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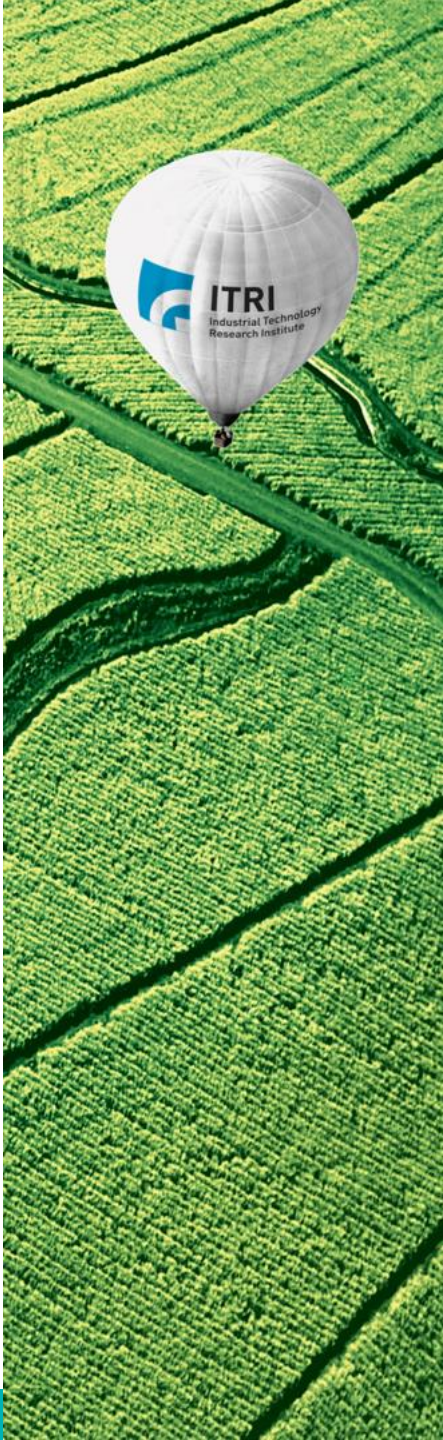
H.266視訊標準進程

林敬傑

29th October 2021



Outline

- Introduction of Versatile Video Coding(VVC)
- Verification results of VVC
- Extensions and explorations of VVC

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Joint Video Expert Team (JVET)

- MPEG & VCEG
  - Joint Video Exploration Team in October 2015
  - After CfP in April 2018, transitioned into the Joint Video Experts Team
- Target: **50% bit-rate saving than HEVC**
- The new video standard was named **Versatile Video Coding (VVC)**
  - MPEG-I Part 3, ISO/IEC DIS 23090-3
- The reference software for VVC is the VVC Test Model (VTM)

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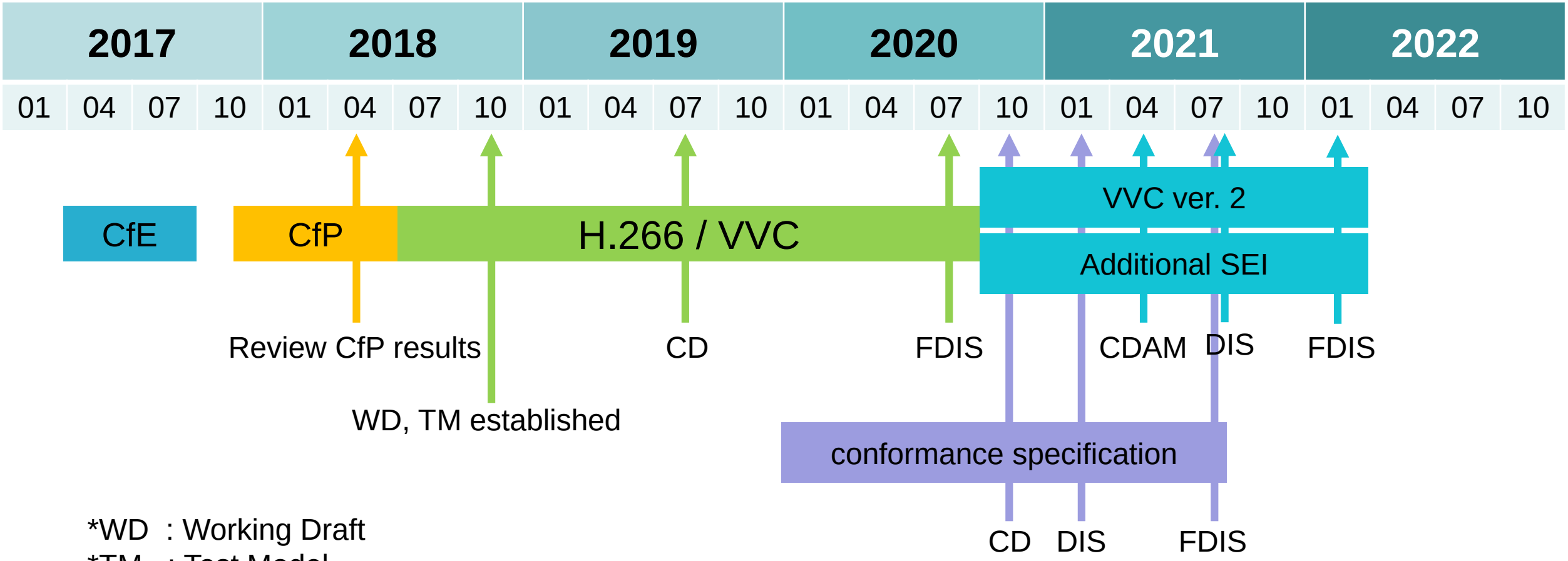
H.266 Timeline



*WD : Working Draft
*TM : Test Model
*CD : Committee Draft
*FDIS: Final Draft International Standard

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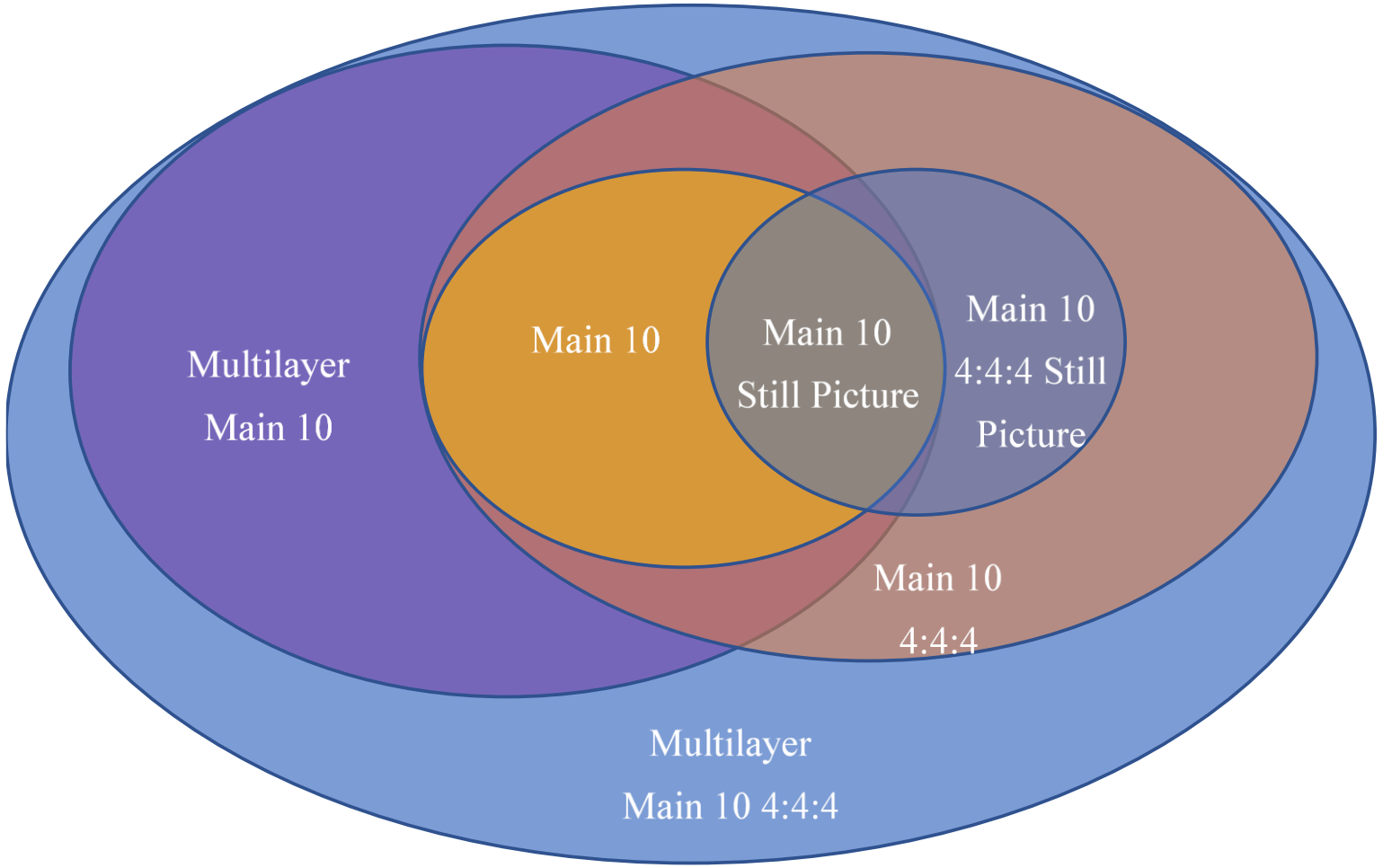
VVC Profiles

- Profiles for Version 1 (6 profiles)



Source: https://www.cs.brandeis.edu/~dcc/Programs/Program2021KeynoteSlides-Sullivan.pdf

Primary design characteristics of VVC version 1

Coding Efficiency

~50% saving over H.265/HEVC

Emph. HD / UHD / 8K resolutions
Emph. HDR / WCG
Eph. 10bit

Versatility

Rendered “screen” content coding
Adaptive resolution changes
Independent sub-pictures
Tiles, slices and wavefronts
Layered multistream & scalability
Bitstream extraction and merging
360° video projection handling
Random access & splicing features
Gradual decoding refresh

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Source: https://www.cs.brandeis.edu/~dcc/Programs/Program2021KeynoteSlides-Sullivan.pdf

Performance comparison(1/3)

- VTM 13 over HM 16.24rc1(new)

	All Intra Main10				
	Over HM-16.24rc1				
	Y	U	V	EncT	DecT
Class A1	-29.03%	-32.17%	-34.07%	1656%	170%
Class A2	-29.29%	-23.92%	-21.06%	2657%	182%
Class B	-21.73%	-26.96%	-30.76%	2872%	187%
Class C	-22.54%	-18.95%	-22.70%	4026%	195%
Class E	-25.75%	-25.91%	-24.45%	2369%	179%
Overall	-25.06%	-25.37%	-26.85%	2700%	184%
Class D	-18.46%	-13.31%	-13.41%	4749%	166%
Class F	-39.33%	-39.73%	-42.22%	4883%	178%

	Random access Main10				
	Over HM-16.24rc1				
	Y	U	V	EncT	DecT
Class A1	-39.74%	-39.41%	-46.15%	654%	165%
Class A2	-43.15%	-40.53%	-39.75%	727%	184%
Class B	-36.20%	-48.61%	-47.19%	723%	169%
Class C	-32.85%	-34.70%	-36.64%	997%	183%
Class E					
Overall	-37.41%	-41.45%	-42.68%	773%	175%
Class D	-30.96%	-31.11%	-30.96%	1128%	173%
Class F	-45.76%	-49.18%	-50.10%	560%	159%

	Low delay B Main10				
	Over HM-16.24rc1				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-29.24%	-34.80%	-32.41%	751%	162%
Class C	-25.89%	-17.42%	-17.95%	916%	173%
Class E	-28.73%	-33.03%	-26.38%	366%	147%
Overall	-28.00%	-28.56%	-26.08%	670%	161%
Class D	-25.01%	-12.57%	-11.79%	953%	182%
Class F	-40.20%	-41.56%	-41.87%	490%	143%

	Low delay P Main10				
	Over HM-16.24rc1				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-33.97%	-37.79%	-34.99%	701%	171%
Class C	-27.68%	-17.28%	-18.05%	844%	191%
Class E	-32.32%	-36.86%	-30.30%	366%	152%
Overall	-31.46%	-30.72%	-28.17%	634%	172%
Class D	-26.32%	-11.99%	-10.87%	890%	189%
Class F	-39.97%	-41.10%	-41.48%	527%	149%

Performance comparison(2/3)

- PSNR-based Common Test Conditions BD-Rate savings relative to HEVC reference software (10 bit)

vs HM	AI			RA			LDB			LDP		
	gain	Enc.	Dec.	gain	Enc.	Dec.	gain	Enc.	Dec.	gain	Enc.	Dec.
VTM 1.0	4%	9.6X	1.1X	8%	2.2X	0.8X	8%	1.6X	0.8X	9%	1.5X	0.9X
VTM 2.0	18%	18X	1.6X	23%	3.7X	1.3X	18%	3.2X	1.3X	22%	2.9X	1.3X
VTM 3.0	19%	19X	1.6X	27%	5.3X	1.3X	21%	4.4X	1.2X	24%	3.7X	1.2X
VTM 4.0	21%	22X	1.7X	32%	8X	1.5X	23%	6.6X	1.4X	27%	5.8X	1.5X
VTM 5.0	23%	34X	1.9X	33%	10X	1.9X	25%	7.4X	1.5X	28%	6.9X	1.6X
VTM 6.0	24%	27X	2.0X	35%	10X	1.9X	25%	7.7X	1.7X	29%	7.4X	1.8X
VTM 7.0	24%	27X	1.8X	35%	9.5X	1.8X	29%	6.9X	1.7X	33%	6.4X	1.8X
VTM 8.0	24%	31X	2.2X	35%	10.7X	2X	30%	7.7X	1.7X	33%	7.0X	1.8X
VTM 9.0	25%	27X	2.0X	36%	10X	1.9X	31%	7.5X	1.7X	34%	6.8X	1.7X
VTM10.0	25%	26X	1.7X	36%	8.6X	1.6X	31%	6.6X	1.4X	34%	6.2X	1.5X
VTM11.0	25%	26X	1.8X	41%	8X	1.6X	31%	6.6X	1.5X	34%	6.2X	1.6X
VTM12.1	25%	26X	1.8X	38%	8X	1.7X	28%	6.8X	1.6X	31%	6.3X	1.7X
VTM13	25%	27X	1.8X	37%	8X	1.8X	28%	6.7X	1.6X	31%	6.3X	1.7X

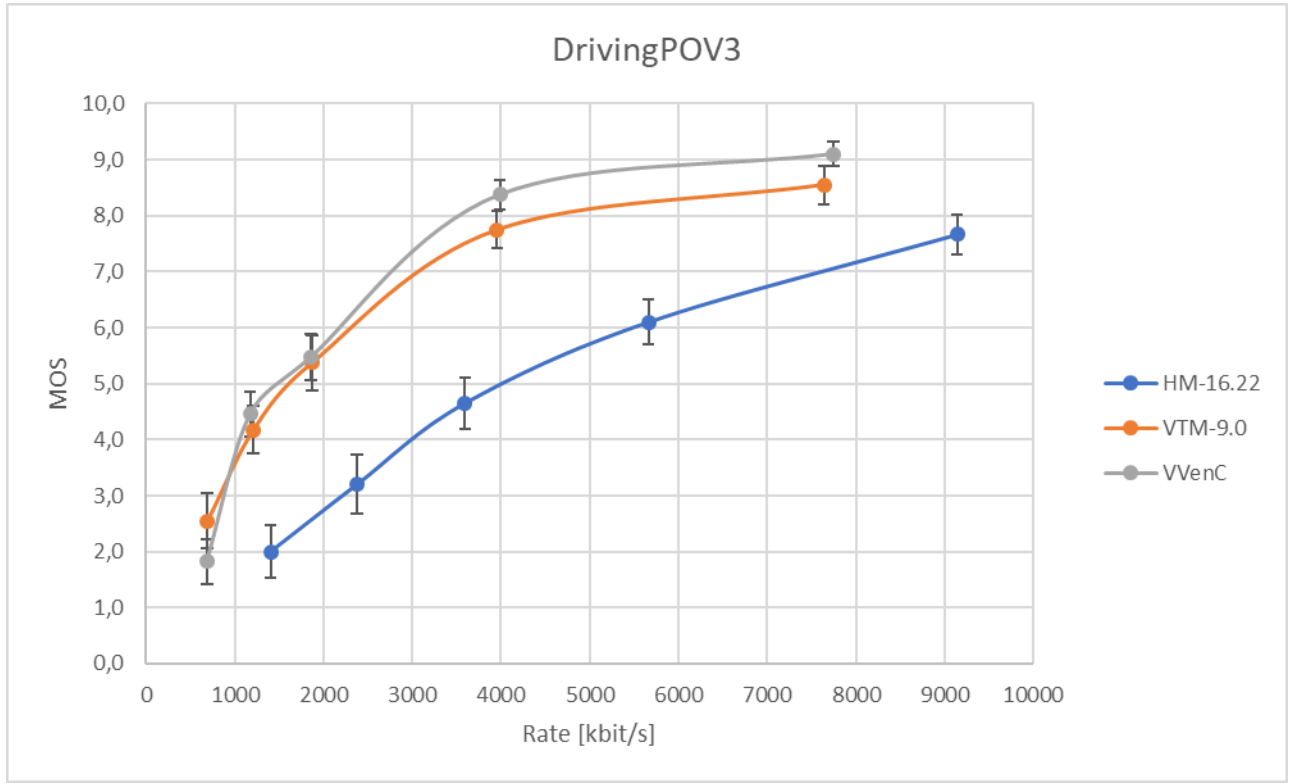
Performance comparison (3/3)

- PSNR-based Common Test Conditions BD-Rate savings relative to VTM reference software (10 bit)

	AI			RA			LDB			LDP		
	gain	Enc.	Dec.	gain	Enc.	Dec.	gain	Enc.	Dec.	gain	Enc.	Dec.
VTM 2.0 vs. VTM 1.0	14.5%	1.9X	1.5X	16.1%	1.7X	1.5X	10.8%	2.0X	1.5X	14.1%	1.9X	1.4X
VTM 3.0 vs. VTM 2.0	1.6%	1X	1X	5.8%	1.4X	1X	3.4%	1.4X	0.9X	3.3%	1.2X	0.9X
VTM 4.0 vs. VTM 3.0	2.4%	1.1X	1X	5.5%	1.5X	1.2X	3.6%	1.5X	1.1X	3.6%	1.6X	1.1X
VTM 5.0 vs. VTM 4.2	2.5%	1.6X	1X	2.4%	1.3X	1.1X	1.2%	1.1X	1.1X	1.5%	1.2X	1.1X
VTM 6.0 vs. VTM 5.2	1.4%	0.8X	1X	2.3%	0.9X	1X	0.7%	1.1X	1.1X	1.5%	1.1X	1.1X
VTM 7.0 vs. VTM 6.2	0.2%	1X	1X	-0.1%	1X	1.1X	5.2%	0.9X	1.2X	5.1%	0.9X	1.2X
VTM 8.0 vs. VTM 7.0	-0.4%	1.1X	1.3X	0.2%	1.1X	1.1X	0.9%	1.1X	1.0X	0.2%	1.1X	1.0X
VTM 9.0 vs. VTM 8.1	1.2%	1X	1X	1.7%	1X	1X	1.1%	1.0X	1.1X	1.1%	1.0X	1.0X
VTM10.0 vs. VTM 9.0	-0.01%	1X	1X	-0.03%	1X	1X	-0.13%	1X	1X	-0.13%	1X	1X
VTM11.0 vs. VTM10.2	0.00%	1X	1.1X	7.9%	1X	1X	0.00%	1X	1X	0.00%	1X	1X
VTM12.1 vs. VTM11.0	0.00%	1X	1X	0.00%	1X	1X	-0.01%	1X	1X	0.01%	1X	1X
VTM13 vs. VTM12.1	0.00%	1X	1X	1.37%	1X	1X	0.00%	1X	1X	0.00%	1X	1X

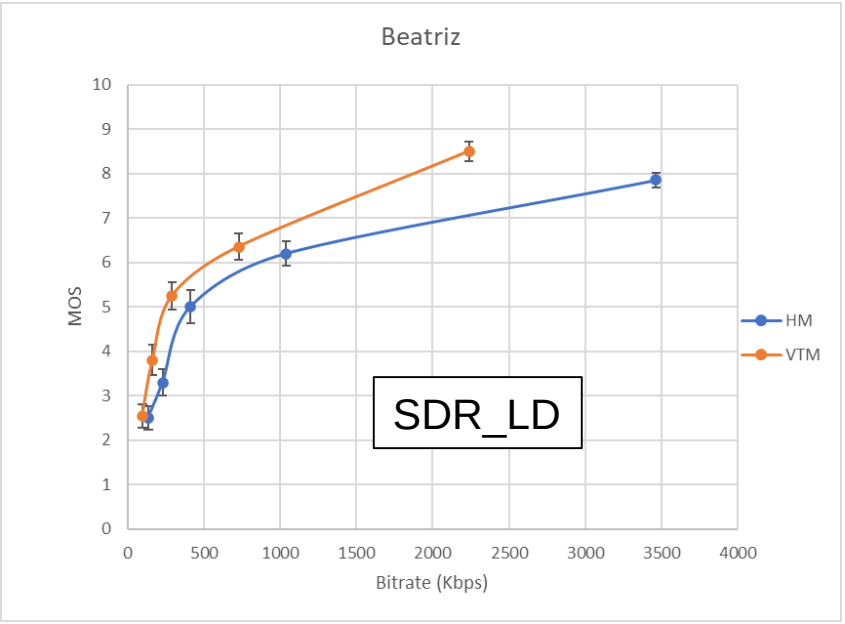
Verifications of VVC

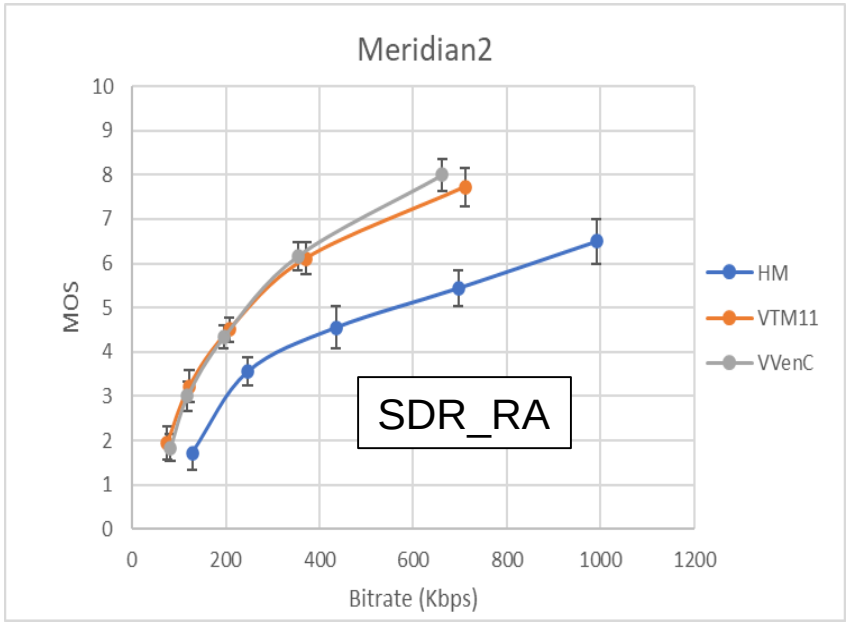
- Overall average bitrate saving of about 50% of VVC over HEVC
  - 5 SDR UHD test sequences
  - Random Access test condition

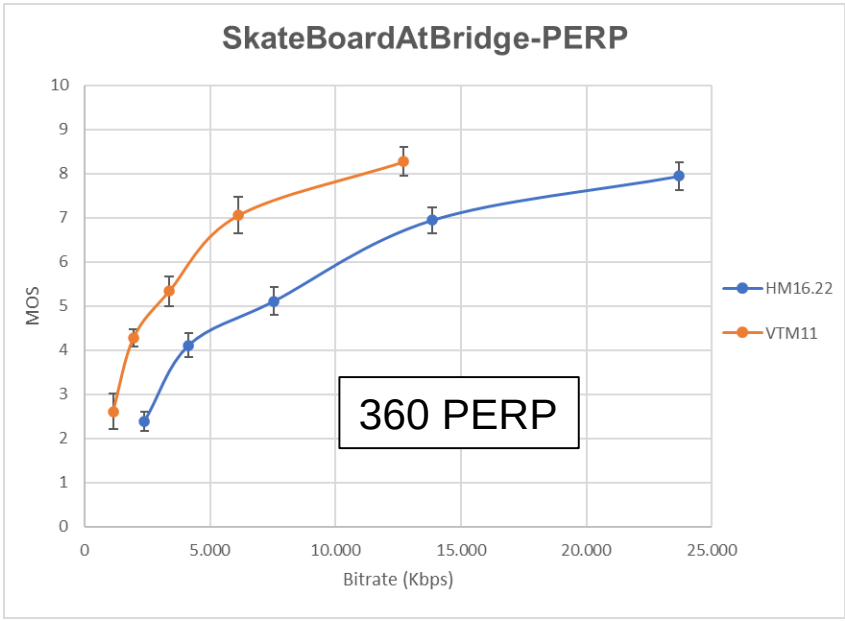


Verification test for VVC

- Results of formal subjective tests performed in the SDR HD LD, SDR HD RA, and 360° video categories

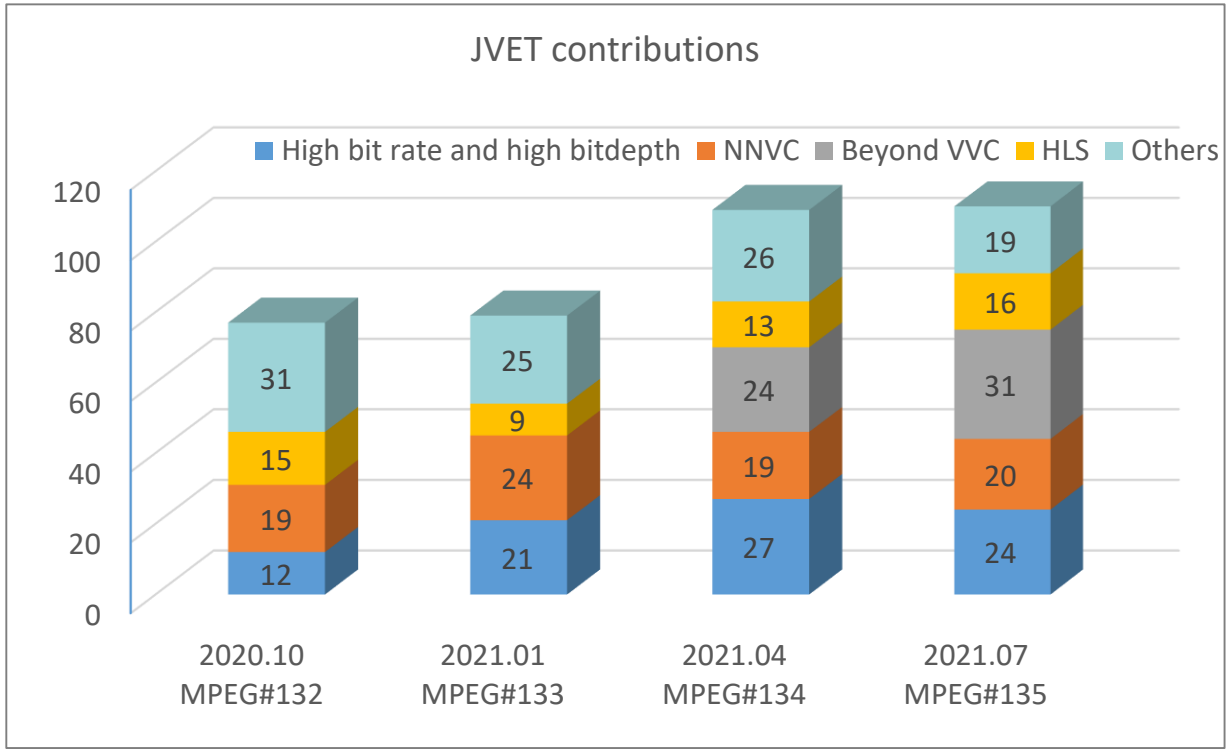






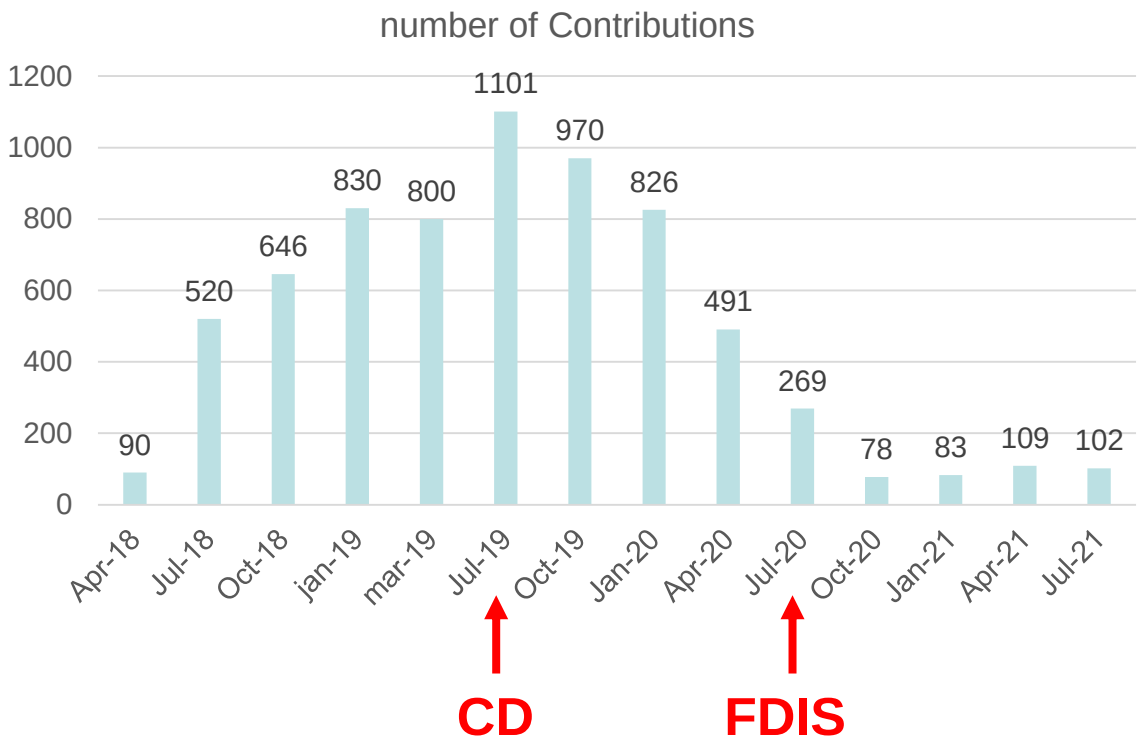
Joint Video Expert Team (JVET)

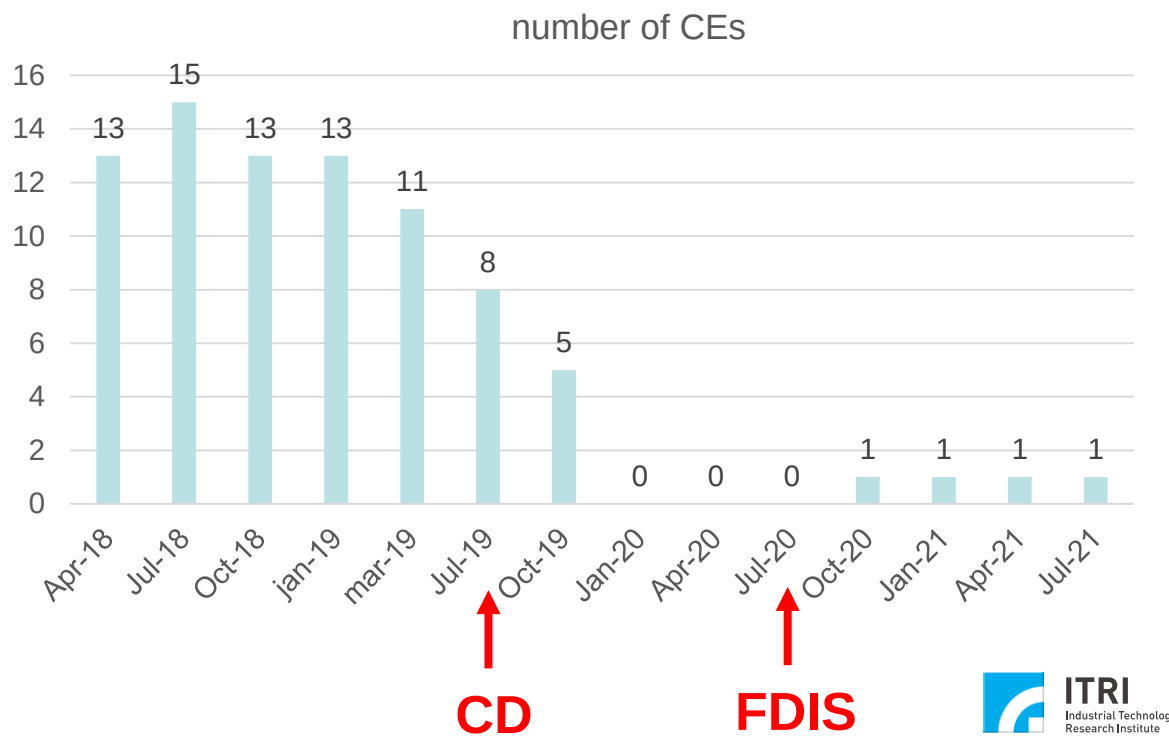
- 23rd Meeting of JVET (6th Virtual meeting)
  - Date: 7–15 July 2021
  - Approximately 250 participants
  - Roughly 110 contributions
    - 24 high bit rate and high bit depth
    - 20 Neural network based video coding
    - 31 Enhanced compression beyond VVC capability
    - 16 High level syntax
    - 19 Others



Number of JVET contributions and CEs

- JVET提案數量在H.266 Version 1 完成FDIS之後快速減少，後續為H.266 Version 2的標準制定與探索實驗。
- 本次會期JVET在InterDigital、Dolby的主導下成立新了的CE，探討Film grain synthesis的相關議題





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Core experiment for VVC extension

- CE : Entropy Coding for High Bit Depth and High Bit Rate Coding
  - Study of possible needs to extend VVC towards high end
    - Necessary changes in entropy coding
    - Internal precision of inverse transform and scaling
    - Impact for other tools that were originally designed in 10 bit
  - Most of these methods were similarly to HEVC (Rext)

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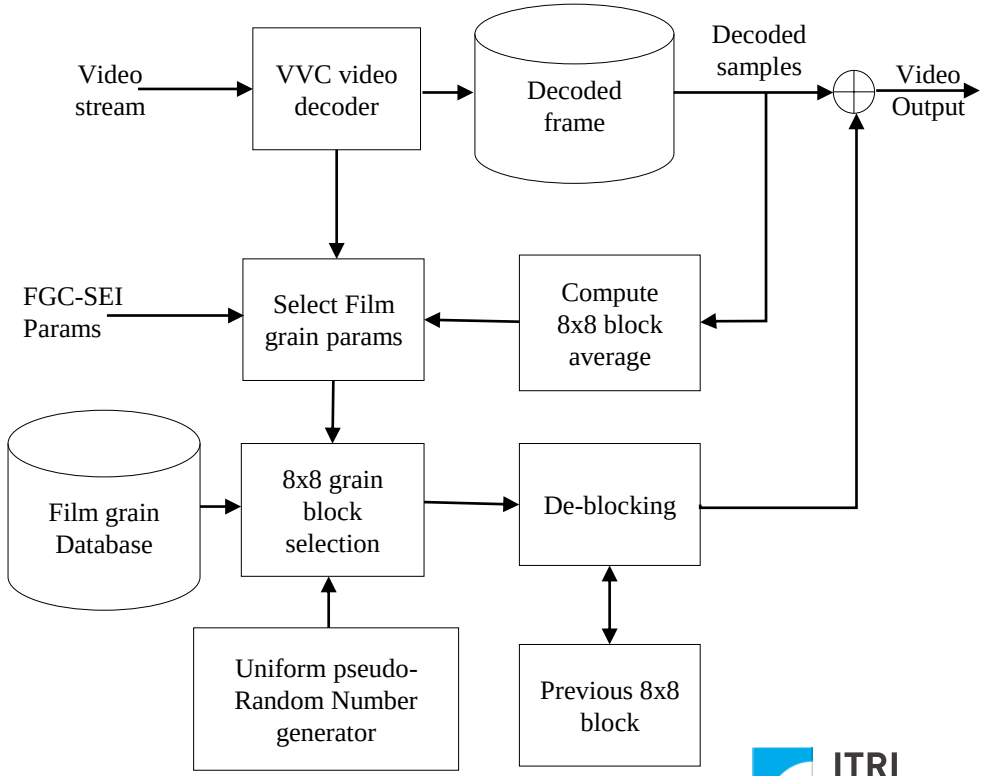
Core experiment for VVC extension

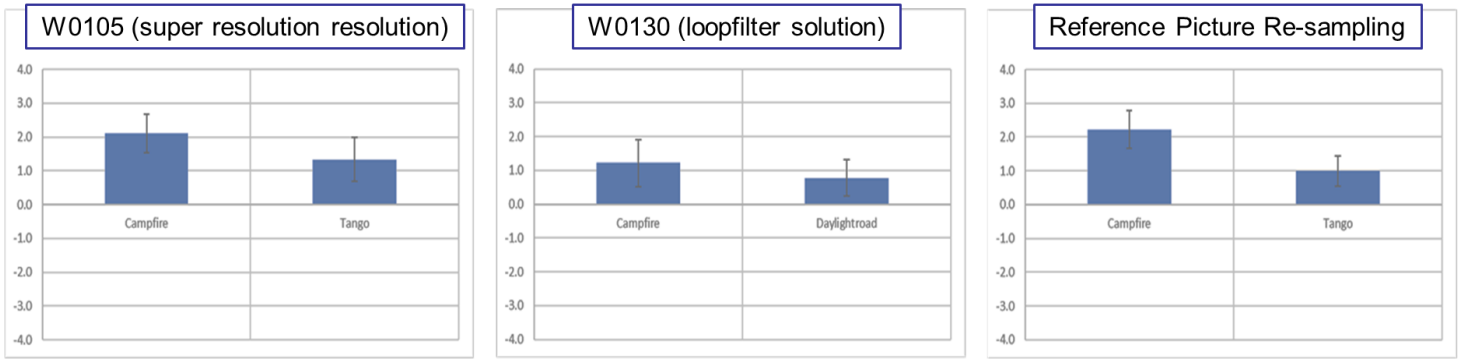
- Core Experiment on Film Grain Synthesis
  - Dolby, InterDigital, Ittiam, Alibaba, Comcast, INSA Rennes, Picsel Labs
  - Study of grain blending processes for the film grain characteristics SEI message
  - Have comparable performance compared to SMPTE RDD 5, but with lower complexity in implementation



Source: “Core Experiment on Film Grain Synthesis”, Teleconference, JVET-W2022, July, 2021

Explorations

- EE1 : Neural Network-based Video Coding
  - Conditions for testing, training and complexity assessment
    - both for individual coding tools and end-to-end architectures
  - **Loop filtering** and **super resolution** methods are subject of investigation
  - Understanding impact of training recognized to be important
  - Main discussion topics in terms of CTC:
    - Complexity reporting(kMAC/pixel, CPU runtime), memory needs
    - Conducted expert viewing sessions, results shown benefit with NN-based methods

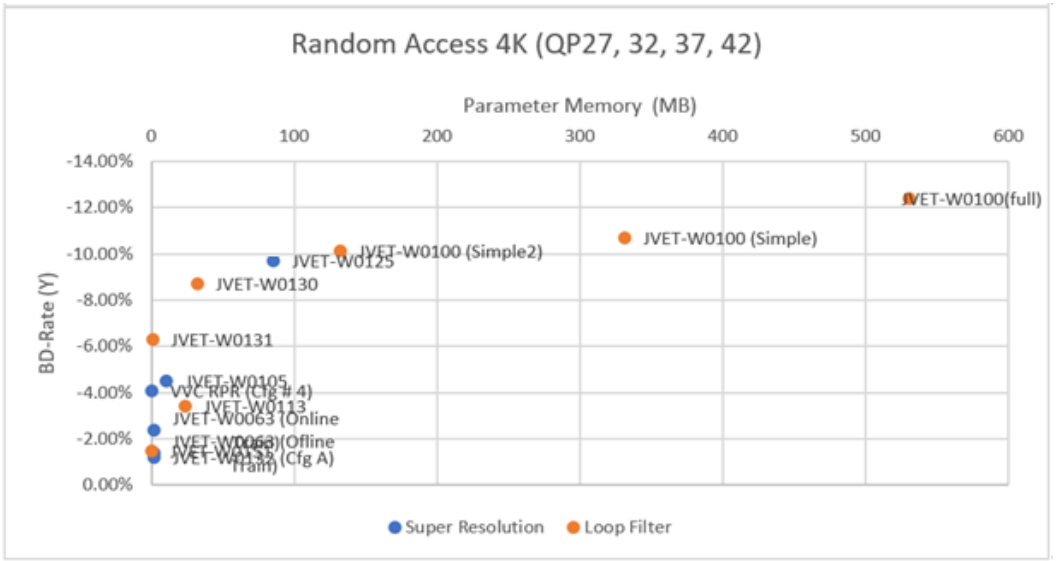


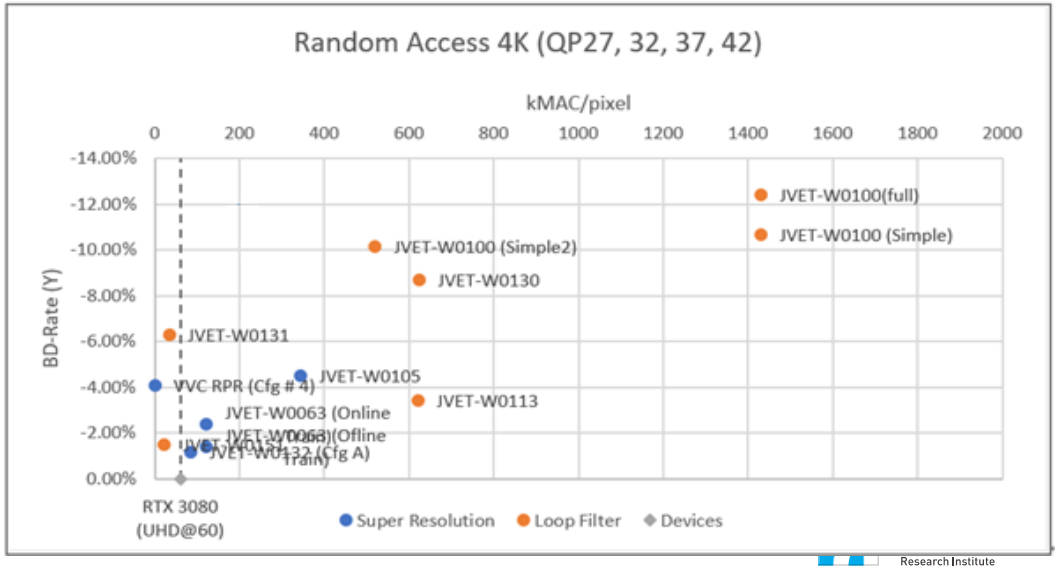
Proposed methods compared against VTM anchor

Source: “EE1-related: Report on results of remote viewing session”, Teleconference, JVET-W0186, July, 2021

EE1 : Neural Network-based Video Coding

- Super resolution :
  - down-sample all frames / RPR / inter frames / adaptive selection
  - 12-18% coding gain from best proposal (0.3x ~ 2.3x decT)
- NN based loop filter
  - 9-12% coding gain from best proposal (>1000x decT)





Explorations

- EE2 : Enhanced Compression beyond VVC capability
  - Primary goal: Study non-NN-based video coding tools not included in current VVC profiles
  - Software package “ECM” (Enhanced Compression Model) was established as basis reference software
    - ECM is the high anchor in EE, low anchor is VTM
  - Tool-on/-off tests to investigate “orthogonality” of tools
  - Tools in EE:
    - Partitioning: ABT, UBT, UQT
    - Intra prediction: TIMD, blending DIMD modes
    - Inter prediction: ARMC with template matching or bilateral matching, GPM with MMVD and template matching, extension of template matching to CIIP, GPM, Affine merge modes, and boundary sub-blocks
    - Transform: Extended MTS and LFNST
    - Loop filter: Cross-component SAO

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ECM-1.0 over VTM-11.0

	All Intra Main 10				
	Y	U	V	EncT	DecT
Class A1	-5.78%	-9.67%	-10.61%	219%	216%
Class A2	-5.47%	-7.85%	-5.90%	212%	200%
Class B	-5.00%	-7.15%	-7.52%	246%	213%
Class C	-6.04%	-7.43%	-7.71%	247%	198%
Class E	-6.20%	-7.84%	-6.72%	251%	241%
Overall	**-5.64%**	**-7.86%**	**-7.67%**	**236%**	**212%**
Class D	-4.86%	-5.53%	-5.56%	251%	200%
Class F	-10.03%	-11.63%	-12.07%	214%	258%
Class TGM	-14.61%	-16.09%	-15.97%	213%	282%

	Random Access Main 10				
	Y	U	V	EncT	DecT
Class A1	-12.21%	-13.33%	-15.84%	279%	453%
Class A2	-13.45%	-14.39%	-14.09%	268%	546%
Class B	-11.52%	-12.24%	-11.79%	271%	481%
Class C	-13.26%	-13.23%	-13.39%	266%	415%
Class E					
Overall	**-12.51%**	**-13.15%**	**-13.49%**	**271%**	**469%**
Class D	-14.39%	-13.40%	-13.32%	280%	449%
Class F	-12.13%	-13.26%	-13.60%	253%	348%
Class TGM	-12.67%	-14.71%	-14.89%	245%	255%

	Low Delay B Main 10				
	Y	U	V	EncT	DecT
Class B	-9.55%	-9.45%	-9.76%	237%	287%
Class C	-10.99%	-9.24%	-10.94%	251%	254%
Class E	-9.22%	-10.12%	-8.20%	200%	241%
Overall	**-9.95%**	**-9.55%**	**-9.76%**	**231%**	**264%**
Class D	-13.37%	-11.54%	-12.00%	257%	264%
Class F	-10.91%	-10.19%	-10.47%	233%	232%
Class TGM	-10.70%	-12.82%	-13.62%	191%	186%

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Common Test Conditions

- Current Common Test Conditions(CTC)
  - 360
  - HDR/WCG
  - Non-420 / SCC
  - Lossless, near lossless, and mixed lossy/lossless
  - SDR
  - Neural network-based video coding
  - Enhanced compression tool testing
  - High Bit Depth and High Bit Rate Coding

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AHGs for 22th JVET Meeting

- Project Management (AHG1) *
- Draft text and test model algorithm description editing (AHG2) *
- Test model software development (AHG3) *
- Test material and visual assessment (AHG4) *
- Conformance testing (AHG5)
- ~~360° video coding tools, software and test conditions (AHG6)~~
- ECM software development (AHG6) ← new
- Coding of HDR/WCG material (AHG7)
- High bit-depth, high bit rate and high frame rate coding (AHG8)
- SEI message studies (AHG9) *
- Encoding algorithm optimizations (AHG10)
- Neural-network-based video coding (AHG11)
- Enhanced compression beyond VVC capability (AHG12)

* merge JVET and JCT-VC

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Thank You

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