

# **JCTVC-T0117**

## **Non-CE2: improved inter merge for unified IBC and inter framework**

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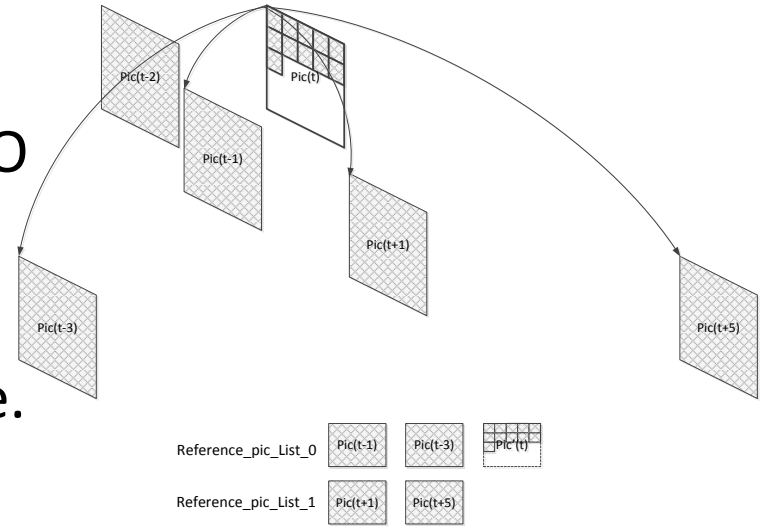
20<sup>th</sup> JCT-VC meeting, Feb. 2015

**INTERDIGITAL**

Creating the Living Network

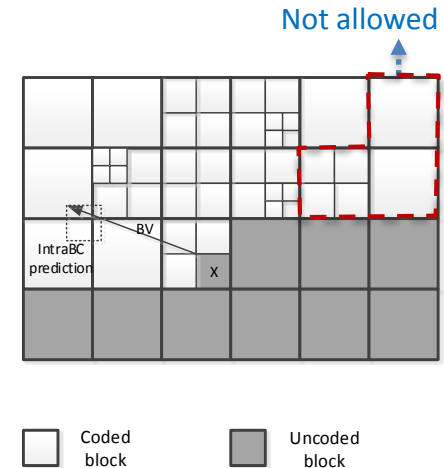
# CE-2 Test1 Unified IBC and inter framework

1. In unified IBC and inter framework tested in CE-2 Test-1 (JCTVC-T0094), IBC is treated as inter mode by adding the current reconstructed picture without deblocking and SAO in the reference picture list.
2. IBC will share the same merge process with traditional inter mode.



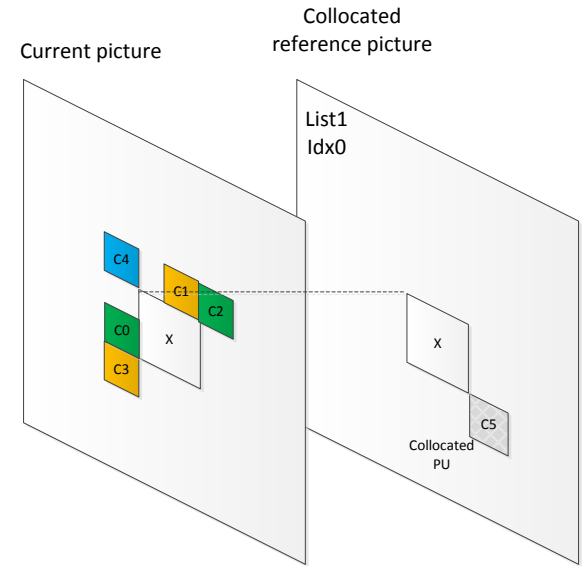
# Modified inter merge process for IBC

1. Only valid BV merge candidates are added in the merge candidate list. BVs are considered invalid if any of the following is true:
  - If the BV makes reference to any unreconstructed samples or any samples within the same CU;
  - If the BV makes references to any samples outside of the picture boundary;
  - If the BV makes reference to samples inside a region which is not allowed for IBC (for parallel decoding implementation consideration).



# Modified inter merge process for IBC

2. Add one BV from the temporal collocated blocks in collocated reference picture (if available)
  - This is achieved using the existing TMVP process by setting the target reference picture to the current partially reconstructed picture  $Pic'(t)$  (instead of the 0-th reference picture in list-0)
  - For current block X, if collocated PU C5 is IBC coded, then its BV will be used as merge candidate.



# Modified inter merge process for IBC

3. If the merge candidate list is not full, then traditional default zero MVs and five default BVs are appended in an interleaving order starting from MV first

➤ The five default BVs in integer pixel are defined in order:

$(-PU_x - PU_w, 0)$

$(-PU_x - 2*PU_w, 0)$

$(0, -PU_y - PU_h)$

$(0, -PU_y - 2*PU_h)$

$(-PU_x - PU_w, -PU_y - PU_h)$

# Proposed encoder optimization

1. The BV and MV bi-prediction search is added for  $2N \times 2N$  partitions if CU size is no greater than  $32 \times 32$ 
  - Only performed when the MV resolution in the current slice is not integer MV (i.e., `use_integer_mv_flag = 0`) to reduce the encoding complexity
2. Encoder optimization methods in JCTVC-T0116 are applied
  - IBC  $N \times 2N$  and  $2N \times N$  partition checking proposed in JCTVC-T0116 is already included in CE2 test 1 software base

# Simulations

- Test-A: modified inter merge method
- Test-B: Test-A + encoder improvements in JCTVC-T0116

## Performance evaluation for Test-A, 444 lossy coding (SCM-3.0 anchor)

	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 & 720p	-1.2%	-2.7%	-2.6%	-3.2%	-5.2%	-5.1%	-3.4%	-4.9%	-4.8%
RGB, mixed content, 1440p & 1080p	-0.7%	-1.5%	-1.6%	-1.2%	-2.7%	-2.9%	-1.6%	-3.1%	-3.2%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	-0.2%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	-0.2%	-0.1%	-0.1%	0.1%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	-1.6%	-3.0%	-3.1%	-3.6%	-5.3%	-5.4%	-3.8%	-5.1%	-5.4%
YUV, mixed content, 1440p & 1080p	-1.1%	-2.1%	-2.2%	-1.6%	-3.5%	-3.6%	-2.1%	-4.7%	-5.1%
YUV, Animation, 720p	-0.1%	-0.3%	-0.4%	-0.2%	-0.8%	-0.3%	-0.1%	-0.1%	-0.1%
YUV, camera captured, 1080p	0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.3%	0.0%	0.1%	0.1%
Enc Time[%]	107%			100%			100%		
Dec Time[%]	95%			95%			97%		

# Performance evaluation for Test-A 444 lossless coding (SCM-3.0 anchor)

	All Intra				Random Access				Low Delay B			
	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)
RGB, text & graphics with motion, 1080p & 720p	0.2%	0.0%	-1.8%	1.7%	-1.4%	-1.4%	-3.0%	0.0%	-1.5%	-1.6%	-4.9%	-0.1%
RGB, mixed content, 1440p & 1080p	0.1%	0.1%	-0.2%	0.3%	-0.2%	-0.2%	-0.4%	0.0%	-0.2%	-0.2%	-0.4%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.9%	0.8%	-0.6%	2.6%	-1.0%	-0.9%	-2.6%	0.2%	-1.1%	-1.2%	-4.6%	0.1%
YUV, mixed content, 1440p & 1080p	0.2%	0.2%	-0.2%	0.6%	-0.1%	-0.2%	-0.4%	0.0%	-0.1%	-0.2%	-0.3%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	98%				96%				97%			
Dec Time[%]	96%				102%				101%			

# Performance evaluation for Test-A 420 lossy and lossless coding (SCM-3.0 anchor)

	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
Text & graphics with motion, 720p	-2.8%	-3.2%	-3.2%	-2.9%	-4.1%	-3.9%	-2.4%	-3.5%	-3.7%
Mixed content, 480p	-1.3%	-1.3%	-1.5%	-0.7%	-1.5%	-1.5%	0.2%	0.1%	-0.9%
Animation, 768p	-1.1%	-1.9%	-2.3%	-1.1%	-3.0%	-2.7%	-0.5%	-1.0%	-2.6%
Average of all sequences	-2.0%	-2.4%	-2.6%	-1.9%	-3.1%	-3.0%	-1.3%	-2.0%	-2.7%
Enc Time[%]	92%			100%			99%		
Dec Time[%]	98%			94%			96%		

	All Intra				Random Access				Low Delay B			
	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)
Text & graphics with motion, 720p	-0.7%	-0.7%	-0.8%	-0.5%	-1.2%	-2.2%	-4.0%	-0.4%	-0.4%	-0.8%	-1.4%	-0.2%
Mixed content, 480p	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Animation, 768p	0.1%	0.1%	0.1%	0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Average of all sequences	-0.2%	-0.3%	-0.8%	0.1%	-0.1%	-1.1%	-4.0%	0.0%	-0.1%	-0.4%	-1.4%	0.0%
Enc Time[%]	74%				94%				95%			
Dec Time[%]	96%				97%				99%			

# Performance evaluation for Test-B 444 lossy coding (SCM-3.0 anchor)

	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 & 720p	-2.8%	-4.3%	-4.0%	-4.3%	-6.3%	-6.1%	-4.5%	-6.2%	-6.1%
RGB, mixed content, 1440p & 1080p	-1.5%	-2.3%	-2.4%	-1.4%	-3.1%	-3.2%	-2.1%	-3.6%	-3.8%
RGB, Animation, 720p	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%	-0.1%	-0.3%	-0.4%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	-0.2%	-0.2%	-0.3%	0.0%	0.0%	-0.1%
YUV, text & graphics with motion, 1080p & 720p	-3.1%	-4.3%	-4.3%	-4.5%	-6.3%	-6.5%	-4.9%	-6.3%	-6.3%
YUV, mixed content, 1440p & 1080p	-1.9%	-2.8%	-3.0%	-2.0%	-3.8%	-4.1%	-2.5%	-4.9%	-5.4%
YUV, Animation, 720p	-0.3%	-0.6%	-0.6%	-0.3%	-1.0%	-0.7%	-0.2%	-0.6%	-0.2%
YUV, camera captured, 1080p	0.0%	-0.1%	-0.1%	-0.2%	-0.2%	-0.5%	0.0%	0.1%	-0.1%
Enc Time[%]	105%			99%			99%		
Dec Time[%]	94%			91%			97%		

# Performance evaluation for Test-B 444 lossless coding (SCM-3.0 anchor)

	All Intra				Random Access				Low Delay B			
	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)
RGB, text & graphics with motion, 1080p & 720p	-0.5%	-0.8%	-2.7%	0.2%	-1.5%	-1.7%	-3.7%	-0.3%	-1.5%	-1.9%	-6.1%	-0.2%
RGB, mixed content, 1440p & 1080p	-0.1%	-0.1%	-0.3%	0.1%	-0.2%	-0.2%	-0.5%	0.0%	-0.2%	-0.2%	-0.4%	0.0%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	0.2%	0.1%	-1.0%	1.7%	-1.1%	-1.1%	-3.2%	0.0%	-1.0%	-1.4%	-5.7%	0.0%
YUV, mixed content, 1440p & 1080p	0.0%	0.0%	-0.4%	0.3%	-0.2%	-0.2%	-0.4%	0.0%	-0.2%	-0.2%	-0.4%	0.0%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	100%				96%				96%			
Dec Time[%]	96%				94%				96%			

# Performance evaluation for Test-B 420 lossy and lossless coding (SCM-3.0 anchor)

	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
Text & graphics with motion, 720p	-4.6%	-5.0%	-5.1%	-3.6%	-4.7%	-4.9%	-3.3%	-3.6%	-5.5%
Mixed content, 480p	-1.6%	-1.7%	-2.0%	-0.9%	-1.6%	-1.9%	0.0%	-0.5%	-0.4%
Animation, 768p	-1.4%	-2.2%	-2.5%	-1.2%	-3.2%	-3.0%	-0.7%	-1.6%	-2.8%
Average of all sequences	-3.1%	-3.5%	-3.7%	-2.3%	-3.6%	-3.7%	-1.8%	-2.3%	-3.6%
Enc Time[%]	91%			96%			96%		
Dec Time[%]	98%			92%			93%		

	All Intra				Random Access				Low Delay B			
	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Avg.)	Bit-rate change (Min)	Bit-rate change (Max)
Text & graphics with motion, 720p	-2.3%	-2.3%	-3.9%	-0.7%	-1.3%	-2.4%	-4.3%	-0.5%	-0.4%	-0.7%	-1.1%	-0.3%
Mixed content, 480p	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Animation, 768p	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Average of all sequences	-0.7%	-1.1%	-3.9%	0.0%	-0.1%	-1.2%	-4.3%	0.0%	-0.1%	-0.4%	-1.1%	0.0%
Enc Time[%]	73%				94%				95%			
Dec Time[%]	99%				95%				97%			

## Performance evaluation for Test-A, 444&420 lossy coding (CE-2 Test-1 as anchor)

	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 & 720p	-0.6%	-0.7%	-0.7%	-1.0%	-1.2%	-1.2%	-1.1%	-1.1%	-1.2%
RGB, mixed content, 1440p & 1080p	0.0%	0.0%	-0.1%	-0.5%	-0.5%	-0.5%	-0.7%	-0.6%	-0.7%
RGB, Animation, 720p	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
YUV, text & graphics with motion, 1080p & 720p	-0.9%	-1.0%	-0.9%	-1.3%	-1.4%	-1.2%	-1.4%	-1.3%	-1.4%
YUV, mixed content, 1440p & 1080p	-0.6%	-0.4%	-0.5%	-0.7%	-0.8%	-0.9%	-0.7%	-0.8%	-0.9%
YUV, Animation, 720p	-0.1%	-0.3%	-0.3%	0.0%	-0.4%	-0.3%	-0.1%	-0.3%	-0.3%
YUV, camera captured, 1080p	-0.1%	-0.2%	-0.2%	0.0%	-0.1%	-0.2%	0.0%	0.1%	-0.1%

	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
Text & graphics with motion, 720p	0.0%	-0.3%	-0.2%	-0.8%	-1.0%	-0.9%	-1.2%	-2.5%	-0.9%
Mixed content, 480p	-0.3%	-0.3%	-0.3%	-0.2%	-0.4%	-0.2%	0.1%	0.3%	-0.8%
Animation, 768p	-0.5%	-0.7%	-0.8%	-0.4%	-0.9%	-0.6%	-0.1%	0.2%	-1.1%
Average of all sequences	-0.2%	-0.4%	-0.4%	-0.5%	-0.8%	-0.7%	-0.6%	-1.1%	-0.9%

## Performance evaluation for Test-B, 444&420 lossy coding (CE-2 Test-1 as anchor)

	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 & 720p	-2.2%	-2.3%	-2.1%	-2.1%	-2.4%	-2.2%	-2.3%	-2.5%	-2.5%
RGB, mixed content, 1440p & 1080p	-0.8%	-0.8%	-0.9%	-0.7%	-0.9%	-0.8%	-1.2%	-1.2%	-1.3%
RGB, Animation, 720p	-0.1%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%	0.0%	-0.2%	-0.1%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	-0.1%
YUV, text & graphics with motion, 1080p & 720p	-2.3%	-2.3%	-2.2%	-2.2%	-2.5%	-2.4%	-2.5%	-2.5%	-2.4%
YUV, mixed content, 1440p & 1080p	-1.3%	-1.2%	-1.3%	-1.1%	-1.1%	-1.3%	-1.2%	-1.0%	-1.2%
YUV, Animation, 720p	-0.3%	-0.5%	-0.5%	-0.2%	-0.6%	-0.7%	-0.2%	-0.8%	-0.4%
YUV, camera captured, 1080p	-0.1%	-0.2%	-0.2%	0.0%	-0.2%	-0.4%	0.0%	0.1%	-0.3%

	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
Text & graphics with motion, 720p	-1.8%	-2.2%	-2.2%	-1.6%	-1.6%	-2.0%	-2.0%	-2.5%	-2.8%
Mixed content, 480p	-0.7%	-0.8%	-0.9%	-0.4%	-0.5%	-0.6%	0.0%	-0.4%	-0.3%
Animation, 768p	-0.8%	-1.0%	-1.0%	-0.5%	-1.1%	-0.8%	-0.3%	-0.5%	-1.4%
Average of all sequences	-1.3%	-1.5%	-1.6%	-1.0%	-1.2%	-1.4%	-1.1%	-1.5%	-1.8%

# Conclusions

- This contribution proposes modified inter merge process for unified IBC and inter framework
- For “RGB/YUV, text & graphics with motion, 1080p & 720p” 444 lossy coding, “YUV, text & graphics with motion, 720p” 420 lossy coding

		444 Lossy coding		420 Lossy coding	
		SCM-3.0 anchor	CE-2 Test-1 as anchor	SCM-3.0 anchor	CE-2 Test-1 as anchor
Test-A	AI	-1.4%,-2.9%,-2.8%	-0.7%,-0.8%,-0.8%	-2.8%,-3.2%,-3.2%	0.0%,-0.3%,-0.2%
	RA	-3.4%,-5.3%,-5.3%	-1.2%,-1.3%,-1.2%	-2.9%,-4.1%,-3.9%	-0.8%,-1.0%,-0.9%
	LD	-3.6%,-5.0%,-5.1%	-1.2%,-1.2%,-1.3%	-2.4%,-3.9%,-3.7%	-1.2%,-2.5%,-0.9%
Test-B	AI	-2.9%,-4.3%,-4.2%	-2.3%,-2.3%,-2.2%	-4.6%,-5.0%,-5.1%	-1.8%,-2.2%,-2.2%
	RA	-4.4%,-6.3%,-6.3%	-2.2%,-2.4%,-2.3%	-3.6%,-4.7%,-4.9%	-1.6%,-1.6%,-2.0%
	LD	-4.7%,-6.3%,-6.2%	-2.4%,-2.5%,-2.4%	-3.3%,-3.6%,-5.5%	-2.0%,-2.5%,-2.8%

**Thanks Microsoft for cross-checking!**  
**(JCTVC-T0165)**