



# intoPIX

Take **IMAGING** to the **NEXT LEVEL**

# ABOUT INTOPIX

## In a nutshell

- Headquarter: Mont-Saint-Guibert , Belgium
- Founded : in 2006 , privately owned
- Team: 30 people
- Model : B2B business – technology licensing and engineering
- Finance : zero debt company – profitable growth
- 7 granted patents - 2 pending patents
- Technology provider of innovative image processing & compression technologies empowering visual communications



Cores Technologies & Capabilities	Products	Applications / Markets	Select Customers
<ul style="list-style-type: none"><li>• Image/Video Compression</li><li>• Image Processing</li><li>• Security/Encryption</li><li>• AV over IP</li><li>• Algorithm Research</li><li>• FPGA/ASIC design</li><li>• Software acceleration (x86-64, GPU, ARM)</li></ul>	<ul style="list-style-type: none"><li>• IP-cores for FPGA/ASIC</li><li>• SDKs for CPU / GPU</li><li>• Software</li><li>• Reference designs</li><li>• Engineering Services</li></ul>	<ul style="list-style-type: none"><li>• Digital Cinema</li><li>• Pro AV</li><li>• Broadcast</li><li>• Industrial Vision</li><li>• Automotive</li><li>• GIS / Aerospace</li><li>• Consumer Electronics</li></ul>	 A grid of logos for various select customers, including Sony Digital Cinema 4K, Panasonic, Christie, ARTEL VIDEO SYSTEMS, AJA VIDEO SYSTEMS, MEDIA LINKS, nevion, NEC, AXON, NTTAT, grass valley (a BELDEN BRAND), embrionix, Icron, CRESTRON, and Blackmagicdesign. An ellipsis (...) is located at the bottom right of the grid.

# CORNERSTONE OF CINEMA DIGITALIZATION

65% of cinemas around the world use intoPIX's technologies



**1 bn**  
people / year

# EMMY AWARD WINNING TECHNOLOGY

intoPIX's technologies are used in live broadcast of major events

✓ OLYMPIC GAMES

✓ FIFA WORLD CUP

# PIONEERING NEW TV FORMATS

intoPIX's technologies are part of Japanese national TV's 8K Super Hi-Vision TV channel



# MAKING RAW FASTER, BETTER, SMALLER

intoPIX's technologies increase RAW quality & simplify the imaging & camera workflows





# EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT



AND THE INTOPIX  TicoXS SOLUTIONS

# WE HAVE MORE PIXELS TO MANAGE, STORE AND TRANSPORT

... and the roads are jammed already!



*"How to put **more cars** on the road  
without creating traffic jams & delaying  
arrival times of each passenger?"*

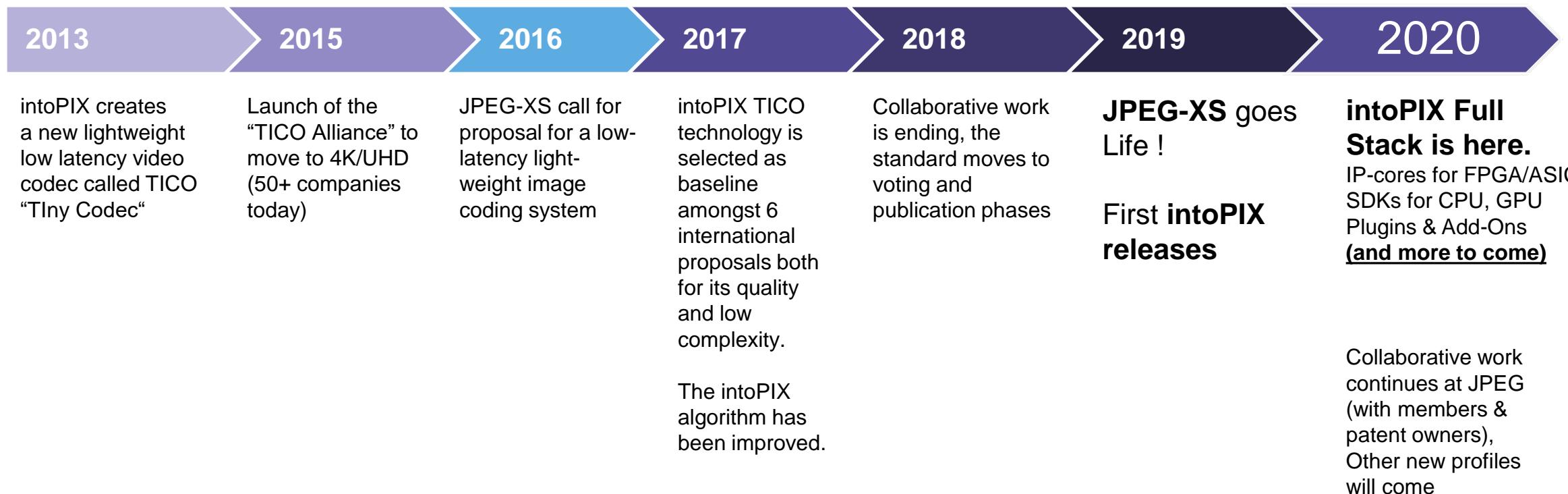
# WHAT IF A “LITE” TECHNOLOGY COULD HELP?



# JPEG XS STANDARDIZATION : THE JOURNEY

From intoPIX TICO proprietary compression to the ISO JPEG XS and intoPIX TICO"XS" implementation

**XS = Xtra Small  
Xtra Speed**



# JPEG XS STANDARDIZATION : THE JOURNEY

Call for a new JPEG standard (2017)

**XS = Xtra Small  
Xtra Speed**

**As stated in the Joint Photographic Expert Group (JPEG):**

“JPEG XS is a **new compression algorithm** with **very low latency and very low complexity**.

By offering various degrees of parallelism, JPEG XS can be efficiently implemented on various platforms such as **FPGAs, ASICs, CPUs and GPUs** and excels with high multi-generation robustness.

It is particularly optimized for visual lossless compression as defined in ISO/IEC 29170-2 for both natural and synthetic images. It **offers truly transparent compression with undistinguishable flickering between original and compressed image** (as defined in ISO/EIC 29170-2). Typical compression ratios are between 2:1 and 10:1 for both 4:4:4 and 4:2:2 images and image sequences with up to 16-bit component precision but can also be higher depending on the nature of the image or the requirements of the targeted application.

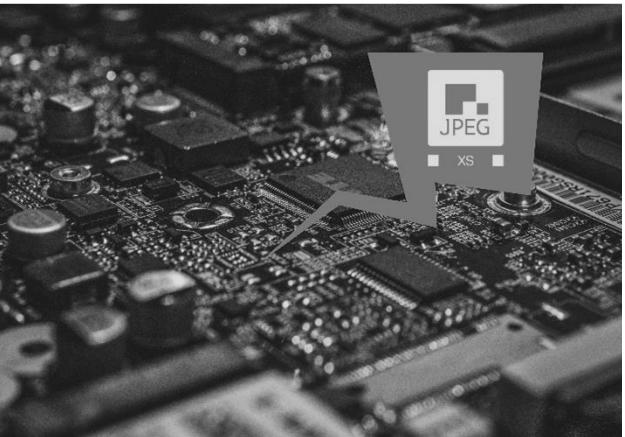
Typical parameterizations address a maximum algorithmic **latency between 1 - 32 video lines for a combined encoder-decoder suite.”**

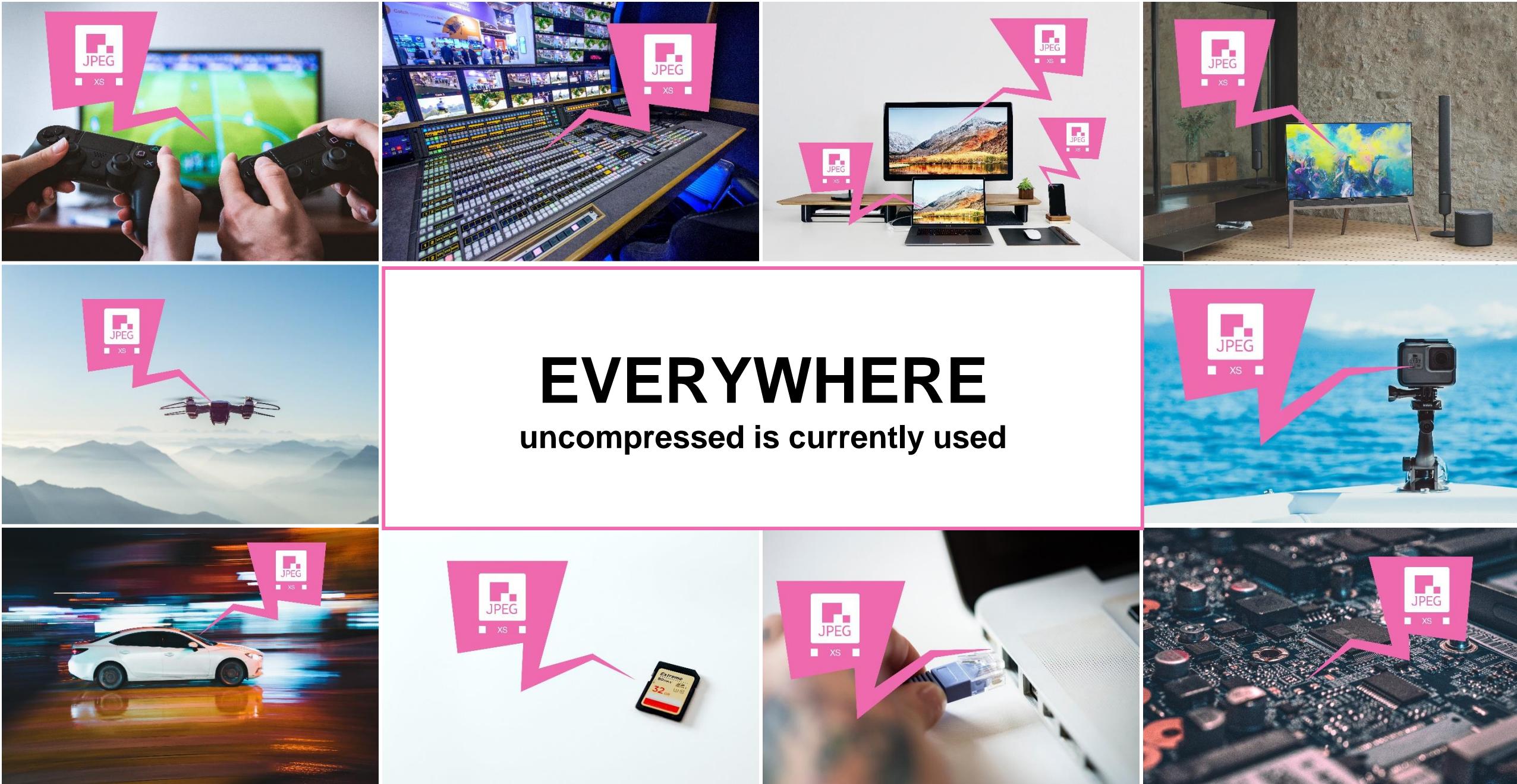
Joint Photographic Expert Group (2017)



# WHERE

## can JPEG XS be implemented?





# THE ALTERNATIVE?

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- **Expensive hardware upgrade:** big investments, huge transition costs
- **Heavy infrastructures & systems:** complete redesign, higher complexity , complete re-installation...
- **Higher power consumption:** more interfaces, more bandwidth, more memory



# JPEG XS BENEFITS

# BENEFITS OVERVIEW



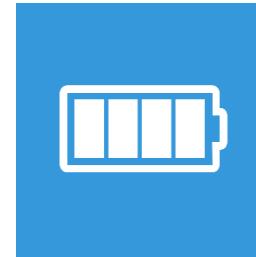
## JPEG XS standard

Standardized at ISO  
Co-created by intoPIX



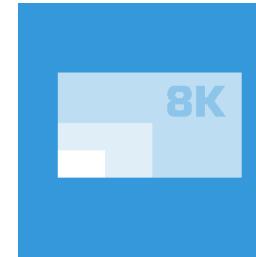
## Perfect image quality

Fully transparent  
down to 3bpp  
Visually lossless up  
to 1.5bpp  
HDR capability  
Constant quality



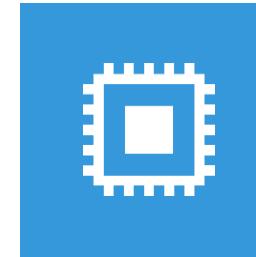
## Low power

No external memory,  
only a few internal  
SRAMs



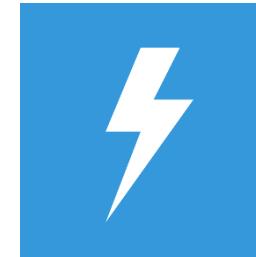
## Better quality pixels

More pixels, higher bit  
depth, high frame rates,  
all at the cost of  
baseband HD



## Ultra-low complexity

Low logic & low memory  
in ASIC or FPGA  
Highly parallelizable for  
CPU & GPU



## Microsecond latency

Line-based processing  
(or even less than a line)

# A STANDARD FOR INDUSTRY-WIDE SUPPORT

From users' feedback to innovation to adoption to standardization - the logical path



## 1. intoPIX TICO (TIny COdec) for Professional Media Networks (2013)

- Submitted to the Joint-Task Force for Media Networks (JT-NM) in 2013

## 2. TICO SMPTE RDD35 for interoperability (2016)

- Specifies TICO compression, RTP payload, mapping on SDI
- available on the IEEE/SMPTE library

## 3. Supported and promoted by the TICO Alliance

- Open organization collaborating on adoption and interoperability
- [www.tico-alliance.org](http://www.tico-alliance.org)

## 4. TICO goes JPEG-XS: ISO standard & profiles (2018-2019)

- Call for proposal initiated 3 years ago at JPEG by intoPIX
- Standard and profiles coming at JPEG, and new payload RTP at IETF
- Open specification available on ISO website
- **intoPIX releases new TICO-XS codecs**

# PIXEL PERFECT QUALITY

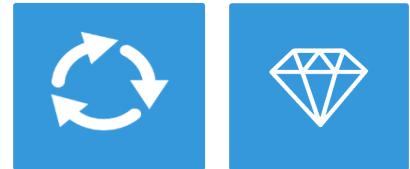
Any content, any application



- ✓ Lossless quality for human vision
- ✓ Lossless quality for machine vision (AI, analytics)
- ✓ Robust to multi-generation (encoding/decoding loop)
- ✓ Robust to error propagation
- ✓ CBR (constant bitrate)

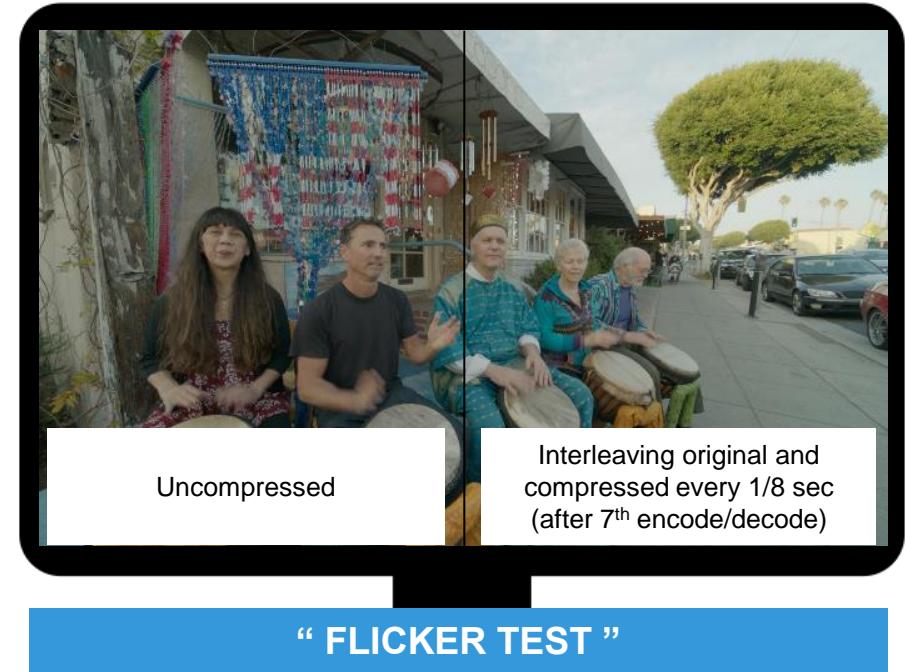
# PIXEL PERFECT QUALITY

Using rigorous ISO quality assessments methods



- ✓ Full transparency to uncompressed down to 3bpp (~10:1)
- ✓ Robust over multiple encoding passes (same PSNR)
- ✓ Visually lossless down to 1.5bpp (20:1) on most film/TV content
- ✓ Smooth degradation down to 0.5bpp: no blocking artefacts!

4K Content examples (CGI, desktop, natural image, ..)



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

# PIXEL PERFECT QUALITY

Typical operating bitrates\*

FORMATS	XS BITRATES (1bpp to 3bpp)
HD 720p60 HD 1080i60	70 Mbps - <b>195 Mbps</b>
HD 1080p60	150 Mbps - <b>390 Mbps</b>
4K 2160p60	500 Mbps - <b>1,4 Gbps</b>
8K 4320p60	2 Gbps - <b>5,6 Gbps</b>

(\*)less compression can always be applied

# PIXEL PERFECT QUALITY

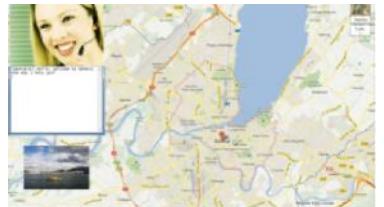
Subjective evaluation setup at ISO JPEG committee



Evaluation based on “flicker test” means:

- interleaving of original and processed (compressed and decompressed) 4K image every 1/8 sec
- Playback on 4K professional Eizo monitor 10bit at 24Hz with viewing distance: 0.5m
- Used 7<sup>th</sup> generation of multi-generation test at compression ratios ranging from 3:1 to 10:1
- No. of participants: 360 scores (= persons) in total (from 4 universities/research centers)

Example content (CGI, desktop, natural image, ..)

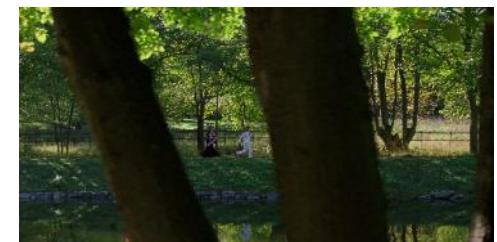
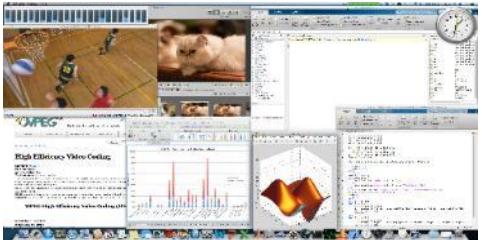


# PIXEL PERFECT QUALITY

Objective evaluation setup at ISO



Example of 4K video sequences (CGI, desktop, natural image, ...)



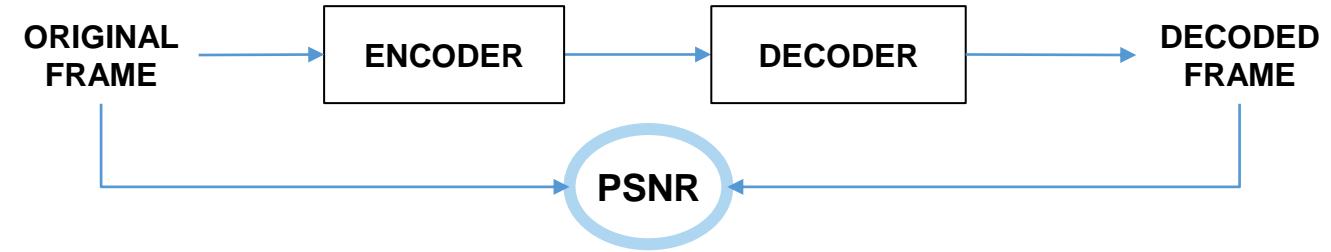
# PIXEL PERFECT QUALITY

Objective evaluation method: single- and multi-generation experiments



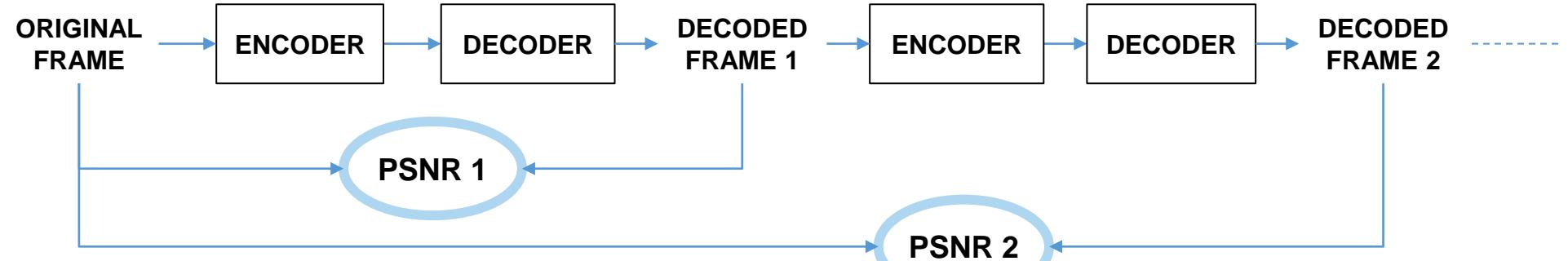
## SINGLE GENERATION EXPERIMENT

Performed at 3, 4, 5, 6, 8, 10, 12 and 14 bpp  
(originals 24bpp up to 36bpp)



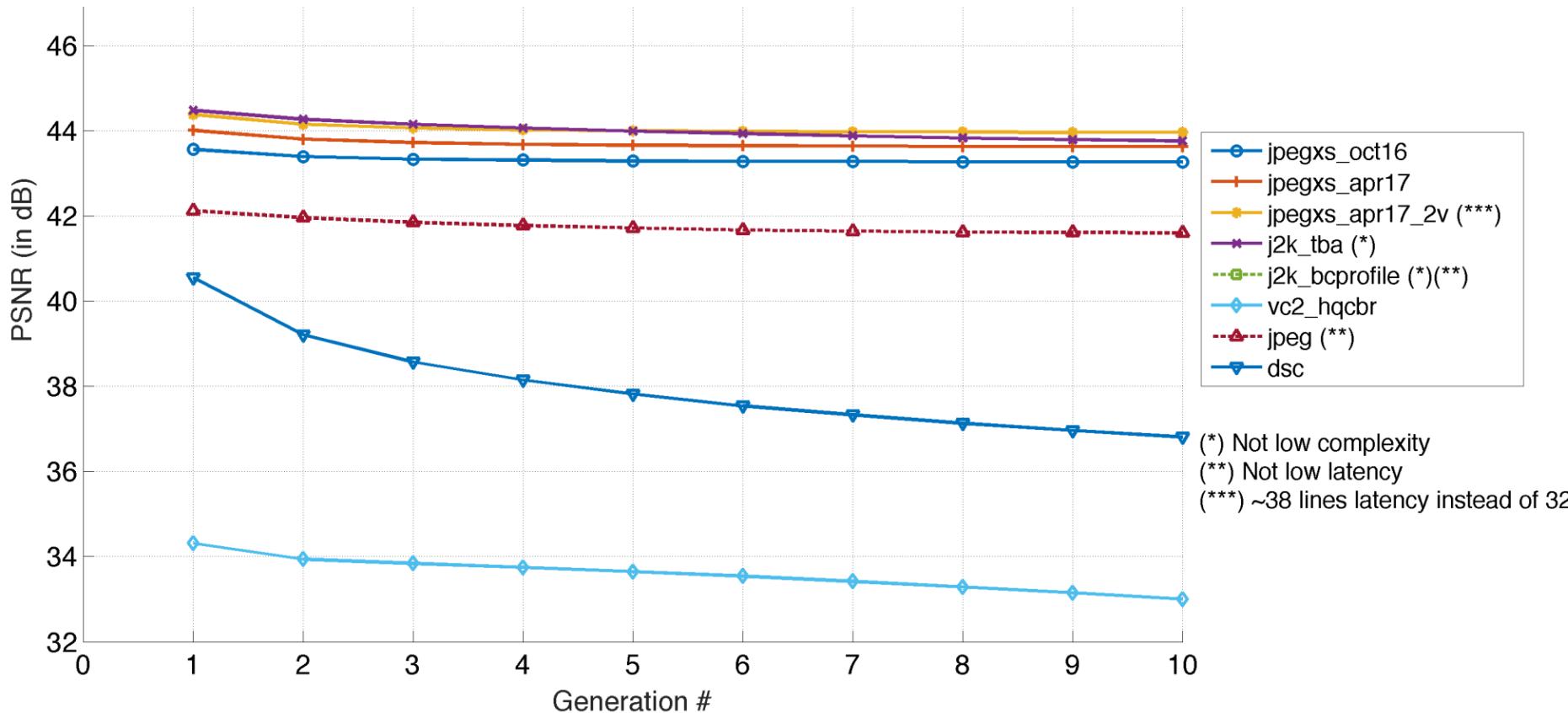
## MULTI GENERATION EXPERIMENT

Performed at 6 bpp  
for 10 generations



# PIXEL PERFECT QUALITY

Robust to multiple encoding generations



JPEG XS keeps the same quality after multiple encoding /decoding.

Other codecs such as DSC or VC2 for example are significantly loosing their quality after multiple encode/decode

- Notes:**
- JPEG is 8bit only
  - J2K is 4x - 5x more complex and needs external memory

# PIXEL PERFECT QUALITY

Added IntoPIX Innovative processing



- **Optional modes (COMING):** *intoPIX implementation offers additional modes for both natural & screen content. These modes bring further quality on top of JPEG-XS profiles for more compression efficiency with very low complexity impact.*

# MINIMAL LATENCY

From 0,5 lines to 16 video lines, encoding & decoding in **microseconds**



“

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

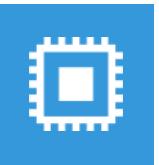
Massachusetts Institute of Technology (MIT)

“

- 1/10 of milliseconds / Without perceptible delay - perfect for human interaction
- Cascade 50 encoders/decoders and do not suffer from higher latency!
- Maximum responsiveness (few  $\mu$ s) – lines - perfect for event detection, machine vision and other latency critical applications

# MINIMAL COMPLEXITY

... leading to maximum efficiency

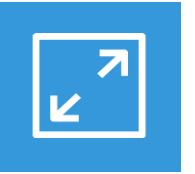


- **Low power / low logic and no external memory for hardware**
- **Fast and compact on multi-platform: highly parallelizable in software**
- Better syntax :
  - Depending on the JPEG-XS profile, could go up to 10x faster/smaller than JPEG2000 ISO standard in FPGA, ASIC, CPU, GPU
  - GPU: 100x to 1000x more options to parallelize compared to JPEG2000 ISO standard

- Best ratio cost/infrastructure trade-off
- Best ratio power trade-off
- Aggregation of multiple streams on one port/cable
- Support of higher pixel rates

# FUTURE-PROOF

More pixels, higher bit depth, higher frame rates ...



## Multiple resolutions

- HD, 4K, 8K... up to 16K or more if needed

## Multiple chroma formats

- 4:4:4, 4:2:2, 4:2:0 (grayscale), 4:0:0 (alpha) , 4:2:2:4, 4:4:4:4

## Any color space

- RGB, YUV, XYZ, RAW,...

## Multiple bit depths

- 8, 10, 12, 14,16 bit

## HDR support

- All signaling support (SDR, HDR,...)

## Any frame rates

- No limitations

## Scalability

- XS Proxies are part(s) of the XS master !

# MULTI-RESOLUTION FLEXIBILITY

Built-in 1- to 2-level downscaler and partial extraction in all intoPIX solutions



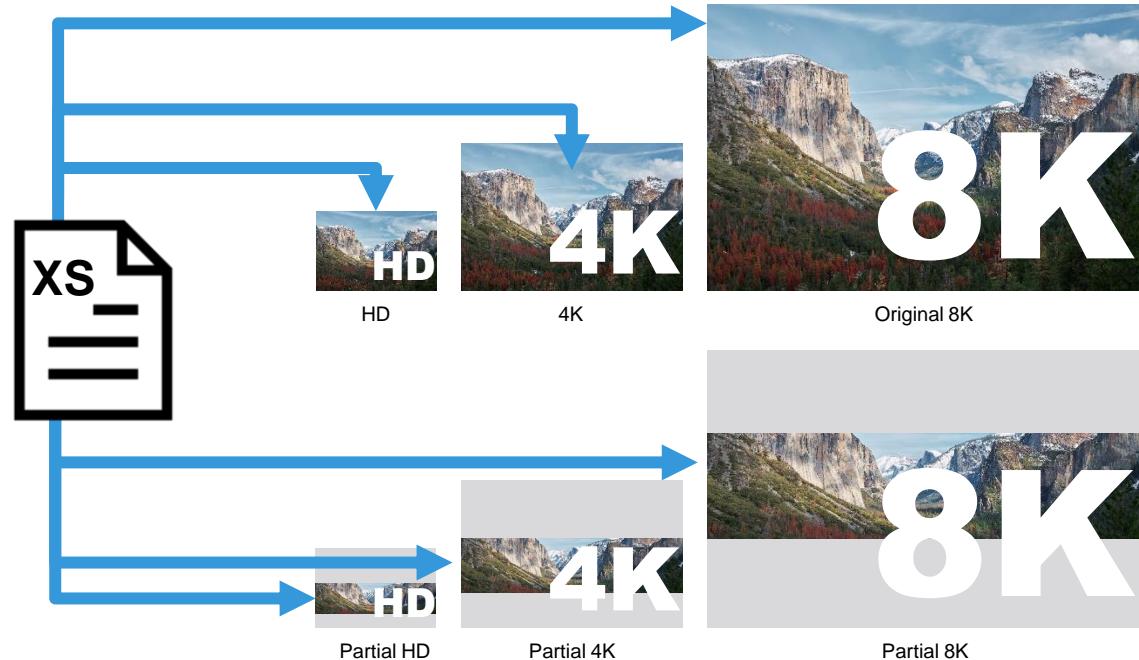
**Proxy is part of the master, not separated.**

- Easy to build video monitoring or editing applications, that will only decode smaller resolutions of all the incoming HD, 4K or 8K streams
- Less consuming software decoding to access HD or 4K proxies from 8K master. Eliminate need for additional 4K/8K downscaler within workflows
- Reduce CPU/GPU decoding requirements (ie. less consumption to decode proxy HD than 4K & 8K )
- Monitoring UHDTV streams as if they were HD streams
- Partial extraction for faster analytics and detection for faster image analytics/classification for AI systems

**Ease of transcoding and playout**

- Direct output of 3 resolutions from a single JXS compressed stream

=> Example: from a 8K XS file/stream, transcode 8K and 4K resolutions to HEVC and HD resolution to H264.

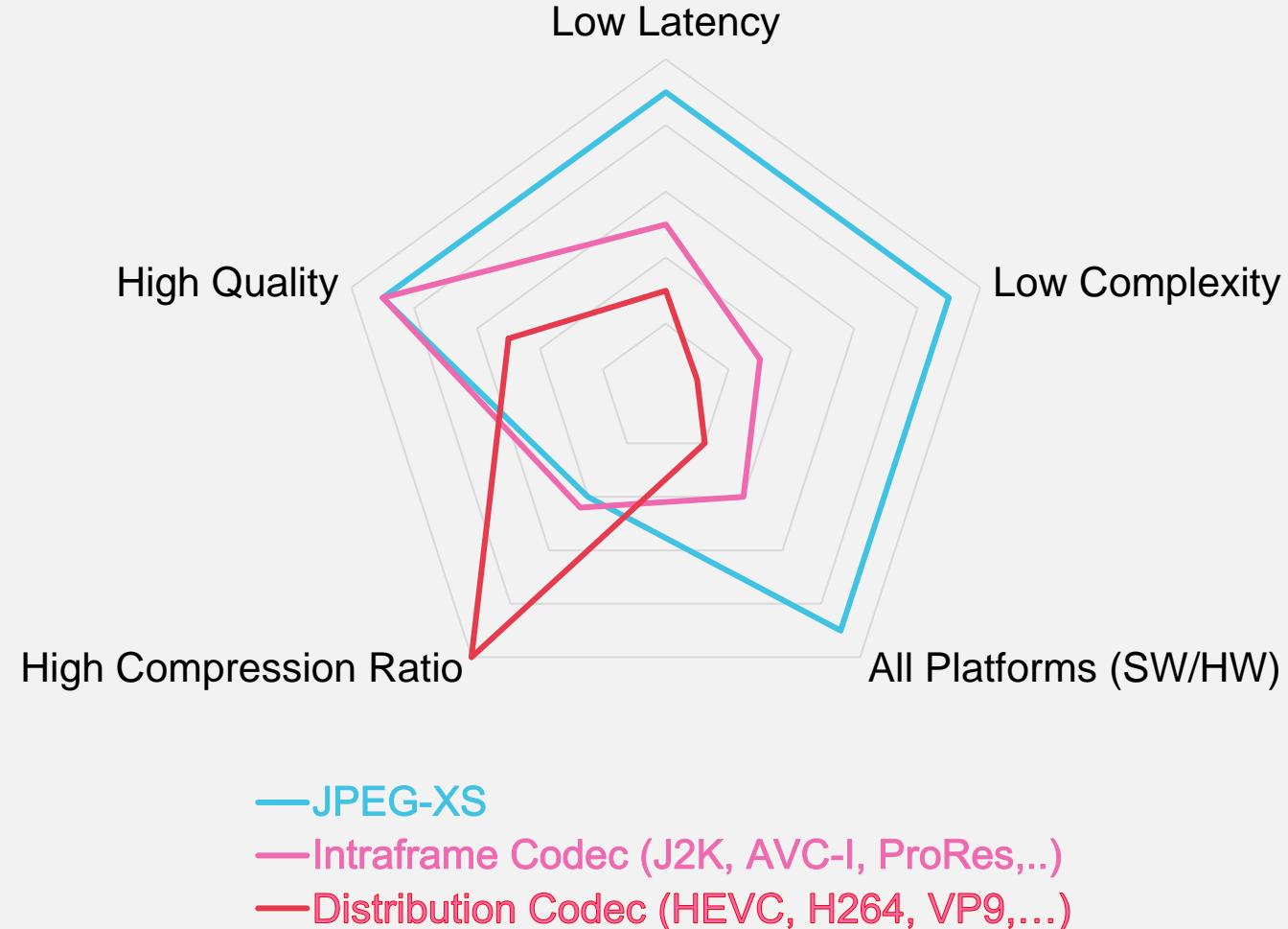


# JPEG-XS, REAL ALTERNATIVE TO UNCOMPRESSED

...versus other intraframe and distribution codecs



Combining the best speed, complexity and quality in one codec



# JPEG XS CAN BE USED WHEN

UNCOMPRESSED DATA RATES ARE NOT REALISTIC



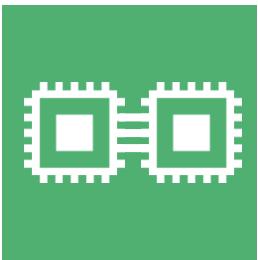
IP Production  
Remote production



Cloud processing  
& storage



Automotive



Chip-to-chip



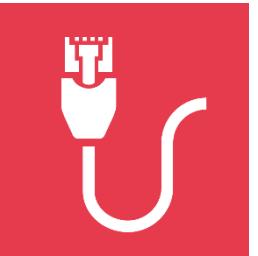
Displays  
& Mobile



AR/VR  
Headsets



5G &  
Wireless



AV over IP  
KVMs

BUT LATENCY & COMPLEXITY  
ARE CRITICAL

- ✓ **Support More pixels** using existing devices and infrastructures
- ✓ **Reduce internal video bandwidth (and power!)** or 'cost-effectively' increase storage capacity
- ✓ **To build an efficient hardware & software-based ecosystem** without expensive processing, bandwidth, latency and storage capacity
- ✓ **Without affecting the quality/latency/complexity**



# TICO-XS FULL STACK

Q3 2020 releases

# THE TICO-XS FULL STACK

Optimal implementations of JPEG XS



## IP-CORES for FPGA & ASIC



- ENCODERs & DECODERs
  - configurable footprint according to the targeted application
  - focus on High Profile (for highest quality) with adjustable compression rate (with CBR)
  - ~ 10 lines of latency to encode or decode (whatever the video format)
  - no DDR
  - Downscale at decoder
- Ported & validated in most of the current & (even) “oldest” series of FPGAs + synthetized on 28nm TSMC
  - TICO-XS cores have a similar size (and interfaces) than TICO-RDD35 cores and are 4-5 x smaller than J2K cores. Firmware upgrade is feasible!
  - Many HD, 4K encoders/decoders can fit in a single FPGA.
  - NEW 8K CORES!



## SDKs for CPU or GPU



- ENCODER & DECODER are available
- constant performances increases over the previous releases (doubled speed from Spring 20Q1 releases)
- up to 8K resolutions!
- ADD-Ons (SDI, FFmpeg, Part3, Downscale at decoder)



# IP-CORES

# TICO-XS IP-CORES

## Overview



### HD CORES

- HD 60fps 422 or HD 60fps 422 / 444
- HD 120fps / 240fps 422

### 4K CORES

- 4K 60 fps 422 or 4K 60fps 422 / 444
- 4K 120 fps 422

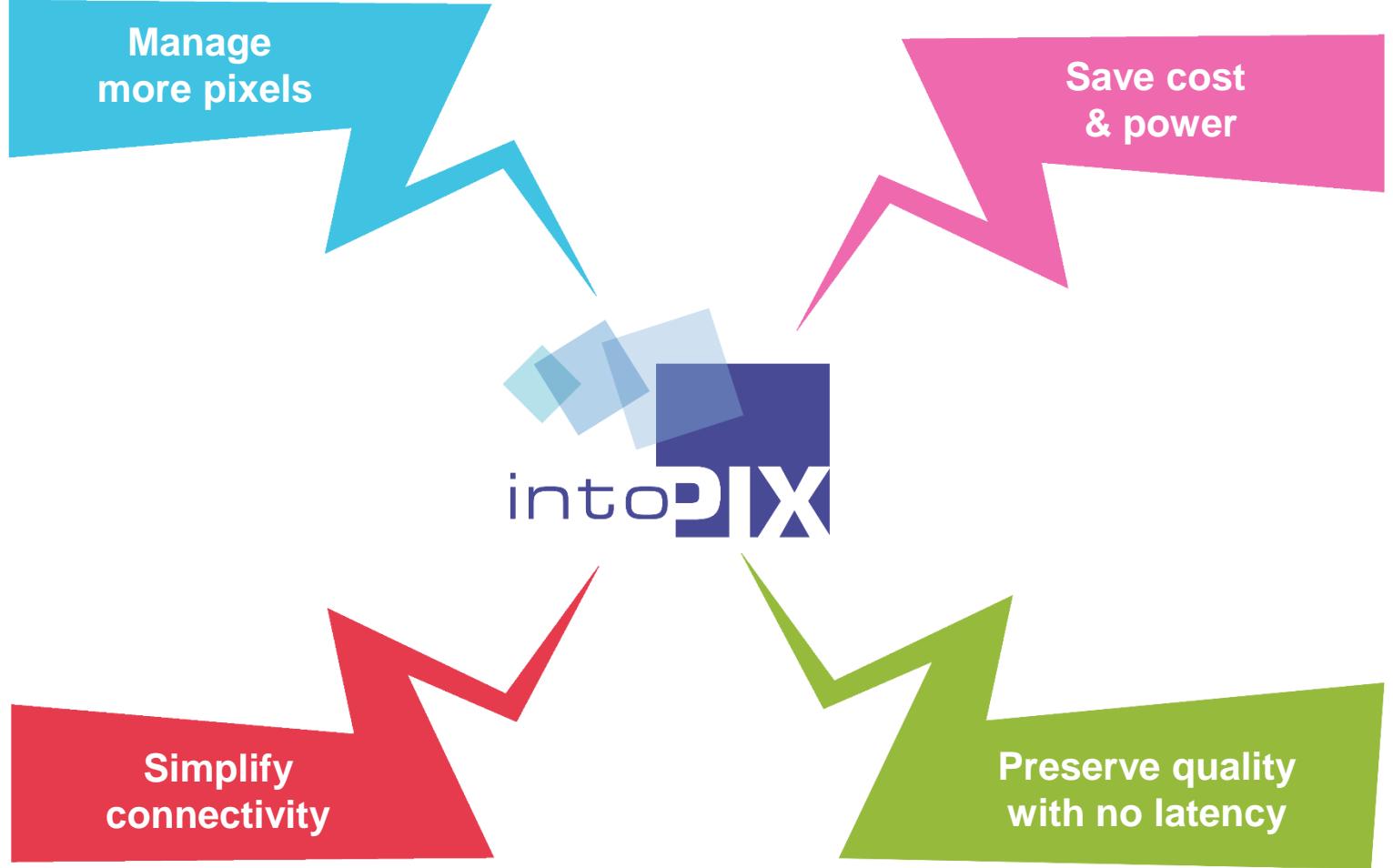
### 8K CORES

- 8K 60fps 422 or 8K 60 fps 422/ 444
- 8K 120fps 422

NEW

### For all CORES

- Any releases are always compatible with current & previously deployed TICO-XS encoder/decoder IPs & SDKs (ie feature release, XS compliant release,...)
- Different architectures developed supporting various pixel per clock (x2, x4, x8) & Size configurable for various maximum bitrate
  - Synthesis on 28nm TSMC
  - Ported on Xilinx & Altera devices
- Fixed Latency
- Adjustable compression rate / Constant bitrate
- Optimized for real-time operations on 100%
- (OPTION) Proxy/Downscaler in the decoder
  - -1 res (1/2w; 1/2h) & -2 res (1/4w; 1/4h)
- (OPTION) Monochrome / Alpha channel ADD-ON



Manage  
more pixels

Save cost  
& power

Simplify  
connectivity

Preserve quality  
with no latency