JPEG-XS and ST 2110

Jean-Baptiste Lorent
intoPIX

ST 2110 IS TAKING OFF

It is designed to become
the infrastructure of choice
GOING IP BRINGS MANY BENEFITS

- **REDUCING COMPLEXITY**
  - less cables
  - bi-directional

- **INCREASING AGILITY**
  - re-routing
  - easy configuration
  - less space
  - simplified workflows
  - smaller buildings & OB

- **LOWERING COSTS**
  - less cables
  - bi-directional
  - COTS equipment

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IP SHOWCASE THEATRE AT IBC2019: 13–17 SEPTEMBER 2019

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IP SHOWCASE THEATRE AT IBC2019: 13–17 SEPTEMBER 2019
WE HAVE MORE PIXELS TO MANAGE, STORE AND TRANSPORT

… but the roads are jammed already!

“Can we put more cars on the road without creating traffic jams & delaying arrival times of each passenger?”

HD NEEDS 10GBE INFRASTRUCTURES

Uncompressed = 2.4 Gbps for HD60

Intra-frame compression is needed for the storage to ease read & write access to the disks & to reduce storage cost of all incoming streams

Many solutions exist for downsampling great amounts of streams in low resolution

COTS in this case means at least 10GBe ports for all devices & switches (At least Cat 6 cables)
**4K NEEDS 25GBE INFRASTRUCTURES**

Uncompressed = 9.6 Gbps for 4K60

Intra-frame compression is needed for the storage to ease read & write access to the disks & to reduce storage cost of all incoming streams.

**8K NEEDS 100GBE INFRASTRUCTURES**

Uncompressed: 38.4 Gbps for 8K60, 76.8 Gbps for 8K120

Intra-frame compression is needed for the storage to ease read & write access to the disks & to reduce storage cost of all incoming streams.

New scaling capabilities needed for monitoring (even more steps down).

COTS in this case means at least 100/400GbE ports for all devices & switches.
WHAT IF A TECHNOLOGY COULD HELP?

... easily managing more pixels over a limited bandwidth, safeguarding low latency and a pixel perfect quality?

CALL FOR A NEW STANDARD

ISO-standardization of JPEG XS

Manage more pixels

Save cost & power

Simplify ST2110 connectivity

Preserve quality with no latency
CALL FOR A NEW STANDARD

ISO-standardization of JPEG XS

XS: Xtra Small Xtra Speed

2016

Call for proposal

A new low-latency lightweight image coding system
Liaison with AIMS, SMPTE and VSF

2017

TICO selected

as baseline amongst 6 international proposals.

2018

Collaborative work.

The standard moves to voting and publication phases

2019

JPEG-XS goes Life!

First products adopted/deployed at IBC 2019

WHERE

can JPEG XS be implemented?
Where can JPEG XS be implemented?

In any application for which *pixel perfect quality, minimal latency, low complexity,* and *efficient video bandwidth* are crucial!
A DIFFERENT APPROACH TO CREATING A CODEC
Combining the best speed, complexity and quality in one codec

Low Latency
High Quality
High Compression Ratio
All Platforms (SW/HW)
Low Complexity

JPEG XS
Intra-frame codec
Distribution Codec

JPEG XS’ BENEFITS
The most advanced lightweight codec

VISUALLY LOSSLESS
CONSTANT QUALITY
LOW COMPLEXITY
MULTI-PLATFORM
NO LATENCY
SCALABILITY
OPEN SPECIFICATIONS & INTEROPERABILITY
SUBJECTIVE AND OBJECTIVE QUALITY EVALUATION
Using CGI, desktop and natural content

New ISO/IEC 29170-2 method for near-lossless quality assessment on both natural & synthetic images)

- Full transparency to uncompressed down to 3bpp (10:1)
- Visually lossless down to 1.5bpp (20:1) on film/TV content
- Smooth degradation down to 0.5bpp (ringing artefacts/ no blocking artefacts!)

"FLICKER TEST"
Uncompressed
Interleaving original and compressed every 1/8 sec (after 7th encode/decode)

Test on 360 scores (= persons) in total (from 4 universities/research centers)
**HIGH QUALITY IN MICROSECONDS**

**Content:** Alexa Drums 444 / 8 Bit

<table>
<thead>
<tr>
<th>PSNR (dB)</th>
<th>bpp compression ratio</th>
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<tr>
<td>60</td>
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<td>25</td>
<td>7</td>
</tr>
<tr>
<td>20</td>
<td>8</td>
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</table>

**Profiles:**
- JPEG XS (WD)
- VC2
- ProRes 444
- ProRes 422 HQ
- ProRes 422 LT
- ProRes 422 Proxy

Above 40dB typically visually lossless.

Natural image with equally distributed details vertically on JPEG-XS.
HIGH QUALITY IN MICROSECONDS

Mixed desktop content with natural images, CGI content, and text on JPEG-XS

PSNR (dB)

Downsampling reduces quality

444 recommended for text and mixed content

Richter ScreenContent 444 / 8Bit

JPEG XS (WD)
VC2 LD
ProRes
ProRes 4444
JPEG2000

4:1
6:1
8:1
12:1

Mixed desktop content with natural images, CGI content, and text on JPEG-XS
BEST QUALITY IN SINGLE- AND MULTI-GENERATION

SINGLE GENERATION EXPERIMENT

![Diagram of single generation experiment]

MULTI GENERATION EXPERIMENT

Performed for 10 generations

![Diagram of multi generation experiment]

BEST QUALITY IN MULTI-GENERATION

![Graph showing PSNR vs generation number]

Notes:
- JPEG is 8bit only
- J2K is 3 to 5x more complex and needs external memory

(*) Not low complexity
(**) Not low latency
MINIMAL COMPLEXITY ON ALL PLATFORMS

...leading to maximum efficiency

- Multiple degrees of parallelism for optimed CPU, GPU, FPGA and ASIC implementations.
- Multiple profiles for low power, Low logic
  - no external memory in hardware (FPGA, ASIC)
  - The smallest codec for FPGA at this efficiency
- Optimal syntax for software and speed optimizations (CPU, GPU)
  - 5x faster or more than JPEG2000 ISO standard in CPU, GPU
- Best trade-off between cost, power consumption and quality

MINIMAL LATENCY

- Down to a few microseconds (down to 1/10 of a millisecond) = only a few video lines.
- Maximum responsiveness (few μs) - perfect for any latency critical applications
- CBR (constant bitrate) for reliable video over IP transport.

"Humans are able to detect a latency only above 13 milliseconds."

Massachusetts Institute of Technology (MIT)
MAXIMUM FLEXIBILITY
Future proof thanks to support of extensive number of video formats

Multiple resolutions — HD, 4K, 8K... up to 16Kx16K
Multiple chroma formats — 4:4:4, 4:2:2, 4:2:0, grayscale
Multiple color formats — RGB, YUV, ...
Multiple bit depths — From 8, 10, 12, 14 to 16bit
HDR support

• HD/4K/8K downscaler within workflows (i.e. for monitoring purpose)
• Lower CPU/GPU decoding requirements (less consumption to decode HD than 4K & 8K )
• Partial extraction for faster analytics and detection
### JPEG XS IS AN ISO STANDARD

Open specifications ensuring interoperability

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<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>STATUS</th>
<th>TARGET DATE</th>
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<td>ISO/IEC 21122-1</td>
<td>Part 1: Core coding system</td>
<td>Published</td>
<td>n.a.</td>
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<td>ISO/IEC 21122-2</td>
<td>Part 2: Profiles and buffer models</td>
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<td>Part 3: Transport and container formats</td>
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<td>ISO/IEC 21122-4</td>
<td>Part 4: Conformance testing</td>
<td>Under last ballot - DIS</td>
<td>Q3 2019</td>
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<td>ISO/IEC 21122-5</td>
<td>Part 5: Reference software</td>
<td>First ballot - CD</td>
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<td>ISO/IEC 21122-1 AMD1</td>
<td>Amd 1: extended capabilities</td>
<td>Working Draft</td>
<td>Q2 2020</td>
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<td>ISO/IEC 13818-1 AMD1</td>
<td>Carriage of JPEG XS over MPEG-2 TS</td>
<td>Under last ballot (Draft AMD - DAM)</td>
<td>Q4 2019</td>
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<td>IETF RFC JPEG XS RTP</td>
<td>JPEG XS RTP payload [<a href="https://datatracker.ietf.org/doc/draft-ietf-payload-rtp-jpegxs/">https://datatracker.ietf.org/doc/draft-ietf-payload-rtp-jpegxs/</a>]</td>
<td>Current version formally adopted by IETF payload WG</td>
<td>Q4 2019</td>
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<td>SMPTE ST 2110-22</td>
<td>Compressed essence in ST2110</td>
<td>Published</td>
<td>n.a.</td>
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### JPEG-XS, WITH ST 2110

**Part -22 (Compressed video essence)**

- Video RTP Packet  [Part 20/22]
- Audio RTP Packet  [Part 30/31]
- Data RTP Packet   [Part 40]
- PTP Sync Packet
- Control Packet

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Curated by Video Services Forum vsf.tv
JPEG XS ➤ ST 2110 BANDWIDTH-EFFICIENT WORKFLOW

<table>
<thead>
<tr>
<th>FORMATS</th>
<th>JPEG XS BITRATES</th>
<th>IP NETWORKS &amp; SDI MAPPING</th>
<th>INFRASTRUCTURE</th>
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<tbody>
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<td>HD 720p60</td>
<td>70 Mbps - 200 Mbps</td>
<td>1 to x streams over 1GbE</td>
<td>CAT5e</td>
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<tr>
<td>HD 1080p60</td>
<td>150 Mbps - 400 Mbps</td>
<td>1 to x streams over 1GbE</td>
<td>CAT5e</td>
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<tr>
<td>4K 2160p60</td>
<td>500 Mbps - 1,6 Gbps</td>
<td>1 stream over 1GbE</td>
<td>CAT5e</td>
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<tr>
<td></td>
<td></td>
<td>1 to x streams over 10GbE</td>
<td>HD/3G-SDI</td>
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<td>Down to a single SDI cable</td>
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</tr>
<tr>
<td>8K 4320p60</td>
<td>2 Gbps - 6,4 Gbps</td>
<td>1 stream over 2.5GbE</td>
<td>CAT5e</td>
</tr>
<tr>
<td></td>
<td></td>
<td>up to 4 streams over 10GbE</td>
<td>CAT5e</td>
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<tr>
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<td>Down to a single SDI cable</td>
<td>CAT5e</td>
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<tr>
<td></td>
<td></td>
<td>3G/6G/12G-SDI</td>
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<tr>
<td>8K 4320p120</td>
<td>4 Gbps - 12,8 Gbps</td>
<td>2 streams over 10GbE</td>
<td>CAT6</td>
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<tr>
<td></td>
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<td>Down to a single SDI cable</td>
<td>6G/12G-SDI</td>
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JPEG XS ➤ COST-EFFECTIVE ST2110 INFRASTRUCTURES

COTS in this case means max. 10GbE ports for all devices & switches.
XS meets all the ST2110 quality requirements
→ CBR, latency, quality, complexity, ...

All existing advantages of moving to IP are kept
→ flexibility, scalability, unlimited accessibility

XS bandwidth-reduction enables to achieve more with ST2110
→ Higher pixel rates, more streams, cheaper cables (CAT5e, 3G-SDI) and interfaces (<1Gpbs, <10Gbps), reduced costs, reduced storage, reduced IP packets, ...
→ Upgrade capability
→ Ease the remote production and cloud migration

Fully standardized

Thank You
Live CPU, GPU & FPGA demos at intoPIX booth (Hall 10 D31) in HD, 4K & 8K

jb.lorent@intopix.com

Thank you to our Media Partners

Curated by Video Services Forum vsf.tv
About us, intoPIX

• Founded in 2006, HQ in Belgium.
• Technology provider of innovative compression technologies empowering visual communications.
• Member of AIMS, VSF, SMPTE and JPEG committees.
• Deliver unique FPGA/ASIC IP cores and fast CPU/GPU SDKs to manage more pixels, preserve quality with no latency, save cost & power and simplify connectivity.
• Track record in terms of success stories, innovation achievements and effectiveness in enhancing Broadcast applications.
  – EMMY for technology & engineering on JPEG2000 VSF TR01, Invention & Standardization of TICO at SMPTE RDD35 and at JPEG as JPEG-XS, IABM Game Changer, IABM Peter Wayne Award for Innovation, EY Belgian Most promising growing company finalist, Delloite Fast50,...Serving 100+ customers worldwide

• More info on: www.intoPIX.com