

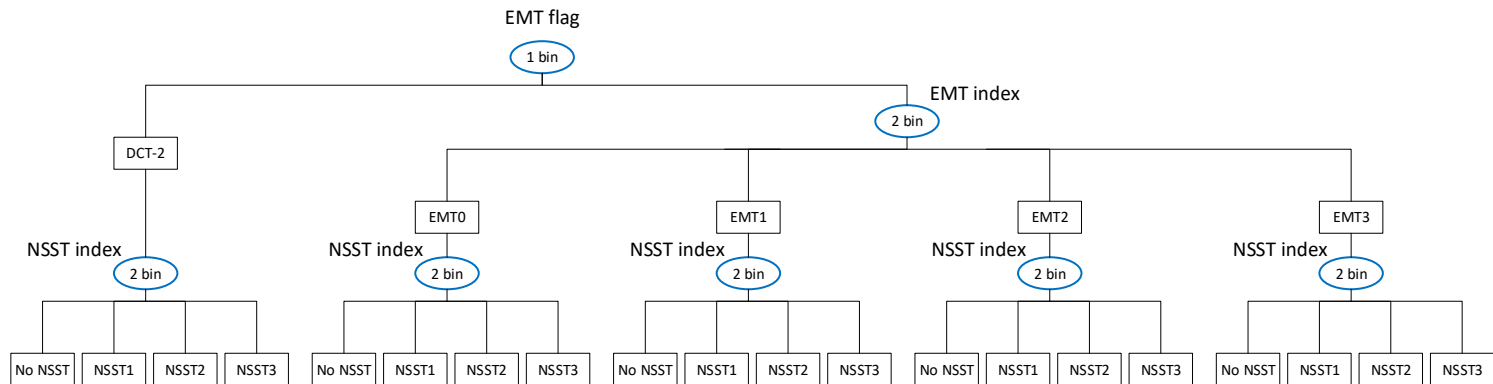
Coupled primary and secondary transform (JVET-J0054)

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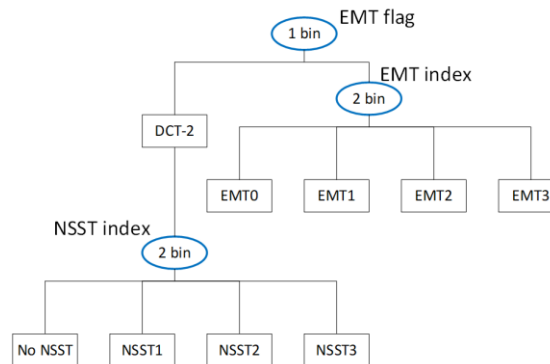
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Introduction

- In JEM-7.0, EMT and NSST are signaled independently, and complexity is multiplied to each other (up to $4 \times 5 = 20 \times$ luma RD checks, $4 \times$ chroma RD checks)



- In NexSoftware 1.8.5.1 and Tencent's CfP response, EMT and NSST are signaled exclusively, and complexity is added to each other (up to $4 + 4 = 8 \times$ luma RD checks, $4 \times$ chroma RD checks)



Problem Statement

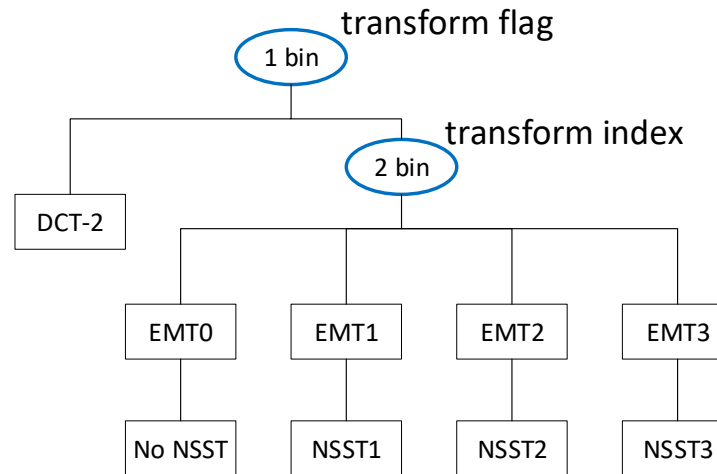
- Coding gain of EMT and NSST heavily overlaps with each other
 - For both EMT and NSST, part of the coding gain comes from increased encoder RD checks

	Anchor: EMT off, NSST off					Anchor: EMT off					Anchor: NSST off				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A	-5.65%	-5.12%	-5.43%	236%	112%	-1.69%	-1.20%	-1.13%	117%	109%	-1.49%	-3.34%	-3.22%	173%	96%
Class A2	-6.56%	-7.56%	-7.69%	219%	109%	-1.45%	-0.89%	-0.71%	116%	108%	-2.60%	-5.71%	-5.86%	165%	95%
Class B	-4.60%	-4.35%	-5.36%	248%	107%	-1.54%	-0.77%	-0.73%	121%	107%	-1.23%	-3.08%	-4.08%	171%	98%
Class C	-5.06%	-3.58%	-4.05%	259%	98%	-1.07%	-0.17%	-0.14%	125%	103%	-2.25%	-3.04%	-3.40%	171%	98%
Class D	-4.55%	-3.12%	-3.32%	282%	100%	-1.02%	-0.16%	0.01%	128%	102%	-1.90%	-2.82%	-3.14%	171%	99%
Class E	-5.51%	-5.72%	-6.61%	222%	104%	-1.34%	-0.80%	-0.67%	117%	107%	-2.07%	-3.47%	-4.56%	168%	97%
Overall	-5.28%	-4.85%	-5.36%	244%	105%	-1.36%	-0.67%	-0.57%	121%	106%	-1.89%	-3.56%	-4.02%	170%	97%

- Different transform schemes are applied for luma and chroma
 - Luma: Both EMT and NSST are applied
 - Chroma: Only NSST is applied
 - Not a unified design

Proposal

- It is proposed to couple EMT and NSST to further reduce the encoder complexity
 - Lighter encoder RD checks (up to 5x RD checks for both luma and chroma)
 - Only one set of transform related syntax
 - Unified transform scheme for luma and chroma



Simulation Results

- Anchor: JVET-J0029, EMT off, NSST off

Test #1: JVET-J0029

		All Intra Main10				
		Y	U	V	EncT	DecT
Class A1		-5.6%	-5.1%	-5.4%	230%	107%
Class A2		-6.6%	-7.6%	-7.7%	217%	108%
Class B		-4.6%	-4.4%	-5.4%	243%	106%
Class C		-5.1%	-3.6%	-4.0%	259%	98%
Class D		-4.5%	-3.1%	-3.3%	282%	100%
Class E		-5.5%	-5.7%	-6.6%	222%	104%
Overall		-5.3%	-4.9%	-5.4%	242%	104%

Test #2: JVET-J0029 w/ proposed method

		All Intra Main10				
		Y	U	V	EncT	DecT
Class A1		-4.9%	-4.9%	-5.8%	180%	114%
Class A2		-6.0%	-7.0%	-7.7%	178%	117%
Class B		-4.1%	-4.8%	-5.1%	185%	113%
Class C		-5.0%	-3.9%	-3.8%	197%	110%
Class D		-4.1%	-3.0%	-2.9%	212%	111%
Class E		-6.1%	-6.8%	-7.0%	180%	114%
Overall		-4.9%	-5.0%	-5.3%	188%	113%

Conclusion

- Evidence has been shown that the design of EMT and NSST can be further simplified and unified
- It is proposed to further study this Coupled Primary and Secondary Transform in future to find better tradeoff between complexity and coding performance on transform design