

MEDIATEK

CE1-related: Separate tree partitioning at 64x64-luma/32x32-chroma unit level

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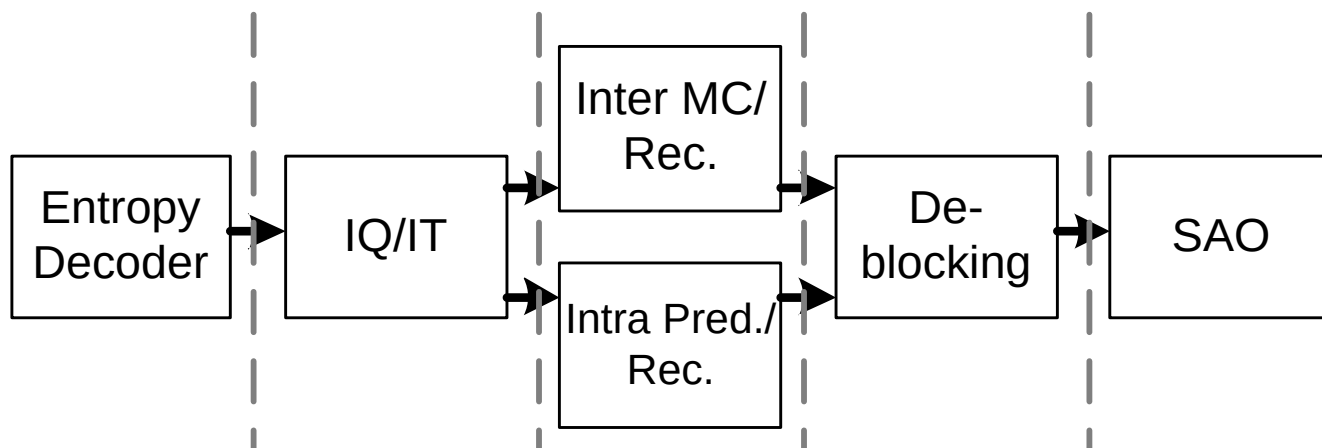
Overall Summary

- The CTU-level separate tree partitioning in JEM-7.0 is expensive for hardware implementation
- Proposed to start separate tree partitioning at 64x64-luma/32x32-chroma units instead of CTUs
 - A CTU is first implicitly split into 64x64-luma/32x32-chroma units.
 - The coding tree under each 64x64-luma/32x32-chroma unit is separated.

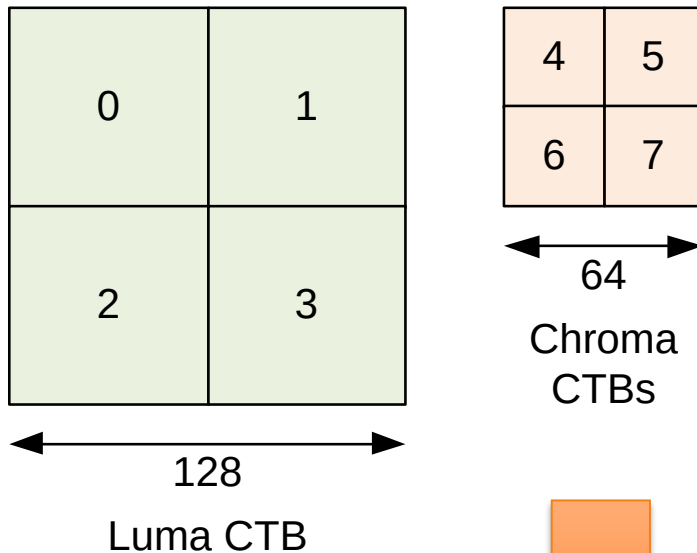
		VTM					BMS				
		Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Separate tree + MDMs + proposed	AI	-0.99%	-11.20%	-11.24%	83%	103%	-0.81%	-9.80%	-9.80%	60%	100%
	RA	-0.23%	-5.91%	-5.70%	100%	94%	-0.19%	-5.69%	-5.52%	96%	100%
	LB	-0.07%	-3.18%	-3.73%	99%	99%	-0.15%	-2.68%	-2.83%	99%	101%

Pipelined Hardware Video Decoder

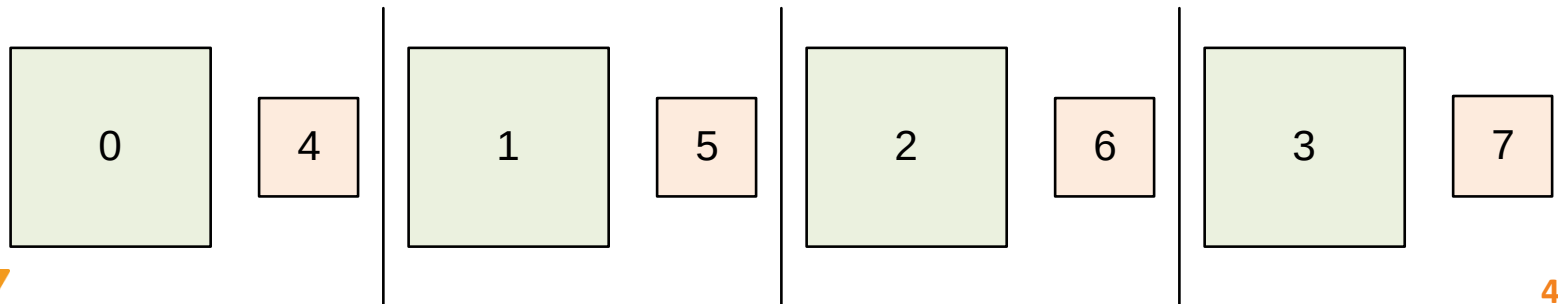
- Pipelined architecture is usually utilized to improve the processing throughput.
- The data is pipelined with data units (DUs). Each DU contains one $N \times N$ luma block and two $M \times M$ chroma blocks
 - $N \times N$ and $M \times M$ are equal to the maximum luma transform block (TB) size and the maximum chroma TB size, respectively.
 - In VTM-1.0, the maximum luma TB size is 64×64 , and the maximum chroma TB size is 32×32 .



Data Processing Order

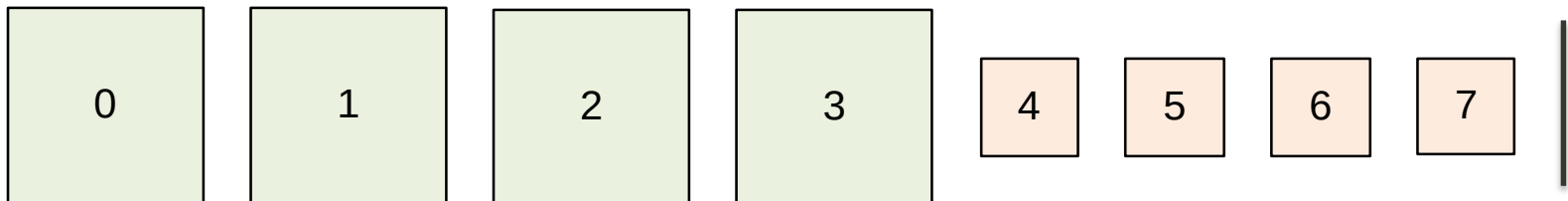


- In VTM-1.0, a CTU of 128x128 luma and 64x64x2 chroma samples can be divided into four DUs
 - Each DU contains one 64x64 luma block and two 32x32 chroma blocks.



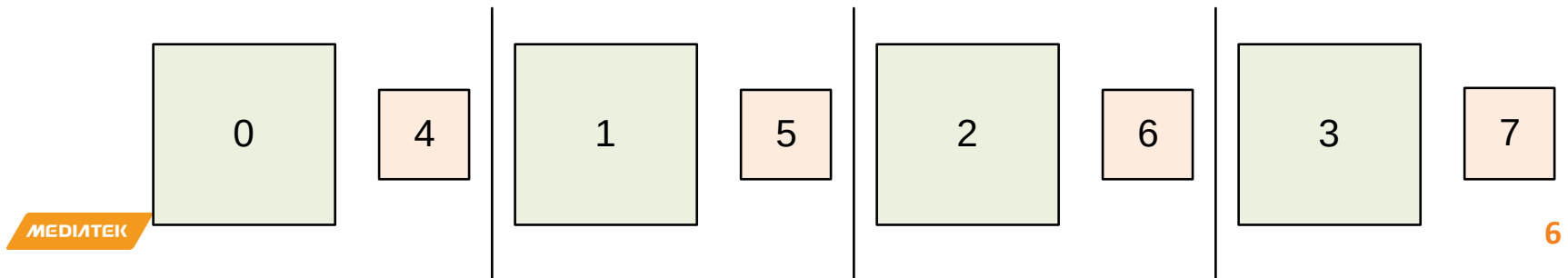
JEM Separate Tree Partitioning

- In JEM-7.0 separate tree partitioning, the luma coding tree block (CTB) is first signaled, then the chroma CTBs are signaled
- Change the pipelined architecture from maximum TB pipelining to CTU pipelining
 - In VTM-1.0, from 64x64 block pipeline to 128x128 block pipeline
 - Hardware areas for pipeline stages increase significantly (4x of that of shared tree partitioning)



Proposed Method

- Proposed to start separate tree partitioning starting at maximum TB size unit instead of CTU
 - A CTU is first implicitly split into 64x64-luma/32x32-chroma units
 - The coding tree under each 64x64-luma/32x32-chroma unit is separated
- The data processing order can be easily supported by maximum TB pipelining hardware decoder architecture



Simulation Results – Separate tree partitioning + MDMS

- Anchor: default VTM/BMS
- Test: separate tree partitioning + multiple DM (MDMS) + proposed method
- Encoding time is reduced by 10% and 40% in VTM-1.0 and BMS-1.0, respectively

		VTM-1.0					BMS-1.0				
		Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Separate tree + MDMS + proposed	AI	0.13%	-7.28%	-8.59%	90%	98%	-0.81%	-9.80%	-9.80%	60%	100%
	RA	-0.03%	-3.22%	-4.23%	100%	100%	-0.19%	-5.69%	-5.52%	96%	100%
	LB	-0.09%	-1.87%	-2.77%	101%	100%	-0.15%	-2.68%	-2.83%	99%	101%

Simulation Results – Separate tree partitioning + MDMS

- Anchor: default VTM/BMS + LM + 65 intra angular modes
- Test: separate tree partitioning + multiple DM (MDMS) + proposed method + LM + 65 intra angular
- Encoding time is reduced by 17% and 40% in VTM and BMS

		VTM					BMS				
		Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Separate tree + MDMS + proposed	AI	-0.99%	-11.20%	-11.24%	83%	103%	-0.81%	-9.80%	-9.80%	60%	100%
	RA	-0.23%	-5.91%	-5.70%	100%	94%	-0.19%	-5.69%	-5.52%	96%	100%
	LB	-0.07%	-3.18%	-3.73%	99%	99%	-0.15%	-2.68%	-2.83%	99%	101%

Simulation Results

- Anchor: LM + 65 intra angular + separate tree partitioning + MDMS
- Test: LM + 65 intra angular + separate tree partitioning + MDMS + **proposed method**
- Negligible impact on BD-rate

		VTM					BMS				
		Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Separate tree + MDMS + proposed	AI	-0.02%	-0.01%	-0.02%	101%	101%	-0.02%	-0.04%	-0.03%	100%	103%
	RA	0.00%	-0.01%	0.01%	100%	100%	0.02%	-0.05%	-0.01%	100%	99%
	LB	-0.03%	0.00%	-0.18%	100%	101%	0.02%	-0.15%	0.42%	100%	99%

Conclusions

- Proposed to start separate tree partitioning at 64x64-luma/32x32-chroma units instead of CTUs
 - A CTU is first implicitly split into 64x64-luma/32x32-chroma units.
 - The coding tree under each 64x64-luma/32x32-chroma unit is separated.
- The data processing order can be easily supported by maximum TB pipelining hardware decoder architecture.

All-intra	VTM					BMS				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Separate tree + MDMs + proposed	-0.99%	-11.20%	-11.24%	83%	103%	-0.81%	-9.80%	-9.80%	60%	100%



everyday genius

- Anchor: default VTM-1.0/BMS-1.0
- Test: separate tree partitioning + multiple DM (MDMS) + proposed method

	All Intra Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	0.73%	-6.20%	-5.11%	89%	99%	-1.28%	-11.06%	-5.05%	54%	102%
Class A2	0.50%	-6.99%	-4.69%	93%	103%	-0.28%	-9.82%	-4.81%	59%	104%
Class B	-0.11%	-7.18%	-10.59%	88%	93%	-0.83%	-9.32%	-13.98%	59%	99%
Class C	-0.13%	-5.17%	-7.58%	95%	101%	-1.22%	-8.69%	-9.44%	65%	97%
Class E	-0.12%	-11.60%	-14.00%	87%	98%	-0.26%	-10.80%	-13.05%	61%	99%
Overall	0.13%	-7.28%	-8.59%	90%	98%	-0.81%	-9.80%	-9.80%	60%	100%
Class D	-0.05%	-4.21%	-5.96%	97%	102%	-0.61%	-7.60%	-7.37%	67%	97%
	Random Access Main 10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	0.10%	-2.21%	-1.72%	101%	97%	-0.07%	-3.48%	-2.13%	96%	99%
Class A2	0.10%	-3.32%	-1.62%	100%	100%	-0.09%	-6.51%	-2.60%	96%	100%
Class B	-0.09%	-4.53%	-7.62%	100%	102%	-0.22%	-7.22%	-9.78%	96%	100%
Class C	-0.14%	-2.26%	-3.84%	100%	99%	-0.31%	-4.83%	-4.92%	95%	100%
Overall	-0.03%	-3.22%	-4.23%	100%	100%	-0.19%	-5.69%	-5.52%	96%	100%
Class D	-0.08%	-2.26%	-3.58%	100%	99%	-0.14%	-5.76%	-5.56%	93%	100%
	Low delay B Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class B	-0.07%	-0.59%	-1.61%	102%	99%	-0.05%	-2.02%	-2.48%	100%	102%
Class C	0.01%	-0.16%	-0.54%	100%	103%	0.00%	-1.06%	-1.36%	99%	100%
Class E	-0.26%	-6.27%	-7.67%	99%	100%	-0.50%	-5.94%	-5.37%	98%	100%
Overall	-0.09%	-1.87%	-2.77%	101%	100%	-0.15%	-2.68%	-2.83%	99%	101%
Class D	-0.02%	-0.97%	-1.64%	100%	99%	0.02%	-1.91%	-2.59%	101%	102%

- Anchor: default VTM-1.0/BMS-1.0 + LM + 65 intra angular modes
- Test: separate tree partitioning + multiple DM (MDMS) + proposed method + LM + 65 intra angular

	All Intra Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-1.64%	-11.73%	-7.12%	78%	106%	-1.28%	-11.06%	-5.05%	54%	102%
Class A2	-0.72%	-11.27%	-6.84%	86%	110%	-0.28%	-9.82%	-4.81%	59%	104%
Class B	-0.90%	-10.70%	-15.02%	81%	102%	-0.83%	-9.32%	-13.98%	59%	99%
Class C	-1.28%	-9.69%	-10.27%	89%	100%	-1.22%	-8.69%	-9.44%	65%	97%
Class E	-0.35%	-13.44%	-14.76%	80%	98%	-0.26%	-10.80%	-13.05%	61%	99%
Overall	-0.99%	-11.20%	-11.24%	83%	103%	-0.81%	-9.80%	-9.80%	60%	100%
Class D	-0.78%	-8.37%	-8.13%	91%	100%	-0.61%	-7.60%	-7.37%	67%	97%
	Random Access Main 10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.16%	-3.53%	-2.49%	100%	88%	-0.07%	-3.48%	-2.13%	96%	99%
Class A2	-0.19%	-6.71%	-3.08%	101%	93%	-0.09%	-6.51%	-2.60%	96%	100%
Class B	-0.23%	-7.53%	-9.74%	100%	92%	-0.22%	-7.22%	-9.78%	96%	100%
Class C	-0.32%	-5.05%	-5.03%	99%	102%	-0.31%	-4.83%	-4.92%	95%	100%
Overall	-0.23%	-5.91%	-5.70%	100%	94%	-0.19%	-5.69%	-5.52%	96%	100%
Class D	-0.22%	-5.64%	-5.57%	101%	103%	-0.14%	-5.76%	-5.56%	93%	100%
	Low delay B Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class B	-0.03%	-2.00%	-2.82%	101%	100%	-0.05%	-2.02%	-2.48%	100%	102%
Class C	0.00%	-1.48%	-1.60%	100%	99%	0.00%	-1.06%	-1.36%	99%	100%
Class E	-0.22%	-7.42%	-8.06%	97%	94%	-0.50%	-5.94%	-5.37%	98%	100%
Overall	-0.07%	-3.18%	-3.73%	99%	99%	-0.15%	-2.68%	-2.83%	99%	101%
Class D	0.03%	-2.35%	-2.41%	102%	105%	0.02%	-1.91%	-2.59%	101%	102%

- Anchor: LM + 65 intra angular + separate tree partitioning + MDMS
- Test: LM + 65 intra angular + separate tree partitioning + MDMS
+ proposed method

	All Intra Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.03%	-0.01%	-0.07%	100%	101%	-0.04%	0.01%	0.02%	101%	106%
Class A2	-0.01%	-0.07%	-0.02%	100%	102%	-0.01%	-0.02%	-0.03%	101%	103%
Class B	-0.02%	0.02%	-0.02%	101%	100%	-0.01%	-0.04%	0.00%	99%	105%
Class C	-0.02%	0.04%	0.05%	102%	103%	0.00%	-0.02%	-0.08%	99%	99%
Class E	-0.04%	-0.08%	-0.08%	100%	101%	-0.03%	-0.13%	-0.08%	102%	104%
Overall	-0.02%	-0.01%	-0.02%	101%	101%	-0.02%	-0.04%	-0.03%	100%	103%
Class D	-0.01%	0.11%	-0.04%	101%	101%	0.01%	0.01%	0.02%	101%	103%
	Random Access Main 10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	0.00%	-0.14%	-0.13%	100%	100%	-0.01%	-0.10%	-0.11%	100%	100%
Class A2	-0.02%	0.03%	0.01%	100%	98%	0.00%	0.00%	-0.12%	101%	99%
Class B	-0.01%	0.05%	0.02%	100%	102%	0.05%	0.06%	0.13%	101%	100%
Class C	0.01%	-0.03%	0.10%	100%	100%	0.00%	-0.20%	-0.01%	99%	98%
Overall	0.00%	-0.01%	0.01%	100%	100%	0.02%	-0.05%	-0.01%	100%	99%
Class D	0.03%	0.26%	0.10%	100%	99%	0.04%	-0.11%	0.06%	100%	101%
	Low delay B Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class B	-0.03%	-0.04%	-0.34%	101%	101%	-0.01%	0.07%	0.23%	100%	98%
Class C	0.02%	0.05%	-0.03%	99%	99%	0.03%	0.27%	0.22%	101%	102%
Class E	-0.08%	-0.01%	-0.13%	101%	101%	0.06%	-1.06%	1.00%	98%	98%
Overall	-0.03%	0.00%	-0.18%	100%	101%	0.02%	-0.15%	0.42%	100%	99%
Class D	0.01%	-0.14%	-0.11%	101%	99%	0.01%	-0.30%	-0.70%	102%	104%