Appear

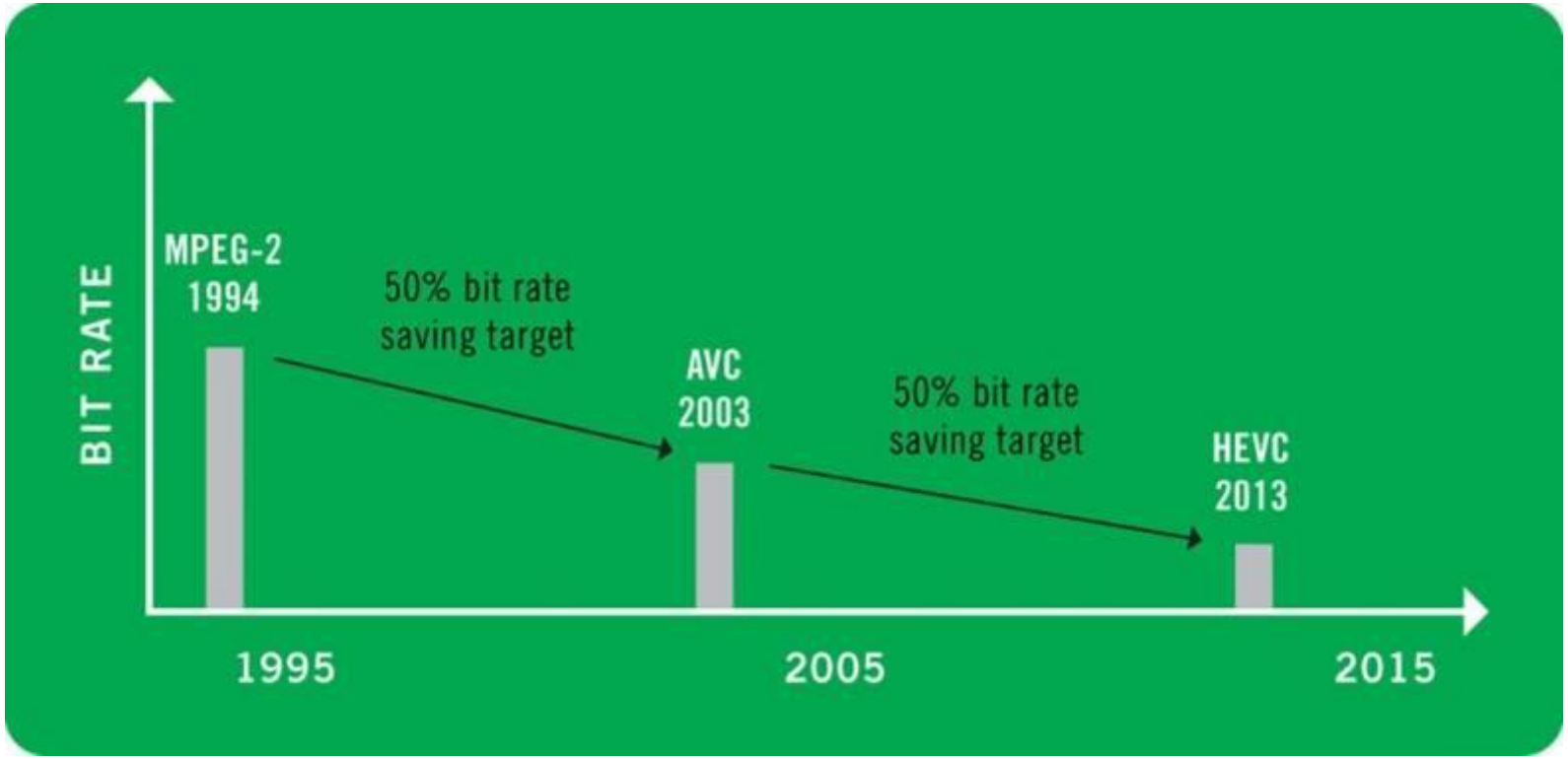
redefining video delivery

Appear

JPEG XS: A general introduction

Introduction to JPEG XS

- The evolution of compression technologies has for many years focused on improving low bitrate performance (compression gain).



Introduction to JPEG XS

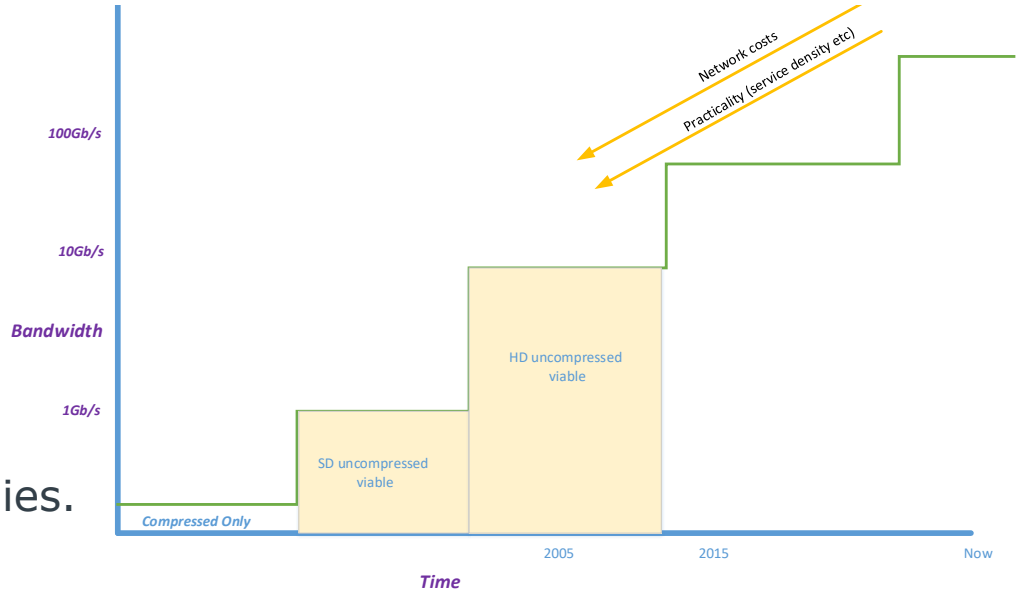
- The evolution of compression technologies has for many years focused on improving low bitrate performance (compression gain).

But JPEG XS is not about this!

Introduction to JPEG XS

- To understand the role of JPEG XS, you need to look at what is happening in the un-compressed space.
- There's a continual fight between having the benefits of uncompressed video, and the huge amount of bandwidth required to deliver it
    - In terms of practicality over real networks
    - And in terms of network costs
- The problem is not going away! Network bandwidth continues to increase BUT so does video resolution and video complexity!
- Already we have UHD & HDR, tomorrow HFR and 8K
- Plus new VR and gaming applications driving bandwidth up and latency down!
- New applications in automotive and security are also potential targets for ultra low latency codec technologies.

Networks improve but video complexity continues to increase



Why do some customers want to go uncompressed?

…when there are so many codec options around?

…In other words what is the attraction to uncompressed?

- Until recently, no codec has offered anything similar to transmitting uncompressed.
  - Latency. Compare zero with approx. 50ms with JPEG2K
  - VQ performance: Compare transparent with acceptance of some degree of degradation
  - Concatenation performance: As above. Not an issue with uncompressed.

- Uncompressed transmission sometimes seems to be achievable, but then the industry continually adopts higher resolution, higher pixel / frame rate formats that dramatically push up bitrate again. And / Or requires higher service densities.

- It’s a never-ending cycle that always makes bandwidth at a premium. Video engineers always want more and more bandwidth!

- Remember: Reducing latency also drives up bandwidth needs and is currently a big industry topic.

How can you make uncompressed viable?

- Currently, the honest answer for most applications beyond SD resolution is it isn't viable, especially for 1080p and above.

- The solution is increasingly to ask a different question…

"Since I don't need a large coding gain to make a big difference in terms of bitrate viability, can I find a codec that delivers this WITHOUT imposing traditional codec issues (latency, generation Loss, high complexity and high cost)?"

The answer is yes, you can engineer a codec to fit this requirement…

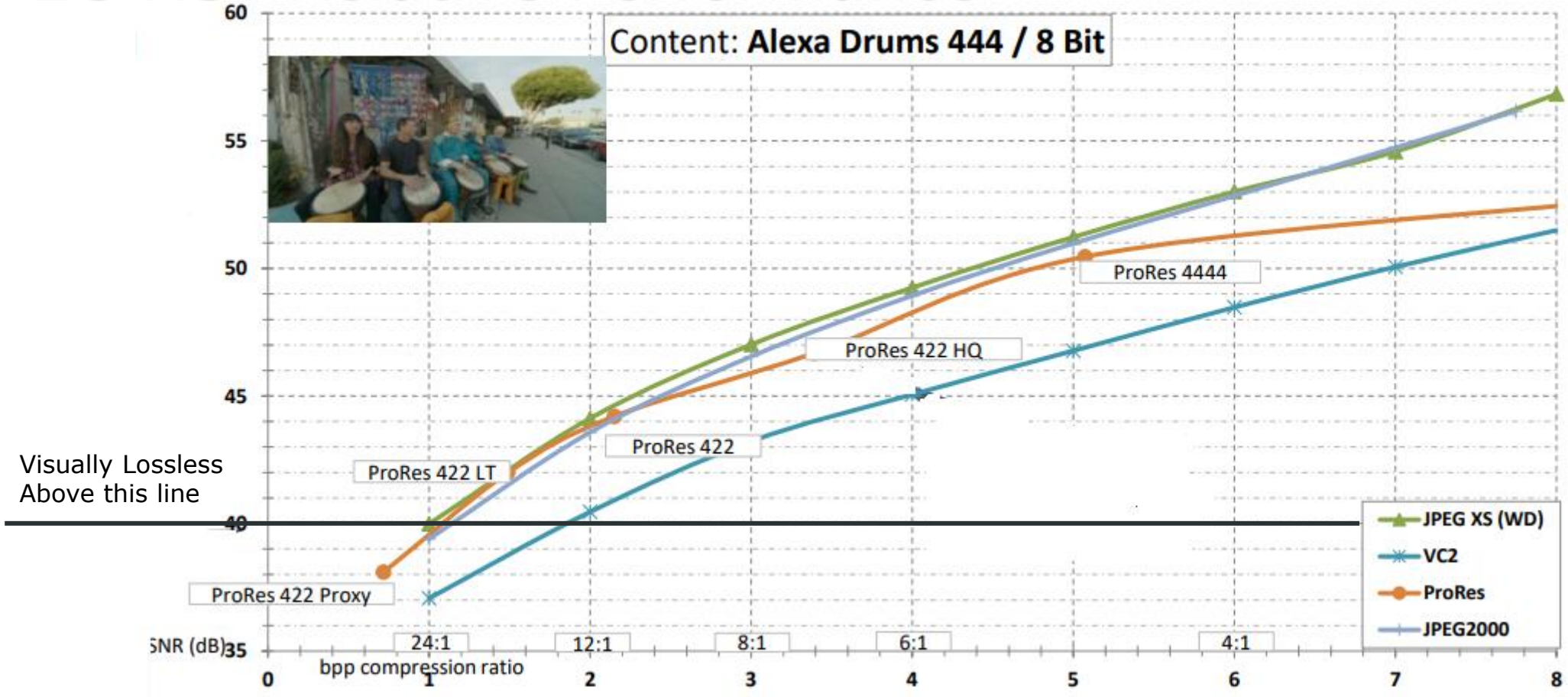
Introduction to TICO

- The first codec showing what is possible is TICO.
- TICO (Tiny Codec) is a product of Belgian company Intopix.
- TICO was designed to solve the problem of producing UHD content at sports events with 3Gb/s (1080p) infrastructure.
- The requirement was to provide a simple, small footprint codec that could be integrated into camera hardware easily (requires minimum hardware resources and power) BUT
  - Provides a useful bitrate reduction (say, 4:1 making a 12Gb/s UHD feed fit into 3Gb/s)
  - Offers latency so low you can ignore it (target of 1ms making it a fraction of a frame)
  - Provides lossless VQ performance so there are no quality or concatenation concerns

The key to speed is the codec simplicity (intra frame coding only) with wide adoption of task parallelization to drop the latency to the 1ms domain

JPEG XS on X: Graph courtesy of Intopix

JPEG XS: Relative Performance



Note JPEG XS offers similar VQ to JPEG 2K at the same bitrate BUT JPEG XS does this with up to 5 times less hardware complexity AND with sub ms latency. XS is also specified to support the latest video resolutions, up to 8K, and streaming standards (ST2110).

JPEG XS: Usable Coding-gain range

- For consistency, the new ISO/IEC29170-2 standard (2015) is often used to evaluate near lossless encoders.
- Measured against this standard, JPEG XS can deliver;
  - Full transparency at ratios up to 10:1
  - Visually lossless transparency up to 20:1 (with typical film / TV content)
  - Appear will support compression ratios from 5:1 to 36:1

- Latency will depend on the coding mode but will be a maximum of 32 video lines (ranges from 1 to 32 lines)
- ATV will allow you to set specific bitrates in XS mode; you are not restricted to absolute ratios!

Note: It is often difficult to compare JPEG2K performance because several profiles exist and some require significant (>100ms) latency. When comparing, be sure to include the hardware complexity required, latency and coding gain which for JPEG2K can depend greatly on profile.

JPEG2K and JPEG XS

JPEG 2K

(3 to 5 times as complex as JPEG XS and is considerably more memory intensive)

JPEG 2K wavelet based codec

- Relatively complex and resource consuming for the performance offered
- Dates back to the days when network performance was poor so relatively high compression gain was important (eg. HD at 200Mb/s)
- Still significant latency (at just over 1 frame)

+

MPEG TS encapsuation

- MPEG_TS was designed for MPTS transmission over wide pipes (eg. Satellite) and is not optimal for IP
- A modern standard needs to use native IP encapsulation and be designed for SMPTE 2110 compatibility.

JPEG XS

TICO XS codec

- Light on hardware resources (significantly lighter than JPEG2K)
- Designed to adapt today's most bandwidth intensive video resolutions and framerates to the capabilities of modern networks
- Latency so low (approx. 1ms) you can ignore it

+

ISO/IEC 21122

- Native RTP encapsulation
- Designed for IP networks
- Designed for SMPTE 2110 compatibility

JPEG XS Standardization

Part 1: Core Coding system (ISO/IEC 21122-1)

- Defines the video codec. Baseline codec is TICO from Intopix

Part 2: Profiles and buffer models (ISO/IEC 21122-2)

- Provides flexibility to target different operational and implementation needs whilst retaining interoperability.

Part 3: Transport and container (ISO/IEC 21122-3)

- Defines the method and metadata required to build a basic JPEG XS code stream

Part 4: Conformance testing (ISO/IEC 21122-4)

- Defines compliance testing or JPEG XS compliance

Part 5: Reference software (ISO/IEC 21122-5)

- Provides a source of reference software

IETF RFC JPEG XS RTP

- Defines how JPEG XS transport can be carried via RTP

SMPTE 2110-22 (Compressed essence in ST2110)

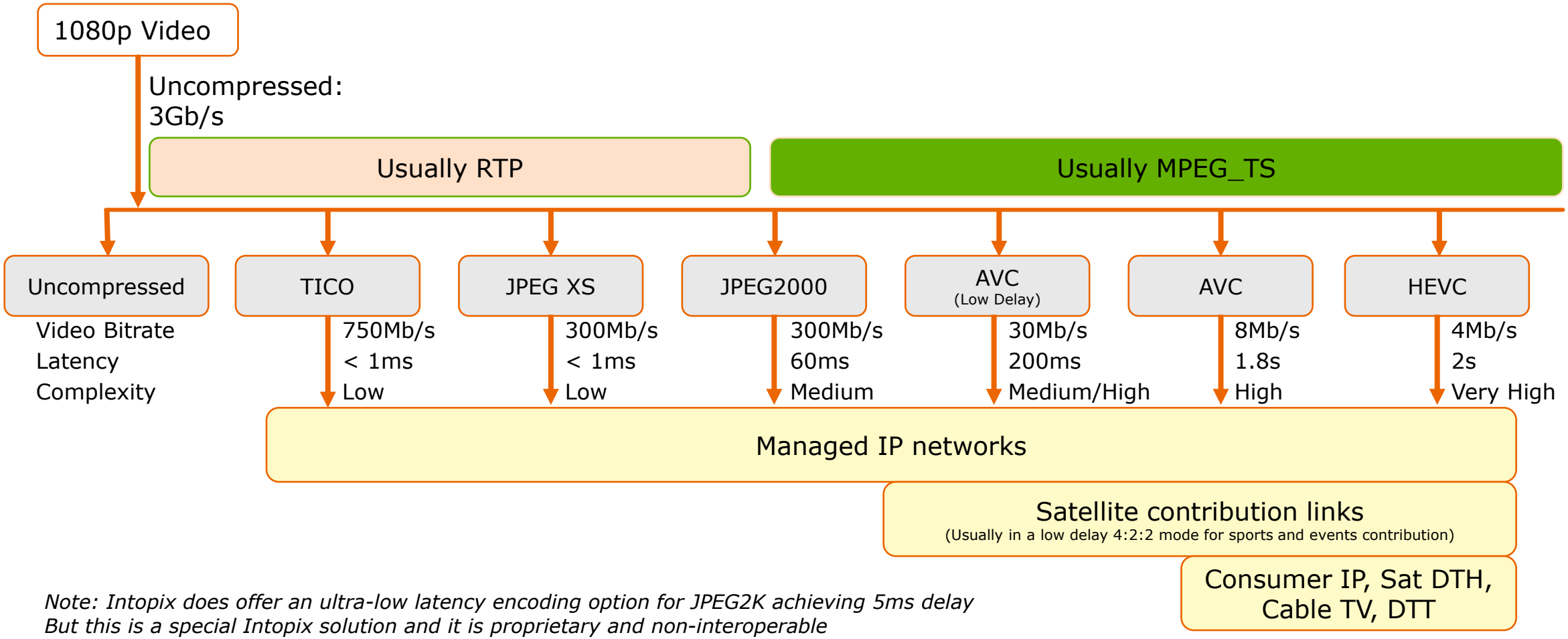
- Defines how JPEG XS RTP can be carried as a compressed video essence within the ST2110 standard

MPEG_TS encapsulation

- It is also possible to encapsulate JPEG XS into MPEG2_TS
- Some operators are interested in this because:
  - It can provide a simple distribution format over WAN
  - Redundancy protection schemes commonly used to protect MPEG_TS will work
  - Many existing workflows are MPEG_TS based so this approach offers great compatibility.

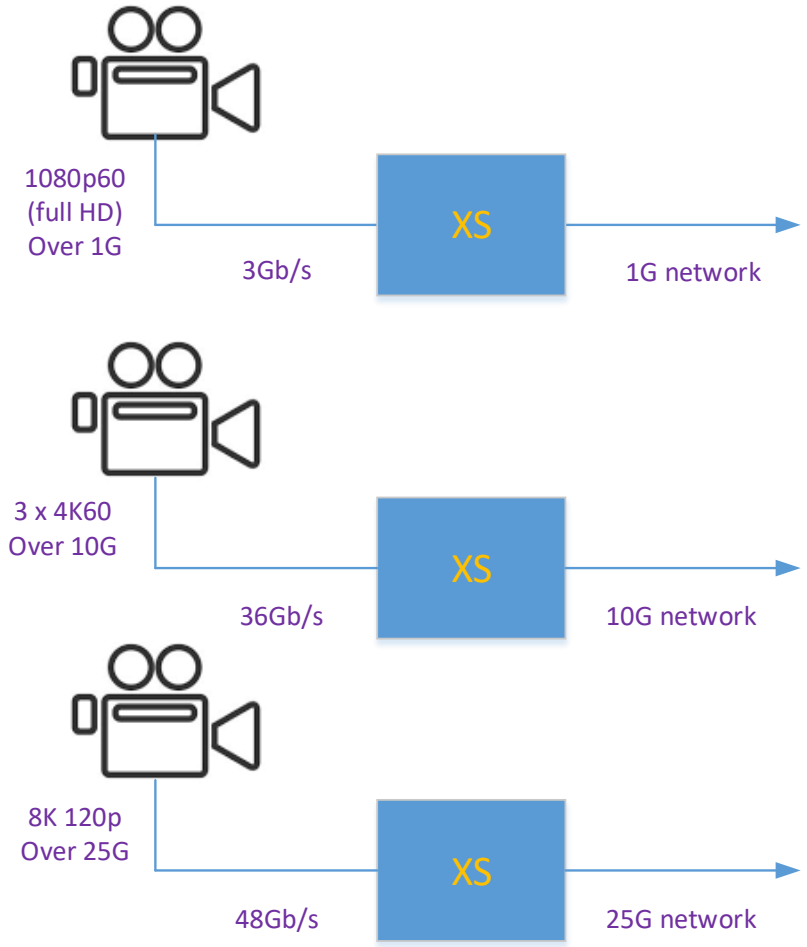
Summarizing JPEG XS v other popular codecs

- Let's see how some common codecs supported by X platform compare and where JPEG XS fits



Note: Intopix does offer an ultra-low latency encoding option for JPEG2K achieving 5ms delay
But this is a special Intopix solution and it is proprietary and non-interoperable

JPEG XS example use case: Coding gain

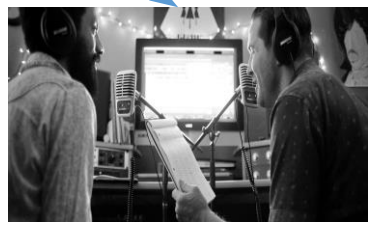


JPEG XS example use case: I want to……

- Implement a codec offering a useful coding gain of up to 20:1 and beyond, delivering very high, reference quality VQ ✓
- Offering true lossless performance at ratios up to 10:1 ✓
- With almost zero delay (just a few ms) ✓
- With minimal hardware and power requirements to potentially give me high service density and high cost efficiency ✓
- With simple intra frame compression so each frame is encoded uniquely and can be edited without restriction ✓
- So I can enjoy all of the benefits of uncompressed delivery with a fraction of the bandwidth required, since for higher resolution formats especially, the full uncompressed bandwidth might either not be available or might be too expensive to contemplate ✓
- I want to enjoy all these benefits whilst taking advantage of the latest IP delivery standards (ST-2110) for flexibility and efficiency reasons. ✓
- I want to enjoy all of these benefits whilst preserving my simple MPEG_TS workflows since my distribution,redundancy protection and ingest is currently based on MPEG_TS ✓

use case with SMPTE2110 support

Combining the benefits of XS's codec with state-of-the-art IP delivery

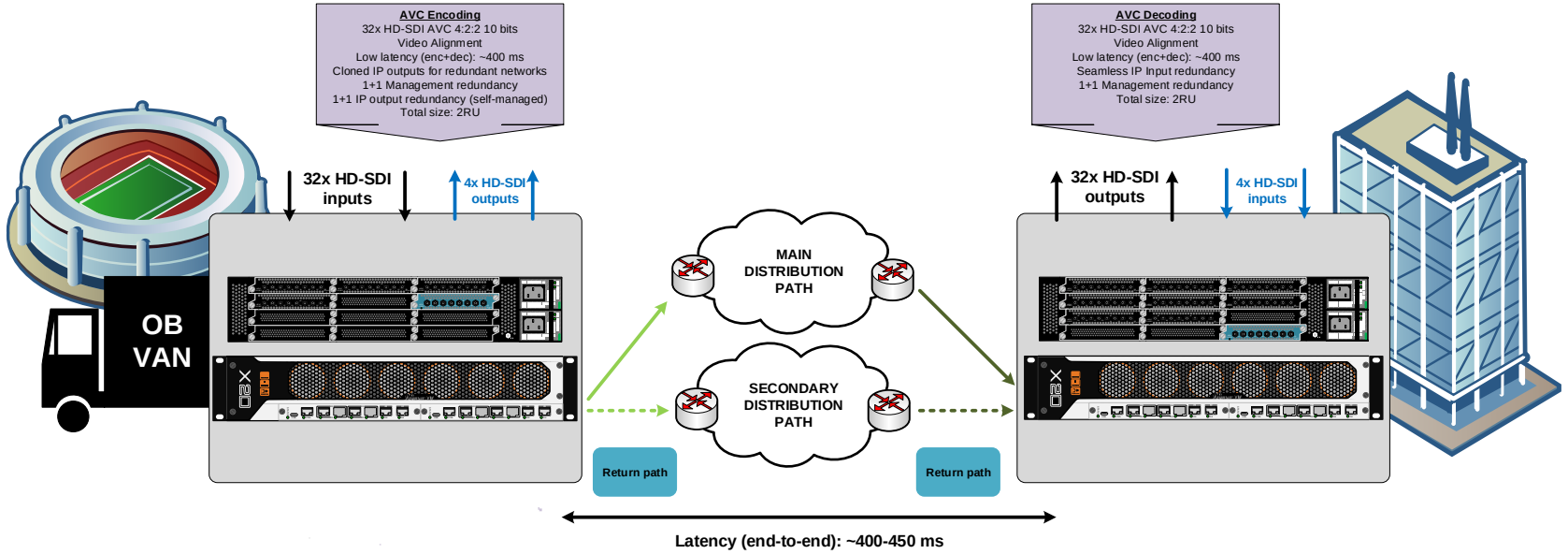


- Example use case illustrating the flexibility benefits of all-IP delivery with ST-2110
- Compared to uncompressed, JPEG-XS enables video bitrates to be reduced by up to 1:20 (or with compromises even more)
- JPEG XS does this without imposing the traditional drawbacks of using compression on the customer.

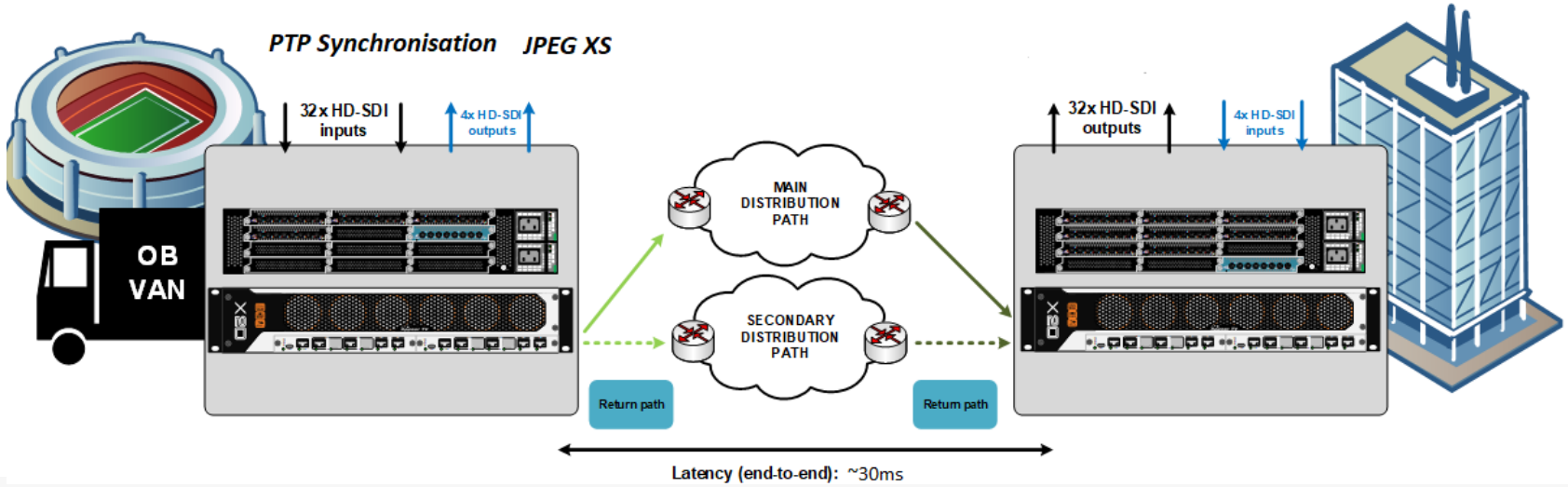
JPEG XS example use case

Multi-channel distribution

Current AVC/HEVC Solution (with service synchronisation)

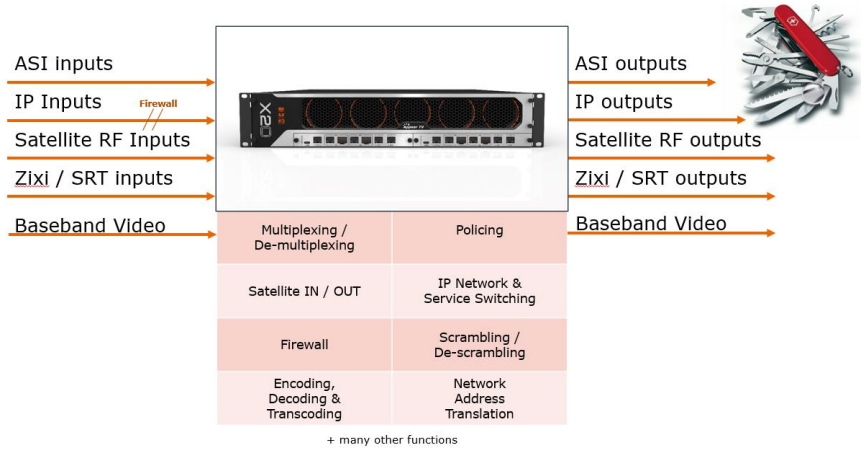


Additional solution Using JPEG XS (services synced)



Appear platform for JPEG XS integration

- Appear X platform is already the 'univers
- It's a 'living system' offering software-de functionality and the ability to easily add
- JPEG XS will be offered on X platform in

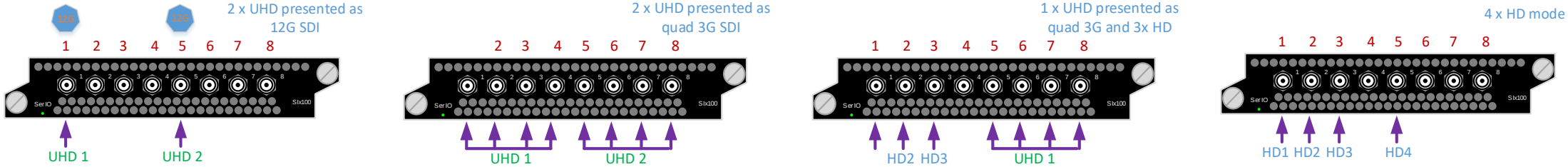


1. Software-defined option for existing SDI / IP gateway

2. New High-bandwidth IP interface module

options for existing SDI/IP gateway

- Standards compliant JPEG XS encode image and decode image (defined at module level)
- Encapsulation performed according to JPEG XS (ISO/IEC 21122)
- ST-2110 compliant towards the chassis backplane
- Density (per module) will be;
  - Up to 4 x HD services
  - Up to 2 x UHD services
  - 1 x UHD and 3 x HD services in mixed mode
- An MPEG_TS encapsulation image option is expected later this year.
- The SDI connectors can be used as follows; (illustrates encode case but decode identical)
  (note: Provisional only: Appear TV may change these designations for the final release. It is not confirmed that 3 x HD with quad UHD presentation will be supported initially; this could become quad UHD with 2 HD)

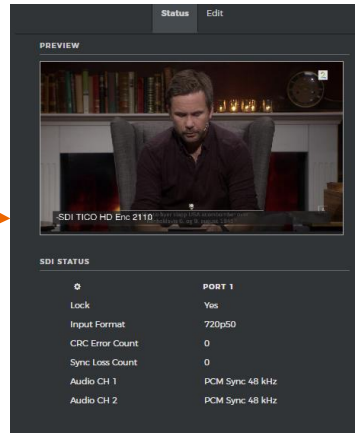


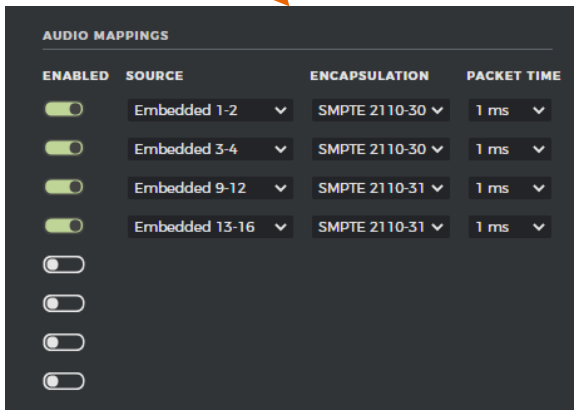
- Note: SD will not be supported unless supported by a suitable customer use case.
- Service density beyond 4 x HD will not be supported to leave free FPGA space for future features (such as input frame store).

options for existing SDI/IP gateway

Features from launch will include;

- HD/UHD video support (as per previous slide)
- Optional auto input format detection mode
- Ability to define an absolute video bitrate (rather than a fixed compression ratio)
- ST-2110 presentation too / from the chassis backplane
- Audio presented as unique ST-2110/30 or /31 flows (the ability to package multiple channels of audio into the same flow to trade efficiency for outright flexibility may be offered later)
- Ancillary data mapped as ST-2110 / 40 flow
- All flow IP address defined on output module, for video, audio flows and ANC data
- Video input monitoring (using a sub-sampled, downscaled image which can be exported via the API as a .PNG
- Decode functionality mirrors encoder
- Possible future MPEG_TS encapsulation option (to be confirmed)





Hew high-bandwidth IP interface module

IP interface version with broadly similar functionality to SDI version but offering increased FPGA capacity;

- Dual QSFP28 interfaces supporting;
  - A maximum of 40Gb/s (40G QSFP+ mode)
  - 4 x 10G QSFP with break-out cable
  - 1 x 10G with QSFP+ to SFP+ adapter
  - 1 x 25G with QSFP28 to SFP28 adapter
  - Essence de-skew and de-jitter*

Input / Output stream format:

- SMPTE 2110 uncompressed via QSFP interfaces
- SMPTE 2110 via chassis backplane (Q3 2020)
- MPEG_TS support via chassis backplane (Q4 2020).

- The addition of MPEG_TS support will offer compatibility with existing J2K workflows, an alternative trunk distribution option to 2110, and will retain compatibility with advanced MPEG_TS seamless redundancy options.

*The de-skew feature will offer synchronized multi-channel delivery for remote production and VAR

Hew high-bandwidth IP interface module

JPEG XS Service density and specifications

- Expected density is currently 6 x HD services OR
  4 x HD with 2x UHD per module
- Compliance: JPEG XS standard (ISO/IEC 21122-1 - High profile)
- Adjustable coding gain from 5:1 to 36:1 ratio
- Sub-millisecond latency (<32 lines).
- Bit depth: 10 bits
- Colour format: YCbCr
- Colour subsampling: 4:2:2
- 2110(-22) Encapsulation according too RTP Payload Format for ISO/IEC 21122 (JPEG XS), (Codestream packetization mode).
- Number of passthrough audio essences per video: 8x 2110-30/31
- Number of passthrough ANC essences per video: 1x 2110-40

Hew high-bandwidth IP interface module

Basic features for Q3 2020 (V1) delivery:

- SMPTE 2110 passthrough
- RTP status indication
  - Bitrate
  - SSRC field validation
  - Sequence error counter
  - Delay reporting
- Essence Status - example:

ESSENCE STATUS

LABEL	STANDARD	STATUS
Video	ST2110-20	No lock
Audio 1	N/A	N/A
Anc	ST2110-40	N/A

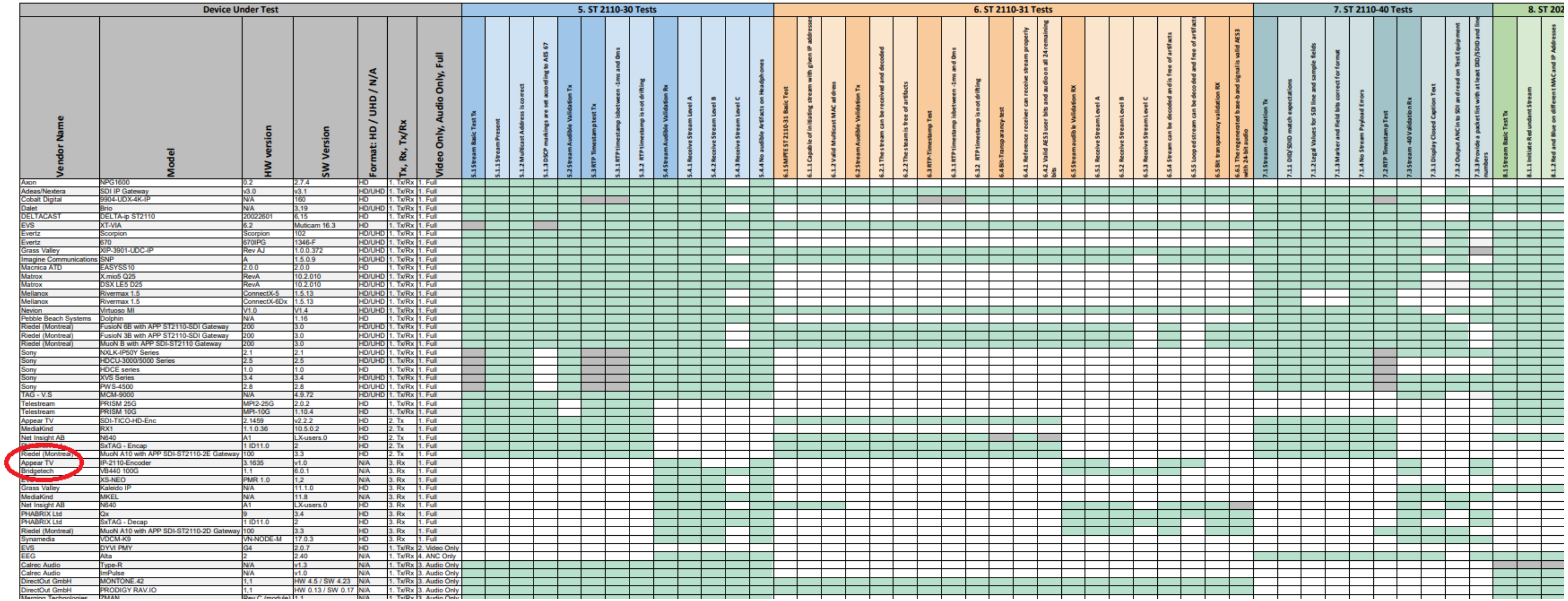
Basic features for Q4 2020 (V2) add:

- Video Test Pattern Generator
- Video Policer (to stop transmission of formats prohibited by a network operator)
- Bitrate Policer (specify a bitrate limit for each essence type)
- IGMPv3 SSM support
- Essence multiplexing (adding essences from any source to create a new combination)
- Video thumbnail monitoring
- Source specific alarm filtering
- MPEG_TS support (encode XS too and decode XS from MPEG_TS)

Appear commitment to interoperability

- All Appear solutions are designed to use open standards and be interoperable wherever possible
- Appear is a participant at the JT-NM interoperability workshops & is committed to support the ST2110 standard fully

JT-NM Tested March 2020 – SMPTE ST 2110 Self-Testing Results



Vendor Name	Model	HW version	SW Version	Format: HD / UHD / N/A	Tx, Rx, Tx/Rx	Video Only, Audio Only, Full
Axon	NPG1600	0.2	2.7.4	HD	1. Tx/Rx	1. Full
Adeas/Nextera	SDI IP Gateway	v3.0	v3.1	HD/UHD	1. Tx/Rx	1. Full
Cobalt Digital	9904-UDX-4K-IP	N/A	160	HD	1. Tx/Rx	1. Full
Dalet	Brio	N/A	3,19	HD/UHD	1. Tx/Rx	1. Full
DELTACAST	DELTA-ip ST2110	20022601	6,15	HD	1. Tx/Rx	1. Full
EVS	XT-VIA	6.2	Muticam 16.3	HD	1. Tx/Rx	1. Full
Evertz	Scorpion	Scorpion	102	HD/UHD	1. Tx/Rx	1. Full
Evertz	670	670IPG	1346-F	HD/UHD	1. Tx/Rx	1. Full
Grass Valley	XIP-3901-UDC-IP	Rev AJ	1.0.0.372	HD/UHD	1. Tx/Rx	1. Full
Imagine Communications	SNP	A	1.5.0.9	HD/UHD	1. Tx/Rx	1. Full
Macnica ATD	EASYSS10	2.0.0	2.0.0	HD	1. Tx/Rx	1. Full
Matrox	X.mio5 Q25	RevA	10.2.010	HD/UHD	1. Tx/Rx	1. Full
Matrox	DSX LE5 D25	RevA	10.2.010	HD/UHD	1. Tx/Rx	1. Full
Mellanox	Rivermax 1.5	ConnectX-5	1.5.13	HD/UHD	1. Tx/Rx	1. Full
Mellanox	Rivermax 1.5	ConnectX-6Dx	1.5.13	HD/UHD	1. Tx/Rx	1. Full
Nevion	Virtuoso MI	V1.0	V1.4	HD/UHD	1. Tx/Rx	1. Full
Pebble Beach Systems	Dolphin	N/A	1.16	HD	1. Tx/Rx	1. Full
Riedel (Montreal)	FusioN 6B with APP ST2110-SDI Gateway	200	3.0	HD/UHD	1. Tx/Rx	1. Full
Riedel (Montreal)	FusioN 3B with APP ST2110-SDI Gateway	200	3.0	HD/UHD	1. Tx/Rx	1. Full
Riedel (Montreal)	MuoN B with APP SDI-ST2110 Gateway	200	3.0	HD/UHD	1. Tx/Rx	1. Full
Sony	NXLK-IP50Y Series	2.1	2.1	HD/UHD	1. Tx/Rx	1. Full
Sony	HDCU-3000/5000 Series	2.5	2.5	HD/UHD	1. Tx/Rx	1. Full
Sony	HDCE series	1.0	1.0	HD	1. Tx/Rx	1. Full
Sony	XVS Series	3.4	3.4	HD/UHD	1. Tx/Rx	1. Full
Sony	PWS-4500	2.8	2.8	HD/UHD	1. Tx/Rx	1. Full
TAG - V.S	MCM-9000	N/A	4.9.72	HD/UHD	1. Tx/Rx	1. Full
Telestream	PRISM 25G	MPI2-25G	2.0.2	HD	1. Tx/Rx	1. Full
Telestream	PRISM 10G	MPI-10G	1.10.4	HD	1. Tx/Rx	1. Full
Appear TV	SDI-TICO-HD-Enc	2.1459	v2.2.2	HD	2. Tx	1. Full
MediaKind	RX1	1.1.0.36	10.5.0.2	HD	2. Tx	1. Full
Net Insight AB	N640	A1	LX-users.0	HD	2. Tx	1. Full
[illegible]	SxTAG - Encap	1 ID11.0	2	HD	2. Tx	1. Full
Riedel (Montreal)	MuoN A10 with APP SDI-ST2110-2E Gateway	100	3.3	HD	2. Tx	1. Full
Appear TV	IP-2110-Encoder	3.1635	v1.0	N/A	3. Rx	1. Full
Bridgetech	VB440 100G	1.1	6.0.1	N/A	3. Rx	1. Full
[illegible]	XS-NEO	PMR 1.0	1,2	N/A	3. Rx	1. Full
Grass Valley	Kaleido IP	N/A	11.1.0	HD	3. Rx	1. Full
MediaKind	MKEL	N/A	11.8	N/A	3. Rx	1. Full
Net Insight AB	N640	A1	LX-users.0	HD	3. Rx	1. Full
PHABRIX Ltd	Qx	9	3.4	HD	3. Rx	1. Full
PHABRIX Ltd	SxTAG - Decap	1 ID11.0	2	HD	3. Rx	1. Full
Riedel (Montreal)	MuoN A10 with APP SDI-ST2110-2D Gateway	100	3.3	HD	3. Rx	1. Full
Synamedia	VDCM-K9	VN-NODE-M	17.0.3	HD	3. Rx	1. Full
EVS	DYVI PMY	G4	2.0.7	HD	1. Tx/Rx	2. Video Only
EEG	Alta	2	2.40	N/A	1. Tx/Rx	4. ANC Only
Calrec Audio	Type-R	N/A	v1.3	N/A	1. Tx/Rx	3. Audio Only
Calrec Audio	ImPulse	N/A	v1.0	N/A	1. Tx/Rx	3. Audio Only
DirectOut GmbH	MONTONE.42	1,1	HW 4.5 / SW 4.23	N/A	1. Tx/Rx	3. Audio Only
DirectOut GmbH	PRODIGY RAV.IO	1,1	HW 0.13 / SW 0.17	N/A	1. Tx/Rx	3. Audio Only
Merging Technologies	ZMAN	Rev C (module)	1.1	N/A	1. Tx/Rx	3. Audio Only


Thank you!