

# **TE12: Evaluation of transform coefficient coding (HHI\_TRANSFORM\_CODING) with tool breakdown**

**(JCTVC-C059/m18082)**

**Vivienne Sze, Madhukar Budagavi**

**Texas Instruments Inc.**

**Joint Collaborative Team on Video Coding (JCT-VC)  
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**

**3rd Meeting: Guangzhou, CN, 7-15 October, 2010**

# HHI\_TRANSFORM\_CODING

- Proposed in JCTVC – A116 (HHI Fraunhofer)
- HHI\_TRANSFORM\_CODING is a context modeling scheme that aims to improve coding efficiency using three tools:

## ***1. Adaptive scanning order of significance map***

- Every diagonal scan can switch direction **depending** on location of significant coefficients

## ***2. Proposed context modeling for significance map***

- Context selection **depends** on neighboring coefficients

## ***3. Proposed context modeling for coefficient levels***

- Context selection **depends** on number of non-zero coefficient in previous sub-block of the same macroblock

**HHI\_TRANSFORM\_CODING introduces dependencies into Context Modeling which is already difficult to parallelize.**

# Cross-Verification

- TMuC-0.7 under common conditions (JCTVC-B300)
- Simulation platform is LSF equipped with Intel(R) Xeon(R) CPU X5570@2.93GHz 64 bits Linux machines

Default setting	Alternative setting	Parameters for Alternative setting
HHI_TRANSFORM_CODING <b>On</b>	HHI_TRANSFORM_CODING <b>Off</b>	#define HHI_TRANSFORM_CODING 0

- Coding Efficiency Results (BD-Rate) for High Efficiency Test

Intra	Random Access	Low Delay
1.4	1.3	2.0

- HHI\_TRANSFORM\_CODING has a 1.3 to 2.0% coding **gain** compared to when it is disabled (Samsung proposal)
- Results have been verified to match those obtained from Samsung

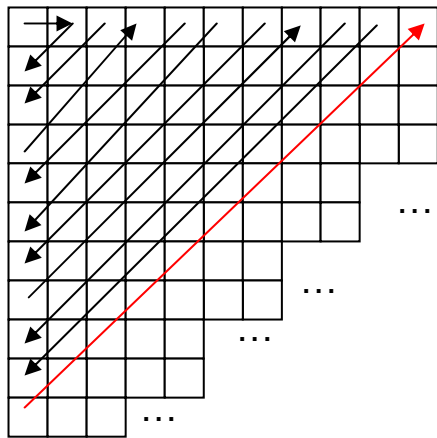
# Context Selection For Significance Map

- In Samsung proposal, (i.e. HHI\_TRANSFORM\_CODING disabled), the context used for significant\_coeff\_flag in every position is known. Thus, context selection can be done in parallel.

1	1	1	1	1	1	
1	1	1	1	1	1	...
1	1	1	1			
1	1	1				
1	1					
1	:					

# Adaptive Scan

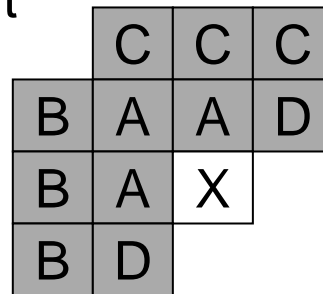
- Direction of the diagonal scan depends on the location of significant coefficients of the previous diagonal scan
  - bottom-left or top-right
- Each diagonal scan can be in any direction; thus scans must be done serially
- *Within* a given scan, the context selection of significant\_coeff\_flag can still be done in parallel.



1	2	3	4	5	6
2	3	4	5	6	...
3	4	5	6		
4	5	6			
5	6				
6	:				

# Proposed context modeling for significance map

- For >8x8 transforms, context of significant\_coeff\_flag depends on up to **11 neighbors**.
- When used with zig-zag scan or adaptive scan, the context selection for the majority of significant\_coeff\_flag elements cannot be done in parallel (especially at the decoder)
- Context selection of last\_significant\_coeff\_flag also modified to depend on distance from top-right



Context for significant\_coeff\_flag in position X depends on surrounding positions highlighted in grey

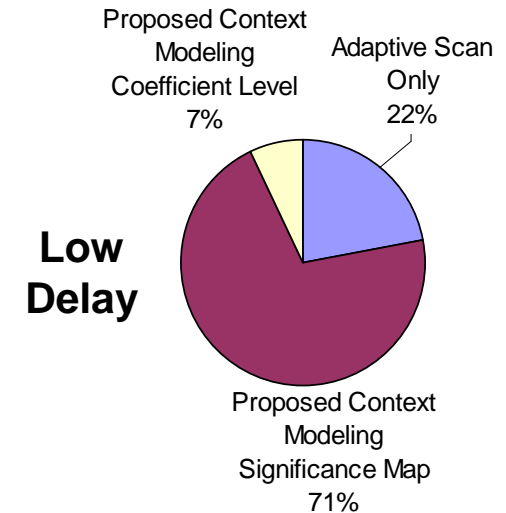
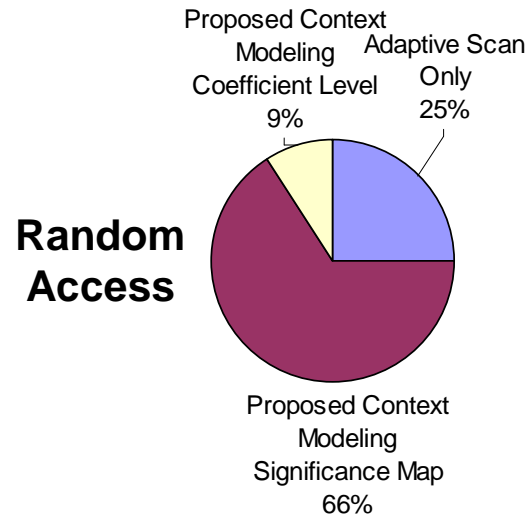
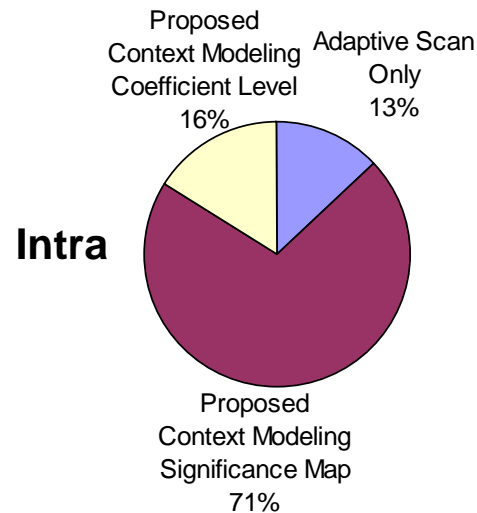
# Proposed context modeling for coefficient level

- Different contexts can be used for each 4x4 sub-block to encode `coeff_abs_level_minus_one` depending on the statistics of already coded sub-blocks
  - number of coefficients whose  $|\cdot| > 1$  in the previous sub-block within the same macroblock.
- Introduces dependencies between sub-blocks, which may limit parallelism in context modeling.

**Due to the increased complexity in context selection, it is important to understand the coding gains of each tool.**

# Coding Efficiency Breakdown

Tool Under Test (TMuC-0.7.3)	Average Gain (BD-rate)
HHI_TRANSFORM_CODING (all three tools)	1.3 to 2.0 %
Adaptive Scan	0.2 to 0.4%
Proposed context selection significance map	0.9 to 1.4 %
Proposed context selection coefficient level	0.1 to 0.2 %



**Majority of the coding efficiency gain due to proposed context modeling for significance map**



# Conclusions and Recommendations

- Coding gain of HHI\_TRANSFORM\_CODING was verified to be 1.3 to 2.0%
- Majority of gains (0.9 to 1.4%) due to proposed context selection for significance map. As such, we recommend the following be investigated
  - Breakdown of coding gains between significant\_coeff\_flag and last\_significant\_coeff\_flag. The former introduces much more complexity than the latter
  - Complexity reduction of approach
- Other two tools have a poor trade-off between coding gain and complexity;
  - Increases complexity in context modeling which is already difficult to parallelize