

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 18.15%/17.49% higher than the HM16.19, and the unweighted bin to bit ratio is 10.49%/8.01% 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)			EncT	DecT
	Y	U	V	Y	U	V	HM16.19	VTM 4.0	Diff (%)	HM16.19	VTM 4.0	Diff (%)		
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)			EncT	DecT
	Y	U	V	Y	U	V	HM16.19	VTM 4.0	Diff (%)	HM16.19	VTM 4.0	Diff (%)		
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														
	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														
	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	-13.93%	-6.30%	-8.32%	2.80%	10.64%	8.60%	0.82	0.97	18.07%	1.20	1.34	11.12%	1055%	161%
Class A2	-16.82%	-1.84%	-2.11%	-2.05%	11.51%	11.41%	0.71	0.85	19.64%	1.18	1.27	8.01%	1180%	156%
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	-14.35%	-2.41%	-3.11%	0.76%	12.32%	11.42%	0.74	0.87	17.57%	1.18	1.28	7.85%	1066%	175%
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.