

Extending 8K over a single, cost-effective wire at the speed of light with TICO lightweight compression

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Introduction

With HD omnipresent and 4K seemingly still in its early stages, an even higher resolution, namely 8K (or UHD TV2) is arising. Display and projection manufacturers are already presenting their first 8K-capable products and the 2018 Winter Olympics were partly filmed in this currently largest video resolution format. Taking a peek into the future, Japan's national TV "NHK" has even



announced to broadcast the full Olympic games on home turf in 2020 in glorious 8K. Together with other rapid improvements in video quality such as HDR and higher frame rates, data amounts are skyrocketing. Increasing your resolution from HD (1920x1080) to 4K (3840x2160) already quadruples the total pixel count to 8,294,400 pixels. Doubling the height and width of 4K again, total pixels reach a whopping 33.2 million pixel per image. At 60 frames per second that leads to 120 billion pixel to be transported, managed and stored every minute. That's 8K.

Currently the industry is struggling to upgrade their infrastructures to handle 4K video, which at 60fps, 4:2:2,10bit requires nearly 12Gbps. With 8K on the verge, a future-proof solution has to be found.

What challenge derives from that?

Uncompressed storage and transmission becomes unaffordable and unmanageable within systems and infrastructures. Moving to UHD TV2 requires an expensive hardware upgrade, a heavy renewal of infrastructure and will increase the power consumption notably.

The table below shows the required bandwidth arriving with a transition to 8K and higher quality video. Retaining the current approach of uncompressed video, the only options are:

1. increasing the amount of cables or
2. using expensive, high-bandwidth cables.

Both would lead to vast investments and an additional rise in power consumption.

Resolution	Format	Bitrate	Interface (SDI)	Interface (IP)
HD	60i, 4:2:2, 10 bit	1.485 Gbps	HD-SDI	10GbE
4K	60p, 4:2:2, 10 bit	11.88 Gbps	4x 3G-SDI	25GbE
8K	60p, dual green, 10bit	23.76 Gbps	8x 3G-SDI	40GbE
			16x 3G-SDI	
8K	60p, 4:2:2, 10 bit	47.52 Gbps	4x 12G-SDI	100GbE

Existing solutions for carrying 8K uncompressed

In an **SDI** setting, 8K 60P, 4:2:2, 10bit would require the distribution of a single video stream over 16 3G-SDI cables or 4x 12G-SDI cables. This in turn increases the number of I/O interfaces and cross points in a matrix switcher, making it necessary to use an 80x80 matrix switcher. Ultimately, a very complex setup that can easily lead to unstable operation.

Use of standard IT technologies, building an agile, flexible, reconfigurable and scalable workflow, dealing agnostically with a multiplicity of formats with a ubiquitous accessibility – all these are advantages of IP. Working with a modern **IP based infrastructure**, the 48Gbps of an 8K stream however, would force implementers to settle on the usage of 100Gb Ethernet connections. A technology that is currently extremely costly, and thereby eliminates a major advantage of using COTS IP products.

The new **Ultra High Speed HDMI** (or HDMI 2.1) extends the original 18Gbps bandwidth of HDMI 2.0 to the exact 48Gbps necessary for 8K 60p video transport. Compared to SDI and Ethernet however, HDMI does not provide sufficient cable length. It is often needed to use specific extenders that also will often leverage CAT5 or CAT 6 Ethernet cables.

Our suggested Solution: TICO compression

The solution to this issue is a video codec that behaves like uncompressed video in terms of quality, latency and complexity. Lightly compressed storage and transmission remains affordable and manageable within systems and infrastructures. It involves a low-cost hardware upgrade and reduces the renewal of infrastructures for the same power consumption.

What is TICO compression

Available in FPGAs and on CPU & GPU, intoPIX TICO is a lightweight mezzanine compression codec that has been specifically designed to achieve lossless quality at low compression ratios, for a very low FPGA complexity and cost. It is an intra-frame codec, which makes it perfectly suitable for low-latency applications in comparison to inter-frame codecs that require frame buffers and thus reduce speed. The mezzanine codec's line-based latency translates into less than 1 millisecond that is induced to the workflow.

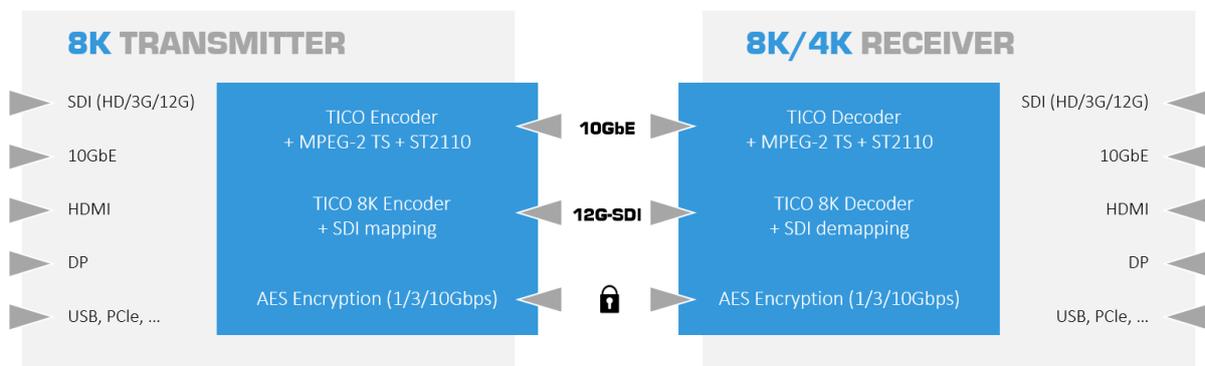
The technology has been invented by intoPIX and uses a novel Tiny Entropy COder (TECO). It has been submitted at the SMPTE as RDD35, which was subsequently be adopted as basis to the development of TICO-XS (the new coming ISO standardized JPEG XS) . In fact, TICO is currently the most deployed codec in the broadcast market for HD & 4K studio over IP infrastructures. Thus using it for 8K seems to come naturally. With a compression ratio of 2:1 to 6:1, it drastically reduces bandwidth occupied by video data, enabling its users to transport 8K 60p videos over a standard 10Gb Ethernet system or a single 12G-SDI cable.



TICO SMPTE RDD35 features:

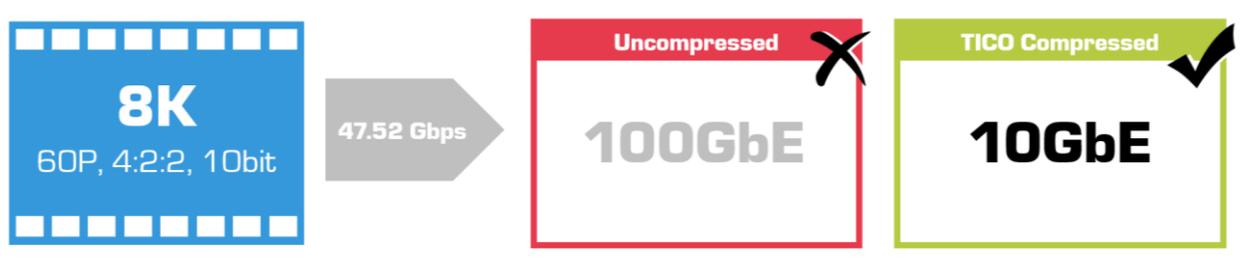
- Supports 8K and UltraHD 8K video at frame rates up to 60 fps
- Robust to multiple en-/decoding generations
- Supports 4:2:0 & 4:2:2 workflows up to 12bit
- Smallest use of logic & memory (no external DDR), for FPGA (Intel / Xilinx) or ASIC
- Runs 8K on CPU & single GPU
- Best quality up to 6:1 compression (from math. to visually lossless)
- Few pixel lines of latency (less than 1 milliseconds end-to-end)
- Embedded downscaler to decode 4K resolution from 8K TICO source without additional processing

TICO over single cable transport schemes



8K TICO on 10GbE

In a time of rising resolutions and the constant need for simplified connectivity (of things), many AV professionals are switching to IP-based infrastructures. TICO compression can reduce the bandwidth of an 8K 60p video stream to less than 8Gbps while remaining lossless quality and inducing virtually no latency. This enables users to run it over standard 10GbE networks (and CAT6 cables & switch) – a currently extremely cost-effective installation with the additional advantage of simple cable length extension by adding a switch every 100 meters.



A standardized way to transport 8K with TICO over RTP IP (like SMPTE ST 2110)

Until now, we have used recommended SMPTE ST 2022-5/6 to transport video (SDI over IP). Both of these are “multiplex” standards, where the video, audio, and ancillary data signals (plus blanking and padding) are wrapped into a SDI frame and transported as a single IP stream. A Recipient who wants just one element still has to transport and take the whole stream from the network, in order to extract the part they want.

SMPTE ST 2110 (uncompressed over IP) puts each part of the signal into a different stream:

Video, Audio(s), and ANC(s) all separately routable.

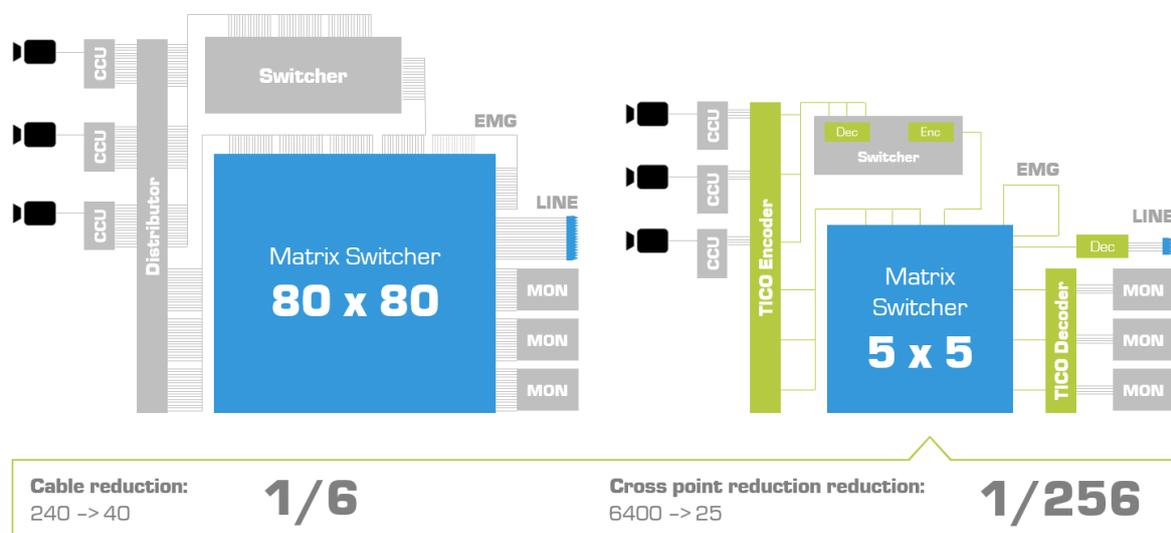
The TICO RDD35 standard includes the RTP payload specifications for TICO compressed over IP.

8K TICO on 12G-SDI

Especially the broadcast industry is massively invested in SDI infrastructures and prolong a costly conversion to Ethernet. To avoid the management of more cables, complex interfaces, additional complexity and the splitting of one stream over multiple cables, TICO 8K compression can enable its users to retain their current 16x3G-SDI or 4x12G-SDI cabling and still transport 8K video.



Deploying mezzanine compression for 8K not only saves cost, but also greatly reduces power consumption and infrastructure complexity. Next to a reduced amount of cables, TICO compression also reduces the amount of cross-points in a matrix switcher from 6400 to a mere 25.



A standardized way to transport 8K with TICO over SDI

The transport of TICO compressed video over SDI is described in the SMPTE RDD35. It specifies TICO bitstream mapping and detection in 3G-SDI environments (including protecting the EAV/SAV codes). The transport of these 3G bitstreams over a quad-link serial digital interface, operating at a nominal rate of 12 Gb/s, is then defined by the SMPTE ST 2082.

Real examples from the field

Japanese national TV broadcaster NHK has already successfully implemented TICO for 8K over 12G-SDI and 10GbE – a crucial cornerstone for consolidating their leading role in 8K broadcast. Already demonstrating their implementations at NAB and IBC earlier on in the year, and with a first in-field test during the PyeongChang Winter Olympics, the Japan Broadcasting Corporation (NHK)¹ will launch their first 8K UHD TV channel in December 2018 under the name 8K Super Hi-Vision.

Solutions for multiple platforms

Implementable on various platforms, TICO compression is a versatile solution that offers its users the possibility to run the compression algorithm on FPGA, ASIC, CPU or GPU – all including the codec's previously described features without limitations.

¹ To read more about NHK's 8K broadcasting efforts visit their website or read the white paper:

<http://www.nhk.or.jp/8k/indexe.html>

<https://ieeexplore.ieee.org/document/8281417/>

Implementation benefits

IPX-TICO FPGA IP-cores:

- Low-cost implementation in any Intel / Xilinx FPGA: very low FPGA logic and internal RAM usage
- Encoder and decoder have approximately the same complexity
- IP-core customizable per application, delivered within an HDK to speed up the integration
- Various pixel per clock implementations

FastTICO CPU & GPU SDKs:

- Encoder and decoder have approximately the same complexity
- Highly parallelizable to scale up to 8K on 100% CPU or 100% GPU architectures

Conclusion

8K video confronts AV professionals with exuberant data amounts to manage, transport and store. For any application such as: AV over IP, production workflows, bidirectional broadcasting, remote collaboration, KVM, video over IP routing, or other time-accurate broadcasting -> delay is unacceptable and you need to assure unaffected video quality.

- ⇒ With TICO compression at 5:1 compression ratio, it is possible to build AV equipment that offers pristine and robust quality during the transfer of 8K content over a single cable (12G-SDI or 10GbE), while inducing less than 1 millisecond of delay.

Using this lightweight video compression codec, over IP Networks (i.e. SMPTE ST 2110) or through SDI, is a smart upgrade path to manage UHDTV 8K, high frame rates and number of streams, while assuring visual quality, very low hardware complexity and cost-effectiveness.

Take the NEXT STEP using TICO lightweight compression

For more details about 8K solutions including TICO see:



www.intopix.com/TICO



www.tico-alliance.org



www.intopix.com/XilinxTICO



www.intopix.com/XilinxTransport



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