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On LFNST index and MTS index signalling

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Overall Summary

- Propose to parse the LFNST index and the MTS index right after parsing the last significant coefficient position of the first nonzero transform blocks (TB)
- When the MTS index is not equal to 0, coefficients in the MTS zero-out region are not parsed
- Inverse quantization (IQ) and inverse transform (IT) process can be performed before all coefficients in the current coding unit (CU) are parsed
 - Same data path for all other video coding standards

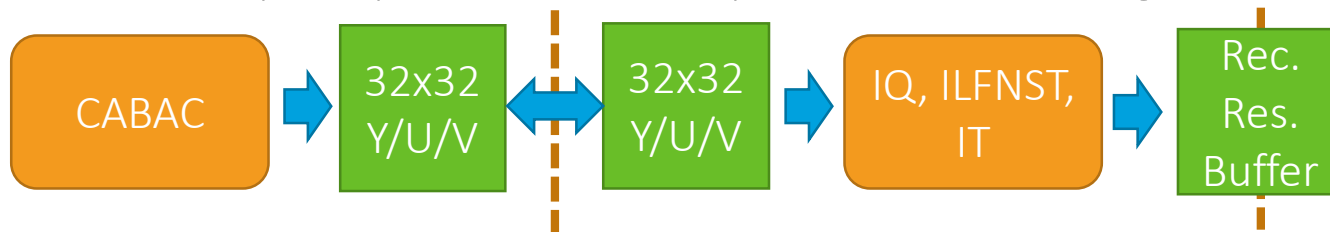
	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
Proposed method	0.01%	0.11%	0.20%	0.01%	0.07%	0.15%	0.03%	0.03%	0.08%

Introduction

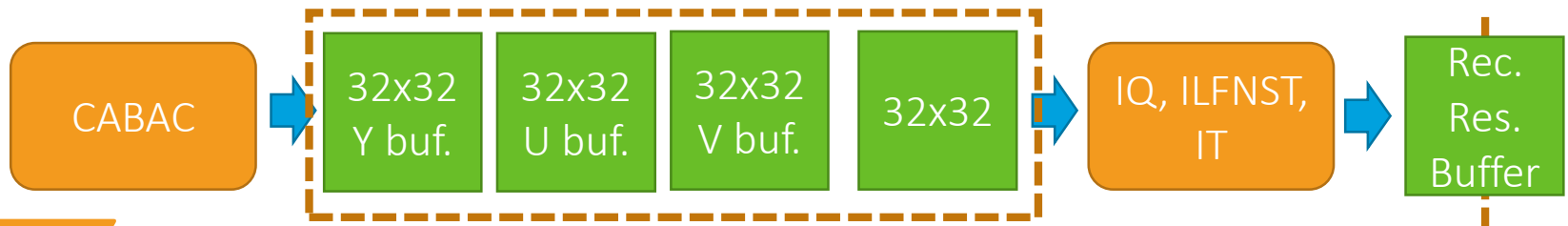
- In VTM7.0, there are two main problems in the design of LFNST index and MTS index signalling
- Problem 1: MTS signalling redundancy
 - In VTM7.0, since the MTS index is parsed at the end of each CU, coefficients in MTS zero-out region are parsed even though the MTS index is not equal to 0
- Problem 2: latency of IQ and IT process
 - In VTM7.0, both LFNST index and MTS index are parsed at the end of each CU, IT can only be performed after the entire CU's coefficients are parsed
 - For all other video coding standards, all IQ/IT required information can be parsed before the coefficient parsing
 - **New data path or control/synchronization circuit is required only for VVC**

Buffer Requirement and Latency

- If all transform and quantization related information can be parsed before the first TB
 - Two 32x32 buffers, one TB delay
 - The complete parsed TB can be push to the next stage



- If all transform and quantization related information can NOT be parsed before the first TB, e.g. at the end of CU
 - Four 32x32 buffers, 3 TB delay
 - Need to store all coefficients of three colour components + one temp buffer



Proposed Method

- Parse LFNST index and MTS index right after parsing the last significant coefficient position of the first nonzero TB
 - LFNST index signalling
 - Signalled when the last significant position is not DC position (same as VVC Draft 7)
 - If the LFNST index is not equal to 0, in the remaining TBs, the x and y position of the last significant coefficient position must be smaller than 4
 - MTS index signalling
 - After LFNST index (same as VVC Draft 7)
 - If the MTS index is not equal to 0, coefficients in the MTS zero-out region are not parsed
- MTS signalling redundancy is removed
- IQ and IT can be performed after parsing the first nonzero TB

Results

All Intra Main10					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.16%	0.29%	100%	99%
Class A2	-0.01%	0.22%	0.12%	100%	98%
Class B	0.01%	0.09%	0.19%	100%	98%
Class C	0.02%	0.08%	0.15%	100%	98%
Class E	0.02%	0.02%	0.24%	101%	99%
Overall	0.01%	0.11%	0.20%	100%	98%
Class D	0.04%	0.06%	0.27%	101%	97%
Class F	0.01%	0.03%	0.22%	99%	97%

Random access Main10					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.03%	0.14%	0.06%	100%	98%
Class A2	-0.03%	0.09%	0.16%	100%	108%
Class B	0.01%	0.01%	0.23%	99%	100%
Class C	0.01%	0.07%	0.10%	99%	99%
Class E					
Overall	0.01%	0.07%	0.15%	100%	101%
Class D	0.03%	-0.20%	0.03%	100%	98%
Class F	-0.03%	0.06%	-0.07%	100%	99%

Low delay B Main10					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.07%	-0.17%	0.09%	101%	99%
Class C	0.06%	0.06%	0.00%	100%	99%
Class E	-0.06%	0.33%	0.15%	99%	99%
Overall	0.03%	0.03%	0.08%	100%	99%
Class D	0.01%	-0.25%	-0.16%	99%	97%
Class F	0.15%	0.04%	0.52%	100%	101%

Conclusion

- A method to parse the LFNST index and MTS index right after parsing the last significant coefficient position is proposed
- Since MTS index can be obtained before subblock coefficient parsing, MTS signalling redundancy is removed
- Both LFNST index and MTS index can be obtained after parsing the first nonzero TB, IQ and IT process can be started much earlier than VTM7.0 to **reduce the latency and reduce the control circuit for multi-standard implementation**
- Thank Tencent for cross-checking!

	AI			RA			LB		
	Y	U	V	Y	U	V	Y	U	V
Proposed method	0.01%	0.11%	0.20%	0.01%	0.07%	0.15%	0.03%	0.03%	0.08%

The background is a solid green color with a repeating pattern of white line-art icons. These icons include various nautical items like anchors, lifebuoys, and seashells, as well as outdoor and travel-related items like a compass, a map, a tent, and a bird in flight. There are also symbols for technology like a smartphone and a Wi-Fi signal.

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Thank you!