



# Convey UHD 4K Video over 1Gbit Ethernet with intoPIX JPEG2000 “Ultra-Low-Latency” Compression Profile

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## Introduction

Considering the uncompressed bandwidth of a UHD 4K video stream in 4:2:2 or 4:4:4 and the massive amount of deployed Gigabit Ethernet infrastructures, a codec that can offer the same benefits in terms of quality, latency and reliability than uncompressed transport with a sufficient compression ratio to go under 1Gbit/second is a key advantage.

intoPIX JPEG2000 Ultra Low Latency FPGA IP-cores are perfectly answering this challenge. The implementation brings a visually lossless compression with the necessary compression ratio and a latency going below 1 frame from the encoder to the decoder. Deployed in the AV industry (Broadcast & Pro-AV) today for HD and UHD 4K, it enables to reach a total of 10 milliseconds for a transmission.

Since 2007, intoPIX has been developing a 4K JPEG2000 FPGA Codecs in order to efficiently and invisibly tackle important cost and bandwidth challenges faced by the AV industry. intoPIX has pushed the boundaries of traditional JPEG2000 compression technology used in Digital Cinema with a state-of-the-art, innovative Ultra Low Latency implementation assuring visual quality and bandwidth under 1Gbit/s and compressing the 4K bandwidth to a manageable rate with only 10 millisecond of latency. The technology, called Ultra-Low-Latency is now used in Live production and contribution applications.

## Catching the momentum

The industry is moving to 4K (UHDTV) and 1GbE ports and routers are affordable. Current VSF JPEG2000 TR01 recommends the use of the Broadcast JPEG2000 profile (ISO 15444-1 AMD3) with a MPEG2 transport stream encapsulation. JPEG 2000 is an



LESS THAN  
10 ms LATENCY



Intra-Frame codec which makes it well adapted to low-latency applications in comparison with Inter-Frame codec. The regular JPEG2000 implementation have typically about 3 fields/frames or more of total latency.

## Below 10 millisecond with Ultra Low Latency mode

intoPIX Ultra-Low latency JPEG2000 compression goes below 1 frame for the total compression latency. Using the same parameters of the JPEG2000 Broadcast profile with intoPIX smart JPEG2000 horizontal striping of the image preserving the quality at the boundaries of each stripes, it reduces this latency below one frame in total.

### Visually Lossless quality

The comfort zone for visually lossless quality with JPEG2000 compression is usually in a range going from 4:1 to 16:1. For Cinema projection application, where the viewing distance is much controlled than in other AV application it can go up to 30:1 with still visually lossless quality.

JPEG2000 Video	Min bitrate (Mbit/s)	Max bitrate (Mbit/s)
1080i60 422 (1,5Gbit/s)	75	200
1080P60 422 (3Gbit/s)	100	400
2160P60 422 (12Gbit/s)*	400	1000

\*For reference and comparison, today 4K24p444-12bit Cinema movies are using 250Mbit/s JPEG2000 encoding (JPEG2000 DCI profile) and is moving to 500Mbit/s JPEG2000 encoding for higher frame rates.

In high-quality applications where compression is applied in lossless or visually-lossless modes, the horizontal striping is not an issue. More over intoPIX Ultra Low latency mode brings additional robustness at the stripe boundaries when a higher compression ratio is applied. The striping mechanism typically preserves the visually lossless quality within the VSF TR01 recommended compressed bitrates ranges.

### Key benefits

- Enables to carry 4K over 1GbEthernet IP network
- Goes below 10 milliseconds (encoder + decoder)
- Offers a visually lossless quality needed in production workflows & professional AV applications

## Standardization and SMPTE 2022 1/2

Broadcast contribution is today already using JPEG2000 for HD transmission. Today 1GE is the obvious affordable port. 4K JPEG2000 can be carried easily wrapped in MPEG2-TS and SMPTE 2022 ½ standards.

In 2015, VSF J2K Interop Group ([www.videoservicesforum.com](http://www.videoservicesforum.com)) will provide a recommendation for carrying JPEG2000 Ultra Low Latency over MPEG2-TS and SMPTE 2022 1/2.

## FPGA implementation benefits:

Important benefits of the intoPIX JPEG2000 implementation on Xilinx is that it offers a competitive solution:

- The encoder and decoder consumes approximately the same amount of FPGA resources. Enabling the implementation of either an encoder or a decoder on the same FPGA devices.
- The cores are easy to implement as they are provided with a reference design running on Xilinx development kits.
- The Ultra-Low Latency can be activated with any intoPIX JPEG2000 cores without consuming more FPGA resources.
- The JPEG2000 Ultra-Low-Latency IP-cores are delivered with an optional MPEG2-TS encapsulation / de-encapsulation IP-core that comply with the VSF TR01 recommendation and offers a large flexibility for custom implementation.

## Conclusion

In Live production workflows, bidirectional broadcasting, Remote collaboration, KVM, Video over IP routing, or other time accurate broadcasting, the slightest delays are unacceptable. AV manufacturers strives to bring solutions guaranteeing extreme low latency combined with image quality and Quality of Service.

With FPGA-based JPEG2000 ultra-low latency video technology now available, it is possible to build AV equipment that offers an incredible and robust quality during the transfer of 4K content over 1GbE links with less than 10 milliseconds of delay.

## Take the NEXT STEP using JPEG2000 ULL on Xilinx FPGAs

For more details about intoPIX 4K over IP compression FPGA solutions including JPEG2000

1. [www.intopix.com/XilinxJPEG2000](http://www.intopix.com/XilinxJPEG2000)
2. [www.intopix.com/XilinxTransport](http://www.intopix.com/XilinxTransport)

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