



# Non-SCE3.1: Disabling adaptive predictor compensation for bi-prediction

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# Overall Summary

- An adaptive predictor compensation (APC) is proposed in SCE3.1 to allow using reconstructed base layer (BL) samples to refine enhancement layer (EL) sample predictors
  - Only applied to inter 2Nx2N CU with at least one non-zero residue
  - $\text{Pred}_{\text{EL}}' = (\text{Pred}_{\text{EL}} + \text{Rec}_{\text{BL}}) \gg 1$
  - **In this proposal, we disable APC for bi-prediction CU.**
- 0.8% average BD-rate savings
- 4% encoding time increase, no decoding time increase
- **No increase in the worst case memory bandwidth and computation**

	Multipliers	Adders	Memory Bandwidth	# of Ref. Frames	Tables Size
Avg. case	99%	99%	101%		
Worst case	100%	100%	100%	100%	100%

# Adaptive Predictor Compensation (APC)

- The BL reconstructed picture may predict the current EL picture better than the EL reference picture for regions that newly appear or have light changes
- Therefore, the BL reconstructed texture can be used to refine the EL motion compensated predictors
- SCE 3.1:
  - Apply the APC to inter 2Nx2N CU that has at least one non-zero residue
  - Signal an APC\_enable\_flag to enable or disable the refinement
- Additional restriction to reduce the worst case bandwidth
  - **Disabling APC for bi-prediction CU**
- $\text{Pred}_{\text{EL}}' = (\text{Pred}_{\text{EL}} + \text{Rec}_{\text{BL}} \times 1) \gg 1$

# Simulation Results

- Anchor: SHM-1.0 IntraBL mode
- Provides 0.2-2.4% BD-rate savings
  - Compared with the original APC in SCE3.1, the average BD-rate increase is around 0.13%
- The encoding time is roughly increased by 4%, and the decoding time is roughly unchanged.
- Thank Canon for cross-verification

	RA-2x	RA-1.5x	RA-SNR	LP-2x	LP-1.5x	LP-SNR	LB-2x	LB-1.5x	LB-SNR	Enc. T	Dec. T
Proposed	-0.2%	-0.3%	-0.3%	-1.4%	-1.4%	-2.4%	-0.4%	-0.2%	-0.4%	104%	100%

# Bandwidth and Complexity Analysis

- Experiments were conducted according to the methodology defined in JCTVC-L0440
- No worst case bandwidth increase

	Average Computations		Average Memory Bandwidth		
	Multipliers	Adders	8b/8b	64b/256b	64b/512b
Proposed	99%	99%	102%	101%	101%

	Worst Case Computations		Worst Case Memory Bandwidth		Memory Usage	
	Multipliers	Adders	MemBW (2D:4x2)	MemBW (2D:8x2)	# of Ref. Frames	Tables Size
Proposed	100%	100%	100%	100%	100%	100%

# Comparison

	Constraint	Avg. Y-BD-rate	Avg. BW	Avg. comp.	LDP BW	LDP comp.	LDP Enc.T
M0220	Uni-pred, no smaller than 8x8, bypass bi,	-0.7%	104%	105%	111%	111%	116%
M0297	Uni-pred, no smaller than 8x8, change to uni-MV	-0.8%	102%	104%	107%	110%	111%
Proposed	Uni-pred, 2Nx2N with residual, bypass bi,	-0.8%	101%	99%	105%	100%	104%

# Conclusions

- In the proposed adaptive predictor compensation (APC), the reconstructed BL samples can be used to refine the EL sample predictors.
  - Only applied to inter 2Nx2N CU with at least one non-zero residue, and is **disabled for bi-prediction CU**
  - $\text{PredEL}' = (\text{PredEL} + \text{RecBL}) \gg 1$
- Simulation results
  - 0.8% average BD-rate savings
  - The encoding time is roughly increased by 4%, and the decoding time is roughly unchanged.
  - The average case bandwidth increase is 3%, and the average computations are roughly unchanged.
  - **No worst case bandwidth and computation increase**

# BD-rates and Runtimes

	RA HEVC 2x			RA HEVC 1.5x			RA HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-0.2%	-1.1%	-1.2%				-0.2%	-0.9%	-1.1%
Class B	-0.2%	-0.8%	-1.0%	-0.3%	-1.1%	-1.3%	-0.3%	-1.5%	-2.0%
<b>Overall (Test vs Ref)</b>	-0.2%	-0.9%	-1.1%	-0.3%	-1.1%	-1.3%	-0.3%	-1.4%	-1.7%
<b>Overall (Test vs single layer)</b>	19.0%	30.7%	31.5%	16.2%	27.0%	29.1%	14.5%	27.0%	30.3%
<b>EL only (Test vs Ref)</b>	-0.3%	-1.1%	-1.2%	-0.4%	-1.3%	-1.6%	-0.4%	-1.5%	-1.9%
Enc Time[%]		105.2%			104.4%			103.8%	
Dec Time[%]		100.0%			99.8%			100.8%	
Enc Mem[%]		#DIV/0!			#DIV/0!			#DIV/0!	
BL Match		Matched			Matched			Matched	

	LD-P HEVC 2x			LD-P HEVC 1.5x			LD-P HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-1.3%	-3.3%	-3.6%				-1.6%	-4.1%	-4.7%
Class B	-1.5%	-2.8%	-3.5%	-1.4%	-4.5%	-5.2%	-2.7%	-7.7%	-9.1%
<b>Overall (Test vs Ref)</b>	-1.4%	-3.0%	-3.5%	-1.4%	-4.5%	-5.2%	-2.4%	-6.7%	-7.9%
<b>Overall (Test vs single layer)</b>	24.3%	32.3%	33.2%	20.8%	26.7%	28.5%	19.5%	24.7%	27.0%
<b>EL only (Test vs Ref)</b>	-1.8%	-3.4%	-4.0%	-1.9%	-5.3%	-6.1%	-3.0%	-7.5%	-8.8%
Enc Time[%]		105.1%			103.5%			103.6%	
Dec Time[%]		100.2%			99.5%			99.7%	
Enc Mem[%]		#DIV/0!			#DIV/0!			#DIV/0!	
BL Match		Matched			Matched			Matched	

## Optional Tests

	LD-B HEVC 2x			LD-B HEVC 1.5x			LD-B HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-0.3%	-1.4%	-1.5%				-0.3%	-1.4%	-1.7%
Class B	-0.4%	-1.1%	-1.3%	-0.2%	-1.6%	-1.7%	-0.4%	-2.0%	-2.4%
<b>Overall (Test vs Ref)</b>	-0.4%	-1.2%	-1.4%	-0.2%	-1.6%	-1.7%	-0.4%	-1.8%	-2.2%
<b>Overall (Test vs single layer)</b>	27.8%	35.6%	36.6%	24.4%	30.8%	32.8%	23.2%	31.0%	34.0%
<b>EL only (Test vs Ref)</b>	-0.5%	-1.4%	-1.6%	-0.5%	-1.9%	-2.1%	-0.6%	-2.1%	-2.5%
Enc Time[%]		105.0%			104.2%			103.7%	
Dec Time[%]		100.0%			99.0%			99.7%	
Enc Mem[%]		#DIV/0!			#DIV/0!			#DIV/0!	
BL Match		Matched			Matched			Matched	

# Average Bandwidths & Computations

	RA HEVC 2x					RA HEVC 1.5x					RA HEVC SNR				
	8b/8b	64b/25 6b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds
	Class A	100%	100%	100%	100%	100%						100%	100%	100%	99%
Class B	100%	100%	100%	99%	100%	100%	100%	100%	99%	100%	100%	100%	100%	99%	99%
Overall	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>99%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>99%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>99%</b>	<b>99%</b>

	LD-P HEVC 2x					LD-P HEVC 1.5x					LD-P HEVC SNR				
	8b/8b	64b/25 6b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds
	Class A	105%	104%	104%	100%	102%						108%	107%	107%	98%
Class B	105%	104%	104%	100%	102%	105%	104%	104%	100%	101%	110%	107%	108%	97%	98%
Overall	<b>105%</b>	<b>104%</b>	<b>104%</b>	<b>100%</b>	<b>102%</b>	<b>105%</b>	<b>104%</b>	<b>104%</b>	<b>100%</b>	<b>101%</b>	<b>110%</b>	<b>107%</b>	<b>108%</b>	<b>97%</b>	<b>99%</b>

	LD-B HEVC 2x					LD-B HEVC 1.5x					LD-B HEVC SNR				
	8b/8b	64b/25 6b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds	8b/8b	64b/2 56b	64b/5 12b	Mults	Adds
	Class A	100%	100%	100%	99%	99%						100%	100%	100%	98%
Class B	100%	99%	99%	99%	99%	100%	99%	99%	99%	99%	99%	99%	99%	97%	97%
Overall	<b>100%</b>	<b>99%</b>	<b>99%</b>	<b>99%</b>	<b>99%</b>	<b>100%</b>	<b>99%</b>	<b>99%</b>	<b>99%</b>	<b>99%</b>	<b>100%</b>	<b>99%</b>	<b>99%</b>	<b>97%</b>	<b>98%</b>