

Usage of CRI for HDR video compression with dynamic range adaptation

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Experiment purpose

Conclusion from previous JCTVC meeting

- CRI can be used to perform dynamic range adaptation (DRA) (a.k.a. reshaping) as implemented in ETM

Main goal of this contribution

- Confirm that CRI can be used for DRA
- Reproduce similar performance as ETM (HDR-only mode) using CRI
 - Replacing luma PWP model of ETM by PWL model from CRI

Propose to amend the Annex A of the document “Conversion and Coding Practices for HDR/WCG Video” - doc. JCTVC-X0066

- Illustrate usage of CRI for DRA

Reminders

DRA/Reshaping in ETM (HDR-only mode)

- For compression efficiency purpose
- Based on 3 1D-LUTs applied to each one of the Y, Cb, Cr 10-bit PQ component
- Inverse LUTs applied at decoder
 - Luma: PWP model - up to 8 pieces
 - Chroma: PWL model - up to 32 pieces

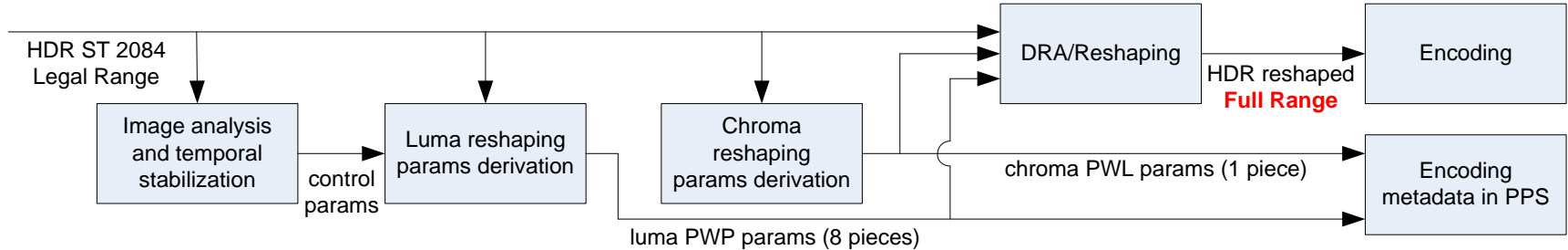
Colour Remapping Information (CRI)

- 3 Pre-LUTs modeled by PWL functions - up to 33 coded points
- 1 intermediate 3x3 Matrix
- 3 Post-LUTs modeled by PWL functions - up to 33 coded points

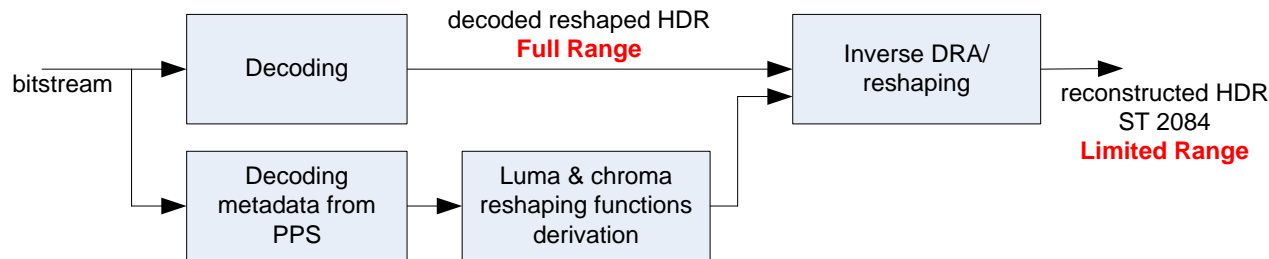
Experiment based on JCTVC-W0084 modified ETM

Modified ETM from JCTVC-W0084

■ Encoder side



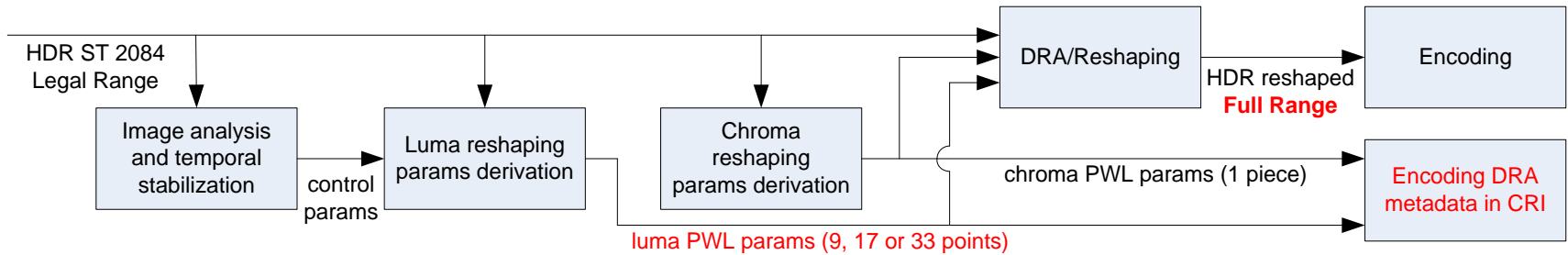
■ Decoder side



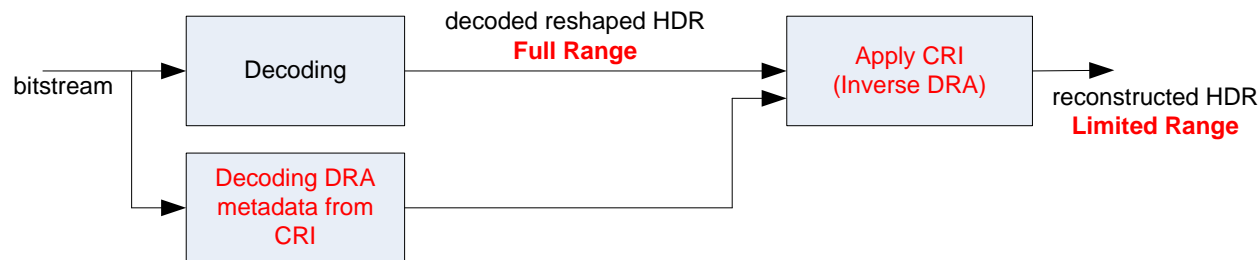
Experiment using CRI

Alternate scheme using CRI

■ Encoder side



■ Decoder side



- Applies directly to 4:2:0 decoded YCbCr signal, using the 3 Pre-LUTs of CRI
- 3x3 Matrix and 3 Post-LUTs not enabled

Range management

In order to fully benefit from the codewords range, the reshaped signal is in Full Range

The inverse reshaping using CRI has to go back to limited range.

This is managed directly by the CRI LUTs

- Luma

$$PreLUT_0[i] = Clip3(\frac{876}{1023} * invLUT_{DRA_0}[i] + 64 + 0.5, 0, 1023)$$

- Chroma - for $k=1$ or 2

$$PreLUT_k[i] = Clip3(\frac{896}{1023} * (invLUT_{DRA_k}[i] - 512) + 512 + 0.5, 0, 1023)$$

where $invLUT_{DRA_k}$ are the inverse reshaping LUT applying in full range

Objective metrics - ETM vs CRI 9points

	X	Y	Z	XYZ	DE100	PSNRL100
FireEaterClip4000r1	-1.19%	-0.55%	-3.96%	-1.70%	-3.19%	-0.15%
Market3Clip4000r2	0.82%	0.93%	0.46%	0.71%	-9.96%	0.31%
SunRise	3.14%	3.69%	0.61%	2.32%	-29.76%	1.61%
BikeSparklers cut1	0.07%	0.04%	-0.69%	-0.20%	-3.82%	0.30%
BikeSparklers cut2	0.13%	0.07%	-0.60%	-0.15%	-5.04%	0.59%
GarageExit	-0.27%	-0.06%	-0.27%	-0.20%	-8.16%	-0.05%
ShowGirl2Teaser	-1.46%	-1.02%	-3.11%	-1.82%	-7.10%	-0.26%
StEM_MagicHour cut 1	0.06%	0.21%	-0.25%	-0.06%	-2.79%	0.28%
StEM_MagicHour cut 2	0.07%	0.09%	-0.34%	-0.14%	-1.29%	0.34%
StEM_MagicHour cut 3	-0.42%	-0.33%	-0.46%	-0.41%	-0.83%	-0.12%
StEM_WarmNight cut 1	-1.28%	-0.92%	-0.47%	-0.85%	-4.88%	0.87%
StEM_WarmNight cut 2	-0.59%	-0.12%	-0.40%	-0.40%	-2.81%	0.44%
BalloonFestival	-0.11%	-0.10%	-0.29%	-0.18%	-7.06%	-1.75%
EBU_04_Hurdles	1.49%	1.73%	0.98%	1.34%	-6.13%	3.91%
EBU_06_Start	-0.22%	0.17%	0.00%	-0.01%	-11.14%	1.90%
Overall	0.02%	0.26%	-0.59%	-0.12%	-6.93%	0.55%

Objective metrics - ETM vs CRI 33 points

	X	Y	Z	XYZ	DE100	PSNRL100
FireEaterClip4000r1	-1.06%	-0.41%	-3.73%	-1.53%	-3.13%	-0.19%
Market3Clip4000r2	-0.10%	0.00%	-0.27%	-0.13%	-10.73%	-0.04%
SunRise	-0.63%	-0.12%	-1.47%	-0.80%	-29.11%	-0.60%
BikeSparklers cut 1	-0.11%	-0.15%	-0.58%	-0.27%	-3.82%	-0.04%
BikeSparklers cut 2	0.01%	-0.05%	-0.70%	-0.25%	-5.47%	0.11%
GarageExit	-0.26%	-0.08%	-0.08%	-0.13%	-7.55%	-0.12%
ShowGirl2Teaser	-0.95%	-0.46%	-2.58%	-1.29%	-6.75%	0.30%
StEM_MagicHour cut 1	-0.27%	-0.13%	0.19%	0.01%	-2.77%	-0.06%
StEM_MagicHour cut 2	-0.04%	-0.03%	-0.48%	-0.26%	-1.05%	0.05%
StEM_MagicHour cut 3	-0.40%	-0.35%	-0.47%	-0.42%	-1.06%	-0.26%
StEM_WarmNight cut 1	-0.62%	-0.54%	-1.19%	-0.82%	-4.94%	-0.06%
StEM_WarmNight cut 2	-0.94%	-0.34%	-0.31%	-0.51%	-2.84%	0.10%
BalloonFestival	-0.09%	0.09%	-0.22%	-0.09%	-6.80%	2.11%
EBU_04_Hurdles	0.04%	-0.26%	-0.41%	-0.23%	-6.02%	-0.63%
EBU_06_Start	-0.33%	-0.11%	-0.07%	-0.15%	-5.27%	0.08%
Overall	-0.38%	-0.20%	-0.82%	-0.46%	-6.49%	0.05%

PSNR_YUV of reshaped versions

Sequence	Psnr 9 points	Psnr 17 points	Psnr 33 points
FireEaterClip4000r1	66.34	64.98	65.54
Market3Clip4000r2	53.06	62.27	66.14
SunRise	52.98	62.06	66.18
BikeSparklers cut 1	55.55	62.13	66.39
BikeSparklers cut 2	54.00	62.00	65.81
GarageExit	51.39	61.71	65.44
ShowGirl2Teaser	58.70	64.25	66.23
StEM_MagicHour cut 1	60.06	66.47	63.64
StEM_MagicHour cut 2	62.35	63.84	67.03
StEM_MagicHour cut 3	60.31	63.08	63.59
StEM_WarmNight cut 1	48.72	59.33	66.18
StEM_WarmNight cut 2	54.54	63.22	62.95
BalloonFestival	53.80	63.67	66.77
EBU_04_Hurdles	48.92	63.00	66.83
EBU_06_Start	48.44	61.86	65.47
Overall	55.28	62.92	65.61

Thanks Qualcomm for cross-checking (JCTVC-X0059)

Conclusions

It is confirmed that CRI is able to reproduce the behaviour of the ETM

CRI can be efficiently used as a reshaper metadata container, in view of improving compression efficiency

It is proposed to add a description of CRI SEI usage for DRA in Annex A of the document “Conversion and Coding Practices for HDR/WCG Video”. Cf Contribution JCTVC-X0066