

JVET-O0308

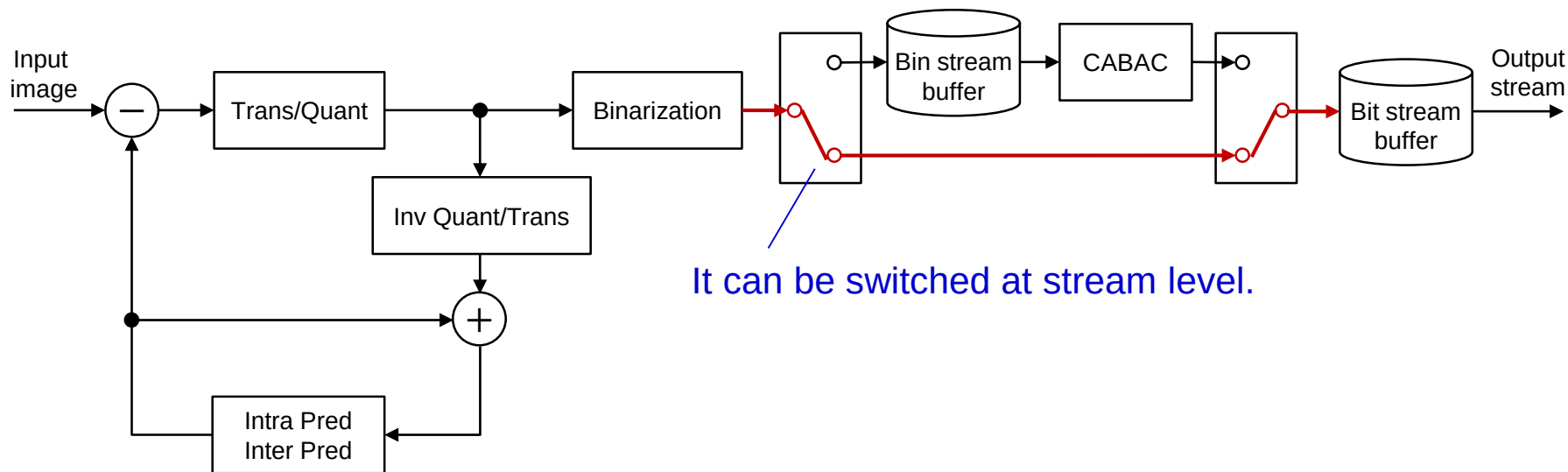
CABAC skip mode

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Introduction

Propose CABAC skip mode which directly outputs binarized bins.
It was originally proposed by JVET-M0089 and JVET-N0207.



It can avoid all processing delay due to CABAC throughput.

CABAC throughput issue

HEVC H/W decoder specification

- Standard : HEVC Main10, Level5.1, High tier
- Operation frequency : 450MHz (High performance H/W)

Test conditions

- Sequence : DaylightRoad (4K/10bits/60fps)
- GOP : LDB (only first is I-Pic)
- Bitrate : 200Mbps

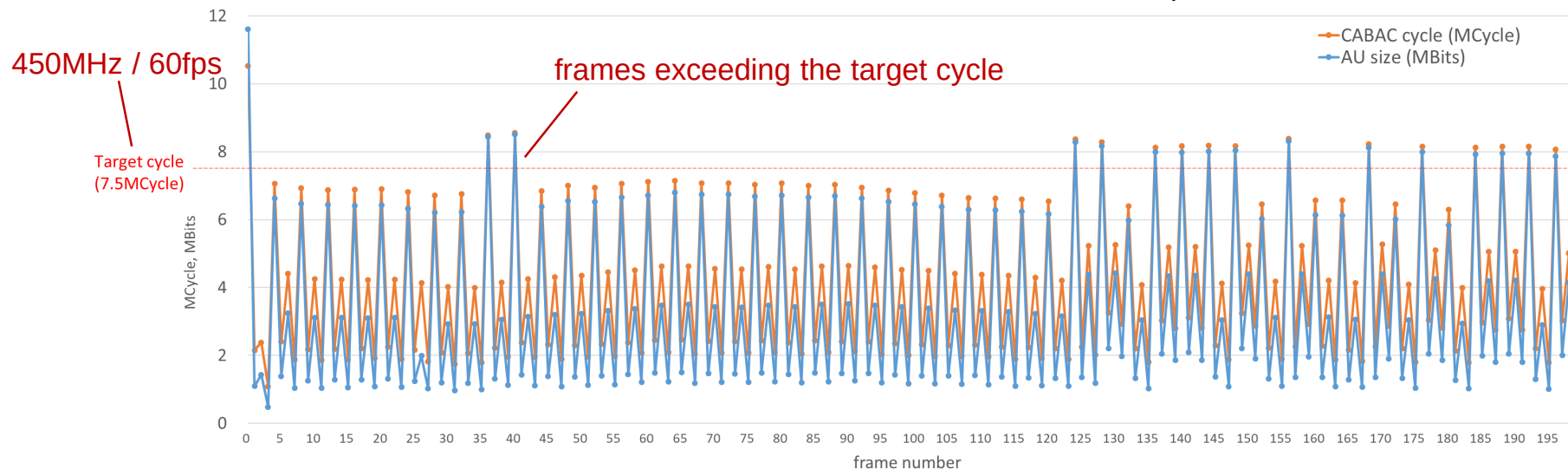


Fig. HEVC H/W decoder performance (Latency = 1 frame)



bin to bit ratio : 1.34

CABAC throughput : 0.98 bins / 1cycle

CABAC throughput issue

■ Typical use cases

- Normal bitrate
- Large initial delay
- Large bin buffer
- Limited bin to bit ratio

CABAC cycle is smoothed over several picture periods and hidden under the target cycles.

■ Special use cases

- Very high bitrate
- Small initial delay
- Small bin buffer
- Large bin to bit ratio
- Small MinCr

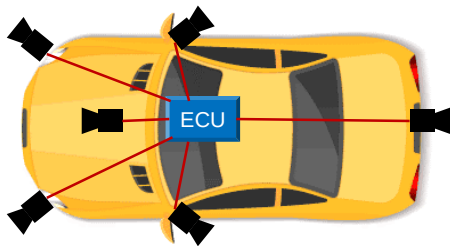
← Target of CABAC skip mode

It is difficult to guarantee to complete processing within the specified period even for the conformance hardware decoder.
This issue may be more likely to occur in VVC than in HEVC.

Example of CABAC skip mode use cases

Delay of several milliseconds is required for video codec in these fields, but bitrate is not so critical. Some applications still use H.264 with CAVLC due this issue.

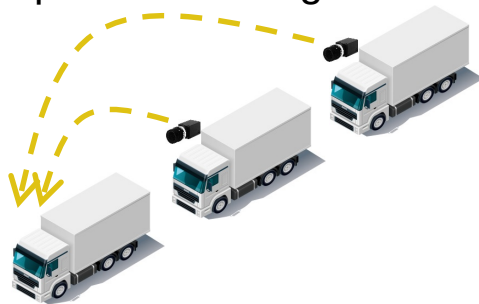
ex1) Automotive camera



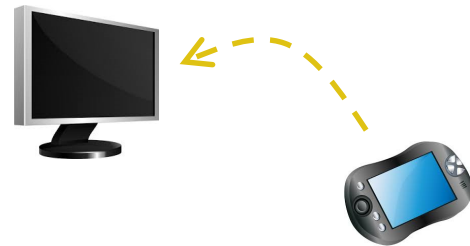
ex3) Remote operation



ex2) Cooperative driving



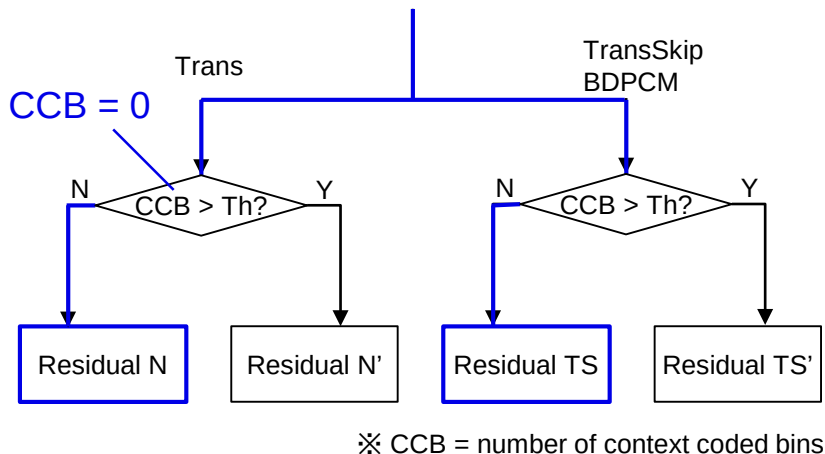
ex4) Wireless display



Proposed method of CABAC skip mode

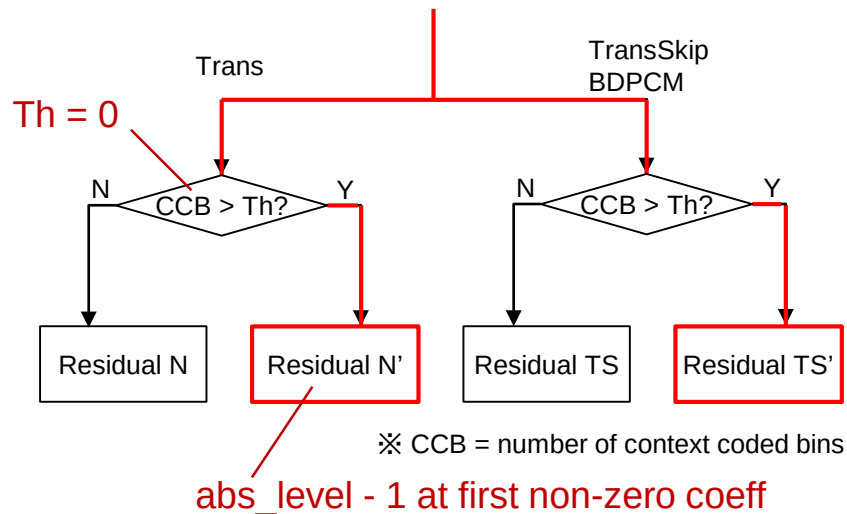
Method1 (same as N0207)

- Reuse normal residual binarization.



Method2 (new proposal)

- Reuse residual binarization of exceeding max CCB.
- $\text{abs_level} - 1$ at first non-zero coeff of TU.



Simulation results

Anchor : VTM-5.0

Test : CABAC skip mode method1 (same as N0207)

	All Intra Main10				
	Y	U	V	EncT	DecT
Class A1	32.44%	20.55%	22.99%	116%	98%
Class A2	29.22%	22.69%	25.71%	101%	99%
Class B	28.04%	24.07%	22.98%	102%	100%
Class C	23.86%	22.08%	21.54%	92%	100%
Class E	25.41%	21.39%	20.88%	102%	100%
Overall	27.60%	22.36%	22.76%	102%	99%
Class D	22.98%	21.46%	21.23%	90%	99%
Class F	24.32%	23.83%	23.16%	103%	95%
TGM	21.29%	23.11%	23.11%	96%	101%

Random Access Main 10				
Y	U	V	EncT	DecT
28.65%	21.11%	19.45%	99%	90%
26.61%	15.72%	19.79%	92%	91%
28.29%	16.03%	14.74%	95%	93%
24.01%	15.57%	14.60%	95%	96%
26.89%	16.86%	16.65%	95%	93%
22.63%	14.12%	14.65%	95%	95%
25.52%	23.17%	23.07%	101%	96%
27.68%	28.45%	28.44%	100%	94%

Low delay B Main10				
Y	U	V	EncT	DecT
33.09%	10.22%	7.36%	88%	91%
29.17%	15.34%	13.31%	89%	96%
27.47%	9.59%	7.07%	93%	96%
30.38%	11.77%	9.27%	90%	94%
27.73%	9.13%	10.94%	90%	95%
31.76%	24.60%	24.16%	99%	95%
31.58%	31.64%	31.77%	100%	97%

Simulation results

Anchor : VTM-5.0

Test : CABAC skip mode method2 (new proposal)

	All Intra Main10				
	Y	U	V	EncT	DecT
Class A1	20.37%	9.13%	10.86%	111%	90%
Class A2	17.98%	11.25%	13.67%	97%	90%
Class B	16.58%	12.63%	11.84%	98%	91%
Class C	15.00%	12.99%	13.10%	92%	92%
Class E	16.30%	12.65%	12.51%	98%	94%
Overall	17.05%	11.90%	12.37%	98%	91%
Class D	14.14%	12.37%	12.65%	89%	92%
Class F	18.75%	17.79%	17.32%	99%	91%
TGM	19.51%	20.37%	20.41%	91%	100%

Random Access Main 10				
Y	U	V	EncT	DecT
18.95%	10.79%	10.98%	98%	87%
17.35%	8.55%	12.34%	92%	89%
18.12%	8.32%	6.58%	95%	90%
16.27%	8.54%	8.20%	95%	94%
17.64%	8.92%	9.04%	95%	90%
15.44%	7.40%	8.21%	95%	95%
20.17%	17.58%	17.74%	99%	95%
25.27%	25.24%	25.21%	96%	94%

Low delay B Main10				
Y	U	V	EncT	DecT
21.38%	4.35%	1.12%	91%	88%
20.01%	9.30%	7.88%	91%	95%
20.48%	5.41%	4.43%	96%	96%
20.70%	6.26%	4.20%	92%	93%
19.56%	4.37%	5.84%	92%	95%
25.55%	19.14%	18.14%	98%	94%
29.09%	28.19%	28.19%	98%	97%

The loss is reduced significantly compared to method1.

We propose this method.

Additional information1

Anchor : VTM-5.0

Test : CABAC skip mode method2 with Low QP (2, 7, 12, 17)

	All Intra Main10					Random Access Main 10					Low delay B Main10				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	16.05%	14.21%	14.82%	95%	78%	20.46%	14.27%	14.28%	90%	77%					
Class A2	10.90%	11.11%	11.34%	84%	72%	16.41%	16.93%	17.42%	83%	77%					
Class B	12.78%	13.48%	14.32%	89%	78%	18.31%	17.82%	17.03%	96%	80%	17.45%	18.05%	17.94%	101%	80%
Class C	9.89%	10.16%	10.54%	89%	77%	16.41%	17.26%	15.51%	86%	81%	16.17%	18.53%	18.10%	87%	81%
Class E	13.72%	13.77%	14.29%	87%	79%						21.21%	21.87%	20.41%	80%	80%
Overall	12.53%	12.52%	13.06%	89%	77%	17.85%	16.78%	16.15%	89%	79%	17.96%	19.16%	18.61%	91%	80%
Class D	8.91%	9.01%	9.22%	90%	80%	14.41%	15.19%	13.67%	88%	84%	15.11%	16.20%	15.98%	89%	82%
Class F	12.95%	12.13%	12.46%	91%	85%	18.36%	14.40%	13.46%	90%	90%	18.31%	16.84%	16.25%	91%	90%
TGM	15.66%	15.00%	15.08%	89%	98%	14.36%	16.50%	16.39%	93%	96%	17.34%	17.14%	16.98%	94%	97%

The performance is not so different from the normal QP conditions.

Additional information2

Anchor : HEVC (HM-16.19)

Test : CABAC skip mode method2

	All Intra Main10				
	Y	U	V	EncT	DecT
Class A1	-11.97%	-33.71%	-30.63%		
Class A2	-11.50%	-17.32%	-8.97%		
Class B	-7.75%	-16.17%	-25.12%		
Class C	-9.62%	-12.51%	-18.17%		
Class E	-12.36%	-15.07%	-21.11%		
Overall	-10.26%	-18.29%	-21.14%		
Class D	-5.80%	-9.32%	-12.10%		
Class F	-26.58%	-29.40%	-32.52%		

	Random Access Main 10				
	Y	U	V	EncT	DecT
	-22.65%	-32.26%	-36.21%		
	-28.43%	-30.86%	-22.22%		
	-20.66%	-32.49%	-36.03%		
	-16.20%	-21.04%	-25.64%		
	-21.42%	-29.06%	-30.53%		
	-14.71%	-19.23%	-22.50%		
	-27.69%	-30.85%	-33.35%		

	Low delay B Main10				
	Y	U	V	EncT	DecT
	-10.31%	-18.78%	-22.79%		
	-7.17%	-11.53%	-16.03%		
	-10.27%	-19.52%	-24.76%		
	-9.25%	-16.55%	-21.03%		
	-6.09%	-10.32%	-12.71%		
	-20.49%	-25.09%	-27.65%		

CABAC skip mode still has enough advantages over HEVC.

Additional information3

Anchor : H.264/CABAC (JM-19.0)

Test : H.264/CAVLC (JM-19.0)

	All Intra Main10				
	Y	U	V	EncT	DecT
Class A1	33.76%	31.65%	30.88%		
Class A2	24.44%	22.30%	21.34%		
Class B	22.35%	17.38%	18.62%		
Class C	9.61%	8.04%	8.34%		
Class E	21.95%	20.65%	22.58%		
Overall	21.70%	19.05%	19.49%		
Class D	7.50%	6.32%	6.18%		
Class F	11.77%	11.26%	11.24%		

Random Access Main 10				
Y	U	V	EncT	DecT
35.41%	25.00%	23.75%		
29.90%	19.21%	17.67%		
25.08%	13.79%	14.62%		
16.36%	10.86%	11.09%		
25.78%	16.33%	16.12%		
13.91%	7.70%	7.92%		
16.60%	13.89%	14.02%		

Low delay B Main10				
Y	U	V	EncT	DecT
28.23%	15.41%	17.07%		
19.01%	11.42%	11.49%		
28.76%	24.62%	26.64%		
25.29%	16.38%	17.60%		
17.10%	8.69%	9.29%		
20.61%	17.84%	18.53%		

The loss of method2 is less than that of CAVLC on H.264.

- CABAC skip mode can avoid processing delay due to CABAC throughput.
- 17%, 18%, 21% bits increasing for AI, RA, LDB on VTM-5.0.
It still has enough advantages over HEVC.
The performance is almost same for low QP conditions.
- The loss of CABAC skip mode is less than that of CAVLC on H.264.

We propose to introduce CABAC skip mode into VVC.

Thanks Canon for cross-checking of the proposal (method2).