Live Production as we know it
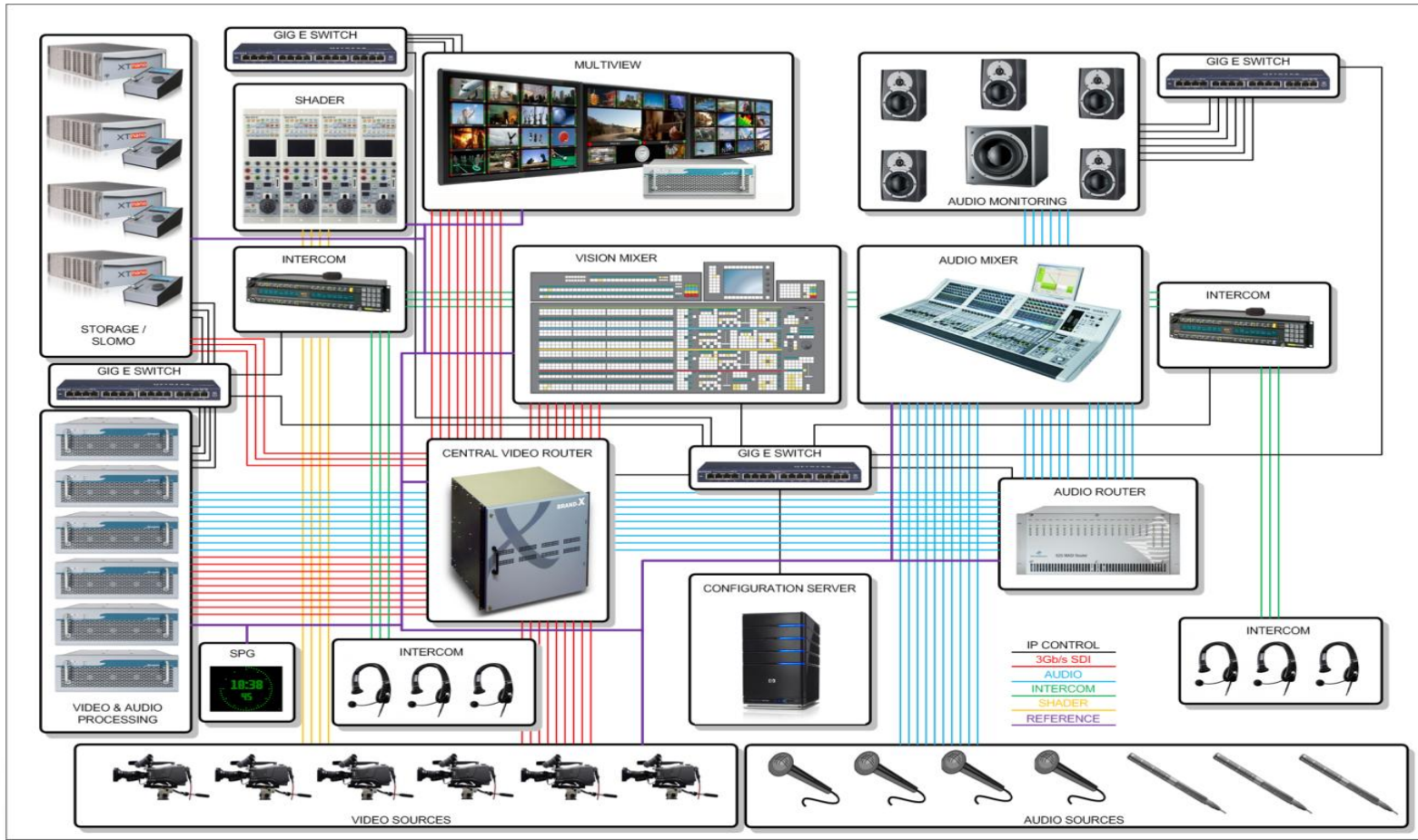
Live Production infrastructures: the next wave !

today

Ethernet

3 Gbps

HD-SDI

SDI

Composite

1Gb AVB SWITCH

SHADER

MULTIVIEW

AUDIO MONITORING

1Gb AVB SWITCH

INTERCOM

VISION MIXER

AUDIO MIXER

INTERCOM

STORAGE / SLOMO

100Gb AVB SWITCH

100Gb AVB SWITCH

1Gb AVB SWITCH

LESS DISTRIBUTION AMPLIFIERS

VIDEO & AUDIO PROCESSING

SPG

10:30 45

INTERCOM

100Gb AVB SWITCH

CONFIGURATION SERVER

IP CONTROL
100Gb AVB
10Gb AVB
1Gb AVB
REFERENCE

INTERCOM

VIDEO SOURCES

AUDIO SOURCES

What is AVB ?

- **AVB = Audio Video Bridging**

- **A set of standards created by the IEEE**

- **From the charter of the IEEE AVB task group:**

"specifications that will allow time-synchronized low latency streaming services through 802 networks"

The AVB key elements

Audio Video Bridging (AVB)

Time Synchronization	**Traffic Shaping**
Bandwidth Reservation	**Configuration**

AVB terminology

- **Stream**
  - A "pipe" that contains one or more channels of audio and/or video data in an AVB cloud

- **Talker**
  - An entity in the AVB cloud that can send a stream

- **Listener**
  - An entity in the AVB cloud that can receive a stream

- **Controller**
  - An entity on the network which configures and connects Talkers and Listeners in an AVB network

AVB synchronization

- Guarantees accurate **absolute** timing of all AVB enabled nodes

- IEEE802.1AS is a special (more tightly defined) profile of IEEE1588

- Uses timestamp that is exchanged regularly between all nodes
  - The timestamp is based on an EPOCH absolute reference time (0:00:00 Jan. 1, 1970)
  - Switches will measure delay in switch and add correction factor to timestamp message
    - Each node receives original timestamp plus cumulative delay thru the network Adding correction factor to timestamp results in actual time that is in sync

- No special reference infrastructure is needed
  - No need for extra Cables
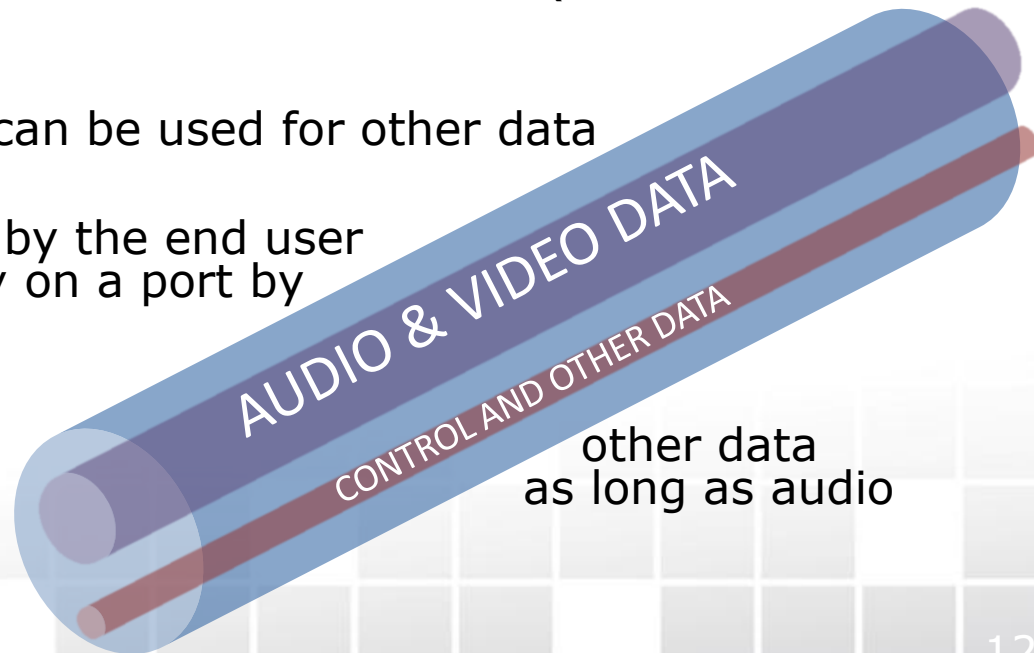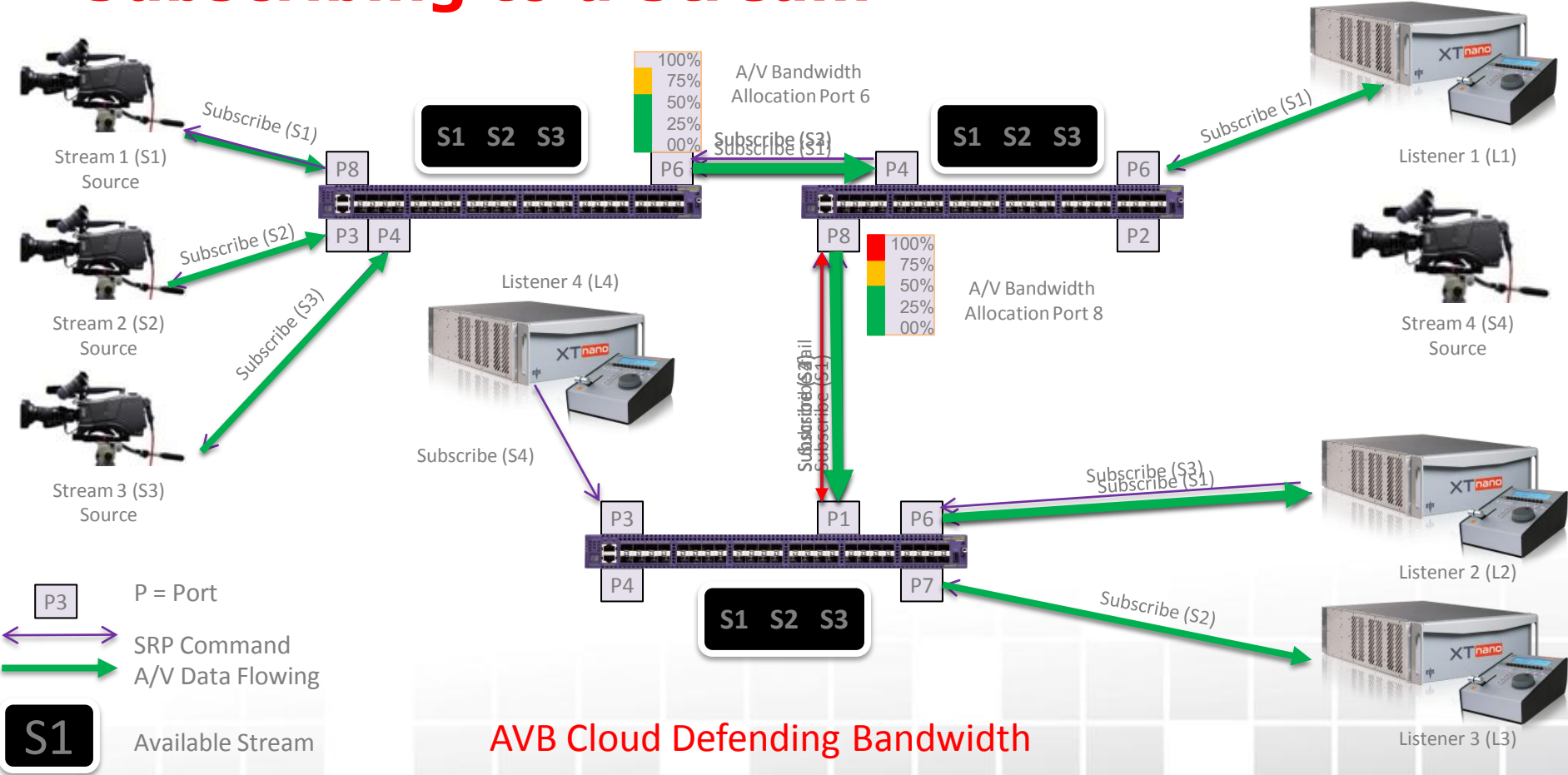 - No reference distribution amplifiers (DA's)
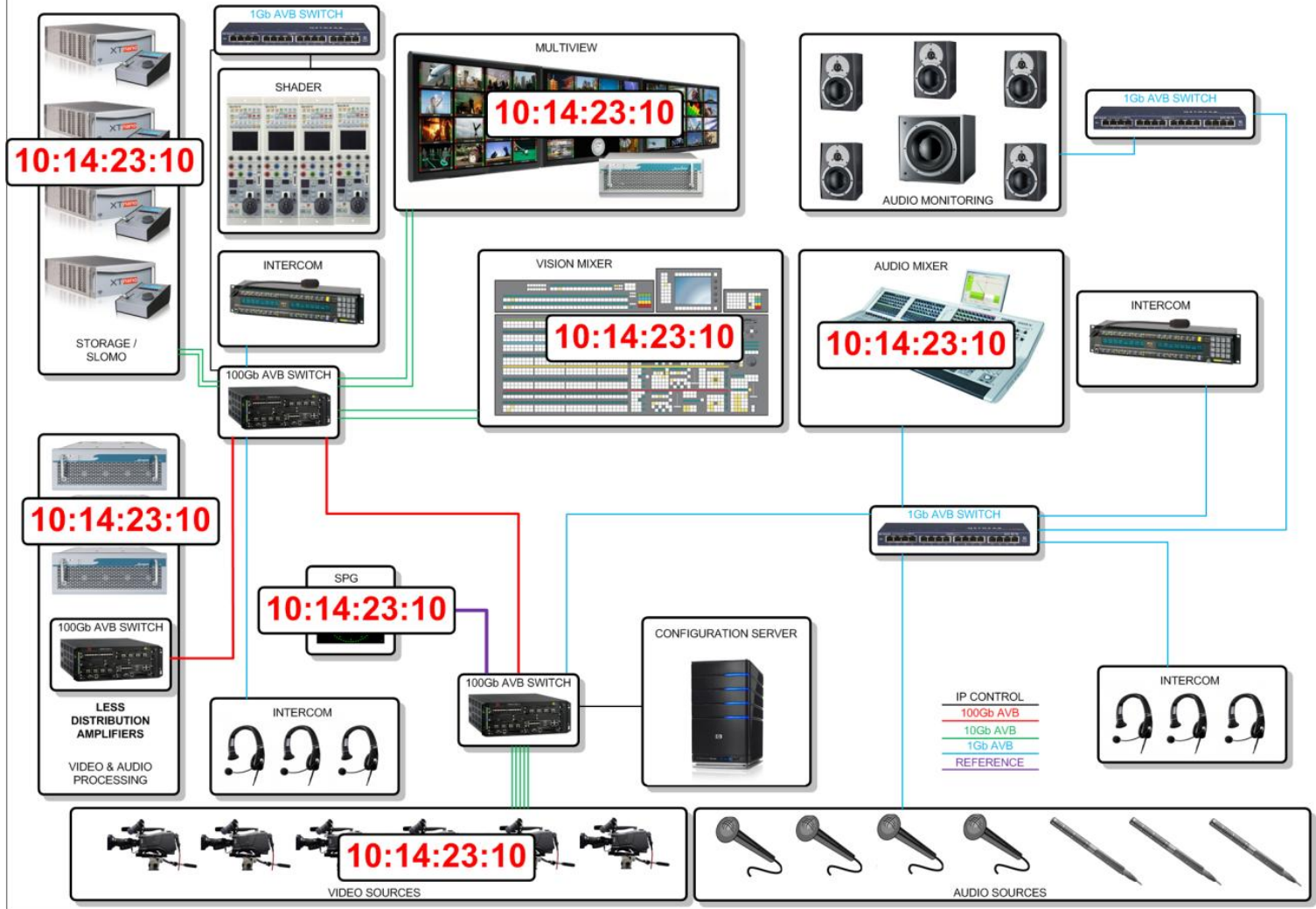
Admission Control/bandwidth management

- This technology makes sure that the payload (audio and video) can use a predefined amount of the bandwidth.

- For AVB audio this is 75% of the maximum data rate (often 1Gb Ethernet)

- The other 25% of bandwidth can be used for other data

- This percentage is adjustable by the end user depending on switch flexibility on a port by port basis

- When available control and may use more bandwidth and video data need less

AUDIO & VIDEO DATA

CONTROL AND OTHER DATA

other data as long as audio

Subscribing to a Stream

Stream 1 (S1) Source
Subscribe (S1)
P8
S1 S2 S3
100%
75%
50%
25%
00%
A/V Bandwidth Allocation Port 6
P6
Subscribe (S2)
Subscribe (S1)
P4
S1 S2 S3
Subscribe (S1)
P6
Listener 1 (L1)

Stream 2 (S2) Source
Subscribe (S2)
P3 P4
P8
100%
75%
50%
25%
00%
A/V Bandwidth Allocation Port 8
P2
Stream 4 (S4) Source

Stream 3 (S3) Source
Subscribe (S3)
Listener 4 (L4)
Subscribe (S4)
P3
Subscribe (S2)
Subscribe (S1)
P1 P6
Subscribe (S3)
Subscribe (S1)
Listener 2 (L2)

P4
S1 S2 S3
P7
Subscribe (S2)

P3 P = Port

SRP Command
A/V Data Flowing

S1 Available Stream

AVB Cloud Defending Bandwidth

Listener 3 (L3)

Forwarding, Queuing & Traffic Shaping

- **Priority based scheduling**
  - Time sensitive streams have highest priority (Audio & Video)
  - Other data can eventually be passed but as a factor of waiting time and available space. (data that is in a queue for a longer time will raise in the priority scale).

- **Traffic shaping: AVB nodes must 'behave'**
  - Avoid bursts in the network as this can create momentarily peaks in bandwidth on the network which may exceed capacity of link buffers-> packet drop !
  - No jumbo-frames !
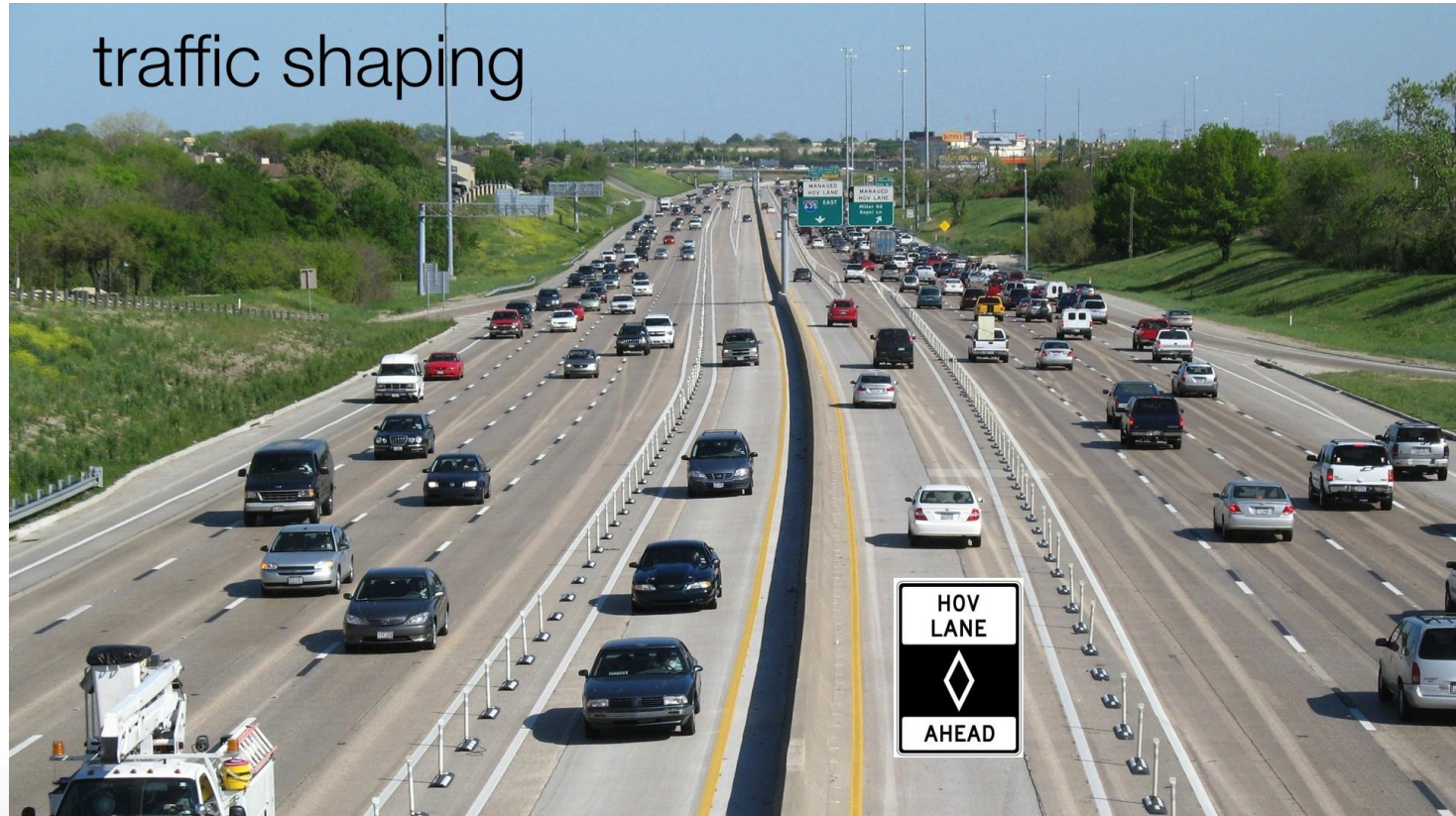
Example: Ethernet packets in light Traffic

light traffic

Example: Ethernet packets in heavy Traffic

heavy traffic

Example: Ethernet packets in an AVB system
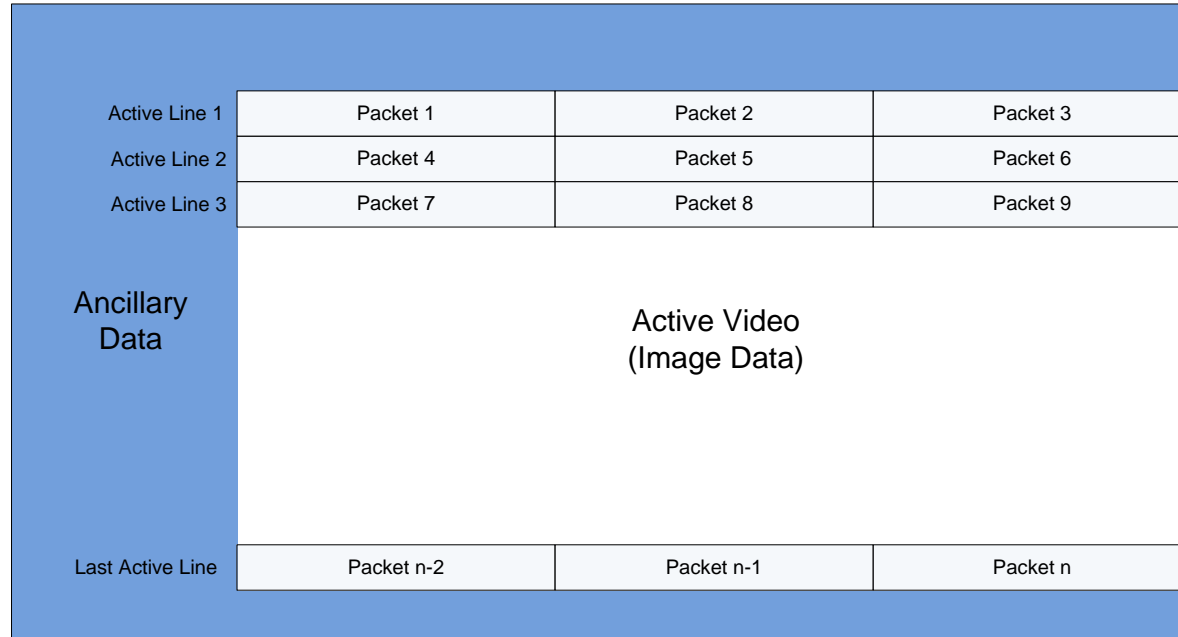

traffic shaping

HOV LANE ◇ AHEAD

AVB Configuration Protocol

- **Discovery**
  - Devices announce their presence to any listening controller

- **Configuration**
  - Controllers learn more about devices of interest and configure them

- **Connection Management**
  - Controllers make connections between Listeners and Talkers

- **Control**
  - Controllers interact with devices to control gain, phase, timing etc.

IEEE 1722 RAW Video Format - 1

- Transmit (only) (active) video
  - audio, data as separate streams

- Save bandwidth (can be upto 40% !) vs SDI format
  - Vertical blanking can still be send (optionally)

- Horizontal resolution (active picture): upto 65535 pixels (16-bit field)

- Vertical resolution (active picture): upto 65535 pixels (16-bit field)

- Frame-rate: 24, 25, 30, 35, 85 Hz
  - Multiplier: 1, 2, 3, 4
  - Including all 1000/1001 variants

- Bit-depth: 8,10,12 or 16 bit

- Pixel format: 4:1:1, 4:2:0, 4:2:2, 4:4:4, …..

- Color space/coding: YCbCr, sRGB, XYZ, YCM, Bayer, BT601, BT709, …..

IEEE 1722 RAW Video Format - 2

Active Line 1	Packet 1	Packet 2	Packet 3
Active Line 2	Packet 4	Packet 5	Packet 6
Active Line 3	Packet 7	Packet 8	Packet 9

Ancillary Data

Active Video (Image Data)

| Last Active Line | Packet n-2 | Packet n-1 | Packet n |

Active pixels	sample words per pixel	Bits per sample word	Packets per Line	Packet Payload size
720	2	10	2	900
1280	2	10	3	1067
1920	2	10	4	1200
3840	2	10	7	1372

Typical characteristics of an AVB network

- All nodes are **_fully synchronised_** to a (very stable) network clock
  - Allows very accurate recovery of media clocks
    - SDI can be recovered within broadcast quality jitter specifications
    - Audio clock can be recovered maintaining phase relation

- **_Low latency_**: typically **_2ms_** overall network delay
  - Allows for complex/distributed networks (multiple hops)

- The network **_self-manages bandwidth reservation_** such that links will never get overcommitted and/or packets are dropped

- Uses **_multi-cast_**, so only one copy of each active source on any given link or backbone

How real is Ethernet AVB ?

- 100Mbps, 1Gbps,10Gbps, 40Gbps and 100 Gbps Ethernet AVB switches are shipping

- Several professional AVB audio products on the market from several vendors:
  - Audio processors, audio consoles, speakers, etc
  - Intercom systems

- First broadcast quality AVB video products have started shipping

- Compliance testing and certification process is up and running

ESPN in the USA is on-air with AVB audio !

"The audio infrastructure here is primarily AVB," says Jonathan Pannaman, senior director of technology, ESPN.
"We have a little MADI transport in parts, but even that will be converted to AVB at some point.
The entire comms infrastructure is all AVB, from the [router] core to the panels."

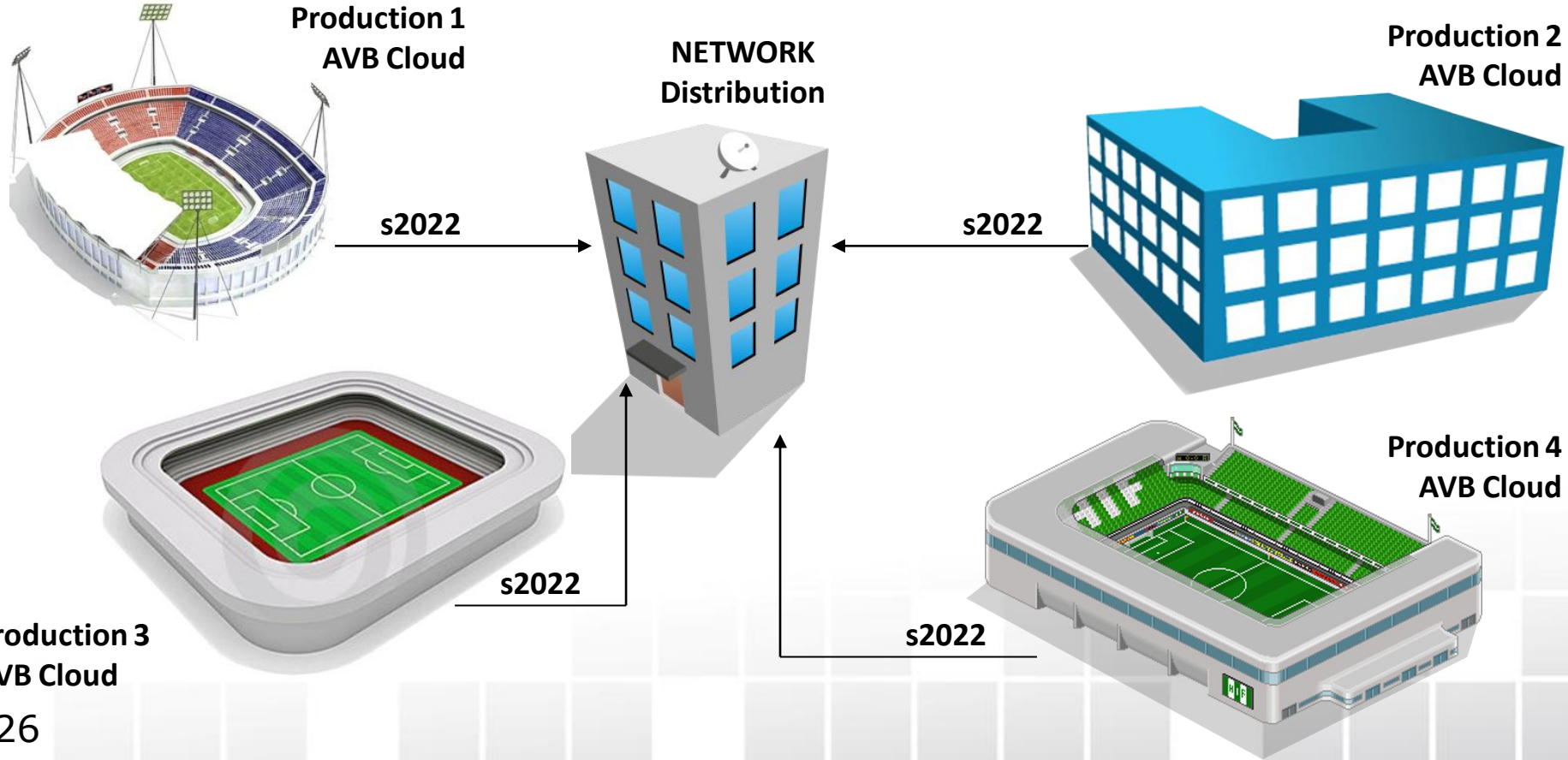# Relevant companies with AVB products (or are working on it)

Ethernet AVB vs SMPTE2022-6

Ethernet AVB	SMPTE 2022-6

▪ Complete framework/solution for real-time, low-latency audio, video and data transport
   ▪ Includes (clock-)synchronisation
   ▪ Includes bandwidth management/QoS
	▪ Specifies only transport layer protocol
	
	   ▪ No (clock-)synchronisation
	   ▪ No bandwidth management/QoS

▪ Supports separate transport of video, audio and (ANC) data	▪ Video is transported as encapsulated SDI, no solution for audio or ANC data (+ waste of bandwidth !)
▪ Allows for 'any' type of future video format	▪ Limited to (existing) SDI formats
▪ Plug-and-play	▪ IP addresses management (fiddling)

AVB and s2022 hand in hand

Production 1
AVB Cloud

NETWORK
Distribution

Production 2
AVB Cloud

s2022

s2022

s2022

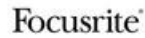s2022

Production 3
AVB Cloud

Production 4
AVB Cloud

26

A very important element: _interoperability_

Ensuring that AVB nodes talk to AVB nodes

AVnu Alliance

AVnu Alliance members (overview)

Summarising the key benefits of Ethernet - AVB

- Based on ***existing*** and ***open standards*** from a very reputable and succesful standards body (IEEE)

- Provides ***one framework*** for reliable, time-synchronised, real-time transport of ***video, audio and data***

- ***Proven technology*** that is ***available now***: large professional AVB audio systems being deployed in the field

- ***Interoperability*** is going to be taken care of: ***AVnu alliance***

- ***Plug-and play :*** no conflicts or fiddling with IP addresses, etc

- ***Fool-proof:*** the network is self-managing, it does not rely on the skills of network engineers or a (proprietery) software management layer.

- ***Perfect co-existence*** (and reserved bandwidth for) with standard IP traffic (eg. control, monitoring, etc)
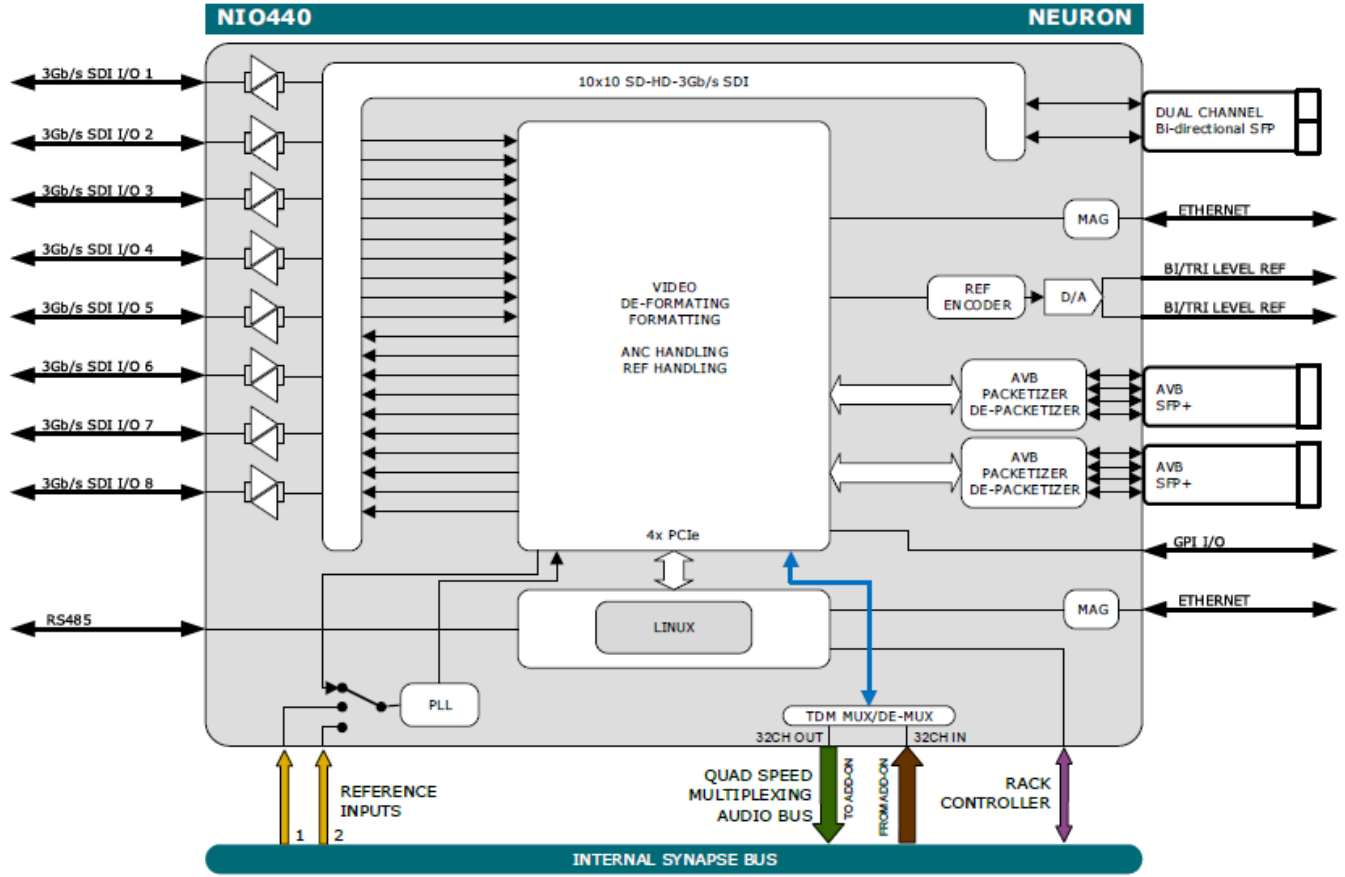
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Thank you !

Come and see us at our booth:

#SU5405