the DUTCH GUILD *of* MULTI-MEDIA ENGINEERS

AXON
THE HEART OF BROADCAST

The future backbone of our industry

ETHERNET WILL ALWAYS WIN, BUT WHAT VERSION WILL WE USE?

Peter Schut, CTO | VP of R&D
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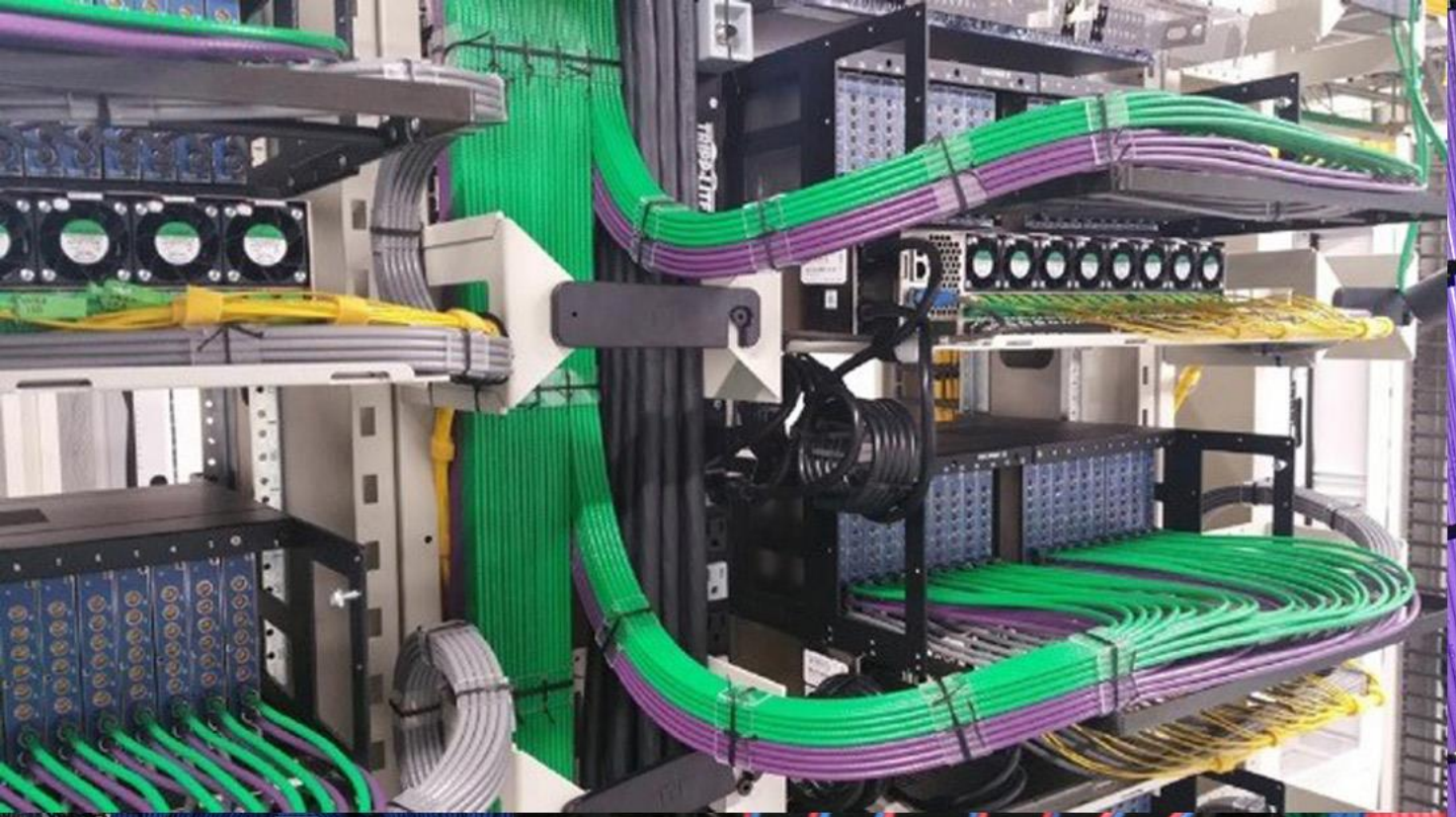
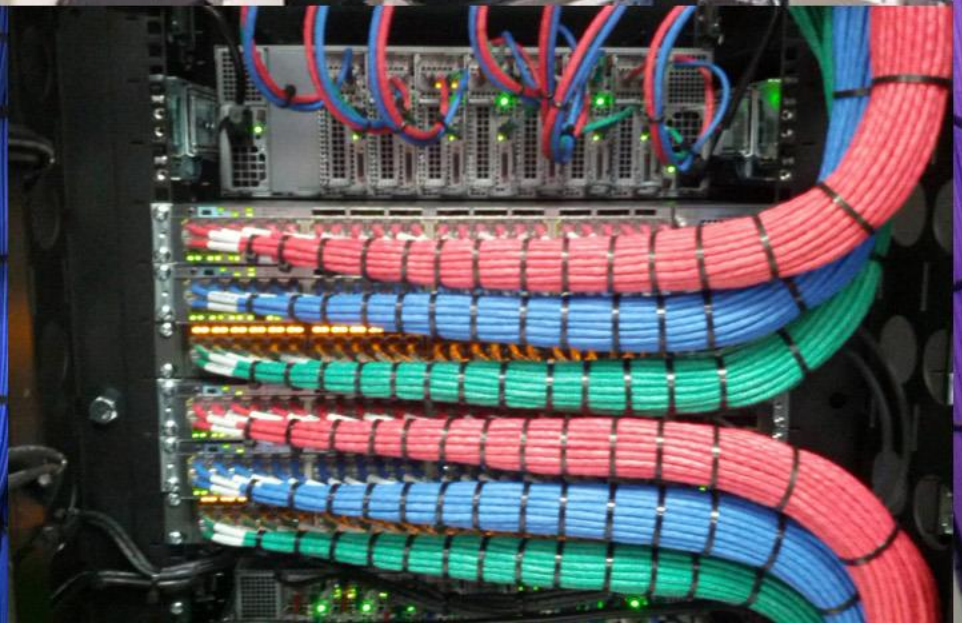
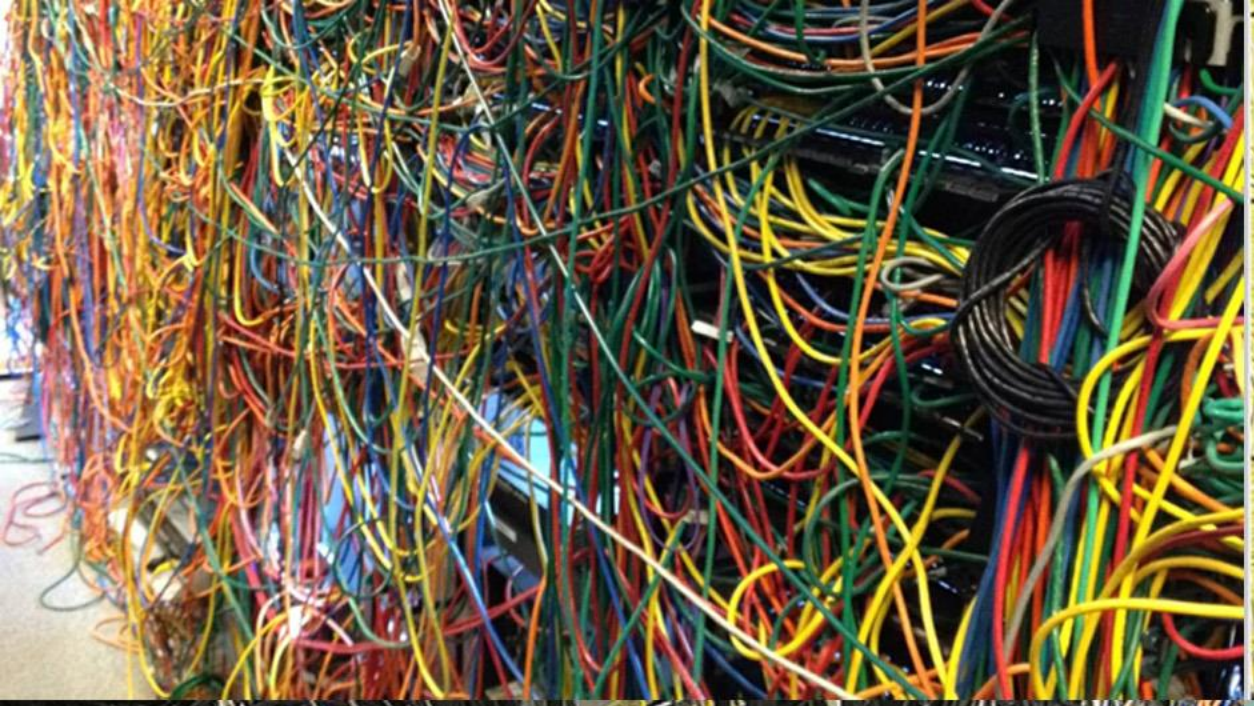
www.axon.tv

Our precious broadcast industry





Why again did we want to abandon SDI in favor of IT equipment?



It looks like the introduction of Ethernet is causing a mess

The main reasons to abandon SDI?

- COTS – Commercial Of The Shelf (no propriety model)
  - Lower cost …….. ✓
  - Lower cost of ownership …….. ???
- We want more flexibility
  - Like a single network for all data …….. ???
  - Distributed routing …….. ✓
- We want a backbone that is agnostic to all current and future formats
  - 4K, 8K, HDR …… these standards are not ideal to run over a dedicated wire like SDI

Ethernet should meet these requirements

Even though Ethernet in its basic form doesn’t work for this application

Why Ethernet doesn’t work right out of the box

- Best-Effort Delivery Strategy
  - The data will arrive but don’t ask me when
- Non-Deterministic
  - Ethernet is random
- No Concept of Isochronous Delivery
  - There is no sense of time and timing
- Is Not Content-Aware
  - All data is treated equally

Ethernet will always win

We just need to enhance Ethernet with a protocol that will allow the above features to work

How difficult can this be?


SMPTE
UNITED STATES

So what has our industry come up with so far?

Technologies that are offered:

- AVB (with future TSN on Layer 3)
- ST2022-6 (Sony with 2022-6 (?) GV with 2022-6)
- VSF-TR03
- VSF-TR04 (not part of this presentation)
- VSF-TR05 (not part of this presentation)
- The Advanced Media Workflow Association (AMWA NMI project)
- ASPEN by Evertz (how open is this?)
- Dante
- Ravenna
- AES67

Flavor	Protocol		Timing and Sync		Essence				Optional Compression	QOS	Discovery	Identity	Control	Notes
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SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
AVB	L2	IEEE 1722	1588 (802as)		IEEE 1722	IEEE 1722	IEEE 1722	IEEE 1722	Optional	Self managed	IEEE 1722.1	IEEE 1722.1	IEEE 1722.1	Fully standardized and based on an IEEE protocol not specifically designed for broadcast (A/V Consumer, automotive)
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AVB


AXON
THE HEART OF BROADCAST

Audio Video Bridging IEEE802.1

Open IT Standard

Self Management

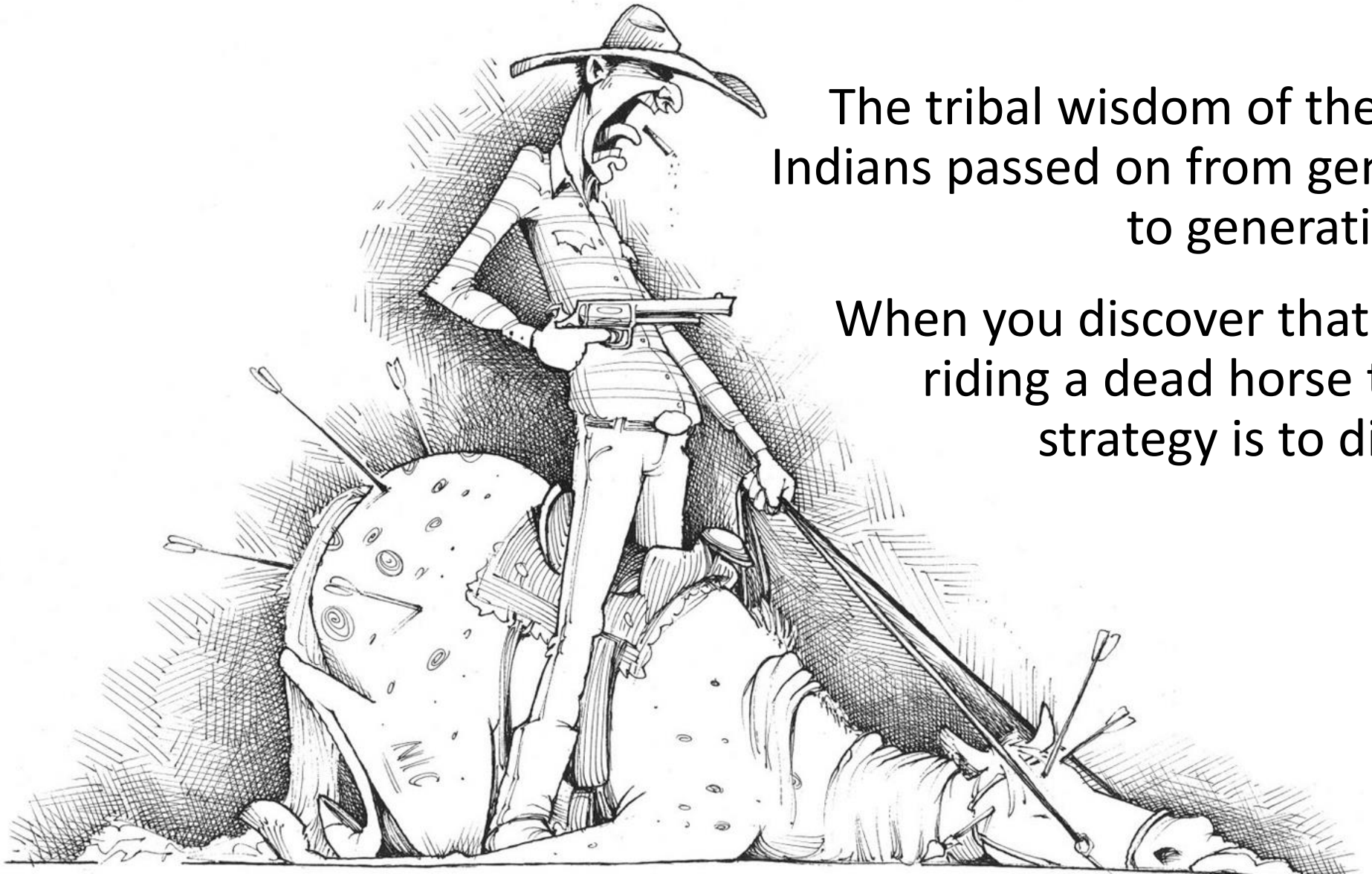
QoS included

DEC included

.....!

AVB still is a superior technology compared to all other offerings

THE DEAD HORSE THEORY



The tribal wisdom of the Dakota Indians passed on from generation to generation says:

When you discover that you are riding a dead horse the best strategy is to dismount

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ST 2022-6

Brad Gilmer of VSF;

“The VSF developed SMPTE 2022 for long-haul video transport over IP networks,”

“It quickly found its way inside facilities, which is **not** what the inventors of 2022 intended”


Ahum …
…. Okay

We said so .....

ST-2022 takes SDI in its entirety over IP/RTP as a single stream

ST-2022 tells nothing about timing but there is a tendency to use ST-2059

Unfortunately ST-2059 timing fights with AES67 in the same port (this needs to be solved)

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VSF-TR03

VSF has corrected their design, rethinking the applications and came up TR03

Definitely a step in the right direction and VSF-TR03 seems like a powerful alternative

TR-03 proposes the time-related essence (video, audio and ancillary data, aka Payload) to be carried over an IP network as separate elementary RTP streams.

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AMWA

Advanced Media Workflow Association

Working on NMI (Networked Media Incubator)

The technical goals of the group will be guided by the Reference Architecture (RA) published by the Joint Task Force on Networked Media.
JT-NM (EBU/SMPTE/VSF)

AMWA will use a slightly modified/enhanced VSF-TR03 standard

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SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
AVB	L2	IEEE 1722	1588 (802as)		IEEE 1722	IEEE 1722	IEEE 1722	IEEE 1722	Optional	Self managed	IEEE 1722.1	IEEE 1722.1	IEEE 1722.1	Fully standardized and based on an IEEE protocol not specifically designed for broadcast (A/V Consumer, automotive)
SMPTE 2022-6	IP/L3	RTP	NA	RTP timestamp	SDI				2022-2	SDN	NA	NA	NA	can use ST2059 as reference
VSF TR3	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp (RFC7273)	RFC4175	RFC3190	ST291	ST291	NA	SDN	multiple options	optional Session Anouncement Protocol (SAP)	NA	next generation VSF based proposal to correct shortcomings in ST 2022-6 protocol
AMWA	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp (RFC7273)	RFC4175 + header extensions	RFC3190 + header extensions	ST291 + header extensions	ST291 + header extensions	√ (VC2 ?)	SDN	mDNS DNS-SD HTTP-based	Universal Unique ID (UUID) based	NA	basically based on VSF-TR03 with defined Discovery and Identity
Aspen	IP/L3	RTP	1588 (PTP) ST2059		RDD37	ST302	X	ST2038	√	SDN	NA	NA	NA	Aspen uses a MPEG2 TS data wrapper (multiple 188 byte chunks in one Ethernet packet = more overhead)
GV	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp	ST 2022-6	embedded	X		√	SDN	multiple options	proprietary and DNS	NA	RFC3190 for intercom /Timecode in SDI
Sony	IP/L3	RTP	ST2059?		proprietary	proprietary		proprietary	proprietary	SDN				At time of writing Sony remains vague on the used standards and protocols
Dante	IP/L3	RTP	1588		NA	proprietary	NA	NA	NA	DiffServ	√	√	proprietary	A proprietary system with many Audio adopters and AES67 included
Ravenna	IP/L3	RTP	1588		NA	Accepts multiple RFC's	NA	NA	NA	DiffServ				Ravenna acts as a framework for multiple types of RTP transport (AES67 is one of them)
AES67	IP/L3	RTP	1588	RTP timestamp (RFC7273)	NA	RFC3351 (16 bit) RFC3190	NA	NA	NA	DiffServ	multiple options			Fights with current version of ST2059 (Caution AES67 may involve a patent owned by Audinate/Dante)

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Aspen

ASPEN is an encapsulation format that takes uncompressed
SD, HD, 3G and Ultra HD signals and packetizes them into an MPEG-2 Transport Stream

ASPEN is fully compatible with SMPTE ST 2059 PTP-based synchronization

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	Transport	Payload	Clock Sync	Payload Sync	Video	Audio	Time Code	ANC/Metadata						
SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
AVB	L2	IEEE 1722	1588 (802as)		IEEE 1722	IEEE 1722	IEEE 1722	IEEE 1722	Optional	Self managed	IEEE 1722.1	IEEE 1722.1	IEEE 1722.1	Fully standardized and based on an IEEE protocol not specifically designed for broadcast (A/V Consumer, automotive)
SMPTE 2022-6	IP/L3	RTP	NA	RTP timestamp	SDI				2022-2	SDN	NA	NA	NA	can use ST2059 as reference
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Aspen	IP/L3	RTP	1588 (PTP) ST2059		RDD37	ST302	X	ST2038	√	SDN	NA	NA	NA	Aspen uses a MPEG2 TS data wrapper (multiple 188 byte chunks in one Ethernet packet = more overhead)
GV	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp	ST 2022-6	embedded	X		√	SDN	multiple options	proprietary and DNS	NA	RFC3190 for intercom /Timecode in SDI
Sony	IP/L3	RTP	ST2059?		proprietary	proprietary		proprietary	proprietary	SDN				At time of writing Sony remains vague on the used standards and protocols
Dante	IP/L3	RTP	1588		NA	proprietary	NA	NA	NA	DiffServ	√	√	proprietary	A proprietary system with many Audio adopters and AES67 included
Ravenna	IP/L3	RTP	1588		NA	Accepts multiple RFC's	NA	NA	NA	DiffServ				Ravenna acts as a framework for multiple types of RTP transport (AES67 is one of them)
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Sony/GV

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SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
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Aspen	IP/L3	RTP	1588 (PTP) ST2059		RDD37	ST302	X	ST2038	√	SDN	NA	NA	NA	Aspen uses a MPEG2 TS data wrapper (multiple 188 byte chunks in one Ethernet packet = more overhead)
GV	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp	ST 2022-6	embedded	X		√	SDN	multiple options	proprietary and DNS	NA	RFC3190 for intercom /Timecode in SDI
Sony	IP/L3	RTP	ST2059?		proprietary	proprietary		proprietary	proprietary	SDN				At time of writing Sony remains vague on the used standards and protocols
Dante	IP/L3	RTP	1588		NA	proprietary	NA	NA	NA	DiffServ	√	√	proprietary	A proprietary system with many Audio adopters and AES67 included
Ravenna	IP/L3	RTP	1588		NA	Accepts multiple RFC's	NA	NA	NA	DiffServ				Ravenna acts as a framework for multiple types of RTP transport (AES67 is one of them)
AES67	IP/L3	RTP	1588	RTP timestamp (RFC7273)	NA	RFC3351 (16 bit) RFC3190	NA	NA	NA	DiffServ	multiple options			Fights with current version of ST2059 (Caution AES67 may involve a patent owned by Audinate/Dante)

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ST2038	Carriage of Ancillary Data Packets in an MPEG-2 Transport Stream

Dante

Dante™

Dante (by Audinate) is a well established audio over IP network system with many compatible manufacturers

Flavor	Protocol		Timing and Sync		Essence				Optional Compression	QOS	Discovery	Identity	Control	Notes
	Transport	Payload	Clock Sync	Payload Sync	Video	Audio	Time Code	ANC/Metadata						
SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
AVB	L2	IEEE 1722	1588 (802as)		IEEE 1722	IEEE 1722	IEEE 1722	IEEE 1722	Optional	Self managed	IEEE 1722.1	IEEE 1722.1	IEEE 1722.1	Fully standardized and based on an IEEE protocol not specifically designed for broadcast (A/V Consumer, automotive)
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VSF TR3	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp (RFC7273)	RFC4175	RFC3190	ST291	ST291	NA	SDN	multiple options	optional Session Anouncement Protocol (SAP)	NA	next generation VSF based proposal to correct shortcomings in ST 2022-6 protocol
AMWA	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp (RFC7273)	RFC4175 + header extensions	RFC3190 + header extensions	ST291 + header extensions	ST291 + header extensions	√ (VC2 ?)	SDN	mDNS DNS-SD HTTP-based	Universal Unique ID (UUID) based	NA	basically based on VSF-TR03 with defined Discovery and Identity
Aspen	IP/L3	RTP	1588 (PTP) ST2059		RDD37	ST302	X	ST2038	√	SDN	NA	NA	NA	Aspen uses a MPEG2 TS data wrapper (multiple 188 byte chunks in one Ethernet packet = more overhead)
GV	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp	ST 2022-6	embedded	X		√	SDN	multiple options	proprietary and DNS	NA	RFC3190 for intercom /Timecode in SDI
Sony	IP/L3	RTP	ST2059?		proprietary	proprietary		proprietary	proprietary	SDN				At time of writing Sony remains vague on the used standards and protocols
Dante	IP/L3	RTP	1588		NA	proprietary	NA	NA	NA	DiffServ	√	√	proprietary	A proprietary system with many Audio adopters and AES67 included
Ravenna	IP/L3	RTP	1588		NA	Accepts multiple RFC's	NA	NA	NA	DiffServ				Ravenna acts as a framework for multiple types of RTP transport (AES67 is one of them)
AES67	IP/L3	RTP	1588	RTP timestamp (RFC7273)	NA	RFC3351 (16 bit) RFC3190	NA	NA	NA	DiffServ	multiple options			Fights with current version of ST2059 (Caution AES67 may involve a patent owned by Audinate/Dante)

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ST2038	Carriage of Ancillary Data Packets in an MPEG-2 Transport Stream

Ravenna

RAVENNA

Ravenna is also an audio network protocol developed by Lawo

Flavor	Protocol		Timing and Sync		Essence				Optional Compression	QOS	Discovery	Identity	Control	Notes
	Transport	Payload	Clock Sync	Payload Sync	Video	Audio	Time Code	ANC/Metadata						
SDI	SDI	baseband	Synchron	TRS	√	√	√	√	NA	Self managed	NA	NA	NA	
AVB	L2	IEEE 1722	1588 (802as)		IEEE 1722	IEEE 1722	IEEE 1722	IEEE 1722	Optional	Self managed	IEEE 1722.1	IEEE 1722.1	IEEE 1722.1	Fully standardized and based on an IEEE protocol not specifically designed for broadcast (A/V Consumer, automotive)
SMPTE 2022-6	IP/L3	RTP	NA	RTP timestamp	SDI				2022-2	SDN	NA	NA	NA	can use ST2059 as reference
VSF TR3	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp (RFC7273)	RFC4175	RFC3190	ST291	ST291	NA	SDN	multiple options	optional Session Anouncement Protocol (SAP)	NA	next generation VSF based proposal to correct shortcomings in ST 2022-6 protocol
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Aspen	IP/L3	RTP	1588 (PTP) ST2059		RDD37	ST302	X	ST2038	√	SDN	NA	NA	NA	Aspen uses a MPEG2 TS data wrapper (multiple 188 byte chunks in one Ethernet packet = more overhead)
GV	IP/L3	RTP	1588 (PTP) ST2059	RTP timestamp	ST 2022-6	embedded	X		√	SDN	multiple options	proprietary and DNS	NA	RFC3190 for intercom /Timecode in SDI
Sony	IP/L3	RTP	ST2059?		proprietary	proprietary		proprietary	proprietary	SDN				At time of writing Sony remains vague on the used standards and protocols
Dante	IP/L3	RTP	1588		NA	proprietary	NA	NA	NA	DiffServ	√	√	proprietary	A proprietary system with many Audio adopters and AES67 included
Ravenna	IP/L3	RTP	1588		NA	Accepts multiple RFC's	NA	NA	NA	DiffServ				Ravenna acts as a framework for multiple types of RTP transport (AES67 is one of them)
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AES67

AES67 is a standard for audio over IP interoperability developed by the

AES67 patent claim on the technology by Audinate.

This makes implementing AES67 a bit tricky
(If you license Dante you get AES67 for free)

Dante, Ravenna and AES67 audio standards use DiffServ as the QoS method

Timing & Latency

Timing is a challenge in IP networks but enough has been developed and tested that in the future this should be no problem

Audio, video and data locking is also a challenge but with individual timestamps a correct sync is easier than before

All timing based on IEEE 1588 has the option to use a defined starting point
(Jan 1, 1970)

Latency is as much a challenge as it is in current SDI systems

Seamless switching

Seamless switching is important in our industry

ST 2022-7 seamless Protected Switching of 2022 IP datagrams

A way to send two matching streams of packets from a source to a destination over different paths, and have the receiver switch seamless between them.

We call this “destination switching” and is not a difficult method

“source switching” on the other hand is quite difficult and can only be managed in a tightly controlled environment of hard and software

Compression

There will be some:

VC2 (Dirac)
Tico
LLVC
….
Is it worth it … ?

SDN

or

Self Management

The broadcast industry tends to put QoS and management in the hands of an SDN!

And .....
There are many flavors of SDN

An alternative is TSN (Time Sensitive Networks) aka AVB2

TSN is the future of big networks according to the IT industry

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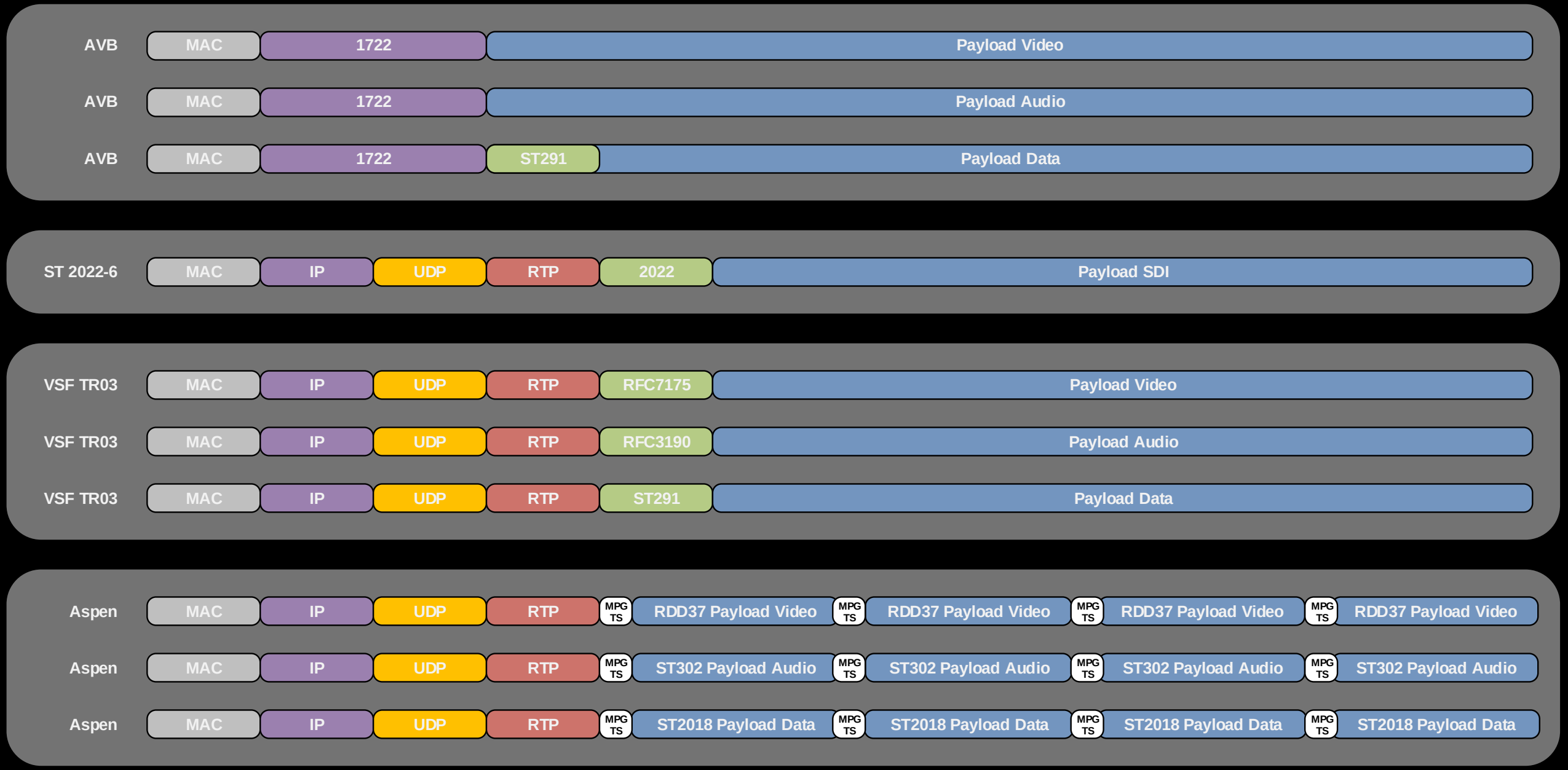
AVB
MAC
1722
Payload Video
AVB
MAC
1722
Payload Audio
AVB
MAC
1722
ST291
Payload Data
ST 2022-6
MAC
IP
UDP
RTP
2022
Payload SDI
VSF TR03
MAC
IP
UDP
RTP
RFC7175
Payload Video
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MAC
IP
UDP
RTP
RFC3190
Payload Audio
VSF TR03
MAC
IP
UDP
RTP
ST291
Payload Data
Aspen
MAC
IP
UDP
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MPG TS
RDD37 Payload Video
MPG TS
RDD37 Payload Video
MPG TS
RDD37 Payload Video
MPG TS
RDD37 Payload Video
Aspen
MAC
IP
UDP
RTP
MPG TS
ST302 Payload Audio
MPG TS
ST302 Payload Audio
MPG TS
ST302 Payload Audio
MPG TS
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Aspen
MAC
IP
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ST2018 Payload Data
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So where does this leave you as an end-user

- Too many choices
- Poor interoperability
- An SDN for all offerings (except AVB)
- To compress or not to compress TiCo/VC2/LLVC?
- Do I invest in this now?

And where does that leave us manufacturers?

- Too many choices
- Every flavor costs time and money
- You can waste quite a bit of both

The Future?

?

If you need to built something now ....

Use SDI.

(and be very happy with it)

If you need to built something now on IP ….

Use ST 2022-6

(and be sure you will need to change soon)

If you need to built something in the future ….

Use VSF-TR03

(or TR04 or TR05 or ….)

If you need to built something soon on IP, and be ready for anything that might come ….

Use a vendor that will follow all future formats

NEURON ETHERNET INFRASTRUCTURE

AXON THE HEART OF BROADCAST

No 3rd party IP cores

We are adapting our core to all above proposals and become agnostic on the used encapsulation format

THANK YOU

peter.schut@axon.tv

AXON
THE HEART OF BROADCAST