JPEG-XS and ST 2110

IP Showcase Theater @ NAB

IP

ST 2110 is taking off

It is designed to become the infrastructure of choice

TICO Alliance

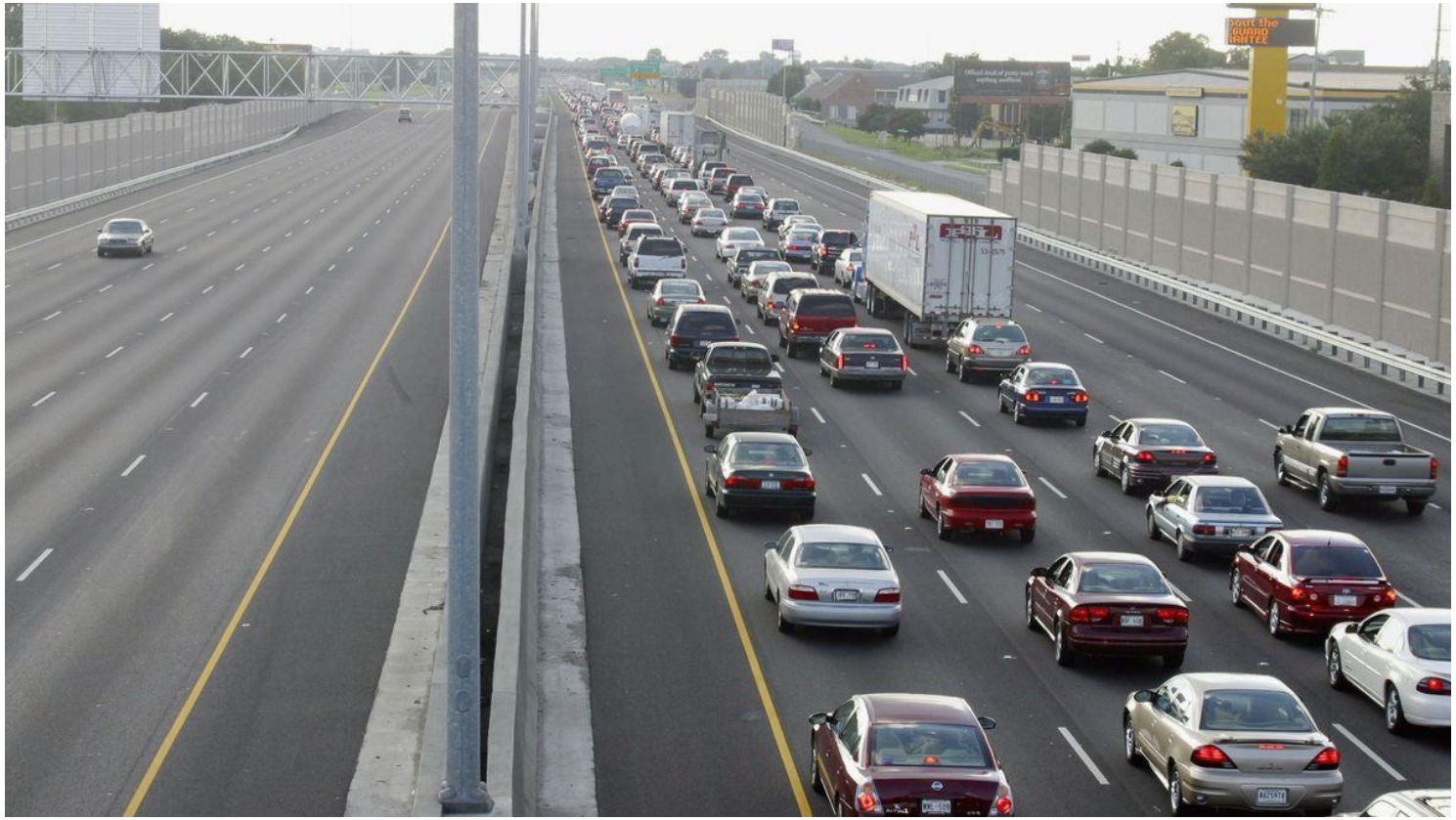
What is the « real » economics of going IP ?

- Reducing complexity
  - *less cables, bi-directional*
- Becoming more agile
  - *re-routing, easy configuration, less space, smaller building & OB , simplified workflows*
- Reducing Cost?

We have more pixels to manage, store and transport

… but the roads are jammed already

« Can we put more cars on a road without creating traffic jam & delaying the arrival time of each passengers ? »



HD: Needs 10GbE infrastructures

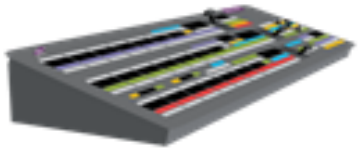
Uncompressed: **2.4 Gbps** for HD 60fps

IP INFRASTRUCTURE **10GbE**

IP CAMERAS

IP REPLAY & STORAGE

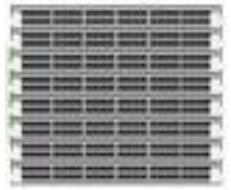
Intra-frame compression is needed for the storage to ease read & write access to the disks & to reduce storage cost of all incoming streams



IP PRODUCTION SWITCHER

IP MONITORING

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



COTS IP SWITCH

COTS in this case means at least **10GbE ports** for all devices & switches

(At least Cat 6 cables)

4K: Needs at least 25GbE infrastructures

$$

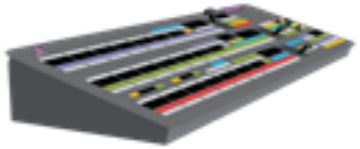
Uncompressed : **9.6Gbps** for 4K 60fps

IP INFRASTRUCTURE 25GbE ?

IP CAMERAS

IP REPLAY & STORAGE

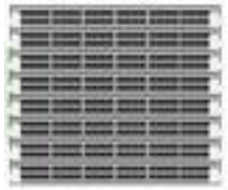
Intra-frame compression is needed for the storage to ease read & write access to the disks & to reduce storage cost of all incoming streams



IP PRODUCTION SWITCHER

IP MONITORING

New scaling capabilities needed for monitoring



COTS IP SWITCH

COTS in this case means at least **25GbE ports** for all devices & switches

8K: Needs at least 100/400GbE infrastructures

$$$

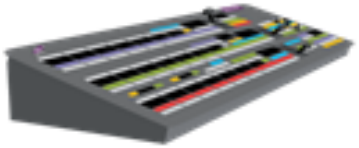
Uncompressed: **38,4Gbps** for 8K 60fps and **76,8Gbps** for 8K 120fps

IP INFRASTRUCTURE 100/400GbE?

IP CAMERAS

IP REPLAY & STORAGE

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

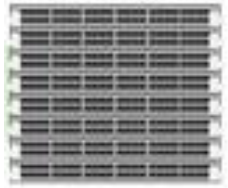


IP PRODUCTION SWITCHER

IP MONITORING

New scaling capabilities needed for monitoring

(even more steps down)



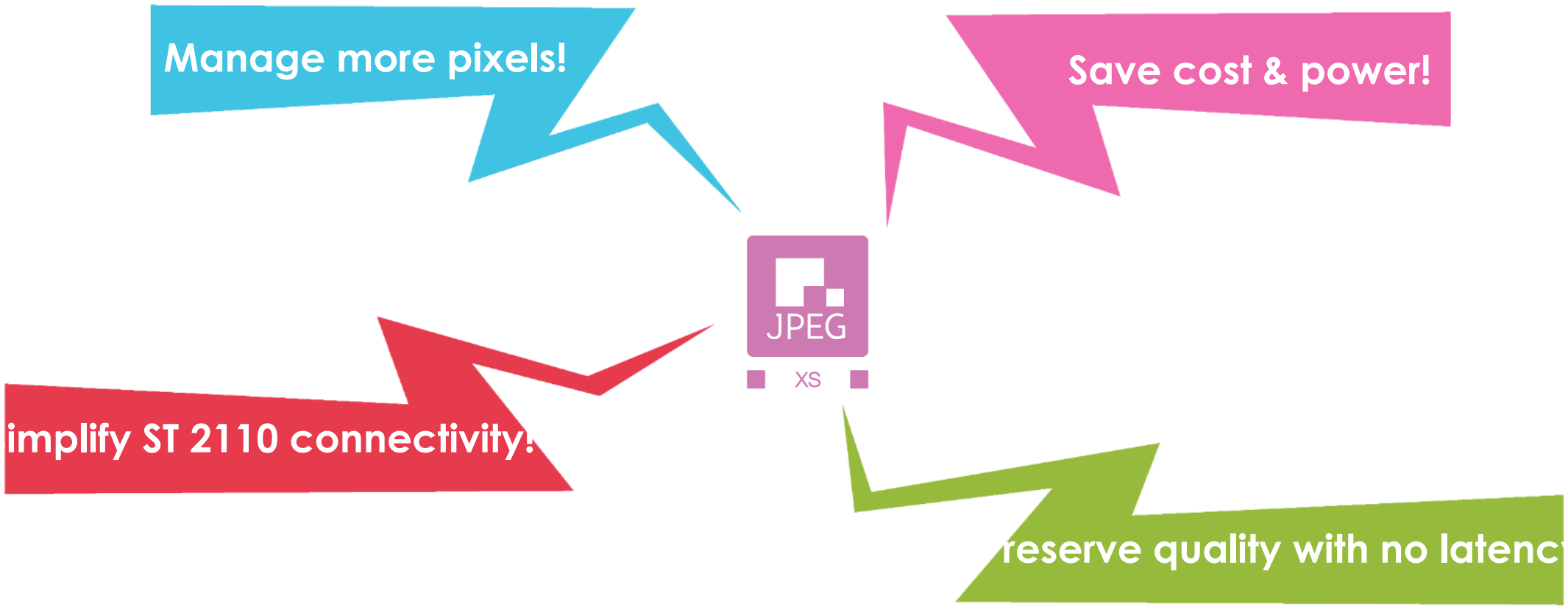
COTS IP SWITCH

COTS in this case means at least **100/400GbE ports** for all devices & switches

What if a technology could help

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

Call for a new standard



Call for a new standard

2016	2017	2018	2019
Call for proposal **A new low-latency ligthweight image coding system** *Liaison with AIMS, SMPTE and VSF*	TICO selected as baseline amongst 6 international proposals.	Collaborative work. The standard moves to voting and publication phases	**JPEG-XS** goes Life ! First implementations shown at NAB 2019

XS= **X**tra **S**mall
Xtra **S**peed

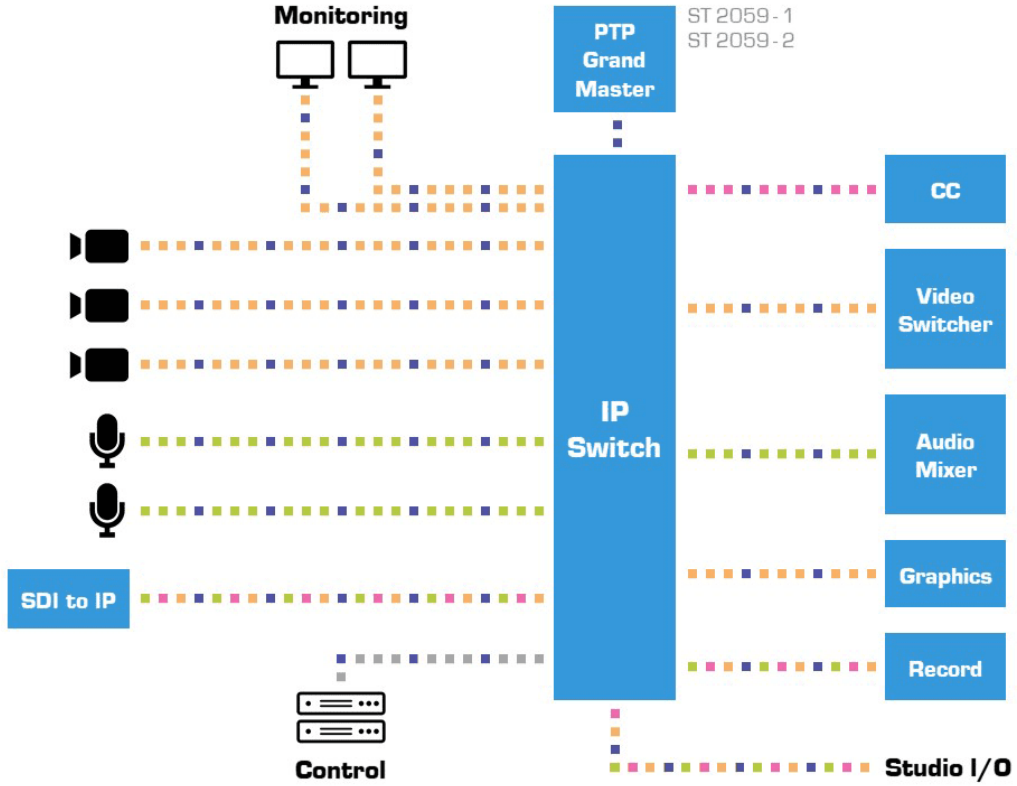
Where can JPEG XS be implemented?

Where can JPEG XS be implemented?

JPEG-XS, Coming to ST2110

- **The new 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



JPEG-XS, coming to ST 2110 ongoing standardisation

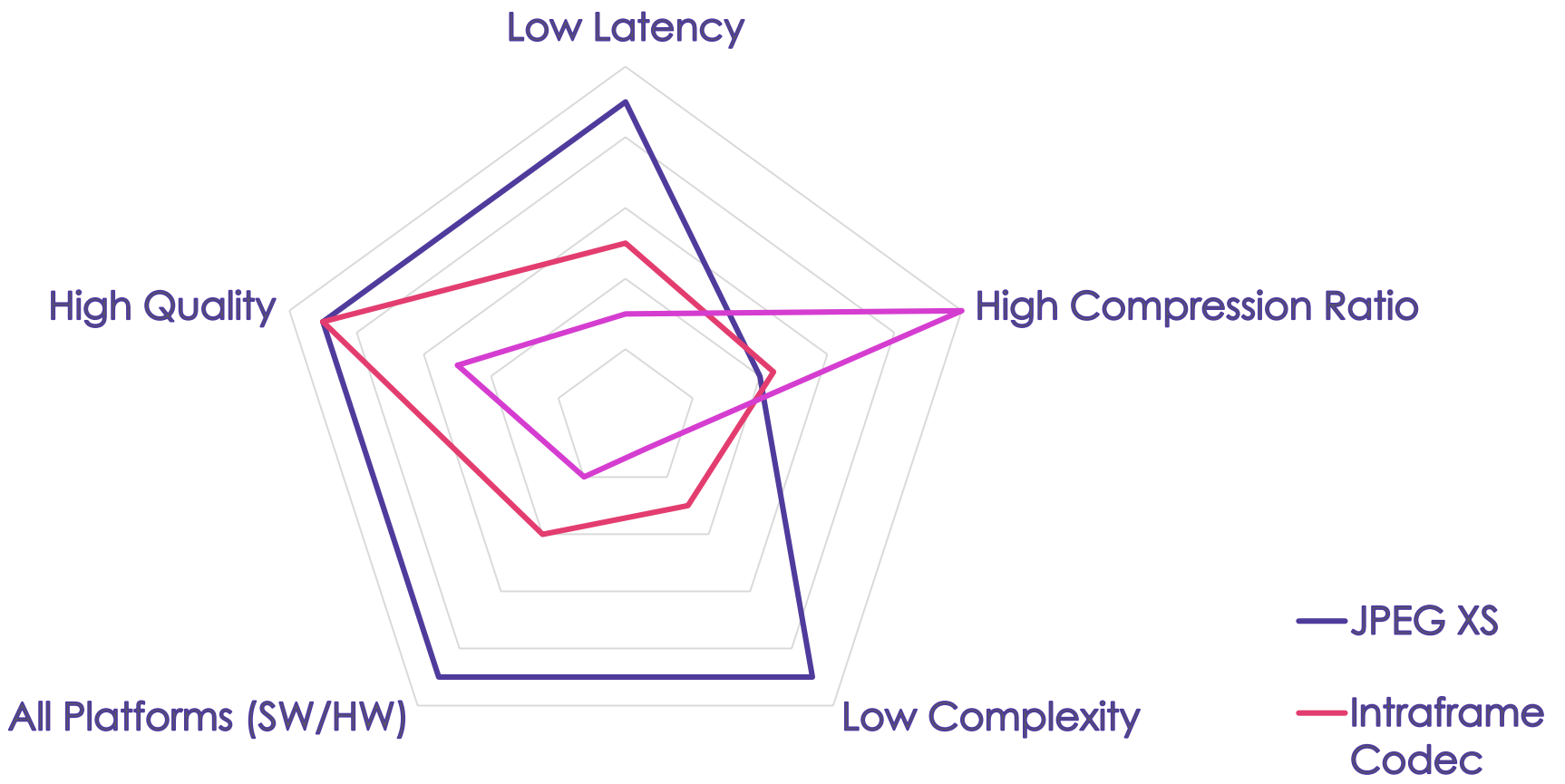
ITEM	Description	Target Date
ISO/IEC 21122-1	Part 1 : Core coding system	Q2 2019: PROOF – to be soon published + AMD for extended cap. Q2 2020
ISO/IEC 21122-2	Part 2 : Profiles and buffer models	Q2 2019: submitted to ISO for publication + AMD for extended cap Q2 2020
ISO/IEC 21122-3	Part 3 : Transport and container formats	Q3 2019: under last ballot – Final DIS
ISO/IEC 21122-4	Part 4: Conformance testing	Q3 2019: under last ballot - DIS
ISO/IEC 21122-5	Part 5 Reference software	Q4 2019: first ballot - CD
IETF RFC JPEG-XS RTP	JPEG-XS RTP payload	Draft formally adopted by IETF payload WG https://datatracker.ietf.org/doc/draft-ietf-payload-rtp-jpegxs/
SMPTE 2110-22	Compressed essence in ST 2110	Final Stage.

JPEG-XS, Benefits to ST 2110

- transport of compressed essence *instead of uncompressed*.
  - better in bandwidth to manage multiple streams in HD, 4K and 8K
- keep all existing advantages of moving to IP
  - flexibility, scalability, unlimited accessibility
- better impact on operating and infrastructure costs
  - upgrade capability, lower investments, lighter infrastructures & systems smaller interfaces, ease the remote production and cloud migration.

JPEG-XS , Replacing Uncompressed

Combining the best speed, complexity and quality in one codec



JPEG XS, Rigorous ISO Quality Assessments

Tests with objective and subjective methods

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

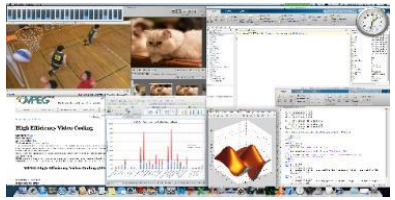
- ✓ Full transparency to uncompressed down to 3bpp (10:1)
- ✓ Visually lossless down to 1.5bpp (20:1) on film/TV content
- ✓ Smooth degradation down to 0.5bpp

  (ringing artefacts/ no blocking artefacts!)

"FLICKER TEST"

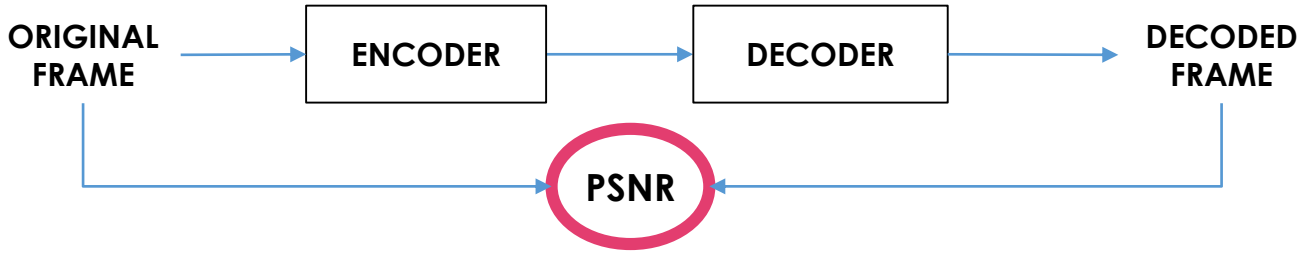
Test on 360 scores (= persons) in total (from 4 universities/research centers)

JPEG XS, Example content (CGI, desktop, natural)



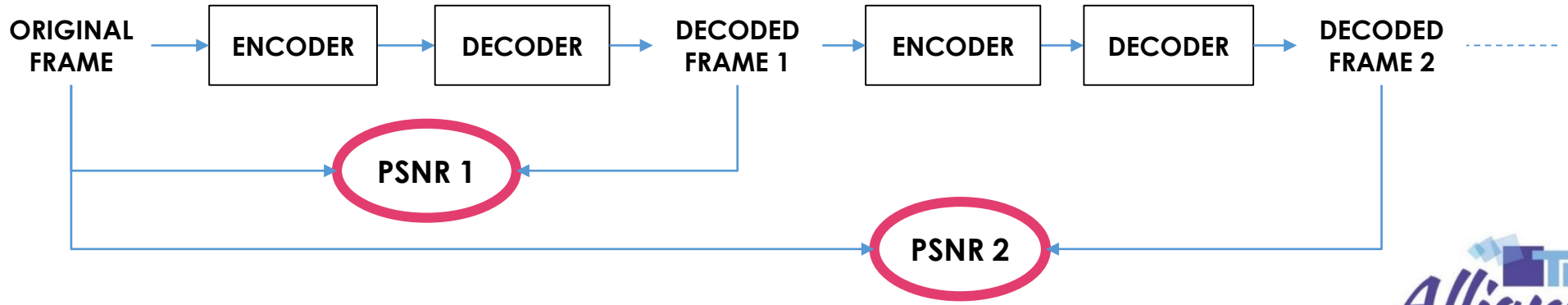
JPEG XS, Best quality in single- and multi-generation

SINGLE GENERATION EXPERIMENT

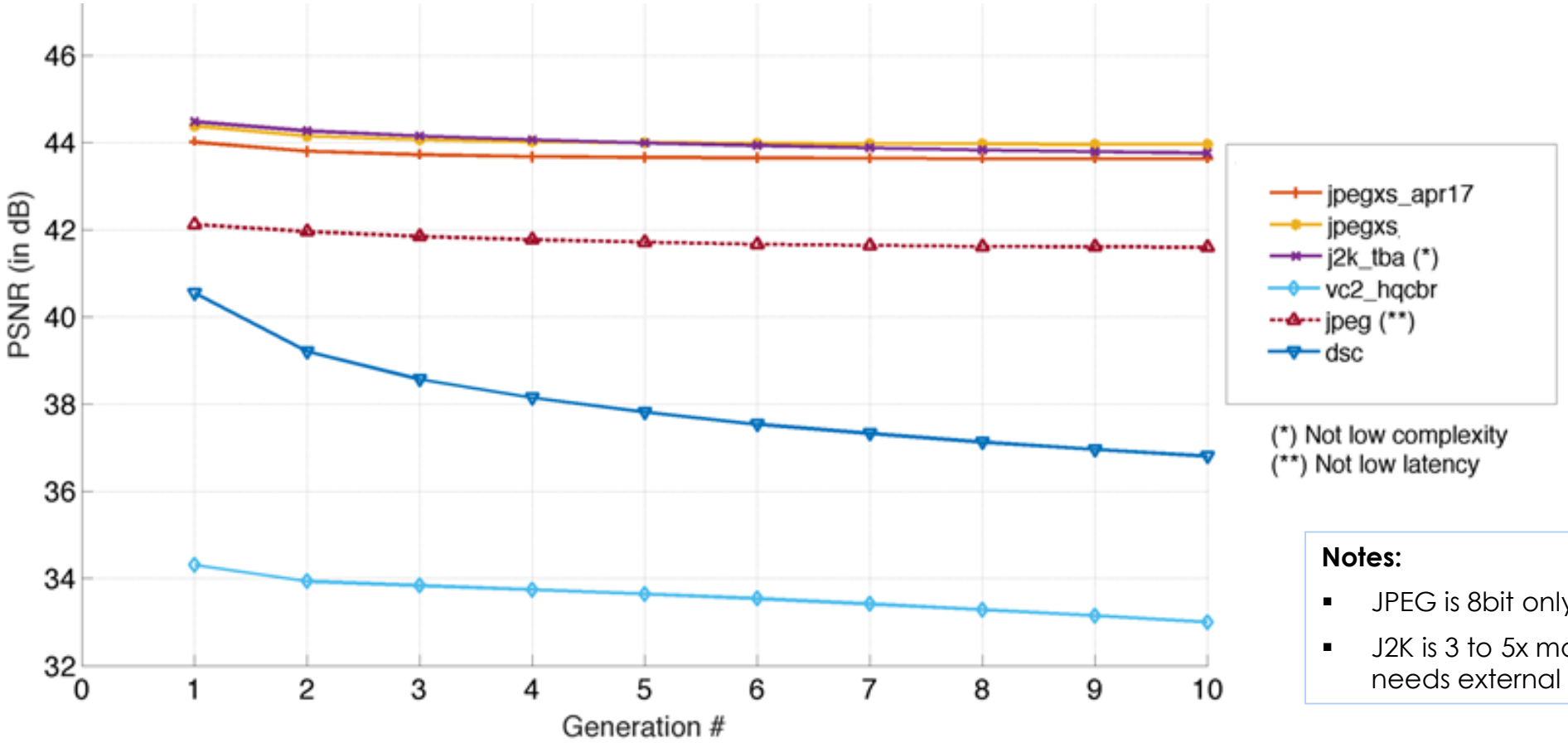


MULTI GENERATION EXPERIMENT

Performed for 10 generations



JPEG XS, Best quality in multi-generation



Notes:

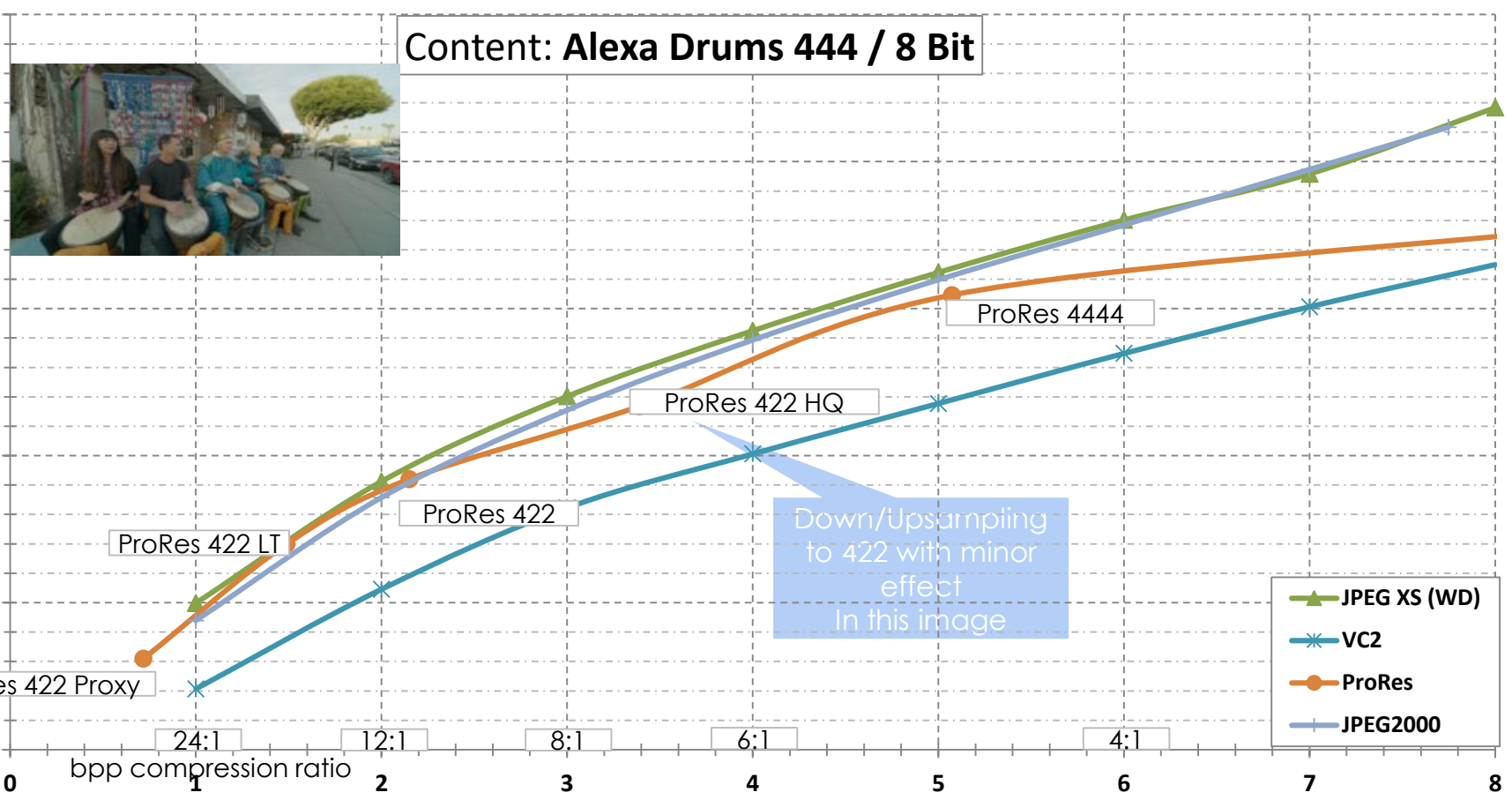
- JPEG is 8bit only
- J2K is 3 to 5x more complex and needs external memory

JPEG-XS, High Quality in microseconds

Test: Natural image with equally distributed details vertically on JPEG-XS

JPEG-XS, High Quality in microseconds

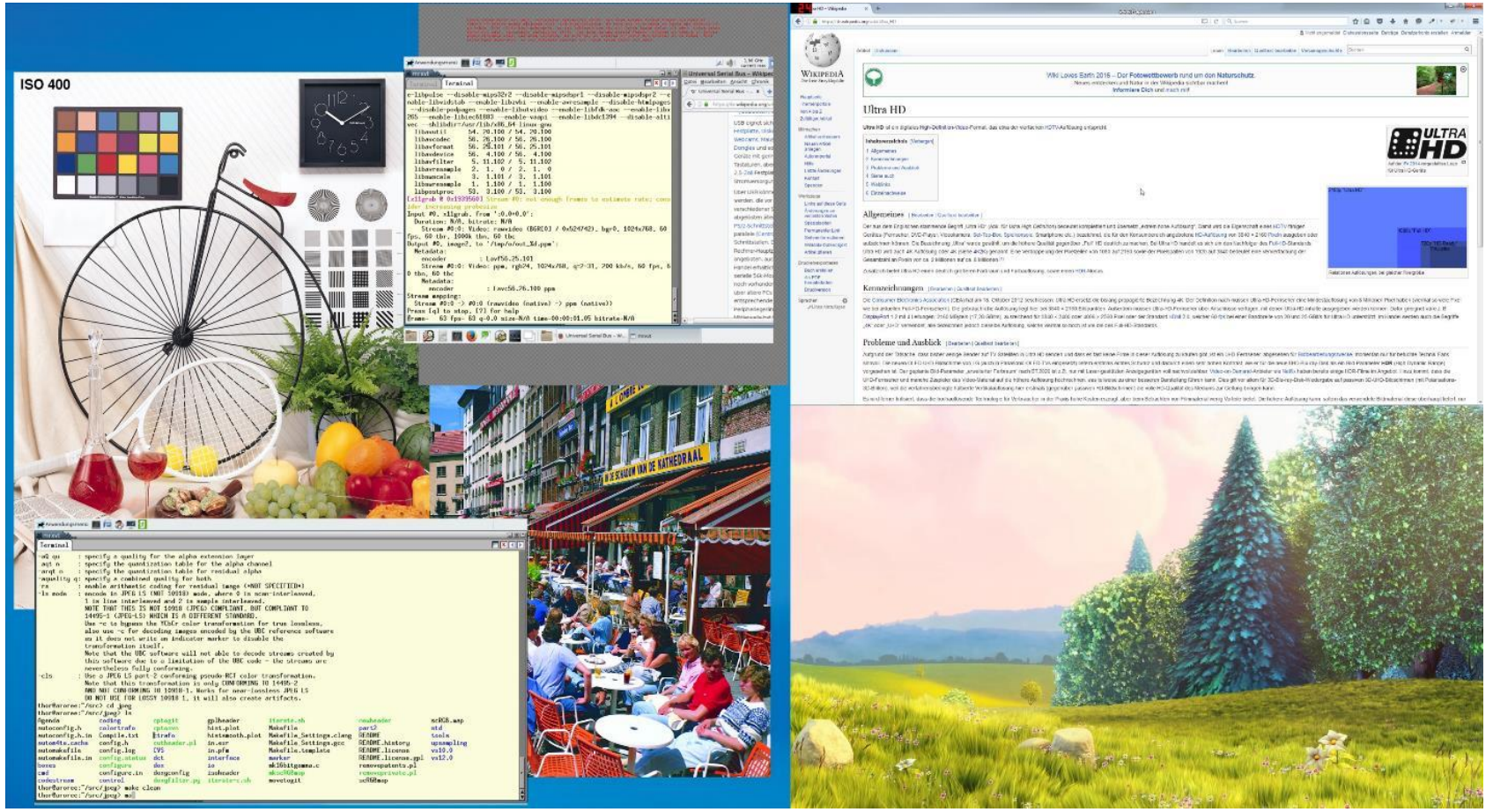
Test: Natural image with equally distributed details vertically on JPEG-XS



Above 40dB **typically visual lossless**

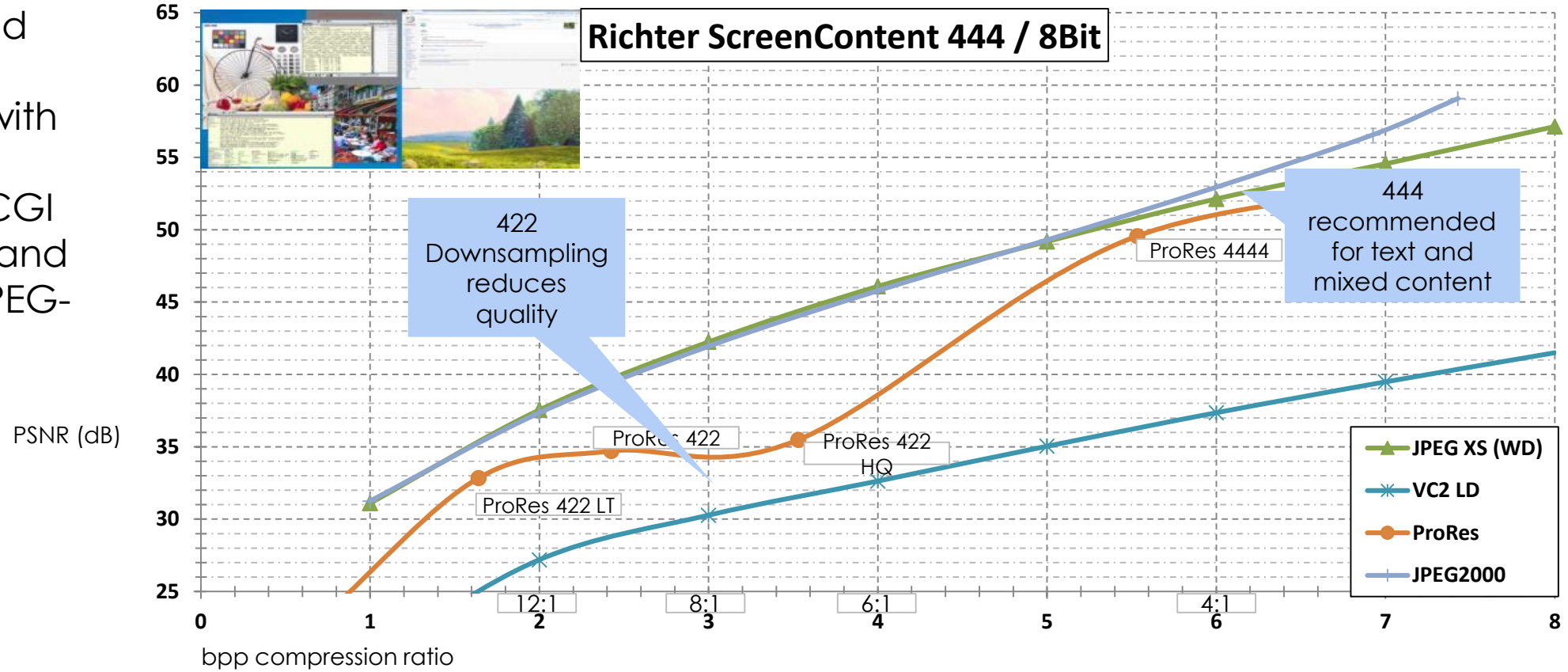
JPEG-XS, High Quality in microseconds

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



JPEG-XS, High Quality in microseconds

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



JPEG-XS, Minimal latency

- Down to a few **microseconds** (down to 1/10 of a millisecond): **:** only a few video lines.
- Maximum responsiveness (few µs) – lines - 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)

JPEG XS, All platforms

Minimal complexity…leading to maximum efficiency

- 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)
  - *up to 5x faster or more than JPEG2000 ISO standard in CPU, GPU*
- Best ratio cost/infrastructure trade-off & Best ratio power trade-off

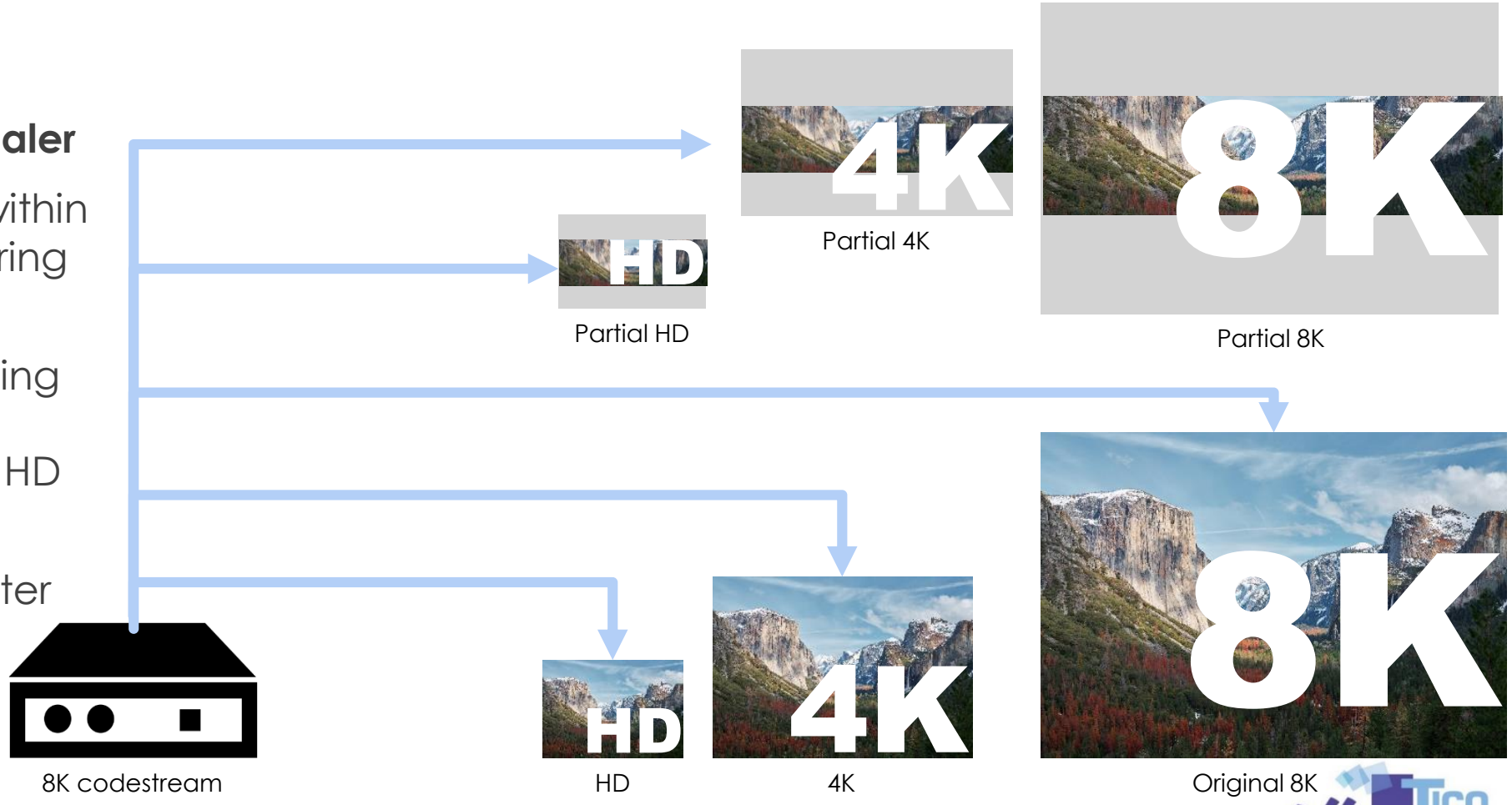
JPEG XS, Maximum Flexibility

- **Multiple resolutions :** HD, 4K, 8K… up to at least 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 :** HDR support

JPEG XS, Maximum Flexibility

Built-in 1- to 2-level downscaler

- 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, ST 2110 Bandwidth-efficient workflo

HD, 4K, 8K uses no more than **10GbE or even just CAT5e**

FORMATS	JPEG-XS	IP NETWORKS & SDI MAPPING
HD 720p60 /1080i60	200 Mbps - 70 Mbps	1 to x streams over 1GbE (CAT 5e)
HD 1080p60	400 Mbps - 150 Mbps	1 to x streams over 1GbE (CAT 5e)
4K 2160p60	1,6 Gbps - 500 Mbps	1 stream over 1GbE (CAT 5e) 1 to x streams over 10GbE (CAT 6) *Down to a single SDI cable (HD/3G-SDI)*
8K 4320p60	6,4 Gbps - 2 Gbps	1 to 4 streams over 10 GbE (CAT 6) *Down to a single SDI cable (3G/6G/12G-SDI)*
8K 4320p120	12,8 Gbps - 4 Gbps	1 to 2 streams over 10 GbE (CAT 6) *Down to a single SDI cable (6G/12G-SDI)*

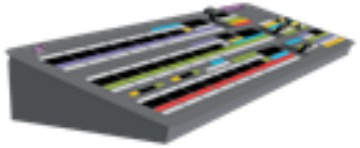
JPEG XS, ST 2110 Bandwidth-efficient workflo

HD, 4K, 8K uses no more than **10GbE** **or even just CAT5e**

IP INFRASTRUCTURE **max. 10GbE**

IP CAMERAS

IP REPLAY & STORAGE

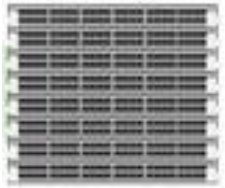


IP PRODUCTION SWITCHER

IP MONITORING

Full access to 8K proxies directly from the coded streams

No scaling required, even from a simple laptop



COTS IP SWITCH

COTS in this case means max. **10GbE ports** for all devices & switches

Conclusion

- JPEG-XS meets all the ST2110 quality requirements
  - CBR, latency, quality, complexity, …
- JPEG-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, …

ST2110-22 & JPEG-XS are enabling to create cost-effective, bandwidth-efficient and high quality IP production workflows

Tico Alliance