

Daala Update

IETF 94 (横浜市)

Progress Since Prague

- Focusing here on changes that impact compression performance
 - Lots of code clean-up, refactoring, optimization, tools work, etc. also
- Metrics from AWCY (not yet updated to follow draft-daede-netvc-testing recommendations)
- All metrics on ntt-short-1

Lapping/Deblocking

4-Point Lapping

- Used to use 8-point lapping for all edges except the interior edges of a 4x4 split
- Now use 4-point lapping for all edges
 - Produces much less ringing, loses some detail
 - Regression on keyframes, but want to minimize differences between keyframes and other frames

	RATE (%)	DSNR (dB)
PSNR	-3.64821	0.12193
PSNRHVS	-1.36706	0.06994
SSIM	-2.39326	0.06152
FASTSSIM	0.35914	-0.01095

Haar DC Quantizer Scale Fix

- Change to 4-point lapping also changed the magnitude of our transform basis functions
 - Changes quantizer scalings used for Haar DC
 - Initial patch forgot to update them

	RATE (%)	DSNR (dB)
PSNR	-0.12695	0.00420
PSNRHVS	-0.24144	0.01230
SSIM	-0.09652	0.00247
FASTSSIM	0.00628	-0.00019

Thor Deblocking Support

- Added the option to use the Thor deblocking filter in place of lapping
 - **Currently disabled by default**
 - Replaces lapping postfilter, disables prefilter
 - Shows small metrics improvements, but visual impact less clear (testing would be appreciated!)

	RATE (%)	DSNR (dB)
PSNR	-1.62531	0.05432
PSNRHVS	-2.61102	0.13528
SSIM	-2.02496	0.05203
FASTSSIM	-0.40289	0.01185

Motion Compensation

Multiple References

- Currently adds one long-term reference (“golden frame”)
- Reference patterns inferred at decoder (not signaled)

	RATE (%)	DSNR (dB)
PSNR	-0.98404	0.03283
PSNRHVS	-0.70880	0.03637
SSIM	-0.91264	0.02345
FASTSSIM	-0.70136	0.02079

Coding References

- Code the number of references used by each frame
- Update per-MV reference index entropy coding to use this value

	RATE (%)	DSNR (dB)
PSNR	0.00820	-0.00027
PSNRHVS	0.00731	-0.00037
SSIM	0.00778	-0.00020
FASTSSIM	0.00709	-0.00021

MV Prediction Only from Same Reference

- Initial MV prediction just took a median-of-four ignoring which reference was used for each MV
 - Now take a median of just the neighbors that come from the same reference as the MV being predicted
 - Hurts on frames with no/low motion, helps on high motion

	RATE (%)	DSNR (dB)
PSNR	-0.33343	0.01104
PSNRHVS	-0.37274	0.01901
SSIM	-0.40101	0.01027
FASTSSIM	-0.47167	0.01399

Use 2D Median for MV Prediction

- Traditionally “median” computed on each $\{x,y\}$ component separately
 - Predictor may not match any neighboring MV
- “2D Median” uses MV which minimizes the L1 distance to all other MVs (“Fréchet median”)
 - Order of predictors now matters because of ties

	RATE (%)	DSNR (dB)
PSNR	-0.48907	0.01497
PSNRHVS	-0.41923	0.01990
SSIM	-0.35126	0.00831
FASTSSIM	-0.61234	0.01701

Pad Frames to Multiples of 64

- Pre-requisite for 64x64 motion compensation and 64x64 transforms
- PVQ currently still wastes bits coding outside the visible region
 - Large loss for small frame sizes, negligible for HD

	RATE (%)	DSNR (dB)
PSNR	1.25393	-0.04121
PSNRHVS	1.28445	-0.06505
SSIM	1.24512	-0.03166
FASTSSIM	1.22453	-0.03607

Add 64x64 MC Support, Drop 4x4

- Dropping 4x4 MC was measured to be about a 0.8% gain on all metrics
 - May just be poor encoder decisions, but 4x4 is expensive for hardware
 - May revisit adding it later
- Dropping 4x4 made adding 64x64 easy

	RATE (%)	DSNR (dB)
PSNR	-6.64171	0.19601
PSNRHVS	-6.12492	0.28447
SSIM	-6.62569	0.15629
FASTSSIM	-4.34795	0.11693

Deringing

New Directional Deringing Filter

- Initial implementation of the filter presented by Jean-Marc yesterday
 - Replaces Thor's CLPF

	RATE (%)	DSNR (dB)
PSNR	-2.59648	0.08697
PSNRHVS	-2.34415	0.12077
SSIM	-2.01717	0.05205
FASTSSIM	1.54049	-0.04506

Fixed Rounding in Directional Filter

- Just a bugfix to remove a small, positive bias

	RATE (%)	DSNR (dB)
PSNR	-0.01553	0.00052
PSNRHVS	-0.06663	0.00339
SSIM	-0.01703	0.00044
FASTSSIM	0.13600	-0.00401

Changed Second Stage Filter from 3-Tap to 5-Tap

- What it says in the title

	RATE (%)	DSNR (dB)
PSNR	-0.22569	0.00746
PSNRHVS	-0.27843	0.01417
SSIM	-0.23581	0.00602
FASTSSIM	0.82520	-0.02423

Eliminated Division from Second Stage Filter

- Initially computing a straight average: $\{1, 1, 1, 1, 1\}/5$ filter
- Now uses $\{3, 3, 4, 3, 3\}/16$ filter

	RATE (%)	DSNR (dB)
PSNR	0.01743	-0.00058
PSNRHVS	0.01395	-0.00071
SSIM	-0.00179	0.00005
FASTSSIM	-0.06009	0.00177

Adaptive Deringing Threshold

- Initial implementation had a constant threshold derived from the quantizer
- Now use
 - Higher threshold (stronger filter) when blocks are more directional
 - Lower threshold (weaker filter) when they aren't

	RATE (%)	DSNR (dB)
PSNR	-0.76074	0.02522
PSNRHVS	-0.28551	0.01453
SSIM	-0.29491	0.00753
FASTSSIM	1.03718	-0.03041

Avoid Deringing Skipped Regions

- Deringing enabled/disabled on 32x32 supeblock level
 - May be enabled for a superblock even when some/most of it is skipped
- For each 8x8 sub-block, check if it and its surrounding 4x4 sub-blocks are skipped

	RATE (%)	DSNR (dB)
PSNR	-0.11368	0.00376
PSNRHVS	-0.13742	0.00700
SSIM	-0.06023	0.00154
FASTSSIM	-1.12903	0.03351

Always Dering Keyframes

- Predictors in keyframes have not already been deringed in a previous frame
- Therefore we shouldn't automatically disable deringing on skipped blocks
 - Can still disable with signaling, of course

	RATE (%)	DSNR (dB)
PSNR	-0.02038	0.00063
PSNRHVS	-0.01166	0.00056
SSIM	-0.01862	0.00045
FASTSSIM	-0.14413	0.00404

Entropy Coding/Signaling

Reduced Overhead Entropy Coder

- Implemented from draft-terriberry-netvc-codingtools Section 2.3.1
 - More expensive, but more accurate
 - Currently enabled, but easy to switch back to cheaper method

	RATE (%)	DSNR (dB)
PSNR	-0.33121	0.01085
PSNRHVS	-0.37603	0.01932
SSIM	-0.26811	0.00666
FASTSSIM	-0.30768	0.00893

Enabled Robust PVQ Coding by Default

- PVQ codes the gain for each band as a difference from the predictor
 - Gain needed to compute K (PVQ codebook size) and quantized θ resolution (implying a max θ)
 - Now compute K directly from quantized index of the gain, rather than the actual gain
 - No longer cap θ index

	RATE (%)	DSNR (dB)
PSNR	0.30264	-0.00998
PSNRHVS	0.18257	-0.00929
SSIM	0.20565	-0.00524
FASTSSIM	0.25232	-0.00741

Per-Superblock Quantizer Scaling

- Added signaling to change the quantizer at the 32x32 superblock level
 - Selects from a small set of quantizers per-frame (up to 4)
 - Currently unused by the encoder

	RATE (%)	DSNR (dB)
PSNR	0.10823	-0.00357
PSNRHVS	0.09732	-0.00496
SSIM	0.11055	-0.00281
FASTSSIM	0.09419	-0.00277

Encoder-Only Improvements

Late Skip (Encoder Only)

- Block size RDO and PVQ use different metrics to skip a block
 - The mismatch meant sometimes PVQ would skip four, e.g., 16x16 blocks, then decide to code some coefficients at 32x32, and block size RDO would prefer the former to the latter
 - Now add a second skip test using block size RDO metric

metric	RATE (%)	DSNR (dB)
PSNR	-2.62788	0.08843
PSNRHVS	-1.51820	0.07823
SSIM	-0.88610	0.02276
FASTSSIM	3.61704	-0.10484

Enlarge PVQ Search Range (Encoder Only)

- We only search a limited number of gains and angles when quantizing with PVQ
 - $[gain] - 1 \dots [gain] \rightarrow [gain] - 2 \dots [gain]$
 - $[\theta] - 1 \dots [\theta] \rightarrow [\theta] - 2 \dots [\theta]$
- Less energy preservation, but reduces likelihood of late skip override

	RATE (%)	DSNR (dB)
PSNR	0.10495	-0.00333
PSNRHVS	-1.08766	0.05263
SSIM	0.18518	-0.00450
FASTSSIM	-0.95734	0.02703

Always Skip Large PVQ Bands (Encoder Only)

- Limits the maximum size of a PVQ band to 128
 - Skips diagonal HF band of 32x32
 - Will skip all HF bands of 64x64
 - Losses for that are higher (0.4%)
- Follow-on work will remove signaling for these bands

	RATE (%)	DSNR (dB)
PSNR	0.05094	-0.00159
PSNRHVS	0.00896	-0.00043
SSIM	0.03375	-0.00081
FASTSSIM	0.04501	-0.00127

Merged PVQ λ and Block Size RDO λ (Encoder Only)

- Approximate scaling compensation added to block size RDO metric so that the same λ value could be used for both
- Re-tuned both PVQ and MC λ values

	RATE (%)	DSNR (dB)
PSNR	-0.34542	0.01133
PSNRHVS	-0.72897	0.03730
SSIM	-0.10040	0.00249
FASTSSIM	-0.43809	0.01283

Contrast-Preservation Term in Block Size RDO Metric (Encoder Only)

- An attempt to get back some of the FastSSIM losses from previous changes
- Additional penalty added if standard deviation of each 4x4 sub-block does not match the input

	RATE (%)	DSNR (dB)
PSNR	-0.33624	0.01114
PSNRHVS	-0.05177	0.00269
SSIM	-0.72102	0.01849
FASTSSIM	-1.28252	0.03806

Use Block Size RDO Metric for CLPF Decision (Encoder Only)

- CLPF (later deringing) enabled on per-SB basis (unless skipped)
- Encoder decision was made with mean-squared error (MSE)
- Now use the block size RDO metric

	RATE (%)	DSNR (dB)
PSNR	0.20362	-0.00673
PSNRHVS	-0.12923	0.00659
SSIM	0.10963	-0.00280
FASTSSIM	-2.47576	0.07383

Track MVs for All References (Encoder Only)

- MV search seeded with candidates from previous frames
- Now remember results of search for every reference to seed future searches, even if we don't choose that reference

	RATE (%)	DSNR (dB)
PSNR	-0.03100	0.00102
PSNRHVS	-0.02335	0.00119
SSIM	-0.02388	0.00061
FASTSSIM	-0.00363	0.00011

Perform Initial MV Search at Halfpel Resolution (Encoder Only)

- Initial MV search uses basic block matching (BMA)
- Round all search candidates to halfpel instead of fullpel
 - Still uses 1-pixel steps during hill-climbing
- Add halfpel refinement step at the end of BMA

	RATE (%)	DSNR (dB)
PSNR	-1.11919	0.03484
PSNRHVS	-1.45769	0.07039
SSIM	-1.24743	0.02995
FASTSSIM	-1.38737	0.03907

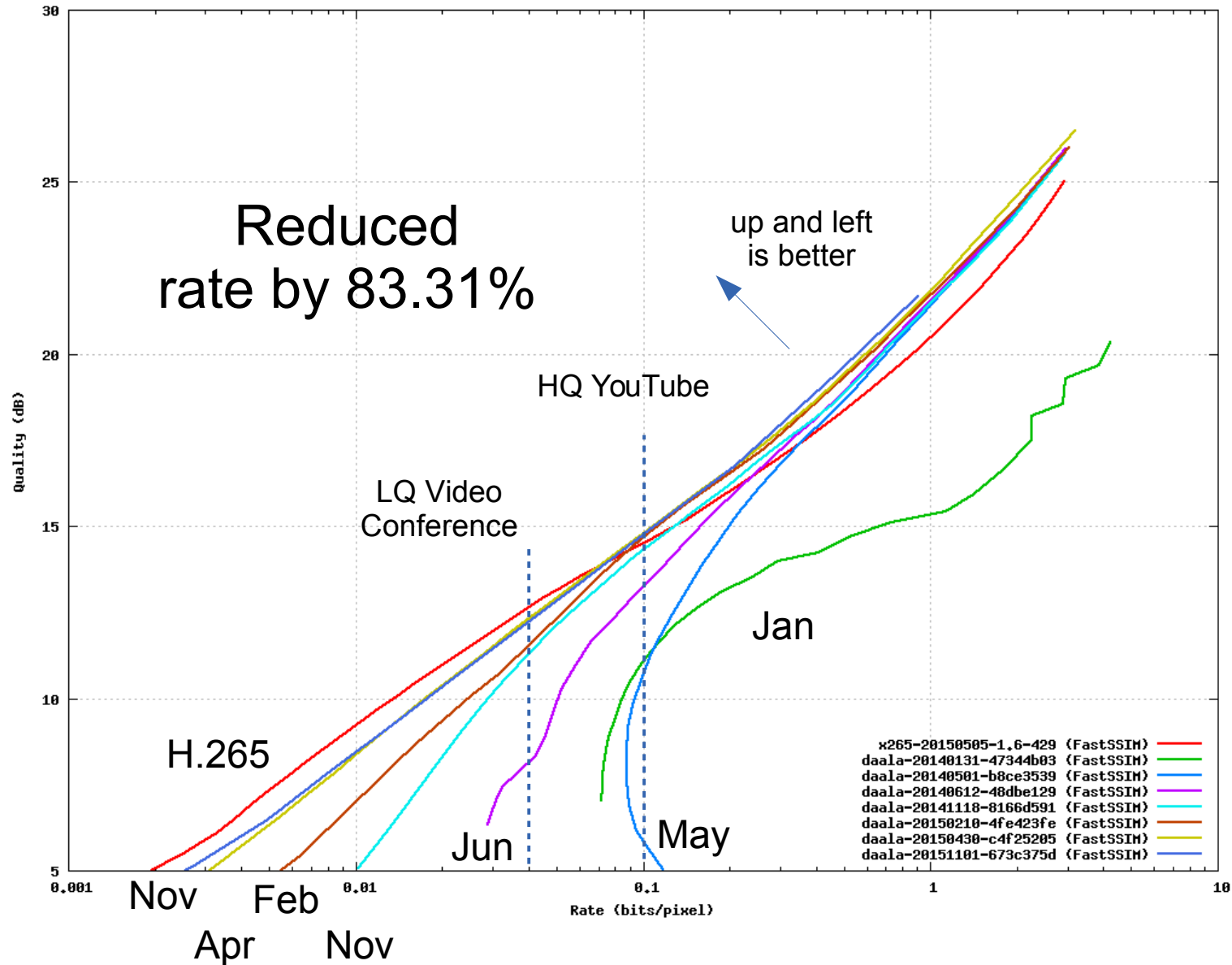
Summary

Summary

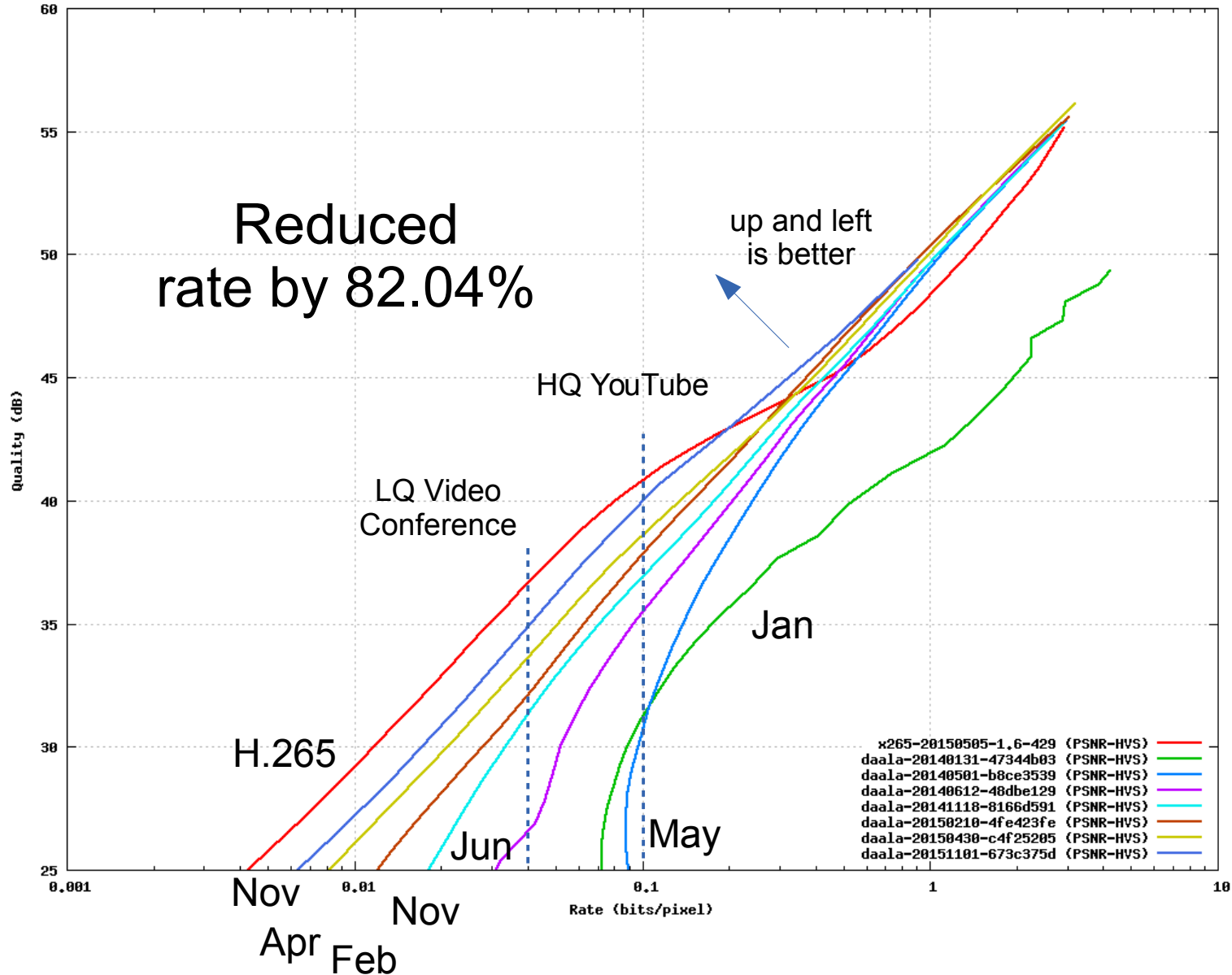
- 191 commits
- 8 new contributors
 - Michael Bebenita, Max Bernstein, Luca Barbato, Mark Harris, Will Howard, Paul Forti, Kyle Sieftring, Edward Wang

	RATE (%)	DSNR (dB)
PSNR	-18.31761	0.62646
PSNRHVS	-15.03827	0.78938
SSIM	-15.09915	0.39153
FASTSSIM	-0.19503	-0.00206

Daala Progress: FastSSIM January 2014 to November 2015



Daala Progress: PSNR-HVS January 2014 to November 2015



In-Progress Changes

- Full-precision references
 - <https://review.xiph.org/984/>
- B-frames
 - <https://review.xiph.org/1034/>
- 64x64 Transforms
 - <https://review.xiph.org/1014/>
 - <https://review.xiph.org/1015/>
 - <https://review.xiph.org/1016/>
 - <https://review.xiph.org/1017/>
 - <https://review.xiph.org/1018/>
 - <https://review.xiph.org/1020/>
 - <https://review.xiph.org/1021/>
 - <https://review.xiph.org/1022/>
- Quantizer simplifications
 - <https://review.xiph.org/1042/>

Questions?