

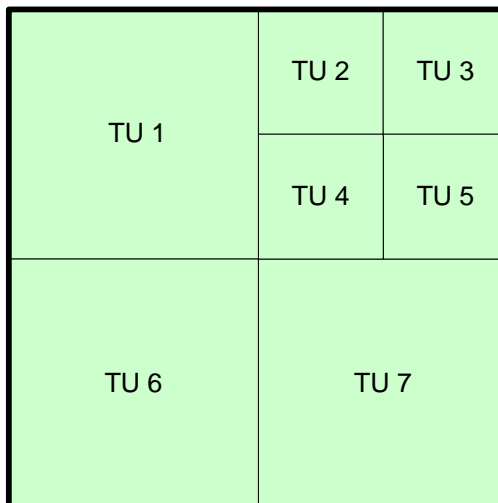


G112 – Changing Luma/Chroma Coefficient Interleaving from CU to TU level

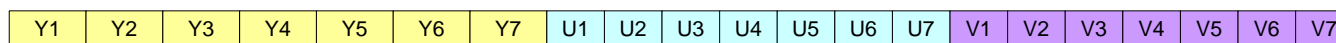
Tim Hellman & Yong Yu
Broadcom Corporation

Present Coefficient Interleave: CU Level

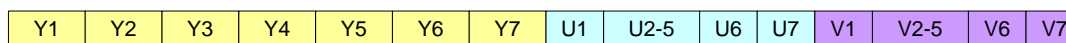
CU Example



Coefficient Order in Stream (All > MinTrafoSize)

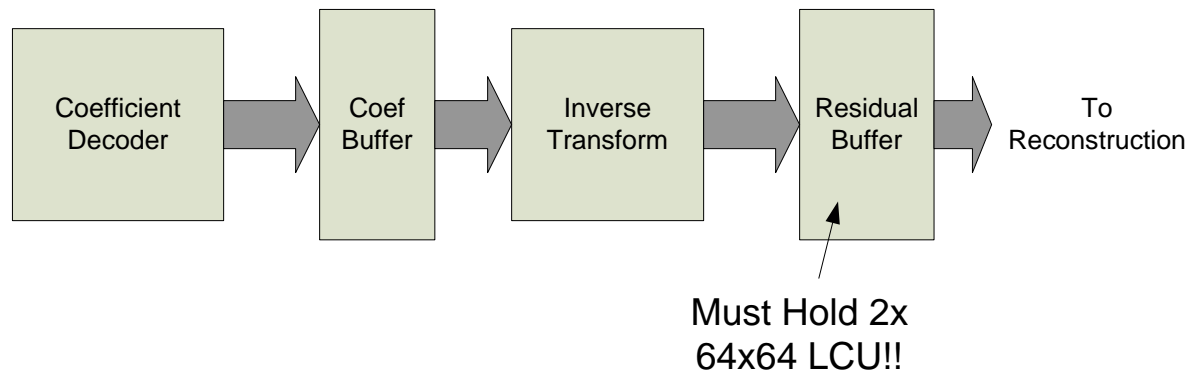


Coefficient Order in Stream (TU2-TU5 = MinTrafoSize)

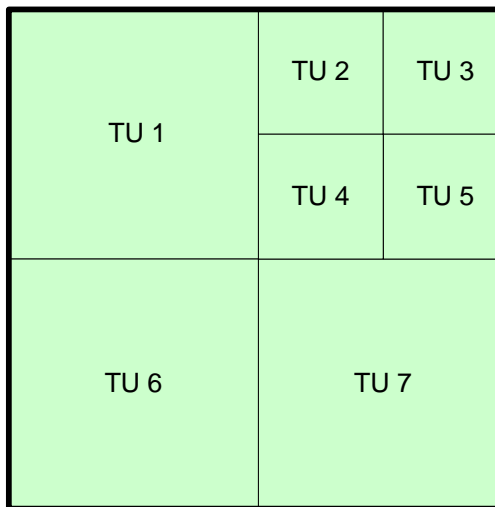


Why Is This A Problem?

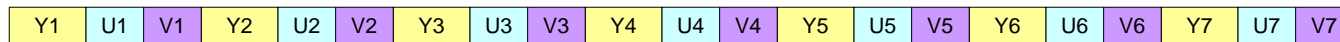
- Must wait for whole CU to get Y/U/V for any TU
 - Max Trafo Size = 32x32, Max CU size = 64x64
 - 32x32 Trafo hand-off must wait for $64 \times 64 \times 1.5 = 6144$ coefficients!
- Translates to Large Decoder Cost
 - Stages done in parallel: buffer between each stage (sized for worst-case)
 - Huge output buffer needed for 64x64 LCU (12K Bytes = 4 HD Line Buffers!)
 - 75% reduction possible if all color components available simultaneously



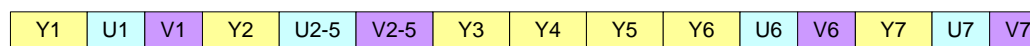
Proposed Solution: TU Interleave



Coefficient Order in Stream (All > MinTrafoSize)



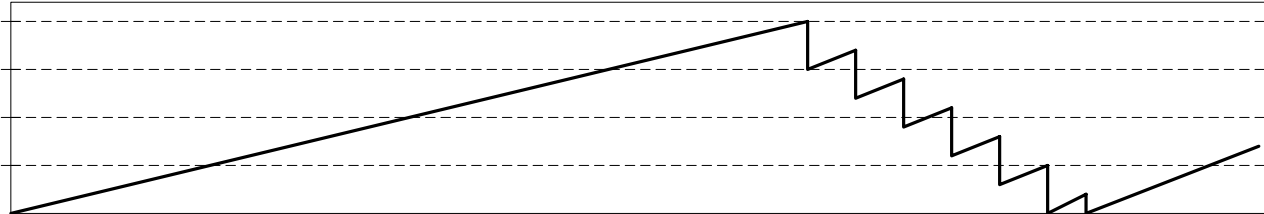
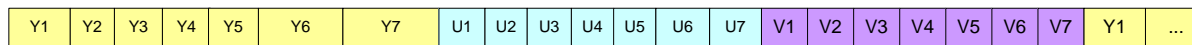
Coefficient Order in Stream (TU2-TU5 = MinTrafoSize)



Min Size TUs

Residual Buffer Level Comparison

Buffer Level – CU Interleave



Buffer Level – TU Interleave



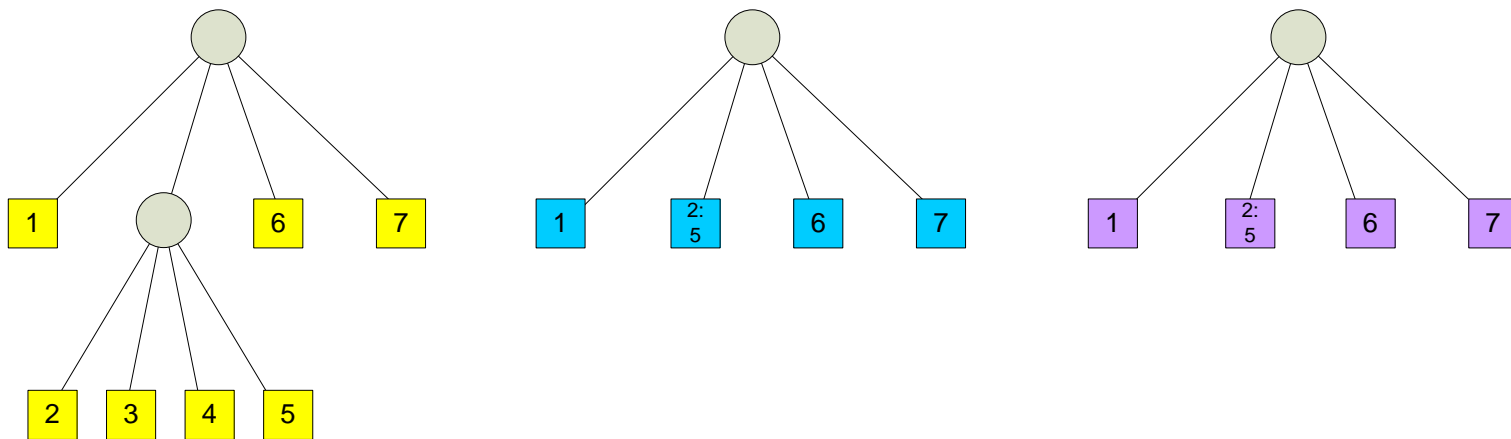
Interleave Details



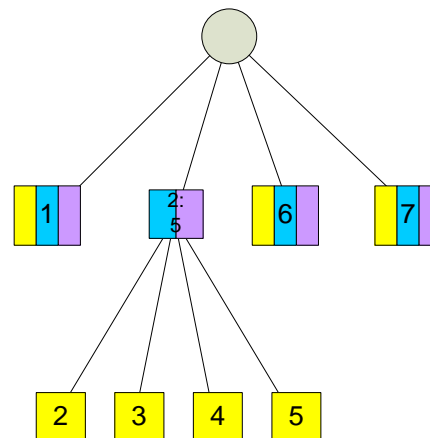
- **Simply send all components at each leaf TU**
 - Only have to traverse the 'split tree' once
 - Eliminates need for extra buffering in max LCU case
 - Just changes coef order (no change to coef coding)
- **MinTrafoSize**
 - When Luma TU = MinTrafoSize, only 1 Chroma TU for 4 Luma TU
 - Simply send the Chroma after the first Luma (Last would work as well)
 - Works for both square and rectangular blocks

YUV Interleave: Tree View

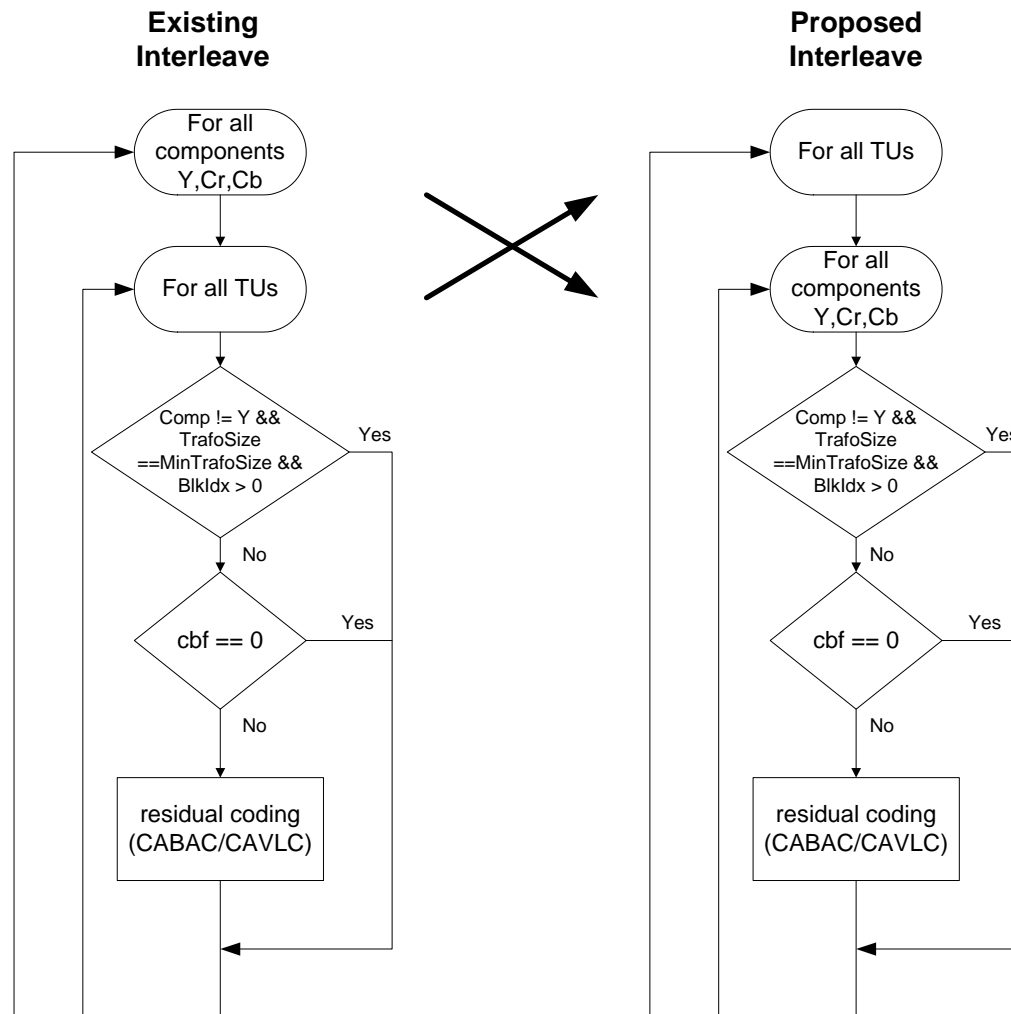
Existing Interleave (TU2-5 = MinTU)



New Interleave (TU2-5 = MinTU)



Syntax Change: Graphically



No Effect On Coding Efficiency



	HE-AI	LC-AI	HE-RA	LC-RA	HE-LD	LC-LD
Class A	0.0%	0.0%	0.0%	0.0%		
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class C	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Class D	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
Class E	0.0%	0.0%			-0.1%	-0.2%
All	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

- Thanks to TI for Cross-check

Other Details



- PCM Mode creates the same buffer headache with 64x64 CU
 - Solution: New SPS element: MaxIPCMCUSize, (pair to existing MinIPCMCUSize)
 - Max allowed is 32x32
 - Bonus: Reduces overhead of PCM flag in all streams
- Eliminate 32x32 Chroma Transform
 - What?? We have a 32x32 Chroma Transform today?
 - Yes, only if MinTrafoSize = 32x32
 - Creates both buffer problem, and transform throughput problem
 - Possible Solutions
 - Limit MinTrafoSize < MaxTrafoSize (except for 4x4)
 - Create 'MinChromaTrafoSize' (one less than MinTrafoSize)

Conclusion



- Recommend
 - Change Interleave from CU to TU level
 - Add MaxIPCMCUSize to SPS
 - Limit MinTrafoSize < MaxTrafoSize
- Note: Panasonic G381 - Nearly identical proposal, independently derived