

# Non-CE6: Shape Adaptive Transform Selection for ISP, SBT and MTS

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# Introduction

Table 8-13 – Specification of trTypeHor and trTypeVer depending on tu\_mts\_idx[ x ][ y ]

| tu_mts_idx[ x0 ][ y0 ] | 0 | 1 | 2 | 3 | 4 |
|------------------------|---|---|---|---|---|
| trTypeHor              | 0 | 1 | 2 | 1 | 2 |
| trTypeVer              | 0 | 1 | 1 | 2 | 2 |

Table 8-14 – Specification of trTypeHor and trTypeVer depending on cu\_sbt\_horizontal  
cu\_sbt\_pos\_flag

| cu_sbt_horizontal_flag | cu_sbt_pos_flag | trTypeHor | trTypeVer |
|------------------------|-----------------|-----------|-----------|
| 0                      | 0               | 2         | 1         |
| 0                      | 1               | 1         | 1         |
| 1                      | 0               | 1         | 2         |
| 1                      | 1               | 1         | 1         |

$\text{trTypeHor} = ( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 \ \&\& \ \text{nTbW} \leq \text{nTbH} ) ? 1 : 0$

$\text{trTypeVer} = ( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 \ \&\& \ \text{nTbH} \leq \text{nTbW} ) ? 1 : 0$

Table 8-15 – Specification of trTypeHor and trTypeVer depending on predModeIntra

| predModeIntra                                                                                                                                              | trTypeHor                                                     | trTypeVer                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| INTRA_PLANAR,<br>INTRA_ANGULAR31,<br>INTRA_ANGULAR32,<br>INTRA_ANGULAR34,<br>INTRA_ANGULAR36,<br>INTRA_ANGULAR37                                           | $( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 ) ? 1 : 0$ | $( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 ) ? 1 : 0$ |
| INTRA_ANGULAR33,<br>INTRA_ANGULAR35                                                                                                                        | 0                                                             | 0                                                             |
| INTRA_ANGULAR2,<br>INTRA_ANGULAR4,...,INTRA_ANGULAR28,<br>INTRA_ANGULAR30,<br>INTRA_ANGULAR39,<br>INTRA_ANGULAR41,...,INTRA_ANGULAR63,<br>INTRA_ANGULAR65  | $( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 ) ? 1 : 0$ | 0                                                             |
| INTRA_ANGULAR3,<br>INTRA_ANGULAR5,..., INTRA_ANGULAR27,<br>INTRA_ANGULAR29,<br>INTRA_ANGULAR38,<br>INTRA_ANGULAR40,...,INTRA_ANGULAR64,<br>INTRA_ANGULAR66 | 0                                                             | $( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 ) ? 1 : 0$ |

Current spec is too complicated for transform selection

## VTM4.0:

|                                            |             |
|--------------------------------------------|-------------|
| <b>sps_mts_enabled_flag</b>                | <b>u(1)</b> |
| if( sps_mts_enabled_flag ) {               |             |
| <b>sps_explicit_mts_intra_enabled_flag</b> | u(1)        |
| <b>sps_explicit_mts_inter_enabled_flag</b> | u(1)        |
| }                                          |             |

### - SPS flag to enable implicitMTS:

- **sps\_mts\_enabled\_flag** is true and both **sps\_explicit\_mts\_intra\_enabled\_flag** are false

## Clean up the transform selection process

Table 8-13 – Specification of trTypeHor and trTypeVer depending on tu\_mts\_idx[ x ][ y ]

| tu_mts_idx[ x0 ][ y0 ] | 0 | 1 | 2 | 3 | 4 |
|------------------------|---|---|---|---|---|
| trTypeHor              | 0 | 1 | 2 | 1 | 2 |
| trTypeVer              | 0 | 1 | 1 | 2 | 2 |

Table 8-14 – Specification of trTypeHor and trTypeVer depending on cu\_sbt\_horizontal and cu\_sbt\_pos\_flag

| cu_sbt_horizontal_flag | cu_sbt_pos_flag | trTypeHor | trTypeVer |
|------------------------|-----------------|-----------|-----------|
| 0                      | 0               | 2         | 1         |
| 0                      | 1               | 1         | 1         |
| 1                      | 0               | 1         | 2         |
| 1                      | 1               | 1         | 1         |

$\text{trTypeHor} = ( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 \ \&\& \ \text{nTbW} \leq \text{nTbH} ) ? 1 : 0$

$\text{trTypeVer} = ( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 \ \&\& \ \text{nTbH} \leq \text{nTbW} ) ? 1 : 0$

Table 8-15 – Specification of trTypeHor and trTypeVer depending on predModeIntra

| predModeIntra                                                                                                                                              | trTypeHor                                                     | trTypeVer                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| INTRA_PLANAR,<br>INTRA_ANGULAR31,<br>INTRA_ANGULAR32,<br>INTRA_ANGULAR34,<br>INTRA_ANGULAR36,<br>INTRA_ANGULAR37                                           | $( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 ) ? 1 : 0$ | $( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 ) ? 1 : 0$ |
| INTRA_ANGULAR33,<br>INTRA_ANGULAR35                                                                                                                        | 0                                                             | 0                                                             |
| INTRA_ANGULAR2,<br>INTRA_ANGULAR4,...,INTRA_ANGULAR28,<br>INTRA_ANGULAR30,<br>INTRA_ANGULAR39,<br>INTRA_ANGULAR41,...,INTRA_ANGULAR63,<br>INTRA_ANGULAR65  | $( \text{nTbW} \geq 4 \ \&\& \ \text{nTbW} \leq 16 ) ? 1 : 0$ | 0                                                             |
| INTRA_ANGULAR3,<br>INTRA_ANGULAR5,..., INTRA_ANGULAR27,<br>INTRA_ANGULAR29,<br>INTRA_ANGULAR38,<br>INTRA_ANGULAR40,...,INTRA_ANGULAR64,<br>INTRA_ANGULAR66 | 0                                                             | $( \text{nTbH} \geq 4 \ \&\& \ \text{nTbH} \leq 16 ) ? 1 : 0$ |

## - Embedding shape adaptive transform selection in MTS:

| tu_mts_idx | transform type |             | binarization     |             |            |
|------------|----------------|-------------|------------------|-------------|------------|
|            | horizontal     | vertical    | MTS & TS enabled | MTS enabled | TS enabled |
| 0          | SKIP           | SKIP        | 0                | -           | 0          |
| 1          | DCT-II         | DCT-II      | 10               | 0           | 1          |
| 2          | DST-VII        | DST-VII     | 110              | 10          | -          |
| 3          | DCT-VIII       | DST-VII     | 1110             | 110         | -          |
| 4          | DST-VII        | DCT-VIII    | 11110            | 1110        | -          |
| 5          | ImplicitMTS    | ImplicitMTS | 11111            | 1111        | -          |

## - ISP and SBT uses shape adaptive transform selection

```
trTypeHor = trTypeVer = DCT2;  
if ( width < height )  
    trTypeHor = DST7;  
else if ( height < width )  
    trTypeVer = DST7;  
else if ( width == height )  
    trTypeHor = trTypeVer = DST7;
```

## No ImplicitMTS flag coding

|                                                                                              |                   |
|----------------------------------------------------------------------------------------------|-------------------|
| <code>sps_mts_enabled_flag</code>                                                            | <code>u(1)</code> |
| <code>if( sps_mts_enabled_flag ) {</code>                                                    | <code>-</code>    |
| <code>sps_explicit_mts_intra_enabled_flag</code>                                             | <code>u(1)</code> |
| <code>sps_explicit_mts_inter_enabled_flag</code>                                             | <code>u(1)</code> |
| <code>}</code>                                                                               |                   |
| <code>If (sps_explicit_mts_intra_enabled_flag    sps_explicit_mts_inter_enabled_flag)</code> |                   |
| <code>sps_mts_enabled_flag = 1</code>                                                        |                   |

The encoder can optionally select to always use shape adaptive transform selection (last pair in MTS) to emulate ImplicitMTS

## Test 1: Implicit MTS for ISP and inside MTS

|                | All Intra Main10 |        |        |      |      | Random access Main10 |        |        |      |      | Low delay B Main10 |        |        |      |      |
|----------------|------------------|--------|--------|------|------|----------------------|--------|--------|------|------|--------------------|--------|--------|------|------|
|                | Over VTM-4.0     |        |        |      |      | Over VTM-4.0         |        |        |      |      | Over VTM-4.0       |        |        |      |      |
|                | Y                | U      | V      | EncT | DecT | Y                    | U      | V      | EncT | DecT | Y                  | U      | V      | EncT | DecT |
| Class A1       | 0.00%            | 0.05%  | 0.04%  | 99%  | 99%  | 0.01%                | -0.01% | 0.09%  | 100% | 99%  |                    |        |        |      |      |
| Class A2       | -0.01%           | 0.12%  | -0.01% | 100% | 99%  | -0.03%               | -0.22% | -0.08% | 101% | 99%  |                    |        |        |      |      |
| Class B        | 0.01%            | -0.02% | 0.07%  | 100% | 100% | 0.00%                | 0.15%  | -0.17% | 101% | 101% | 0.00%              | -0.27% | 0.07%  | 101% | 101% |
| Class C        | 0.02%            | -0.08% | -0.05% | 100% | 100% | 0.02%                | -0.07% | 0.12%  | 100% | 100% | 0.01%              | 0.25%  | -0.18% | 101% | 101% |
| Class E        | -0.01%           | 0.09%  | -0.14% | 100% | 100% |                      |        |        |      |      | 0.00%              | 0.30%  | 0.99%  | 101% | 101% |
| <b>Overall</b> | 0.00%            | 0.02%  | -0.01% | 100% | 100% | 0.00%                | -0.01% | -0.02% | 101% | 100% | 0.00%              | 0.04%  | 0.22%  | 101% | 101% |
| Class D        | 0.01%            | 0.02%  | -0.18% | 100% | 100% | 0.00%                | -0.29% | -0.14% | 100% | 99%  | 0.01%              | -0.20% | -0.37% | 101% | 102% |
| Class F        | 0.00%            | 0.06%  | 0.00%  | 98%  | 100% | 0.00%                | -0.24% | -0.11% | 117% | 109% | -0.07%             | -0.28% | -0.25% | 101% | 100% |

Thanks to LGE for cross-check

## Test 2: Implicit MTS for ISP and SBT and inside MTS

|                | All Intra Main10 |        |        |      |      | Random access Main10 |        |        |      |      | Low delay B Main10 |        |        |      |      |
|----------------|------------------|--------|--------|------|------|----------------------|--------|--------|------|------|--------------------|--------|--------|------|------|
|                | Over VTM-4.0     |        |        |      |      | Over VTM-4.0         |        |        |      |      | Over VTM-4.0       |        |        |      |      |
|                | Y                | U      | V      | EncT | DecT | Y                    | U      | V      | EncT | DecT | Y                  | U      | V      | EncT | DecT |
| Class A1       | 0.00%            | 0.05%  | 0.04%  | 99%  | 99%  | 0.08%                | -0.07% | 0.03%  | 99%  | 98%  |                    |        |        |      |      |
| Class A2       | -0.01%           | 0.12%  | -0.01% | 100% | 99%  | 0.14%                | 0.00%  | 0.00%  | 99%  | 99%  |                    |        |        |      |      |
| Class B        | 0.01%            | -0.02% | 0.07%  | 100% | 100% | 0.12%                | 0.13%  | -0.27% | 99%  | 99%  | 0.18%              | -0.21% | -0.23% | 100% | 101% |
| Class C        | 0.02%            | -0.08% | -0.05% | 100% | 100% | 0.16%                | -0.06% | 0.02%  | 100% | 100% | 0.18%              | 0.39%  | -0.13% | 100% | 97%  |
| Class E        | -0.01%           | 0.09%  | -0.14% | 100% | 100% |                      |        |        |      |      | 0.13%              | 0.46%  | 0.56%  | 100% | 99%  |
| <b>Overall</b> | 0.00%            | 0.02%  | -0.01% | 100% | 100% | 0.13%                | 0.01%  | -0.08% | 99%  | 99%  | 0.17%              | 0.16%  | 0.00%  | 100% | 99%  |
| Class D        | 0.01%            | 0.02%  | -0.18% | 100% | 100% | 0.15%                | -0.16% | -0.15% | 100% | 99%  | 0.17%              | 0.31%  | -0.08% | 101% | 102% |
| Class F        | 0.00%            | 0.06%  | 0.00%  | 98%  | 100% | 0.07%                | -0.24% | -0.13% | 116% | 108% | 0.13%              | -0.52% | 0.20%  | 100% | 100% |

Thanks to LGE for cross-check



## Conclusion

- Simplification and cleanup regarding transform selection is presented
- SPS flag is removed
- Results show zero loss (Test1) or reasonable loss (Test2)