MEDIATEK

CE5.3.3 & CE5.3.4: CABAC range sub-interval derivation

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11th JVET Meeting in Ljubljana
10–18 July 2018

Overall Summary

- In JEM counter-based CABAC engine, a 512×64×9-bit look-up table (LUT) is used for rangeOne derivation
  - The table size is 144x of the size of the rangeLPS LUT used in HEVC
- CE5.3.3: Use a 32x8x8-bits LUT for rangeOne derivation
- CE5.3.4: Use a 6-bits by 5-bits multiplier for rangeOne derivation
  - Results are identical to the results of using LUT
- Less than 0.04% BD-rate increases in both VTM and BMS
  - Less than 0.09% BD-rate increases when using a 16x8x8-bits LUT or a 5-bits by 5-bits multiplier

RangeOne Derivation in JEM

- In JEM, the two parameter counter-based CABAC is adopted
  - $P'_0 = P_0 + ((32768*y - P_0)>>K)$
  - $P'_1 = P_1 + ((32768*y - P_1)>>8)$
  - $P = (P_0 + P_1)/2$
- A large look-up table (LUT) is used to derive the RangeOne
  - 512×64×9-bit LUT is used
  - The table size is 144x of the size of the rangeLPS LUT used in HEVC

```
rangeOne = LUT[probLPS>>6][(range>>2) - 64]
rangeZero = range – rangeLPS
```

CE5.3.3: 32x8x8-bits LUT

- Propose to use a 32x8x8-bits LUT for rangeOne derivation
  - The LUT size is the same as the LUT used in HEVC
  - The LUT only stores the rangeLPS value
    - rangeLPS = Probability * Range, where Probability < 0.5
  - probIdx = (P>>15) ^ (P>>9)

```
probIdx   = ( P >= 16384 ) ? 63 – (P>>9) : (P>>9)
rangeLPS  = LUT[ probIdx ][ ( range >> 5 ) & 7 ]
rangeOne  = ( P >= 16384 ) ? range – rangeLPS : rangeLPS
rangeZero = ( P >= 16384 ) ? rangeLPS : range – rangeLPS
```

CE5.3.4: 6-bits by 5-bits Multiplier

- Propose to use a 6-bits by 5-bits multiplier for rangeOne derivation
  - Results are identical to the results of using LUT
  - Users can choose to use LUT or multiplier in their implementations

```
probIdx   = ( P >= 16384 ) ? 63 – (P>>9) : (P>>9)
rangeLPS  = ((2*probIdx+1) *(2*( range >> 5)+1)) >> 3
rangeOne  = ( P >= 16384 ) ? range – rangeLPS : rangeLPS
rangeZero = ( P >= 16384 ) ? rangeLPS : range – rangeLPS
```

Supplementary Data

- CE5.3.3 supplementary:
  - Use a 16x8x8-bits LUT

```
probIdx   = ( P >= 16384 ) ? 31 – (P>>10) : (P>>10)
rangeLPS  = LUT[ probIdx ][ ( range >> 5 ) & 7 ]
```

- CE5.3.4 supplementary :
  - Use a 6-bits by 5-bits multiplier

```
probIdx   = ( P >= 16384 ) ? 31 – (P>>10) : (P>>10)
rangeLPS  = ((2*probIdx+1) *(2*( range >> 5)+1)) >> 3
```

Results of CE5.3.3 and CE5.3.4

- The JEM CABAC engine is enabled in both anchor and test (“CABACEngine : 3)

Method	VTM					BMS				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
CE5.3.3 32x8x8 LUT	0.01 0.00 0.04	0.01 -0.01 -0.07	-0.01 -0.00 -0.16	101 101 101	99 99 99	0.02 -0.01 -0.02	0.04 0.04 -0.12	0.01 0.02 -0.32	98 101 99	98 100 100
CE5.3.4 6x5-bits Multiplier	0.01 0.00 0.04	0.01 -0.01 -0.07	-0.01 -0.00 -0.16	101 101 101	99 99 101	0.02 -0.01 -0.02	0.04 0.04 -0.12	0.01 0.02 -0.32	98 101 99	96 101 97
CE5.3.3 sup. 16x8x8 LUT	0.04 0.03 0.09	0.02 0.00 0.03	0.02 0.01 0.05	100 100 100	98 99 99	0.05 0.03 0.06	0.09 0.04 0.02	0.06 0.06 -0.12	100 101 101	98 101 100
CE5.3.4 sup. 5x5-bits Multiplier	0.04 0.03 0.09	0.02 0.00 0.03	0.02 0.01 0.05	101 102 100	101 105 99	0.05 0.03 0.06	0.09 0.04 0.02	0.06 0.06 -0.12	101 98 102	99 95 103

Thank Qualcomm for cross-checking

Conclusions

- CE5.3.3: Use a 32x8x8-bits LUT for rangeOne derivation
  - Reduce the LUT size by 144x
- CE5.3.4: Use a 6-bits by 5-bits multiplier for rangeOne derivation
  - Results are identical to the results of using LUT
- Users can choose to use LUT or multiplier in their implementations
- Less than 0.04% BD-rate increases in both VTM and BMS
  - Less than 0.09% BD-rate increases when using a 16x8x8-bits LUT or a 5-bits by 5-bits multiplier



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