Joining the Alliance

"Take the Smart Path to Move our World to UHDTV ! »

Operating TICO (SMPTE RDD35) in Studio over IP with SMPTE ST 2022-6 and VSF TR03

Introduction

- TICO is mainly known for its ultra low latency and lightweight compression capability with high encoding quality to address the transition towards higher resolutions and frame rates in Live production.

- The codec and the associated SMPTE RDD35 bring several advanced characteristics that we will review in this presentation.

- These features ease the extension of Live production to UHDTV 4K.
  - Enable to fit UHD4K over 10GbE and 3G-SDI

info@tico-alliance.org
www.tico-alliance.org

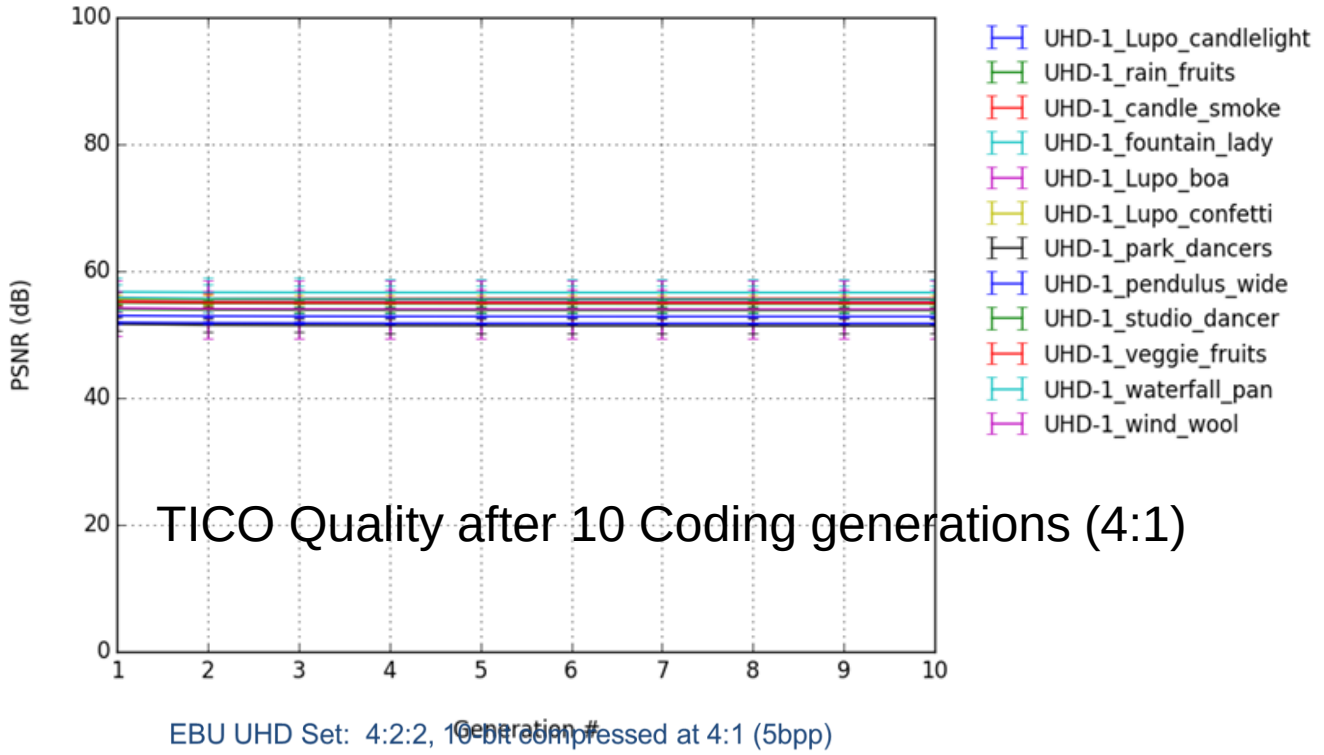
TICO Main features

- Future-proof video format support:
  - multiple resolutions up to 10240x4320 (in SMPTE RDD35)
  - multiple chroma formats : 4:2:2, 4:4:4
  - various bit depths: 8/10/12
  - Any frame rates

- Visually lossless compression up to 4:1
    - 2160p120 422 - bit rates ranging from 19.92Gbps down to 4.98Gbps
    - 2160p60 422 - bit rates ranging from 9.96Gbps down to 2.49Gbps
    - 1080p60 422 - bit rates ranging from 2.49Gbps down to 622Mbps
    - 1080i60 422 - bit rates ranging from 1.24Gbps down to 311Mbps
  - Robust to multiple generations of encoding.

info@tico-alliance.org
www.tico-alliance.org

Multi-generation response



TICO Quality after 10 Coding generations (4:1)

info@tico-alliance.org
www.tico-alliance.org

TICO Main features (2)

- Low latency in hardware & software
  - Fixed latency with CBR
  - Few lines of pixels in hardware
  - Less than 1 frame latency in software

- Lightweight in terms of power, computation, memory
  - Small footprint in hardware (without external memory)
    - The size of a TICO 8K 4320p60 encoder is close to the size of a HD 1080p60 JPEG2000 encoder
  - Efficient in Software to manage UHD and HD real-time

info@tico-alliance.org
www.tico-alliance.org

TICO Advanced features

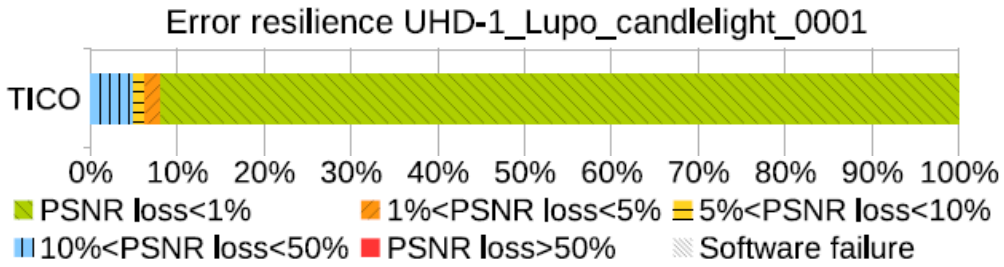
- Extract HD resolution video from UHD resolution bitstream
- Mathematically lossless compression at low compression ratio
- Error resilience
- Bitrate Transcoding

info@tico-alliance.org
www.tico-alliance.org

TICO Advanced features (2)
Resolution scalability from single UHDTV bitstream

- Thanks to its light wavelet transform and its codestream syntax, the algorithm allows to extract a lower resolution proxies from a single TICO codestream
- Use Benefits:
  - Reduce the needs to use 4K downscaler in the workflows (ie for monitoring purpose)
  - Accelerate TICO CPU decoding performances (less consumption to decode HD than 4K)
  - Simplification of the workflow for monitoring UHDTV streams as if they were HD streams

TICO Advanced features (3)
Error resilience to a single bit flip

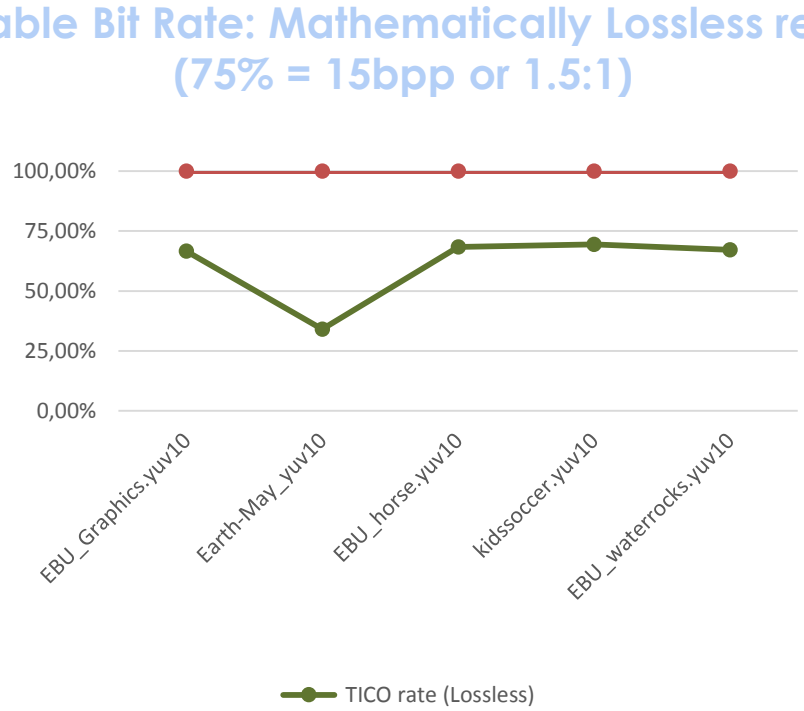


- Error resilience is important in the case of transport over SDI
- TICO codestream demonstrates an optimal error resilience when a one-bit error occurs.
- In most of the cases (91.2 % or the observed errors here , less than 1% PSNR loss), it behaves as uncompressed and only a few pixels of the final image are affected.
  - In the graph here, the original frame is compressed and one bit is flipped at 1000 different random positions in the compressed bitstream. These tampered bit streams are then decompressed by the decoder.
  - The error propagation is limited thanks to its codestream syntax that has a clean split between raw data and coded data.

info@tico-alliance.org
www.tico-alliance.org

TICO Advanced features (4)
Mathematically lossless compression at compression ratio

- Lossless coding is a de-facto feature of the algorithm. So if the expected compression ratio is not high or the image simple as shown here, the results might be math. lossless.
- To guarantee a CBR behavior, either padding, or rate allocation mechanisms will be applied to achieve the desire rate.
- Typical UHDTV-1 60p 422 broadcast content will achieve about 7.5 Gbit/s in math lossless. In other words, 12G-SDI down to a 10GbE with TICO could be lossless.

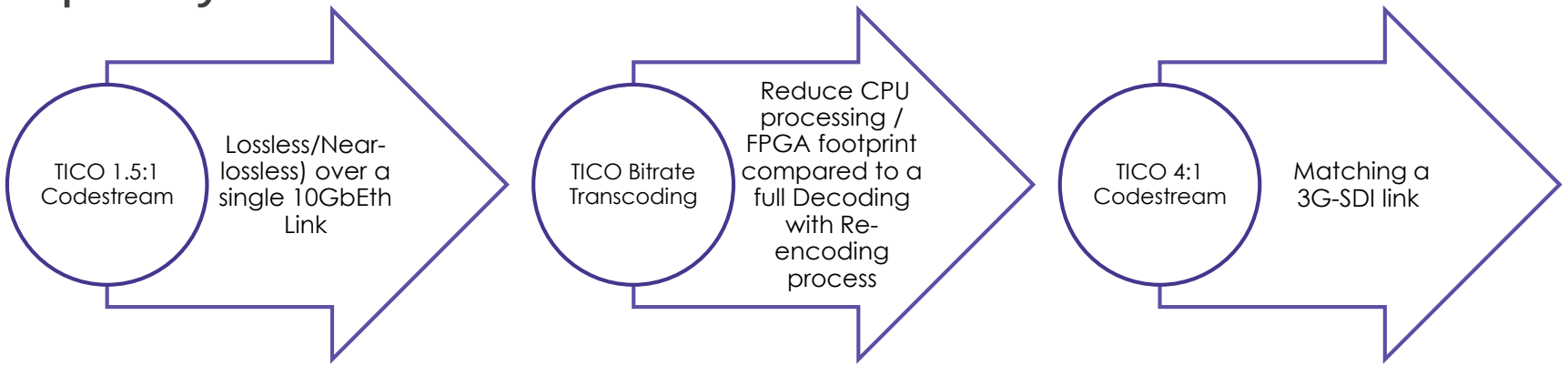


info@tico-alliance.org
www.tico-alliance.org

TICO Advanced features (3)
Bitrate Transcoding

- TICO bitstream structure offers opportunities to perform efficient bitrate transcoding to go from low compression down to higher compression ratio avoiding the need of a full decode and re-encode, reducing computing power or hardware complexity

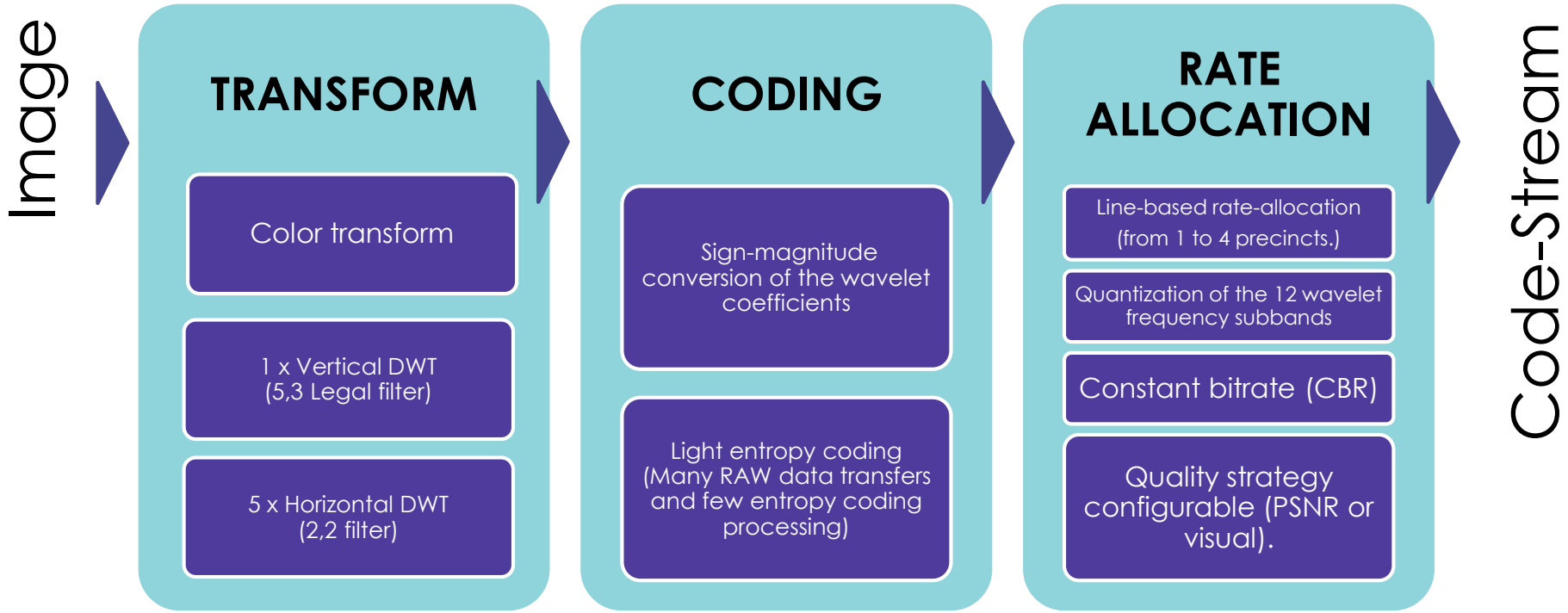
Example:



info@tico-alliance.org
www.tico-alliance.org

TICO Algorithm Overview

with the smallest latency, the smallest memory and the smallest complexity



De-correlation of Information…

…to apply coding efficiently…

info@tico-alliance.org
www.tico-alliance.org

…at a determined bit-rate

TICO Alliance

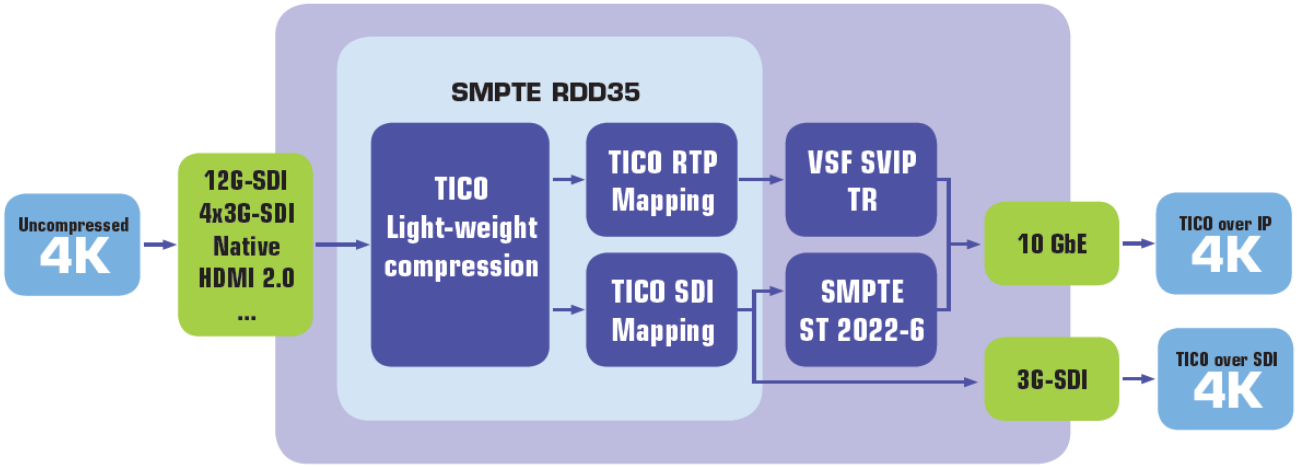
TICO (SMPTE RDD35) with SMPTE ST 2022-6 and VSF TR03

- SMPTE RDD35 describes TICO compression and its mapping in SDI or IP-based infrastructures .
- Technology was submitted to JT-NM and submitted to SMPTE as RDD to guarantee interoperability.
- SMPTE RDD35 has been specified in collaboration with TICO Alliance members and implementers, aiming to be interoperable with 2022-6 to combines both IP and SDI, as well as when use as an independent RTP payload (for VSF TR03)

info@tico-alliance.org
www.tico-alliance.org

TICO (SMPTE RDD35) with SMPTE ST 2022-6 and VSF TR03 (2)

- The SMPTE RDD specifies :
  - TICO compression, its codestream syntax, its decoding process
  - TICO video essence box
  - TICO bitstream mapping on SDI / ST2022-6
  - TICO bitstream mapping on RTP



info@tico-alliance.org
www.tico-alliance.org

Video Essence metadata (SMPTE RDD35)

- TICO Video_essence_box() provides appropriate metadata information to characterize the video essence compressed by TICO.
- The Video_essence_box() is used for both SDI and RTP mapping.
- Supports various resolutions, bit depth, sampling, high frame rates, color primaries, transfer functions.
- Eases the management of the various existing SDI ways of carrying to 4K to be taken into account in the context of a mapping in a single 3G-SDI
  - Source type : define if the source is SDI or not
  - Video input info : in the case of SDI , it informs about the nature of the SDI source (was it 4-Quad , or 2-SI, or …?)
  - Audio input info : as 32 audio channels only can be carried in the 3G-SDI containers, it indicates which audio channels are kept from the source (16 from Link0 + 16 from Link3 or 32 channels from Link4?)
  - VBI input : what has been kept in the 3G-SDI

frame_rate
interlace_mode
sample_bitdepth
sampling_structure
horizontal_size
vertical_size
color_primaries
transfer_characteristic
matrix_coefficients
source_type
video input_info
audio_input_info
VBI_input_info

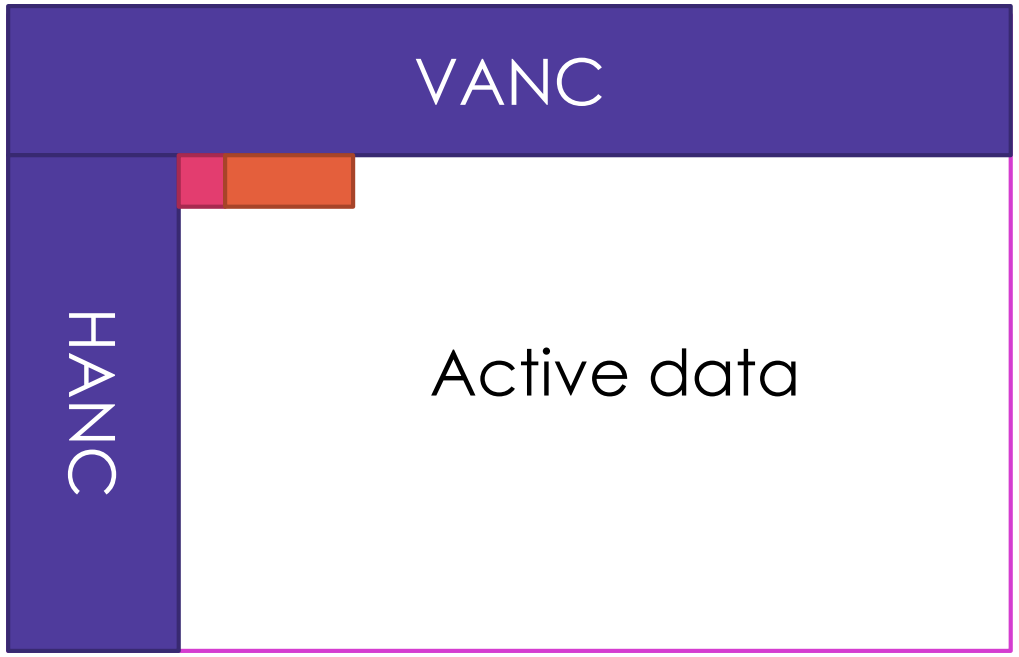
info@tico-alliance.org
www.tico-alliance.org

SDI/ ST 2022-6 mapping with TICO (SMPTE RDD35)

- Defines mapping of TICO bitstream in SDI link
- Does not modify the 3G-SDI container
  - HANC / VANC
- Active video area is replaced by a new Active data area.
  - Compression is signaled using the Detection box (to identify TICO) The SDI payload label remains the same to guarantee interop with already deployed systems
  - Map Video essence box and TICO bitstream data into the full 10 bit range of each active pixel avoiding the forbidden codewords to compress as « less » as possible…

info@tico-alliance.org
www.tico-alliance.org

SDI/ ST2022-6 mapping with TICO (SMPTE RDD35)



TICO-enabled 3G-SDI frame for ST 2022-6

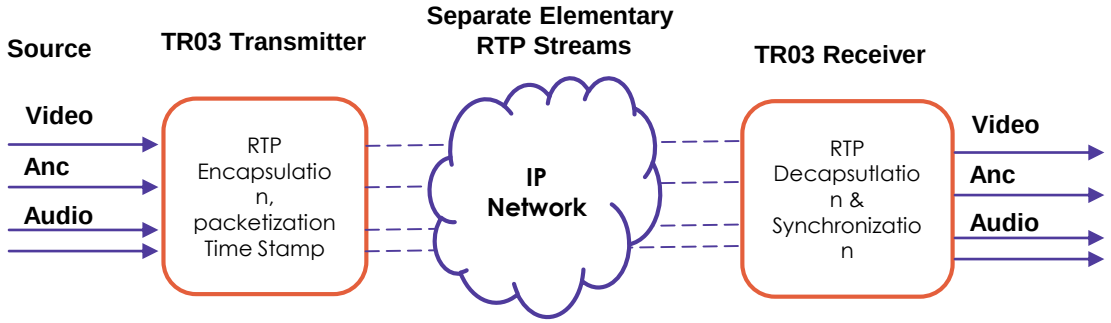
- 3G-SDI container (unchanged)
- TICO Detection
- TICO Video Essence metadata
- TICO bitstream coded 2160p60 video in the 10-bit pixel

info@tico-alliance.org
www.tico-alliance.org

SDI/ ST2022-6 mapping with TICO (SMPTE RDD35)

- Since the TICO bitstream is embedded in standard 3G-SDI, that 3G-SDI can be transported in SMPTE ST 2022-5/6/7. System shall work without any modification of SMPTE ST 2022-5/6/7 standards.

RTP mapping (for VSF TR03) with TICO (SMPTE RDD35)



- VSF TR03 recommends that time-related essences (video, audio and ancillary data) are carried over an IP network as separate elementary RTP streams. (ie RFC4175 , for raw video payload header, AES67 for audio, …) .
- TR-03 is also extensible to compressed video essence.
- SMPTE RDD35 specifies the payload format for TICO video streams over RTP
  - It provides full flexibility in terms of resolutions, frame rates,….

info@tico-alliance.org
www.tico-alliance.org

Conclusions

Flexibility is enabled by the TICO SMPTE RDD35 to scale both SDI and IP bandwidth capacity to UHDTV 4K

It offers some interesting perspectives as more features will be exploited.

- Going below 10GbE and over 3G-SDI with 4K without impacting latency and quality with ST2022-6 and VSF TR03.
- Proxy extraction, Near-Lossless coding, transcode,….
- Implementations / Equipment upgrades / Products have been released by several members

info@tico-alliance.org
www.tico-alliance.org

THANK YOU.

For more information about the TICO ALLIANCE

www.tico-alliance.org

info@tico-alliance.org

info@tico-alliance.org
www.tico-alliance.org