



# Reducing Line Buffers for Motion Data and CABAC

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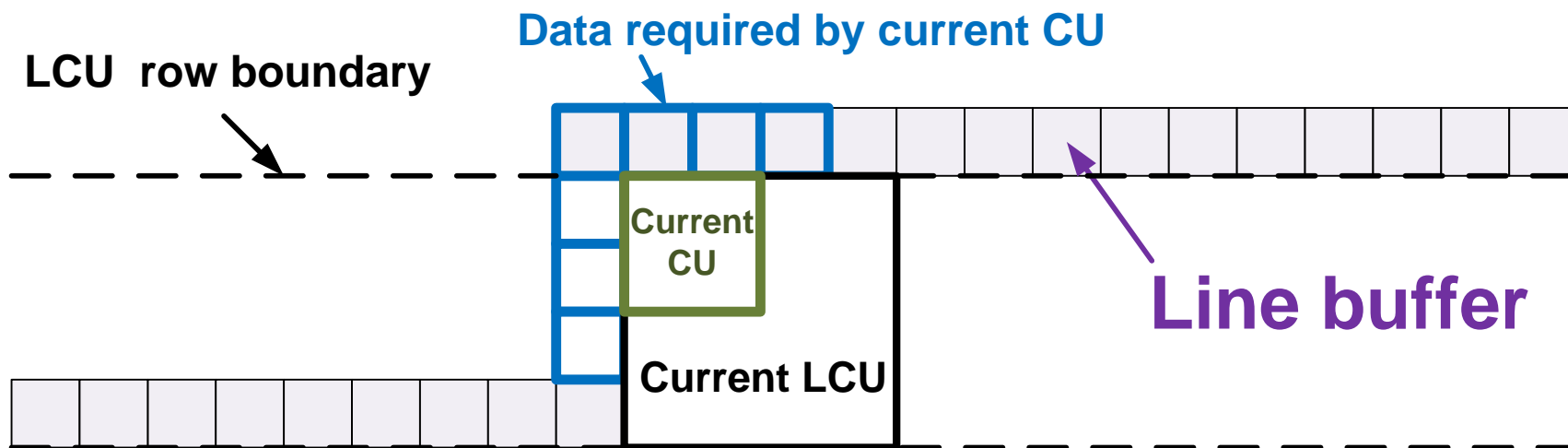


# Overall Summary

- A motion data compression method to reduce line buffer
  - Select the motion data of one 4x4 block to represent the motion data of N 4x4 blocks in the line buffer (N:1 compression)
  - Similar to temporal MV compression but used for reducing the storage size of motion data line buffer
  - Reduce 50% of motion data storage without bit rate increase
- A modified CABAC context formation to reduce line buffer
  - The left block data is used to replace the upper block data if the upper block belongs to the upper LCU
  - No need to store the data of upper blocks for context formation
  - Reduce 94% of CABAC line buffer without bit rate increase
- Combining the above two methods provides 56% of line buffer reduction without bit rate increase

# Line Buffer for Motion Data and CABAC

- Deriving MVP candidates, merge candidates, and CABAC context formation needs the data of upper blocks
  - Need to store these data in line buffer for coding of next LCU row



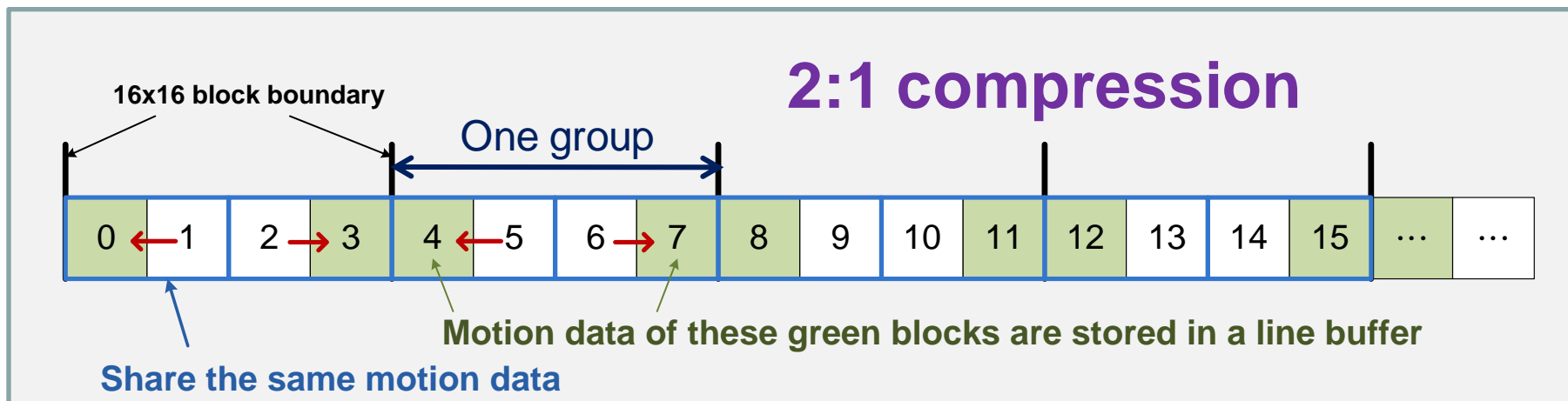
# Line Buffer Size for Motion Data and CABAC

- For 4kx2k video: 10.7K bytes
  - Motion data : 7.7K bytes
  - CABAC only data : 2.2K byte

Data	Usage	CABAC only	Required Bits
<b>inter prediction direction</b>	MVP candidates, merge candidates		32
	CABAC interDir coding		
	CABAC total MVP/merge candidates		
<b>reference picture index</b>	MVP candidates, merge candidates		96
	CABAC refIdx coding		
	CABAC total MVP/merge candidates		
<b>MV</b>	MVP candidates, merge candidates		896
	CABAC total MVP/merge candidates		
<b>depth</b>	CABAC split flag coding	O	16
<b>skip flag</b>	CABAC skip flag coding	O	8
<b>merge flag</b>	CABAC merge flag coding	O	16
<b>luma intra mode</b>	CABAC luma intra mode coding		96
<b>chroma intra mode</b>	CABAC chroma intra mode coding	O	48
<b> MVD &gt;16 ?</b>	CABAC MVD coding	O	32
<b>cbf</b>	CABAC cbf, no residual data flag coding	O	96
<b>trafoDepth</b>	CABAC cbf coding	O	64
<b>Total bits in a 64x64 LCU</b>			<b>1336</b>

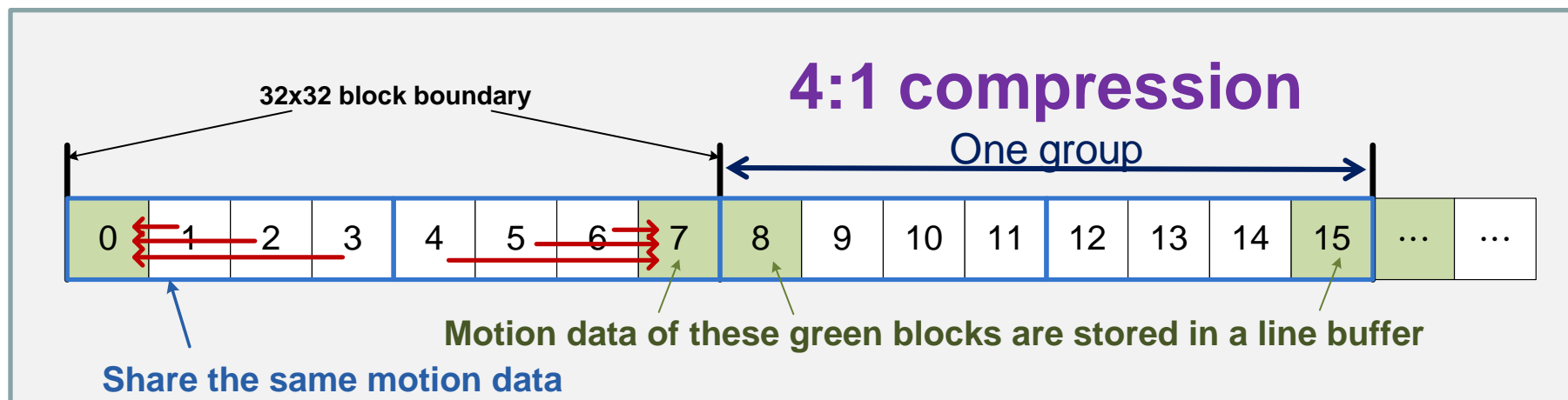
## 2:1 Motion Data Compression

- Divided into several groups. Each group contains four 4x4 blocks.
- The motion data of the first and the last block represents the motion data of the first two and the last two blocks
- Only 50% of memory is required (7.7K bytes to 3.8K bytes)



# 4:1 Motion Data Compression

- Divided into several groups. Each group contains eight 4x4 blocks.
- The motion data of the first and the last block represents the motion data of the first four and the last four blocks
- Only 25% of memory is required (7.7K bytes to 1.9K bytes)



# Result- 2:1 Motion Data Compression

- No bit rate increase, motion data line buffer is reduced by 50%

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.1	0.1	0.0	0.0	0.3
Class B	0.0	-0.1	0.1	0.0	0.0	0.0
Class C	0.0	0.0	0.0	0.0	-0.1	-0.1
Class D	0.0	0.0	-0.2	0.0	0.1	-0.1
Class E						
<b>Overall</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
Enc Time[%]	100%			100%		
Dec Time[%]	98%			99%		

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0	0.2	0.2	0.0	0.0	0.0
Class C	0.0	0.0	-0.2	0.0	0.1	-0.2
Class D	0.0	0.0	0.3	0.0	-0.3	-0.3
Class E	0.0	0.0	-0.3	0.0	0.0	-0.1
<b>Overall</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.1</b>
Enc Time[%]	100%			101%		
Dec Time[%]	100%			101%		

# Result- 4:1 Motion Data Compression

- 0.1% bit rate increase, motion data line buffer is reduced by 75%

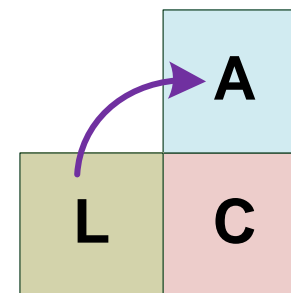
	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.2	-0.1	0.1	0.2	0.3
Class B	0.0	0.0	0.1	0.0	0.1	0.1
Class C	0.1	0.2	0.2	0.1	0.1	0.2
Class D	0.1	0.1	0.2	0.1	0.3	0.1
Class E						
<b>Overall</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.2</b>
Enc Time[%]	100%			100%		
Dec Time[%]	101%			100%		

	Low delay B HE			Low delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0	0.2	0.1	0.0	0.0	-0.2
Class C	0.1	0.1	0.0	0.1	0.0	0.0
Class D	0.1	0.3	0.3	0.1	-0.1	-0.1
Class E	0.1	-0.3	-0.3	0.1	0.3	0.1
<b>Overall</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.0</b>	<b>-0.1</b>
Enc Time[%]	100%			101%		
Dec Time[%]	100%			100%		



# Modified CABAC Context Formation

- The data of the left block is used to replace the data of the upper block if the upper block belongs to the upper LCU row
  - For all the syntax elements in this table except split\_coding\_unit\_flag
  - Reduce 94% of CABAC line buffer



Data	Syntax Elements	Use Upper Blk info.	Required	Saved
<b>depth</b>	split coding unit flag	O	16	
<b>skip flag</b>	Skip_flag	X		8
<b>merge flag</b>	merge_flag	X		16
<b>chroma intra mode</b>	intra_chroma_pred_flag	X		48
<b> MVD &gt;16 ?</b>	mvd_lx	X		32
<b>cbf</b>	cbf, no_residual_data_flag	X		96
<b>trafoDepth</b>	cbf	X		64
<b>Total bits in a LCU</b>			<b>16</b>	<b>264</b>

# Result- Modified CABAC Context Formation

- No bit rate increase, CABAC line buffer is reduced by 94%

	All Intra HE			Random Access HE			Low delay B HE		
	Y	U	V	Y	U	V	Y	U	V
Class A	0.0	-0.2	-0.1	-0.1	0.1	0.0			
Class B	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.2	0.1
Class C	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Class D	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.1	0.0
Class E	0.0	-0.2	0.0				0.0	0.6	0.0
<b>Overall</b>	<b>0.0</b>	<b>-0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.2</b>	<b>0.1</b>
Enc Time[%]	100%			100%			100%		
Dec Time[%]	100%			99%			100%		

# Result- 2:1 Motion Data Compression with Modified CABAC Context Formation

- No bit rate increase, line buffer is reduced by 56%

	Random Access HE			Low delay B HE		
	Y	U	V	Y	U	V
Class A	-0.1	-0.1	0.0			
Class B	0.0	0.1	0.0	0.1	0.4	0.1
Class C	0.0	0.1	0.1	0.0	0.1	-0.2
Class D	0.0	-0.2	0.0	0.0	0.2	0.4
Class E				0.1	0.9	0.2
<b>Overall</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.4</b>	<b>0.1</b>
Enc Time[%]	100%			100%		
Dec Time[%]	100%			99%		

# Result- 4:1 Motion Data Compression with Modified CABAC Context Formation

- 0.1% bit rate increase, line buffer is reduced by 74%

	Random Access HE			Low delay B HE		
	Y	U	V	Y	U	V
Class A	0.0	0.1	0.0			
Class B	0.1	0.2	0.1	0.1	0.2	0.1
Class C	0.2	0.2	0.2	0.1	0.3	0.1
Class D	0.2	-0.1	0.1	0.1	0.0	0.8
Class E				0.2	1.2	0.0
<b>Overall</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.1</b>	<b>0.4</b>	<b>0.2</b>
Enc Time[%]	100%			101%		
Dec Time[%]	100%			101%		

# Cross Verification

- We thank TI and HHI for crosschecking our proposal
  - JCTVC-F670 and JCTVC-Fxxx
- BD-rates and run times are confirmed

# Conclusions

- Proposed a motion data compression method
  - Similar to temporal MV compression, but used for reducing the storage size of motion data line buffer
  - Bit rate increase for 2:1/4:1 motion data compression is 0.0%/0.1%
  - Suggest to adopt 2:1 motion data compression
- Proposed a modified CABAC context formation
  - The data of the left block is used to replace the data of the upper block if the upper block belongs to the upper LCU
  - Reduce 94% of CABAC line buffer without bit rate increase
- These two tools can be considered separately
- 2:1 motion data compression with modified CABAC context formation can reduce 56% (6K bytes) of line buffer size without bit rate increase