

REDEFINING MOBILITY



**AHG18: Limiting the worst-case length for
coeff_abs_level_remaining syntax element to 32 bits**

JCTVC-Q0131

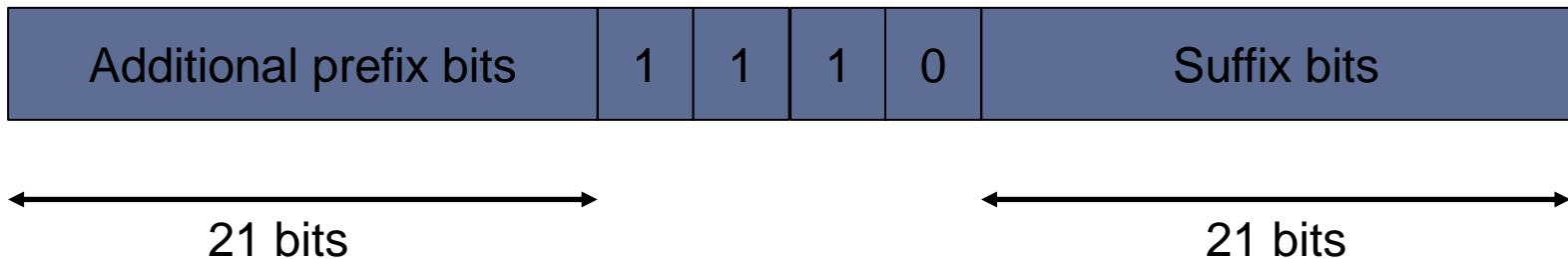
Marta Karczewicz and Rajan Joshi

Introduction

- In HEVC Range Extensions specification, length of the `coeff_abs_level_remaining` syntax element may be greater than 32 bits
 - Considered undesirable for software and hardware implementations
- In HEVC version 1, the transition between Golomb Rice and exponential Golomb was chosen to restrict the length to 32 bits in the worst case
- Proposal
 - Make the binarization dependent on *MAX_TR_DYNAMIC_RANGE*
 - Expand the suffix bits for the last interval to handle all conforming values

Worst case for the current binarization

- `extended_precision_flag` is 1
 - `MAX_TR_DYNAMIC_RANGE` = $\max(15, \text{bit-depth}+6)$
- Input bit-depth = 16
 - `Coeff_abs_level_remaining` is in the range $[0, 2^{22}-1]$
 - Takes into account that significance flag is sent separately.
- `cRiceParam` = 0



Proposed binarization

- Maximum prefix length
 - $32 - MAX_TR_DYNAMIC_RANGE$
- Truncated unary representation for the suffix
- Maximum suffix length
 - $MAX_TR_DYNAMIC_RANGE$
 - Corresponding to all-ones prefix codeword

Binarization for cRiceParam = 0, bit-depth = 16

Input Value	Codeword prefix	Codeword suffix	Prefix code length	Suffix code length	Total codeword length
0	0		1	0	1
1	10		2	0	2
2	110		3	0	3
3	1110		4	0	4
[4, 5]	11110	x	5	1	6
[6, 9]	111110	xx	6	2	8
[10, 17]	1111110	xxx	7	3	10
[18, 33]	11111110	xxxx	8	4	12
[34, 65]	111111110	xxxxx	9	5	14
[66, 129]	1111111110	xxxxxx	10	6	16
[130, 4194433]	1111111111	xxx ... 22 times	10	22	32

Binarization for cRiceParam = 2, bit-depth = 16

Input Value	Codeword prefix	Codeword suffix	Prefix code length	Suffix code length	Total codeword length
[0, 3]	0	xx	1	2	3
[4, 7]	10	xx	2	2	4
[8, 11]	110	xx	3	2	5
[12, 15]	1110	xx	4	2	6
[16, 23]	11110	xxx	5	3	8
[24, 39]	111110	xxxx	6	4	10
[40, 71]	1111110	xxxxx	7	5	12
[72, 135]	11111110	xxxxxx	8	6	14
[136, 263]	111111110	xxxxxxx	9	7	16
[264, 519]	1111111110	xxxxxxxx	10	8	18
[520, 4194823]	1111111111	xxx ... 22 times	10	22	32

AHG18 Results (Lossy – All Intra)

			Average BD-rate Change (%) - All Tiers					
			Intra 16-bit (internal bit depth)			Intra 12-bit (internal bit depth)		
			Y/G	Cb/B	Cr/R	Y/G	Cb/B	Cr/R
SVT			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RExt RGB			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HDR			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4K from HDR			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HDR 4:0:0 Medical			0.0%			0.0%		
4:0:0 Medical			0.0%			0.0%		
Synthetic RGB HDR (+2 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+4 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+6 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Classes			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Encoding Time %			93%			93%		
Decoding Time %			99%			102%		

AHG18 Results (Lossy – Low Delay)

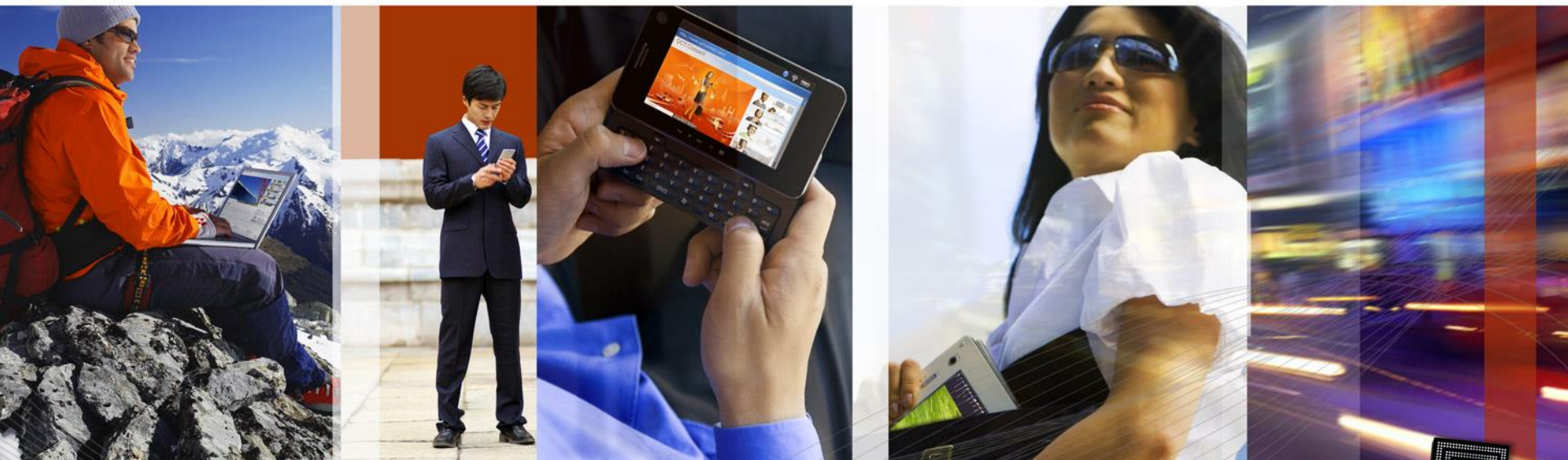
			Average BD-rate Change (%) - All Tiers					
			Lowdelay 16-bit (internal bit depth)			Lowdelay 12-bit (internal bit depth)		
			Y/G	Cb/B	Cr/R	Y/G	Cb/B	Cr/R
SVT			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RExt RGB			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
HDR			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4K from HDR								
HDR 4:0:0 Medical			0.0%			0.0%		
4:0:0 Medical			0.0%			0.0%		
Synthetic RGB HDR (+2 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+4 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+6 MSBs)			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
All Classes			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Encoding Time %			92%			92%		
Decoding Time %			98%			97%		

AHG18 Results (Lossless)

			Average Bit Rate Change (%)			
			Intra 16-bit (internal bit depth)	Intra 12-bit (internal bit depth)	Lowdelay 16-bit (internal bit depth)	Lowdelay 12-bit (internal bit depth)
SVT			0.0%	0.0%	0.0%	0.0%
RExt RGB			0.0%	0.0%	0.0%	0.0%
HDR			0.0%	0.0%	0.0%	0.0%
4K from HDR			0.0%	0.0%		
HDR 4:0:0 Medical			0.0%	0.0%	0.0%	0.0%
4:0:0 Medical			0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+2 MSBs)			0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+4 MSBs)			0.0%	0.0%	0.0%	0.0%
Synthetic RGB HDR (+6 MSBs)			0.0%	0.0%	0.0%	0.0%
All Classes			0.0%	0.0%	0.0%	0.0%
Encoding Time %			97%	99%	96%	95%
Decoding Time %			90%	90%	90%	90%

Conclusions

- A method to restrict the worst-case length of `coff_abs_level_remaining` syntax element is proposed
- Binarization dependent on $MAX_TR_DYNAMIC_RANGE$
 - Maximum suffix bits = $MAX_TR_DYNAMIC_RANGE$
 - Maximum prefix bits = $32 - MAX_TR_DYNAMIC_RANGE$
- Truncated unary representation for prefix
 - Suffix has maximum length when prefix codeword is all ones
- Less than 0.02% difference in BD-rate performance



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