Overview on IP Audio Networking

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ALC NetworX GmbH, Munich

Topics:

- Audio networking vs. OSI Layers
- Overview on IP audio solutions
- AES67 & RAVENNA
- Real-world application examples
- Brief introduction to SMPTE ST2110
- NMOS
- Control protocols

Layer 1

AVB

Layer 2

EtherSound

Layer 3

Audio over IP

Audio over Ethernet

ACIP

TCP

unicast

RAVENNA

AES67

multicast

RTP

UDP

X192

Media streaming

Dante

CobraNet

Livewire

Layer 1

Layer 2

AVB

Terminology often

Sound

Layer 3

Audio over IP

- ambiguous
- used in wrong context
- marketing-driven
- creates confusion

Audio over Ethernet

ACIP

TCP

unicast

RTP

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Media streaming

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Audio over IP

Audio over Ethernet

ACIP

TCP

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RTP

Media streaming

Dante

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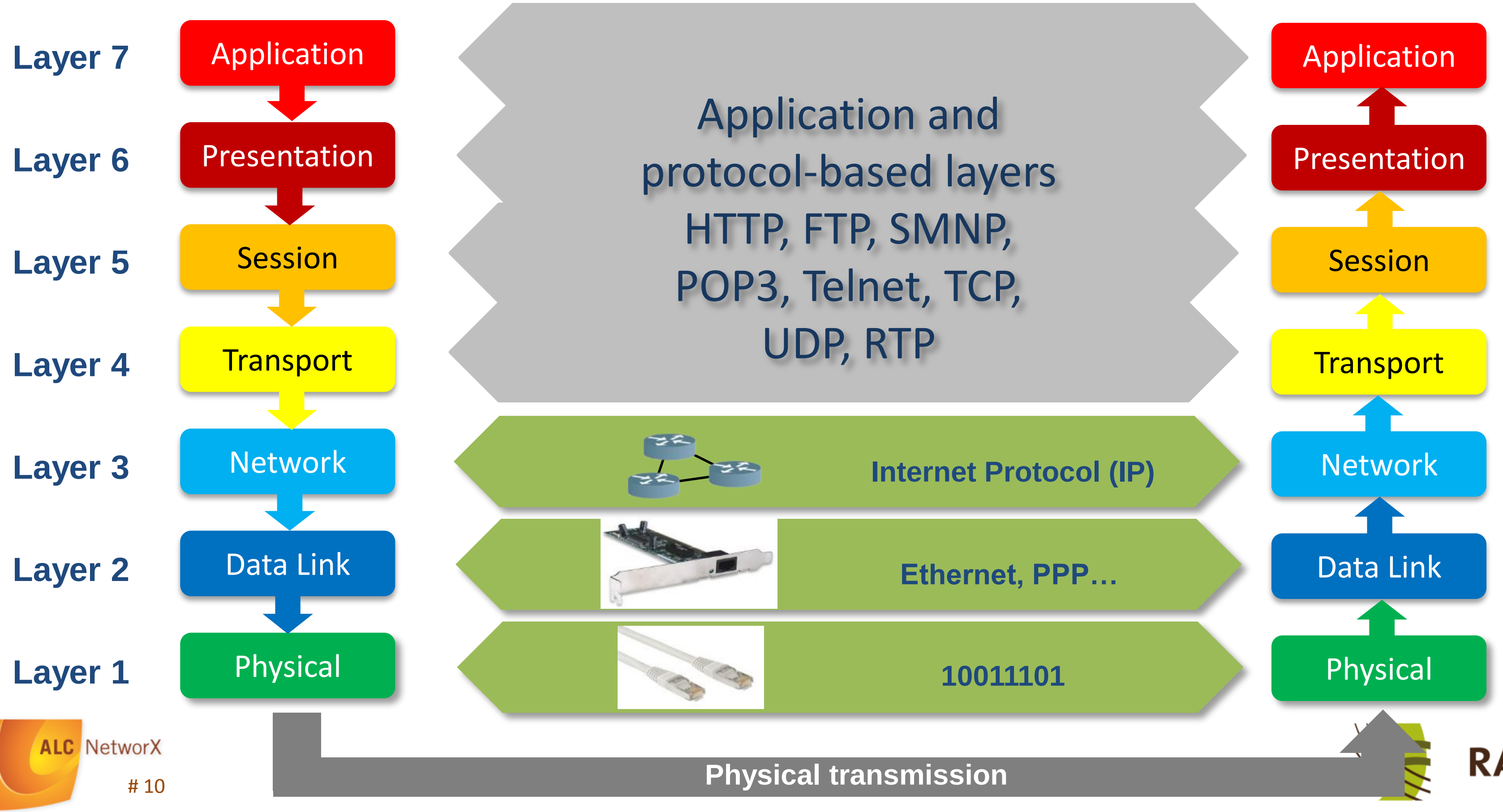
Livewire

Overview on IP Audio Networking

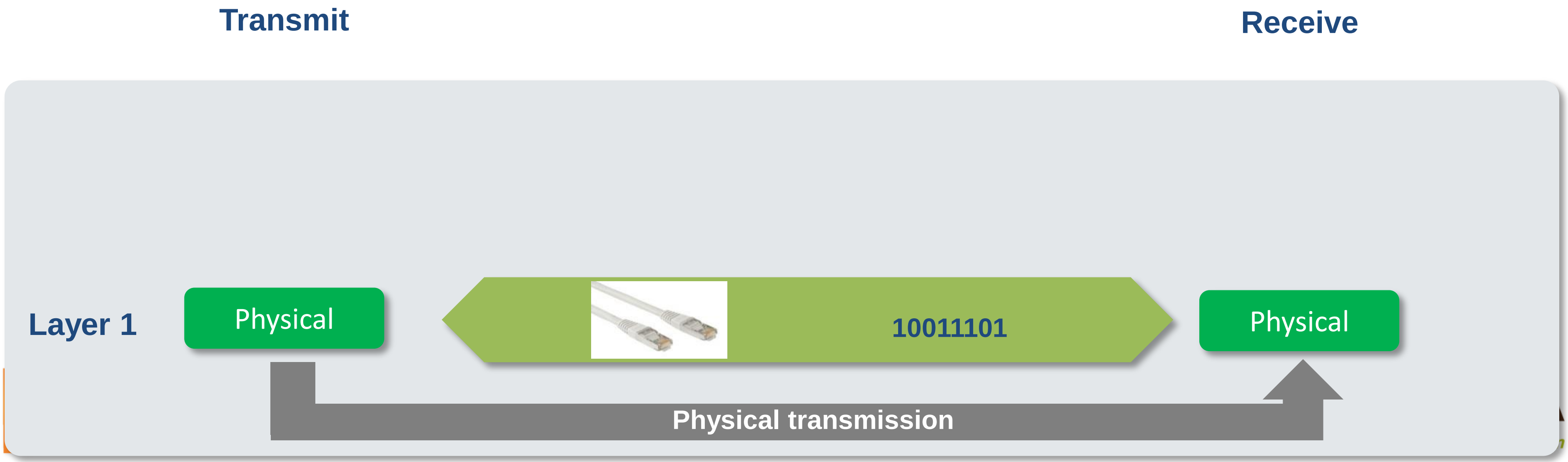


ALC NetworX

RAVENNA AES67 built-in

Classification by OSI network layer:

Layer 1 Systems



Layer 1 systems:

- Examples: SuperMac (AES50), A-Net Pro16/64 (Aviom), Rocknet 300 (Riedel), Optocore (Optocore), MediorNet (Riedel)
- Fully proprietary systems
- Make use of layer 1 physical transport (e.g. CAT5 or fiber)
- Mostly point-to-point or daisy-chain topologies ("switches" need to be custom-built)
- Ring topology may provide high availability
- Ruggedized due to proprietary infrastructure
- Usually very low latencies achievable
- Fixed device & channel capacity (varying between solutions)
- Limited to selected media formats (due to proprietary use of physical layer)

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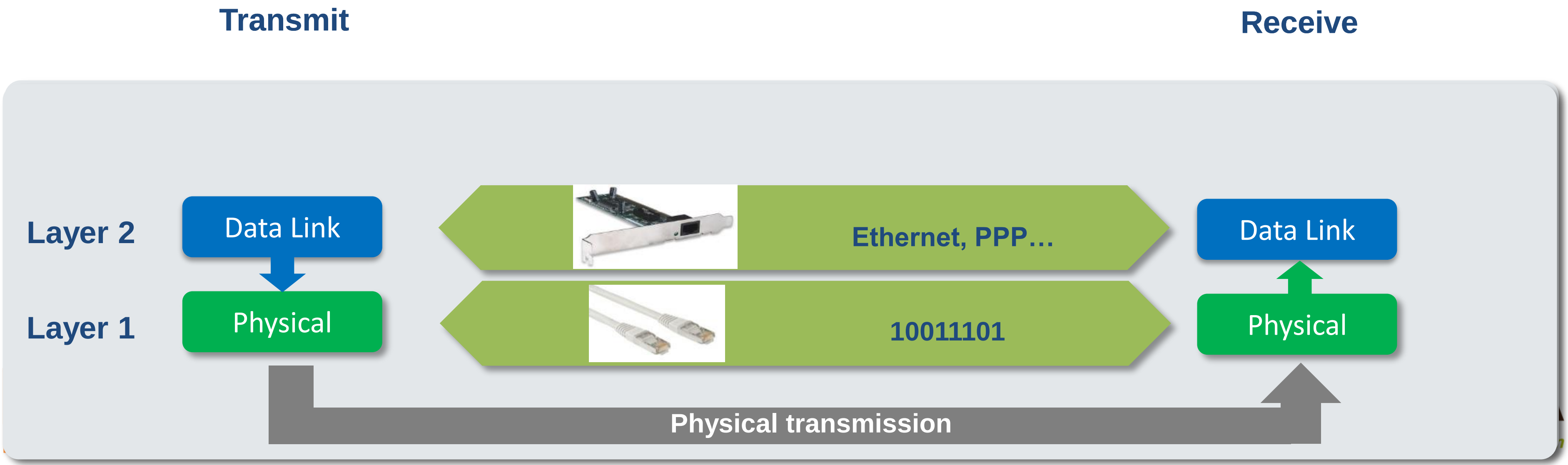
Classification by OSI network layer:

Layer 2 Systems

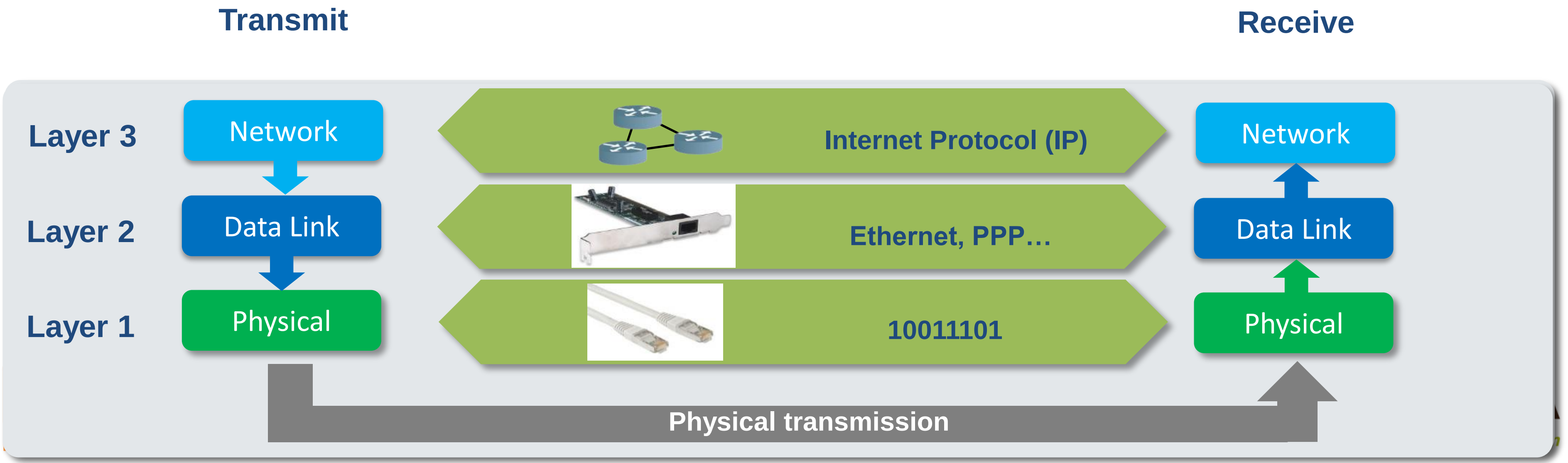


Layer 2 systems ("Audio-over-Ethernet"):

- Examples: CobraNet (Cirrus), EtherSound (Digigram), SoundGrid (Waves)
- Proprietary systems based on layer 2 (data link level)
- Mostly utilizing Ethernet infrastructure (e.g. FE or GbE)
- Operate on structured topologies (star / tree),
  but may also be limited to daisy-chain or ring topologies
- Size of network limited to LAN segment (or lower)
- Fixed device & channel capacity (varying between solutions)
- Limited to selected media formats (due to proprietary end points)
- Usually low to very low latencies achievable
- Ruggedized due to exclusive infrastructure usage

Classification by OSI network layer:

Layer 3 Systems



Layer 3 systems ("Audio-over-IP"):

- (Proprietary) systems based on layer 3 (Internet Protocol)
- May run on any IP-capable infrastructure, mostly Ethernet (sometimes limited to selected network equipment)
- Uses structured topologies (star / tree / mesh), but may also run on daisy-chain or ring topologies
- Size of network not limited (includes routing capabilities)
- Can operate in shared traffic environments
- Flexible / scalable device & channel capacity & flexible choice of media formats
- Latencies vary depending on network environment (and payloads etc.)

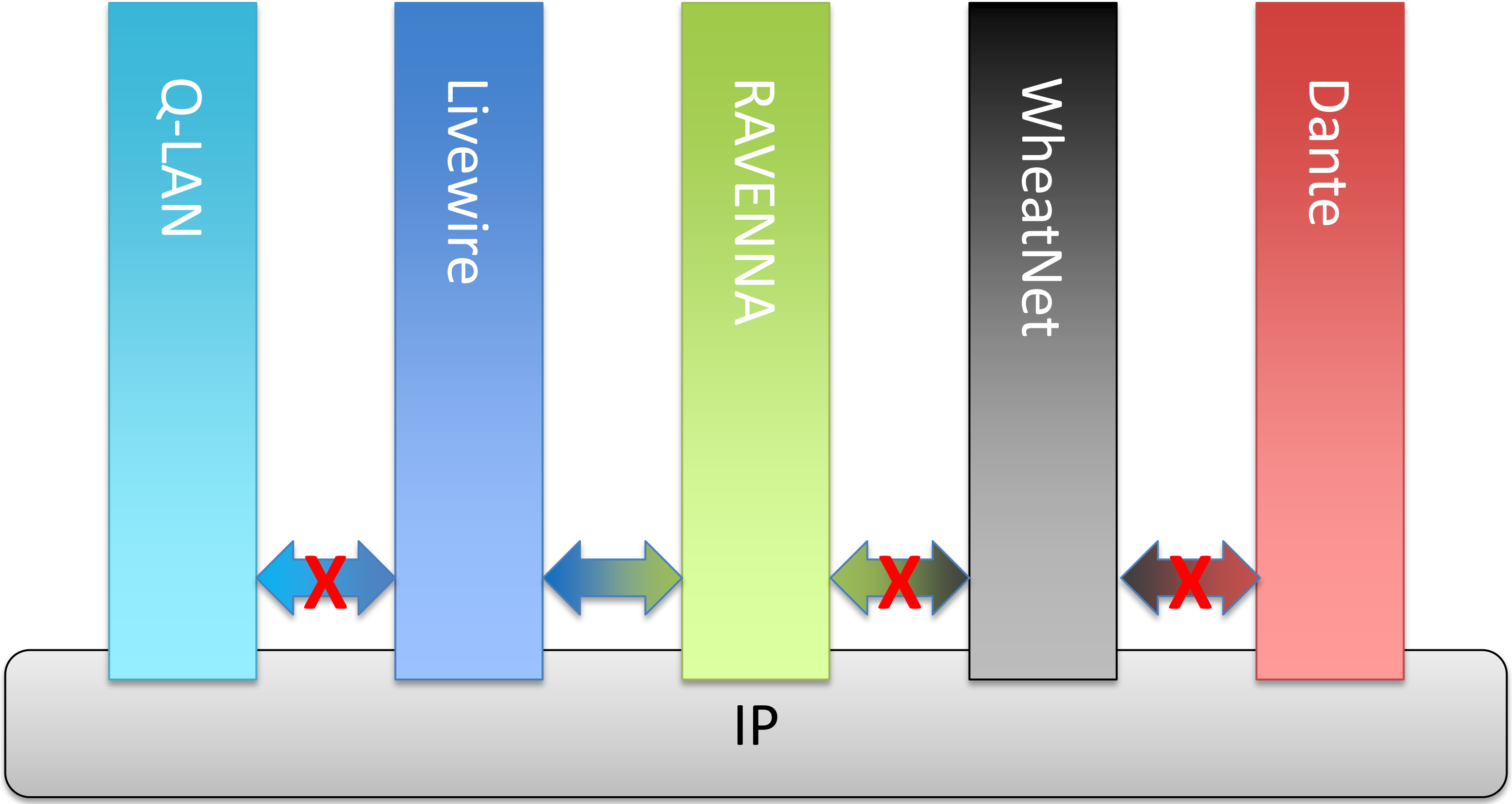
Existing Audio-over-IP solutions / technologies / initiatives:

Technology	Purveyor	Date introduced	Application
Livewire	Telos/Axia	2003	Radio Broadcast
Wheatnet-IP	Wheatstone	2005	Radio Broadcast
Dante	Audinate	2006	Install & Live Sound
N/ACIP	EBU	2007	Broadcast
Q-LAN	QSC Audio Products	2009	Install & Live Sound
RAVENNA	ALC NetworX	2010	Broadcast

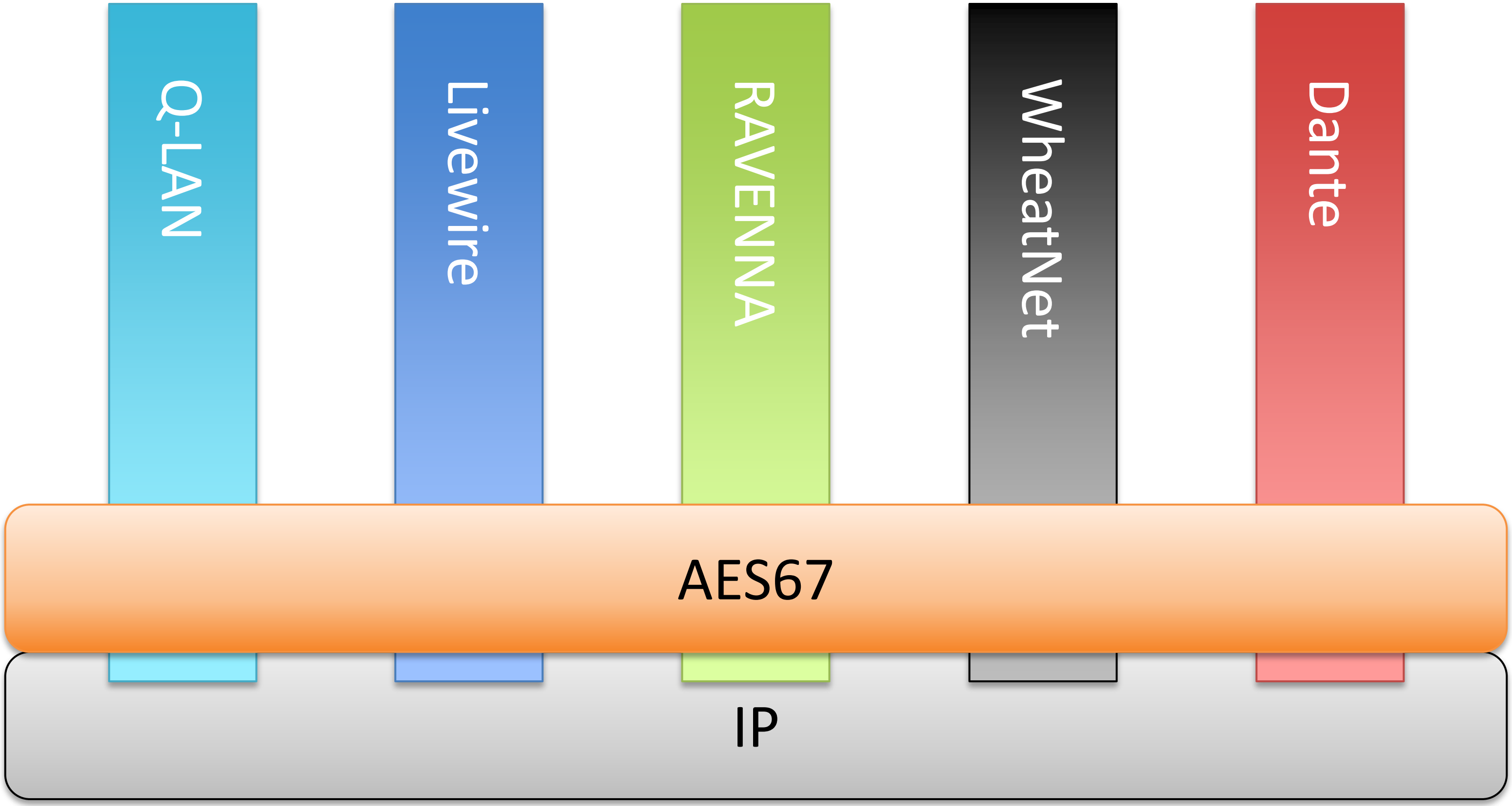
Selected solutions / technologies compared to OSI layer model:

OSI Layer	A-Net	EtherSound	CobraNet	Livewire, Dante & …	RAVENNA
Application					
Presentation					
Session				RTP	RTP
Transport				UDP	UDP
Network				IP	IP
Data Link		Ethernet	Ethernet	Ethernet	Ethernet
Physical	Copper	Copper / Fiber	Copper / Fiber	Copper / Fiber	Copper / Fiber

Overview on IP Audio Networking



Overview on IP Audio Networking



AES67

AES67-2013 Standard for Audio Applications of Networks:

High-performance Streaming Audio-over-IP Interoperability

published on September, 11th, 2013

AES Standard for Audio Applications of Networks - High-performance Streaming Audio-over-IP Interoperability

Scope:

- **Interoperability guidelines** for professional, low-latency audio over campus and local area IP networks **using existing protocols wherever possible.**
- Excludes:
  - Non-IP networking
  - Low-bandwidth media
  - Data compression
  - Low-performance WANs and public Internet
  - Video (should provide good basis for follow-on video project)

Goal: VSF VIDEO SERVICES FORUM → VSF TR-03/04 → AIMS Alliance for IP Media Solutions → SMPTE → ST-2110

- Technology providers may choose to implement interoperability as a special mode, or transition to it as their native mode

AoIP general technology components

- Discovery
- Connection Management
- Session Description
- Encoding
- QoS
- Transport
- Media Clock
- Synchronisation

Timing & Synchronization - Requirements

- Bit transparency → no sample rate conversion → streams need to run on same media clock
- Concurrent operation of different sample rates
- Determinable (low) latency
- Time alignment between streams
- Phase-aligned local word clocks according to AES11 (replacement for "house clock" distribution)

⇨ Clock reassembly from stream data not appropriate
⇨ Distribution of master clock beats not sufficient
⇨ Common understanding of absolute time required ("wall clock")

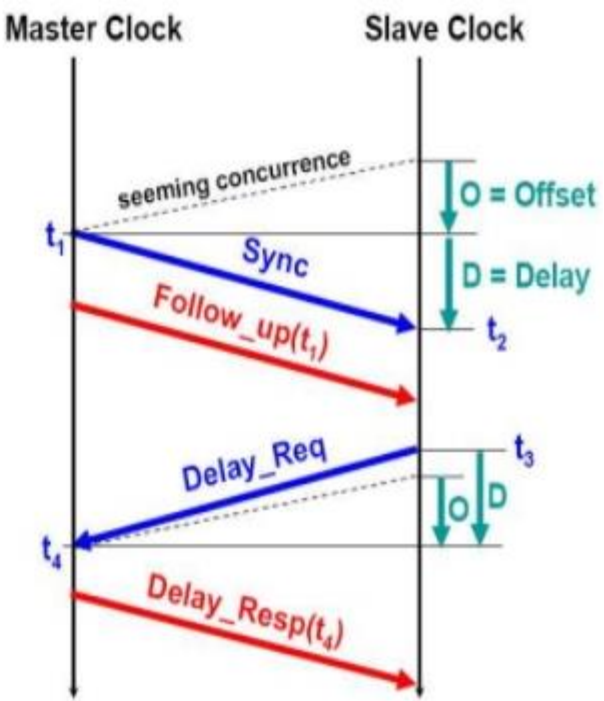
AES67 technology components

Media Clock	48 kHz
Synchronisation	IEEE 1588-2008 (PTPv2)

AES67 synchronization & media clocks

- All nodes are running local clocks
- Local clocks are precisely synchronized to a common wall clock via PTP

IEEE1588 (PTP) – principle of operation



Basic calculations:

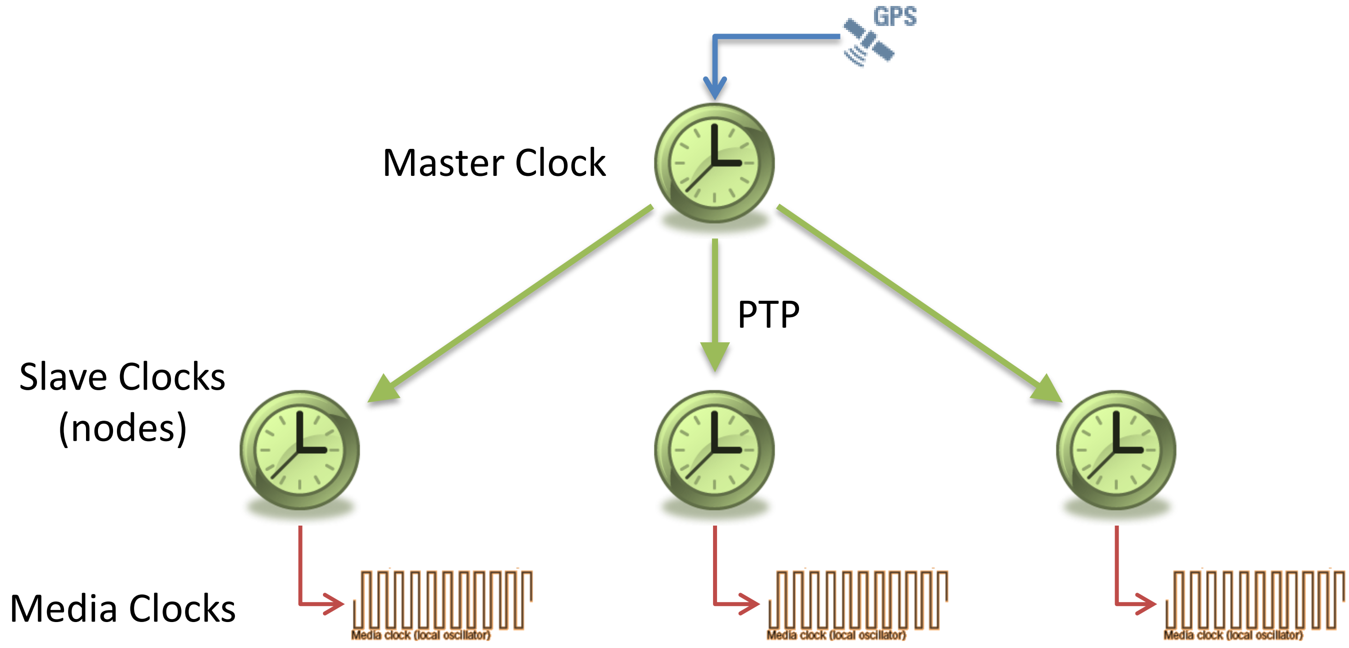
t2 – t1 = Delay + Offset
t4 – t3 = Delay - Offset

Delay = ((t2 – t1) + (t4 – t3)) /2
Offset = (t2 – t1) – Delay

AES67 synchronization & media clocks

- All nodes are running local clocks
- Local clocks are precisely synchronized to a common wall clock via PTP
- Media clocks are generated locally from synchronized local clock

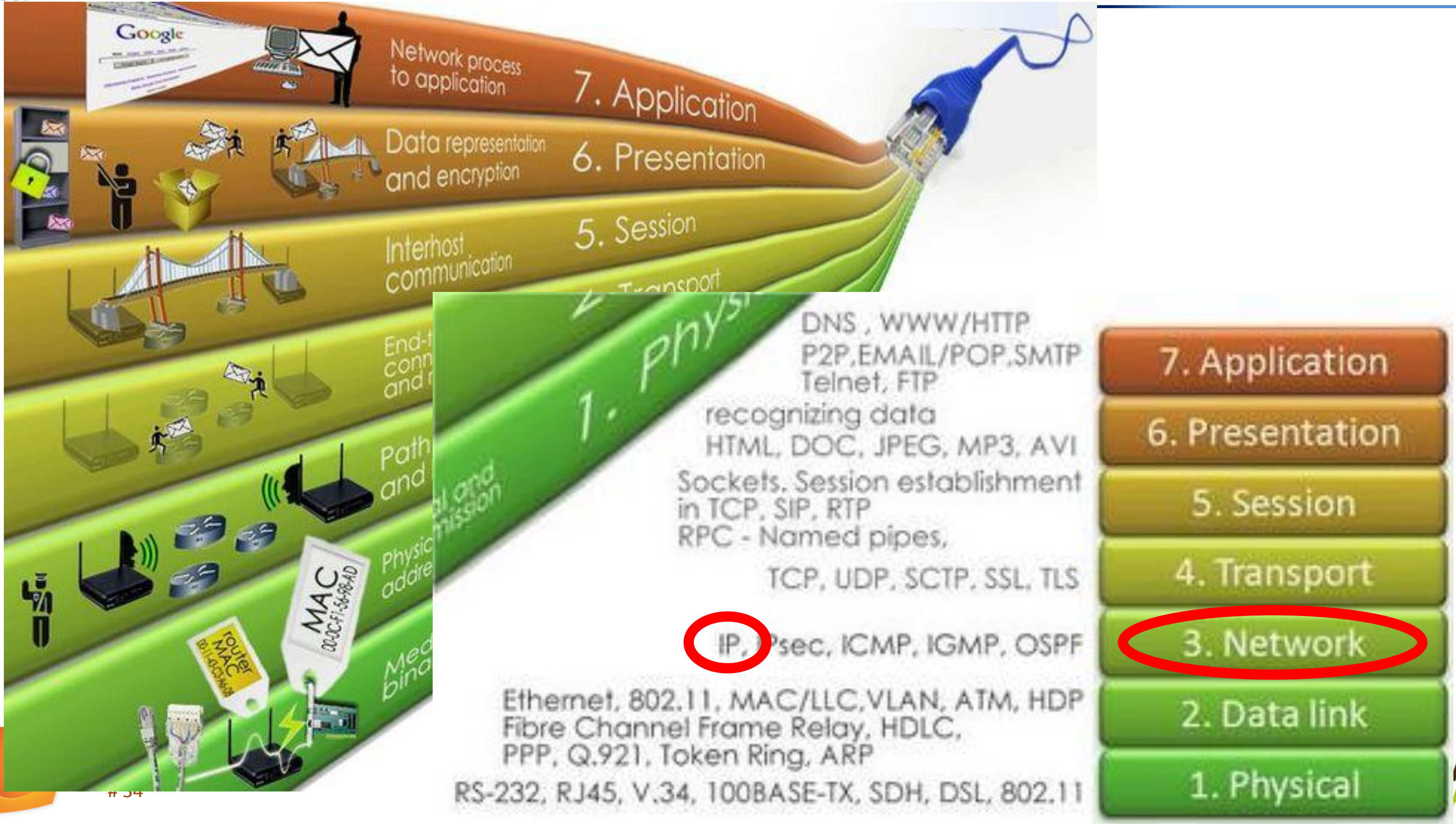
AES67 synchronization & media clocks



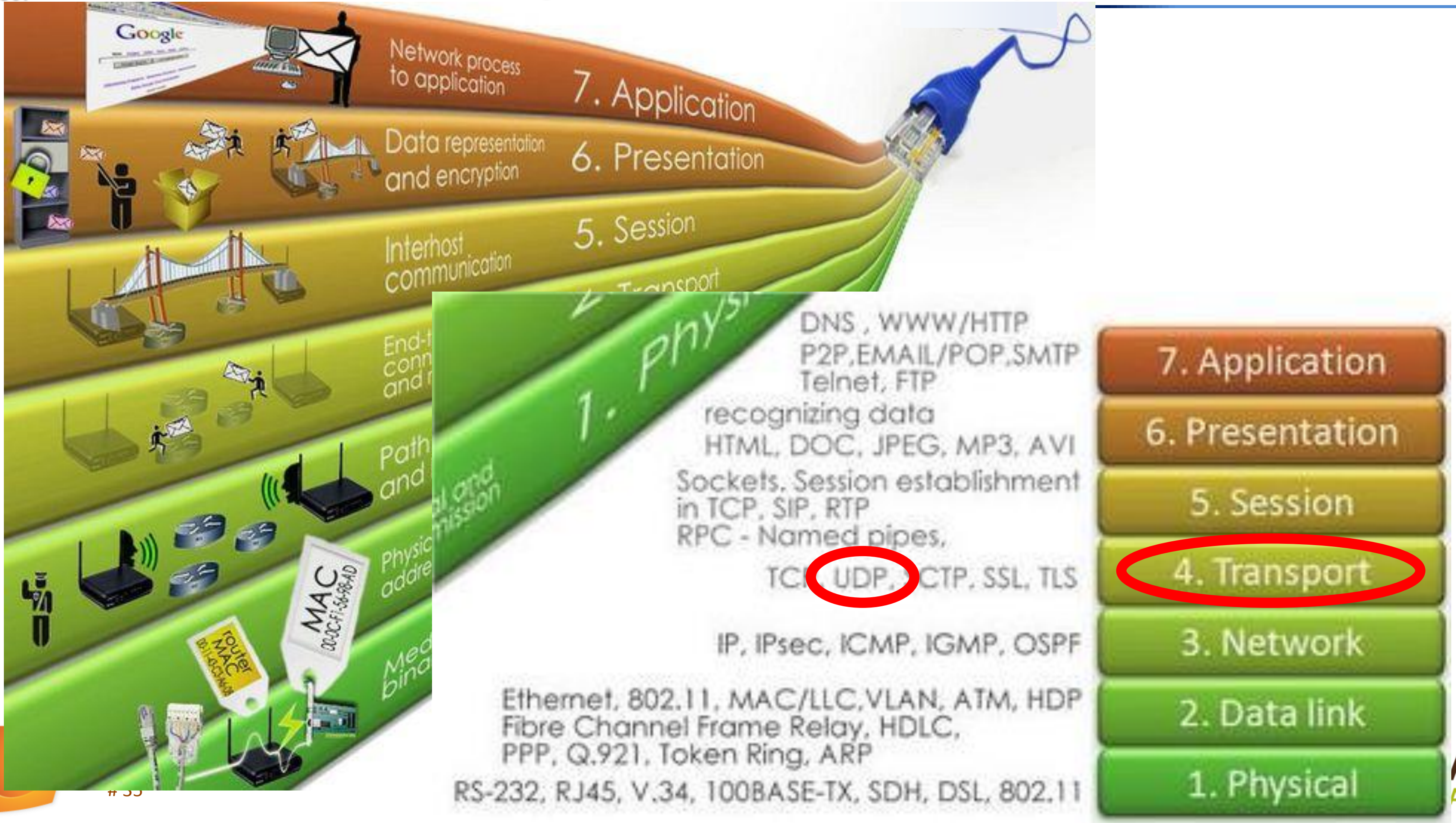
AES67 technology components

Transport	RTP / UDP / IP, unicast & multicast
Media Clock	48 kHz
Synchronisation	IEEE 1588-2008 (PTPv2)

AES Standard for Audio Applications of Networks - High-performance Streaming Audio-over-IP Interoperability

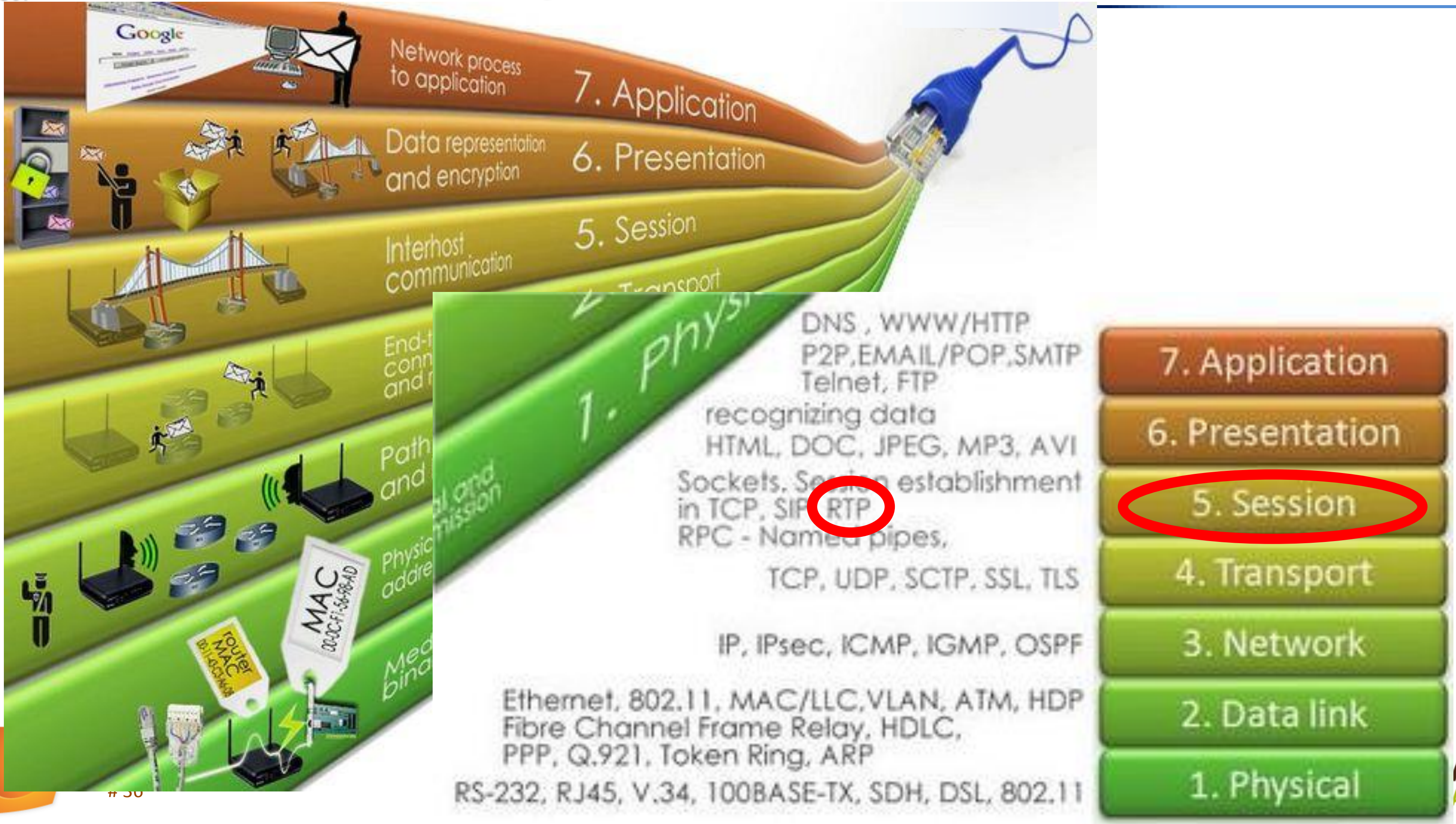


AES Standard for Audio Applications of Networks - High-performance Streaming Audio-over-IP Interoperability

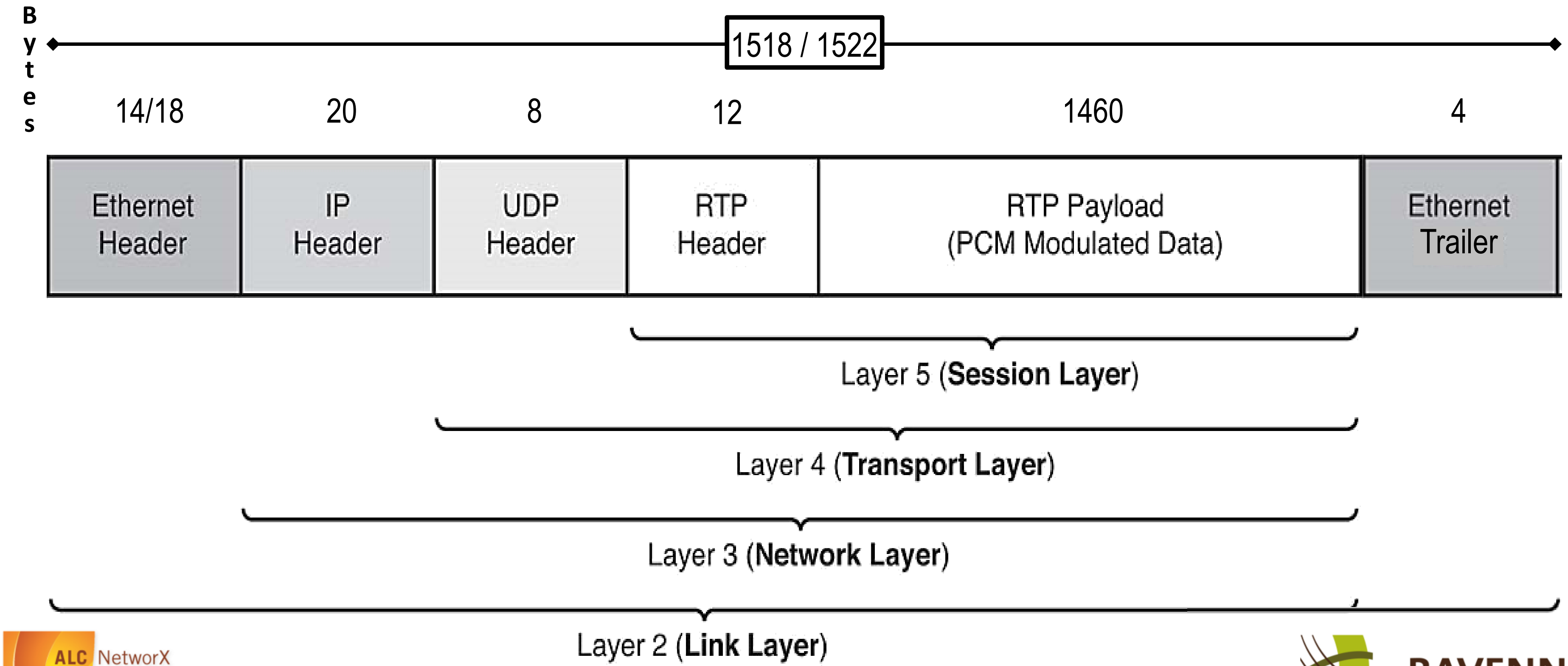


RAVENNA AES67 built-in

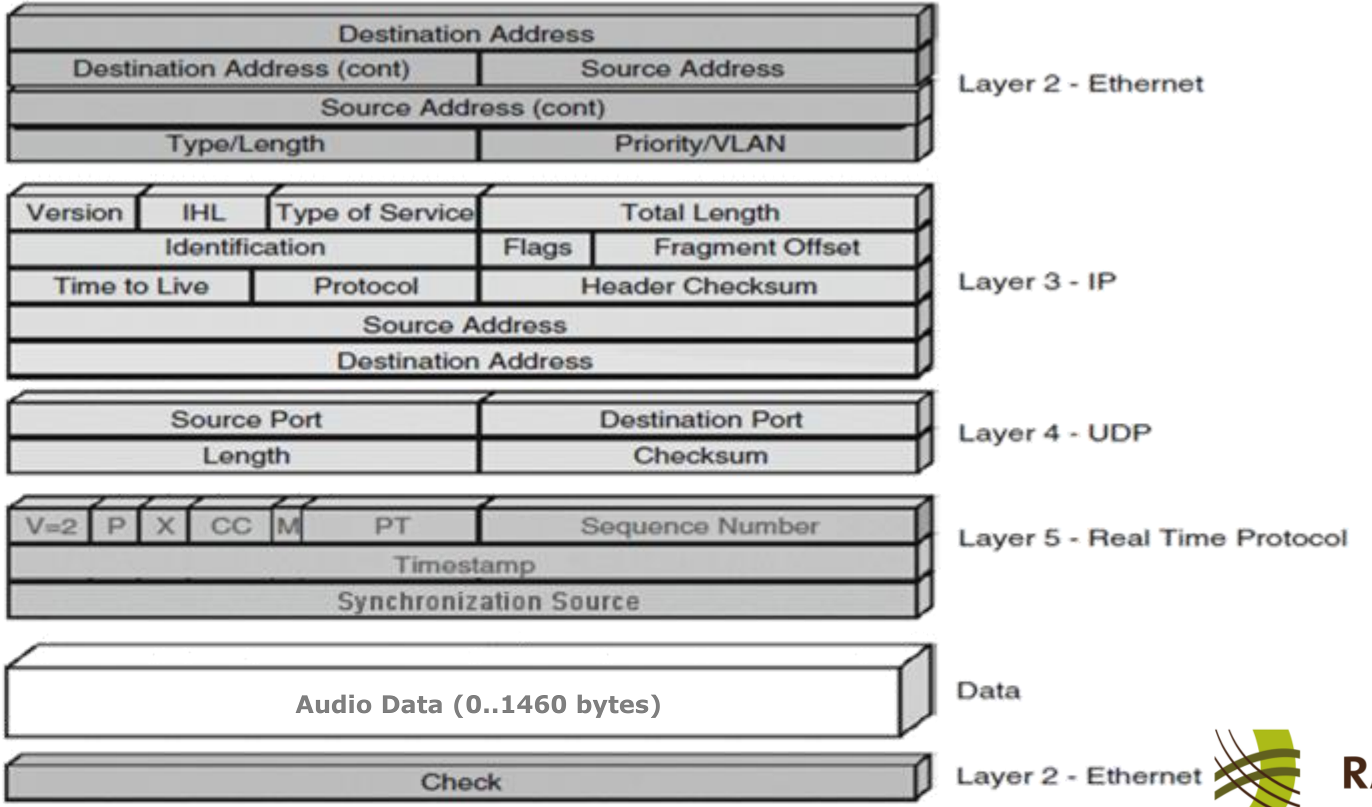
AES Standard for Audio Applications of Networks - High-performance Streaming Audio-over-IP Interoperability



Layered Packet Encapsulation



Layered Packet Encapsulation - RTP



AES67 technology components

QoS	Differentiated Services (DiffServ w/ 3 CoS)
Transport	RTP / UDP / IP, unicast & multicast
Media Clock	48 kHz
Synchronisation	IEEE 1588-2008 (PTPv2)

QoS – Differentiated Services (DiffServ)

- Defined in RFC 2474
- Defines up to 64 traffic classes (i.e. EF, AFx, CSx, BE etc.)
- Packets are tagged with DSCP value (0 – 63)
- Switches store packets in different priority queues (requires proper configuration)
- Egress scheduler forwards packets from higher prioritized queues first (strict priority / weighted round robin / guaranteed minimum bandwidth …)

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- Switches store packets in different priority queues (requires proper configuration)
- Egress scheduler forwards packets from higher prioritized queues first (strict priority, weighted round robin, guaranteed minimum bandwidth)
- Needs to be supported along full path from the transmitting to the receiving end
- No admission control → congestion / packet dropping possible when bandwidth is exceeded

AES67 technology components

Discovery	Not specified
Connection Management	SIP (unicast), IGMP (multicast) + ???
Session Description	SDP (RFC4566, RFC7273)
Encoding	L16/L24, 1..8 ch, 48 samples
QoS	Differentiated Services (DiffServ w/ 3 CoS)
Transport	RTP / UDP / IP, unicast & multicast
Media Clock	48 kHz
Synchronisation	IEEE 1588-2008 (PTPv2)

Discovery & Connection Management in AES67

New stream available!

Read all about it!

```
v=0
o=- 1311738121 1311738121 IN IP4 192.168.1.1
s=Stage left I/O
c=IN IP4 239.0.0.1/32
t=0 0
m=audio 5004 RTP/AVP 96
i=Channels 1-8
a=rtpmap:96 L24/48000/8
a=recvonly
a=ptime:1
a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FF-FE-07-CB-D0:domain-nmbr=0
a=mediaclk:direct=963214424
```

Discovery & Connection Management in AES67

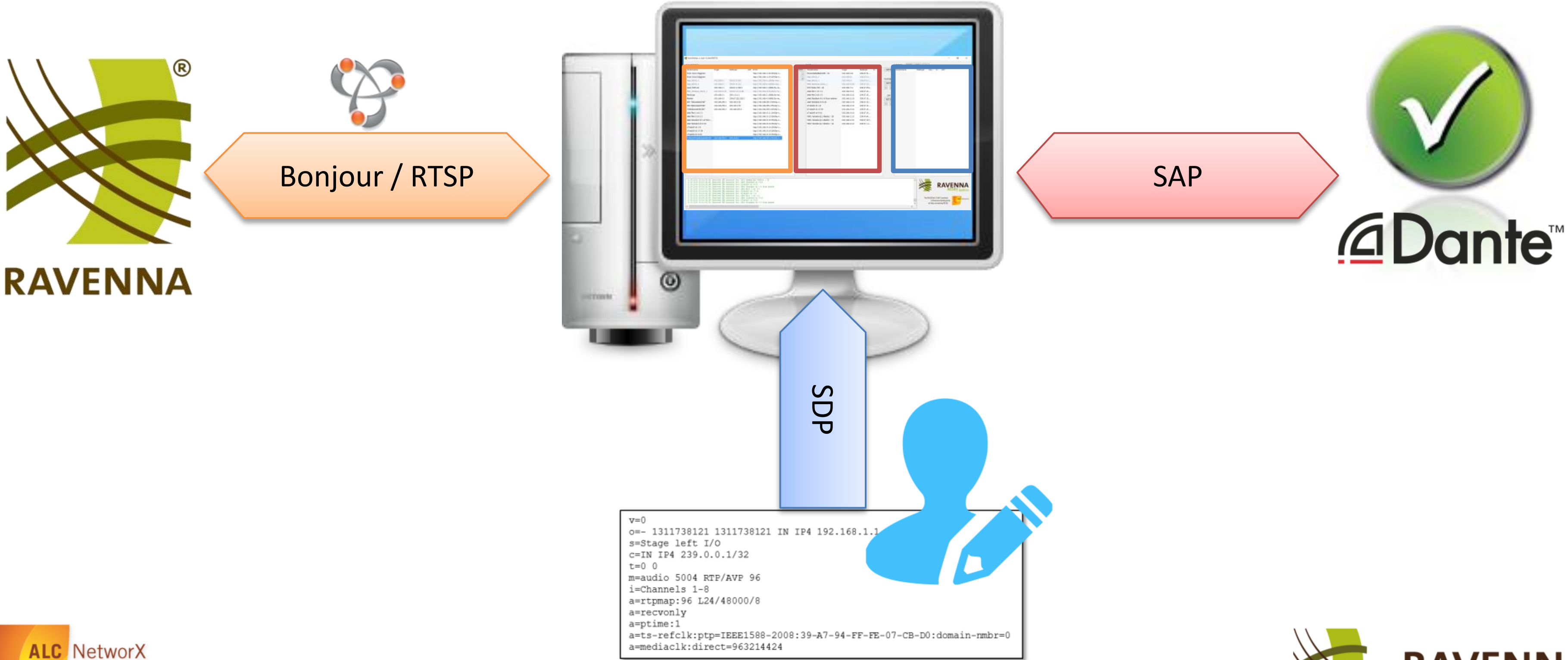
- Discovery: excluded, but several possibilities mentioned (i.e. ZeroConf, SAP and others)
  - Discovery enables enumeration / registration devices & streams
  - Announces protocol / location (uri) for SDP data
- Connection management: SDP, IGMP (multicast), SIP (unicast)
  - SDP data required for connection setup and stream description
  - SDP transport: unicast - SIP, multicast - no protocol specified (assuming manual means available via device-specific UI)
- Real-world problem:
  - different discovery methods used by various systems (i.e. mDNS vs. SAP)
  - No common method for (multicast) SDP exchange
  - Lack of means for manual read-out / entry of SDP data

    ⇨ **No simple interoperability!**

Discovery & Connection Management in AES67

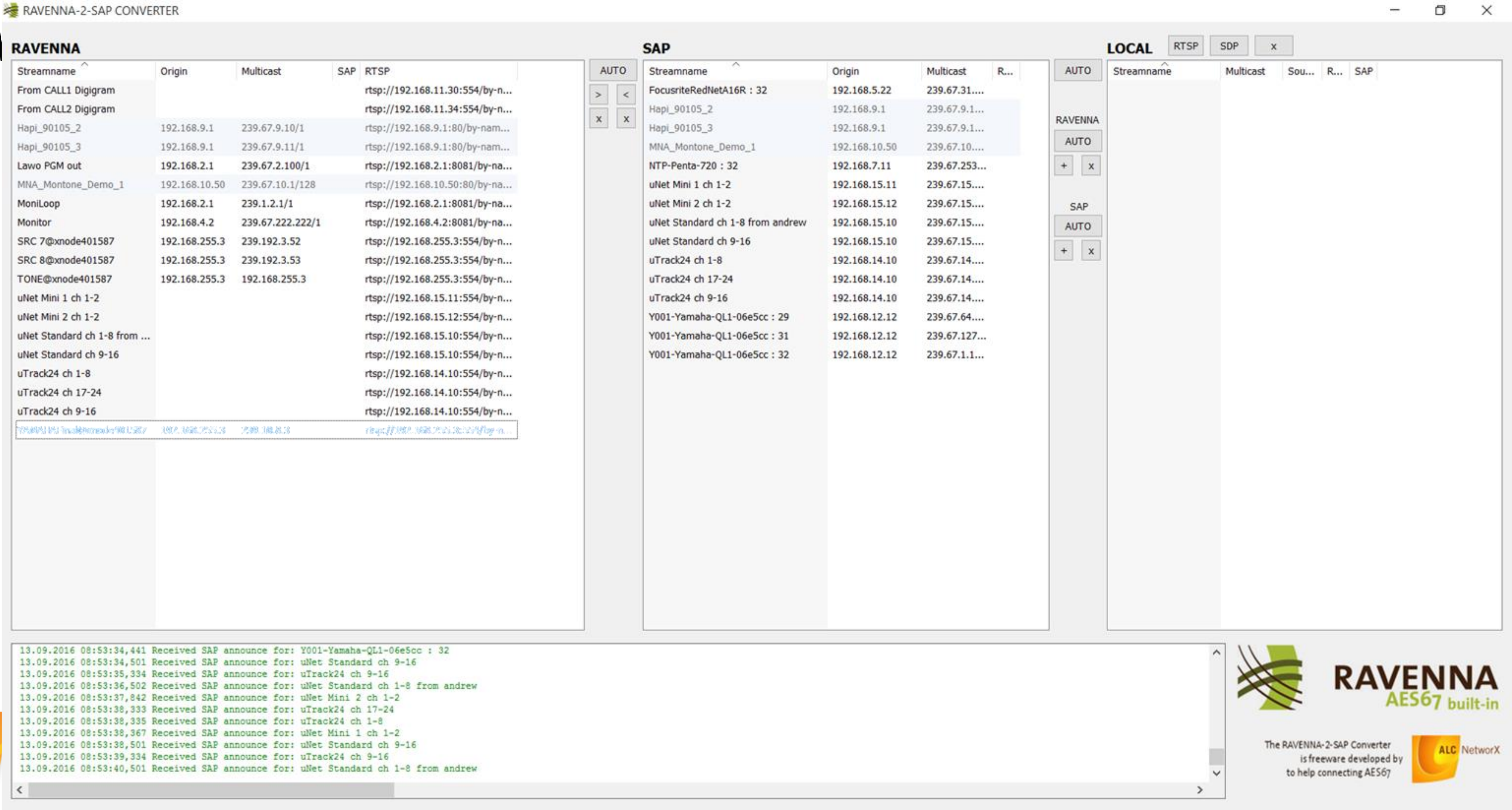
- RAVENNA®: DNS-SD (mDNS), rtsp for SDP transfer
  - Works with multicast & unicast (side-by-side with SIP)
  - Method supported by virtually any media player and / or streaming application
- Dante™ (in AES67 mode): SAP
  - Experimental protocol for announcing multicast sessions
  - Periodically multicast transmission of full SDP data records
  - No manual read-out / entry of SDP data
- Problem solver #1: ***RAVENNA-2-SAP Converter***
  - Converts selected or all RAVENNA announcements into SAP and vice versa
  - Provides full SDP read-out and manual entry through UI

RAVENNA-to-SAP Converter



RAVENNA-to-SAP Converter

RA


RAVENNA-2-SAP CONVERTER
RAVENNA
Streamname Origin Multicast SAP RTSP
From CALL1 Digigram rtsp://192.168.11.30:554/by-n...
From CALL2 Digigram rtsp://192.168.11.34:554/by-n...
Hapi_90105_2 192.168.9.1 239.67.9.10/1 rtsp://192.168.9.1:80/by-nam...
Hapi_90105_3 192.168.9.1 239.67.9.11/1 rtsp://192.168.9.1:80/by-nam...
Lawo PGM out 192.168.2.1 239.67.2.100/1 rtsp://192.168.2.1:8081/by-na...
MNA_Montone_Demo_1 192.168.10.50 239.67.10.1/128 rtsp://192.168.10.50:80/by-na...
MoniLoop 192.168.2.1 239.1.2.1/1 rtsp://192.168.2.1:8081/by-na...
Monitor 192.168.4.2 239.67.222.222/1 rtsp://192.168.4.2:8081/by-na...
SRC 7@xnode401587 192.168.255.3 239.192.3.52 rtsp://192.168.255.3:554/by-n...
SRC 8@xnode401587 192.168.255.3 239.192.3.53 rtsp://192.168.255.3:554/by-n...
TONE@xnode401587 192.168.255.3 192.168.255.3 rtsp://192.168.255.3:554/by-n...
uNet Mini 1 ch 1-2 rtsp://192.168.15.11:554/by-n...
uNet Mini 2 ch 1-2 rtsp://192.168.15.12:554/by-n...
uNet Standard ch 1-8 from ... rtsp://192.168.15.10:554/by-n...
uNet Standard ch 9-16 rtsp://192.168.15.10:554/by-n...
uTrack24 ch 1-8 rtsp://192.168.14.10:554/by-n...
uTrack24 ch 17-24 rtsp://192.168.14.10:554/by-n...
uTrack24 ch 9-16 rtsp://192.168.14.10:554/by-n...
AUTO
SAP
Streamname Origin Multicast R...
FocusriteRedNetA16R : 32 192.168.5.22 239.67.31....
Hapi_90105_2 192.168.9.1 239.67.9.1...
Hapi_90105_3 192.168.9.1 239.67.9.1...
MNA_Montone_Demo_1 192.168.10.50 239.67.10....
NTP-Penta-720 : 32 192.168.7.11 239.67.253...
uNet Mini 1 ch 1-2 192.168.15.11 239.67.15....
uNet Mini 2 ch 1-2 192.168.15.12 239.67.15....
uNet Standard ch 1-8 from andrew 192.168.15.10 239.67.15....
uNet Standard ch 9-16 192.168.15.10 239.67.15....
uTrack24 ch 1-8 192.168.14.10 239.67.14....
uTrack24 ch 17-24 192.168.14.10 239.67.14....
uTrack24 ch 9-16 192.168.14.10 239.67.14....
Y001-Yamaha-QL1-06e5cc : 29 192.168.12.12 239.67.64....
Y001-Yamaha-QL1-06e5cc : 31 192.168.12.12 239.67.127...
Y001-Yamaha-QL1-06e5cc : 32 192.168.12.12 239.67.1.1...
AUTO
RAVENNA
AUTO
SAP
AUTO
LOCAL RTSP SDP
Streamname Multicast Sou... R... SAP
13.09.2016 08:53:34,441 Received SAP announce for: Y001-Yamaha-QL1-06e5cc : 32
13.09.2016 08:53:34,501 Received SAP announce for: uNet Standard ch 9-16
13.09.2016 08:53:35,334 Received SAP announce for: uTrack24 ch 9-16
13.09.2016 08:53:36,502 Received SAP announce for: uNet Standard ch 1-8 from andrew
13.09.2016 08:53:37,842 Received SAP announce for: uNet Mini 2 ch 1-2
13.09.2016 08:53:38,333 Received SAP announce for: uTrack24 ch 17-24
13.09.2016 08:53:38,335 Received SAP announce for: uTrack24 ch 1-8
13.09.2016 08:53:38,367 Received SAP announce for: uNet Mini 1 ch 1-2
13.09.2016 08:53:38,501 Received SAP announce for: uNet Standard ch 9-16
13.09.2016 08:53:39,334 Received SAP announce for: uTrack24 ch 9-16
13.09.2016 08:53:40,501 Received SAP announce for: uNet Standard ch 1-8 from andrew
RAVENNA AES67 built-in
The RAVENNA-2-SAP Converter is freeware developed by to help connecting AES67
ALC NetworX

Discovery & Connection Management in AES67

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  - Works with multicast & unicast (side-by-side with SIP)
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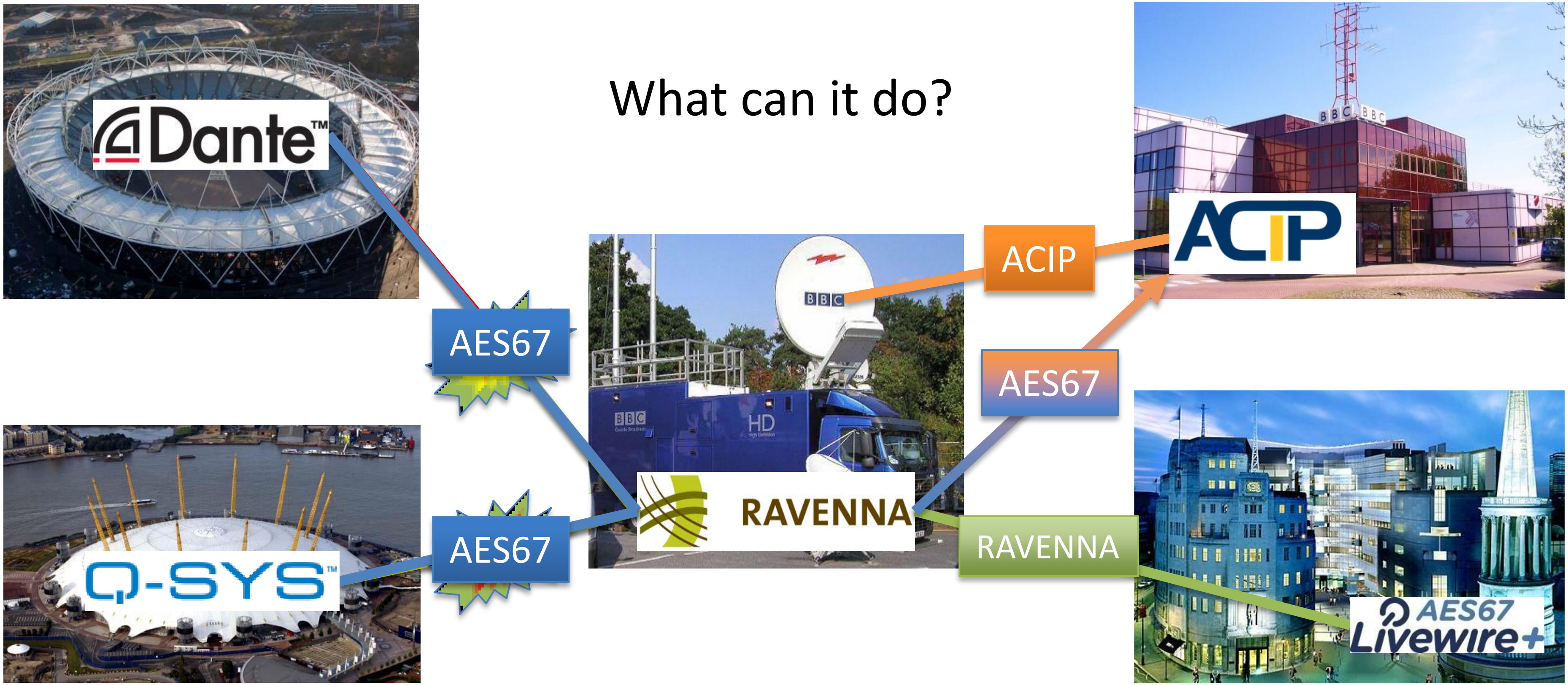
  - Converts selected or all RAVENNA announcements into SAP and vice versa
  - Provides full SDP read-out and manual entry through UI
- Problem solver #2: Use of ANEMAN by Merging (Audio NEtwork MANager).
- Problem solver #3: Use of new industry standard AMWA NMOS IS-04 & IS-05.

What can it do?

What can it do?



AES67 – the "O negative" of audio networking

RAVENNA

Q-SYS™

AES67 Livewire+

ALC NetworX

WHEATNET IP

Dante™

ACIP

RAVENNA AES67 built-in

AES67 – *the "O negative" of audio networking*

Who is supporting it?

AES67 – *the "O negative" of audio networking*

Who is supporting it?

AES67 *built-in!*

*What is **RAVENNA**?*

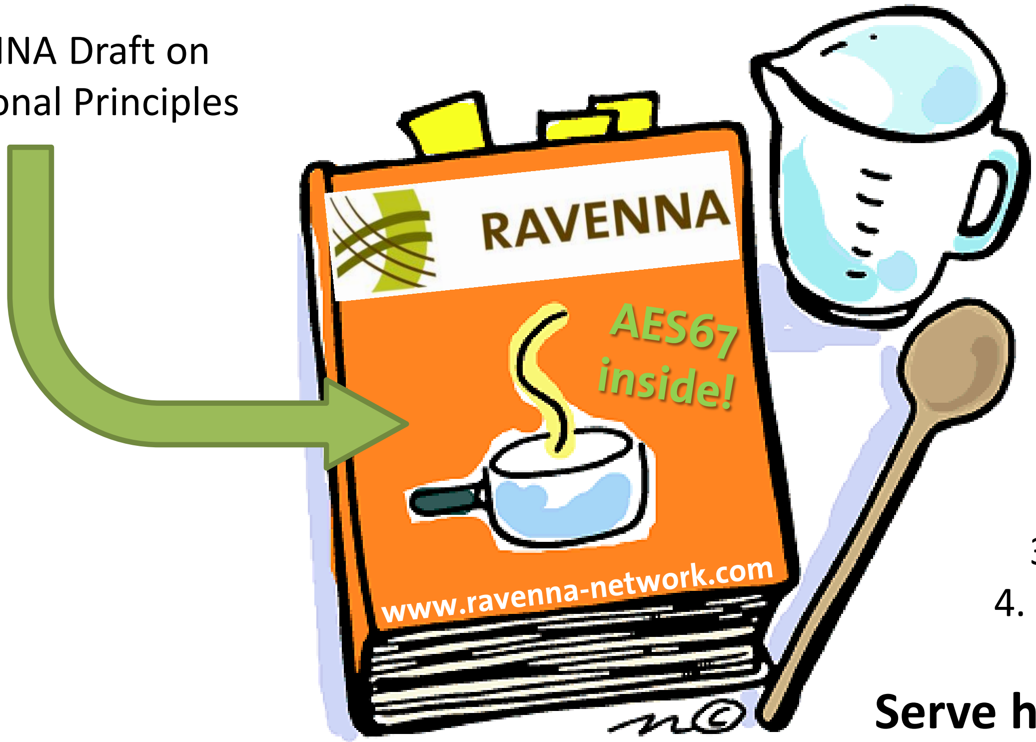
An "Open Technology" platform:

- Based on **technology** publicly **available**
  - ⇨ *No proprietary "black box" design*
- Utilizes **standard protocols**
  - ⇨ *Proven technology, widely supported*
- Designed to work on **existing networks**
  - ⇨ *No new network equipment required*
- **No** proprietary **licensing** policy
  - ⇨ No cost per channel, suits all performance needs

- Draft on operating principles **published** since June 10th, 2011

*What is **RAVENNA**?*

RAVENNA Draft on
Operational Principles



Ingredients:

20 ml PTPv2
500 g RTP
1 pkt multicast
1 pinch of Bonjour

Cooking order:

1. Stew PTP to order
2. Add RTP
3. Mingle with multicast
4. Add Bonjour on top

Serve hot and Enjoy!

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- Draft on operating principles **published** since June 10th, 2011
  - ⇨ *Anybody can implement / support RAVENNA technology*
- **Supported** by renowned companies from the ProAudio industry

RAVENNA Partners (& AES67 Supporters):

ARCHWAVE connecting audio
digigram
SENNHEISER
RIEDEL
LAWO
SCHOEPS Mikrofone
GENELEC®
MERGING
DHD
orban
dimetis® IP Broadcast Pioneer
SONIFEX
SCISYS
SOUND4
HIFI AUDIO STREAMS ENCODERS MODULATION INDEX LLC
NEUMANN.BERLIN
Boldburg
2wcom Wireless-World-Communication
DSA Volgmann
AXIA A TELOS ALLIANCE COMPANY
Telos
LINEAR ACOUSTIC
Omnia
25 seven
JUTEL Excellence On Air Since 1984
GATESAIR
AEQ
COVELOZ CO\CREATE
CALREC
Qbit
AETA AUDIO SYSTEMS superior sound since 1978
WBS WARD-BECK SYSTEMS
arkona TECHNOLOGIES GMBH
INFOMEDIA
WorldCast Systems deliver > transmit > monitor
DirectOut TECHNOLOGIES

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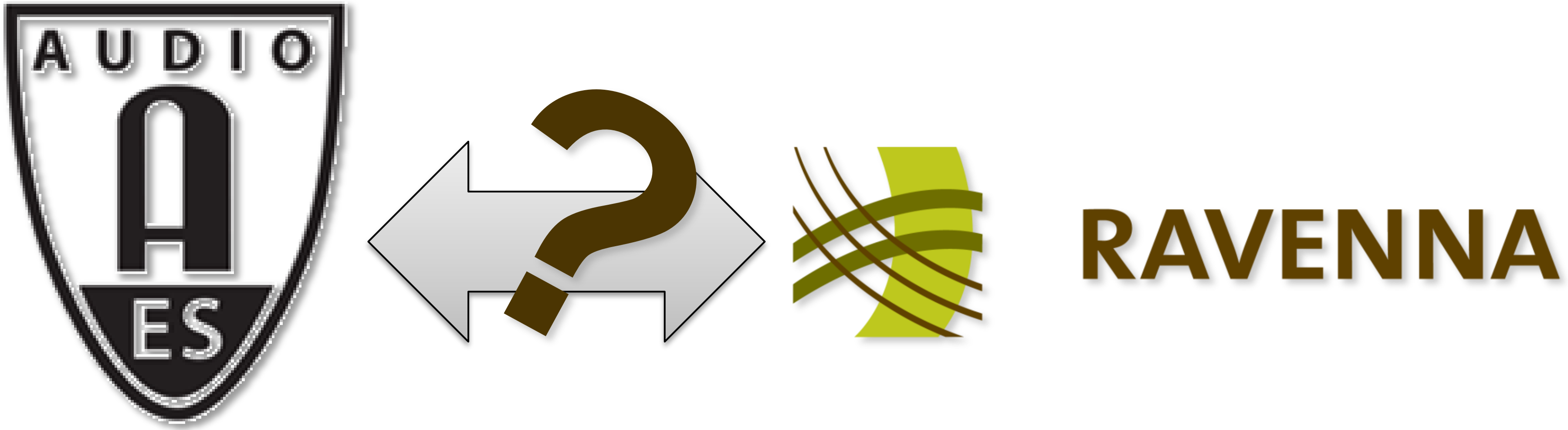
- Draft on operating principles **published** since June 10th, 2011
  - ⇨ *Anybody can implement / support RAVENNA technology*
- **Supported** by renowned companies from the ProAudio industry
  - ⇨ *Broad market acceptance*
- Active participation in AES X192 standardization TG
  - ⇨ ***RAVENNA supports AES67 standard***



AES67

AES67

RAVENNA

AES67	RAVENNA
	+ Discovery
	+ Redundancy
QoS three classes	+ classes adjustable
Media Format L16/L24 PCM	+ AES/EBU, DSD/DXD, Video
48 Samples per packet	+ 1, 6, 12, 64…
1-8 Audio channels	+ 64, 128…
Encoding 48kHz	+ 44.1, 96, 192, 384kHz…

The IP-based Real-Time Media Network

RAVENNA	
	+ Discovery
	+ Redundancy
QoS three classes	+ classes adjustable
Media Format L16/L24 PCM	+ AES/EBU, DSD/DXD, Video
48 Samples per packet	+ 1, 6, 12, 64…
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AES67

More Features

More Options

RAVENNA

AES67 *built-in!*

AES67 – *the "O negative"*
of audio networking

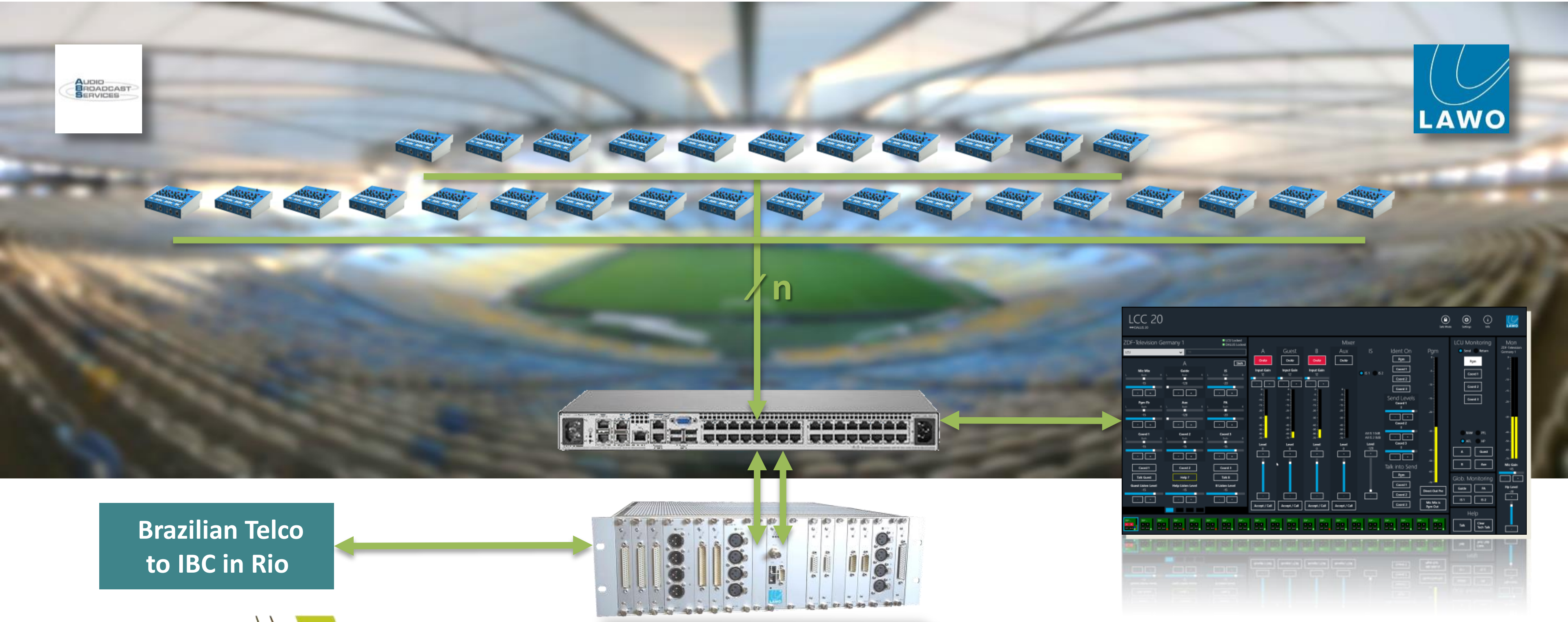
Who is supporting it?

AES67 "real-world" example applications:

RAVENNA @ Soccer World Cup 2014

RAVENNA @ Soccer World Cup 2014

The IP-based Real-Time Media Network



RAVENNA @ Soccer World Cup 2014


Audio Broadcast Services
LAWO
CSC
Commentary Swi
RAVENNA @ Asian Games 2014
17th Asian Games
INCHEON 2014


AUDIO BROADCAST SERVICES
LAWO
INCHEON 2014
RAVENNA @ Asian Games 2014

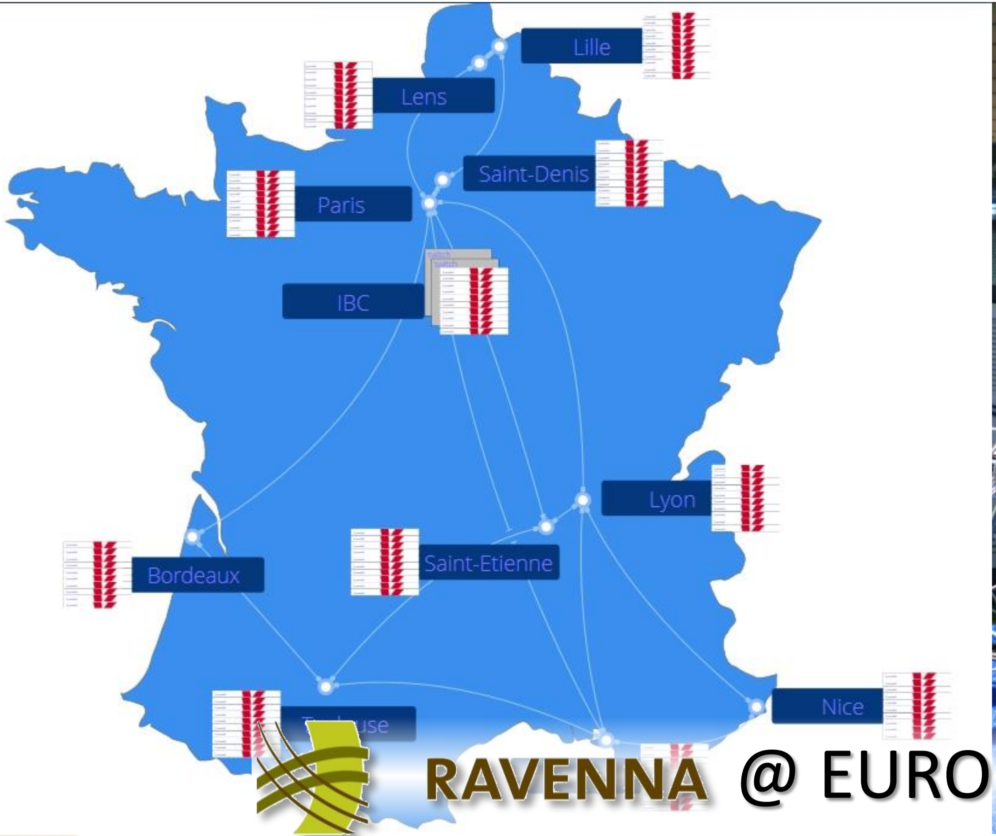
Conventional system setup:

RAVENNA @ Asian Games 2014


IP-based setup:
Opening Ceremony
RAVENNA @ Asian Games 2014

The IP-based Real-Time Media Network

The IP-based Real-Time Media Network



RAVENNA @ EURO 2016

The IP-based Real-Time Media Network

120x V__link4
(12 pro venue)
264x V__remote4
(19-20 per venue, 73 at IBC)
130x A__mic8
(13 pro venue)
480 video streams
~1000 audio channels
22x Arista 7150S (2 per venue, 2 at IBC)

RAVENNA @ EURO 2016

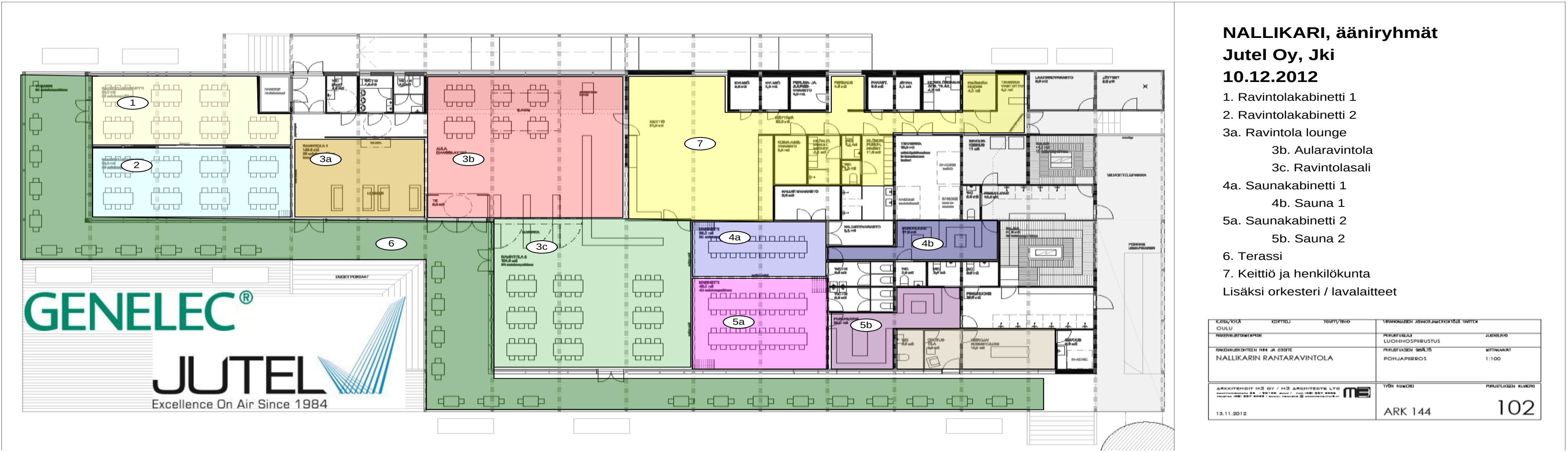

Photo: Ralph Larmann
RAVENNA @ ESC 2015


BUILDING
BRIDGES
SONG CONTEST
VIENNA 2015


10:29:00
Mixerinput 13
ME2A
RAVENNA @ ESC 2015


BUILDING
BRIDGES
SONG CONTEST
VIENNA 2015

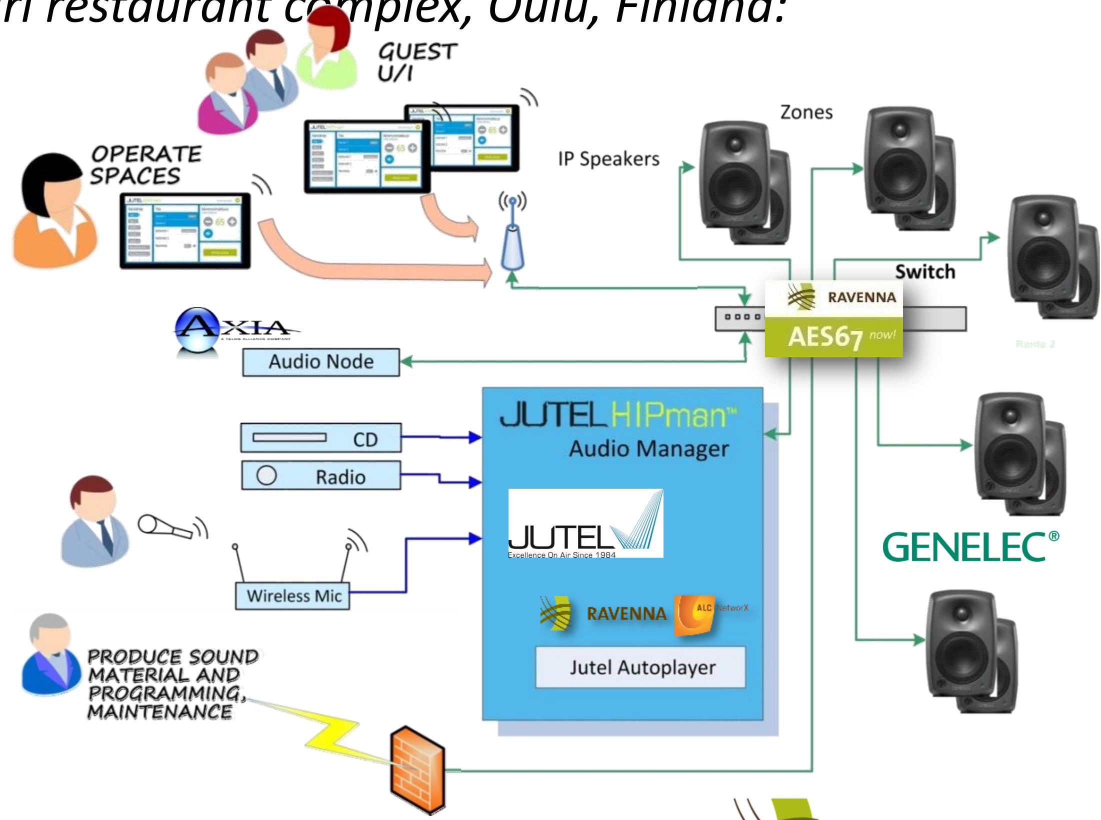
AES67 Installed Sound Pilot: Nallikari restaurant complex, Oulu, Finland:



- Multi-zone restaurant environment with programmable background music
- Audio processing, playout, routing and remote control functions
- Wireless user control via Android tablets

AES67 Installed Sound Pilot: Nallikari restaurant complex, Oulu, Finland:

- Jutel HIPman audio management, processing & play-out system w/ RAVENNA Virtual Sound Card
- 30 IP-driven Genelec speakers
- Axia xNode for PTP GM and utility audio I/O (mic, monitoring)
- Android tabs for wireless control
- Remote maintenance access
- Common network for all services
- RAVENNA/AES67 audio streaming



RAVENNA
AES67 built-in

The IP-based Real-Time Media Network

- 10 Neumann DMI-8 (78 digital mics)

- 2 Lawo MC^{2}56

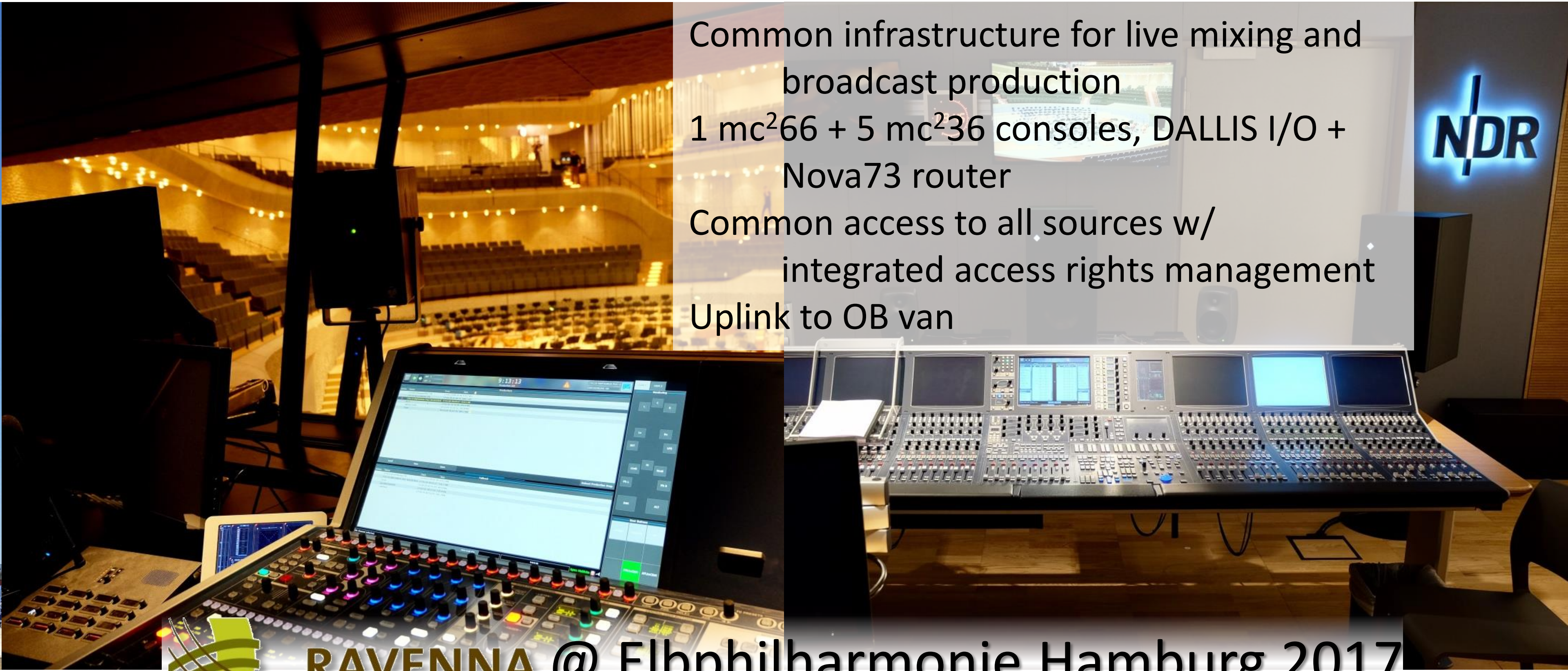
- 1 Merging Pyramix

RAVENNA AES67 built-in

The IP-based Real-Time Media Network

RAVENNA @ Elbphilharmonie Hamburg 2017

The IP-based Real-Time Media Network



- Common infrastructure for live mixing and broadcast production
- 1 mc²66 + 5 mc²36 consoles, DALLIS I/O + Nova73 router
- Common access to all sources w/ integrated access rights management
- Uplink to OB van

RAVENNA @ Elbphilharmonie Hamburg 2017


RAVENNA
NETWORK PARTNER
WINNERS
AV AWARDS 2017
BROADCAST/MEDIA PROJECT OF THE YEAR
LAWO
RAVENNA
AES67 built-in
ELBPHILHARMONIE

Beyond AES67 - other important standards / industry alliances

AUDIO ES — AES67, AES70

SMPTE — ST2110, ST2059

IETF — IP-related suite of protocols

IEEE — Ethernet authority (802.x), PTP (1588)

Media Networking Alliance — Promoting adoption of AES67

AIMS Alliance for IP Media Solutions — Promoting adoption of IP standards for media industry

AMWA Networked Media. Working. — NMOS IS-04/05/06 (D&R, connection management)

EBU — Important tech docs on broadcasting (ACIP)

Beyond AES67 - other important standards / industry alliances

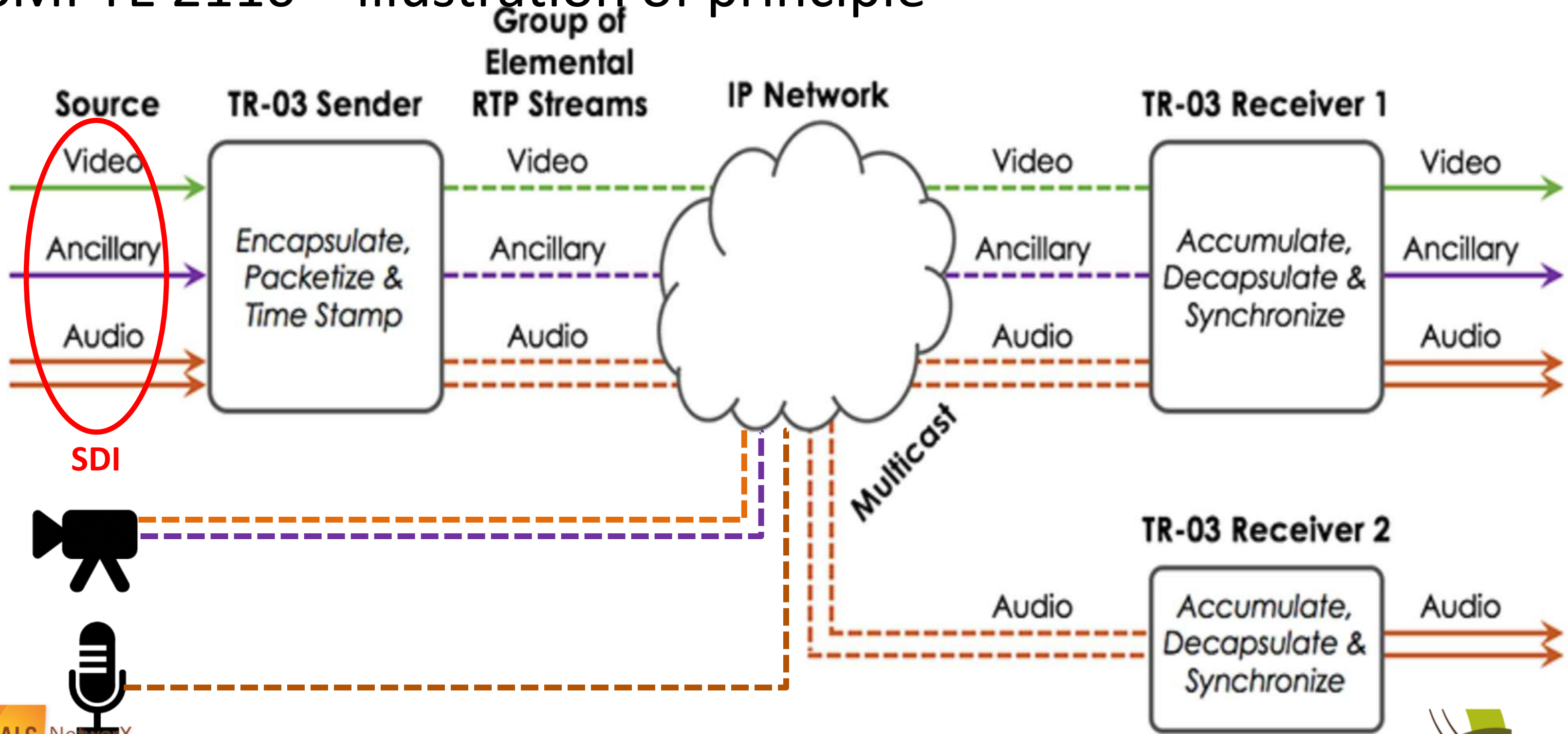
ST2110 - Professional Media over Managed IP Networks

- Defines transport and synchronization of elementary essence streams (video, audio, ancillary data)
- Primarily targeting at live production applications
- AES67 referenced as transport standard for audio essence

Network Media Open Specifications (NMOS)

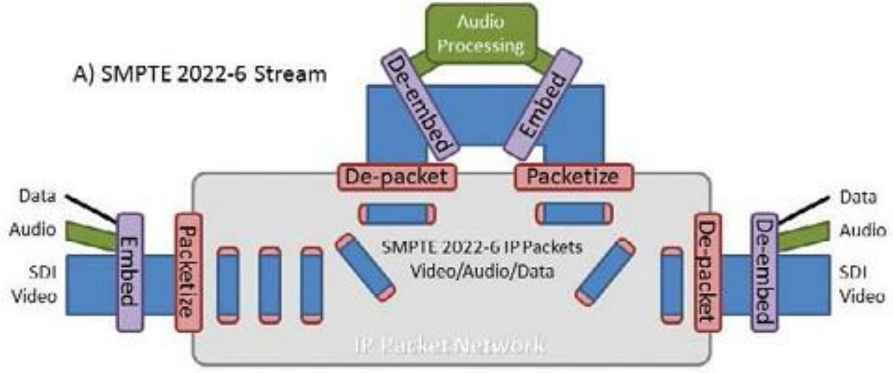
- IS-04 – discovery & registration of network objects (devices, resources, streams etc.)
- IS-05 – connection management
- IS-06 – network control (SDN)

SMPTE 2110 – illustration of principle

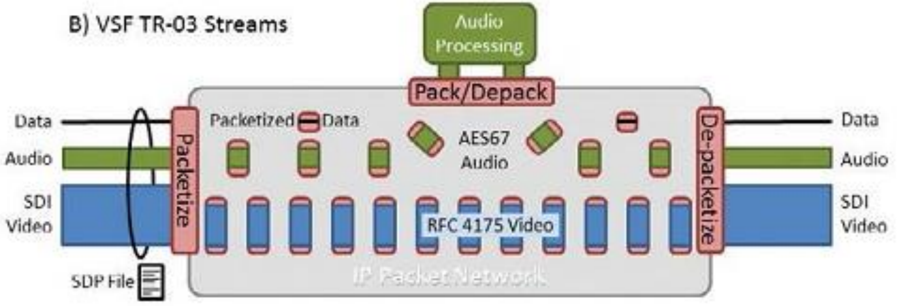


Comparison

ST2022-6



ST2110



Comparison

ST2022-6

- Single stream transport of audio, video and ancillary data
- All media in sync
- Efficient for WAN and point-to-point applications
- Not flexible, requires de-embedding of the whole stream for audio

ST2110

- Separate audio, video and ancillary data streams
- Inter-stream synchronization via RTP, PTP (method is identical to AES67)
- Provides greater flexibility in production networks
- Audio stream transport & format is based on AES67

SMPTE 2110 - Professional Media over Managed IP Networks

Document structure:

- 2110-10: System Timing & Definitions
  - defines transport layer and synchronization (SMPTE2059, clocks, RTP, SDP etc.)
- 2110-20: Uncompressed Active Video
  - defines payload format for raw video (RFC4175, RTP, SDP, constraints)
- 2110-21: Traffic Shaping and Delivery Timing for Uncompressed Active Video
  - defines timing model for senders and receivers (traffic shaping requirements)

SMPTE 2110 - Professional Media over Managed IP Networks

Document structure:

- 2110-30: PCM Digital Audio
  - defines payload format for linear audio (AES67, constraints)
- 2110-31: AES3 Transparent Transport
  - defines payload format for non-linear audio and meta data (RAVENNA AM824)
- 2110-40: Transport of SMPTE Ancillary Data
  - defines RTP payload format for SDI ancillary data (new IETF RFC (draft))
- ~~2110-50~~: Interoperation of ST 2022-6 Streams → ST2022-8
  - what it says… (VSF TR-04)

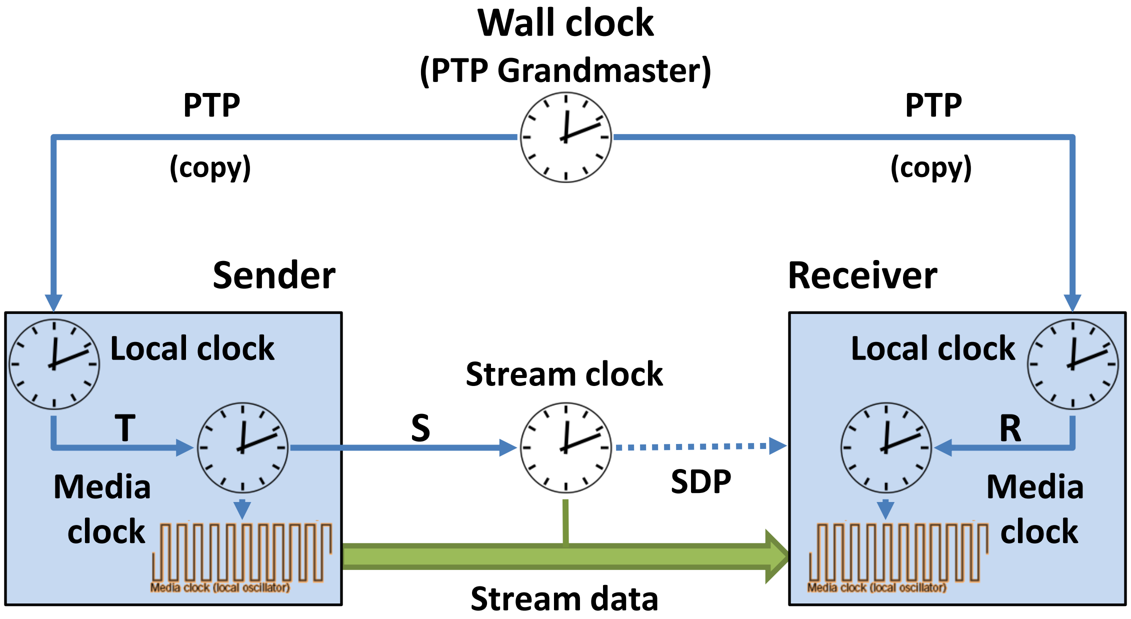
SMPTE 2110 - Professional Media over Managed IP Networks

Constraints of 2110-10 & -30 w/ respect to AES67

- Synchronisation & Timing -

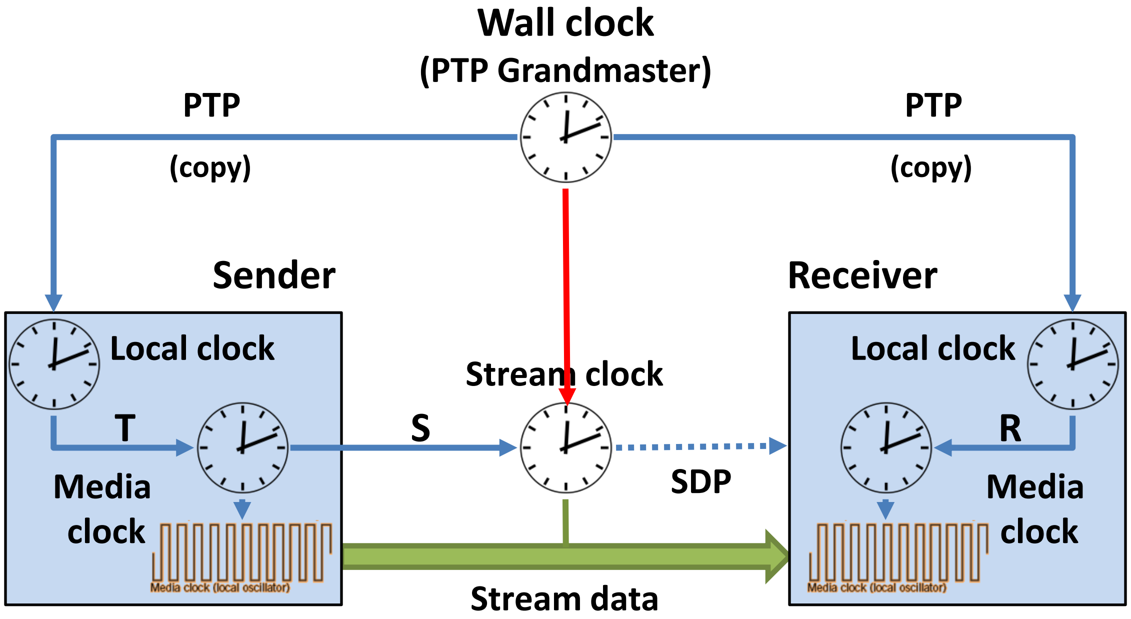
- PTP:
  - support of SMPTE 2059-2 required
  - message rate according to AES-R16-2016 (AES67 PTP Media profile)
  - `defaultDS.slaveOnly=true` for devices not capable of entering PTP master state
  - `a=ts-refclk:ptp=traceable` and `a=tsrefclkts-refclk:localmac=<mac_addr>` allowed
- RTP clock: offset= 0 w/ respect to media clock / network clock
  - `a=mediaclk:direct=0`

AES67 synchronization & media clocks



- Relations **T** and **R** are established on node start-up
- Relation **S** is established on stream start-up
- **S** may be random to defeat crypto attacks
- This offset will be constant throughout the stream's lifetime
- The overall offset (**T** + **S**) will be conveyed via SDP (a=mediaclk:direct=<offset>)

AES67 synchronization & media clocks



- Relations **T** and **R** are established on node start-up
- Relation **S** is established on stream start-up
- **S** may be random to defeat crypto attacks
- This offset will be constant throughout the stream's lifetime
- The overall offset (**T** + **S**) will be conveyed via SDP (a=mediaclk:direct=<offset>) – **must be "0" in ST2110**

SMPTE 2110 - Professional Media over Managed IP Networks

Constraints of 2110-10 & -30 w/ respect to AES67

- Protocols -

- Support of RTCP not required (but must be tolerated)
- Support of SIP (or any other connection management protocol) not required
- Redundancy (optional): SMPTE 2022-7
  - no identical IP source and destination addresses
- Channel assignment map (SDP attributes - optional)
  - `a=fmtp:<payload type> channel-order=<convention>.<order>`
  - Example: `a=fmtp:101 channel-order=SMPTE2110.(51,ST)`

SMPTE 2110 - Professional Media over Managed IP Networks

Constraints of 2110-10 & -30 w/ respect to AES67

- 6 conformance levels:

Level	Supported by the Receiver
A (mandatory)	**Reception of 48 kHz streams with 1 to 8 audio channels at packet times of 1 ms**
B	Level A + 1 to 8 channels at packet times of **125** µs
C	Level A + 1 to **64** channels at packet times of **125** µs

AES67 compliant

SMPTE 2110 - Professional Media over Managed IP Networks

Constraints of 2110-10 & -30 w/ respect to AES67

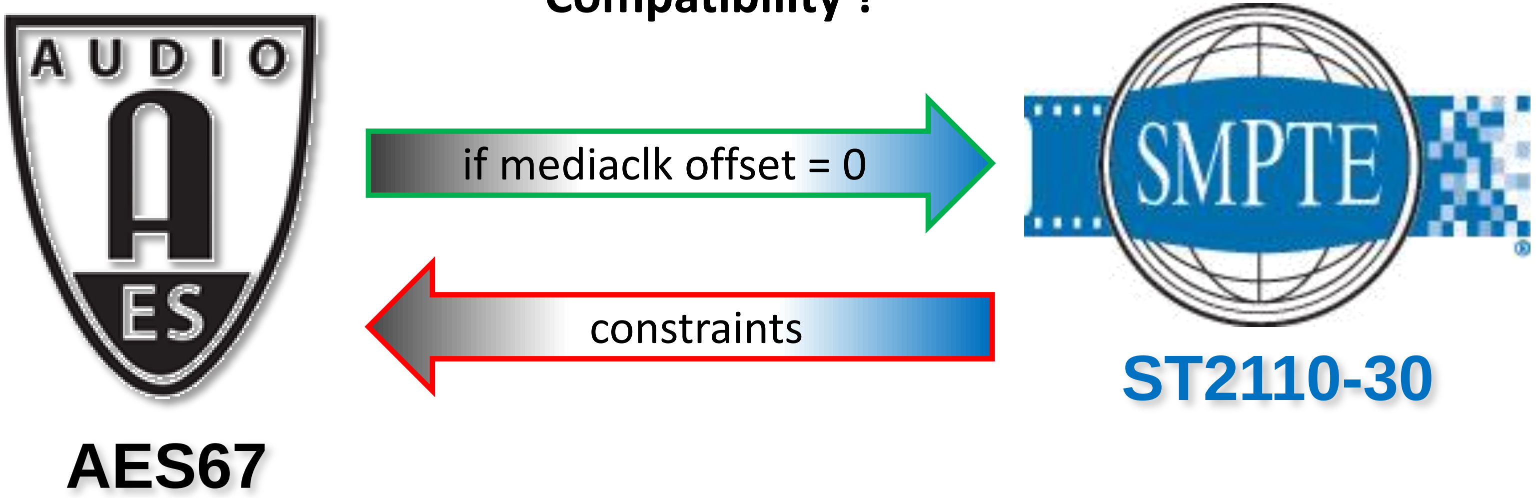
- 6 conformance levels:

96 kHz

Level	Supported by the Receiver
AX	Level A (⇨ 48 kHz) + Reception of 96 kHz streams with 1 to 4 audio channels at packet times of 1 ms
BX	Level B + AX + 1 to 8 channels at packet times of 125 µs
CX	Level C + AX + 1 to 32 channels at packet times of 125 µs

SMPTE 2110 - Professional Media over Managed IP Networks

Compatibility ?



SMPTE 2110 - Professional Media over Managed IP Networks

2110-31 – transparent transport of AES3 audio data

- Builds on RAVENNA's AM824 (IEC 61883-6) payload definition:
  - retains AES67 definitions for synchronization and RTP usage
  - uses 3 bytes for PCM24 + 1 byte for AES3 meta data

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0|0|B|F|  PCUV |                     DATA24                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

  - RTP payload format signaled in SDP:

```
a=rtpmap:<pt> AM824/48000/<nchan>
```

  - retains all other SDP parms

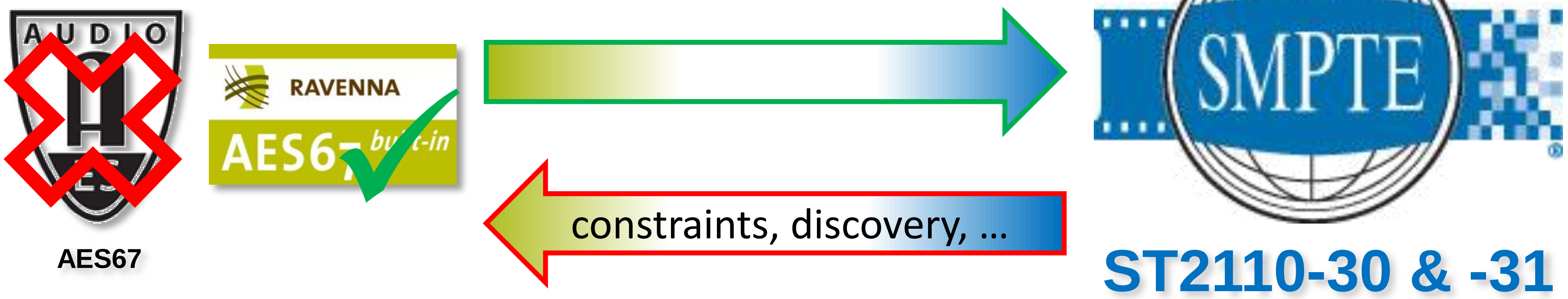
SMPTE 2110 - Professional Media over Managed IP Networks

2110-31 – transparent transport of AES3 audio data

- Can transport any format which can be encapsulated in AES3
  - L24 PCM w/ AES3 subframe meta data (PCUV bits)
  - non-PCM audio and data formats as defined by SMPTE ST 337 / 338 (i.e. Dolby®E etc.)

SMPTE 2110 - Professional Media over Managed IP Networks

Compatibility ?



Control Protocols

JT-NM ROADMAP

of networked media open interoperability

AMWA

EBU

SMPTE

VSF

VIDEO SERVICES FORUM

JT-NM Roadmap

IV. DEMATERIALIZED FACILITIES

CLOUD FIT
Open, secure, public/private cloud solutions

NON MEDIA-SPECIFIC IT
Self-service open APIs suitable for virtualization

III. AUTO-PROVISIONING

Automated resource management for more flexible and sharable infrastructure at scale

II. ELEMENTARY FLOWS

ST2110

More flexible and efficient workflows
New formats supported like UHD and mezzanine compression

I. SDI OVER IP

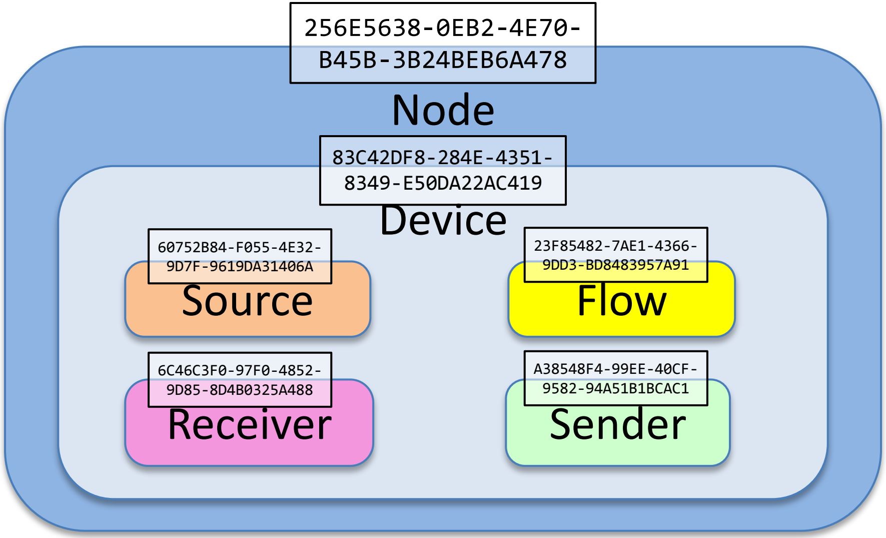
ST2022-6

CURRENT AND MATURE TECHNOLOGY

0. CURRENT SDI

Key elements

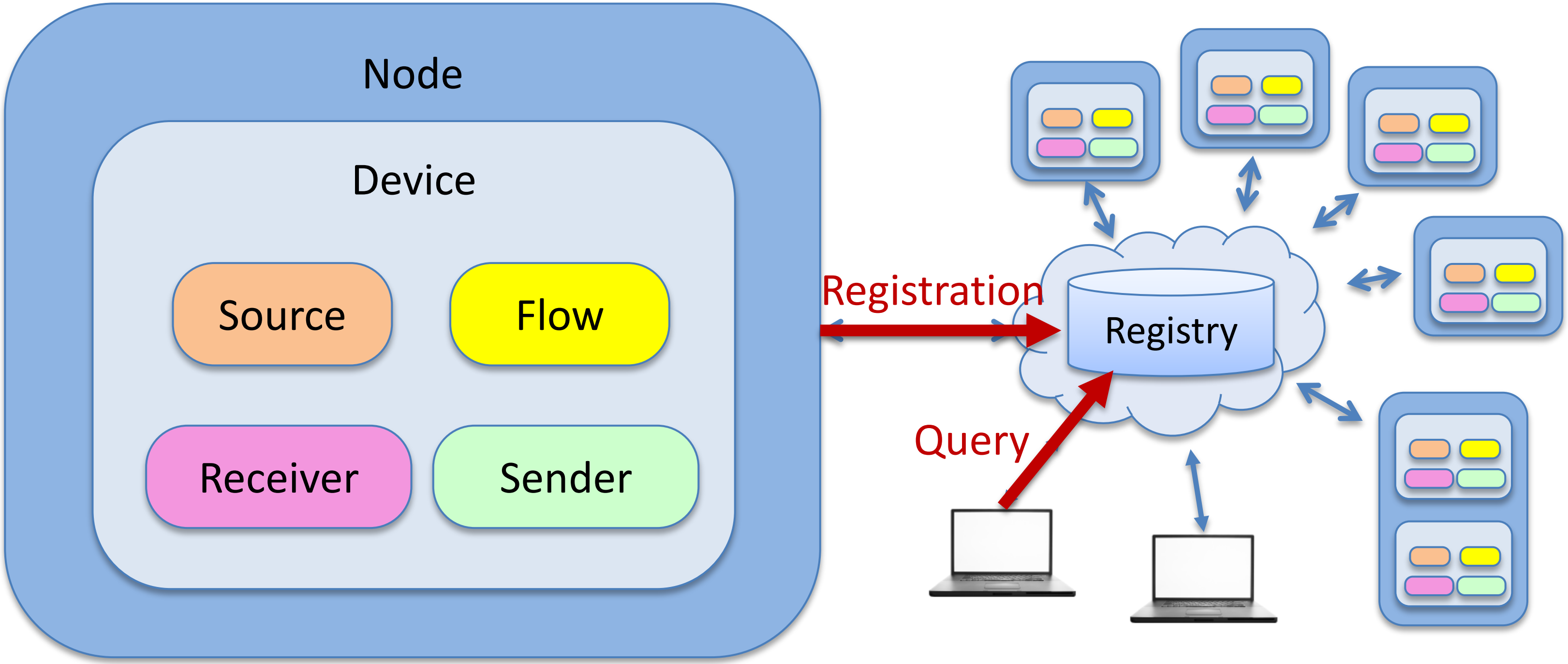
Identity


256E5638-0EB2-4E70-B45B-3B24BEB6A478
Node
83C42DF8-284E-4351-8349-E50DA22AC419
Device
60752B84-F055-4E32-9D7F-9619DA31406A
Source
23F85482-7AE1-4366-9DD3-BD8483957A91
Flow
6C46C3F0-97F0-4852-9D85-8D4B0325A488
Receiver
A38548F4-99EE-40CF-9582-94A51B1BCAC1
Sender

Discovery & Registration

IS-04

Ensure parts of a networked media system can find each other

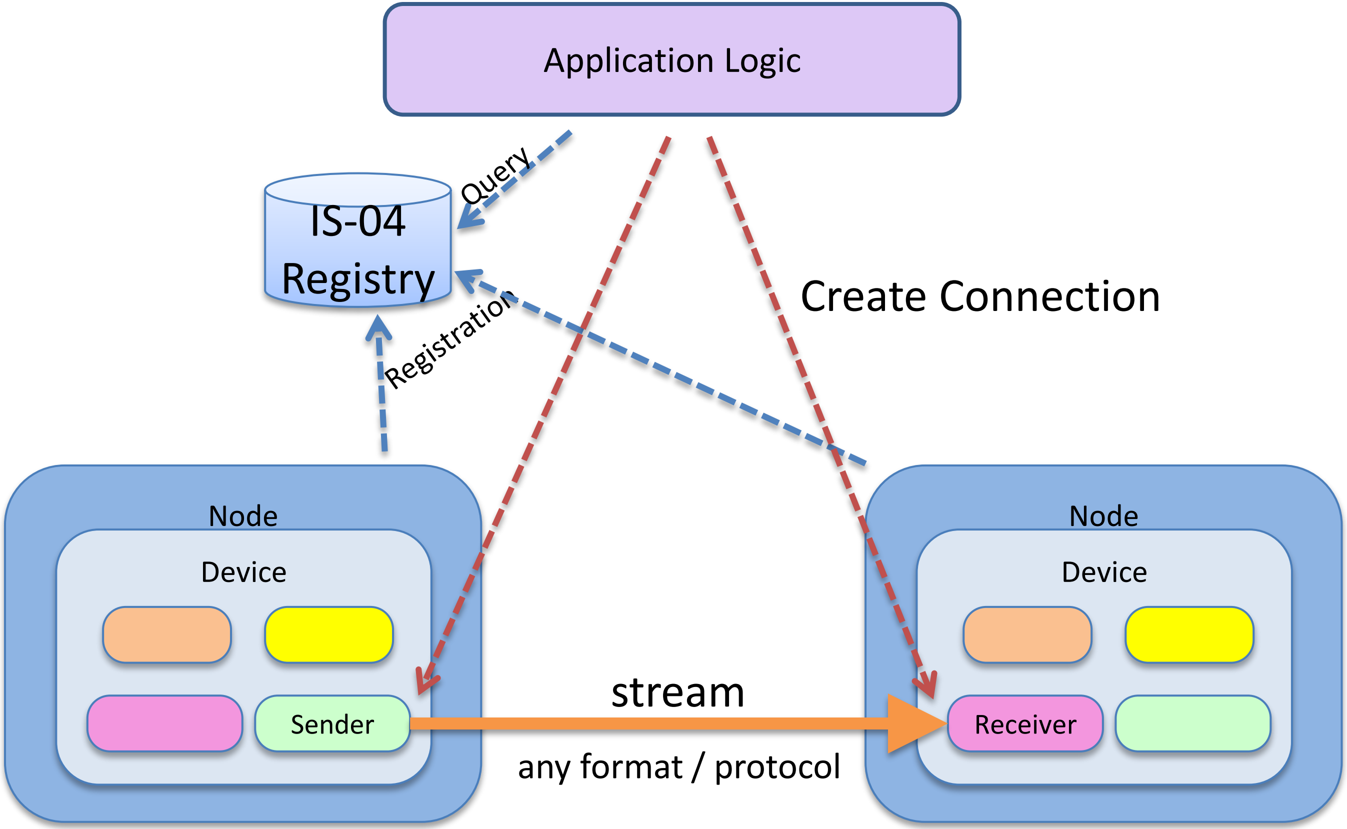


Node
Device
Source
Flow
Receiver
Sender
Registration
Registry
Query

Connection management

IS-05

Make it simple for applications to (dis)connect devices


Application Logic
Query
IS-04
Registry
Registration
Create Connection
Node
Device
Sender
stream
any format / protocol
Node
Device
Receiver

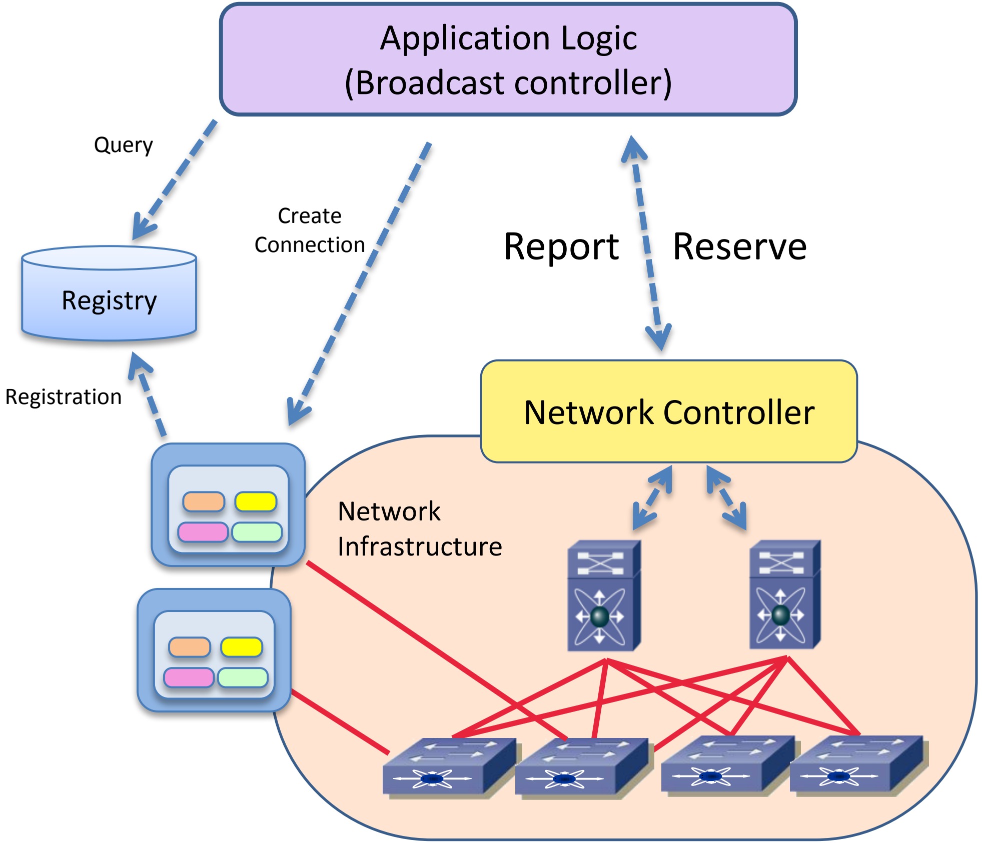
Network Control

IS-06

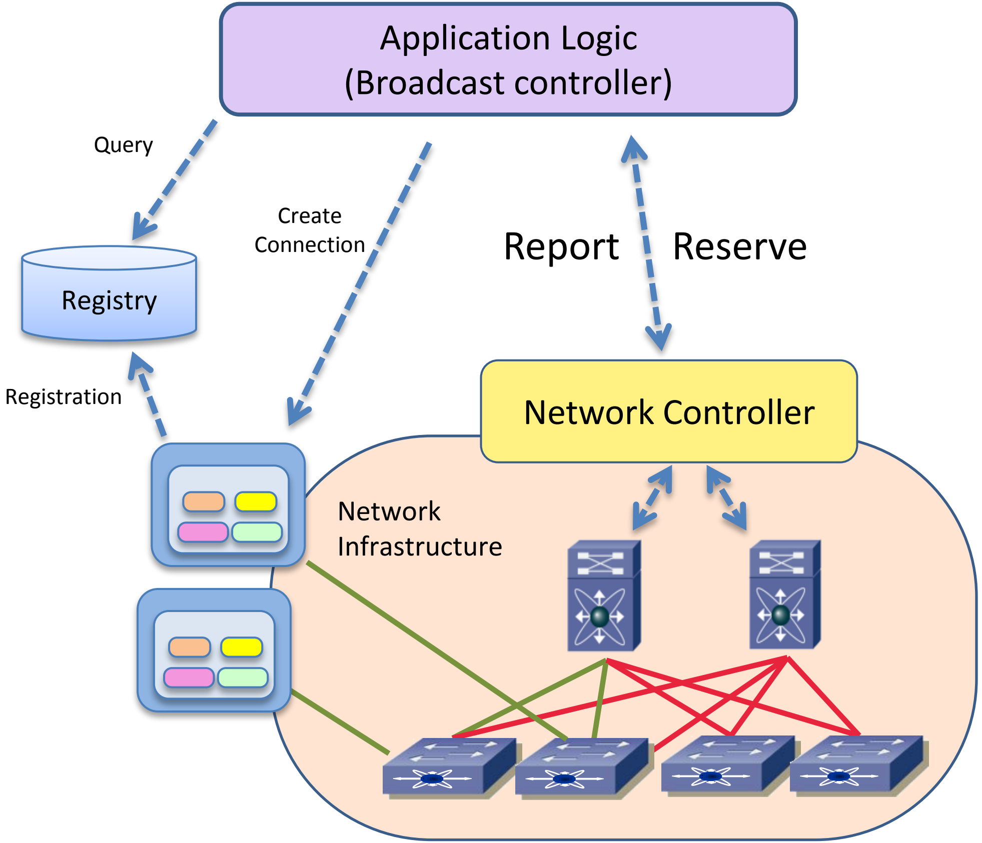
(on-going work)

Reserve and manage low-level network flows

Overview on IP Audio Networking



Overview on IP Audio Networking



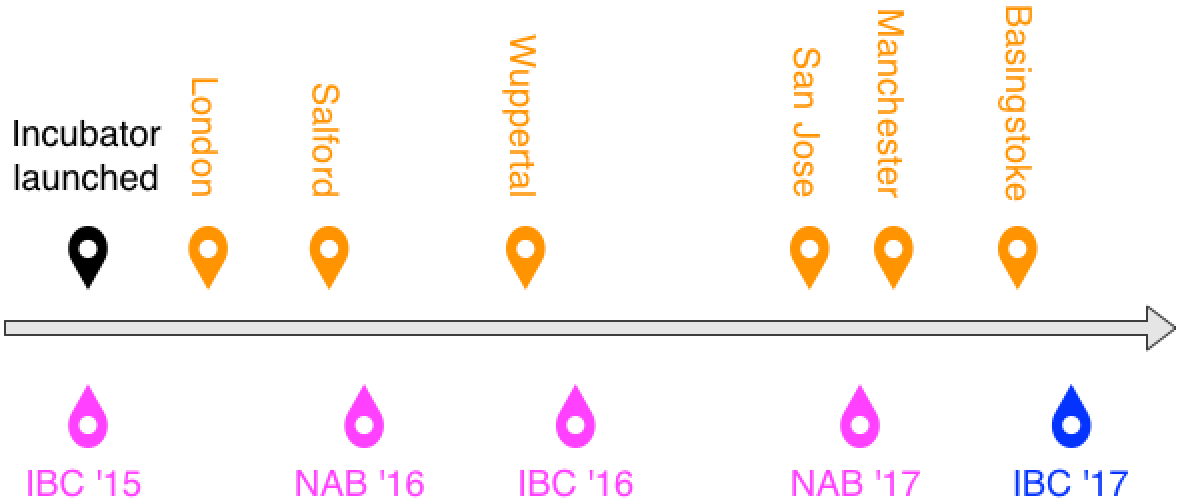
Implementations

Networked Media Incubator

Overview on IP Audio Networking







Incubator launched
London
Salford
Wuppertal
San Jose
Manchester
Basingstoke
IBC '15
NAB '16
IBC '16
NAB '17
IBC '17

networked media NMOS open specifications

Workshop participants

Aperi
Arista
Atos
Avid
Axon Digital Design
Barco Silex
BBC
Bosch
Calrec Audio
CBC Radio-Canada
Cisco
Coveloz
Dalet
dB Broadcast

DirectOut
EBU
Embrionix Design
Ericsson
Evertz
Fox
Glitch Digital
Grass Valley
Harmonic
Imagine Communications
IML
Juniper Networks
KBS
LAWO/ALC NetworX

Macnica
Matrox
Mellanox Technologies
MOG
Nevion
Nextera Video
NHK
Origami Tech
Panasonic
PBS
Riedel
Ross Video
RTI

Snell Advanced Media
Sohonet
Sony
STORDIS
Streampunk Media
Suitcase TV
Tedial
Tektronix
Telestream
Telos Alliance
Telstra
Xytech
Yamaha (Music)

networked media NMOS open specifications

IP SHOWCASE
REAL TIME MEDIA

IP Showcase with ST2110 / AES67 / NMOS IS-04 & IS-05 (IBC 2017)

Overview on IP Audio Networking

networked media NMOS open specifications

JT-NM ROADMAP

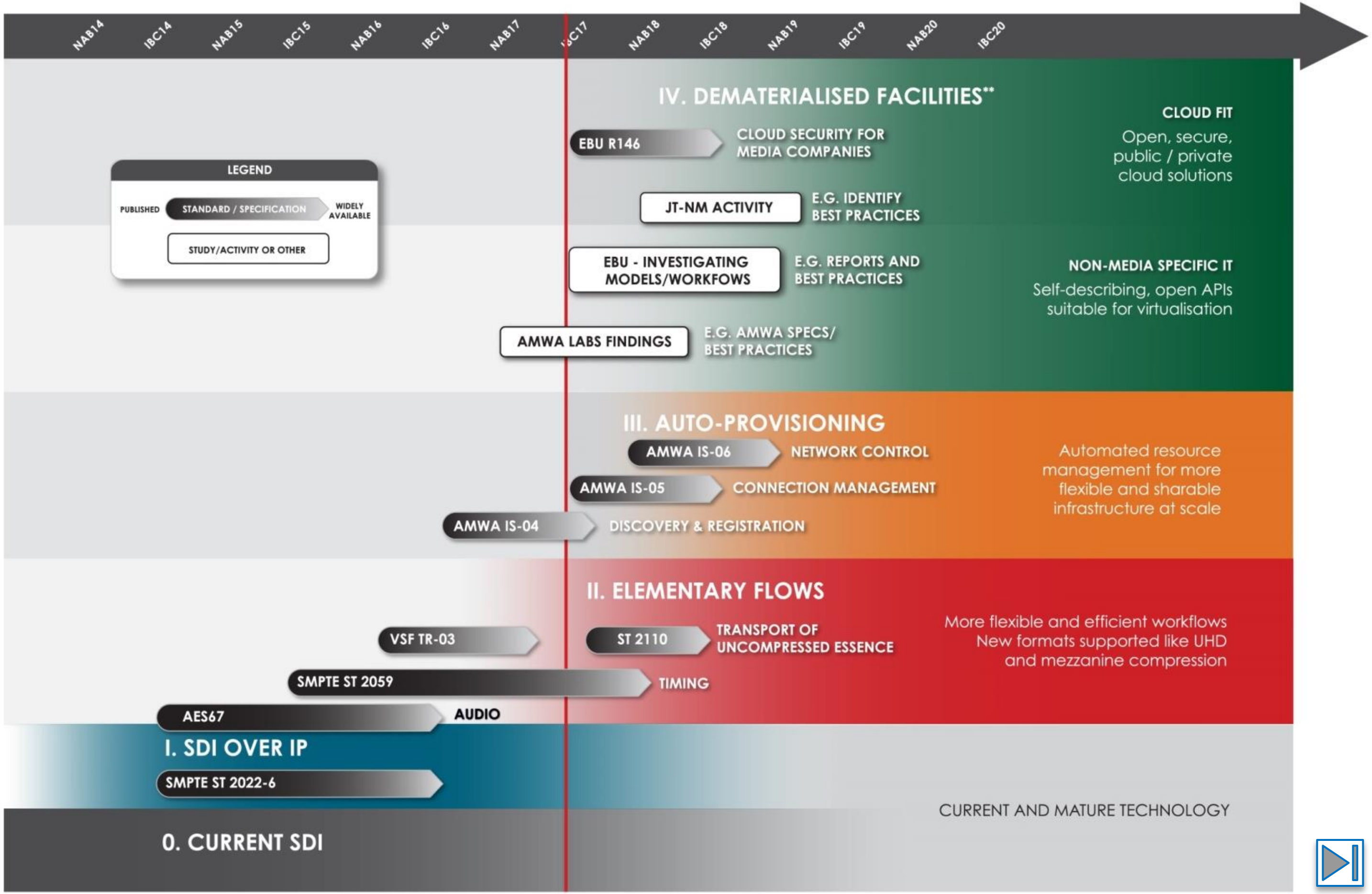
of networked media open interoperability*

AMWA

EBU

SMPTE

VSF VIDEO SERVICES FORUM

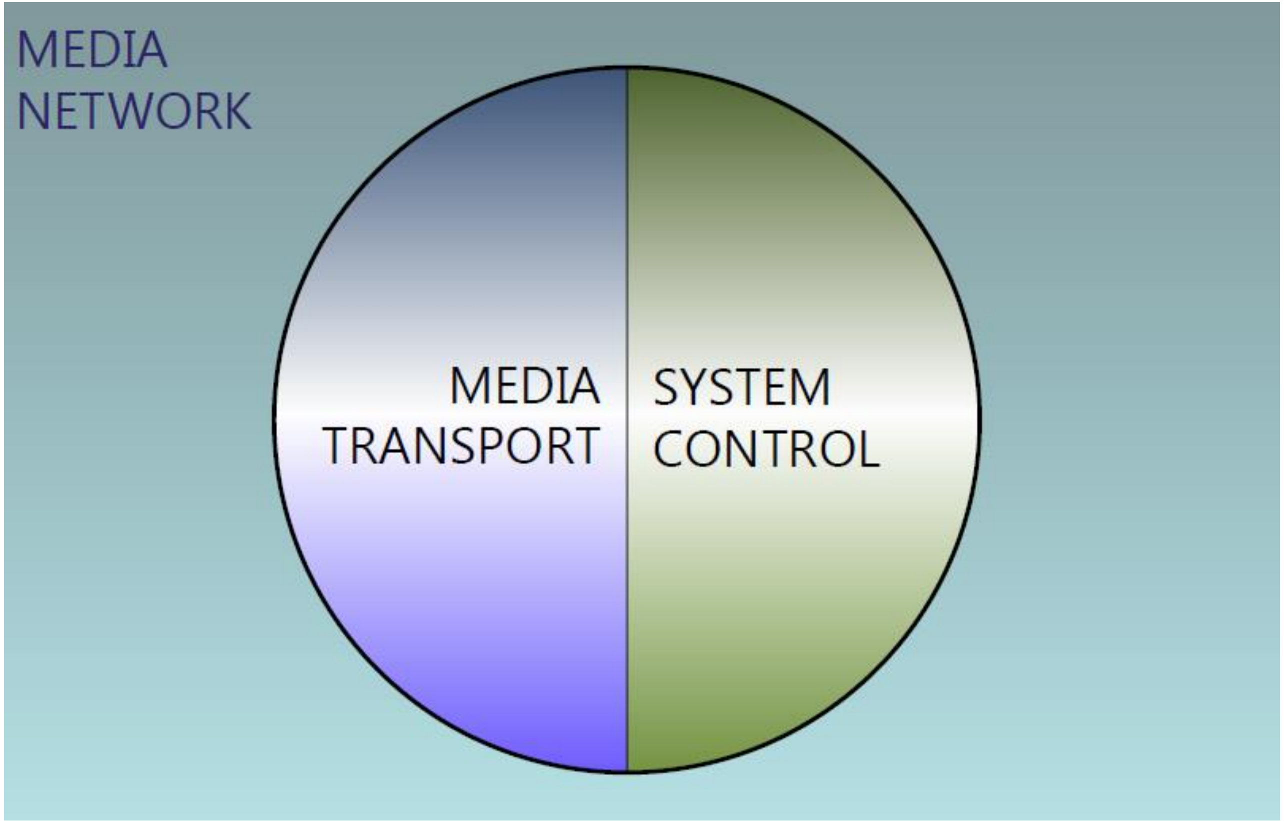


**Additional information on Dematerialised Facilities at jt-nm.org. * JT-NM assumption as of August 2017 and will evolve over time. Visit JT-NM.org for the latest update. Feedback to jt-nm-info@videoservicesforum.org

Device & system control

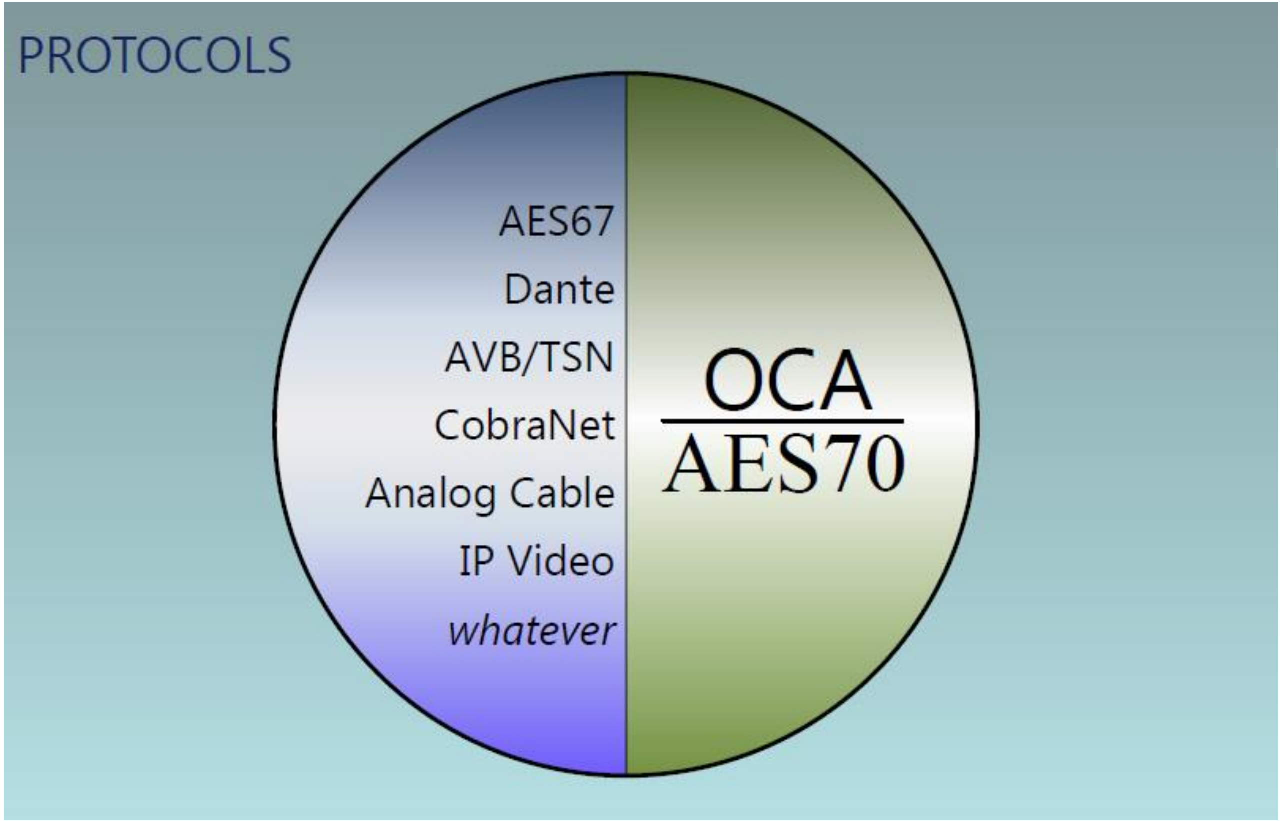
"control protocols"

Overview on IP Audio Networking

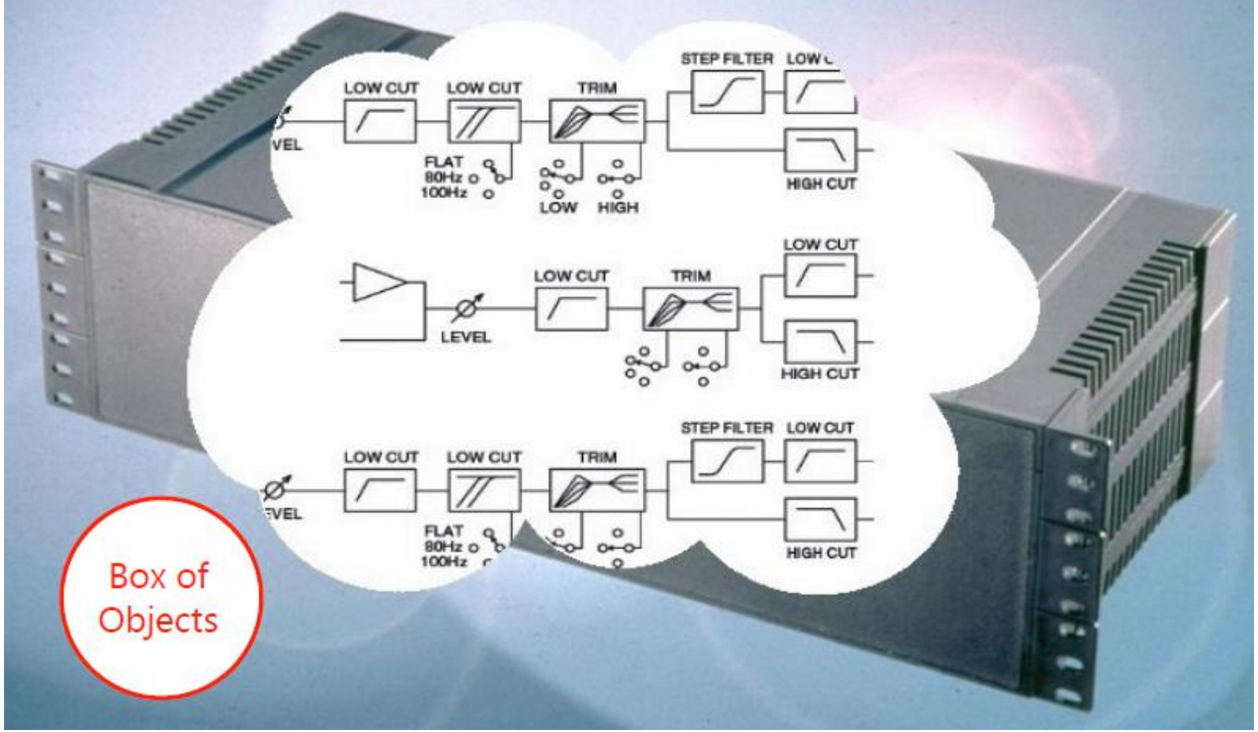


OCA AES70

OPEN CONTROL ARCHITECTURE


PROTOCOLS
AES67
Dante
AVB/TSN
CobraNet
Analog Cable
IP Video
whatever
OCA
AES70

AES70 Device Model



AES70-2015 Control Repertoire

Media Connection Management
- Connection control
- Directory/discovery

Additional Functions
- Control grouping (~VCA groups)
- Crossfading
- Snapshot & preset mangement
- Reconfigurable DSP device setup
- Reliable firmware updating

Signal Monitoring
- Level sensors (meters)
- Frequency sensors
- Time interval sensors
- Temperature sensors
- Aribtrary numeric sensors

Signal Processing
- Gain controls
- Mutes
- Switches (n-position)
- Delays
- Equalizers
- Filters (IIR & FIR)
- Limiters & Compressors
- Expanders & Gates
- Levelers
- Matrices
- Signal generators
- Arbitrary numeric and text parameters

+ *Proprietary extensions as needed*

Other (competing) control protocols:

- AES24 (abandoned)
- AES42 (digital microphone control)
- AES64 (no adoption)
- ST2071 (very complex)
- P1722.1 (AVB-related)
- OSC (MI), DMX (live show control), …
- myriads of proprietary protocols (Dante, Livewire, QSC, Crestron, AMX, HiQnet, …)
- EmBer+ (open technology, many adopters incl. Lawo)
- NMOS IS-0x ?

Thank you for your attention!

Contact information:

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www.ravenna-network.com