

**MEDIATEK**

# CE7-related: Support of signalling default and user-defined scaling matrices

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# Overall Summary

It is proposed to add syntax to support signalling of default and user-defined scaling matrices on top of VTM4.0 conforming to following

- three modes for scaling matrices: OFF, DEFAULT, and USER\_DEFINED
- bigger size range for the blocks (4×4 to 64×64 for luma, 2×2 to 32×32 for chroma)
- rectangular transform blocks (TBs)
- dependent quantization
- multiple transform selection (MTS)
- large transforms with zeroing-out high frequency coefficients
- intra subblock partitioning (ISP)
- intra block copy (IBC, also known as current picture referencing, CPR)

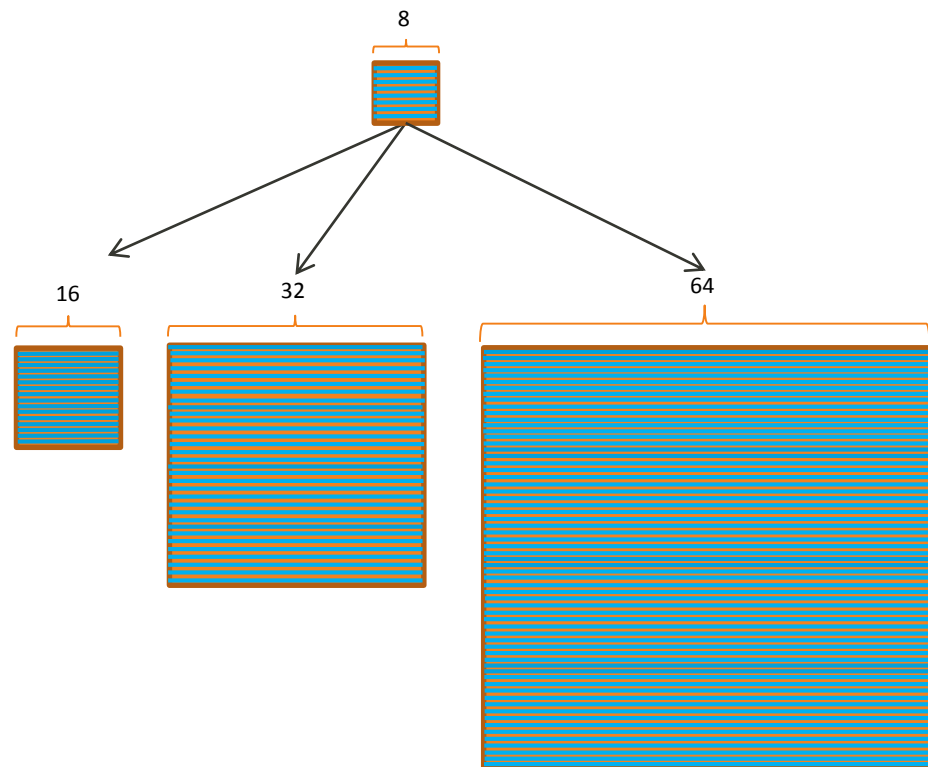
		Y	U	V	Enc. T	Dec. T
Proposed Method	AI	1.46%	-0.33%	-0.95%	103%	97%
	RA	0.39%	-0.32%	-1.18%	103%	106%
	LB	0.76%	-1.15%	-1.82%	100%	109%

# Proposed Quantization Matrices in VVC

- For USER\_DEFINED matrices MatrixType and MatrixType\_DC are updated as follows:
  - **MatrixType: 30** = **2** (2 for intra&IBC\*/inter) × **3** (Y/Cb/Cr components) × **5** (square TB size: from 4×4 to 64×64 for luma, from 2×2 to 32×32 for chroma)
  - **MatrixType\_DC: 14** = **2** (2 for intra&IBC\*/inter × 1 for Y component) × **3** (TB size: 16×16, 32×32, 64×64) + **4** (2 for intra&IBC\*/inter × 2 for Cb/Cr components) × **2** (TB size: 16×16, 32×32)

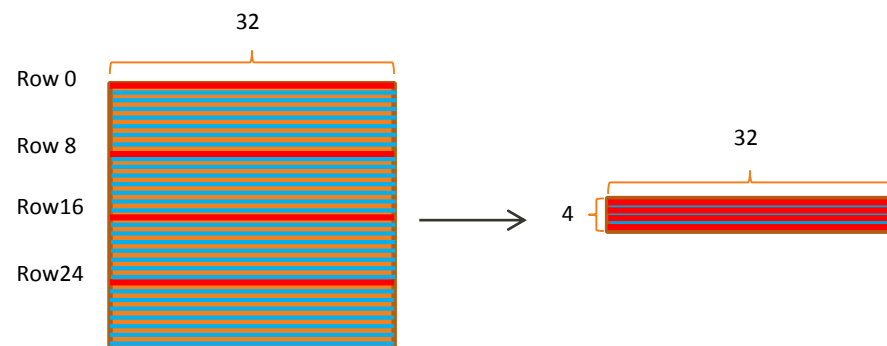
# Proposed Quantization Matrices in VVC (cont.)

- Square matrices of size greater than  $8 \times 8$  obtained from the  $8 \times 8$  base scaling matrix by up-sampling (duplication of elements) to the corresponding square size (i.e.  $16 \times 16$ ,  $32 \times 32$ ,  $64 \times 64$ ).
- For TBs of size smaller than  $8 \times 8$ , all elements of the scaling matrix are signalled.
- If the TBs have size greater than or equal to  $8 \times 8$ , only 64 elements are signalled as a base scaling matrix.
- The DC values are separately coded for  $16 \times 16$ ,  $32 \times 32$ , and  $64 \times 64$  scaling matrices
  - for DEFAULT mode DC value is equal to 16 for all TB sizes



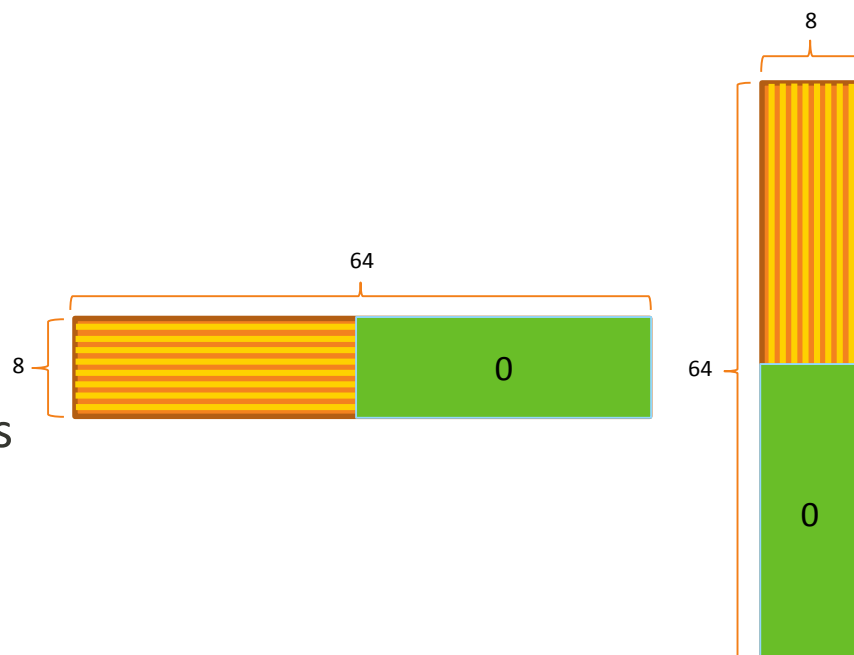
# Proposed Quantization Matrices in VVC (cont.)

- For rectangular TBs, a square quantization matrix of a bigger size is down-sampled to the rectangular size.
- Signalling of the default and user-defined scaling matrices for MTS is supported
  - Since default scaling matrices for MTS are not defined, the default transform scaling matrices for DCT-II can be used



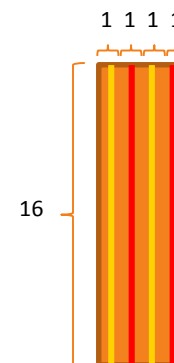
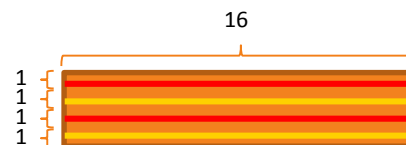
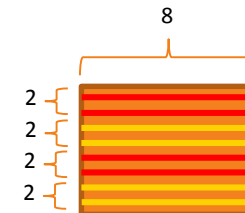
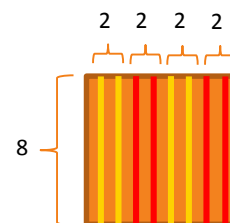
# Proposed Quantization Matrices in VVC (cont.)

- When the zeroing-out of the high frequency coefficients is applied, corresponding high frequencies of the scaling matrices are also zeroed out
  - If the width or height of the TB is greater than or equal to 32, only left or top half of the coefficients is kept, and the remaining coefficients are assigned to zero
  - Number of elements signalled for the  $64 \times 64$  scaling matrix is reduced from  $8 \times 8$  to three  $4 \times 4$  submatrices, since the bottom-right  $4 \times 4$  elements are never used



# Proposed Quantization Matrices in VVC (cont.)

- In case of ISP coding mode (when TBs of sizes  $2 \times 8$ ,  $8 \times 2$ ,  $1 \times 16$ , and  $16 \times 1$  are generated), the corresponding scaling matrices are used as well
  - Obtained in the same way as those generated for the rectangular TBs (i.e., from the corresponding square scaling matrix)
- For both, USER\_DEFINED and DEFAULT modes, scaling matrices are modified to be compatible with other coefficient coding, i.e. dependent quantization



# Results

## Anchor: VTM4.0

		Y	U	V	Enc. T	Dec. T
Proposed Method	AI	1.46%	-0.33%	-0.95%	103%	97%
	RA	0.39%	-0.32%	-1.18%	103%	106%
	LB	0.76%	-1.15%	-1.82%	100%	109%

	All Intra Main10 Over VTM-4.0				
	Y	U	V	EncT	DecT
Class A1	1.65%	1.49%	-0.81%	104%	107%
Class A2	1.98%	0.14%	-0.17%	102%	105%
Class B	1.29%	-1.40%	-1.70%	106%	107%
Class C	1.93%	-0.35%	-0.65%	99%	112%
Class E	0.41%	-0.83%	-1.04%	105%	104%
<b>Overall</b>	1.46%	-0.33%	-0.95%	103%	107%
Class D	2.11%	-0.74%	-0.88%	97%	125%
Class F	0.84%	0.24%	-0.06%	101%	106%

	Random access Main10 Over VTM-4.0				
	Y	U	V	EncT	DecT
Class A1	-0.10%	1.57%	-0.81%	103%	100%
Class A2	-0.55%	-0.51%	-0.63%	101%	103%
Class B	0.45%	-1.27%	-2.05%	105%	102%
Class C	1.39%	-0.40%	-0.76%	100%	117%
Class E					
<b>Overall</b>	0.39%	-0.32%	-1.18%	103%	106%
Class D	1.48%	-1.27%	-0.95%	100%	148%
Class F	0.79%	0.55%	0.05%	101%	117%

	Low delay B Main10 Over VTM-4.0				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.48%	-2.19%	-3.13%	100%	101%
Class C	1.25%	-0.56%	-0.88%	99%	114%
Class E	0.57%	-0.18%	-0.88%	101%	116%
<b>Overall</b>	0.76%	-1.15%	-1.82%	100%	109%
Class D	1.26%	-1.45%	-1.68%	101%	154%
Class F	0.62%	0.18%	0.61%	99%	116%

Thank Qualcomm  
for cross-check



# Conclusions

- In this contribution, it is proposed to add support for signalling the default and user-defined scaling matrices on top of VTM4.0.
- The proposed method of signalling scaling matrices has been implemented on top of VTM4.0 and is conforming to:
  - bigger size range for the blocks ( $4\times 4$  to  $64\times 64$  for luma,  $2\times 2$  to  $32\times 32$  for chroma)
  - rectangular transform blocks (TBs),
  - dependent quantization,
  - multiple transform selection (MTS),
  - large transforms with zeroing-out high frequency coefficients,
  - intra subblock partitioning (ISP)
  - intra block copy (IBC, also known as current picture referencing, CPR)
- The purpose of the experiment is to show the readiness of the software implementation for inclusion into the VTM



*everyday genius*

# Proposed Quantization Matrices in HEVC

- Three modes for scaling matrices are supported in HEVC: OFF, DEFAULT, and USER\_DEFINED.
- For USER\_DEFINED matrices **MatrixType** and **MatrixType\_DC** are as follows:
  - **MatrixType: 20** = 2 (2 for intra/inter × 1 Y component) × 4 (TB size: 4×4, 8×8, 16×16, 32×32) + 4 (2 for intra/inter × 2 Cb/Cr components) × 3 (TB size: 4×4, 8×8, 16×16)
  - **MatrixType\_DC: 8** = 2 (2 for intra/inter × 1 Y component) × 2 (TB size: 16×16, 32×32) + 4 (2 for intra/inter × 2 Cb/Cr components) × 1 (TB size: 16×16)

\* Intra and IBC coding modes currently share the same scaling matrices