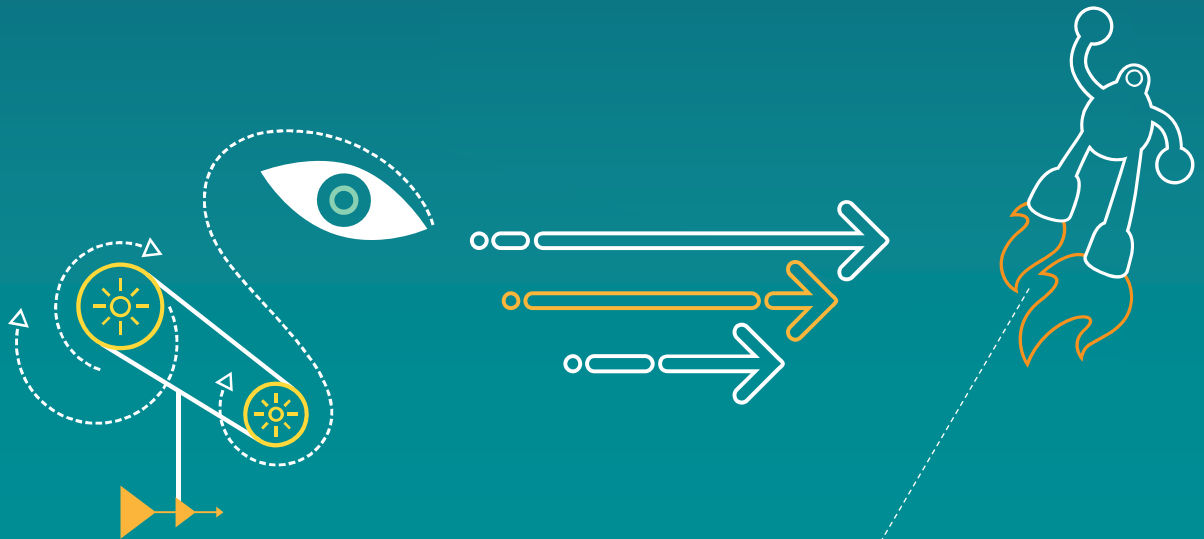
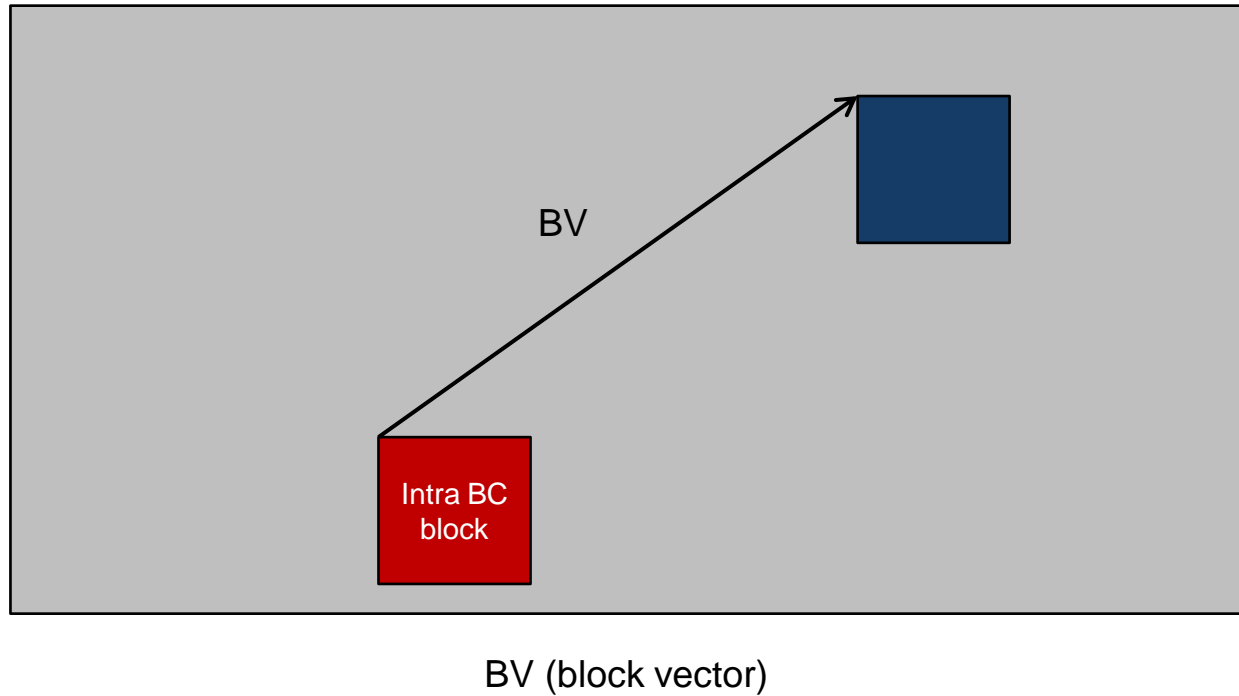


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JCTVC-R0188 Non-SCCE1: Memory bandwidth reduction for Intra block copy



Intra block copy (Intra BC)



The search region for Intra BC is the entire frame for both intra- and inter- frames.

Memory bandwidth evaluation

- Both memory read and write are taken into account in the bandwidth calculation.
- For memory read

$$P = \frac{\left\lceil \frac{m-1+M+L-1}{m} \right\rceil \cdot \left\lceil \frac{n-1+N+L-1}{n} \right\rceil \cdot m \cdot n}{M \cdot N}$$

- For memory write, both the filtered and unfiltered reconstructed samples need to be written to the memory

Memory block configuration	HEVC	SCM
4x2	25.0	28.0
8x2	33.0	36.0

Worst-case memory bandwidth comparison of HEVC and SCM 1.0

- Method 1
 - It is restricted that any reference pixel for Intra BC cannot be from bi-predicted blocks.
 - Method 2
 - Propose to use full frame search region for intra-frame and local search region (e.g. left and current CTB) for inter frame
- * With either method 1 or method 2, the worst-case memory bandwidth is the same as HEVC.

Lossy results for method 1

	All Intra			Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p	0.0%	0.0%	0.0%	2.3%	2.0%	2.1%	4.3%	3.8%	3.9%
RGB, text & graphics with motion,720p	0.0%	0.0%	0.0%	0.3%	0.3%	0.3%	1.2%	1.1%	1.1%
RGB, mixed content, 1440p	0.0%	0.0%	0.0%	0.7%	0.7%	0.7%	1.3%	1.2%	1.2%
RGB, mixed content, 1080p	0.0%	0.0%	0.0%	0.7%	0.6%	0.6%	1.5%	1.3%	1.2%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	-0.1%
YUV, text & graphics with motion, 1080p	0.0%	0.0%	0.0%	1.6%	1.3%	1.3%	3.2%	2.9%	3.0%
YUV, text & graphics with motion,720p	0.0%	0.0%	0.0%	0.3%	0.2%	0.2%	1.2%	1.3%	1.2%
YUV, mixed content, 1440p	0.0%	0.0%	0.0%	0.6%	0.6%	0.6%	1.2%	1.2%	1.3%
YUV, mixed content, 1080p	0.0%	0.0%	0.0%	0.6%	0.7%	0.6%	1.7%	0.8%	1.1%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	-0.2%	-0.1%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%
Enc Time[%]	103%			101%			98%		
Dec Time[%]	104%			101%			101%		

Lossless results for method 1

Bit-rate saving (Average)	AI	RA	LB
RGB, text & graphics with motion, 1080p	0.0%	-4.7%	-3.9%
RGB, text & graphics with motion,720p	0.0%	-0.4%	-0.5%
RGB, mixed content, 1440p	0.0%	-0.2%	-0.4%
RGB, mixed content, 1080p	0.0%	-0.2%	-0.2%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	0.0%	-5.3%	-5.3%
YUV, text & graphics with motion,720p	0.0%	-0.4%	-0.5%
YUV, mixed content, 1440p	0.0%	-0.2%	-0.3%
YUV, mixed content, 1080p	0.0%	-0.2%	-0.3%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	101%	109%	102%
Dec Time[%]	101%	108%	101%

Lossy results for method 2

	All Intra			Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p	0.0%	0.0%	0.0%	7.7%	7.3%	7.4%	9.4%	8.8%	9.0%
RGB, text & graphics with motion,720p	0.0%	0.0%	0.0%	1.3%	1.3%	1.3%	3.9%	3.6%	3.6%
RGB, mixed content, 1440p	0.0%	0.0%	0.0%	2.1%	2.1%	2.1%	2.0%	2.0%	2.0%
RGB, mixed content, 1080p	0.0%	0.0%	0.0%	2.4%	2.4%	2.4%	3.1%	2.9%	2.8%
RGB, Animation, 720p	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	-0.1%	0.1%	0.1%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	0.0%	0.0%	0.0%	6.9%	6.6%	6.7%	8.3%	8.1%	8.1%
YUV, text & graphics with motion,720p	0.0%	0.0%	0.0%	1.2%	1.2%	1.2%	3.3%	3.1%	3.3%
YUV, mixed content, 1440p	0.0%	0.0%	0.0%	2.1%	2.0%	2.1%	1.9%	2.0%	2.0%
YUV, mixed content, 1080p	0.0%	0.0%	0.0%	2.5%	2.4%	2.4%	2.9%	1.9%	2.1%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	-0.4%	-0.1%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	103%			93%			91%		
Dec Time[%]	103%			96%			93%		

Lossless results for method 2

Bit-rate saving (Average)	AI	RA	LB
RGB, text & graphics with motion, 1080p	0.0%	-11.7%	-14.7%
RGB, text & graphics with motion,720p	0.0%	-0.7%	-1.8%
RGB, mixed content, 1440p	0.0%	-1.1%	-1.1%
RGB, mixed content, 1080p	0.0%	-0.6%	-0.6%
RGB, Animation, 720p	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p	0.0%	-12.4%	-15.6%
YUV, text & graphics with motion,720p	0.0%	-0.8%	-2.3%
YUV, mixed content, 1440p	0.0%	-1.2%	-1.2%
YUV, mixed content, 1080p	0.0%	-0.7%	-0.7%
YUV, Animation, 720p	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%
Enc Time[%]	99%	102%	93%
Dec Time[%]	99%	106%	96%

Conclusions

- Two methods are proposed to reduce memory bandwidth for Intra BC
- Both methods can keep the worse-case memory bandwidth the same as HEVC

Thank you

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