

AHG4: Suggested constraint on number of bits/bins per LCU

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Background

- AVC defines a bit-size limit per MB
 - ✓ Bit-size limit: Original data size + 4 % margin (e.g., 3072+128 bits for 4:2:0 8 bit video.)
 - ✓ Very helpful for decoder implementation
 - Determine appropriate buffering storage and operating clock requirements
- The current HEVC text misses such a limit
 - ✓ LCU size can be x16 of macroblock size
 - ✓ Theoretical maximum expansion (x 7.4) of a compressed LCU requires prohibitive buffering storage and operating clock

HEVC should specify an LCU-level bit or bin constraint as AVC.

Suggested approach

- Define a constraint in terms of bin # or bit # per LCU with some margin of the original data size

- Strawman constraint discussed on the reflector

[Constraint in terms of bits]

The number of bits generated by an LCU shall not exceed

$(N \gg 3) * (N \gg 3) * (\text{Num16x16LCUSample} * \text{BitDepth}) * 1.XX$

where $2N$ is the size of the LCU and Num16x16LCUSample is the number of 16x16 LCU luma and chroma samples.

1.20-1.30

[Constraint in terms of bins]

The number of bins generated by an LCU shall not exceed

$(N \gg 3) * (N \gg 3) * (\text{Num16x16LCUSample} * \text{BitDepth}) * 1.XX * 1.YY$

where $2N$ is the size of the LCU and Num16x16LCUSample is the number of 16x16 LCU luma and chroma samples.

1.30

Suggested approach (Cont.)

- Appropriate margin allows to define a well-balanced constraint for both encoder and decoder
 - ✓ As margin is increased, the number of bit-size limit violations is reduced; less re-encoding operations at encoder
 - ✓ Moderate margin (20%-30%) is acceptable for decoder.
- A constraint in terms of bins can be alternative one
 - ✓ The exact number of bits is available after CABAC
 - ✓ The bin constraint does not cap the number of bits in worst case. (However, better than having no constraint.)

Experiment

- Synthesized noise sequence is coded by using different LCU sizes (64x64, 32x32, and 16x16)
- QP=0,4,8, and 12 for RA Main setting; QP=-12, -8, -4, and 0 for RA HE10 setting
- Bit and bin numbers of LCUs are collected.



Synthesized test sequence, *Sandstorms*, (640x240 30Hz 30frames)

Results

- Different LCU sizes show very similar tendency
- Data expansion happens even when QP=12 and QP=0 for RA-Main and HE-10, respectively
 - ✓ Having a margin of 20%-30% seems to be appropriate
- Bin/bit ratio ranges from 1.08 to 1.20 and is less than 1.3; the majority of bins is bypass coded in the tested small QPs.
 - ✓ 1.2 seems to be appropriate bin/bit ratio from a practical point of view

64x64 LCU results

QP	RA-MAIN				QP	RA-HE10			
	w/o transform skipping		w/ transform skipping			w/o transform skipping		w/ transform skipping	
	Bin/bit ratio	Data expansion ratio	Bin/bit ratio	Data expansion ratio		Bin/bit ratio	Data expansion ratio	Bin/bit ratio	Data expansion ratio
0	1.13	1.83	1.08	1.64	-12	1.08	2.11	1.08	2.03
4	1.15	1.55	1.09	1.43	-8	1.09	1.90	1.09	1.90
8	1.17	1.31	1.13	1.27	-4	1.11	1.67	1.09	1.59
12	1.20	1.12	1.12	1.07	0	1.12	1.44	1.09	1.32

Conclusion

- Define a constraint in terms of bin # or bit # per LCU in HEVC based on the following strawman proposals.

[Constraint in terms of bits]

*The number of bits generated by an LCU shall not exceed $(N \gg 3) * (N \gg 3) * (Num16x16LCUSample * BitDepth) * 1.25$ where $2N$ is the size of the LCU and $Num16x16LCUSample$ is the number of $16x16$ LCU luma and chroma samples.*

[Constraint in terms of bins]

*The number of bins generated by an LCU shall not exceed $(N \gg 3) * (N \gg 3) * (Num16x16LCUSample * BitDepth) * 1.25 * 1.20$ where $2N$ is the size of the LCU and $Num16x16LCUSample$ is the number of $16x16$ LCU luma and chroma samples.*

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