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**JCTVC-N0096**

**RCE2: Test B.2: Swapping of scan order for transform skip/bypass**

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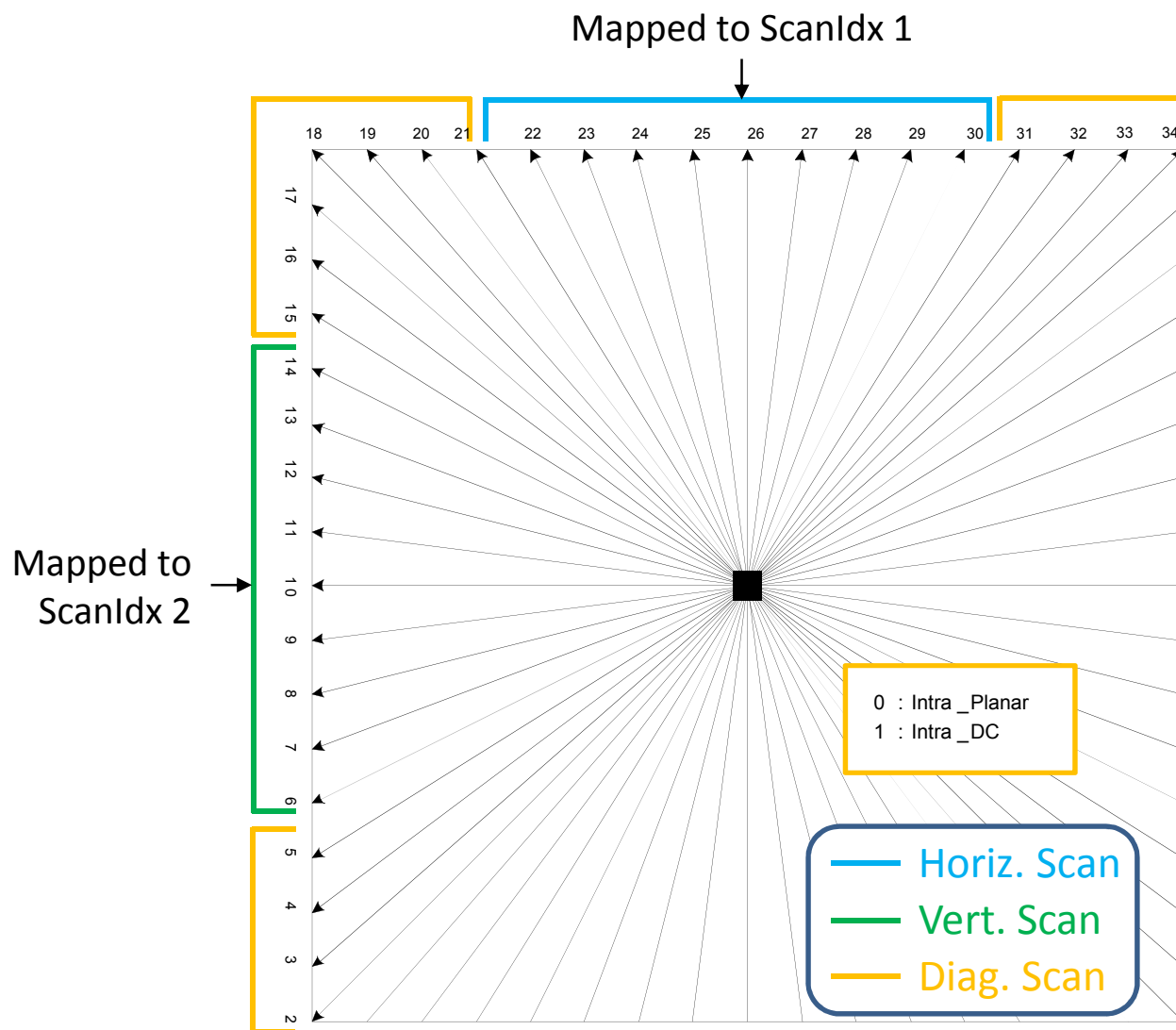
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14<sup>th</sup> JCT-VC Meeting, Vienna, AT  
July 25 – August 02, 2013

# Introduction

- Current HEVC specs: Coefficient scan order is determined by Intra prediction mode
- Current scan order mapping is not optimal for transformed-skipped or bypassed blocks, as it was designed with a transform in mind
- Goal: Improve performance on skipped/bypassed blocks without introducing new scan orders. Also minimize changes to syntax and semantics.
- Jointly proposed for HEVC in JCTVC-J0202, JCTVC-J0212, JCTVC-J0313 (Stockholm, July 2012)
- Combine with constant context from RCE2 Test B.1

# Scan types for Intra transform blocks

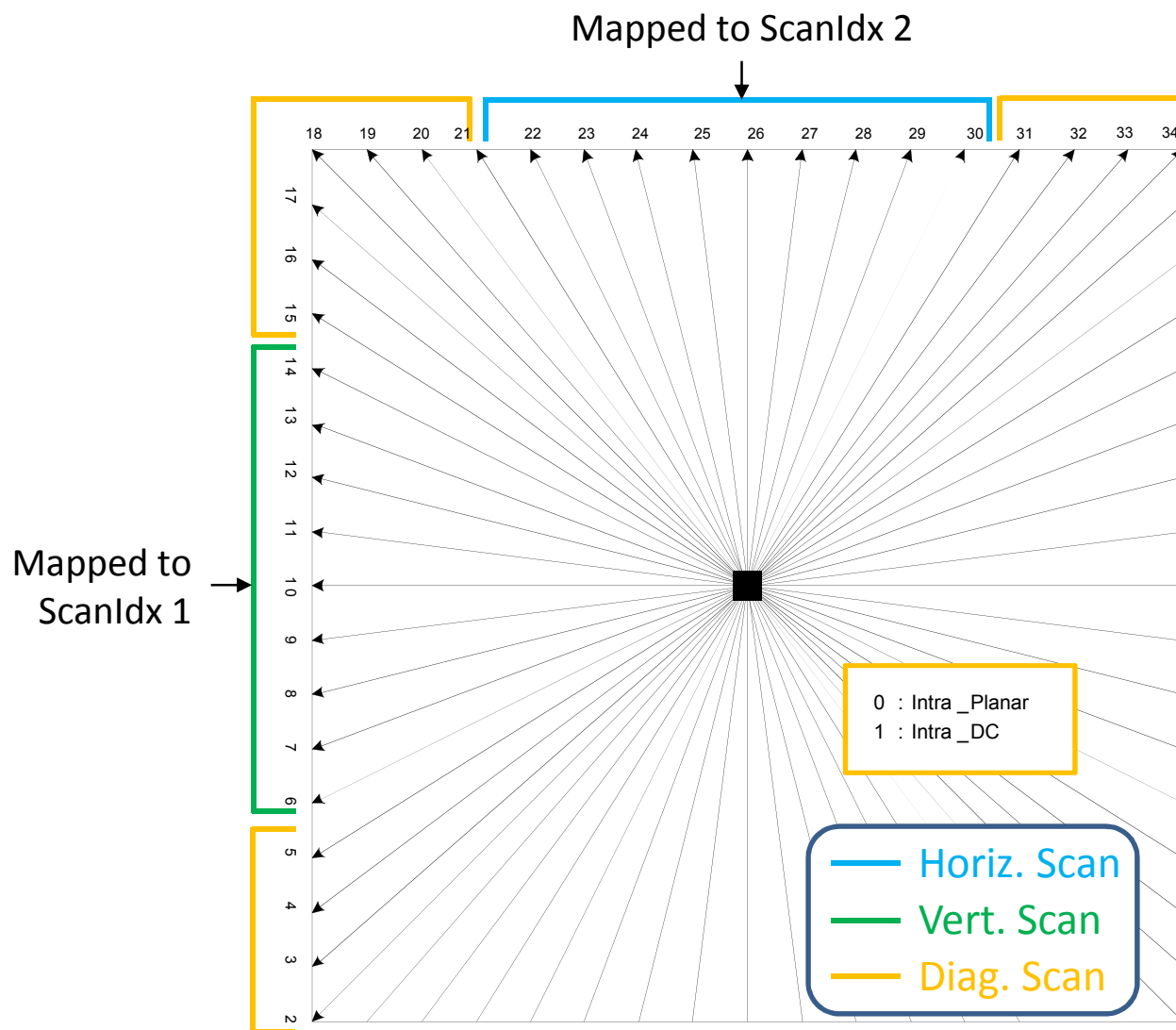


## Scan order depends upon Intra prediction mode

Current HEVC specs:

- Modes 6 – 14 mapped to vertical scan
- Modes 22 – 30 mapped to horizontal scan
- Remaining modes mapped to diagonal scan

# Swapping of scan types



**Scan order depends upon Intra prediction mode**

Current HEVC specs:

- Modes 6 – 14 mapped to **horizontal** scan
- Modes 22 – 30 mapped to **vertical** scan
- No change for diagonal modes

# Implementation (1)

## Modification to HEVC Range Extensions Draft 3 (JCTVC-M1005)

### 7.3.8.11 Residual coding syntax

residual_coding( x0, y0, log2TrafoSize, cIdx ) {	Descriptor
if( transform_skip_enabled_flag && !cu_transquant_bypass_flag && ( log2TrafoSize == 2 ) )	
<b>transform_skip_flag[ x0 ][ y0 ][ cIdx ]</b>	ae(v)
<b>if(transform_skip_flag[ x0 ][ y0 ][ cIdx ]    (cu_transquant_bypass_flag == 1))</b>	
<b>scanIdx = (scanIdx == 1) ? 2 : ((scanIdx == 2) ? 1 : scanIdx</b>	
<b>last_sig_coeff_x_prefix</b>	ae(v)
<b>last_sig_coeff_y_prefix</b>	ae(v)
if( last_sig_coeff_x_prefix > 3 )	

## Implementation (2)

Modification including restriction to 4x4 blocks

### 7.3.8.11 Residual coding syntax

residual_coding( x0, y0, log2TrafoSize, cIdx ) {	Descriptor
if( transform_skip_enabled_flag && !cu_transquant_bypass_flag && ( log2TrafoSize == 2 ) )	
<b>transform_skip_flag[ x0 ][ y0 ][ cIdx ]</b>	ae(v)
<b>if(log2TrafoSize == 2 &amp;&amp; transform_skip_flag[ x0 ][ y0 ][ cIdx ]    (cu_transquant_bypass_flag == 1))</b>	
<b>scanIdx = (scanIdx == 1) ? 2 : ((scanIdx == 2) ? 1 : scanIdx</b>	
<b>last_sig_coeff_x_prefix</b>	ae(v)
<b>last_sig_coeff_y_prefix</b>	ae(v)
if( last_sig_coeff_x_prefix > 3 )	

## Lossless performance, no block-size restriction

	All Intra Main			Random Access Main			Low delay B Main		
	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving
	Ref	Tested		Ref	Tested		Ref	Tested	
Class F	5.2	5.3	-0.4%	31.7	31.8	-0.2%	49.8	49.9	-0.1%
Class B	2.2	2.2	0.0%	2.6	2.6	0.0%	2.6	2.6	0.0%
SC RGB 444	10.1	10.1	-0.2%	100.4	100.5	0.0%	381.6	381.8	-0.1%
SC YUV 444	11.4	11.4	-0.3%	128.9	129.0	0.0%	325.6	326.5	-0.1%
RExt	2.4	2.4	0.0%	2.5	2.5	0.0%	2.5	2.5	0.0%
Enc Time[%]	101%			100%			100%		
Dec Time[%]	96%			103%			96%		

## Lossless performance, 4x4 blocks only

	All Intra Main			Random Access Main			Low delay B Main		
	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving
	Ref	Tested		Ref	Tested		Ref	Tested	
Class F	5.2	5.3	-0.4%	31.7	31.8	-0.2%	49.8	49.9	-0.1%
Class B	2.2	2.2	0.0%	2.6	2.6	0.0%	2.6	2.6	0.0%
SC RGB 444	10.1	10.1	-0.2%	100.4	100.4	0.0%	381.6	382.4	-0.2%
SC YUV 444	11.4	11.4	-0.3%	128.9	129.2	-0.2%	325.6	325.4	-0.1%
RExt	2.4	2.4	0.0%	2.5	2.5	0.0%	2.5	2.5	0.0%
Enc Time[%]	100%			100%			100%		
Dec Time[%]	102%			104%			99%		



## Lossless performance, swap 4x4 only, with const. context

	All Intra Main			Random Access Main			Low delay B Main		
	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving	compression ratio		Bit-rate saving
	Ref	Tested		Ref	Tested		Ref	Tested	
Class F	5.2	5.3	-1.0%	31.7	31.9	-0.6%	49.8	50.0	-0.5%
Class B	2.2	2.2	-0.2%	2.6	2.6	-0.1%	2.6	2.6	-0.1%
SC RGB 444	10.1	10.1	-0.2%	100.4	100.1	0.0%	381.6	380.4	-0.1%
SC YUV 444	11.4	11.4	-0.5%	128.9	129.0	-0.2%	325.6	325.7	-0.2%
RExt	2.4	2.4	-0.1%	2.5	2.5	-0.1%	2.5	2.5	-0.1%
Enc Time[%]	97%			98%			98%		
Dec Time[%]	98%			96%			87%		

# Lossy performance (TS is already limited to 4x4 blocks)

	All Intra HE Main-tier			All Intra HE High-tier			All Intra HE Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-0.9%	-0.8%	-1.0%	-0.9%	-0.9%	-1.0%	-0.9%	-0.9%	-0.9%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC RGB 444	-1.2%	-1.2%	-1.0%	-1.2%	-1.0%	-0.9%	-1.0%	-0.9%	-0.8%
SC YUV 444	-1.1%	-1.0%	-0.8%	-1.1%	-1.0%	-1.0%	-1.1%	-1.0%	-0.9%
RangeExt	0.0%	-0.1%	-0.1%	0.0%	0.0%	-0.1%	0.0%	0.0%	-0.1%
Enc Time[%]	100%			100%			100%		
Dec Time[%]	96%			96%			96%		

	Random Access HE Main-tier			Random Access HE High-tier		
	Y	U	V	Y	U	V
Class F	-0.7%	-0.6%	-0.9%	-0.7%	-0.7%	-0.8%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC RGB 444	-1.1%	-1.0%	-0.8%	-1.1%	-0.9%	-0.9%
SC YUV 444	-0.6%	-0.6%	-0.5%	-0.6%	-0.5%	-0.5%
RangeExt	0.0%	-0.1%	-0.1%	0.0%	0.0%	-0.1%
Enc Time[%]	100%			100%		
Dec Time[%]	92%			92%		

	Low delay B HE Main-tier			Low delay B HE High-tier		
	Y	U	V	Y	U	V
Class F	-0.4%	-0.5%	-0.7%	-0.4%	-0.6%	-0.7%
Class B	0.0%	0.1%	-0.3%	0.0%	0.1%	-0.1%
SC RGB 444	-0.4%	-0.2%	-0.3%	-0.5%	-0.2%	-0.3%
SC YUV 444	-0.3%	-0.1%	-0.1%	-0.3%	-0.3%	-0.3%
RangeExt	0.0%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%
Enc Time[%]	100%			100%		
Dec Time[%]	90%			91%		

# Lossy performance, swap with const. context

	All Intra HE Main-tier			All Intra HE High-tier			All Intra HE Super-High-tier		
	Y	U	V	Y	U	V	Y	U	V
Class F	-1.7%	-1.3%	-1.5%	-1.8%	-1.6%	-1.7%	-1.8%	-1.7%	-1.7%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.1%
SC RGB 444	-2.2%	-1.9%	-1.7%	-2.1%	-1.8%	-1.6%	-2.0%	-1.6%	-1.5%
SC YUV 444	-1.7%	-1.4%	-1.2%	-1.7%	-1.5%	-1.4%	-1.7%	-1.5%	-1.4%
RangeExt	-0.2%	0.0%	-0.2%	-0.2%	0.0%	-0.1%	-0.2%	0.0%	-0.1%
Enc Time[%]	101%			101%			102%		
Dec Time[%]	96%			96%			96%		

	Random Access HE Main-tier			Random Access HE High-tier		
	Y	U	V	Y	U	V
Class F	-1.2%	-1.0%	-1.0%	-1.2%	-1.0%	-1.0%
Class B	0.0%	0.1%	-0.1%	0.0%	0.1%	0.0%
SC RGB 444	-1.5%	-1.2%	-1.1%	-1.6%	-1.2%	-1.1%
SC YUV 444	-1.1%	-0.9%	-0.7%	-1.0%	-0.8%	-0.7%
RangeExt	-0.1%	-0.1%	0.0%	-0.1%	0.1%	0.1%
Enc Time[%]	101%			101%		
Dec Time[%]	93%			93%		

	Low delay B HE Main-tier			Low delay B HE High-tier		
	Y	U	V	Y	U	V
Class F	-0.8%	-0.4%	0.0%	-0.8%	-0.7%	-0.6%
Class B	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
SC RGB 444	-0.8%	-0.5%	-0.6%	-1.0%	-0.7%	-0.7%
SC YUV 444	-0.4%	-0.1%	-0.3%	-0.4%	-0.3%	-0.4%
RangeExt	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%
Enc Time[%]	100%			100%		
Dec Time[%]	96%			96%		

## Summary

- **Improves performance for TS and bypassed blocks**
- **Swapping of flag 1  $\leftrightarrow$  2**
  - **No semantics changes**
  - **No new scan orders introduced**
- **Compatible with constant context method of Test B.1**
- **Cross-verified in JCTVC-N0076 (BBC)**