

JVET-Q0148

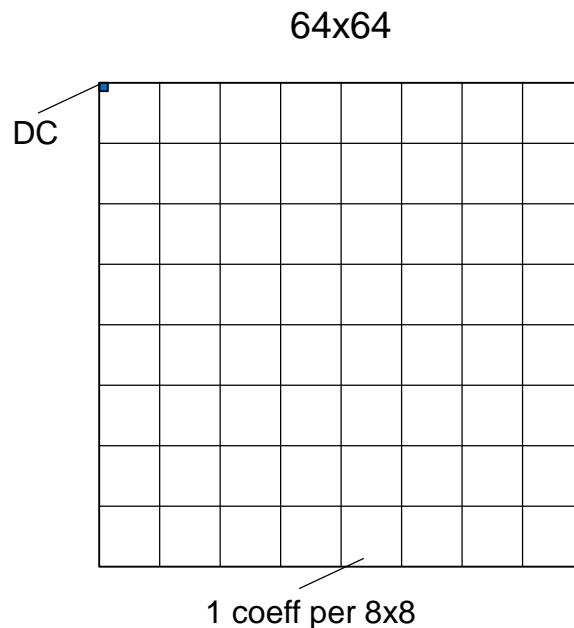
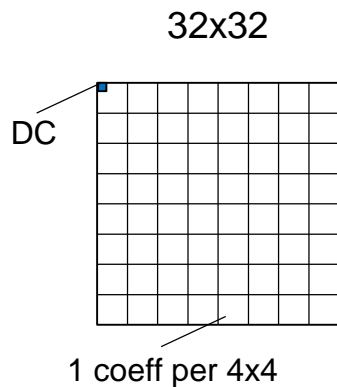
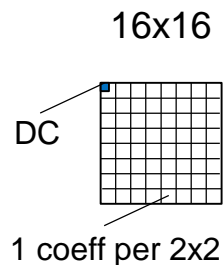
AHG15: Additional coefficients for low frequency
region of 64x64 scaling matrix

K. Abe, T. Toma

Panasonic Corporation

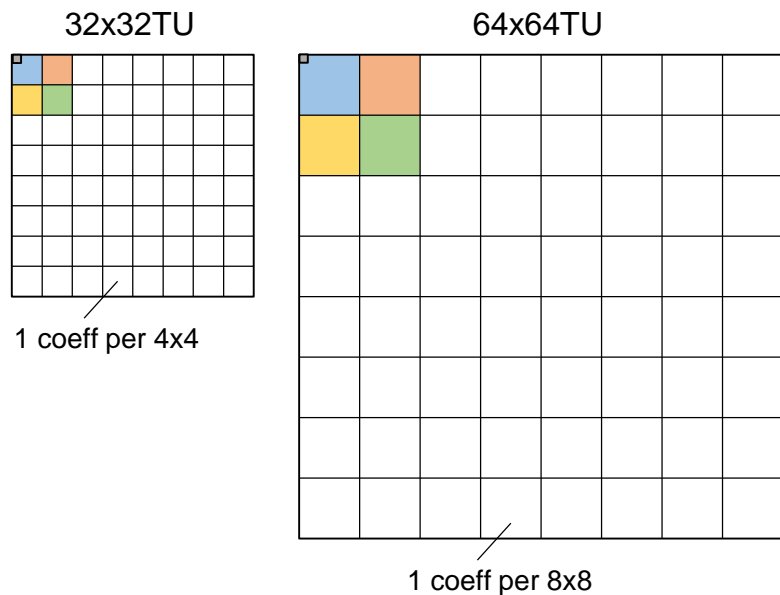
Problem

16x16, 32x32, 64x64 scaling matrices are derived by 8x8 coefficients + DC.
The granularity of controlling quantization would be lower for 64xN / Nx64 TU.



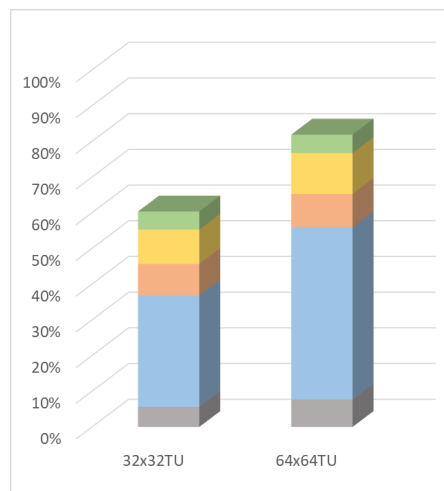
Problem

In 64x64TU, too many non-zero transform coefficients appear in the first 8x8 region. It would be difficult to control the subjective image and bit rate.

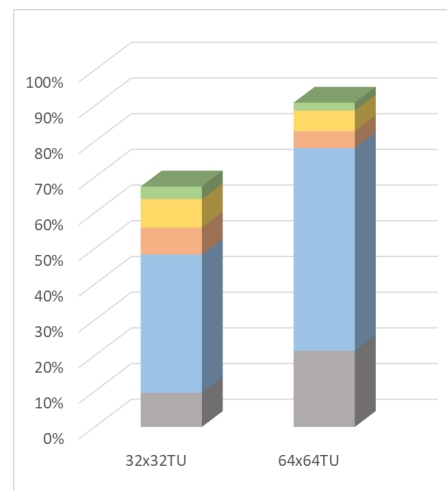


Average ratio of number of non-zero coefficients in a TU.

Intra TU (luma)



Inter TU (luma)

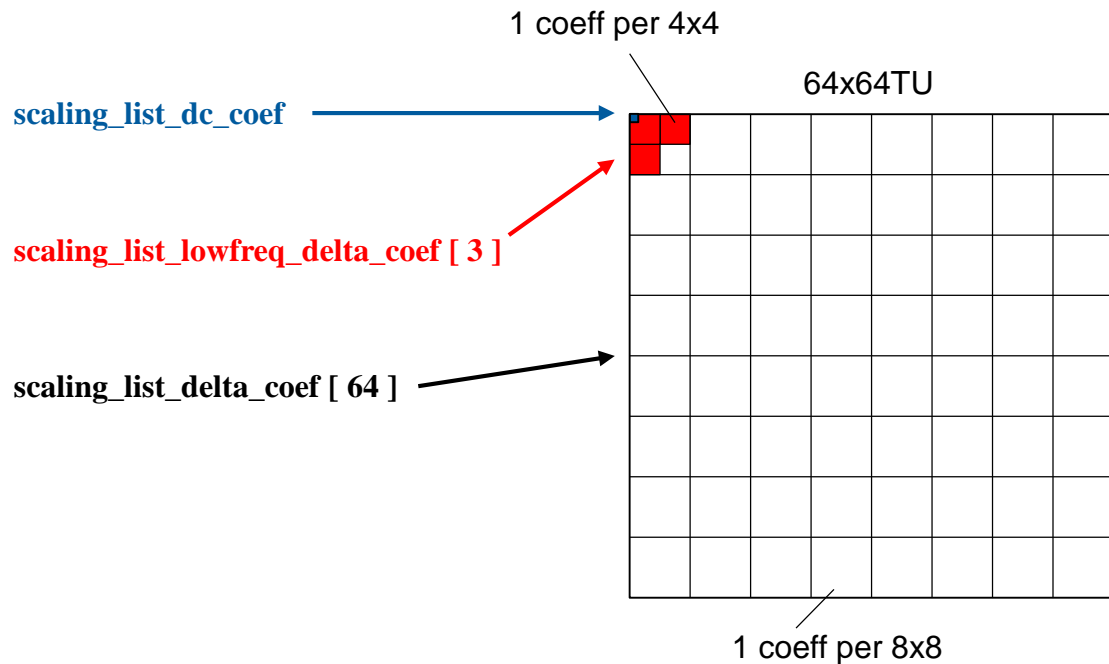


Intra TU : ClassA sequences with QP22 and QP37 (AI/1sec)

Inter TU : ClassA sequences with QP22 and QP37 (RA/1sec)

Proposal

Add three scaling matrix coefficients to the lowest frequency region of 64x64 matrix.
It is also applied to the scaling list prediction mode.







Proposal

(Method1)

- Apply proposal to 64 luma matrices only.

Scaling matrix id (same as VTM-7.0)

| matrixSize | | 2 | 4 | 8 | 16 | 32 | 64 |
|------------|----|---|---|----|----|----|----|
| INTRA | Y |  | 2 | 8 | 14 | 20 | 26 |
| | Cb |  | 3 | 9 | 15 | 21 | 21 |
| | Cr |  | 4 | 10 | 16 | 22 | 22 |
| INTER | Y |  | 5 | 11 | 17 | 23 | 27 |
| | Cb | 0 | 6 | 12 | 18 | 24 | 24 |
| | Cr | 1 | 7 | 13 | 19 | 25 | 25 |

64 chroma matrices reuse 32 chroma matrices (use same id).

| scaling_list_data() { | Descriptor |
|---|------------|
| for(id = 0; id < 28; id ++) { | |
| | |
| if(!scaling_list_copy_mode_flag[id]) { | |
| if(id > 13) { | |
| scaling_list_dc_coef[id - 14] | se(v) |
| nextCoef += scaling_list_dc_coef[id - 14] | |
| } | |
| if(id > 25) { | |
| for(i = 0; i < 3; i++) { | |
| scaling_list_lowfreq_delta_coef[id - 26][i] | se(v) |
| nextCoef += scaling_list_lowfreq_delta_coef[id - 26][i] | |
| } | |
| ScalingListLowfreq[id - 26][i] = nextCoef | |
| } | |
| for(i = 0; i < matrixSize * matrixSize; i++) { | |
| if(!(id > 25 && x >= 4 && y >= 4)) { | |
| scaling_list_delta_coef[id][i] | se(v) |
| nextCoef += scaling_list_delta_coef[id][i] | |
| } | |
| ScalingList[id][i] = nextCoef | |
| } | |
| } | |
| } | |
| } | |
| } | |

Proposal

(Method2)

- Enable individual matrices for 64 chroma.
- Apply proposal to 64 luma and chroma matrices.

Scaling matrix id

| matrixSize | | 2 | 4 | 8 | 16 | 32 | 64 |
|------------|----|---|---|----|----|----|----|
| INTRA | Y | | 2 | 8 | 14 | 20 | 26 |
| | Cb | | 3 | 9 | 15 | 21 | 27 |
| | Cr | | 4 | 10 | 16 | 22 | 28 |
| INTER | Y | | 5 | 11 | 17 | 23 | 29 |
| | Cb | 0 | 6 | 12 | 18 | 24 | 30 |
| | Cr | 1 | 7 | 13 | 19 | 25 | 31 |

64 chroma matrices are only used for 4:4:4 chroma format.
(Copy mode can avoid bit increasing in other format.)

| scaling_list_data() { | Descriptor |
|---|------------|
| for(id = 0; id < 32; id ++) { | |
| | |
| if(!scaling_list_copy_mode_flag[id]) { | |
| if(id > 13) { | |
| scaling_list_dc_coef[id - 14] | se(v) |
| nextCoef += scaling_list_dc_coef[id - 14] | |
| } | |
| if(id > 25) { | |
| for(i = 0; i < 3; i++) { | |
| scaling_list_lowfreq_delta_coef[id - 26][i] | se(v) |
| nextCoef += scaling_list_lowfreq_delta_coef[id - 26][i] | |
| } | |
| ScalingListLowfreq[id - 26][i] = nextCoef | |
| } | |
| for(i = 0; i < matrixSize * matrixSize; i++) { | |
| if(!(id > 25 && x >= 4 && y >= 4)) { | |
| scaling_list_delta_coef[id][i] | se(v) |
| nextCoef += scaling_list_delta_coef[id][i] | |
| } | |
| ScalingList[id][i] = nextCoef | |
| } | |
| } | |
| } | |
| } | |

Simulation results

Scaling matrix ON (existing method)

| | All Intra Over VTM-7.0 | | | | |
|----------------|---------------------------|--------|-------|------|------|
| | Y | U | V | EncT | DecT |
| Class A1 | 9.05% | 12.34% | 7.88% | 104% | 103% |
| Class A2 | 9.11% | 10.41% | 9.34% | 98% | 104% |
| Class B | 9.99% | 6.86% | 6.53% | 102% | 107% |
| Class C | 10.73% | 8.02% | 7.87% | 93% | 114% |
| Class E | 9.30% | 5.59% | 6.76% | 102% | 108% |
| Overall | 9.73% | 8.41% | 7.56% | 100% | 107% |
| Class D | 11.53% | 7.41% | 7.78% | 91% | 126% |
| Class F | 5.77% | 8.39% | 8.79% | 98% | 105% |

| | Random access Over VTM-7.0 | | | | |
|----------------|-------------------------------|--------|--------|------|------|
| | Y | U | V | EncT | DecT |
| Class A1 | 5.99% | 12.25% | 8.04% | 100% | 102% |
| Class A2 | 6.26% | 8.34% | 8.24% | 96% | 101% |
| Class B | 8.40% | 7.65% | 7.01% | 98% | 103% |
| Class C | 8.74% | 8.75% | 8.43% | 96% | 113% |
| Overall | 7.58% | 9.00% | 7.84% | 97% | 105% |
| Class D | 9.33% | 8.08% | 7.98% | 94% | 135% |
| Class F | 5.29% | 9.80% | 10.33% | 99% | 109% |

| | Low delay B Over VTM-7.0 | | | | |
|----------------|-----------------------------|--------|--------|------|------|
| | Y | U | V | EncT | DecT |
| Class B | 9.00% | 4.57% | 3.32% | 98% | 102% |
| Class C | 9.52% | 7.30% | 7.73% | 96% | 113% |
| Class E | 6.66% | -1.26% | -0.32% | 98% | 112% |
| Overall | 8.59% | 4.02% | 3.88% | 97% | 108% |
| Class D | 9.46% | 6.08% | 6.27% | 95% | 133% |
| Class F | 6.01% | 9.70% | 10.32% | 99% | 111% |



Scaling matrix ON (proposed method1)

| | All Intra Over VTM-7.0 | | | | |
|----------------|---------------------------|--------|-------|------|------|
| | Y | U | V | EncT | DecT |
| Class A1 | 9.01% | 12.41% | 7.86% | 105% | 104% |
| Class A2 | 9.05% | 10.38% | 9.36% | 100% | 104% |
| Class B | 9.96% | 6.85% | 6.55% | 103% | 107% |
| Class C | 10.70% | 8.10% | 7.87% | 92% | 114% |
| Class E | 9.30% | 5.59% | 6.80% | 103% | 109% |
| Overall | 9.70% | 8.43% | 7.57% | 100% | 108% |
| Class D | 11.54% | 7.36% | 7.79% | 91% | 129% |
| Class F | 5.79% | 8.31% | 8.82% | 98% | 105% |

| | Random access Over VTM-7.0 | | | | |
|----------------|-------------------------------|--------|--------|------|------|
| | Y | U | V | EncT | DecT |
| Class A1 | 5.88% | 11.99% | 7.80% | 100% | 102% |
| Class A2 | 6.17% | 8.59% | 8.17% | 96% | 101% |
| Class B | 8.31% | 7.51% | 6.88% | 98% | 103% |
| Class C | 8.73% | 8.76% | 8.63% | 96% | 113% |
| Overall | 7.51% | 8.96% | 7.79% | 98% | 105% |
| Class D | 9.35% | 7.98% | 7.97% | 95% | 136% |
| Class F | 5.26% | 9.79% | 10.45% | 99% | 109% |

| | Low delay B Over VTM-7.0 | | | | |
|----------------|-----------------------------|--------|--------|------|------|
| | Y | U | V | EncT | DecT |
| Class B | 8.83% | 4.51% | 3.02% | 98% | 101% |
| Class C | 9.55% | 7.35% | 7.75% | 96% | 113% |
| Class E | 6.63% | -1.65% | -1.14% | 99% | 111% |
| Overall | 8.52% | 3.92% | 3.56% | 98% | 108% |
| Class D | 9.49% | 5.84% | 6.28% | 95% | 133% |
| Class F | 5.98% | 9.31% | 9.95% | 99% | 110% |

Matrices in JCTVC-H1104 (Quantization CE) are used in both tests.

Simulation results (used scaling matrices)

Scaling matrix ON (existing method)

```
INTRA64X64_LUMA =  
 7, 9,13,18,25,35,36,37  
 9,10,15,21,32,35,37,41  
13,15,18,23,35,55,58,59  
18,21,23,26,65,58,64,66  
25,32,35,65,66,66,67,70  
35,35,55,58,66,68,70,73  
36,37,58,64,67,70,76,80  
37,41,59,66,70,73,80,85  
  
INTRA64X64_LUMA_DC =  
6  
  
INTER64X64_LUMA =  
11,15,20,29,36,38,42,43  
15,17,22,29,39,43,45,46  
20,22,32,34,47,48,49,50  
29,29,34,44,50,51,52,53  
36,39,47,50,51,52,55,55  
38,43,48,51,52,53,56,58  
42,45,49,52,55,56,55,60  
43,46,50,53,55,58,60,63  
  
INTER64X64_LUMA_DC =  
9
```

Scaling matrix ON (proposed method1)

```
INTRA64X64_LUMA =  
 9, 9,13,18,25,35,36,37  
 9,10,15,21,32,35,37,41  
13,15,18,23,35,55,58,59  
18,21,23,26,65,58,64,66  
25,32,35,65,66,66,67,70  
35,35,55,58,66,68,70,73  
36,37,58,64,67,70,76,80  
37,41,59,66,70,73,80,85  
  
INTRA64X64_LUMA_LOW_FREQ =  
 7,8,  
 8,  
  
INTRA64X64_LUMA_DC =  
6  
  
INTER64X64_LUMA =  
14,15,20,29,36,38,42,43  
15,17,22,29,39,43,45,46  
20,22,32,34,47,48,49,50  
29,29,34,44,50,51,52,53  
36,39,47,50,51,52,55,55  
38,43,48,51,52,53,56,58  
42,45,49,52,55,56,55,60  
43,46,50,53,55,58,60,63  
  
INTER64X64_LUMA_LOW_FREQ =  
11,13,  
13,  
  
INTER64X64_LUMA_DC =  
9
```

Other matrices are same as JCTVC-H1104 symmetry1.

- Add three scaling coefficients for the lowest region of 64x64 matrix.
 - Method1) Apply proposal to 64 luma matrices only.
 - Method2) Enable individual matrices for 64 chroma, and apply proposal to 64 luma and chroma matrices.
- Can improve the granularity of controlling quantization without any loss.

We propose to adopt this proposal into VVC.

Thanks Sharp for cross-checking of the proposal.