

AHG16/NON-CE7: A STUDY OF BIN TO BIT RATIO IN VTM4.0 AND HM16.19 (JVET-N0049)



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Motivation and Observations

- For a given min compression ratio (MinCR) of a level, the bin to bit ratio dictates the required CABAC throughput (bins/sec) to meet the real time decoding
- A higher bin to bit ratio implies that a CABAC engine needs to process bins at a faster pace in order to deal with the peak bit-rate in real time.
- Observations:
 - For CTC AI/RA configurations, on average the weighted bin to bit ratio is 15.72%/17.39% higher than the HM16.19, and the unweighted bin to bit ratio is 12.38%/13.75% higher than the HM16.19, respectively.
 - For low-QP AI/RA configurations, the weighted bin to bit ratio is 18.11%/17.17% higher than the HM16.19, and the unweighted bin to bit ratio is 10.45%/7.63% higher than the HM16.19, respectively.

Collected Data and Decoder Side Measurements

- **Data collected from the decoder side:**
 - The peak context coded bin rate, bypass bin rate and bit-rate of a coded sequence
 - The average context coded bin rate, bypass bin rate and bit-rate over a coded sequence.
 - The average context coded bin rate, bypass bin rate and bit-rate consumed by the transform coefficients coding over a coded sequence.
- **Measurements:**
 - Weighted BD-binrate for the peak case.
 - Weighted BD-binrate for the average case.
 - Weighted BD-binrate for the transform coefficients coding part.
 - Weighted bin to bit ratio for the peak case.
 - Unweighted bin to bit ratio for the peak case, for the average case, and for the transform coefficients coding part.

Note: In the weighted measurements, a bypass bin is counted as 0.25 context coded bins. In the unweighted measurements, a bypass bin and a context coded bin carry an equal weight (1:1).

Experimental Results for CTC Setting

| | All Intra Main10 | | | | | | | | | | | | | |
|--------------------|-----------------------|---------|---------|--------------------------------|---------|---------|--------------------------------|---------|----------|----------------------------------|---------|----------|-------|------|
| | Over HM16.19 | | | | | | | | | | | | | |
| | BD-bitrate | | | BD-binrate (average, weighted) | | | Bin2bit ratio (peak, weighted) | | | Bin2bit ratio (peak, unweighted) | | | | |
| | Y | U | V | Y | U | V | HM16.19 | VTM 4.0 | Diff (%) | HM16.19 | VTM 4.0 | Diff (%) | EncT | DecT |
| Class A1 | -23.74% | -39.31% | -36.64% | -7.78% | -26.07% | -22.84% | 0.96 | 1.14 | 19.39% | 1.23 | 1.42 | 15.67% | 1325% | 170% |
| Class A2 | -22.96% | -25.02% | -19.85% | -10.21% | -12.07% | -6.17% | 0.97 | 1.13 | 17.10% | 1.24 | 1.42 | 14.18% | 2068% | 178% |
| Class B | -19.13% | -24.25% | -31.00% | -5.57% | -10.60% | -18.38% | 0.95 | 1.10 | 15.10% | 1.23 | 1.38 | 11.93% | 2330% | 188% |
| Class C | -19.52% | -21.31% | -24.54% | -6.18% | -7.63% | -11.10% | 0.91 | 1.05 | 15.43% | 1.19 | 1.34 | 12.06% | 3054% | 245% |
| Class E | -22.80% | -23.91% | -27.15% | -12.31% | -12.62% | -16.06% | 0.95 | 1.06 | 12.56% | 1.23 | 1.34 | 8.90% | 1764% | 159% |
| Overall | -21.23% | -26.18% | -28.00% | -7.97% | -13.10% | -15.09% | 0.95 | 1.10 | 15.72% | 1.23 | 1.38 | 12.38% | 2108% | 189% |
| Class D | -16.31% | -18.23% | -19.64% | -0.81% | -2.73% | -4.22% | 0.89 | 1.04 | 17.63% | 1.18 | 1.33 | 13.12% | 3022% | 335% |
| Class F (optional) | -33.58% | -36.53% | -38.28% | -17.39% | -20.00% | -21.81% | 0.87 | 1.06 | 22.43% | 1.17 | 1.32 | 12.75% | 3097% | 208% |
| | | | | | | | | | | | | | | |
| | Random Access Main 10 | | | | | | | | | | | | | |
| | Over HM16.19 | | | | | | | | | | | | | |
| | BD-bitrate | | | BD-binrate (average, weighted) | | | Bin2bit ratio (peak, weighted) | | | Bin2bit ratio (peak, unweighted) | | | | |
| | Y | U | V | Y | U | V | HM16.19 | VTM 4.0 | Diff (%) | HM16.19 | VTM 4.0 | Diff (%) | EncT | DecT |
| Class A1 | -32.65% | -39.10% | -42.07% | -22.00% | -29.31% | -32.78% | 0.94 | 1.13 | 20.49% | 1.22 | 1.43 | 16.67% | 804% | 171% |
| Class A2 | -37.43% | -35.62% | -29.96% | -28.45% | -25.82% | -19.33% | 0.95 | 1.13 | 17.94% | 1.23 | 1.42 | 15.18% | 852% | 156% |
| Class B | -31.31% | -36.99% | -38.14% | -21.90% | -27.91% | -29.16% | 0.93 | 1.08 | 15.90% | 1.22 | 1.37 | 12.32% | 784% | 177% |
| Class C | -26.50% | -27.38% | -29.19% | -14.87% | -15.71% | -17.78% | 0.88 | 1.03 | 16.42% | 1.18 | 1.33 | 12.20% | 996% | 241% |
| Class E | | | | | | | | | | | | | | |
| Overall | -31.52% | -34.58% | -34.90% | -21.36% | -24.52% | -24.88% | 0.93 | 1.09 | 17.39% | 1.21 | 1.38 | 13.75% | 854% | 186% |
| Class D | -25.61% | -25.09% | -26.33% | -15.20% | -14.46% | -15.91% | 0.86 | 1.02 | 18.44% | 1.17 | 1.32 | 13.32% | 1013% | 356% |
| Class F (optional) | -36.12% | -38.21% | -39.22% | -22.29% | -24.45% | -25.49% | 0.84 | 1.03 | 23.01% | 1.16 | 1.31 | 12.98% | 497% | 185% |

Experimental Results for Low-QP Setting (QP = 2, 7, 12, 17)

| All Intra Main10 | | | | | | | | | | | | | | |
|-----------------------|------------|---------|---------|--------------------------------|--------|--------|--------------------------------|---------|----------|----------------------------------|---------|----------|-------|------|
| Over HM16.19 LQ | | | | | | | | | | | | | | |
| | BD-bitrate | | | BD-binrate (average, weighted) | | | Bin2bit ratio (peak, weighted) | | | Bin2bit ratio (peak, unweighted) | | | EncT | DecT |
| | Y | U | V | Y | U | V | HM16.19 | VTM 4.0 | Diff (%) | HM16.19 | VTM 4.0 | Diff (%) | | |
| Class A1 | -12.20% | -12.63% | -11.82% | 4.68% | 4.03% | 4.88% | 0.87 | 1.03 | 19.08% | 1.22 | 1.39 | 13.78% | 3392% | 165% |
| Class A2 | -13.20% | -4.80% | -4.85% | 4.76% | 11.81% | 11.83% | 0.77 | 0.91 | 18.41% | 1.19 | 1.31 | 9.97% | 3792% | 165% |
| Class B | -11.25% | -5.83% | -6.25% | 5.66% | 10.64% | 10.16% | 0.78 | 0.92 | 18.18% | 1.18 | 1.29 | 9.83% | 3066% | 153% |
| Class C | -11.41% | -5.19% | -5.52% | 4.78% | 10.16% | 9.78% | 0.73 | 0.85 | 16.80% | 1.18 | 1.26 | 6.62% | 3475% | 226% |
| Class E | -14.99% | -6.30% | -5.95% | 1.84% | 11.08% | 11.38% | 0.84 | 0.99 | 18.14% | 1.19 | 1.35 | 13.34% | 3567% | 178% |
| Overall | -12.39% | -6.73% | -6.73% | 4.52% | 9.70% | 9.68% | 0.79 | 0.94 | 18.11% | 1.19 | 1.31 | 10.45% | 3406% | 176% |
| Class D | -11.25% | -5.62% | -6.22% | 4.38% | 9.44% | 8.82% | 0.70 | 0.82 | 16.29% | 1.17 | 1.23 | 5.04% | 3583% | 261% |
| Class F (optional) | -24.83% | -19.01% | -19.41% | -4.30% | 1.67% | 1.20% | 0.73 | 0.93 | 26.95% | 1.14 | 1.28 | 11.76% | 3645% | 228% |
| | | | | | | | | | | | | | | |
| Random Access Main 10 | | | | | | | | | | | | | | |
| Over HM16.19 LQ | | | | | | | | | | | | | | |
| | BD-bitrate | | | BD-binrate (average, weighted) | | | Bin2bit ratio (peak, weighted) | | | Bin2bit ratio (peak, unweighted) | | | EncT | DecT |
| | Y | U | V | Y | U | V | HM16.19 | VTM 4.0 | Diff (%) | HM16.19 | VTM 4.0 | Diff (%) | | |
| Class A1 | -13.11% | -5.92% | -7.84% | 3.80% | 11.12% | 9.20% | 0.82 | 0.96 | 17.18% | 1.20 | 1.33 | 10.57% | 1076% | 167% |
| Class A2 | -15.81% | -1.34% | -1.28% | -0.52% | 12.21% | 12.51% | 0.71 | 0.85 | 18.57% | 1.18 | 1.27 | 7.47% | 1246% | 163% |
| Class B | -13.03% | -1.05% | -1.05% | 2.33% | 14.01% | 13.52% | 0.75 | 0.88 | 17.91% | 1.17 | 1.27 | 8.43% | 946% | 171% |
| Class C | -14.47% | -1.63% | -2.53% | -0.61% | 12.06% | 10.91% | 0.70 | 0.81 | 15.10% | 1.19 | 1.24 | 4.52% | 1156% | 210% |
| Class E | | | | | | | | | | | | | | |
| Overall | -13.99% | -2.24% | -2.85% | 1.27% | 12.55% | 11.76% | 0.74 | 0.87 | 17.17% | 1.18 | 1.28 | 7.63% | 1082% | 178% |
| Class D | -16.10% | -3.05% | -4.05% | -3.16% | 10.07% | 8.78% | 0.68 | 0.78 | 15.41% | 1.18 | 1.22 | 3.52% | 1198% | 261% |
| Class F (optional) | -28.26% | -17.76% | -18.86% | -12.52% | -0.68% | -1.85% | 0.71 | 0.89 | 25.89% | 1.14 | 1.26 | 10.29% | 644% | 178% |

Discussions

- A higher bin to bit ratio generally requires a higher throughput CABAC engine for real time decoding.
- It is unclear at this stage what has caused the higher bin to bit ratio in the VTM4.0.
- Although this is not an immediate concern, it is worth to investigate the root cause of such a phenomenon.