

CE11: Summary report on coefficient scanning and coding (JCTVC-D240/m19001)

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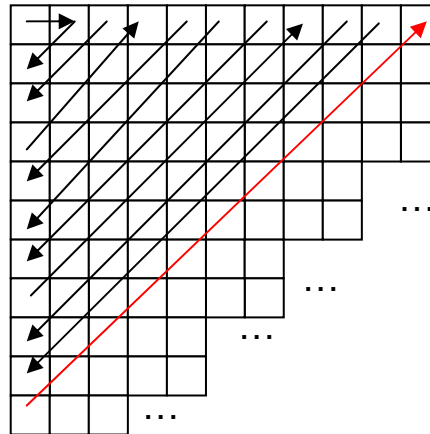
**Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
4th Meeting: Daegu, KR, 20-28 January, 2011**

Sub Experiments in CE11

- **CE.A: Coding Efficiency of Tools in HHI_TRANSFORM_CODING**
JCTVC-A116 (D061)
 - Adaptive Scan Order (HHI)
 - HHI Context Selection of significant_coeff_flag (HHI)
 - HHI Context Selection of last_significant_coeff_flag (HHI)
 - HHI Context Selection of coeff_level_minus1 (HHI)
- **CE.B: HHI_TRANSFORM_CODING Coefficient Scanning**
 - **JCTVC-C114 (D239)**: Zigzag Scan (Motorola)
 - **JCTVC-C227 (D195)**: Simplified context selection (Texas Instruments)
- **CE.C: Adaptive Coefficient Scanning**
 - **JCTVC-C205 (D360)**: Adaptive Coefficient Scan (Samsung)
 - **JCTVC-C250 (D393)**: Mode Dependent Coefficient Scan (Qualcomm)

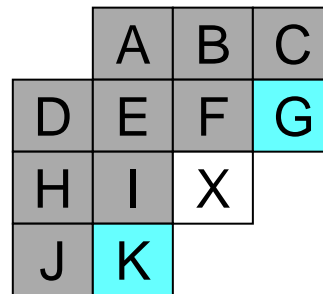
Adaptive Scan Order

- Direction of the diagonal scan depends on the location of significant coefficients of the previous diagonal scan
 - bottom-left or top-right
- Each diagonal scan can be in any direction; thus scans must be done serially



HHI context modeling for significance map

- For $>8 \times 8$ transforms, context of `significant_coeff_flag` depends on up to **10 neighbors**.
- Context selection of `last_significant_coeff_flag` also modified to depend on distance from top-right (diagonal line)



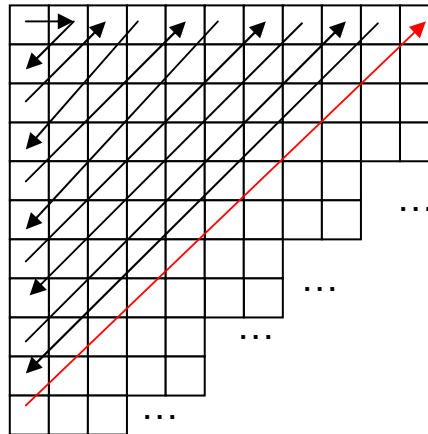
Context for `significant_coeff_flag` in position X depends on surrounding positions highlighted in grey

HHI Context modeling for coefficient level

- TU is broken into 4x4 sub-blocks. Different contexts can be used for each 4x4 sub-block to encode `coeff_abs_level_minus1` depending on the statistics of already coded sub-blocks
 - number of coefficients whose $|\cdot| > 1$ in the previous sub-block within the same TU.

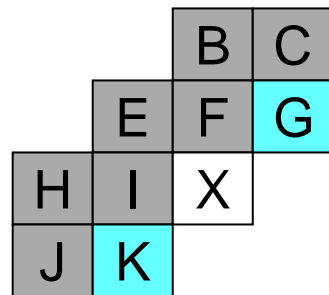
Zigzag Scan (Motorola)

- Fixed zig-zag scan for significance map (same as AVC)

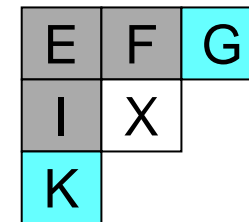


Simplified Context Selection (TI)

- Reduce dependencies on neighbors
- Reduce number of contexts



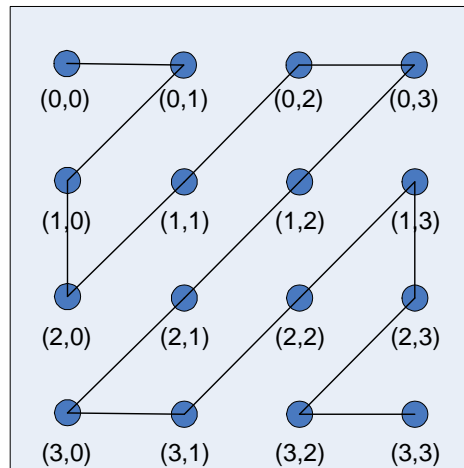
Reduce dependency from 10 \rightarrow 8
(Remove A, D)



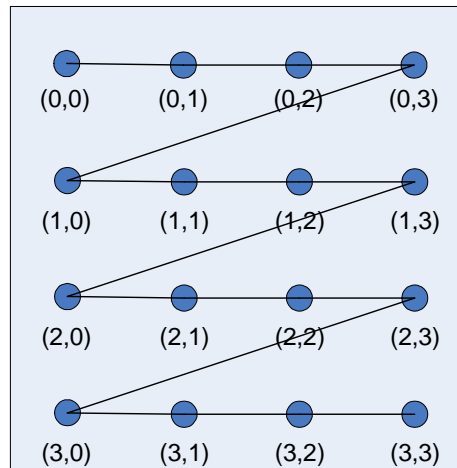
Reduce dependency from 10 \rightarrow 4
(Remove A, D, B, C, H, J)

Adaptive Coefficient Scan (Samsung)

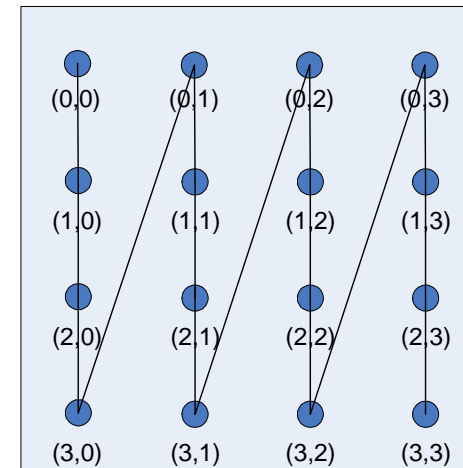
- Reduce number of significant_coeff_flag bins
- Three scan patterns: conventional zig-zag, horizontal and vertical
- Encoder decides on scan pattern based on RDO and signals to decoder



Zigzag scan



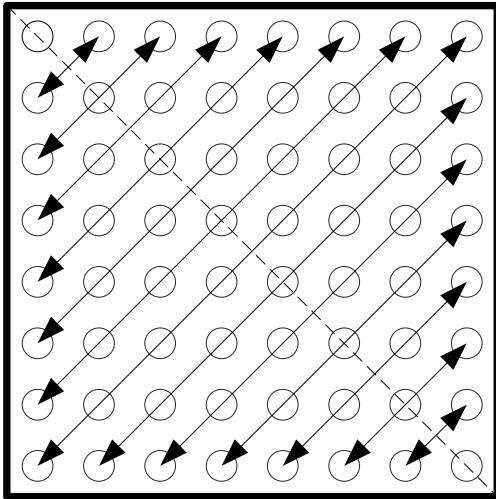
Horizontal scan



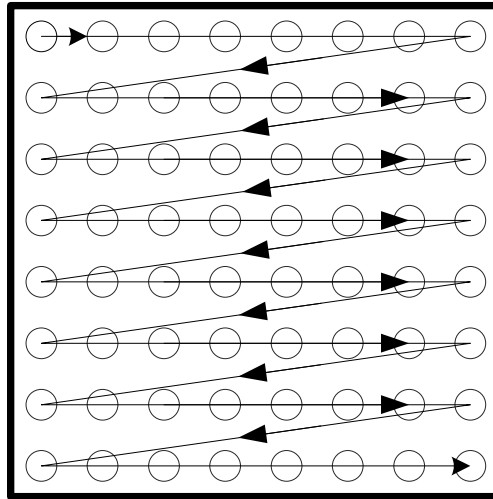
Vertical scan

Mode Dependent Coefficient Scan (Qualcomm)

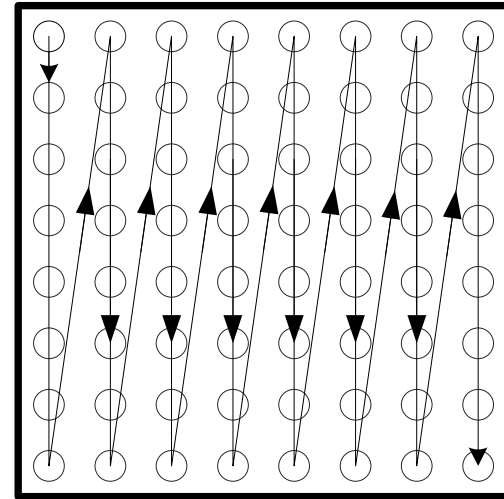
- Intra blocks: scanning order based on prediction mode and TU size (34x5 luma, 4x5 chroma)
- Inter blocks:
 - HHI's Adaptive Scan Order (MDCS)
 - RDO with explicit signaling



TC Zigzag: 0



Horizontal: 1



Vertical: 2

Performance Measurement Criteria

- **Coding Performance Measurements**

- Coding Efficiency Results (BD-Rate) for High Efficiency
- TMuC-0.9 under common conditions

- **Complexity Measurements**

- Simulation platform is LSF equipped with Intel(R) Xeon(R) CPU X5570@2.93GHz 64 bits Linux machines
- The number of bins for the significant_coeff_flag syntax element will be considered when using different scanning methods.

$$\% \text{ sig flag count} = \frac{(\# \text{ significant coeff flag under test} - \# \text{ significant coeff flag in anchor})}{\# \text{ significant_coeff_flag in anchor}}$$


- Scheme of selecting the scan pattern during encoding needs to be described.
- Scheme of updating the scan pattern during parsing needs to be described.

Reported Results

Proposal Document #	Intra		Random Access		Low Delay	
	BD-Rate	% sig flag count	BD-Rate	% sig flag count	BD-Rate	% sig flag count
JCTVC-A116 (disabled adaptive scan)	0.3	2.72	0.2	2.17	0.2	2.82
JCTVC-A116 (disabled HHI context selection of sig flag)	1.8	-12.66	1.4	-16.03	2.8	-27.40
JCTVC-A116 (disabled HHI context selection of last sig flag)	0.0	-1.13	0.3	-5.16	0.9	-12.29
JCTVC-A116 (disabled HHI context selection of coeff)	0.6	-2.06	0.2	-3.45	0.7	-8.78
JCTVC-C227 (reduce by 2)	0.0	-0.22	0.0	-0.17	0.0	0.22
JCTVC-C227 (reduce by 6)	0.2	-1.76	0.1	-1.41	0.0	0.40
JCTVC-C114	0.3	2.70	0.2	2.18	0.2	2.69
JCTVC-C205	-1.2	-6.20	-0.5	-8.35	-0.6	-14.04
JCTVC-C250 (Mode dependent coefficient scanning)	-0.8	-3.22	-0.3	-1.02	-0.1	-0.77
JCTVC-C250 (Signaled coefficient scanning (switched))	-1.1	-10.11	-0.3	-10.84	-0.3	-16.37

Reported Results (cont'd)

Proposal Document #	Intra		Random Access		Low Delay	
	Encode Time	Decode Time	Encode Time	Decode Time	Encode Time	Decode Time
JCTVC-A116 (<u>disabled</u> adaptive scan)	96%	100%	97%	99%	98%	99%
JCTVC-A116 (<u>disabled</u> HHI context selection of sig flag)	103%	105%	92%	94%	97%	100%
JCTVC-A116 (<u>disabled</u> HHI context selection of last sig flag)	102%	101%	96%	97%	103%	106%
JCTVC-A116 (<u>disabled</u> HHI context selection of coeff)	100%	103%	100%	101%	100%	101%
JCTVC-C227 (reduce by 2)	100%	101%	100%	101%	100%	101%
JCTVC-C227 (reduce by 6)	99%	101%	99%	101%	99%	101%
JCTVC-C114	91%	99%	93%	100%	94%	100%
JCTVC-C205	123%	110%	104%	104%	105%	104%
JCTVC-C250 (Mode dependent coefficient scanning)	97%	91%	101%	94%	104%	99%
JCTVC-C250 (Signaled coefficient scanning (switched))	127%	100%	112%	93%	100%	91%


**TEXAS
INSTRUMENTS**

Cross-Verification

Proponent	Document	Tool description	Cross-checker
HHI	JCTVC-A116 (D061)	Adaptive Scan Order in HHI_TRANSFORM_CODING	Motorola (D236)
		Context selection of significant_coeff_flag in HHI_TRANSFORM_CODING	TI (D190)
		Context selection of last_significant_coeff_flag in HHI_TRANSFORM_CODING	TI (D190)
		Context selection of coeff_abs_level_minus1 in HHI_TRANSFORM_CODING	Sharp (D113)
Motorola	JCTVC-C114 (D239)	Zigzag scan for CABAC/PIPE	Qualcomm (D400), Huawei (D309)
Qualcomm	JCTVC-C250 (393)	Low complexity adaptive coefficient scanning	Samsung (D359)
Samsung	JCTVC-C205 (D360)	Low-complexity adaptive coefficients scanning	TI (D189), Nokia (D320), Sony (D382)
TI	JCTVC-C227 (D195)	Parallelization of HHI_TRANSFORM_CODING	HHI (D062), Panasonic (D075)

Additional Documents not in CE11 Report

- **JCTVC-D146** CE11: Cross-verification report for Samsung's proposal (JCTVC-D360) from Microsoft
- **JCTVC-D424** CE11: Cross-check results for Qualcomm's Proposal JCTVC-D393