Utah Scientific

The Transition from Uncompressed SDI to IP Video

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AIMS
Alliance for IP Media Solutions

Evolution of Video

- Black & White to Color (NTSC/PAL)
- Analog to Digital (SDI via SMPTE 259)
- SD-SDI to HD-SDI (SMPTE 292M/274M) & Audio Embedding
- HD-SDI to 4K/8K (?)

All of these changes mean changes at the BASEBAND level

SDI vs. IP

- SDI = Coax
  - 3G/6G/12G/24G means 4-8 times more coaxial cable and some fiber optic proposals in SMPTE 208x
  - Advantage – leverages existing SDI technologies
  - Disadvantage – requires more coaxial cable (or fiber hybrid)

- IP = Fiber
  - 10 Gb to 400 Gb Ethernet topologies
  - Advantage – Uses COTS (Commercial-Off-The-Shelf) Enterprise IT equipment
  - Disadvantage - Currently more expensive and rather new

We are at a cross road

SDI

- Has provided a common uncompressed digital infrastructure
- Low latency
- Perfect synchronization and never drops a frame
- Open and non-proprietary
- 12G Single-Link and 3G Quad-Link are viable choices
- Uni-directional and simple

SDI has been a solid choice for uncompressed video

12 GHz status of Coaxial Cable

A Look at New Coaxial Cable Design for "True" 4K

Posted by Werner Eich on 15/05/2014

Multi-cable formats (dual and quad links) can be used today because the bandwidth on each cable is the same as HD or 3G bandwidths currently used. This is possible because recent video cards contain chips that will separate the video data into two or four signals. The signals then run over separate coax cables at a maximum speed of 3GHz (3GHz for 3G and 1.5 GHz for HD) and at the receiver, they will be transformed back to 6GHz or 12 GHz. Belden believes that its current line of cables will work to 6 GHz, but 12 GHz will require re-design and new cables.

New Cable Design

There are a number of things that can be done to improve performance of the 4K versions listed above. First is to increase

- Belden is now ready with coaxial cable for the next generation of single link 12G
- Belden demonstrated 4794R, a 12 GHz coax cable at NAB 2016 and now paves the way for 12G Single Link use

Formula	-30 dB at ½ clock		-20 dB at ½ clock		-20 dB at ½ clock		-40 dB at ½ clock		-40 dB at ½ clock		-40 dB at ½ clock	
Data Rate:	270 Mb/s		1.5 Gb/s		3.0 Gb/s		3.0 Gbps		6 Gb/s		12 Gb/s	
SMPTE Std:	ST-259M		ST-292M		ST-424M		ST-425		2081-1		2082-1	
Application:	SD-SDI		HD-SDI		3G-SDI		3G-SDI		6GHz 4K		12 GHz 4K	
Cable Part #	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m	Ft.	m
4794R	1716	**523**	480	**146**	329	**100**	659	**201**	449	**137**	306	**93**

This isn't your daddy's coax!

12G SDI strategies

- 12G has a number of different schemes available to use
  - Quad Link
  - Dual Link
- Single-Link 12G

Various methods to achieve higher resolution SDI

IP is the future

- Enterprise IT equipment has enormous market vs. SDI equipment
- Ethernet keeps getting faster: 10 Gbe...25 Gbe…40 Gbe…50 Gbe…100 Gbe…and just recently 200Gbe. Vendors are saying 400Gbe in 18 months!
- Technical Human Resources (HR) largest technical talent pool and growing
- COTS hardware + software allows increased functionality and flexibility
- IP leverages cutting-edge technology

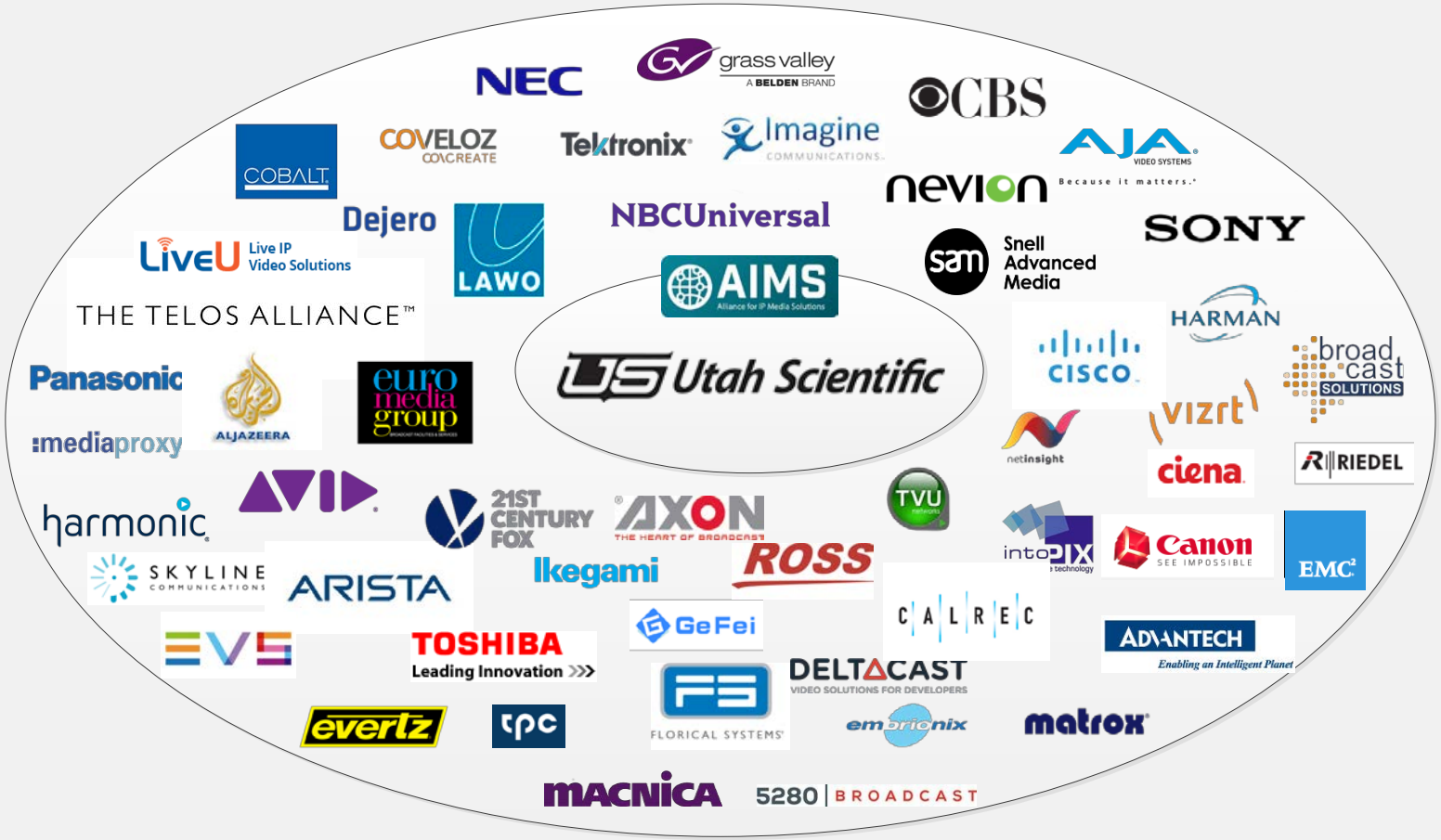
The future seems to be headed toward IP based systems

AIMS

- SMPTE 2022-6 (The start)
- VSF' TR-03 aka SMPTE 2110 Draft
  - Video – RFC 4175
  - Audio – AES 67
  - Data – ST 291 (soon to be updated)
  - Timing/Genlock – SMPTE 2059 (Standard with roots to IEEE 1588)
  - NMOS IS-04 Discovery & Registration
  - Session Description Protocol file

AIMS uses VSF TR-03/04, an Open Standards Initiative

A True Consortium of Today's Best



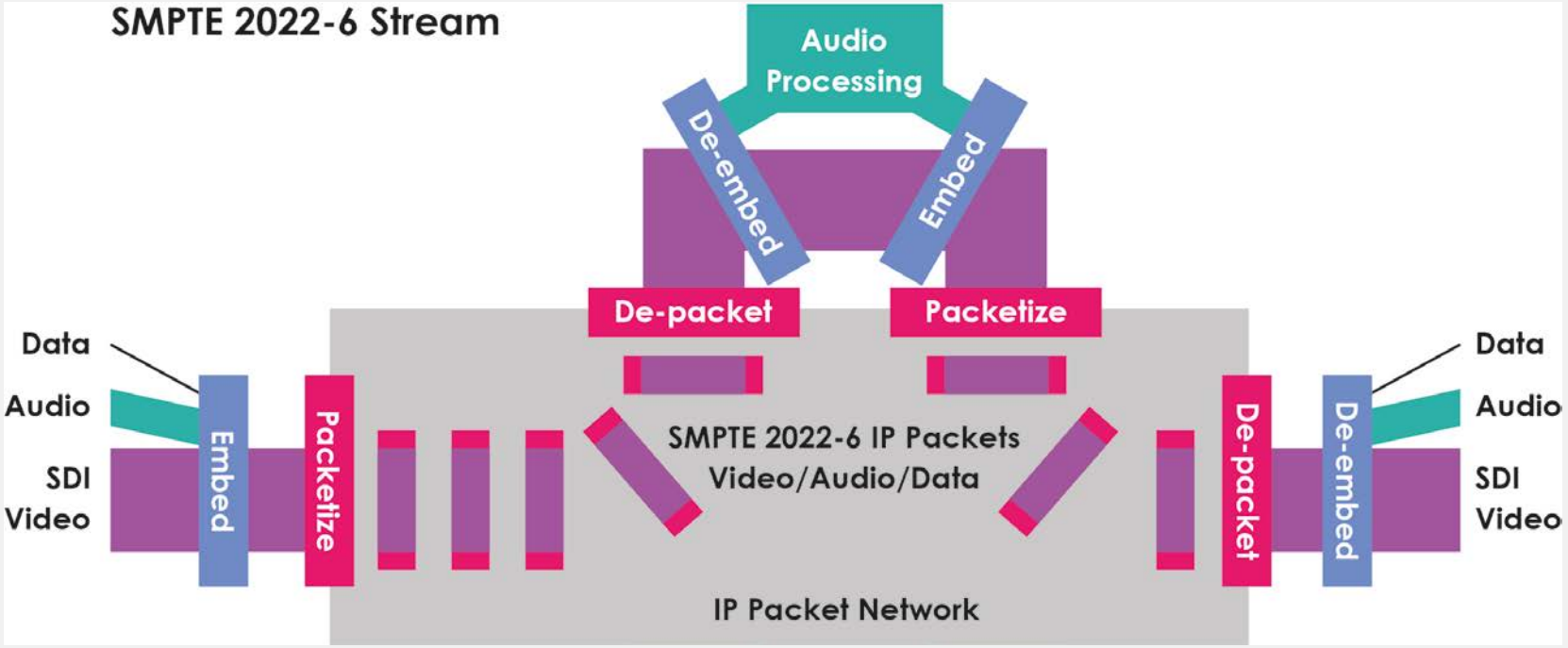
Utah Scientific and over 55 AIMS Members!

IP Formats: 2022-6 and 2110

- SMPTE 2022-6 is the most common uncompressed video format and is included at the beginning of the AIMS roadmap
- 2022-6 can be thought of as **intra-facility** or transport from one broadcast core to another. Think of 2022-6 as an SDI Embedded snapshot converted to IP. It contains all the elements of current SDI
  - FEC (2022-5) is one reason why it's a good choice for long haul
  - Hitless switching feature in 2022-7 for backup and redundant schemes
- 2110 can be thought of as **inter-facility** much like we think of as baseband SDI in current broadcast, satellite and cable facilities. Here all the signals are carried separately

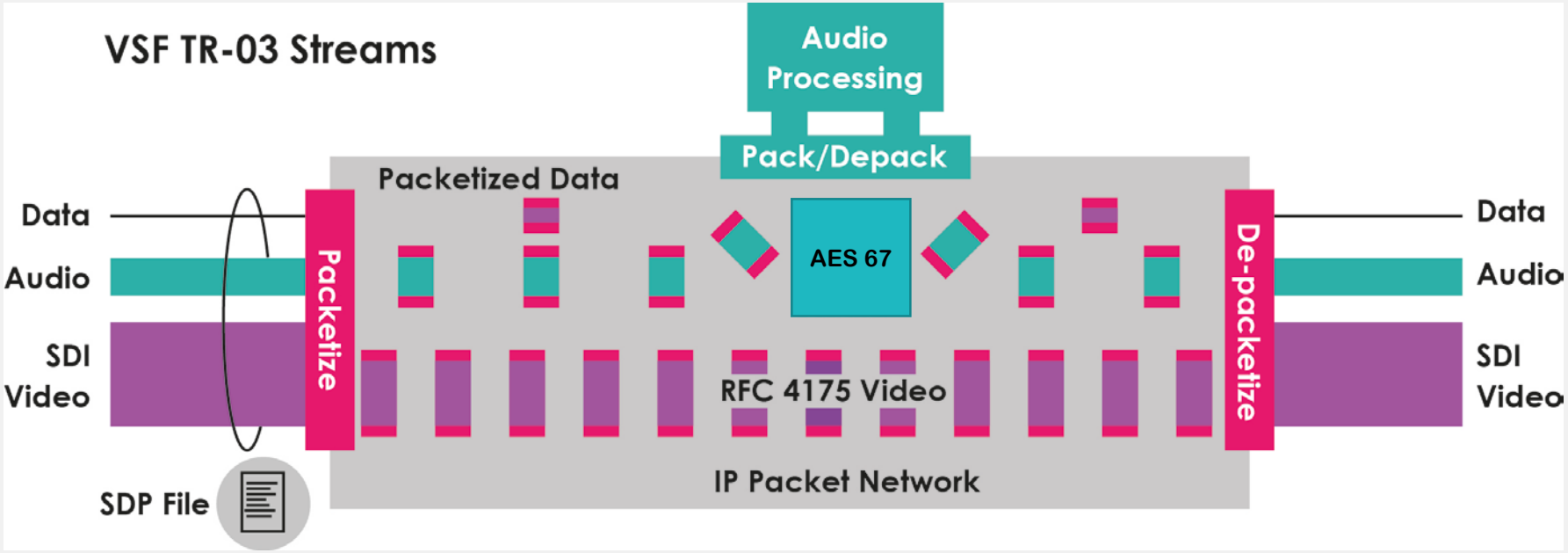
SMPTE 2022-6

- Video, Audio and Data must be embedded before being packetized
- For Audio processing, the audio must be de-embedded and then re-embedded



SMPTE 2110 (TR-03/04)

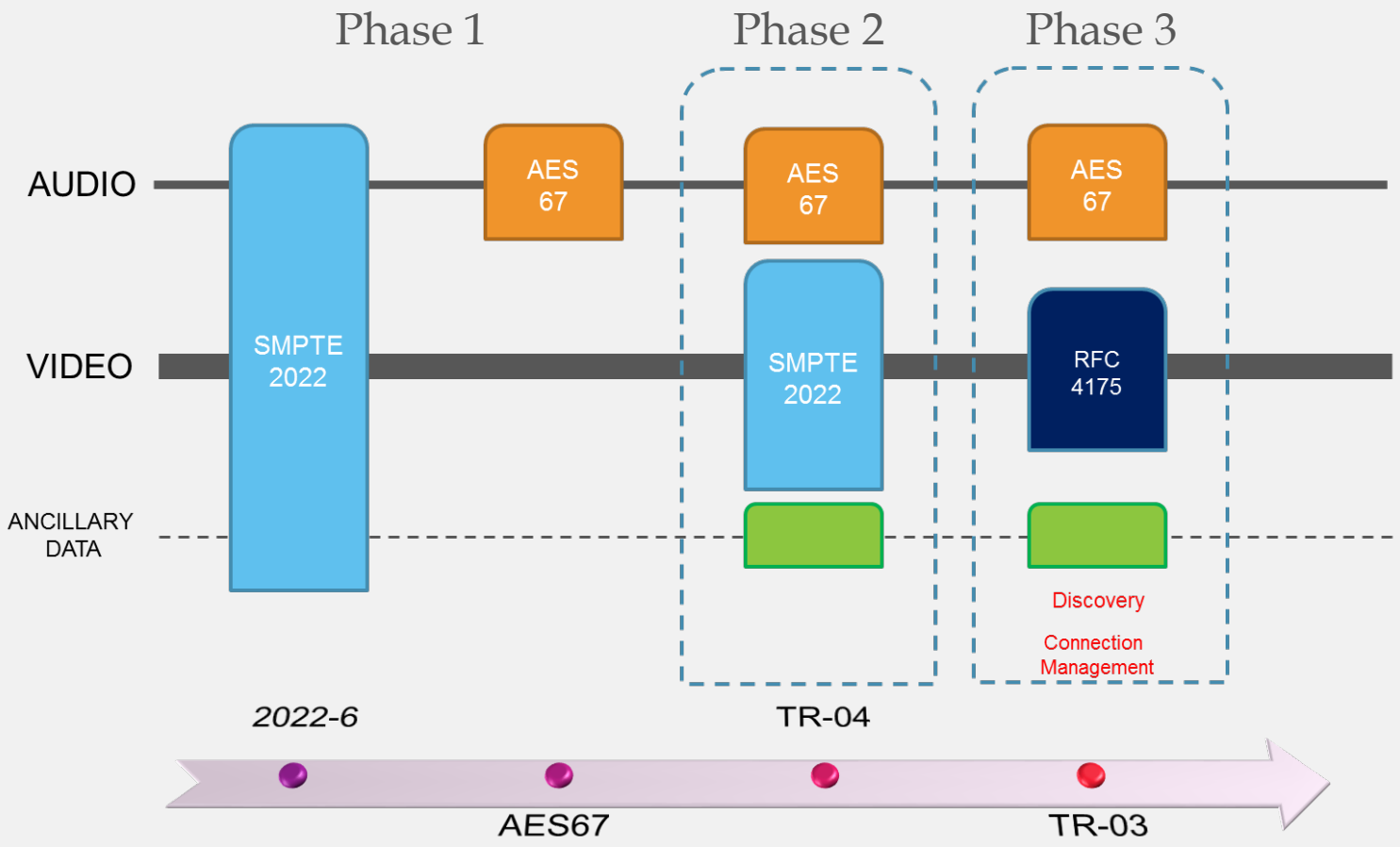
- Video, Audio and Data are ALL separate streams using RTP
- For Audio processing, the audio is simply picked up, processed and sent outbound



Note that this doesn't require an inherent embedding and de-embedding

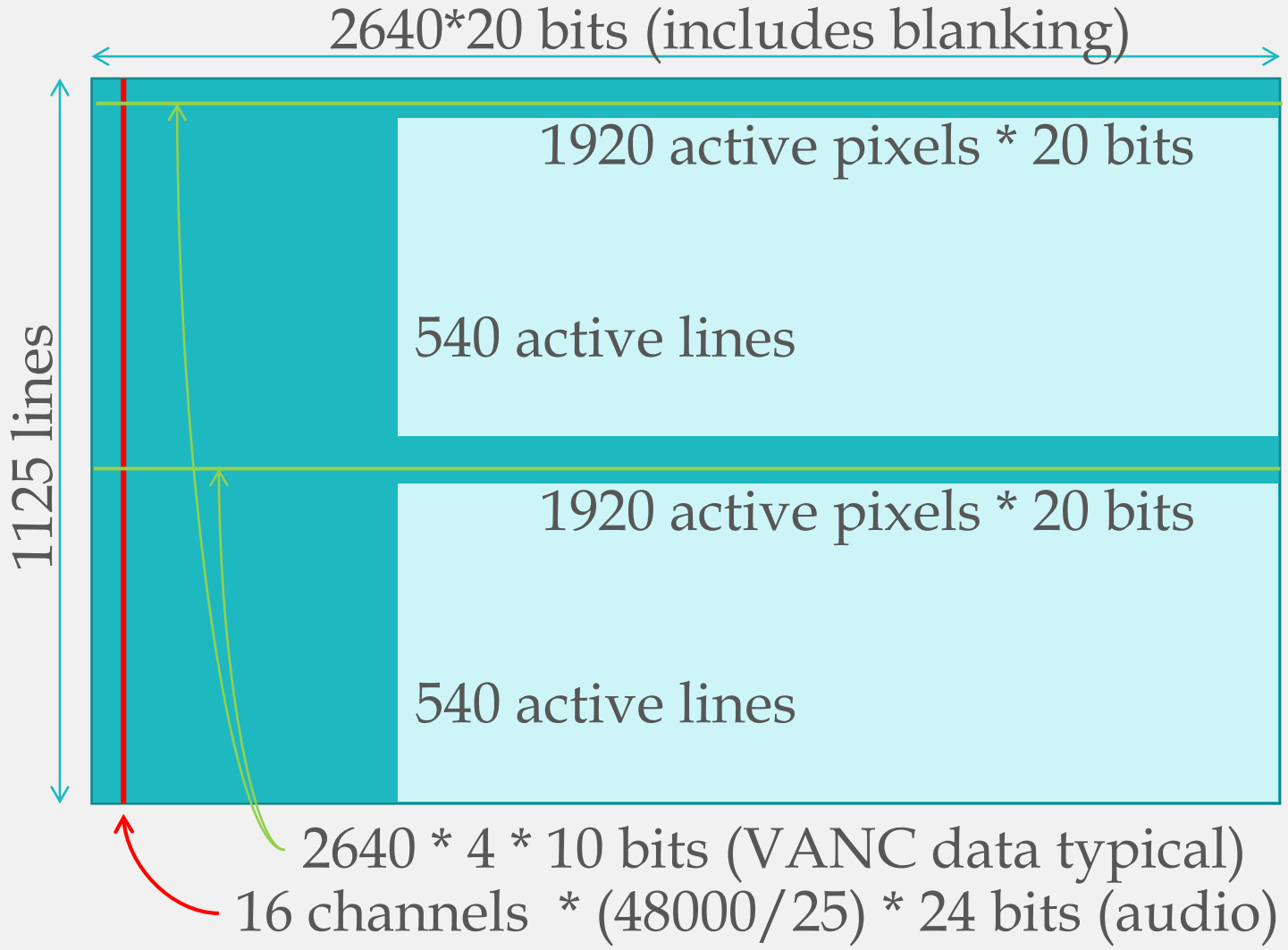
AIMS Roadmap

1. SMPTE 2022-6
2. AES67
3. TR-04 for 2022-6 and AES67
4. TR-03 for RFC 4175 Video Elementary Stream to replace 2022-6



SDI 1080i/25Hz example:

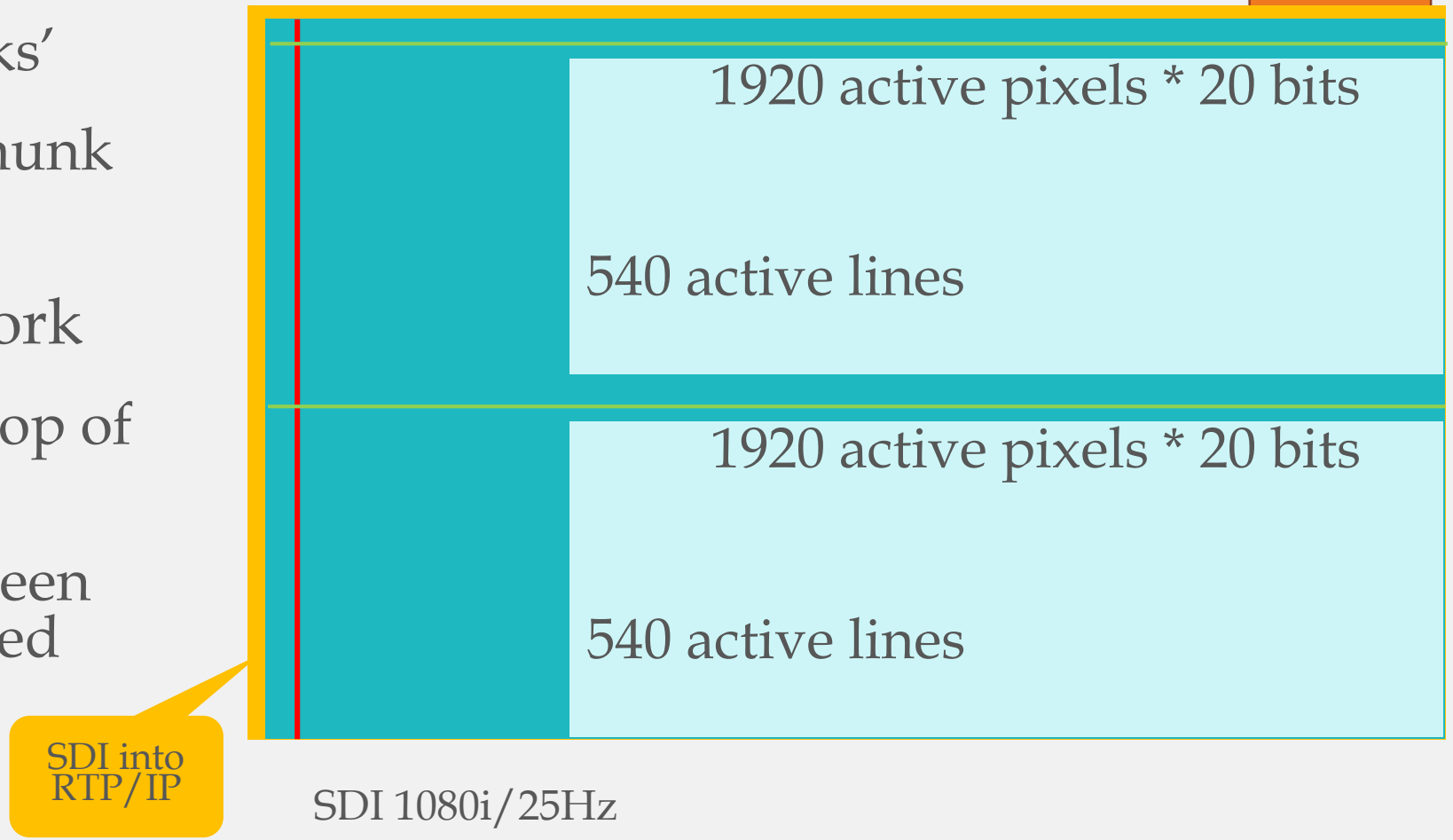
- 1.5 Gb/sec for HD
- 4:2:2/10 bit video
- 16 channels of 48K audio
- VANC data space
- SDI's "Framing" Overhead
  - 16.84% 1080i/29.97
  - 31.01% 720p/59.94
  - 39.66% 1080i/25
  - 56.52% 720p/50



Phase 1: 2022-6 SDI mapped into RTP/UDP/IP

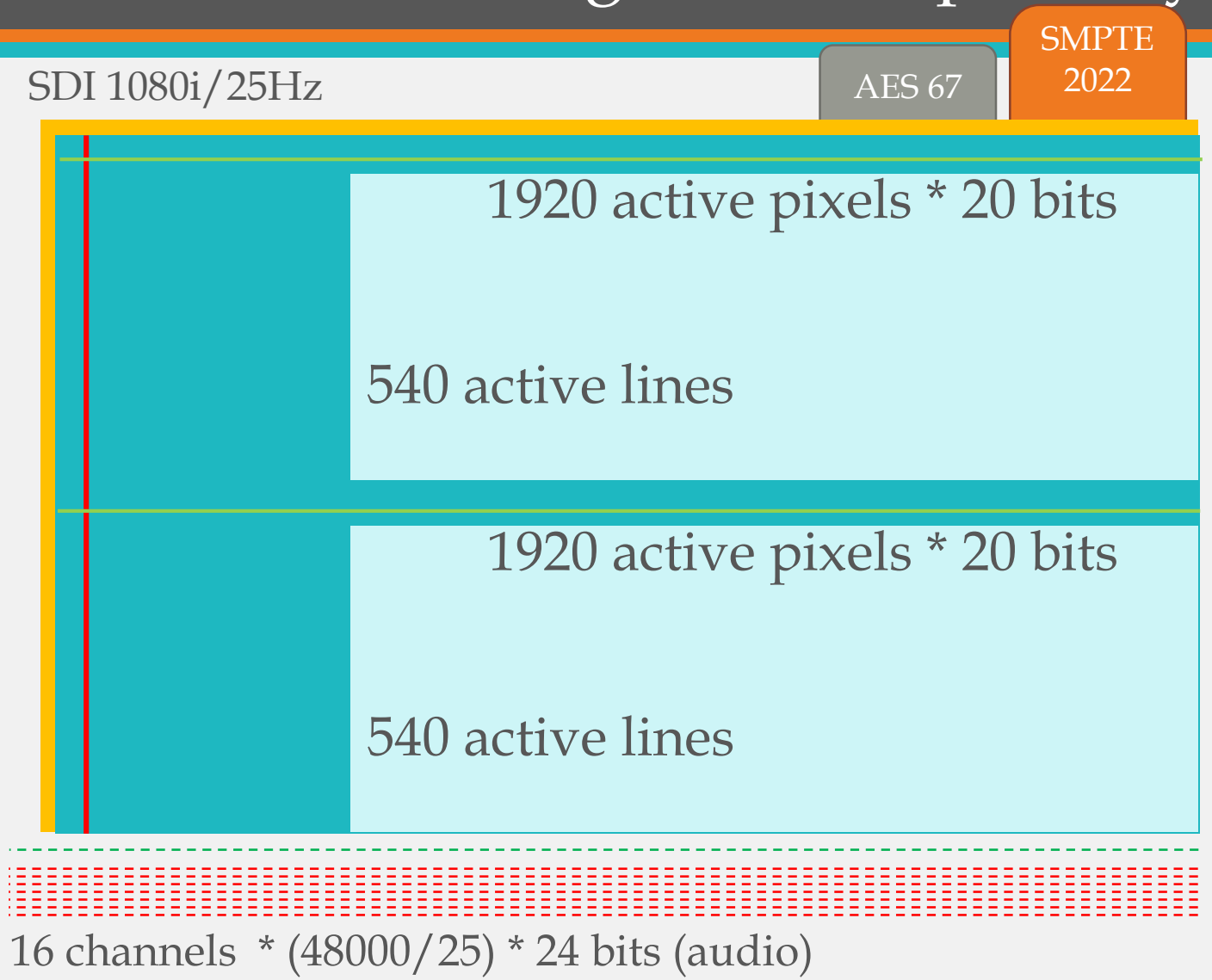
SMPTE 2022

- Segments SDI into ‘chunks’
- Ad’s headers into each chunk
  - Media/RTP/UDP/IP
- Transmitted over network
- Adds 3.3% overhead on top of the SDI signal
- 2022-5 FEC can add between additional overhead if used
  - 5% and 25%



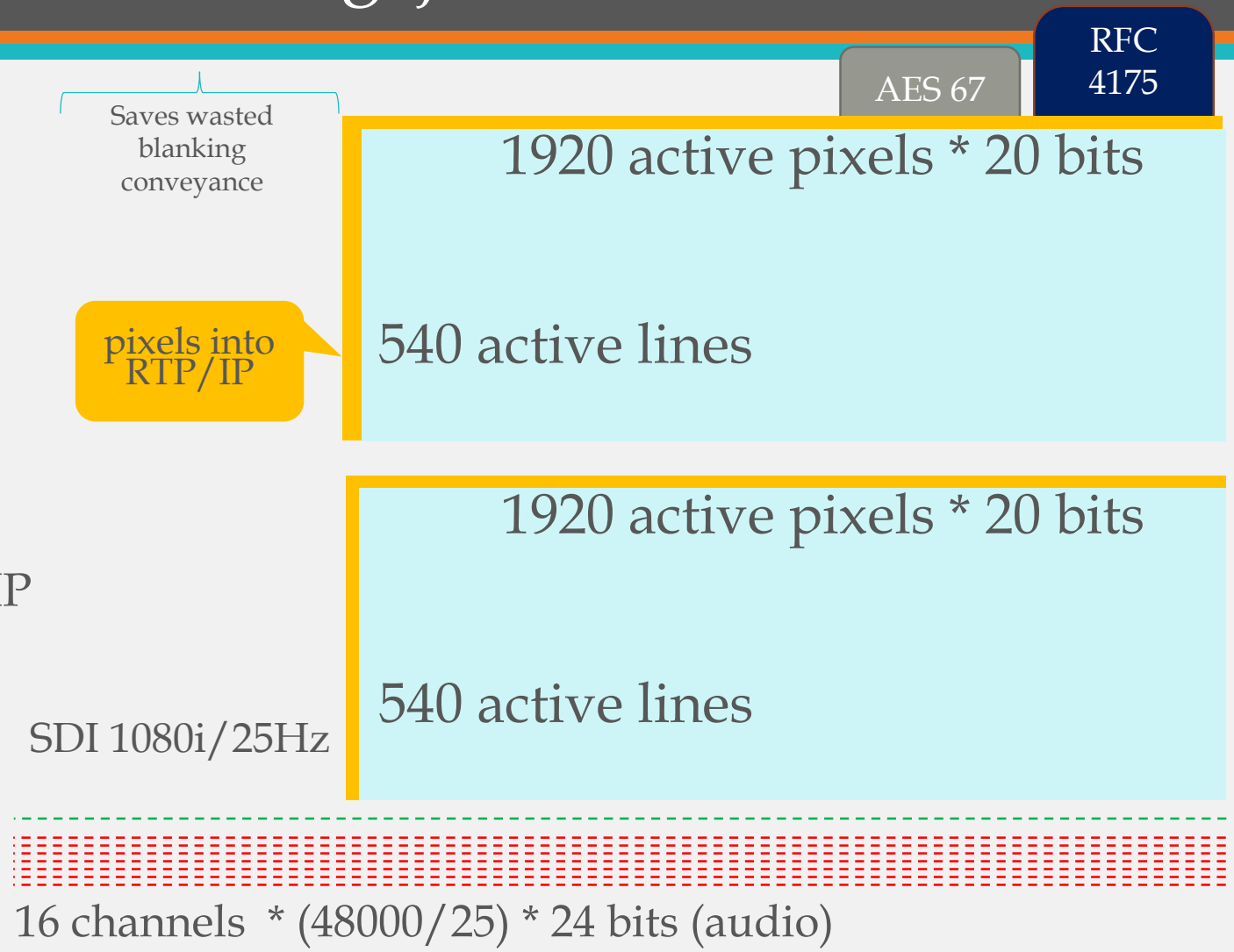
Phase 2: VSF TR-04: SDI over IP, sending Audio separately

- Carry the SDI signal over IP same as SMPTE 2022-6
- Map the audio into AES67 audio/IP streams
  - Compatible with production audio world
  - Separately routed and switched over IP
  - Can be re-joined to the video after audio production
- Also maps VANC separately



Phase 3: VSF TR-03 - No blanking, just video & audio

- Send active video as RFC4175
  - 3.79% overhead TOTAL
- Map the audio separately into AES67 streams
  - Compatible with production audio world
  - Separately routed and switched over IP
  - Can be re-joined to the video after audio production
- Also map VANC separately



SMPTE 2110 (TR-03)

- RFC 4175 Video
- AES 67 Audio
- SMPTE 2059 PTP Timing for A/V Sync and Genlock
- NMOS for Discovery & Registration
- ST 291 Data
- SDP File for Stream Info

RFC 4175

- Contains the video data based on resolution and frame rate
- Packet headers used to contain a given number of lines depending on the resolution
- Header Extensions can be used
- TIME STAMPS!!!

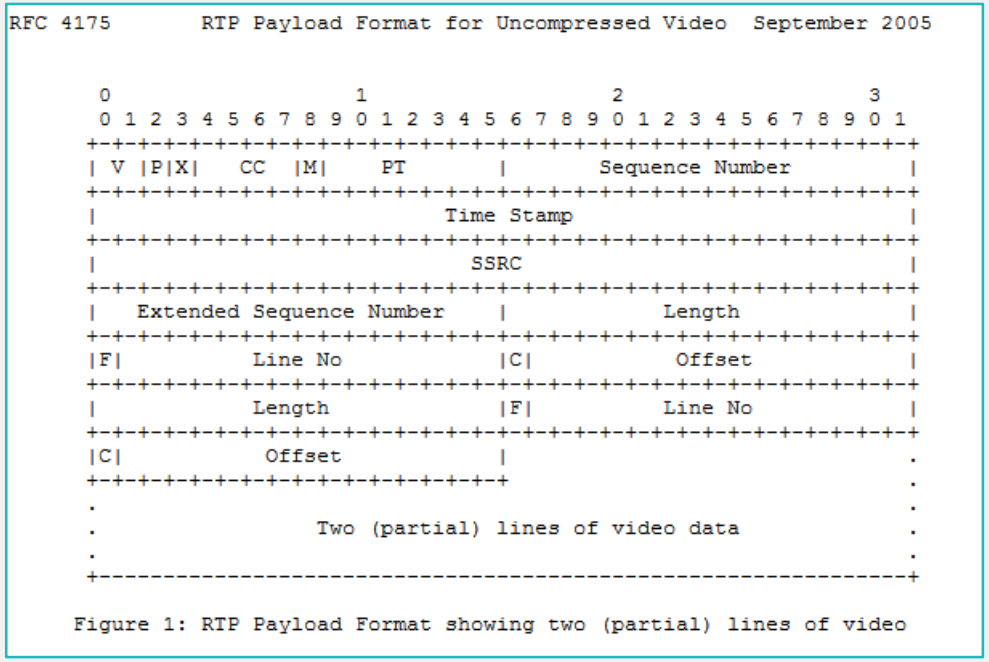
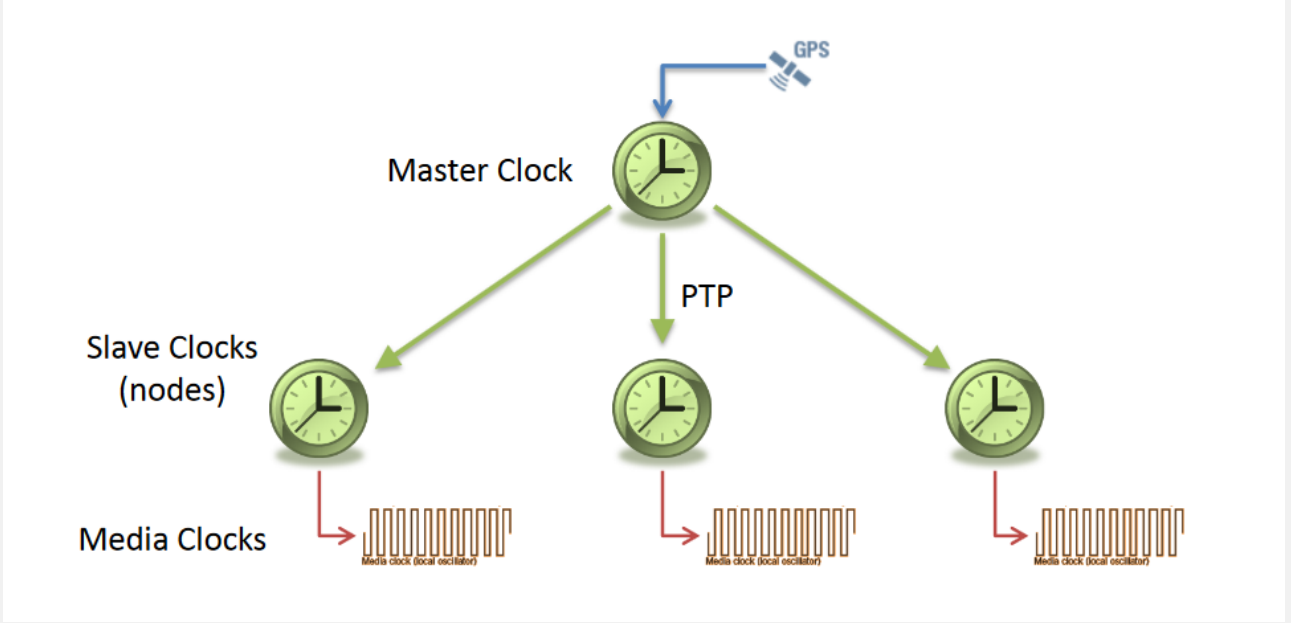


Figure 1: RTP Payload Format showing two (partial) lines of video

AES 67

- Uncompressed Audio adopted by the AES
- Prevalent in 1Gb/sec Ethernet fabric
- Dante, Ravenna and AVB use AES 67
- 48 Khz sampling
- Multiple channels (80 channels no problem)
- TIME STAMPS!!!



SMPTE 2059

- Precision Time Protocol Packets within the 10Gb/sec Ethernet Fabric
  - ST 2059 specifies the phase of a given frame rate (sequence) at a specific instant in the past, called the SMPTE epoch. Very similar to genlock lining up to the original analog four color frames
  - The PTP generator establishes “domains” in number values where the signals can be aligned according to their needs. Think of this like the old Master Sync Generator driving several studios that are timed within each studio but still tied to the MSG.
  - Replaces the boundary clock of the Ethernet switch.

NMOS – Discovery & Registration

- Identifies the device on the Network
  - Receiver or Transmitter
  - Audio or Video
  - IP address

SDP

- Session Description Protocol
- Describe the contents of the multicast transmission
  - IP address
  - Audio type
  - Video type
    - Resolution

An example SDP description is:

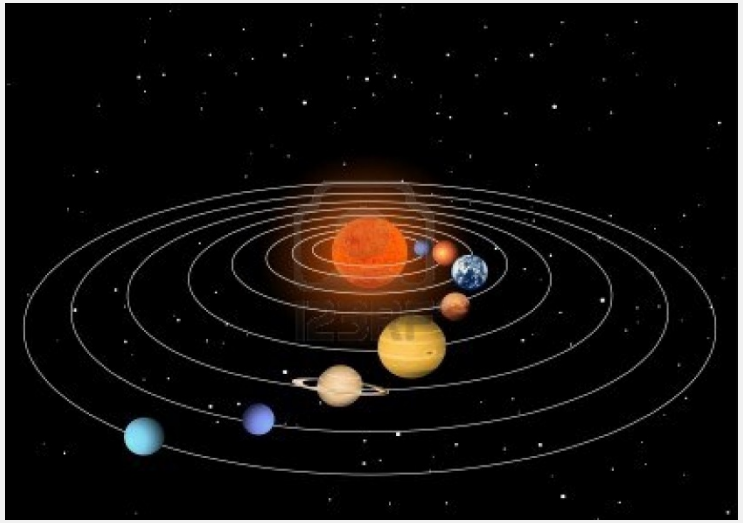
```
v=0
o=jdoe 2890844526 2890842807 IN IP4 10.47.16.5
s=SDP Seminar
i=A Seminar on the session description protocol
u=http://www.example.com/seminars/sdp.pdf
e=j.doe@example.com (Jane Doe)
c=IN IP4 224.2.17.12/127
t=2873397496 2873404696
a=recvonly
m=audio 49170 RTP/AVP 0
m=video 51372 RTP/AVP 99
a=rtpmap:99 h263-1998/90000
```

External SDI-IP Conversion

- SDI:IP Card-based Conversion
  - Four 3G input BNC's/card; 2 SFP+ outputs
  - Require 2-5 RU frames
  - Requires separate controller card/plane
  - Requires redundant power supplies
  - Consumes rack space and power
  - Requires more cabling
  - Requires controller software for configuration and monitoring

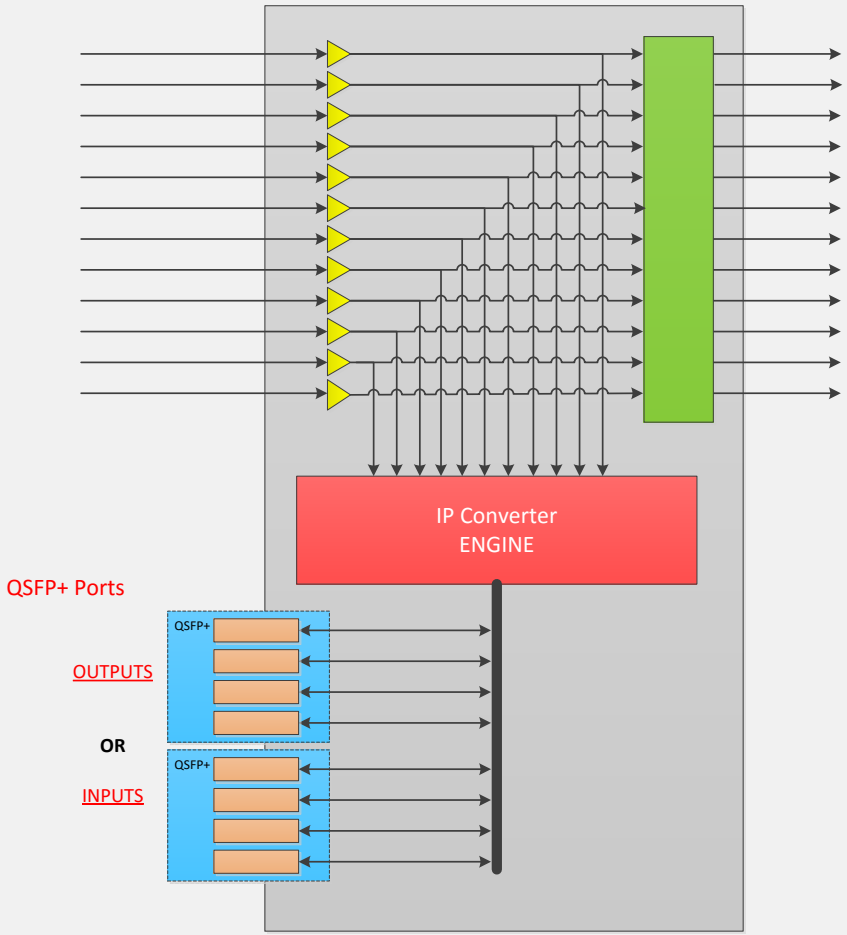
CORE ROUTERS

- The router is the core of any SDI broadcast plant
- Many who have Utah Scientific routers have them in the very center of their operations
- So maybe…
  - The SDI router stays in the center
  - The SDI router becomes the conversion center
  - The SDI router controller controls IP fabric switches
  - The SDI router is actually more economic than frame conversions when there are larger conversions



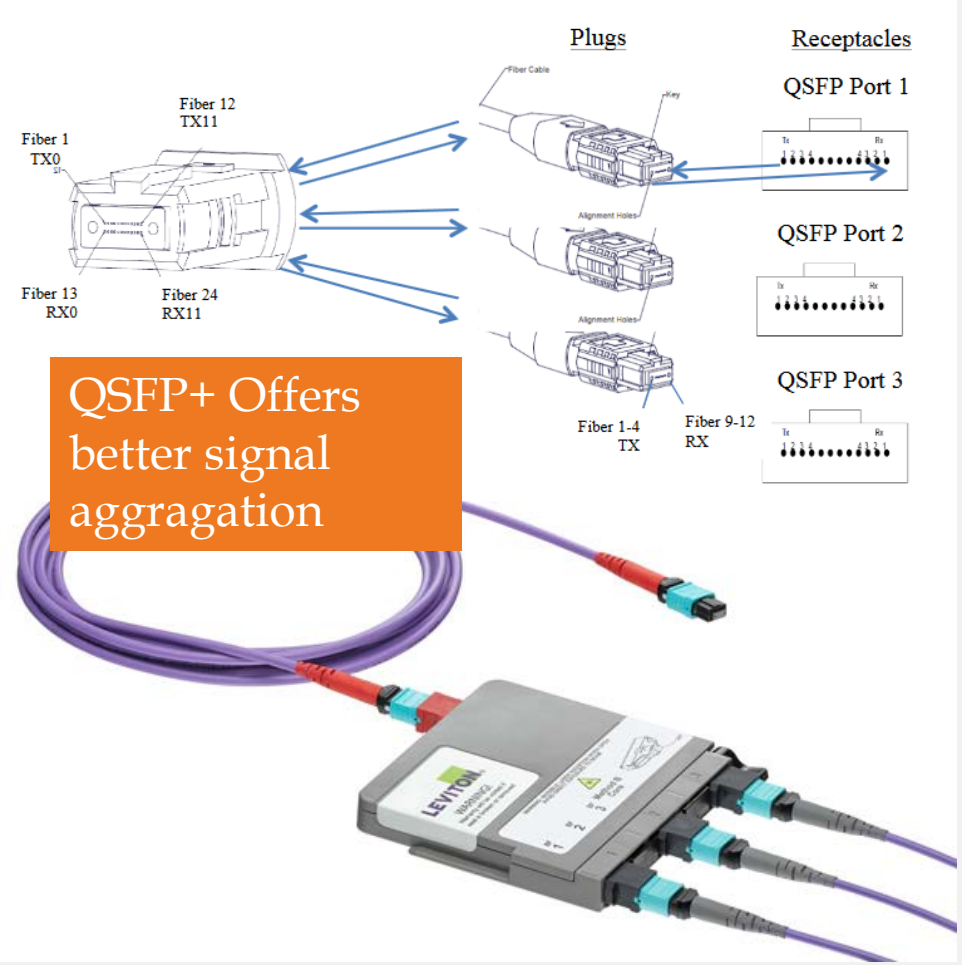
Internal Router Conversion

- Big Router = Big Conversion (12 3G signals /card)
- Replace input or output cards with new cards that supply IP conversion
- 40Gbe QFSP+ Connections
- MAINTAIN current 3G/HD router inputs and outputs



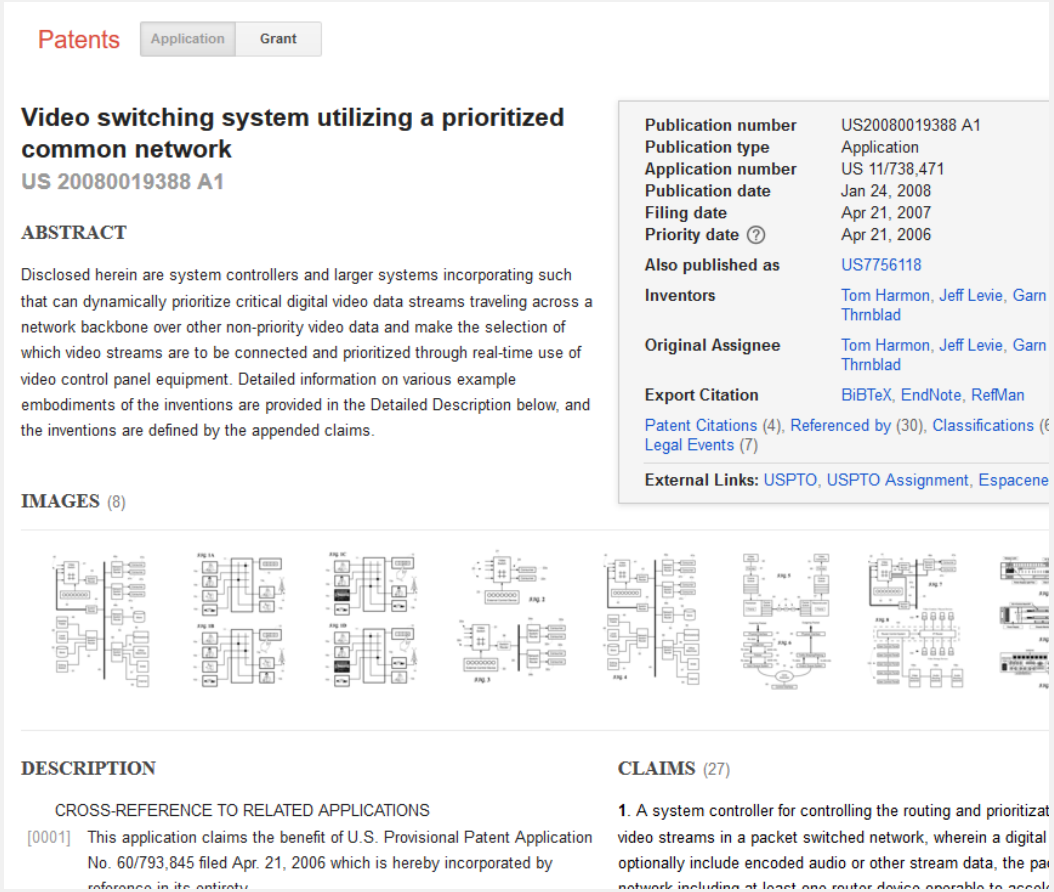
QSFP+ and MXP Modes = High Capacity!

- Most cage-based single card products use 2 10Gbe SFP+ style modules
- Why not higher capacities? 40Gbe? 100Gbe?
- Higher capacities match our larger SDI routing cores…
- 8 12G fits well in 100Gbe
- Within 18 months of 400Gbe ports!



Utah Scientific 400–IP Patent

- Utah Scientific received patent for switching IP in real-time nearly 10 years ago
- Little interest in 2007 about uncompressed IP
- Gigabit switch ports limited bandwidth
- Utah Scientific manufactured the IP switch from available silicon



Patents Application Grant

Video switching system utilizing a prioritized common network

US 20080019388 A1

ABSTRACT

Disclosed herein are system controllers and larger systems incorporating such that can dynamically prioritize critical digital video data streams traveling across a network backbone over other non-priority video data and make the selection of which video streams are to be connected and prioritized through real-time use of video control panel equipment. Detailed information on various example embodiments of the inventions are provided in the Detailed Description below, and the inventions are defined by the appended claims.

Publication number	US20080019388 A1
Publication type	Application
Application number	US 11/738,471
Publication date	Jan 24, 2008
Filing date	Apr 21, 2007
Priority date	Apr 21, 2006
Also published as	US7756118
Inventors	Tom Harmon, Jeff Levie, Garn Thrnblad
Original Assignee	Tom Harmon, Jeff Levie, Garn Thrnblad
Export Citation	BiBTeX, EndNote, RefMan

Patent Citations (4), Referenced by (30), Classifications (6
Legal Events (7)

External Links: USPTO, USPTO Assignment, Espacene

IMAGES (8)

DESCRIPTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 60/793,845 filed Apr. 21, 2006 which is hereby incorporated by

CLAIMS (27)

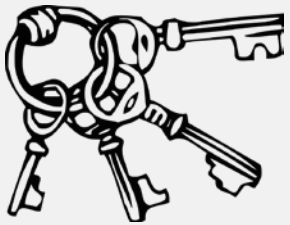
1. A system controller for controlling the routing and prioritizat video streams in a packet switched network, wherein a digital optionally include encoded audio or other stream data, the pa

Next Generation IP controller

- Server based Linux Controller
- Will control many COTS switch fabric
  - Arista
  - Cisco
  - Extreme Networks
  - Others
- SC-'X' and other Router protocol for legacy control
- HTML 5 Web GUI control/Utah Scientific API set

Key Switch Partners

- Because of the AIMS alignment of industry vendors, a common theme for COTS switches is to support Open Standards that switch vendors can incorporate easily without undo complicated setups for end-customers
- It will be wise to work with as many as is practical.
- Arista leads in this arena having worked with others such as Nevion, Lawo, Imagine, GVG and others
- Arista and Utah Scientific are now full partners and will leverage their networking expertise and help develop our upcoming SC-5 controlling system



12G Single Link 4K

- New 4K Market is emerging!

Omega Broadcast Group Chooses Utah Scientific's New UHD-12G Router for First Fully 4K-Capable Truck in Austin Broadcast Market

Visit http://www.utahscientific.com for further information

Omega Broadcast Group, a professional audio/video sales, rental, and design/integration company based in Austin, Texas, has chosen Utah Scientific's all-new UHD-12G digital routing switcher for its upcoming 4K-capable mobile broadcasting vehicle. The new truck, the first in its market designed to provide a complete infrastructure for 4K/ultra-high-definition television (UHDTV), will be used for live broadcasts of high-profile local events including the Austin City Limits and South by Southwest music festivals and the Circuit of the Americas, home of the Formula One Grand Prix, Austin.

06/07/16, 10:23 AM | Audio & Video, Energy & Other Home Systems

SALT LAKE CITY -- June 7, 2016 -- Omega Broadcast Group, a professional audio/video sales, rental, and design/integration company based in Austin, Texas, has chosen Utah Scientific's all-new UHD-12G digital routing switcher for its upcoming 4K-capable mobile broadcasting vehicle. The new truck, the first in its market designed to provide a complete infrastructure for 4K/ultra-high-definition television (UHDTV), will be used for live broadcasts of high-profile local events including the Austin City Limits and South by Southwest music festivals and the Circuit of the Americas, home of the Formula One Grand Prix, Austin.

4K seems to be moving in BOTH directions

- Some Truck OEM's are building based on 4K IP
- Others are building based on 4K SDI
- It is more difficult to provide 4K on IP because of the 10Gbe SFP+ port restriction.
  - 2 SFP+ connections required for 12GBe leaving 4GBe on each port not used
  - Mezzanine compression not widely deployed for 4K but will be coming!
- Single Link 12G seems to be more popular because of the cabling and router size.
- Utah Scientific will be able to offer both alternatives

Let's begin the IP Video Revolution!

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