Efficiency – VVC Test Model 7.0 over HEVC (HM)
  - 38% PSNR-based bitrate reduction for HD and UHD
  - 8.8x encoder and 1.8x decoder runtime
- Versatility – enabled by:
  - Screen content coding tools (gaming, screen sharing,…)
  - Reference picture resampling (adaptive streaming)
  - Multi-layer coding (spatial, temporal, and quality scalability)
  - Independent sub-pictures (tile-based streaming of 360 video, ROI)
- Final Standard by July 2020



Thank you very much!

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