



XS



Fraunhofer Institute for Integrated Circuits IIS

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Coding Techniques in JPEG XS for efficient Video Production and Contribution

JPEG XS is a tailored mezzanine codec for video over IP

ISO/IEC 21122

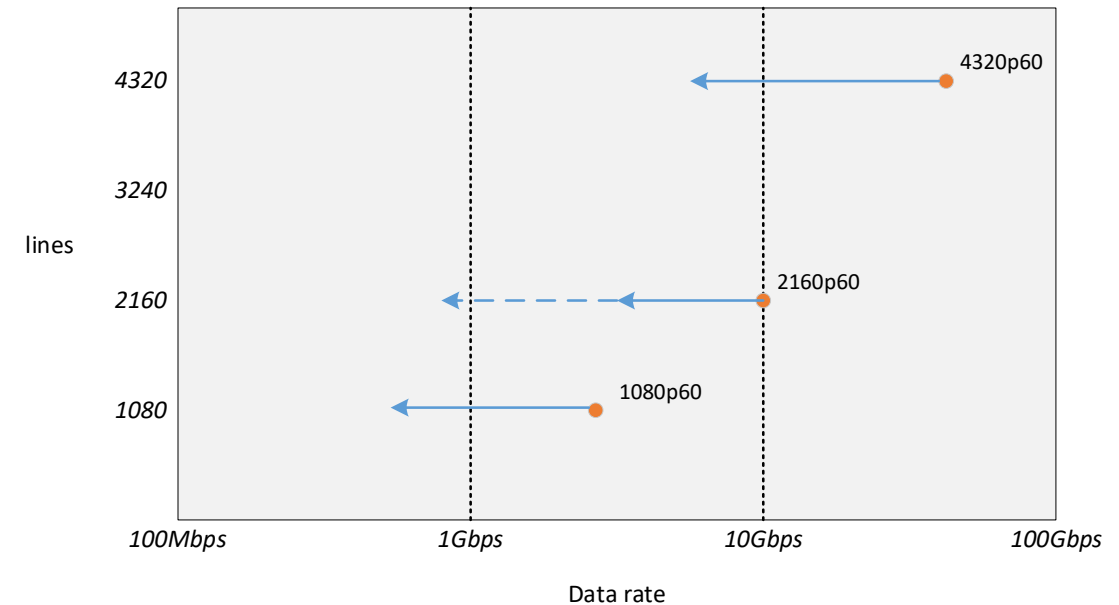
- JPEG XS is a standardized image codec with very low complexity and ultra low latency for video over IP transmission

Application areas

- Video production and contribution
- In-house distribution, In-car communication, ...

Main goals

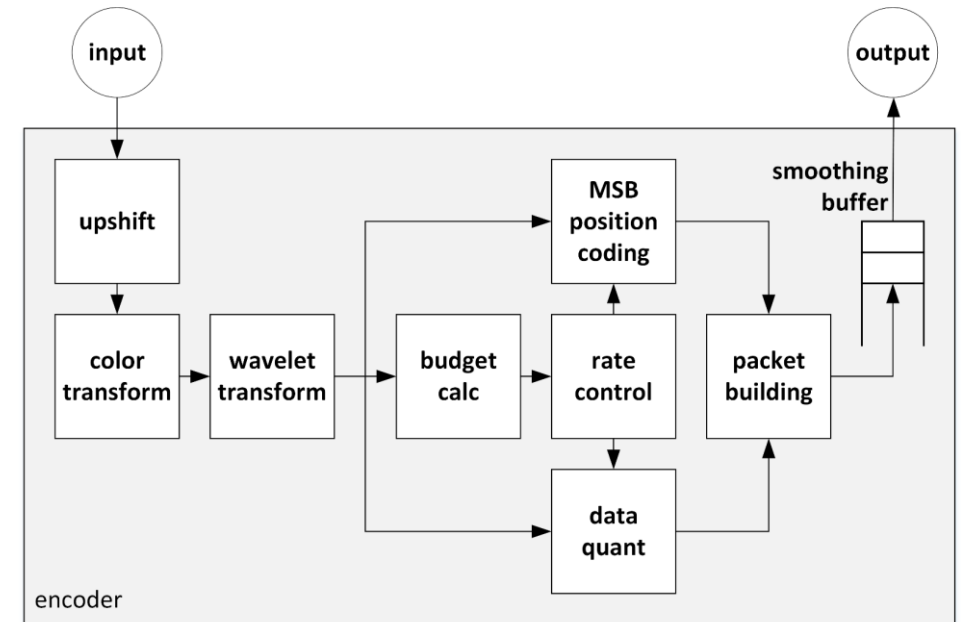
- Replaces SDI and uncompressed video transmission
- Where bandwidth is not the highest priority
- Good compromise between quality and complexity by preserving lowest latency
- Typical compression ratios 2:1 to 10:1 (16:1 for 8k)



JPEG XS architecture

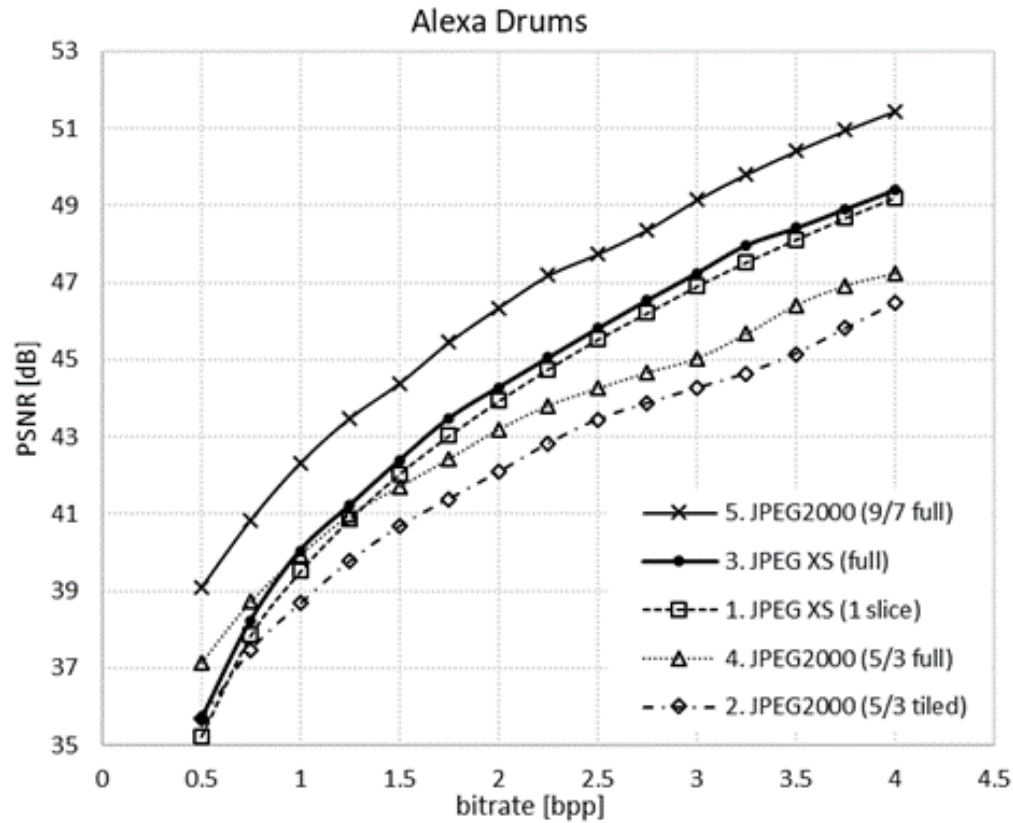
ISO/IEC 21122

- Normalized to 20 bit (good for images with bit depths up to 16 bit per component, for mathematically lossless special handling)
- Simple RCT color transform for RGB (same as used in JPEG 2000)
- LeGall 5/3 wavelet transform with max. 2 vertical and 5 horizontal transforms
- Slicing of transformed coefficients equivalent to 16 lines
- Rate control on each slice, for UHD-1 (4k) ends up in 135 slices
- In hardware e2e latency can be 32line, in software below 200 lines
- Coding of 4 coefficients at once with MSB, entropy coding and if necessary simply raw transmission of lower bits

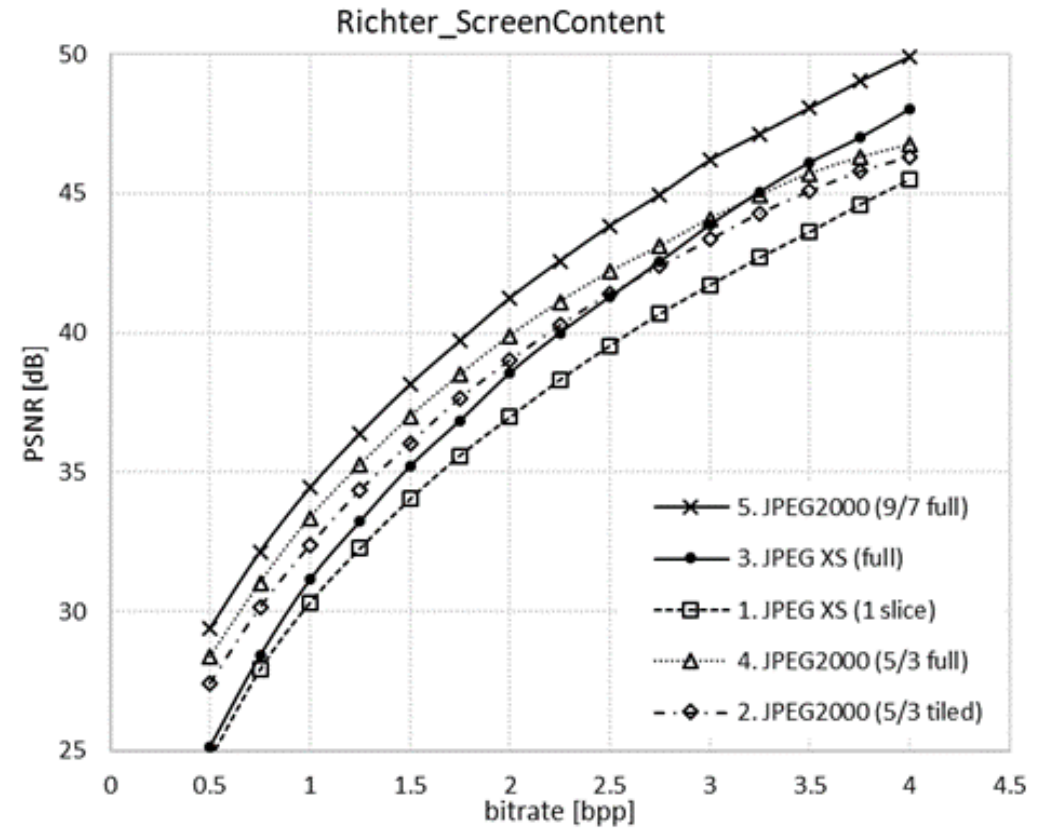


JPEG XS drawbacks of limited transforms and area for rate control

Natural images



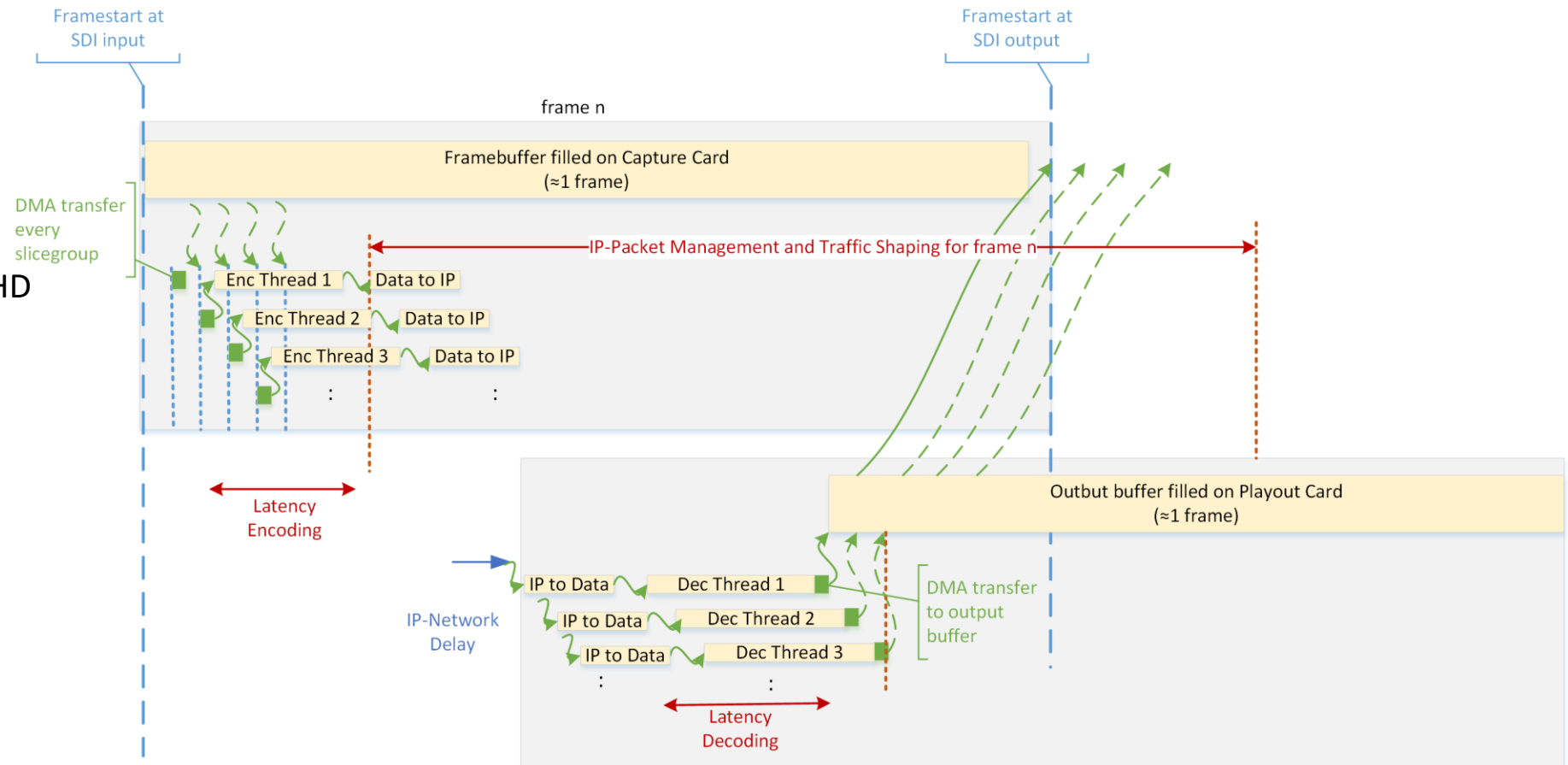
Screen content/semistatic scenes



JPEG XS ultra-low latency implementation example

How ultra-low latency can be achieved:

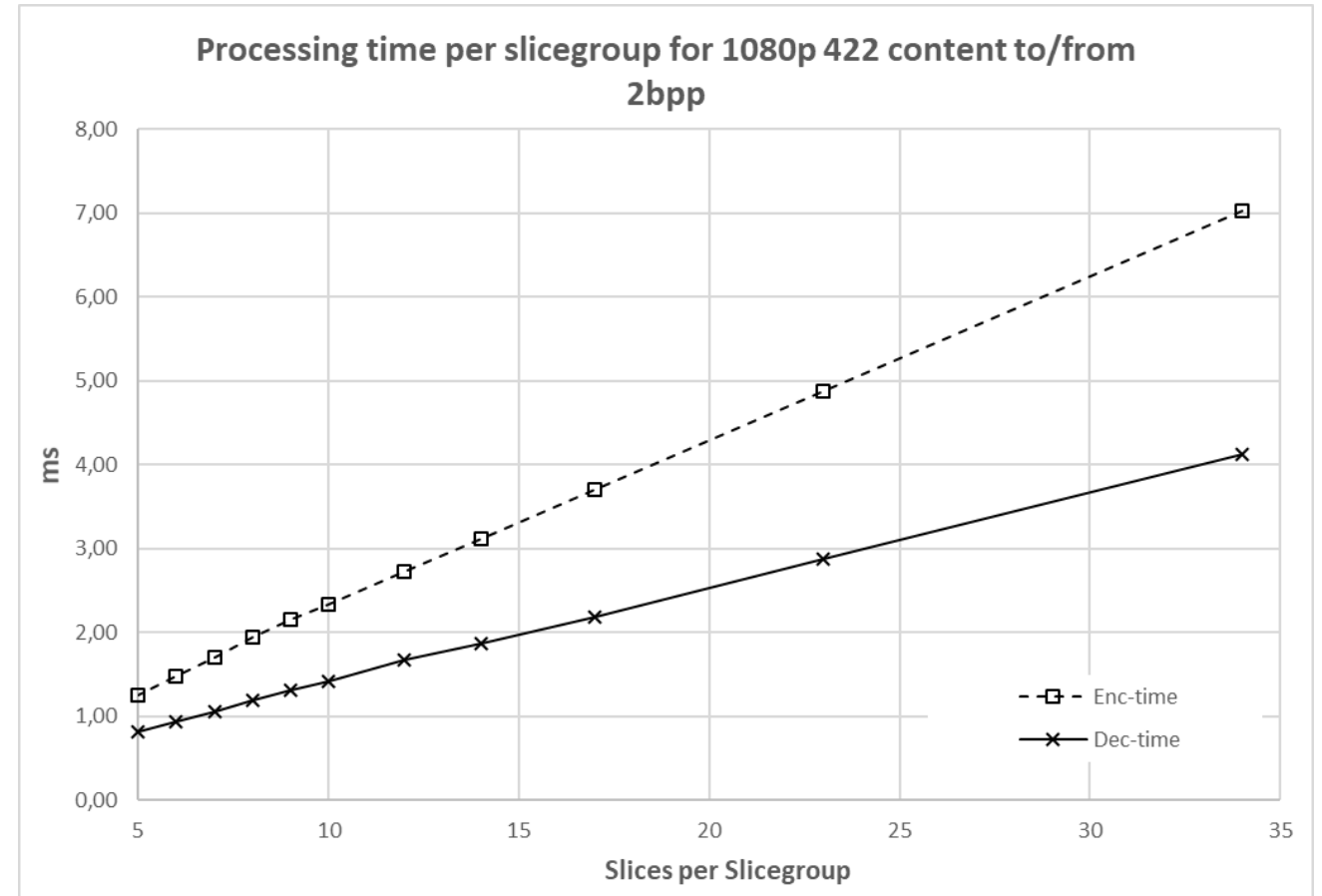
- Splitting slice processing to multiple threads
- Possible configuration for HD video
 - 5-10 slices per thread
 - 6-12 threads



JPEG XS ultra-low latency implementation example

Software processing time

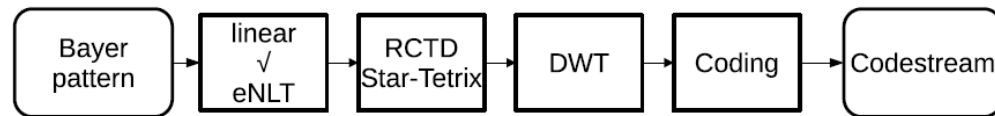
- Example for HD
 - 5-10 slices per thread (slice group)
 - 6-12 threads
- Figure shows software processing time for AMD Threadripper 3970X at 3.7GHz
- Nearly linear behavior down to 3 slices per slice group



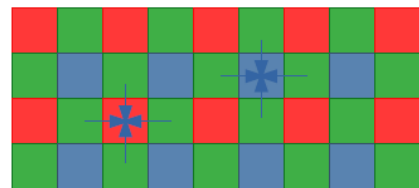
JPEG XS 2nd edition Bayer CFA compression

Adding special processing tools for CFA data

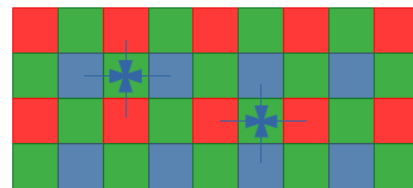
- RCT replaced by non-linear point transform and RCTD or Star-Tetrix transform



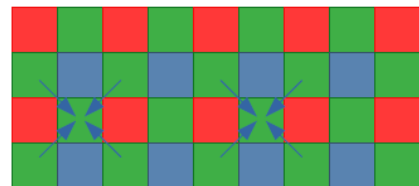
- Star-Tetrix implements the following steps:



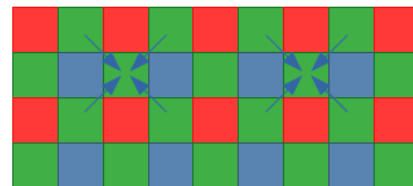
Compute C_b, C_r



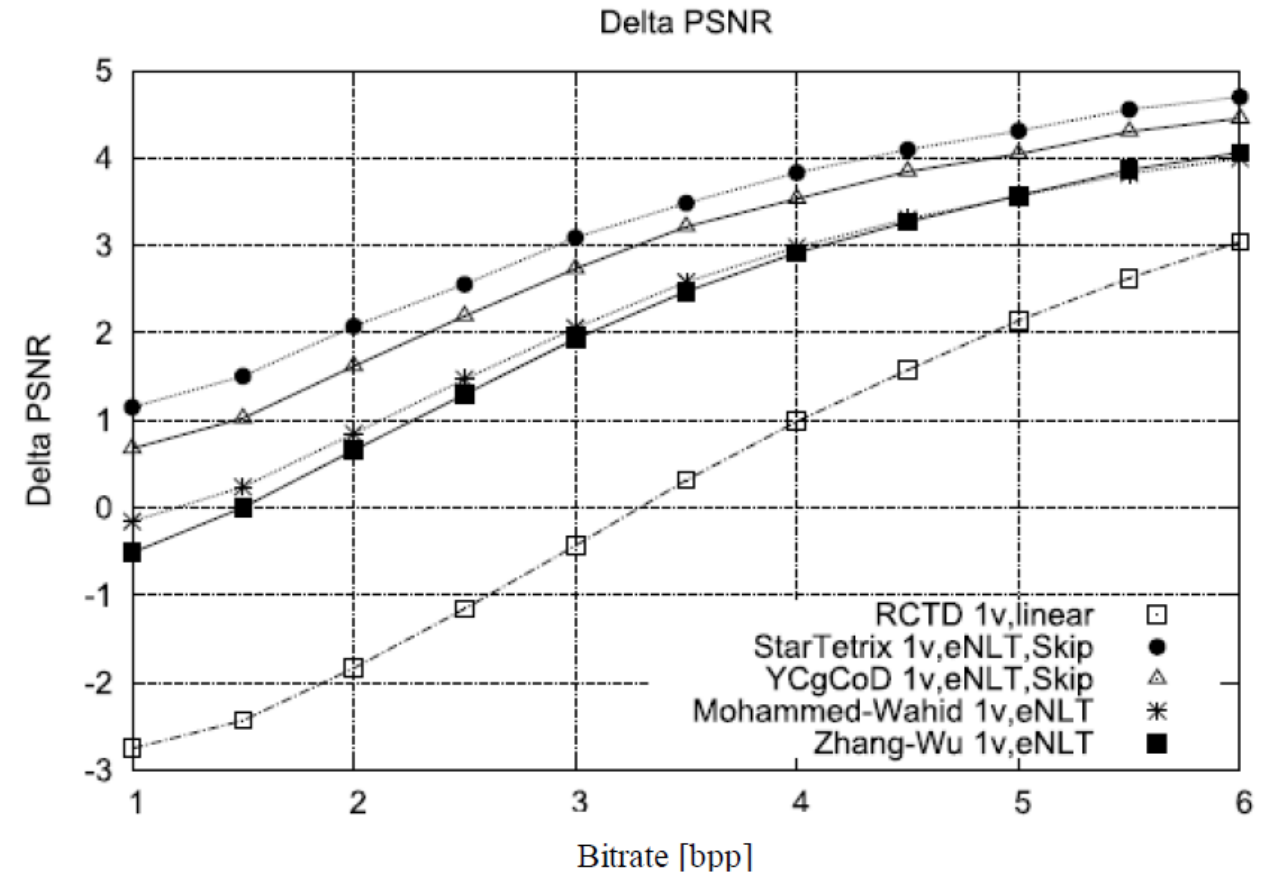
Compute luminances



Compute Δ luminance difference



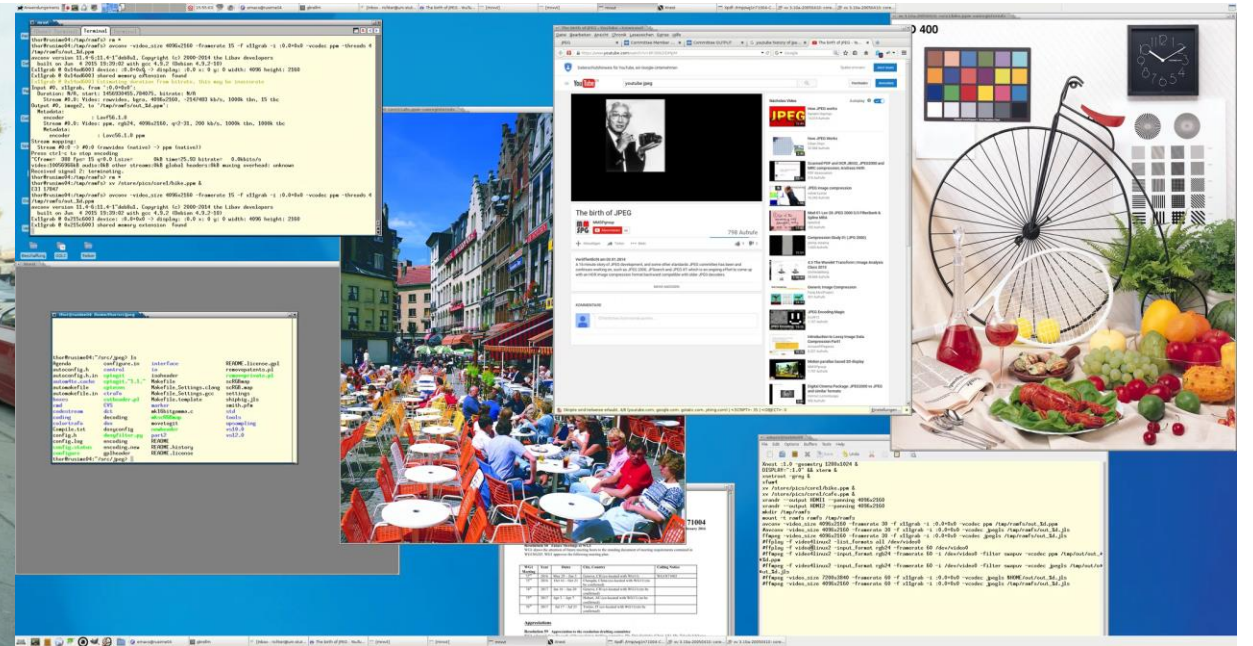
Compute average luminance



Test sequences



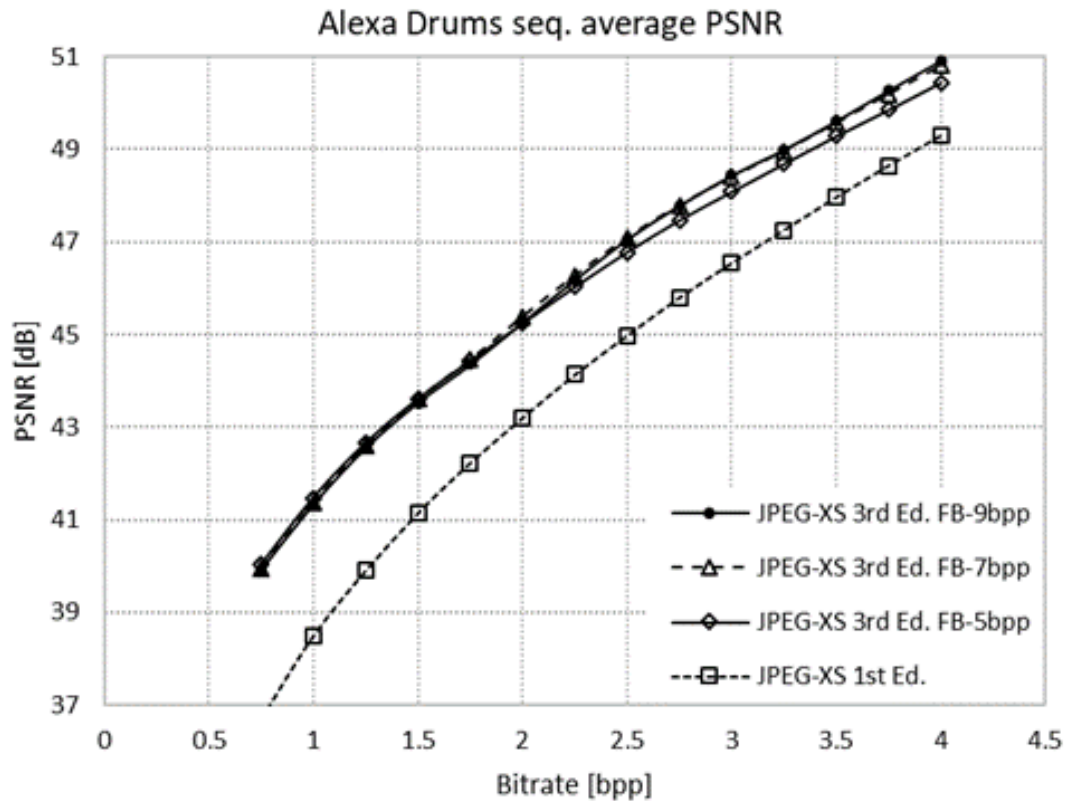
Sequence ARRI_AlexaDrums



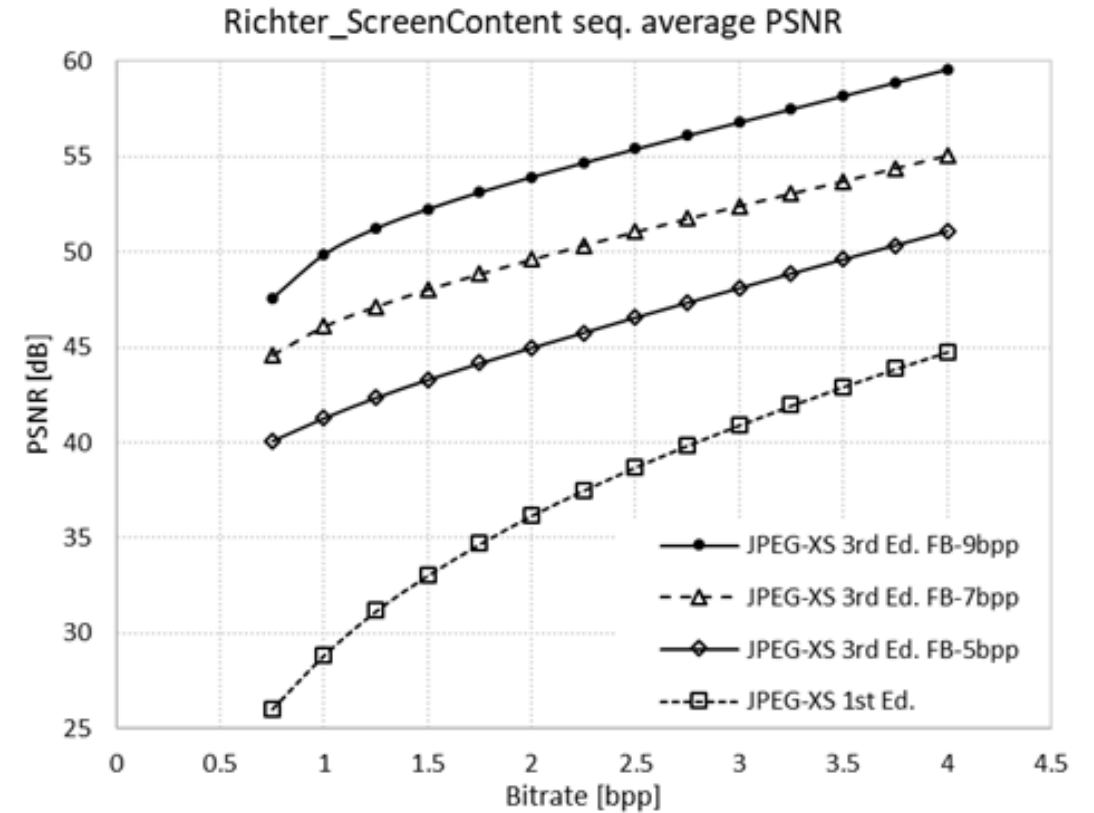
Sequence RICHTER_ScreenContent

JPEG XS 3rd edition screen content compression

Natural images

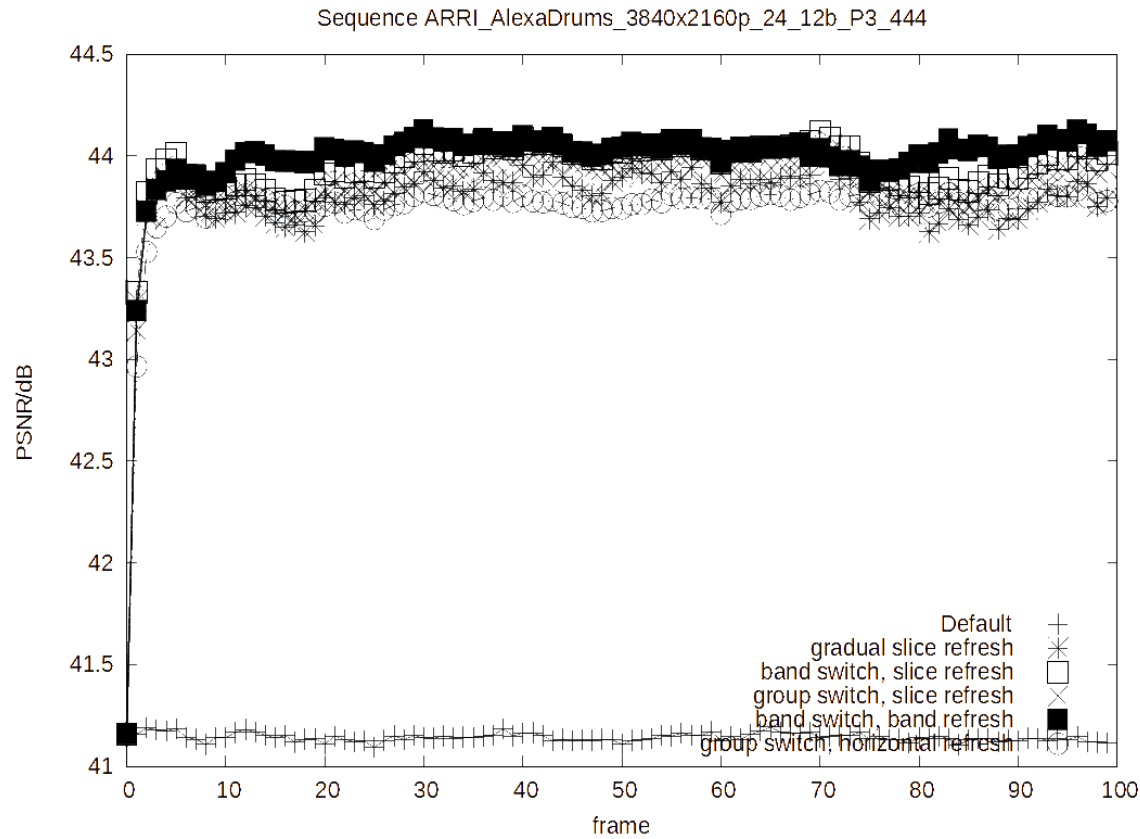


Screen content/semi-static scenes

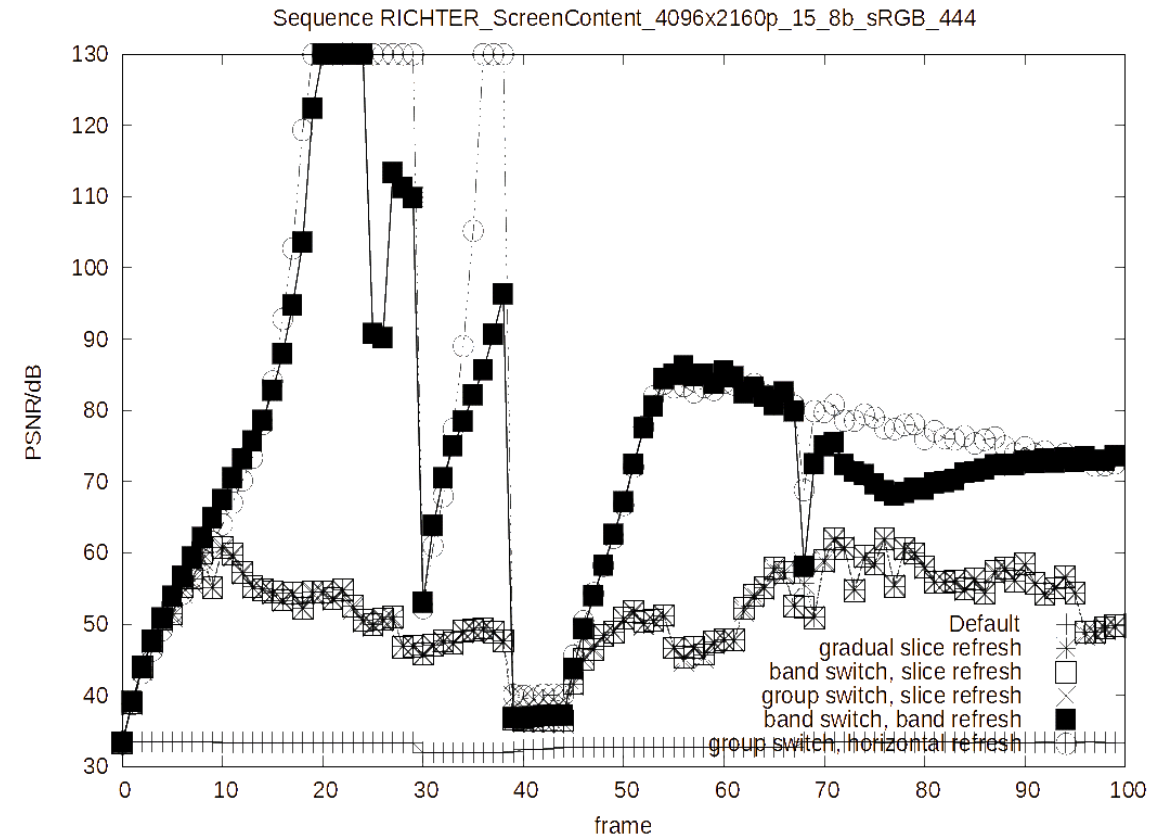


JPEG XS 3rd edition screen content compression

Natural images



Screen content/semi-static scenes



JPEG XS Development

Standards Ecosystem

- Core Coding System: ISO/IEC 21122-1
- Profiles: ISO/IEC 21122-2
- File formats, transport: ISO/IEC 21122-3 (JXS, ISOBMFF, HEIF)
- Conformance: ISO/IEC 21122-4
- Reference Software ISO/IEC 21122-5
- MPEG-TS for JPEG XS: ISO/IEC 13818-1:2019/AMD 1:2020

- RTP for JPEG XS: IETF RFC9134
- File format MXF for JPEG XS: SMPTE ST2124

- VSF TR-07 (JPEG XS Video in MPEG-2 TS)
- VSF TR-08 (JPEG XS Video in ST 2110),
- AMWA BCP-006-01 (NMOS With JPEG XS)
- AIMS/VSF TR-10-11 (IPMX, CBR compressed Video)



Next steps and summary

Next Steps

- Finalizing standardization of 3rd edition of JPEG XS for improved compression of screen content/semi-static scenes
 - ISO IEC 21122-1 DIS
 - ISO/IEC 21122-2/3 CD
- Testing other application areas for this codec

Summary

- JPEG XS is designed as an optimized codec for a special use case
 - Very low complexity
 - Ultra-low latency



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