

JCTVC-S0024

CE4: Summary Report for Core Experiment 4 on Intra Line Copy

Chun-Chi Chen, Xiaozhong Xu, Li Zhang, Tao Lin

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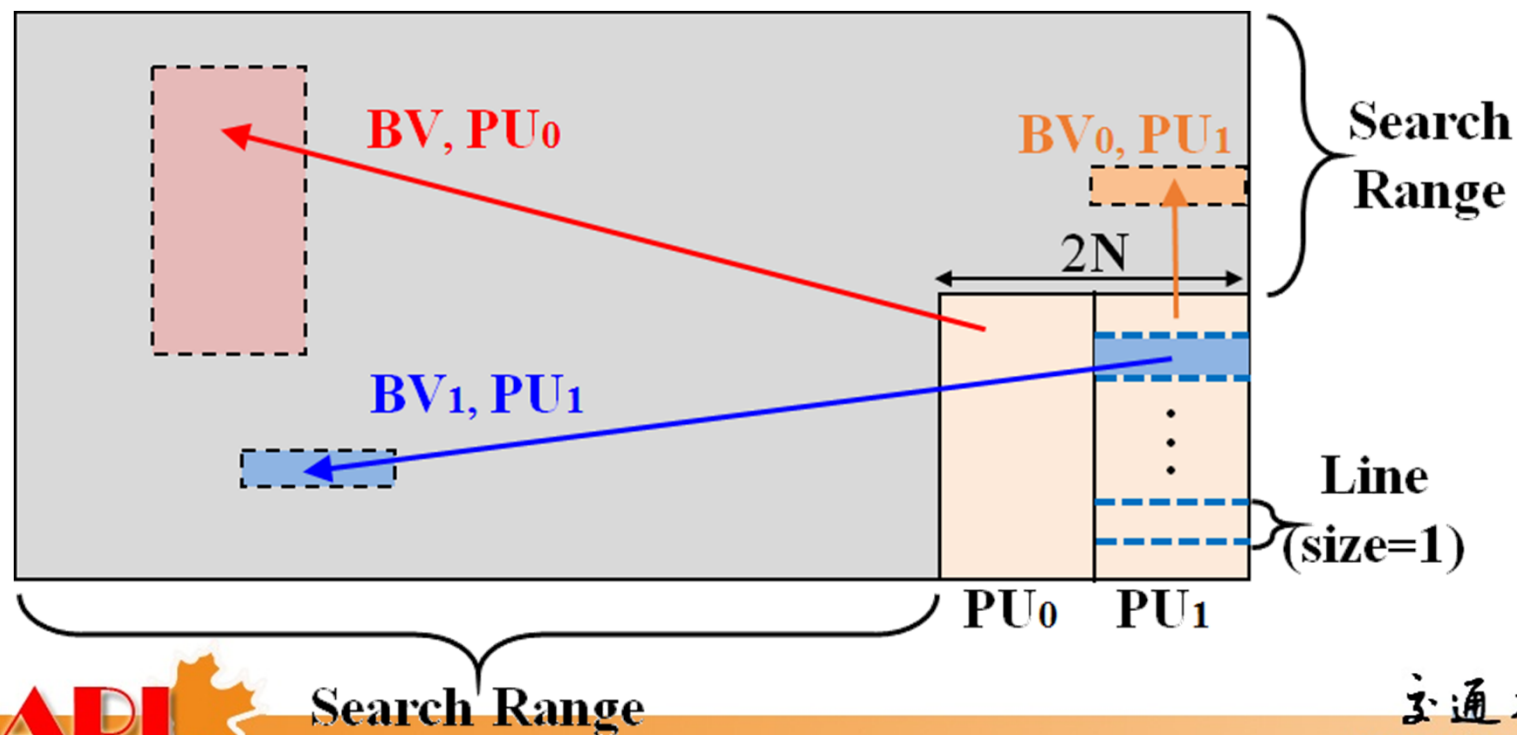
* 2 tests conducted, 1 withdrawn

- **Test A:** Search Range of Intra Line Copy (JCTVC-S0135, NCTU)
 - Cross-checker: JCTVC-S0248, Huawei
- **Test C:** Self-matching Intra Line Copy (JCTVC-S0194, Tongji)
 - Cross-checker: JCTVC-S0233, NCTU/ITRI

* 2 Non-CE contributions

- JCTVC-S0136, S0137 (NCTU)
 - Cross-checker: JCTVC-S0249 (Huawei), JCTVC-S0126, (MediaTek)

- * Switch adaptively between block/line modes at PU level
- * Split a PU into 1-pixel-wide lines (rows or columns)
- * Perform intra-copying operation line-by-line
- * Predict BV in the same way as IBC does



Test A.1: 4-CTU Search Range

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* SCM-2.0

CU Size	8x8				16x16			Others
PU Type	-	4x4	4x8/8x4	8x8	-	8x16/16x8	16x16	
Search Range	-	4-CTU	4-CTU	4-CTU	-	X	4-CTU	X

* Test A.1

CU Size	8x8				16x16			Others
PU Type	Line	4x4	4x8/8x4	8x8	Line	8x16/16x8	16x16	
Search Range	4-CTU	4-CTU	4-CTU	4-CTU	X	X	4-CTU	X

Test A.1: 4-CTU Search Range

Lossy (G/Y BD-rate)	All Intra	Random Access	Low Delay B
RGB, text & graphics with motion, 1080p	-6.4	-3.7	-2.4
RGB, text & graphics with motion, 720p	-3.3	-2.6	-0.9
RGB, mixed content, 1440p	-2.5	-1.7	-1.0
RGB, mixed content, 1080p	-3.7	-3.0	-1.5
YUV, text & graphics with motion, 1080p	-6.2	-3.3	-2.0
YUV, text & graphics with motion, 720p	-3.0	-2.5	-0.9
YUV, mixed content, 1440p	-2.4	-1.8	-0.9
YUV, mixed content, 1080p	-3.7	-2.9	-1.6
Enc Time[%]	119%	103%	102%
Dec Time[%]	106%	102%	102%

Lossless (G/Y BD-rate)	All Intra	Random Access	Low Delay B
RGB, text & graphics with motion, 1080p	7.1	5.3	4.4
RGB, text & graphics with motion, 720p	2.1	1.2	0.6
RGB, mixed content, 1440p	1.1	0.2	0.1
RGB, mixed content, 1080p	1.5	0.3	0.1
YUV, text & graphics with motion, 1080p	7.4	5.6	4.9
YUV, text & graphics with motion, 720p	2.5	1.5	0.8
YUV, mixed content, 1440p	1.2	0.2	0.2
YUV, mixed content, 1080p	1.8	0.3	0.2
Enc Time[%]	115%	103%	103%
Dec Time[%]	101%	103%	100%

Test A.2: Full-frame Search Range

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* SCM-2.0

CU Size	8x8				16x16			Others
PU Type	-	4x4	4x8/8x4	8x8	-	8x16/16x8	16x16	
Search Range	-	2-CTUs	2-CTU	Full Frame	-	X	Full Frame	X

* Test A.2

CU Size	8x8				16x16			Others
PU Type	Line	4x4	4x8/8x4	8x8	Line	8x16/16x8	16x16	
Search Range	2-CTU	2-CTU	2-CTU	Full Frame	X	X	Full Frame	X

Test A.2: Full-frame Search Range (Cont'd)

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Lossy (G/Y BD-rate)	All Intra	Random Access	Low Delay B
RGB, text & graphics with motion, 1080p	-3.8	-2.2	-1.5
RGB, text & graphics with motion, 720p	-1.3	-1.1	-0.7
RGB, mixed content, 1440p	-1.5	-1.1	-0.6
RGB, mixed content, 1080p	-2.2	-1.6	-0.6
YUV, text & graphics with motion, 1080p	-3.7	-2.0	-1.3
YUV, text & graphics with motion, 720p	-1.2	-0.9	-0.5
YUV, mixed content, 1440p	-1.4	-1.0	-0.7
YUV, mixed content, 1080p	-2.1	-1.6	-0.7
Enc Time[%]	117%	103%	101%
Dec Time[%]	101%	101%	103%

Lossless (G/Y BD-rate)	All Intra	Random Access	Low Delay B
RGB, text & graphics with motion, 1080p	4.6	3.2	2.7
RGB, text & graphics with motion, 720p	1.0	0.5	0.3
RGB, mixed content, 1440p	0.7	0.1	0.1
RGB, mixed content, 1080p	0.8	0.1	0.1
YUV, text & graphics with motion, 1080p	4.6	3.4	2.6
YUV, text & graphics with motion, 720p	1.1	0.6	0.4
YUV, mixed content, 1440p	0.7	0.1	0.1
YUV, mixed content, 1080p	0.9	0.2	0.1
Enc Time[%]	115%	104%	102%
Dec Time[%]	101%	101%	100%

Worst-case Number of Context-coded Bins

8

* ~9% increase (484 -> 528) due mainly to increased number of BVs

Prediction Mode (Note: CU Size = 8x8)	4x8, Uni Prediction		4x4, IntraBC		1x4, IntraLC	
	Syntax Elements	#	Syntax Elements	#	Syntax Elements	#
Mode Flag	cu_transquant_bypass_flag	1	cu_transquant_bypass_flag	1	cu_transquant_bypass_flag	1
	cu_skip_flag	1	cu_skip_flag	1	cu_skip_flag	1
	intra_bc_flag	1	intra_bc_flag	1	intra_bc_flag	1
	pred_mode_flag	1	pred_mode_flag	1	intra_lc_flag	4
			palette_mode_flag	1	row_splitting_flag	4
Partition					pred_mode_flag	1
	part_mode	2	part_mode	3	palette_mode_flag	1
	merge_flag	2	abs_bvd_greater0_flag	8	part_mode	3
	inter_pred_idc	2	bvp_flag	4	abs_bvd_greater0_flag	32
	ref_idx_l0	4			bvp_flag	16
MV or BV	abs_mvd_greater0_flag	4				
	abs_mvd_greater1_flag	4				
	mvp_l0_flag	2				
Others	...	464	...	464	...	464
# of Context-coded Bins		488		484		528
Bins per Pixel		7.62		7.56		8.25

- * AI: double the P value
- * RA/LB: impact less on P value

Memory Access Pattern Prediction Mode	Per-pixel Memory Access Bandwidth (P)				
	4x1	8x1	4x2	8x2	4x4
8x8, Bi-prediction (Luma)	9.375	11.25	10	12	12.5
8x8, Bi-prediction (Chroma)	5.5	8.25	6	9	8
4x4, IBC	2	4	3	6	4
1x4, ILC	4	8	6	12	8

- * **Test A.1: 4-CTU search range**
- * **w/ cache: negligible increase**
- * **w/o cache: 5-31% for AI, <3% for RA/LD**

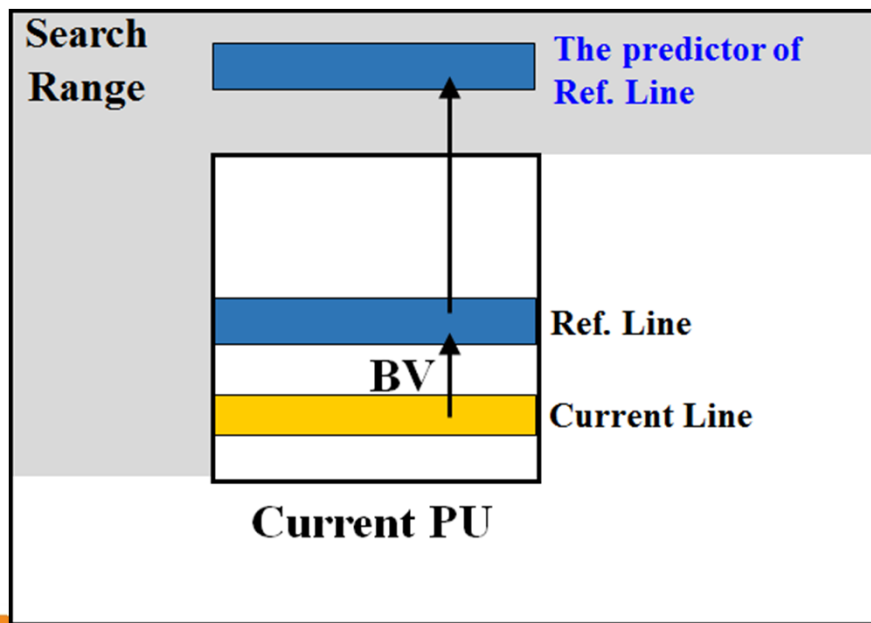
Lossy (G/Y BD-rate)	All Intra							
	8-8	32-64	32-128	64-128	64-256	64-512	64-256 Cache	64-512 Cache
RGB, text & graphics with motion, 1080p	112.2%	112.2%	114.0%	114.0%	123.3%	131.3%	100.0%	100.0%
RGB, text & graphics with motion, 720p	105.9%	105.9%	106.8%	106.8%	111.6%	115.7%	100.0%	100.0%
RGB, mixed content, 1440p	105.7%	105.7%	106.7%	106.7%	111.6%	115.6%	100.0%	100.0%
RGB, mixed content, 1080p	108.9%	108.9%	110.4%	110.4%	118.0%	123.8%	100.0%	100.0%
YUV, text & graphics with motion, 1080p	111.1%	111.1%	112.6%	112.6%	120.4%	127.0%	100.0%	100.0%
YUV, text & graphics with motion, 720p	105.1%	105.1%	105.9%	105.9%	109.8%	113.3%	100.0%	100.0%
YUV, mixed content, 1440p	104.9%	104.9%	105.7%	105.7%	110.0%	113.8%	100.0%	100.0%
YUV, mixed content, 1080p	108.0%	108.0%	109.4%	109.4%	116.1%	121.8%	100.0%	100.0%
Lossy (G/Y BD-rate)	Random Access							
RGB, text & graphics with motion, 1080p	100.8%	100.8%	100.9%	100.9%	101.6%	102.6%	100.1%	100.1%
RGB, text & graphics with motion, 720p	100.1%	100.1%	100.1%	100.1%	100.3%	100.6%	100.0%	100.0%
RGB, mixed content, 1440p	100.1%	100.1%	100.1%	100.1%	100.2%	100.4%	100.0%	100.0%
RGB, mixed content, 1080p	100.0%	100.0%	100.0%	100.0%	100.2%	100.5%	99.9%	99.9%
YUV, text & graphics with motion, 1080p	100.6%	100.6%	100.7%	100.7%	101.3%	102.1%	100.1%	100.1%
YUV, text & graphics with motion, 720p	100.2%	100.2%	100.2%	100.2%	100.3%	100.6%	100.1%	100.1%
YUV, mixed content, 1440p	100.1%	100.1%	100.1%	100.1%	100.2%	100.3%	100.0%	100.0%
YUV, mixed content, 1080p	100.1%	100.1%	100.2%	100.2%	100.3%	100.5%	100.0%	100.0%

- * **Test A.2:** full-frame search range
- * **w/ cache:** negligible increase
- * **w/o cache:** 2-15% for AI, <2% for RA/LD

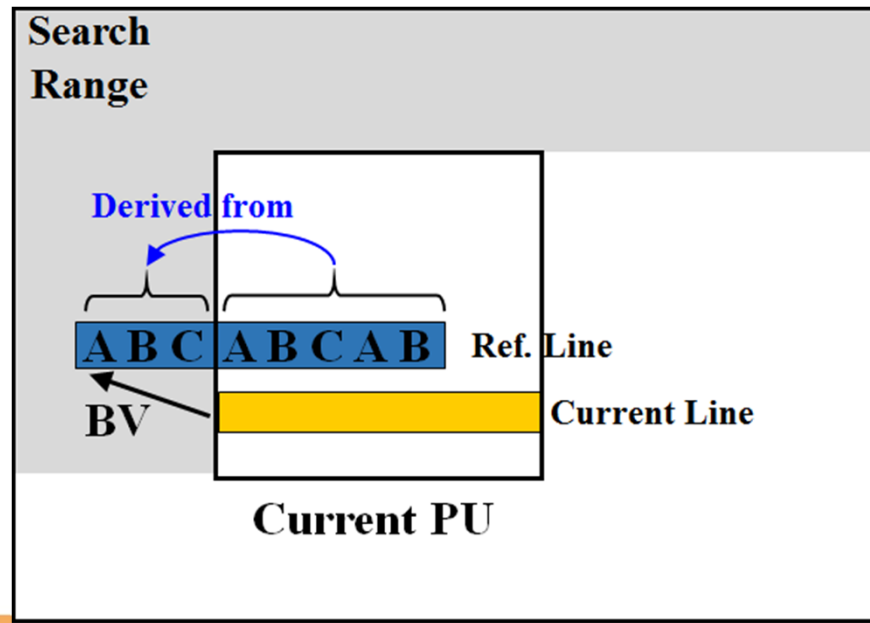
Lossy (G/Y BD-rate)	All Intra							
	8-8	32-64	32-128	64-128	64-256	64-512	64-256 Cache	64-512 Cache
RGB, text & graphics with motion, 1080p	105.8%	105.8%	106.6%	106.6%	111.1%	115.2%	99.6%	99.6%
RGB, text & graphics with motion, 720p	102.9%	102.9%	103.3%	103.3%	105.6%	107.6%	99.8%	99.8%
RGB, mixed content, 1440p	103.5%	103.5%	104.1%	104.1%	107.3%	109.8%	99.8%	99.7%
RGB, mixed content, 1080p	104.9%	104.9%	105.7%	105.7%	110.1%	113.4%	99.6%	99.5%
YUV, text & graphics with motion, 1080p	105.0%	105.0%	105.7%	105.7%	109.3%	112.4%	99.6%	99.5%
YUV, text & graphics with motion, 720p	102.5%	102.5%	102.8%	102.8%	104.7%	106.4%	99.9%	99.9%
YUV, mixed content, 1440p	102.8%	102.8%	103.3%	103.3%	105.9%	108.2%	99.8%	99.7%
YUV, mixed content, 1080p	104.4%	104.4%	105.1%	105.1%	108.9%	112.0%	99.6%	99.5%
Lossy (G/Y BD-rate)	Random Access							
RGB, text & graphics with motion, 1080p	100.4%	100.4%	100.5%	100.5%	100.9%	101.5%	100.0%	100.0%
RGB, text & graphics with motion, 720p	100.1%	100.1%	100.1%	100.1%	100.2%	100.3%	100.0%	100.0%
RGB, mixed content, 1440p	100.1%	100.1%	100.1%	100.1%	100.1%	100.3%	100.0%	100.0%
RGB, mixed content, 1080p	100.1%	100.1%	100.1%	100.1%	100.2%	100.3%	100.0%	100.0%
YUV, text & graphics with motion, 1080p	100.4%	100.4%	100.4%	100.4%	100.7%	101.2%	100.0%	100.0%
YUV, text & graphics with motion, 720p	100.1%	100.1%	100.1%	100.1%	100.1%	100.3%	100.0%	100.0%
YUV, mixed content, 1440p	100.2%	100.2%	100.2%	100.2%	100.2%	100.3%	100.1%	100.1%
YUV, mixed content, 1080p	100.1%	100.1%	100.1%	100.1%	100.2%	100.3%	100.0%	100.0%

- * Allow reference lines to overlap the current CU
 - **in-CU self-matching**: reference line can come from the PU to which the current line belongs
 - **in-line self-matching**: reference line can partially overlap with the current CU

In-CU self-matching



In-line self-matching



Test C vs. Test A.2 (Full-frame Configuration) 13

Lossy (G/Y BD-rate)	All Intra		Random Access		Low Delay B	
	Test A.2	Test C	Test A.2	Test C	Test A.2	Test C
RGB, text & graphics with motion, 1080p	-3.8	-3.8	-2.2	-2.2	-1.5	-1.4
RGB, text & graphics with motion, 720p	-1.3	-1.4	-1.1	-1.0	-0.7	-0.5
RGB, mixed content, 1440p	-1.5	-1.5	-1.1	-1.1	-0.6	-0.7
RGB, mixed content, 1080p	-2.2	-2.2	-1.6	-1.6	-0.6	-0.8
YUV, text & graphics with motion, 1080p	-3.7	-3.7	-2.0	-2.0	-1.3	-1.3
YUV, text & graphics with motion, 720p	-1.2	-1.2	-0.9	-1.0	-0.5	-0.5
YUV, mixed content, 1440p	-1.4	-1.4	-1.0	-1.1	-0.7	-0.7
YUV, mixed content, 1080p	-2.1	-2.1	-1.6	-1.7	-0.7	-0.8
Enc Time[%]	117%	117%	103%	104%	101%	148%
Dec Time[%]	101%	166%	101%	157%	103%	171%

Lossless (G/Y BD-rate)	All Intra		Random Access		Low Delay B	
	Test A.2	Test C	Test A.2	Test C	Test A.2	Test C
RGB, text & graphics with motion, 1080p	4.6	4.5	3.2	3.2	2.7	2.6
RGB, text & graphics with motion, 720p	1.0	0.9	0.5	0.4	0.3	0.3
RGB, mixed content, 1440p	0.7	0.7	0.1	0.1	0.1	0.1
RGB, mixed content, 1080p	0.8	0.7	0.1	0.1	0.1	0.1
YUV, text & graphics with motion, 1080p	4.6	4.6	3.4	3.4	2.6	2.9
YUV, text & graphics with motion, 720p	1.1	1.1	0.6	0.5	0.4	0.4
YUV, mixed content, 1440p	0.7	0.8	0.1	0.1	0.1	0.1
YUV, mixed content, 1080p	0.9	0.9	0.2	0.2	0.1	0.1
Enc Time[%]	115%	92%	104%	129%	102%	130%
Dec Time[%]	101%	136%	101%	177%	100%	153%

- * Up to 6.4% (4-CTU) and 3.8% (full-frame) BD-rate savings
- * 9% increase in worst-case number of context-coded bins
- * Increase in average-case memory access bandwidth due to ILC is up to 14% for AI and 2% for RA/LB.
- * With cache, up to 0.1% increase of the average-case memory access bandwidth is observed
- * Self-matching is reported no gain on top of Test A.2

- * Further study Test A in a CE
- * Present the Non-CE contributions which provide more information for Test A on
 - reducing the number of context-coded bins (JCTVC-S0136)
 - improving the coding performance (JCTVC-S0137)