



**MEDIATEK**

**JVET-Q0187**

# **CE3-related: Rice parameter derivation in residual coding**

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# Overall Summary

- Unified Rice parameter derivation and coding efficiency improvement for lossless coding
- Method 1.1: Reuse RRC's rice parameter table for TSRC
  - $\text{rice\_rrc} = \text{RRC\_rice\_table}[\text{Clip3}(0, 31, \text{absSum} - 5 * \text{baseLevel})]$  (same as VTM7.0)  
 $\text{rice\_tsrc} = \text{RRC\_rice\_table}[\text{Clip3}(0, 31, \text{absSum} - 2 * \text{baseLevel} + 5)]$
- Method 2.1: Remove rice parameter table in RRC and RSRC
  - $\text{rice\_rrc} = \text{Clip3}(0, 39, \text{absSum} - 5 * \text{baseLevel}) \gg 3$   
 $\text{rice\_tsrc} = \text{Clip3}(0, 39, \text{absSum} - 2 * \text{baseLevel} + 5) \gg 3$
- Method 1.2/2.2 is Method 1.1/2.1 with normalized absSum (CE3-1.1.3) in TSRC

Luma BD-rates (%)		Standard QP			Low QP			Lossless		
		AI	RA	LB	AI	RA	LB	AI	RA	LB
Method 1.1	CTC	-0.01	0.00	-0.02	-0.07	-0.02	-0.02	-4.90	-3.69	-2.39
	TGM	-0.37	-0.18	-0.27	-1.09	-1.82	-0.94	-3.80	-6.00	-6.00
Method 1.2	CTC	-0.01	-0.01	-0.04	-0.07	-0.02	-0.02	-5.15	-3.92	-2.35
	TGM	-0.35	-0.21	-0.29	-1.33	-1.97	-1.14	-4.20	-6.26	-6.33
Method 2.1	CTC	0.01	0.00	0.01	-0.01	-0.06	-0.06	-4.89	-3.32	-2.49
	TGM	-0.37	-0.16	-0.28	-1.45	-2.14	-1.18	-4.69	-6.63	-6.75
Method 2.2	CTC	0.01	-0.01	0.01	-0.02		-0.06	-5.19	-3.58	-2.55
	TGM	-0.38	-0.10	-0.11	-1.69	-2.33	-1.27	-5.08	-6.89	-6.94

# Introduction

- In VTM7.0, lossless coding is achieved by forcing encoder to use transform skip mode, so transform skip residual coding (TSRC) is always used
- In VTM7.0, the rice parameter of TSRC is always set to 1
- Using rice parameter equal to 1 is not efficient in lossless coding, since the coefficient levels in lossless coding tend to be larger
- A look-up table is used for the rice parameter derivation in regular residual coding (RRC)
- Simple and unified rice parameter derivation is preferred

# Proposed Method 1.1

- Method 1.1 and Method 1.2 reuse RRC's rice parameter table in TSRC
  - Consider both the sum of the absolute coefficients in the local template and the current base level
  - A fixed offset is applied (offset = 5) for TSRC
- Method 1.1
  - $\text{rice\_rrc} = \text{RRC\_rice\_table}[\text{Clip3}(0, 31, \text{absSum} - 5 * \text{baseLevel})]$   
(same as VTM7.0)
  - $\text{rice\_tsrc} = \text{RRC\_rice\_table}[\text{Clip3}(0, 31, \text{absSum} - 2 * \text{baseLevel} + 5)]$

# Proposed Method 1.2

- Based on Method 1.1, Method 1.2 applies normalization to `absSum` (same as the normalization in CE3-1.1.3) **in TSRC**
  - For TSRC, further consider the number of neighbouring in-the-same-TB coefficients in the local template
  - `absSum = (numAvail == 1)? 2* absSum: absSum`
  - `rice_tsrc = RRC_rice_table[ Clip3(0, 31, absSum – 2*baseLevel + 5)]`

# Proposed Method 2.1

- Method 2.1 and Method 2.2 remove rice parameter table in RRC and TSRC by simple right shift by 3 bits
  - Consider both the sum of the absolute coefficients in the local template and the current base level
  - A fixed offset is applied (offset = 5) for TSRC
  - The maximum rice parameter is equal to 4
- Method 2.1
  - $\text{rice\_rrc} = \text{Clip3}(0, 39, \text{absSum} - 5 * \text{baseLevel}) \gg 3$   
 $\text{rice\_tsrc} = \text{Clip3}(0, 39, \text{absSum} - 2 * \text{baseLevel} + 5) \gg 3$

# Proposed Method 2.2

- Based on Method 2.1, Method 2.2 applies normalization to `absSum` (same as the normalization in CE3-1.1.3) **in TSRC**
  - For TSRC, further consider the number of neighbouring in-the-same-TB coefficients in the local template
  - `absSum = (numAvail == 1)? 2* absSum: absSum`
  - `rice_tsrc = Clip3(0, 39, absSum - 2*baseLevel + 5 ) >> 3`

# Result of the Proposed Methods

- Improve the coding efficiency by 2% to 5% for both TGM and non-TGM sequences in lossless condition
- Also improve the coding efficiency for TGM sequences in CTC QP and low QP
- The rice parameter derivation simplification (Method-2.x) shows almost no loss

Luma BD-rates (%)		Standard QP			Low QP			Lossless		
		AI	RA	LB	AI	RA	LB	AI	RA	LB
Method 1.1	CTC	-0.01	0.00	-0.02	-0.07	-0.02	-0.02	-4.90	-3.69	-2.39
	TGM	-0.37	-0.18	-0.27	-1.09	-1.82	-0.94	-3.80	-6.00	-6.00
Method 1.2	CTC	-0.01	-0.01	-0.04	-0.07	-0.02	-0.02	-5.15	-3.92	-2.35
	TGM	-0.35	-0.21	-0.29	-1.33	-1.97	-1.14	-4.20	-6.26	-6.33
Method 2.1	CTC	0.01	0.00	0.01	-0.01	-0.06	-0.06	-4.89	-3.32	-2.49
	TGM	-0.37	-0.16	-0.28	-1.45	-2.14	-1.18	-4.69	-6.63	-6.75
Method 2.2	CTC	0.01	-0.01	0.01	-0.02		-0.06	-5.19	-3.58	-2.55
	TGM	-0.38	-0.10	-0.11	-1.69	-2.33	-1.27	-5.08	-6.89	-6.94



# Conclusion

- Unified Rice parameter derivation and coding efficiency improvement for lossless coding
- Method 1.1 and Method 1.2 reuse the RRC's rice parameter table in TSRC
- Method 2.1 and Method 2.2 remove rice parameter table in RRC and TSRC
  - Simple and efficient
- Thank LGE for cross-checking!

The background is a solid green color with a repeating pattern of white line-art icons. These icons include various nautical items like anchors, lifebuoys, and seashells, as well as outdoor and travel-related items like a compass, a map, a tent, and a bird in flight. There are also symbols for technology like a smartphone and a Wi-Fi signal.

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**Thank you!**

# Results - Method 1.1

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7	Test		VTM7	Test		VTM7	Test	
Class A1	2.2	2.3	-4.63%	2.2	2.4	-4.71%			
Class A2	1.6	1.7	-8.12%	1.7	1.8	-6.71%			
Class B	2.2	2.3	-3.85%	2.3	2.4	-2.30%	2.3	2.4	-2.33%
Class C	1.9	2.0	-4.76%	2.4	2.5	-2.40%	2.4	2.5	-2.31%
Class D	1.9	2.0	-5.26%	2.8	2.8	-2.53%	2.7	2.8	-2.41%
Class E	2.8	2.9	-3.90%				3.1	3.2	-2.60%
Class F	5.3	5.5	-3.74%	33.7	34.8	-2.70%	50.7	51.9	-2.43%
TGM	11.8	12.3	-3.80%	107.1	115.8	-6.00%	124.9	135.7	-6.00%
<b>Overall with Classes D, F, TGM excluded</b>	<b>2.1</b>	<b>2.2</b>	<b>-4.90%</b>	<b>2.2</b>	<b>2.3</b>	<b>-3.69%</b>	<b>2.6</b>	<b>2.6</b>	<b>-2.39%</b>
Enc Time[%]	100%			102%			101%		
Dec Time[%]	100%			101%			104%		

# Results - Method 1.1

CTC - standard QP

All Intra					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	-0.01%	-0.01%	0.03%	99%	97%
Class A2	0.00%	-0.02%	-0.02%	101%	101%
Class B	0.00%	0.06%	-0.07%	101%	100%
Class C	-0.04%	0.02%	0.03%	99%	98%
Class E	0.00%	-0.02%	-0.07%	100%	99%
<b>Overall</b>	<b>-0.01%</b>	<b>0.01%</b>	<b>-0.02%</b>	<b>100%</b>	<b>99%</b>
Class D	-0.05%	-0.10%	-0.02%	100%	96%
Class F	-0.13%	-0.13%	0.11%	101%	100%
<b>TGM</b>	<b>-0.37%</b>	<b>-0.31%</b>	<b>-0.33%</b>	<b>100%</b>	<b>101%</b>

Random access					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.01%	-0.03%	0.03%	100%	99%
Class A2	-0.03%	-0.05%	0.04%	100%	103%
Class B	0.01%	0.09%	0.11%	100%	103%
Class C	-0.01%	-0.07%	-0.04%	100%	102%
<b>Overall</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.04%</b>	<b>100%</b>	<b>102%</b>
Class D	-0.06%	-0.23%	-0.12%	100%	102%
Class F	-0.15%	-0.13%	-0.07%	100%	103%
<b>TGM</b>	<b>-0.18%</b>	<b>-0.20%</b>	<b>-0.17%</b>	<b>100%</b>	<b>106%</b>

Low delay B					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class B	-0.03%	-0.40%	0.03%	100%	99%
Class C	-0.01%	-0.18%	-0.23%	100%	100%
Class E	-0.04%	0.28%	-0.46%	100%	99%
<b>Overall</b>	<b>-0.02%</b>	<b>-0.16%</b>	<b>-0.18%</b>	<b>100%</b>	<b>100%</b>
Class D	-0.08%	0.24%	-0.06%	100%	100%
Class F	-0.03%	-0.54%	0.29%	100%	99%
<b>TGM</b>	<b>-0.27%</b>	<b>-0.36%</b>	<b>-0.28%</b>	<b>100%</b>	<b>98%</b>

CTC - low QP

All Intra					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	-0.04%	-0.02%	-0.03%	100%	100%
Class A2	0.00%	-0.02%	-0.02%	101%	99%
Class B	-0.03%	-0.05%	-0.08%	100%	100%
Class C	-0.12%	-0.12%	-0.10%	97%	98%
Class E	-0.14%	-0.22%	-0.27%	98%	101%
<b>Overall</b>	<b>-0.07%</b>	<b>-0.08%</b>	<b>-0.10%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.14%	-0.18%	-0.14%	100%	102%
Class F	-1.25%	-0.72%	-0.70%	99%	100%
<b>TGM</b>	<b>-1.09%</b>	<b>-1.00%</b>	<b>-1.00%</b>	<b>101%</b>	<b>100%</b>

Random access					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.01%	-0.01%	100%	100%
Class A2	0.00%	-0.01%	-0.01%	100%	100%
Class B	-0.01%	-0.03%	-0.05%	100%	99%
Class C	-0.05%	-0.04%	-0.03%	100%	105%
<b>Overall</b>	<b>-0.02%</b>	<b>-0.02%</b>	<b>-0.03%</b>	<b>100%</b>	<b>101%</b>
Class D	-0.09%	-0.08%	-0.18%	100%	103%
Class F	-1.57%	-0.68%	-0.78%	100%	102%
<b>TGM</b>	<b>-1.82%</b>	<b>-1.09%</b>	<b>-1.09%</b>	<b>100%</b>	<b>103%</b>

Low delay B					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class B	0.00%	0.00%	-0.01%	100%	103%
Class C	-0.02%	0.01%	-0.01%	99%	99%
Class E	-0.04%	0.02%	0.01%	100%	100%
<b>Overall</b>	<b>-0.02%</b>	<b>0.01%</b>	<b>0.00%</b>	<b>100%</b>	<b>101%</b>
Class D	-0.07%	-0.06%	-0.14%	100%	101%
Class F	-0.53%	-0.54%	-0.61%	100%	100%
<b>TGM</b>	<b>-0.94%</b>	<b>-0.74%</b>	<b>-0.77%</b>	<b>100%</b>	<b>100%</b>

# Results - Method 1.2

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7	Test		VTM7	Test		VTM7	Test	
Class A1	2.2	2.4	-5.04%	2.2	2.4	-5.09%			
Class A2	1.6	1.7	-9.03%	1.7	1.8	-7.44%			
Class B	2.2	2.3	-3.97%	2.3	2.4	-2.37%	2.3	2.4	-2.40%
Class C	1.9	2.0	-4.87%	2.4	2.5	-2.35%	2.4	2.5	-2.25%
Class D	1.9	2.0	-5.41%	2.8	2.8	-2.49%	2.7	2.8	-2.36%
Class E	2.8	2.9	-3.73%				3.1	3.2	-2.41%
Class F	5.3	5.5	-3.75%	33.7	34.8	-2.69%	50.7	52.0	-2.39%
TGM	11.8	12.4	-4.20%	107.1	116.1	-6.26%	124.9	136.2	-6.33%
<b>Overall with Classes D, F, TGM excluded</b>	<b>2.1</b>	<b>2.2</b>	<b>-5.15%</b>	<b>2.2</b>	<b>2.3</b>	<b>-3.92%</b>	<b>2.6</b>	<b>2.6</b>	<b>-2.35%</b>
Enc Time[%]	102%			104%			101%		
Dec Time[%]	99%			102%			104%		

# Results - Method 1.2

CTC - standard QP

All Intra					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	-0.01%	-0.02%	0.03%	100%	97%
Class A2	0.00%	-0.04%	-0.02%	101%	100%
Class B	0.00%	0.05%	-0.07%	100%	99%
Class C	-0.03%	0.05%	0.01%	100%	99%
Class E	0.00%	-0.04%	-0.08%	101%	101%
<b>Overall</b>	<b>-0.01%</b>	<b>0.01%</b>	<b>-0.03%</b>	<b>100%</b>	<b>99%</b>
Class D	-0.04%	-0.05%	-0.08%	100%	97%
Class F	-0.15%	-0.15%	0.06%	100%	100%
<b>TGM</b>	<b>-0.35%</b>	<b>-0.28%</b>	<b>-0.32%</b>	<b>100%</b>	<b>102%</b>

Random access					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.03%	0.01%	100%	101%
Class A2	-0.04%	-0.07%	0.02%	100%	104%
Class B	0.02%	0.01%	0.09%	100%	101%
Class C	-0.01%	-0.07%	-0.02%	100%	100%
<b>Overall</b>	<b>-0.01%</b>	<b>-0.04%</b>	<b>0.03%</b>	<b>100%</b>	<b>101%</b>
Class D	-0.05%	-0.30%	-0.04%	100%	100%
Class F	-0.13%	-0.10%	-0.06%	100%	101%
<b>TGM</b>	<b>-0.21%</b>	<b>-0.25%</b>	<b>-0.20%</b>	<b>101%</b>	<b>101%</b>

Low delay B					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class B	-0.01%	-0.42%	-0.02%	101%	102%
Class C	-0.02%	-0.07%	-0.12%	100%	101%
Class E	-0.13%	0.23%	-0.51%	100%	98%
<b>Overall</b>	<b>-0.04%</b>	<b>-0.14%</b>	<b>-0.17%</b>	<b>100%</b>	<b>101%</b>
Class D	-0.01%	0.18%	0.03%	100%	99%
Class F	-0.15%	-0.47%	0.38%	100%	99%
<b>TGM</b>	<b>-0.29%</b>	<b>-0.35%</b>	<b>-0.42%</b>	<b>100%</b>	<b>98%</b>

CTC - low QP

All Intra					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	-0.03%	-0.02%	-0.03%	101%	101%
Class A2	0.00%	-0.02%	-0.02%	101%	100%
Class B	-0.03%	-0.04%	-0.05%	100%	101%
Class C	-0.13%	-0.13%	-0.12%	97%	95%
Class E	-0.13%	-0.22%	-0.25%	98%	101%
<b>Overall</b>	<b>-0.07%</b>	<b>-0.08%</b>	<b>-0.09%</b>	<b>99%</b>	<b>99%</b>
Class D	-0.17%	-0.18%	-0.15%	100%	101%
Class F	-1.32%	-0.80%	-0.74%	99%	103%
<b>TGM</b>	<b>-1.33%</b>	<b>-1.24%</b>	<b>-1.24%</b>	<b>101%</b>	<b>100%</b>

Random access					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	-0.03%	-0.02%	-0.04%	100%	101%
Class A2	0.00%	-0.01%	0.00%	100%	98%
Class B	-0.01%	-0.03%	-0.04%	100%	101%
Class C	-0.05%	-0.03%	-0.02%	100%	103%
<b>Overall</b>	<b>-0.02%</b>	<b>-0.02%</b>	<b>-0.03%</b>	<b>100%</b>	<b>101%</b>
Class D	-0.10%	-0.02%	-0.13%	100%	101%
Class F	-1.56%	-0.60%	-0.66%	100%	101%
<b>TGM</b>	<b>-1.97%</b>	<b>-1.29%</b>	<b>-1.28%</b>	<b>100%</b>	<b>102%</b>

Low delay B					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class B	0.00%	-0.01%	0.00%	100%	103%
Class C	-0.03%	-0.01%	-0.02%	100%	100%
Class E	-0.03%	-0.04%	0.03%	101%	105%
<b>Overall</b>	<b>-0.02%</b>	<b>-0.02%</b>	<b>0.00%</b>	<b>100%</b>	<b>103%</b>
Class D	-0.10%	-0.01%	-0.09%	100%	100%
Class F	-0.59%	-0.55%	-0.67%	101%	103%
<b>TGM</b>	<b>-1.14%</b>	<b>-0.90%</b>	<b>-0.84%</b>	<b>101%</b>	<b>101%</b>

# Results - Method 2.1

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7	Test		VTM7	Test		VTM7	Test	
Class A1	2.2	2.3	-4.16%	2.2	2.3	-4.09%			
Class A2	1.6	1.7	-8.00%	1.7	1.8	-5.86%			
Class B	2.2	2.3	-3.75%	2.3	2.4	-1.92%	2.3	2.4	-1.93%
Class C	1.9	2.0	-4.84%	2.4	2.5	-2.60%	2.4	2.5	-2.48%
Class D	1.9	2.0	-5.45%	2.8	2.8	-2.74%	2.7	2.8	-2.61%
Class E	2.8	2.9	-4.50%				3.1	3.2	-3.43%
Class F	5.3	5.5	-4.13%	33.7	34.9	-3.14%	50.7	52.3	-2.91%
TGM	11.8	12.4	-4.69%	107.1	116.7	-6.63%	124.9	137.1	-6.75%
<b>Overall with Classes D, F, TGM excluded</b>	<b>2.1</b>	<b>2.2</b>	<b>-4.89%</b>	<b>2.2</b>	<b>2.3</b>	<b>-3.32%</b>	<b>2.6</b>	<b>2.6</b>	<b>-2.49%</b>
Enc Time[%]	99%			100%			100%		
Dec Time[%]	101%			103%			105%		

# Results - Method 2.1

CTC - standard QP

	All Intra				
	Over VTM-7.0				
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.11%	0.11%	99%	101%
Class A2	0.02%	-0.04%	-0.01%	100%	100%
Class B	0.02%	0.02%	-0.05%	99%	99%
Class C	-0.01%	-0.02%	-0.04%	101%	99%
Class E	0.01%	-0.05%	0.02%	101%	99%
<b>Overall</b>	<b>0.01%</b>	<b>-0.03%</b>	<b>0.00%</b>	<b>100%</b>	<b>99%</b>
Class D	-0.01%	0.02%	-0.03%	101%	96%
Class F	-0.14%	-0.17%	-0.09%	99%	100%
<b>TGM</b>	<b>-0.37%</b>	<b>-0.30%</b>	<b>-0.33%</b>	<b>101%</b>	<b>102%</b>

	Random access				
	Over VTM-7.0				
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.09%	0.05%	100%	100%
Class A2	-0.02%	0.14%	0.06%	100%	106%
Class B	0.00%	0.06%	0.10%	100%	100%
Class C	-0.01%	-0.01%	-0.01%	100%	101%
<b>Overall</b>	<b>0.00%</b>	<b>0.03%</b>	<b>0.05%</b>	<b>100%</b>	<b>102%</b>
Class D	0.02%	-0.01%	0.03%	99%	102%
Class F	-0.11%	-0.04%	-0.03%	99%	106%
<b>TGM</b>	<b>-0.16%</b>	<b>-0.19%</b>	<b>-0.09%</b>	<b>100%</b>	<b>101%</b>

	Low delay B				
	Over VTM-7.0				
	Y	U	V	EncT	DecT
Class B	-0.01%	-0.23%	0.23%	99%	100%
Class C	0.02%	-0.41%	-0.02%	99%	99%
Class E	0.03%	0.88%	-0.20%	99%	101%
<b>Overall</b>	<b>0.01%</b>	<b>-0.01%</b>	<b>0.04%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.01%	0.11%	-0.39%	100%	103%
Class F	-0.10%	-0.40%	0.66%	99%	100%
<b>TGM</b>	<b>-0.28%</b>	<b>-0.35%</b>	<b>-0.29%</b>	<b>100%</b>	<b>98%</b>

CTC - low QP

	All Intra				
	Over VTM-7.0-lowQP				
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.02%	-0.02%	99%	100%
Class A2	0.03%	-0.01%	-0.02%	100%	99%
Class B	0.00%	-0.02%	-0.06%	99%	100%
Class C	0.08%	0.06%	0.03%	97%	95%
Class E	-0.21%	-0.38%	-0.48%	97%	100%
<b>Overall</b>	<b>-0.01%</b>	<b>-0.06%</b>	<b>-0.10%</b>	<b>99%</b>	<b>99%</b>
Class D	-0.05%	-0.09%	-0.07%	100%	101%
Class F	-1.40%	-0.81%	-0.79%	98%	100%
<b>TGM</b>	<b>-1.46%</b>	<b>-1.28%</b>	<b>-1.28%</b>	<b>100%</b>	<b>99%</b>

	Random access				
	Over VTM-7.0-lowQP				
	Y	U	V	EncT	DecT
Class A1	-0.07%	-0.09%	-0.11%	99%	99%
Class A2	-0.09%	-0.15%	-0.16%	99%	99%
Class B	-0.05%	-0.10%	-0.14%	99%	100%
Class C	-0.03%	-0.04%	-0.09%	100%	100%
<b>Overall</b>	<b>-0.06%</b>	<b>-0.10%</b>	<b>-0.12%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.07%	-0.04%	-0.13%	100%	107%
Class F	-1.78%	-0.62%	-0.79%	100%	104%
<b>TGM</b>	<b>-2.14%</b>	<b>-1.33%</b>	<b>-1.33%</b>	<b>100%</b>	<b>102%</b>

	Low delay B				
	Over VTM-7.0-lowQP				
	Y	U	V	EncT	DecT
Class B	-0.07%	-0.09%	-0.09%	99%	100%
Class C	-0.03%	-0.04%	-0.05%	99%	100%
Class E	-0.08%	-0.03%	-0.08%	99%	100%
<b>Overall</b>	<b>-0.06%</b>	<b>-0.06%</b>	<b>-0.07%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.08%	-0.09%	-0.20%	99%	103%
Class F	-0.64%	-0.54%	-0.71%	100%	100%
<b>TGM</b>	<b>-1.18%</b>	<b>-0.84%</b>	<b>-0.86%</b>	<b>100%</b>	<b>102%</b>



# Results - Method 2.2

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7	Test		VTM7	Test		VTM7	Test	
Class A1	2.2	2.3	-4.54%	2.2	2.3	-4.46%			
Class A2	1.6	1.7	-8.79%	1.7	1.8	-6.49%			
Class B	2.2	2.3	-3.92%	2.3	2.4	-2.05%	2.3	2.4	-2.06%
Class C	1.9	2.0	-5.06%	2.4	2.5	-2.65%	2.4	2.5	-2.53%
Class D	1.9	2.0	-5.71%	2.8	2.8	-2.82%	2.7	2.8	-2.67%
Class E	2.8	2.9	-4.53%				3.1	3.2	-3.40%
Class F	5.3	5.6	-4.25%	33.7	35.0	-3.22%	50.7	52.4	-2.99%
TGM	11.8	12.5	-5.08%	107.1	117.1	-6.89%	124.9	137.4	-6.94%
<b>Overall with Classes D, F, TGM excluded</b>	<b>2.1</b>	<b>2.2</b>	<b>-5.19%</b>	<b>2.2</b>	<b>2.3</b>	<b>-3.58%</b>	<b>2.6</b>	<b>2.6</b>	<b>-2.55%</b>
Enc Time[%]	101%			102%			101%		
Dec Time[%]	99%			100%			103%		

# Results - Method 2.2

CTC - standard QP

All Intra					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.11%	0.11%	99%	102%
Class A2	0.02%	-0.03%	-0.01%	101%	103%
Class B	0.02%	0.02%	-0.05%	101%	103%
Class C	-0.01%	-0.02%	-0.04%	100%	100%
Class E	0.00%	-0.04%	0.02%	100%	101%
<b>Overall</b>	<b>0.01%</b>	<b>-0.03%</b>	<b>0.00%</b>	<b>100%</b>	<b>102%</b>
Class D	-0.01%	-0.02%	-0.01%	101%	108%
Class F	-0.14%	-0.17%	-0.11%	99%	100%
<b>TGM</b>	<b>-0.38%</b>	<b>-0.27%</b>	<b>-0.32%</b>	<b>100%</b>	<b>100%</b>

Random access					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.09%	0.02%	100%	100%
Class A2	-0.02%	0.17%	0.06%	99%	106%
Class B	0.01%	0.12%	0.07%	100%	101%
Class C	-0.02%	0.13%	0.05%	100%	101%
<b>Overall</b>	<b>-0.01%</b>	<b>0.09%</b>	<b>0.05%</b>	<b>100%</b>	<b>102%</b>
Class D	-0.01%	0.03%	0.00%	99%	102%
Class F	-0.15%	-0.03%	0.08%	99%	102%
<b>TGM</b>	<b>-0.10%</b>	<b>-0.15%</b>	<b>-0.13%</b>	<b>100%</b>	<b>103%</b>

Low delay B					
Over VTM-7.0					
	Y	U	V	EncT	DecT
Class B	0.00%	-0.48%	0.23%	100%	99%
Class C	0.01%	-0.23%	-0.13%	99%	101%
Class E	0.03%	0.88%	-0.20%	99%	100%
<b>Overall</b>	<b>0.01%</b>	<b>-0.06%</b>	<b>0.00%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.03%	0.39%	-0.50%	101%	104%
Class F	-0.14%	0.12%	0.36%	100%	101%
<b>TGM</b>	<b>-0.11%</b>	<b>-0.24%</b>	<b>-0.30%</b>	<b>100%</b>	<b>98%</b>

CTC - low QP

All Intra					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.02%	-0.02%	99%	100%
Class A2	0.04%	-0.01%	-0.01%	100%	100%
Class B	-0.01%	-0.03%	-0.05%	100%	103%
Class C	0.05%	0.06%	0.04%	96%	98%
Class E	-0.21%	-0.40%	-0.47%	98%	105%
<b>Overall</b>	<b>-0.02%</b>	<b>-0.07%</b>	<b>-0.09%</b>	<b>99%</b>	<b>101%</b>
Class D	-0.06%	-0.10%	-0.08%	99%	100%
Class F	-1.47%	-0.85%	-0.83%	98%	100%
<b>TGM</b>	<b>-1.69%</b>	<b>-1.50%</b>	<b>-1.50%</b>	<b>100%</b>	<b>99%</b>

Random access					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class A1	-0.07%	-0.08%	-0.09%	99%	99%
Class A2					
Class B	-0.06%	-0.08%	-0.12%	99%	99%
Class C	-0.03%	-0.04%	-0.07%	100%	100%
<b>Overall</b>					
Class D	-0.10%	0.00%	-0.15%	100%	104%
Class F	-1.93%	-0.76%	-0.91%	100%	100%
<b>TGM</b>	<b>-2.33%</b>	<b>-1.36%</b>	<b>-1.37%</b>	<b>100%</b>	<b>100%</b>

Low delay B					
Over VTM-7.0-lowQP					
	Y	U	V	EncT	DecT
Class B	-0.07%	-0.10%	-0.10%	99%	100%
Class C	-0.03%	0.01%	-0.01%	99%	100%
Class E	-0.07%	-0.02%	-0.06%	99%	100%
<b>Overall</b>	<b>-0.06%</b>	<b>-0.05%</b>	<b>-0.06%</b>	<b>99%</b>	<b>100%</b>
Class D	-0.08%	-0.06%	-0.25%	100%	100%
Class F	-0.64%	-0.52%	-0.63%	100%	103%
<b>TGM</b>	<b>-1.27%</b>	<b>-1.01%</b>	<b>-1.02%</b>	<b>101%</b>	<b>101%</b>