AES67-101: The Basics of AES67

WARD-BECK SYSTEMS

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TorontoAES.org
Vice-Chair

Ward-Beck.Systems - Audio Domains

DB25.audio

PANELS.audio

XLR.audio

PREAMPS.audio

FILTERING.audio

PATCHING.audio

MUTING.audio

VUMETERS.audio

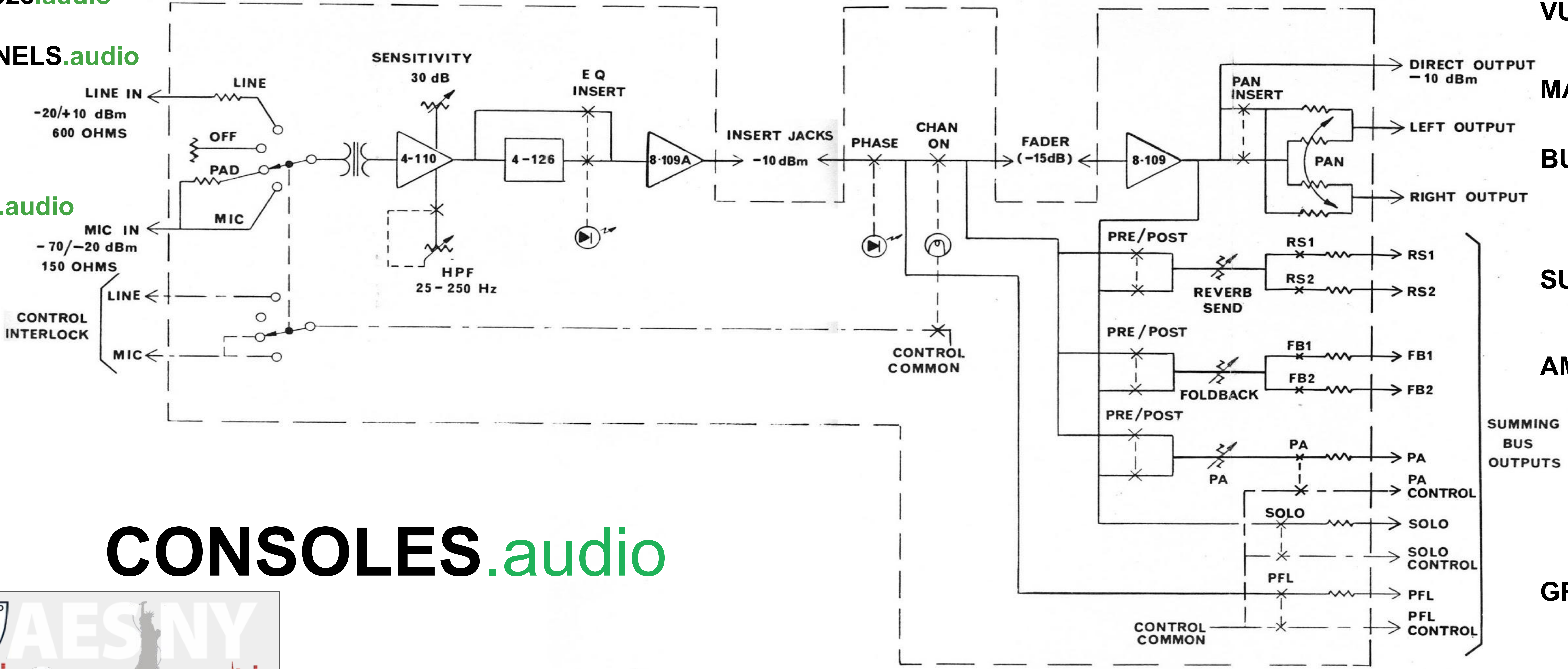
MATRIXING.audio

BUSSING.audio

SUMMING.audio

AMPLIFY.audio

GROUNDING.audio



CONSOLES.audio

AUDIO AES NY Connect 1948 2018

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The least you SHOULD know about networking:

The physical datalink networks transported sessions presented by the application

AES67.audio
2110-30.AES67.audio

TX DATA

7 - Application
6 - Presentation
5 - Session
4 - Transport
3 - Network
2 - Data Link
1 - Physical

RX DATA

PATCHING.audio
MATRIXING.audio
BUSSING.audio

ROUTING.audio
SWITCHING.audio
MULTICASTING.audio

IGMP.audio
CLOCKING.audio

RJ45.audio

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The Road to Incompatibility…

	Dante	RAVENNA	QLAN	Livewire
Control & Monitoring	Proprietary	HTTP, Ember+	TCP, HTTP	HTTP, Proprietary
Discovery	Proprietary	Bonjour	Proprietary	Proprietary
Connection Management	Proprietary	RTSP, SIP, IGMP	Proprietary	Proprietary, HTTP, IGMP
Session Description	Proprietary	SDP	Proprietary	Channel #
Transport	Proprietary, IPv4	RTP, IPv4	RTP, IPv4	RTP, IPv4
Quality of Service	DiffServ	DiffServ	DiffServ	DiffServ/802.1pq
Encoding & Streaming	L16-32, ≤4 ch/flow	L16-32, ≤64 cha/str	32B-FP, ≤16 ch/str	L24, st, surr
Synchronization	PTP1588-2002	PTP1588-2008	PTP1588-2008	Proprietary
Media Clock	44.1kHz, 192kHz	44.1kHz - 384kHz	48kHz	48kHz

AES67

AUDIO ES STANDARDS

AES67-2013 Standard for audio applications of networks: High-performance streaming audio-over-IP interoperability

AES NY Connect 1948 2018

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AES67-2018 Standard for audio applications of networks: High-performance streaming a udio-over-IP interoperability

References

Audio Engineering Society, New York, NY., US.

AES11 - AES recommended practice for digital audio engineering
Synchronization of digital audio equipment in studio operations

Institute of Electrical and Electronics Engineers (IEEE)

IEEE 1588-2008 - IEEE Standard for a Precision Clock Synchronization Protocol
for Networked Measurement and Control Systems, July 2008

Internet Engineering Task Force

RFC 768 – User Datagram Protocol”
RFC 791 – Internet Protocol
RFC 1112 – Host Extensions for IP Multicasting
RFC 2236 - Internet Group Management Protocol, Version 2
RFC 2474 – Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers
RFC 2616 - Hypertext Transfer Protocol - HTTP/1.1
RFC 2974 – Session Announcement Protocol
RFC 3190 – RTP Payload Format for 12-bit DAT Audio and 20- and 24-bit Linear Sampled Audio
RFC 3261 - SIP: Session Initiation Protocol
RFC 3264 - An Offer/Answer Model with the Session Description Protocol (SDP)
RFC 3376 - Internet Group Management Protocol, Version 3
RFC 3550 – RTP: A Transport Protocol for Real-Time Applications
RFC 3551 - RTP Profile for Audio and Video Conferences with Minimal Control
RFC 4566 – Session Description Protocol
RFC 5939 – Session Description Protocol (SDP) Capability Negotiation
RFC 7273 – RTP Clock Source Signalling

AES67.audio DOMAINS:

AES67.audio	Layer	Domain
Device Control	Control & Monitoring	**AES70**.audio
	Discovery	**PATCHING**.audio
Connection Management	Connection Management	**MATRIXING**.audio
	Session Description	**SWITCHING**.audio
Transport	Transport	**IGMP**.audio
	Quality of Service	**MULTICASTING**.audio
	Encoding & Streaming	**ROUTING**.audio
Timing	Synchronization	**CLOCKING**.audio
	Media Clock	

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AES Standards

AES 3 - Serial Digital Audio

AES 10 - Serial Multichannel Audio Digital Interface (sMADI)

AES 14 - XLR-type polarity and gender

AES 59 - 25 pin D-Sub connector

AES67 - High-performance streaming audio-over-IP

AES70 - Audio applications of networks - Open Control Architecture

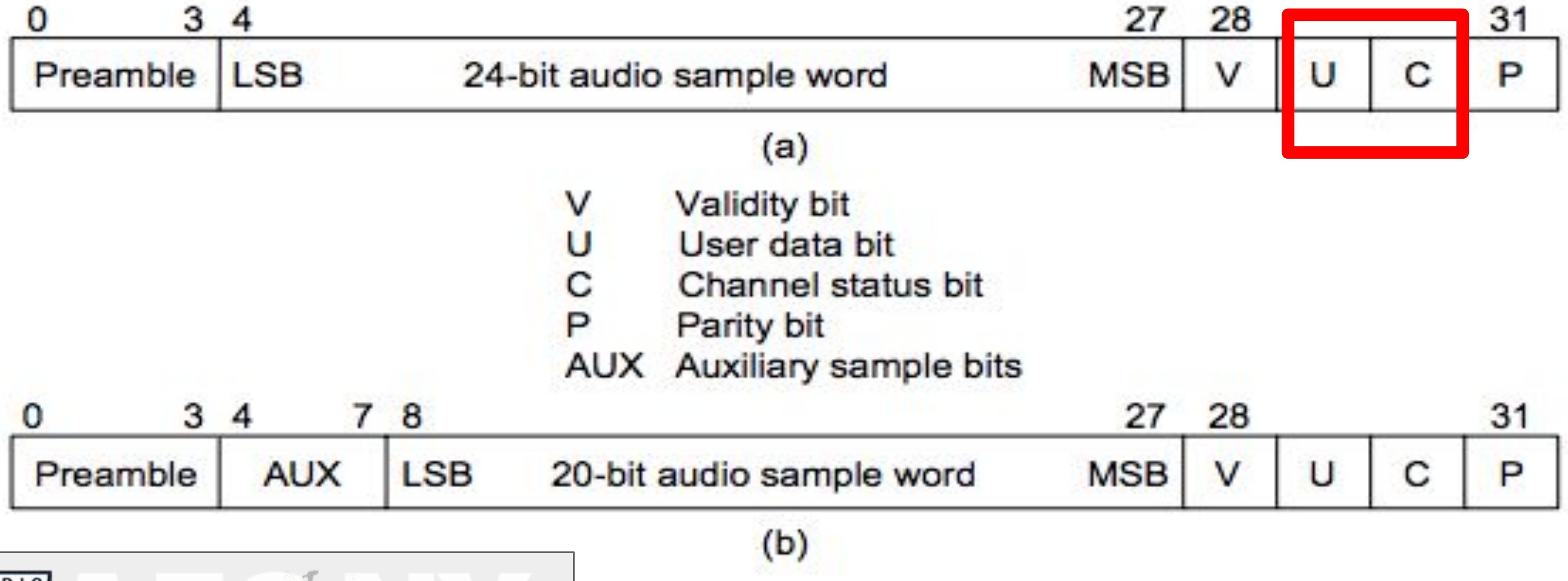
AES3-2003

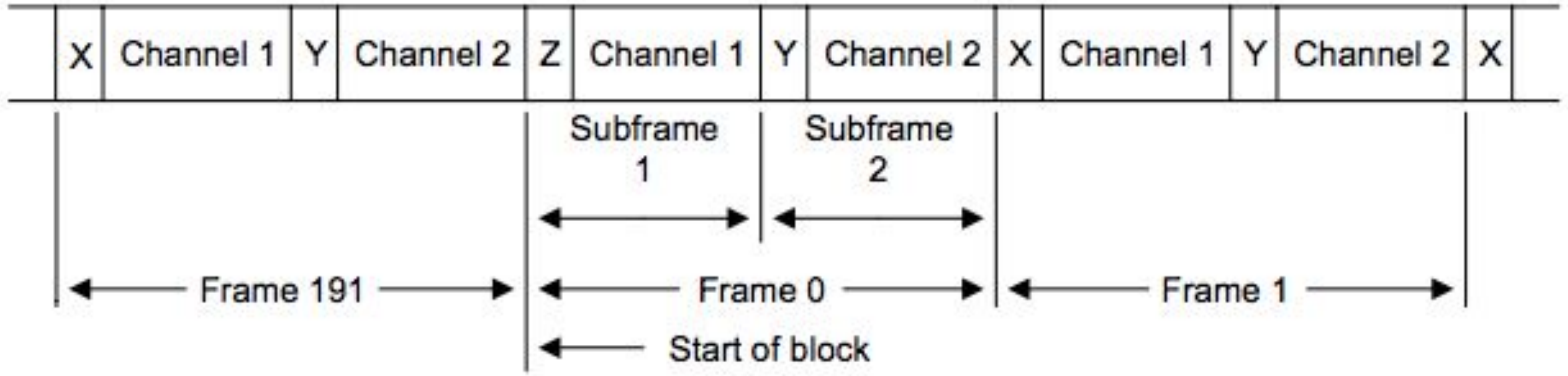
Revision of AES3-1992

AES3-1992

REVISED

AES standard for digital audio — Digital input-output interfacing — Serial transmission format for two-channel linearly represented digital audio data





AES 10 - MADI

AES Recommended Practice for Digital Audio Engineering — Serial Multichannel Audio Digital Interface (MADI)

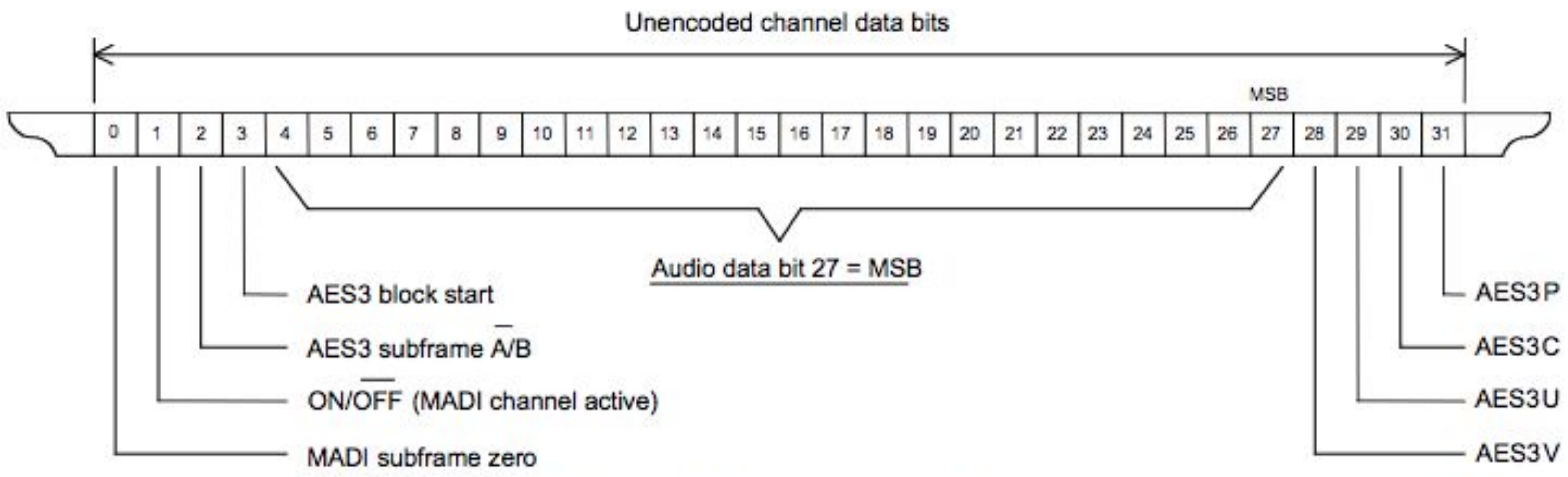


Figure 5 - Channel data format

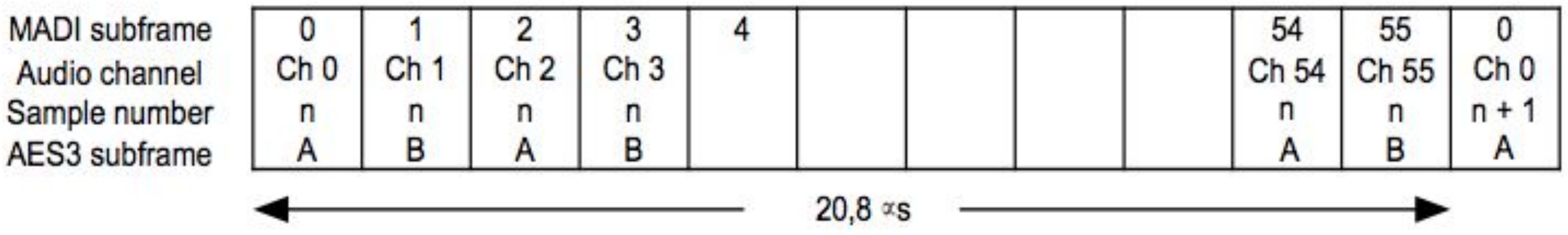
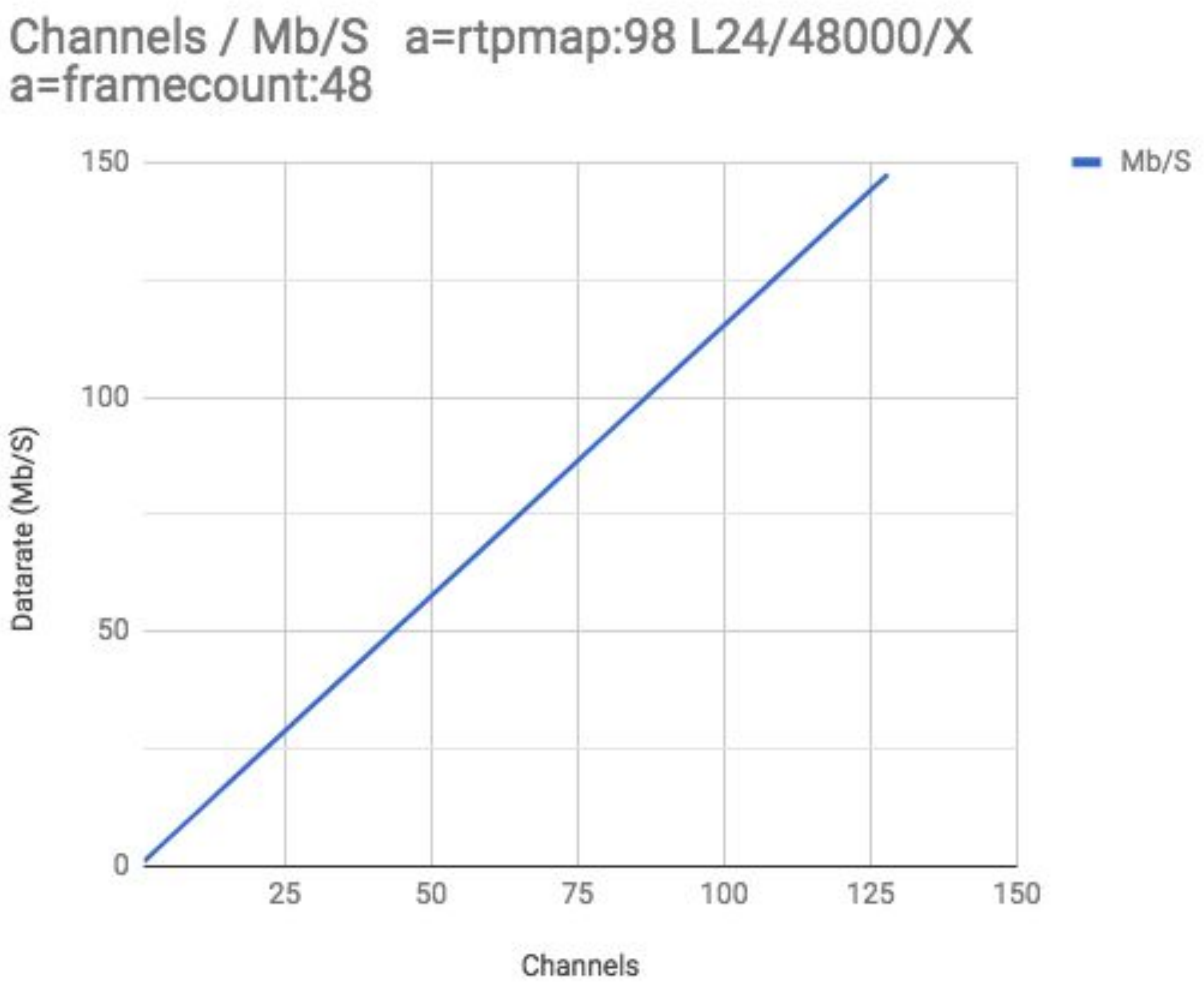
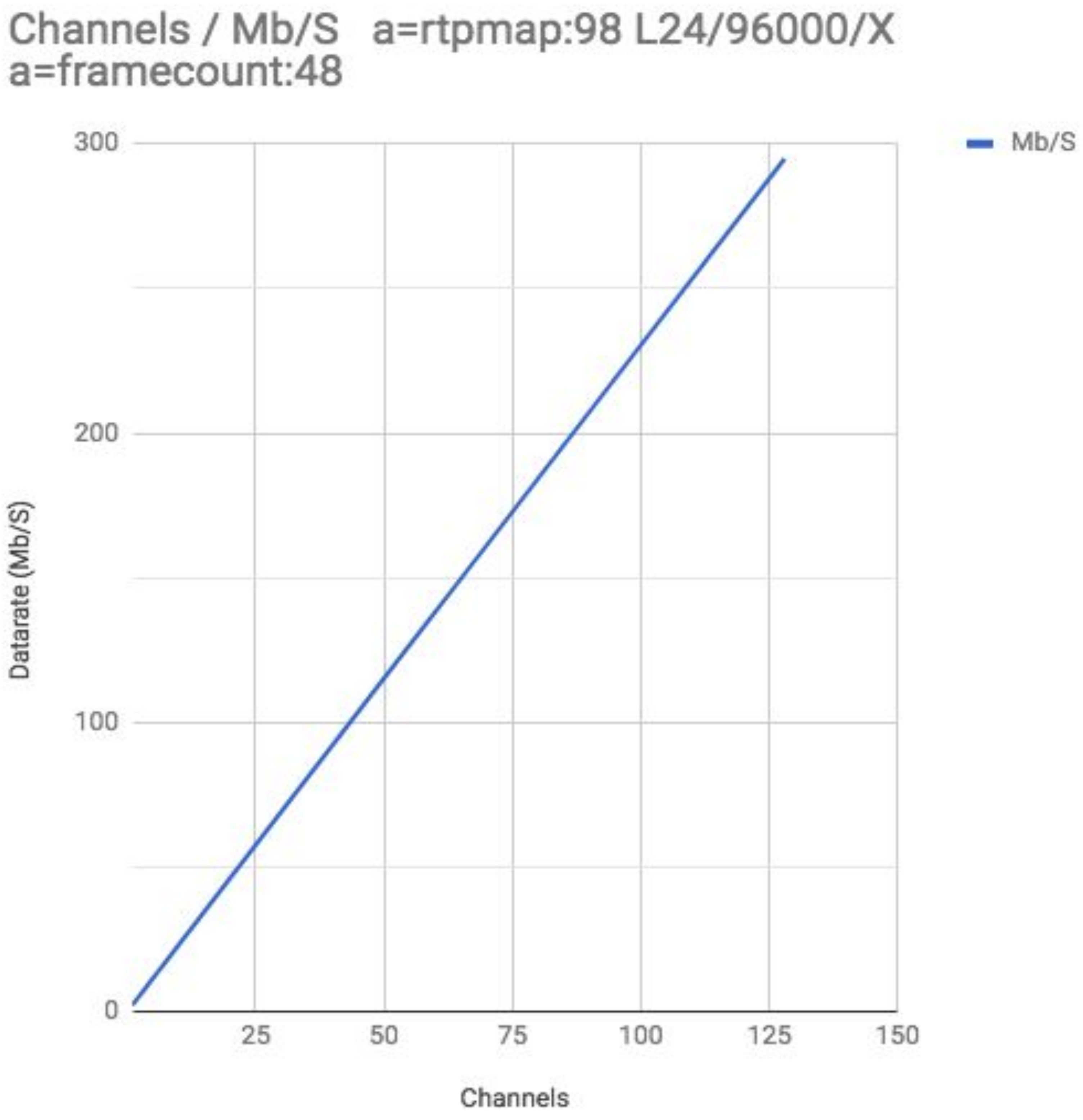


Figure 2 - 48 kHz with 56 channels working

Data Rates

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- **Encoding & Streaming**
- Synchronization
- Media Clock





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RTP Packets - Required and recommended Packet Times

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

EXACT Packet time	**Packet samples (48 kHz)**	**Packet samples (96 kHz)**	**Packet samples (44,1 kHz)**
⅛ millisecond “125 microseconds”	6	12	6
¼ millisecond “250 microseconds”	12	24	12
“333 microseconds”	16	32	16
“1 millisecond”	**48**	**96**	**48**
“4 milliseconds”	192	n.a.	192

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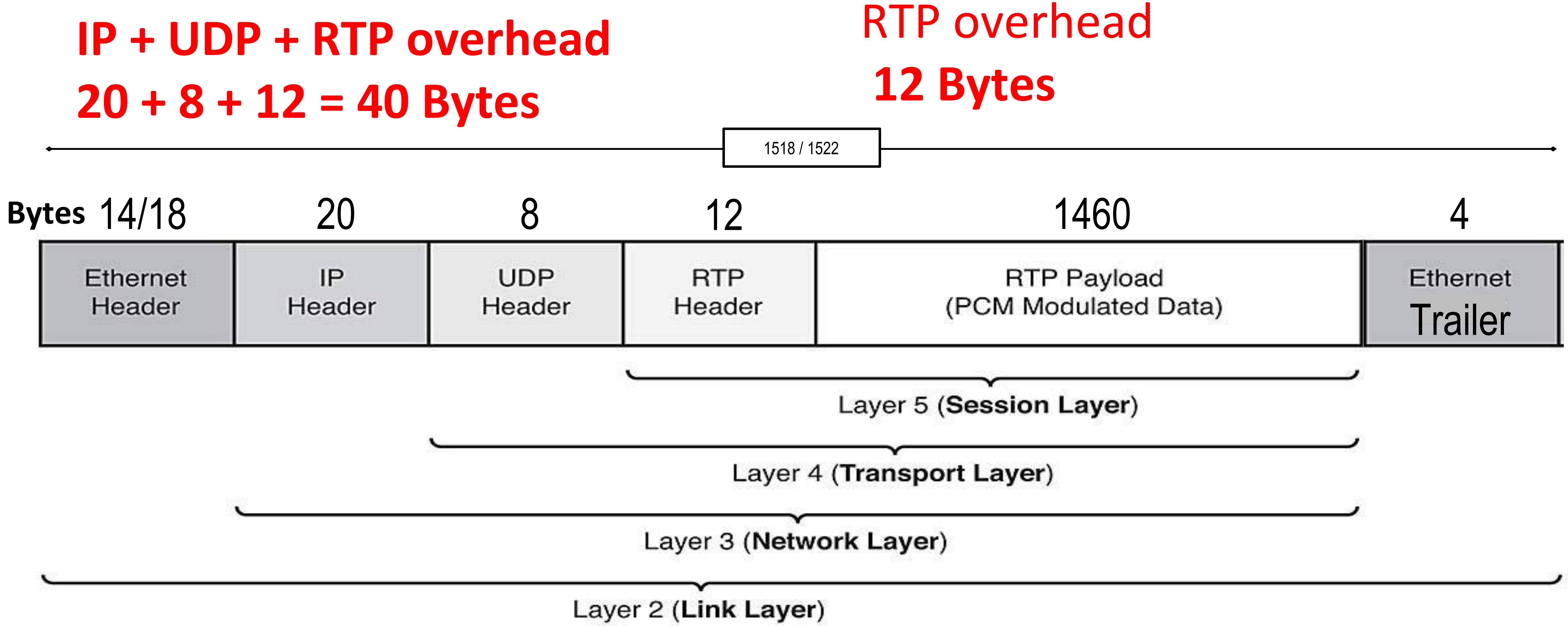
Layered Packet Encapsulation



MTU (maximum transmission unit, largest size of a packet that can be transmitted without being split) 1500 Bytes in an IP/Ethernet LAN: in principle **0 to 1460 bytes** available for RTP **payload** data per packet

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RTP Packets - Required and recommended packet times

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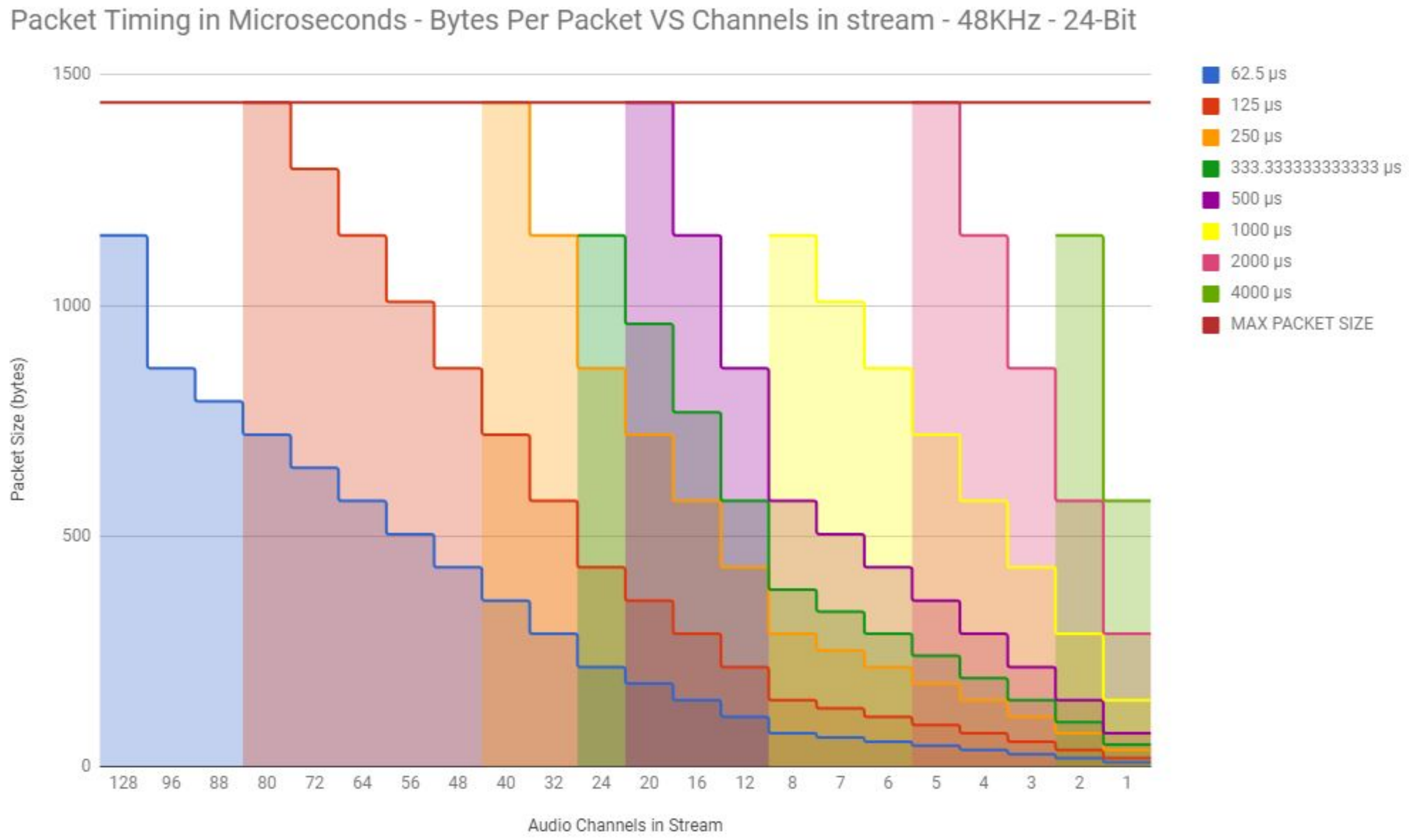
- Media Clock



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RTP Packets - Required and recommended Packet Times

Control & Monitoring

Discovery

Connection Management

Session Description

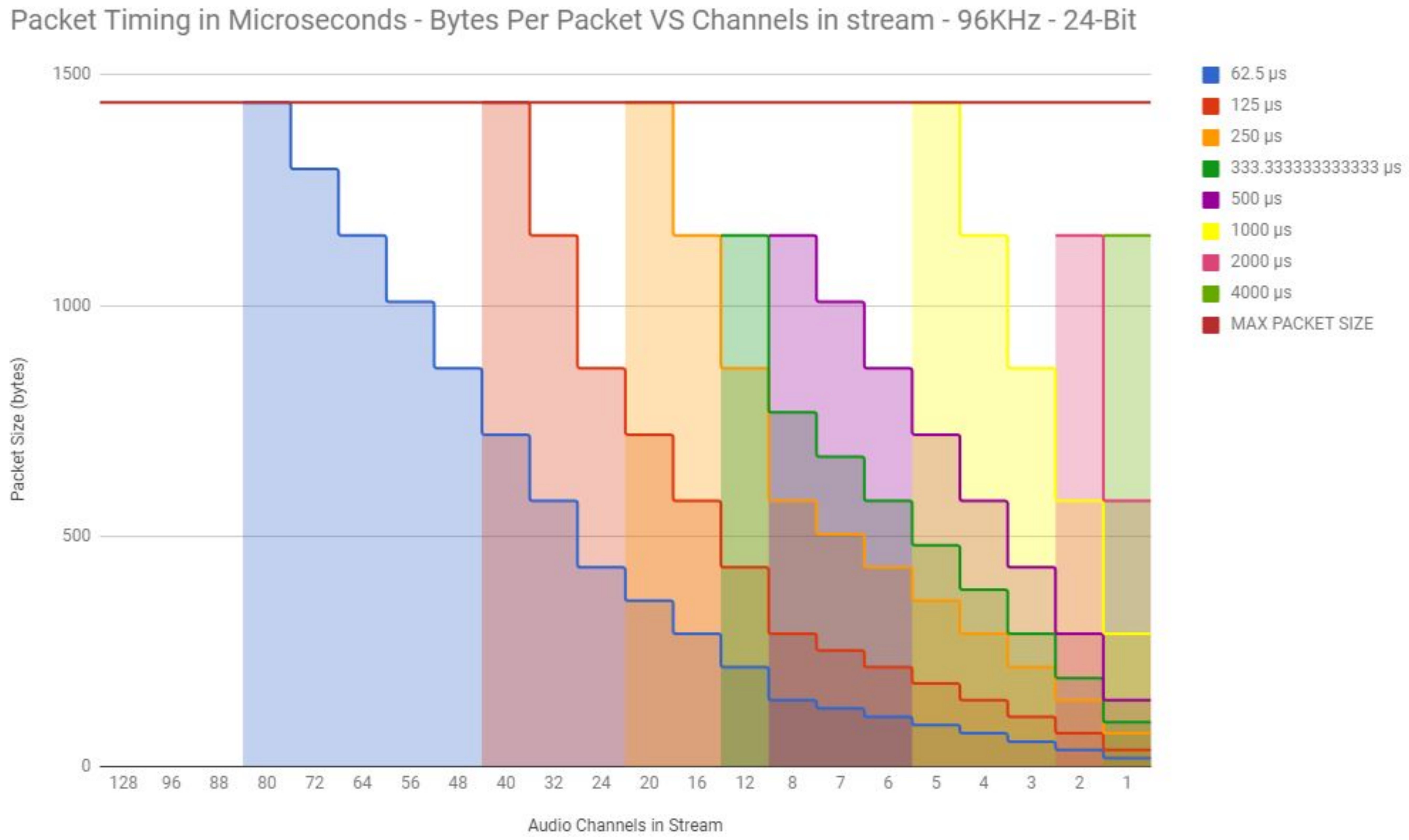
Transport

Quality of Service

Encoding & Streaming

Synchronization

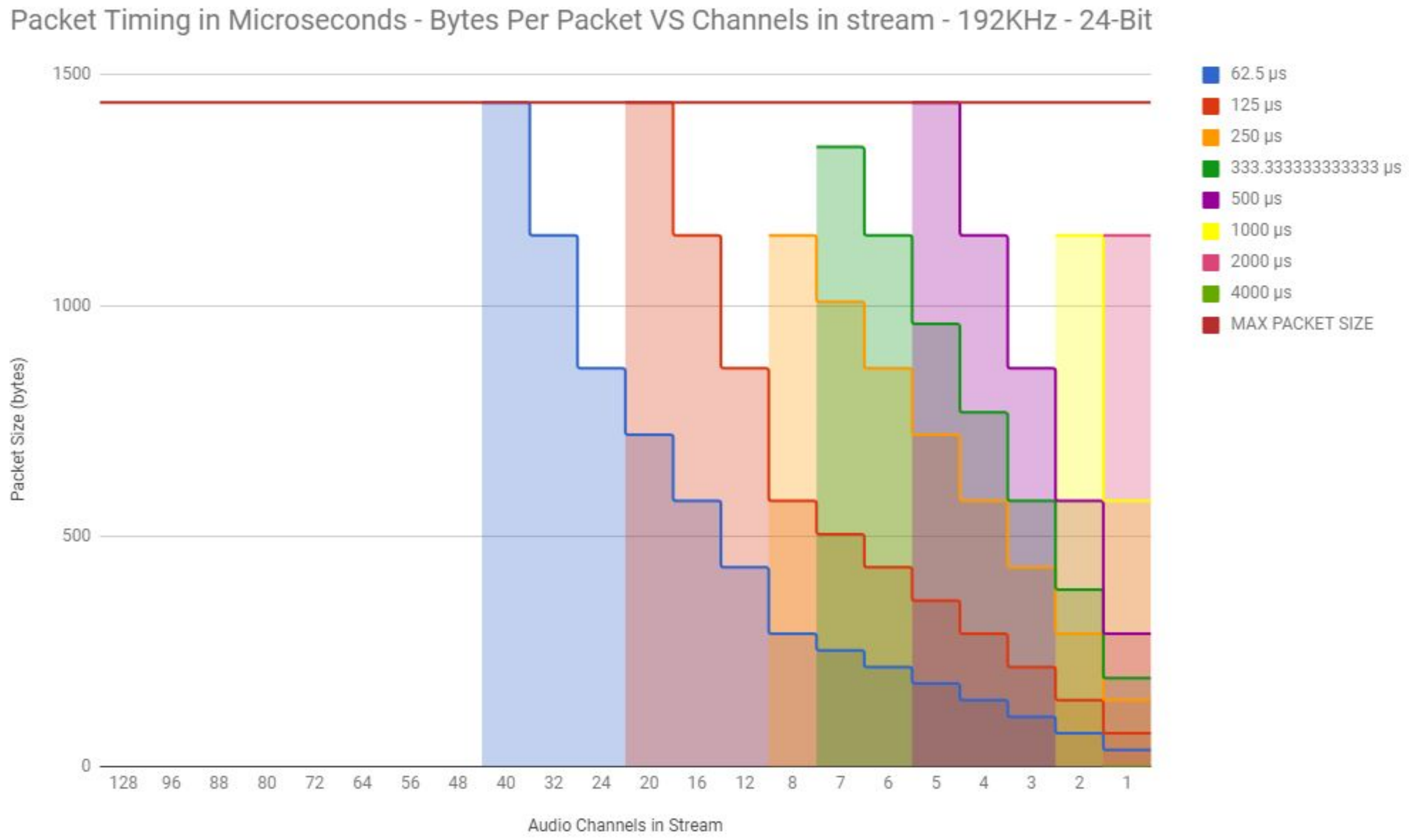
Media Clock



SMPTE Toronto Section – Toronto Technical Conference (TTC) 2018

RTP Packets - Required and recommended Packet Times

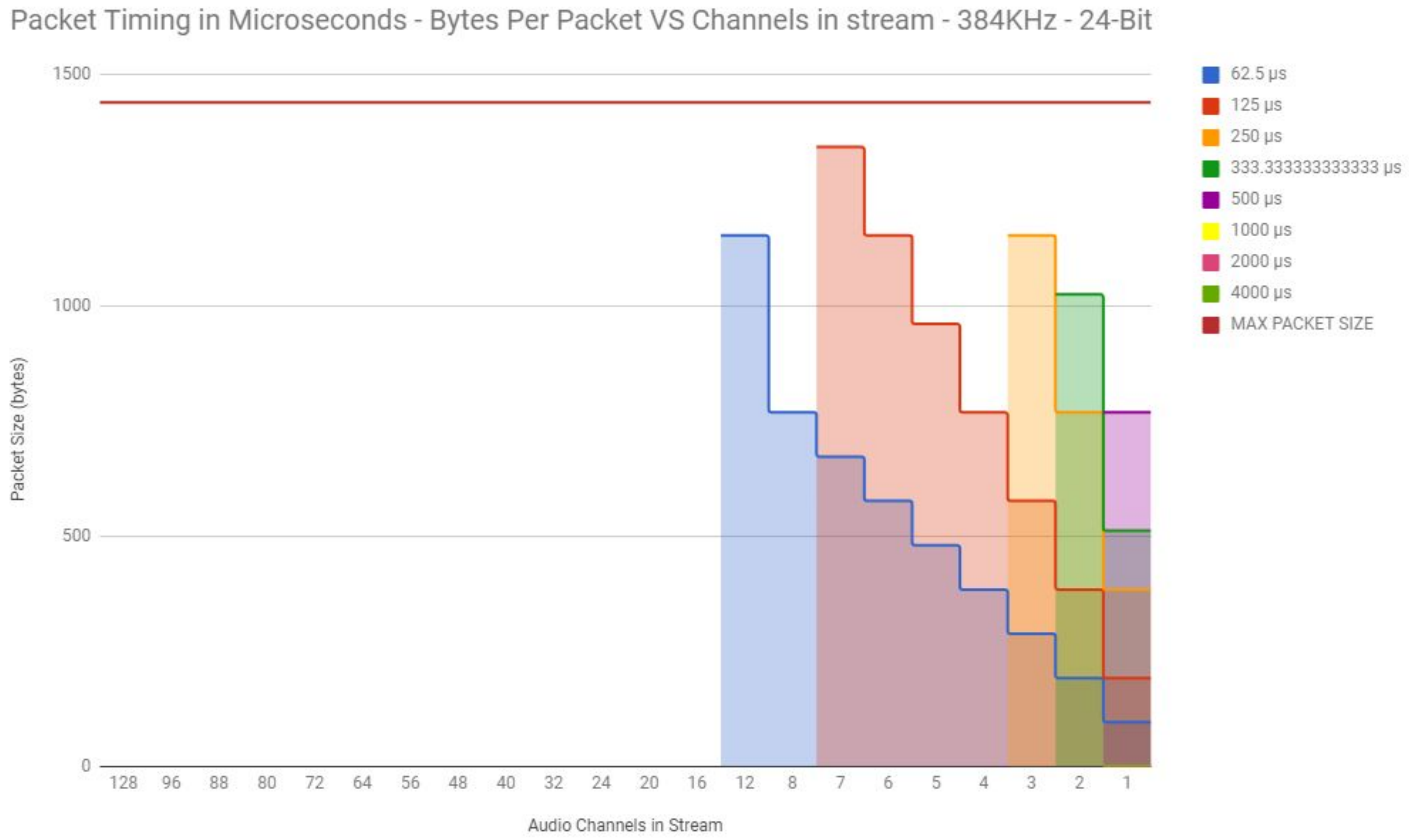
- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- **Encoding & Streaming**
- Synchronization
- Media Clock



WARD-BECK SYSTEMS

RTP Packets - Required and recommended Packet Times

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- **Encoding & Streaming**
- Synchronization
- Media Clock



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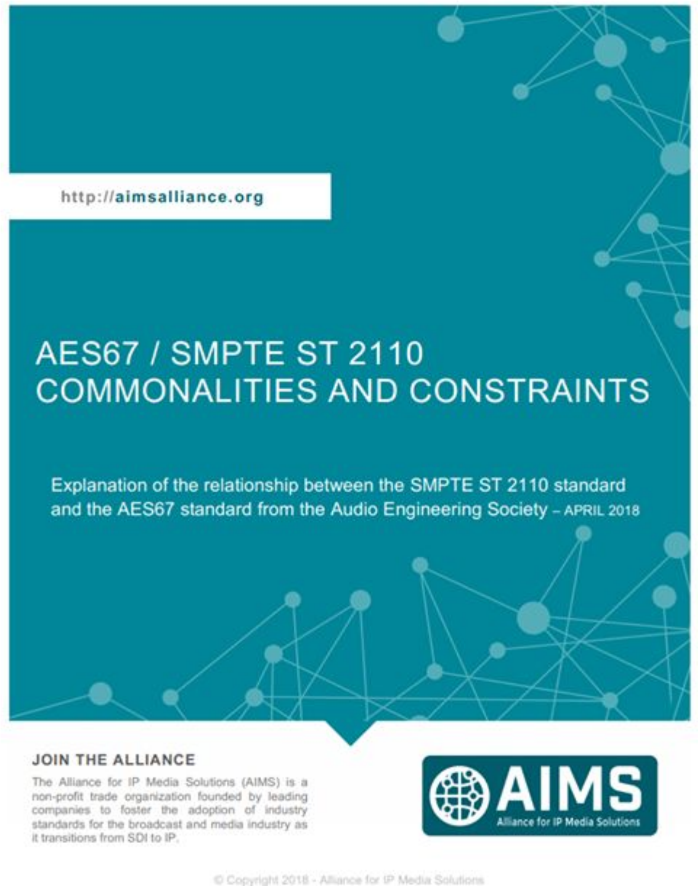
2110-30


http://aimsalliance.org

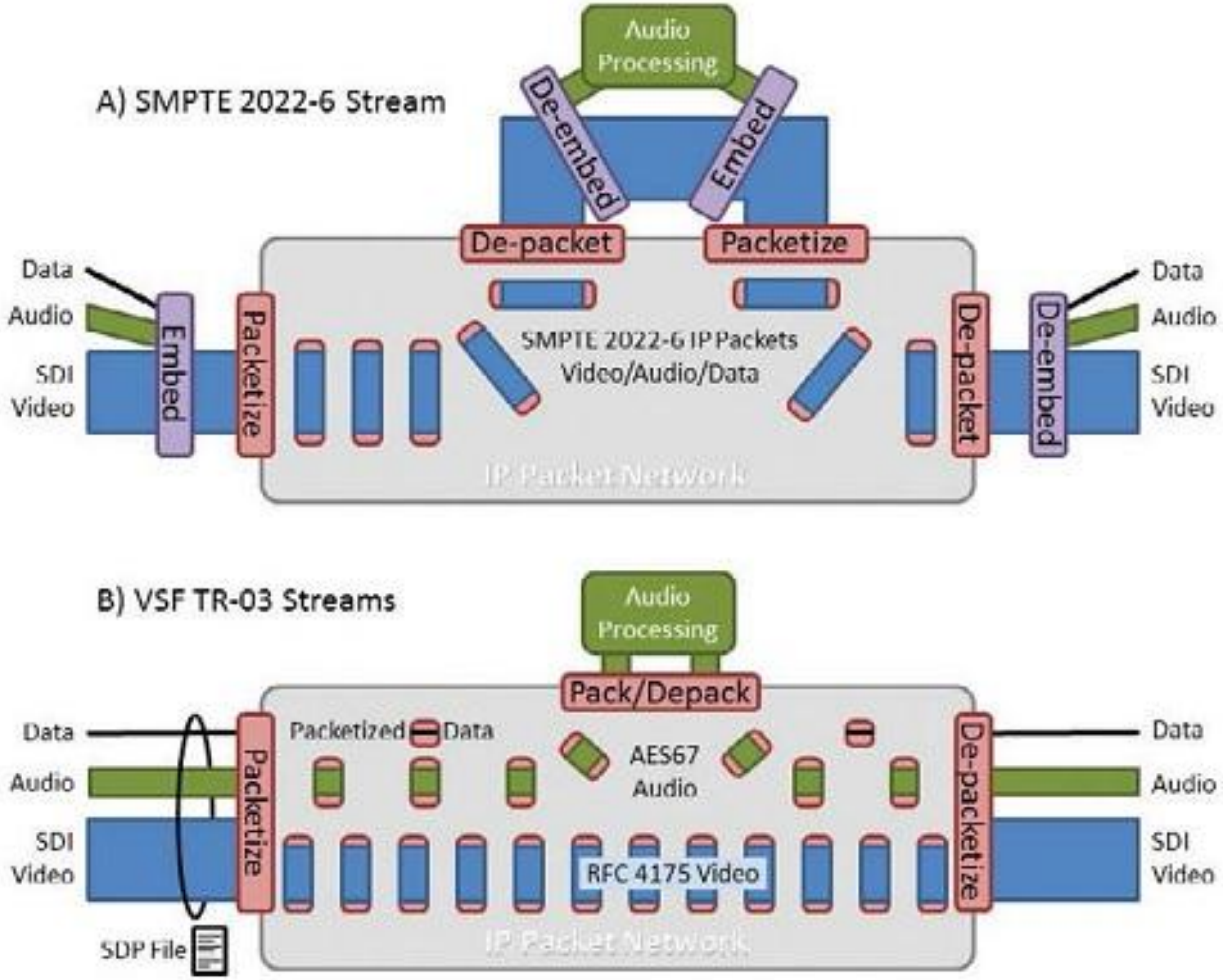
AES67 / SMPTE ST 2110
COMMONALITIES AND CONSTRAINTS

Explanation of the relationship between the SMPTE ST 2110 standard and the AES67 standard from the Audio Engineering Society – APRIL 2018

JOIN THE ALLIANCE

The Alliance for IP Media Solutions (AIMS) is a non-profit trade organization founded by leading companies to foster the adoption of industry standards for the broadcast and media industry as it transitions from SDI to IP.

AIMS
Alliance for IP Media Solutions



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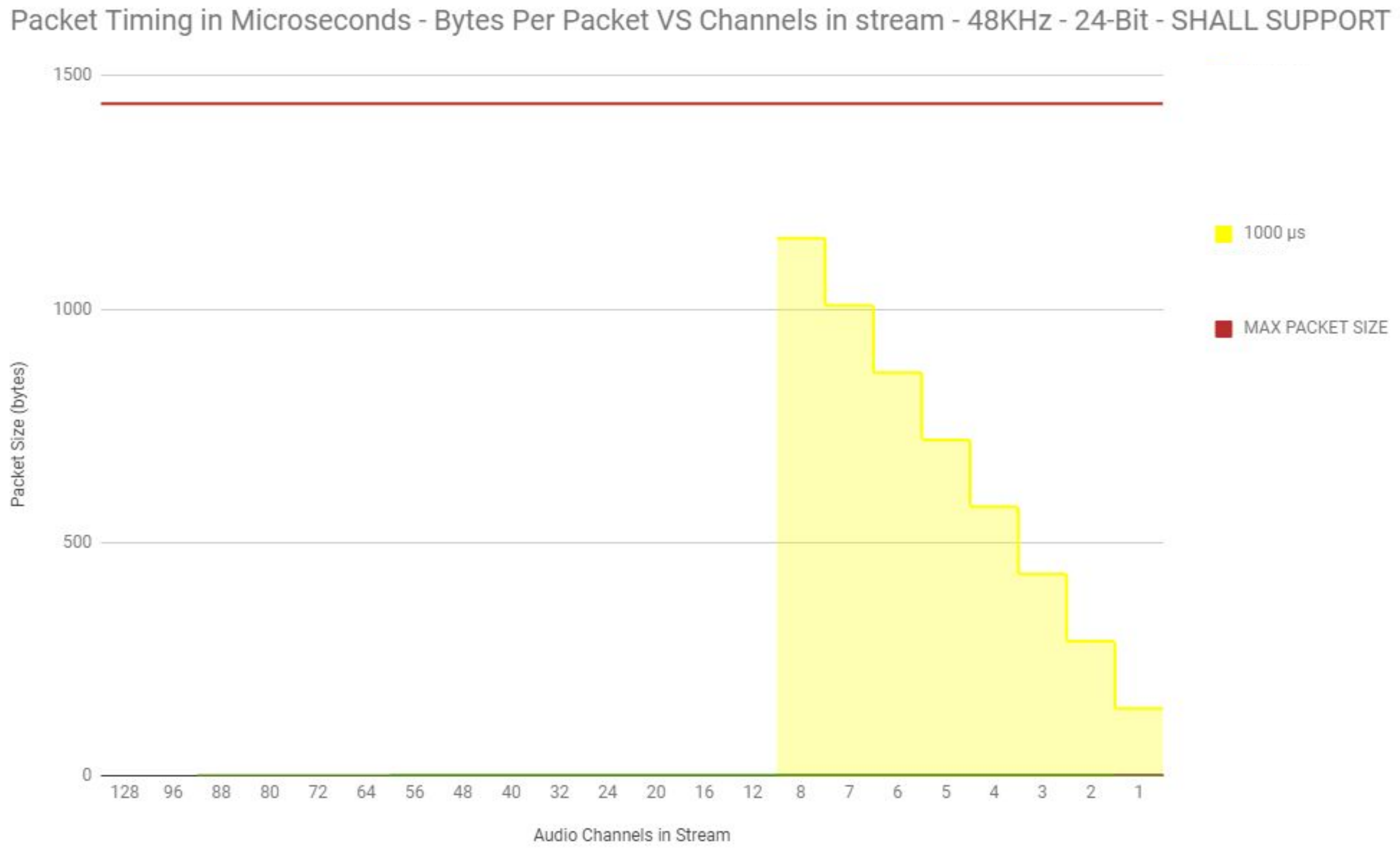
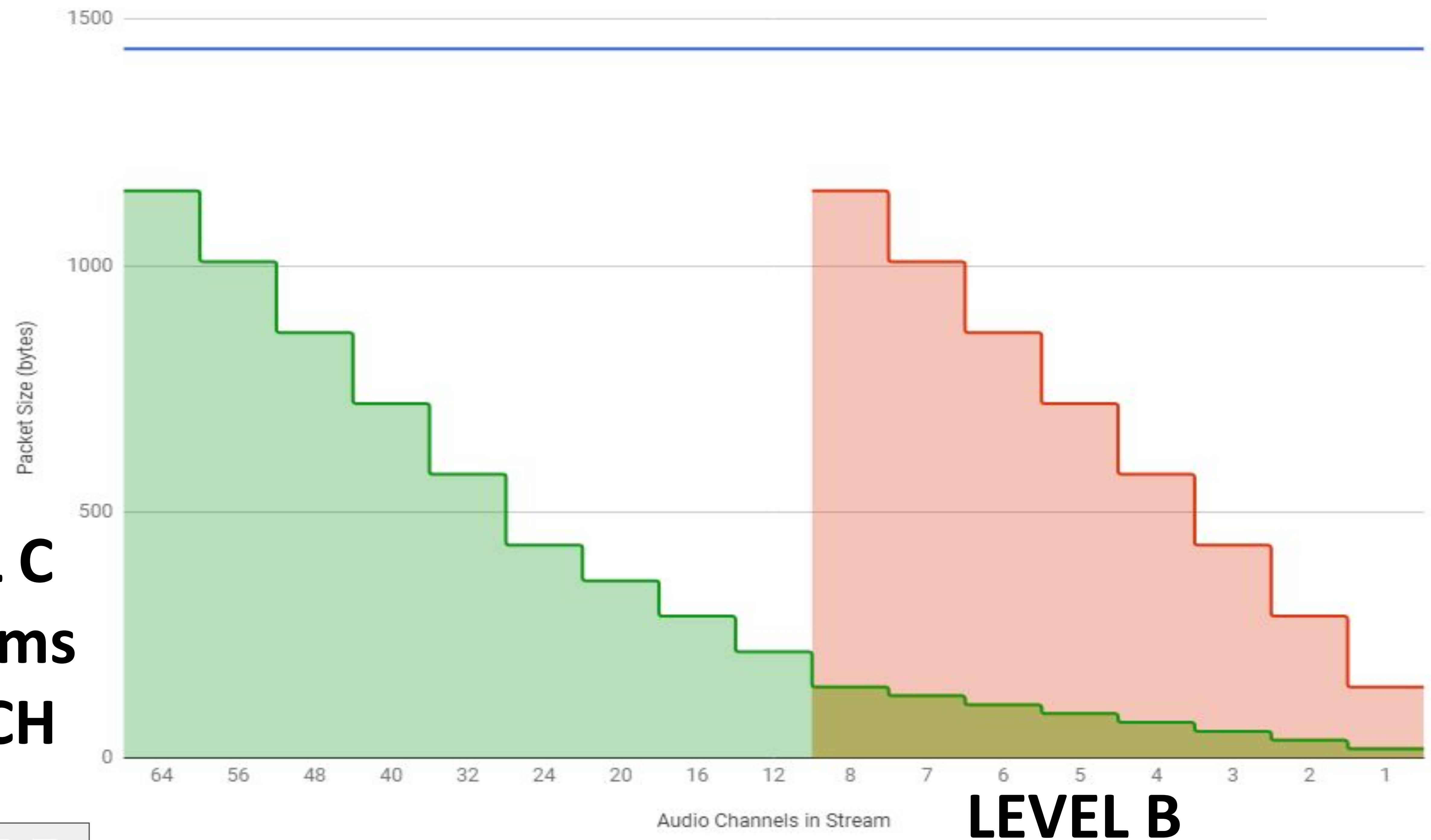
AES67 - RX SHALL SUPPORT
1ms - 1-8 CHANNELS 48KHZ - 24BIT

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock



WARD-BECK SYSTEMS

SMPTE 2110-30



LEVEL A
1ms
1-8 CH

LEVEL C
0.125ms
1-64 CH

LEVEL B
0.125ms
1-8 CH

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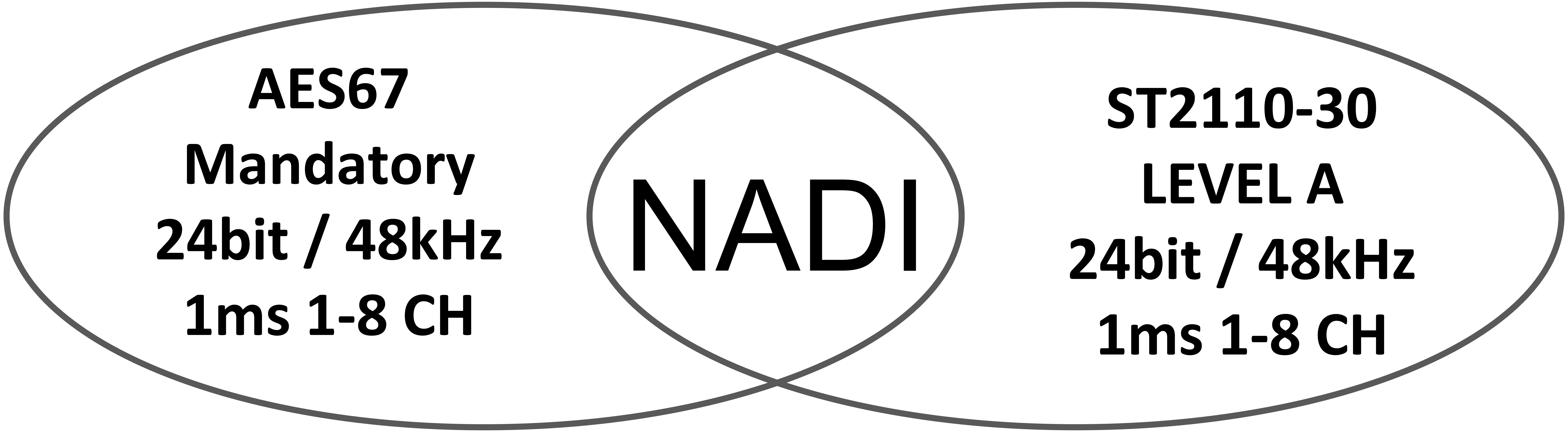

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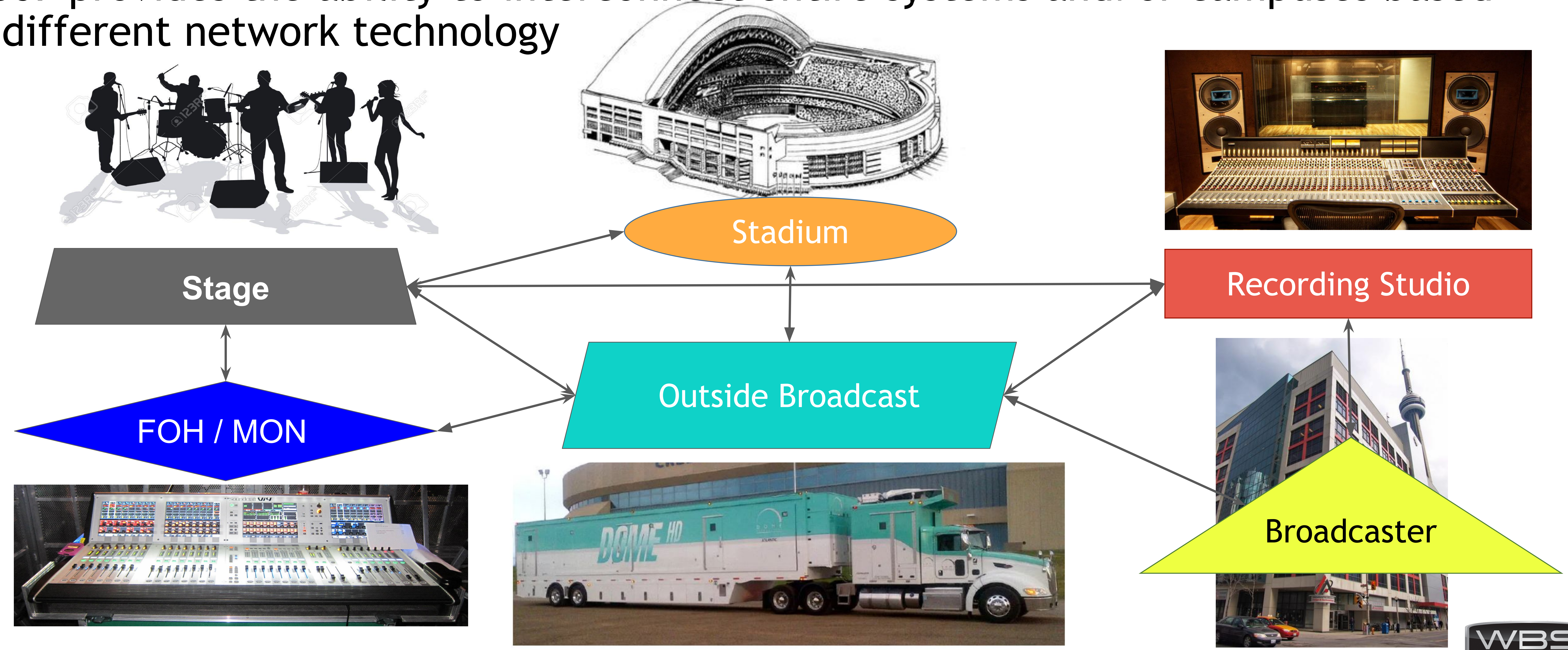
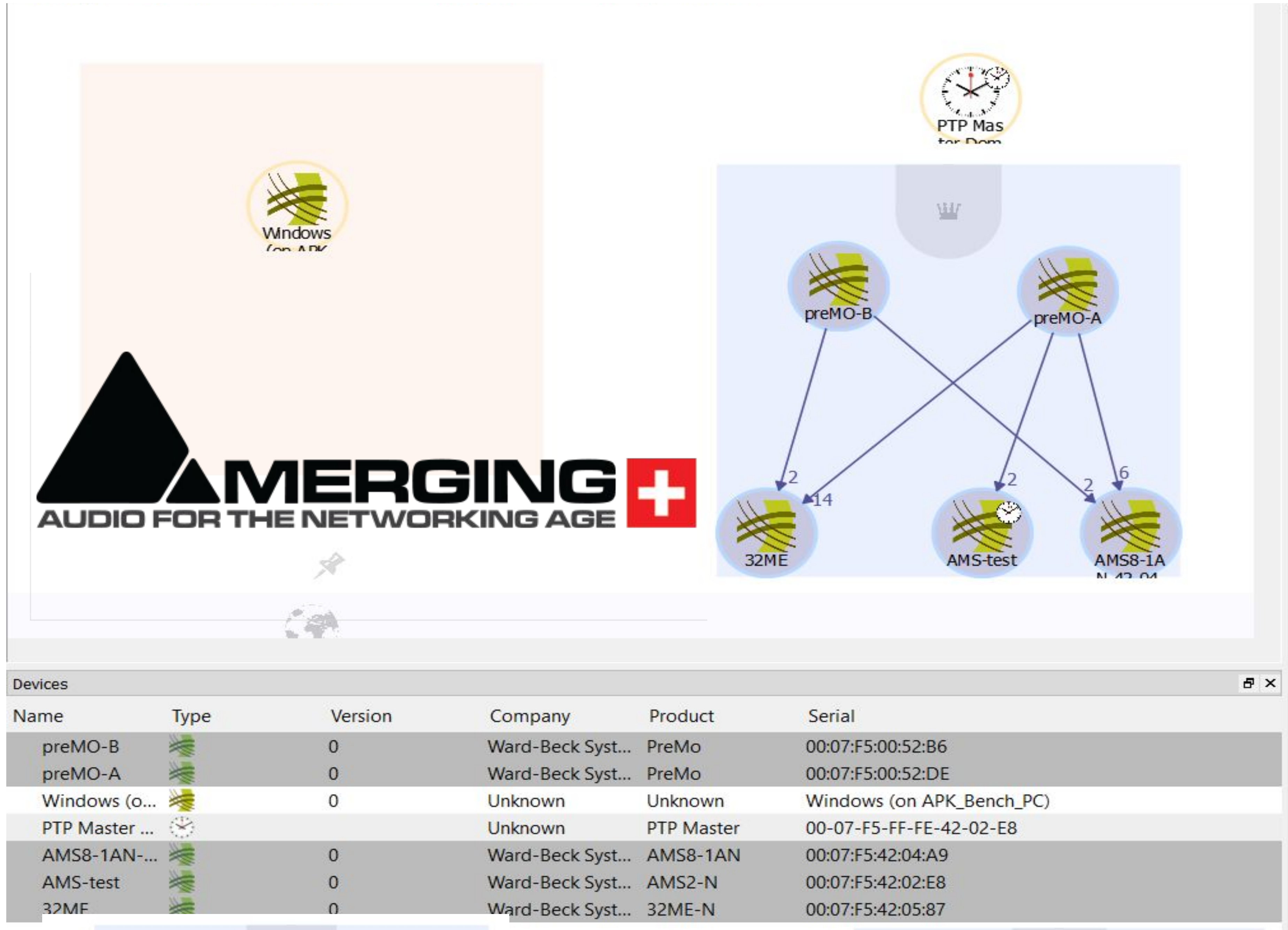
AES67 SOLUTION:

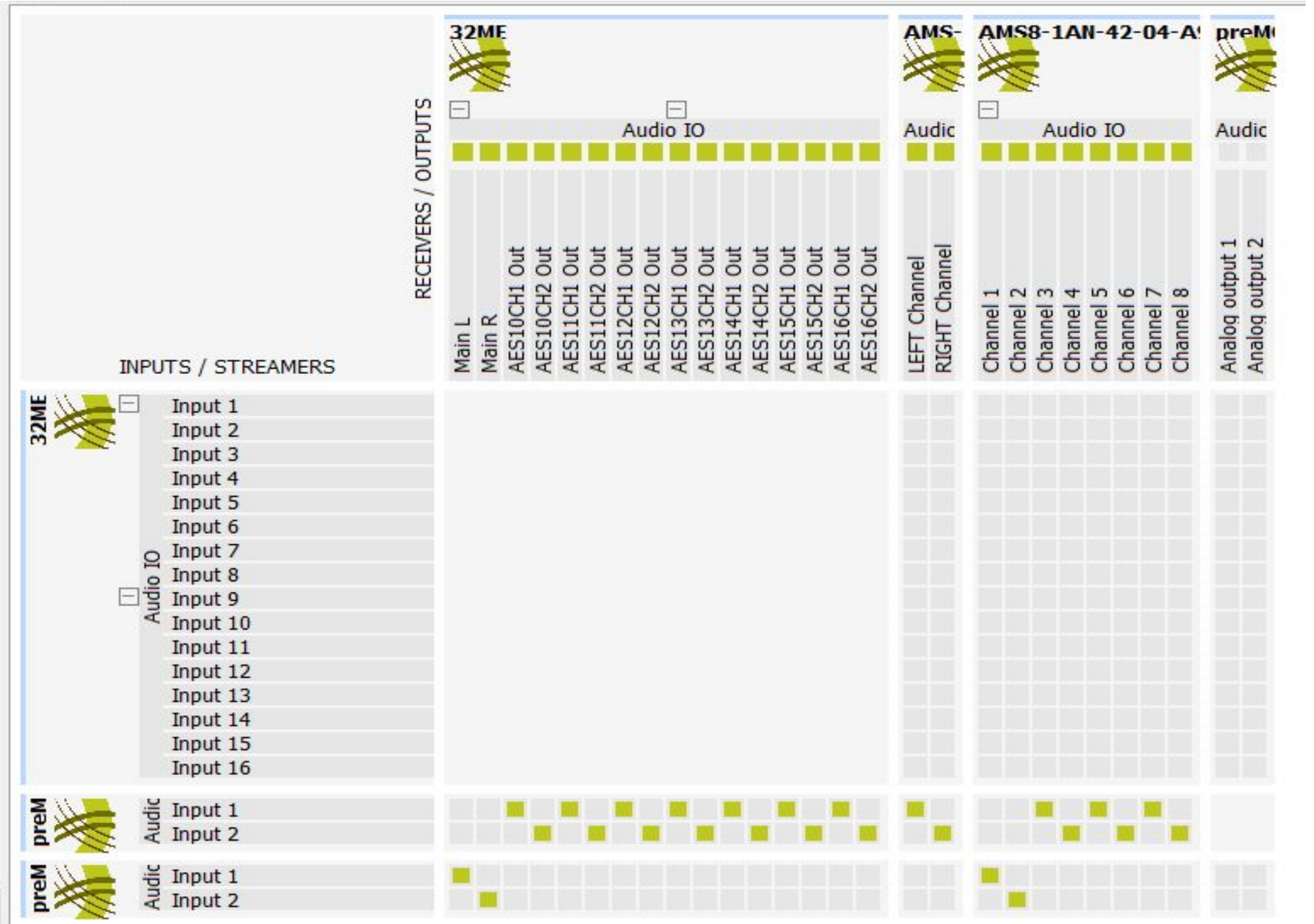
AES67 provides the ability to interconnect entire systems and/or campuses based on different network technology

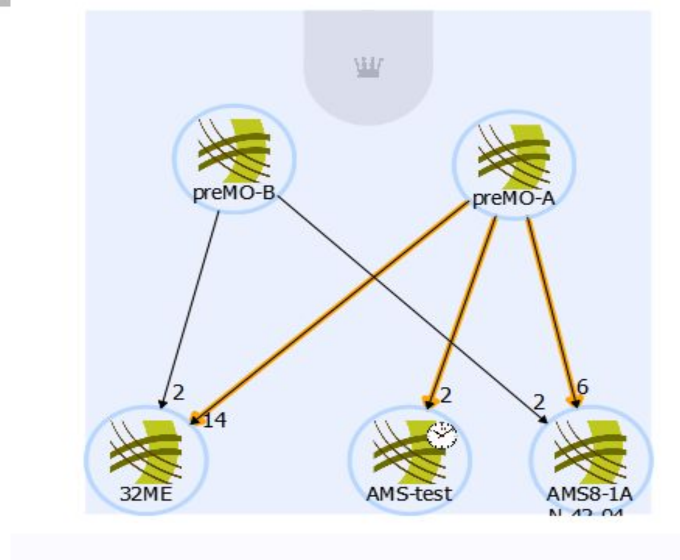


ANEMAN.AES67.audio

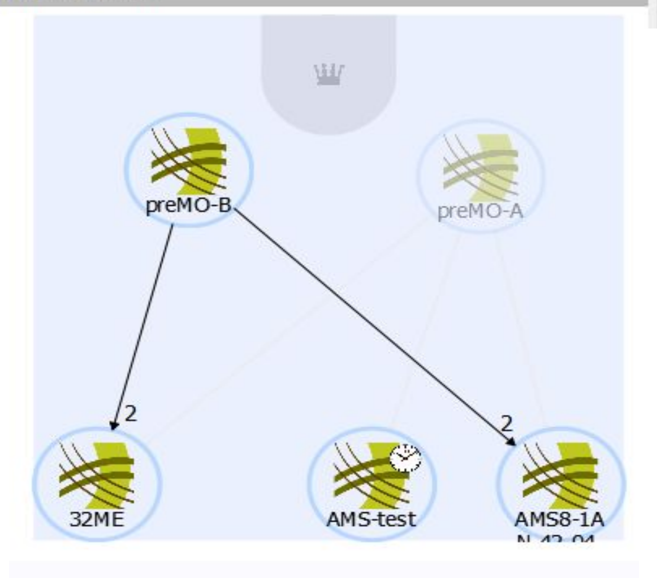
- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock



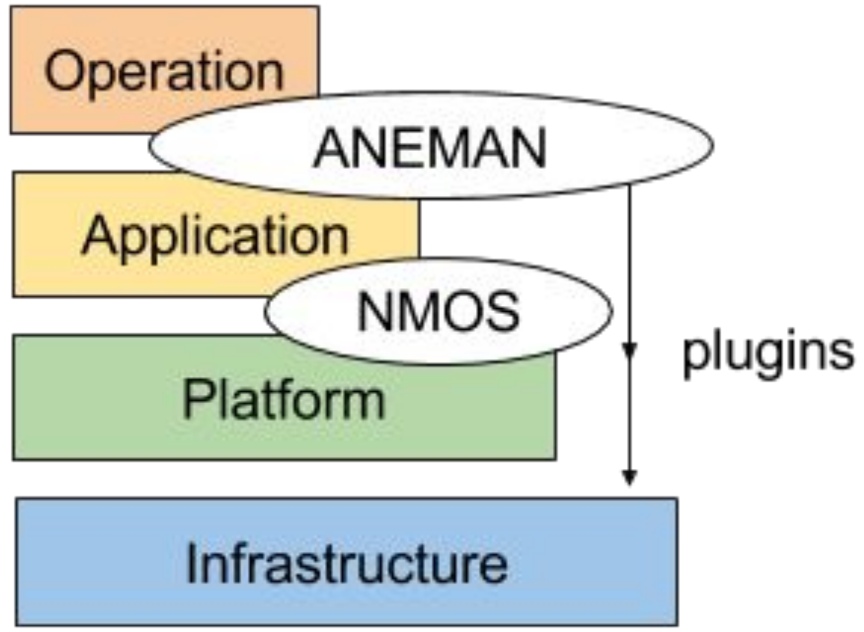




Connection Change



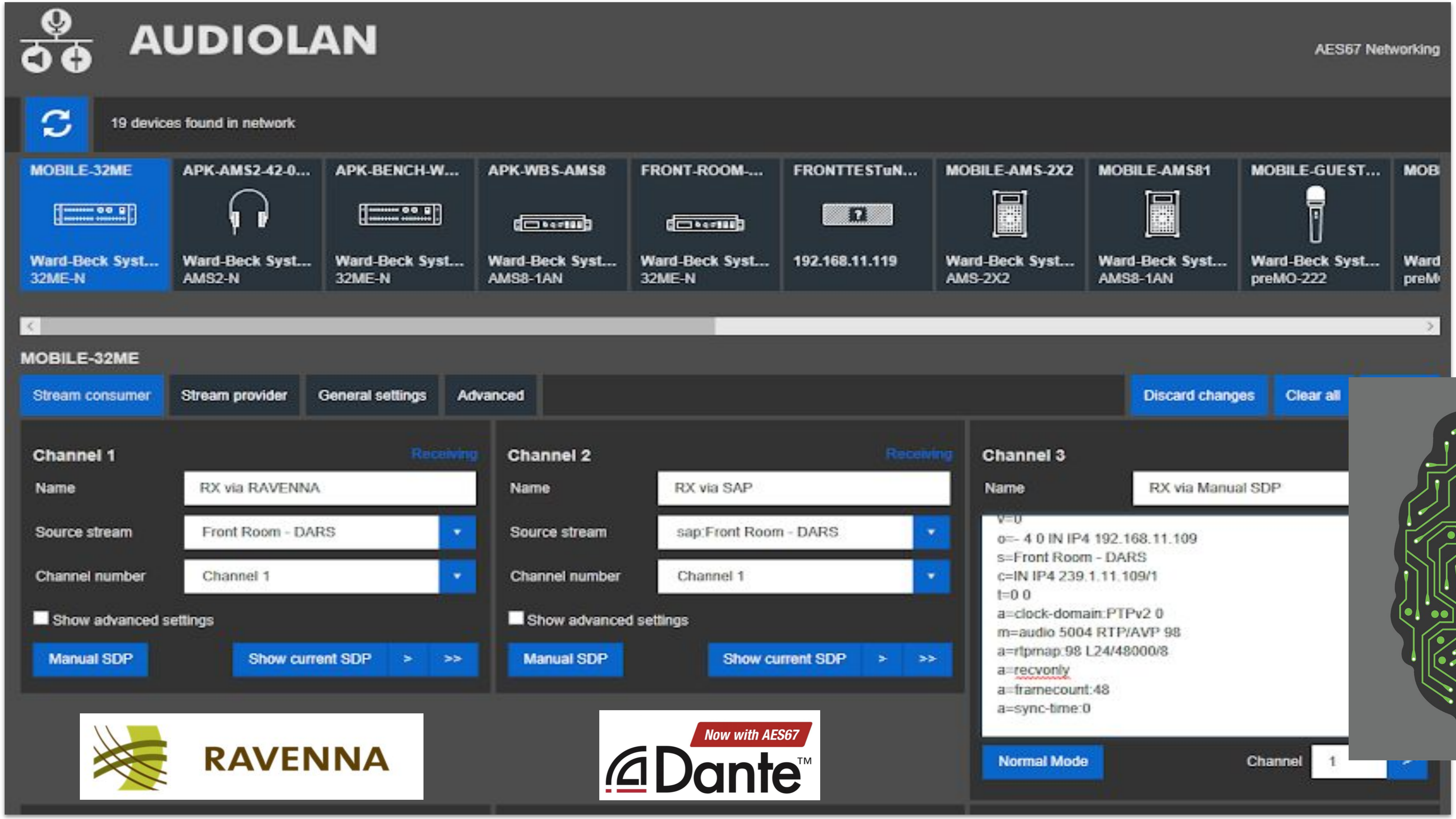
Broken Connection



WARD-BECK SYSTEMS

Mix and Match

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock



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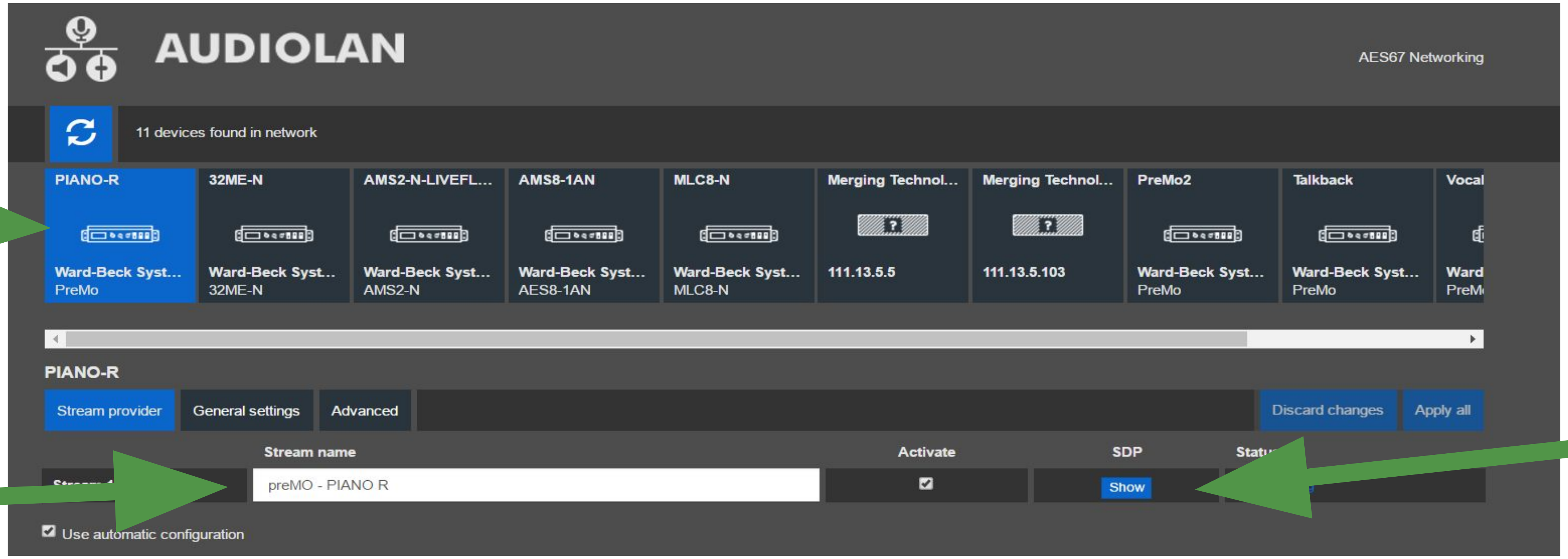
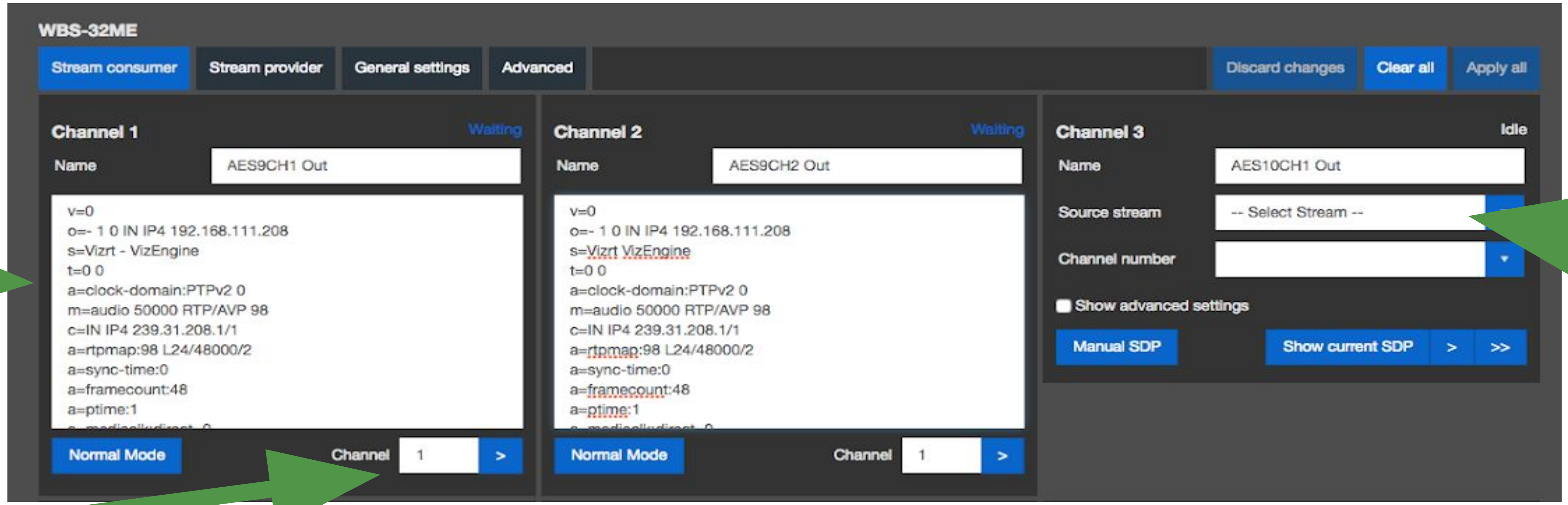
DEVICES IN SUBNET

STREAM NAME OF DEVICE



STREAM SDP INFORMATION

API / MANUAL SDP



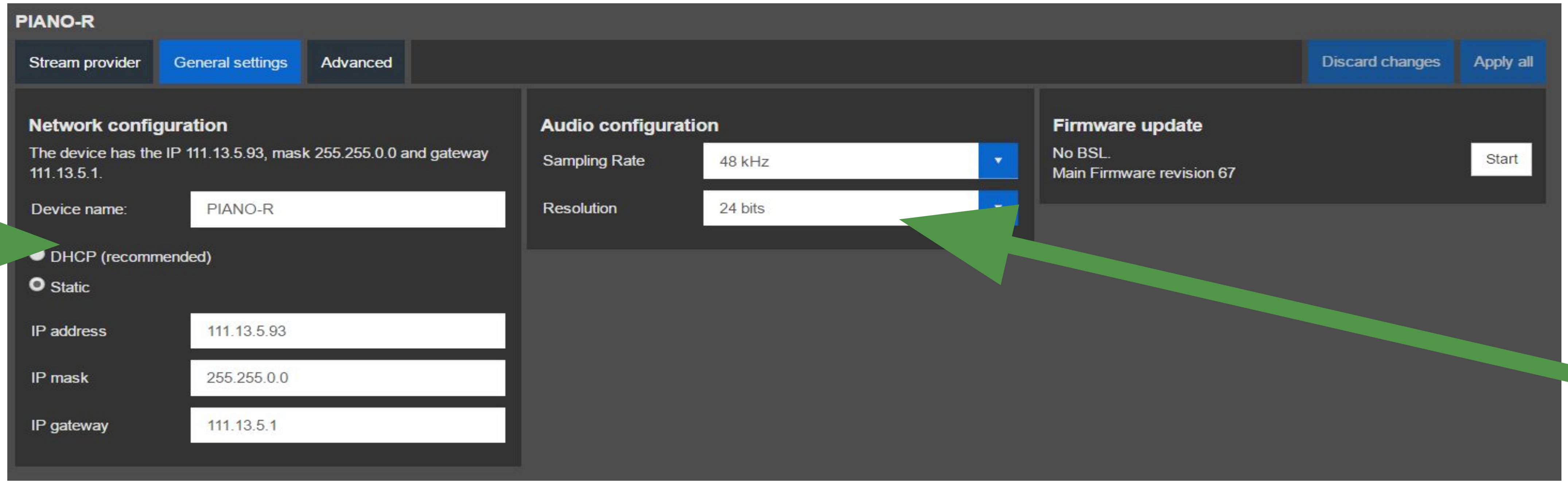
RAVENNA SOURCES

CH IN STREAM

WARD-BECK SYSTEMS

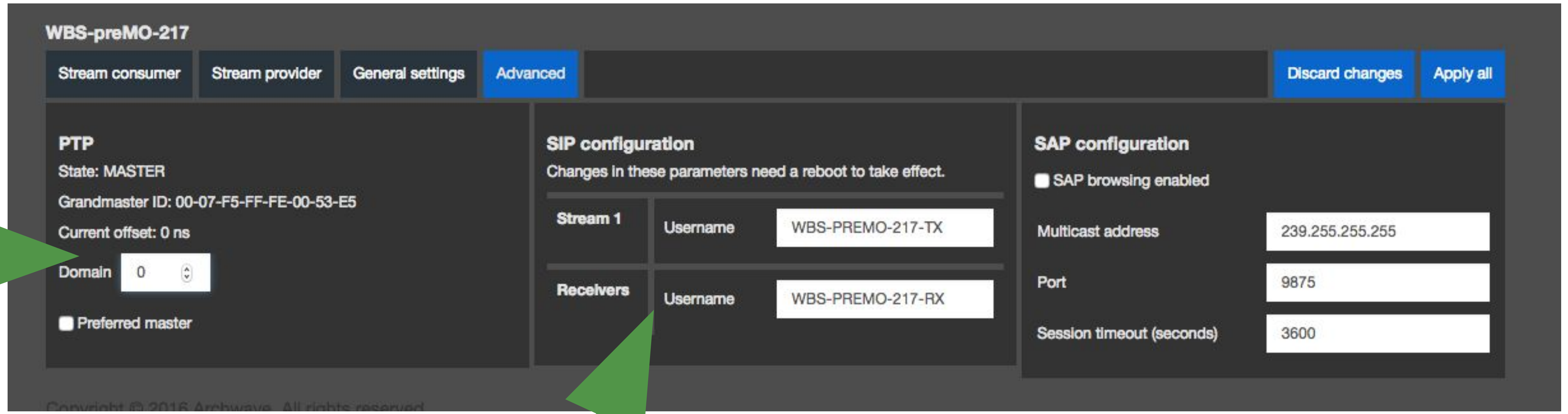
NAME +
IP ADDRESS

CONFIG



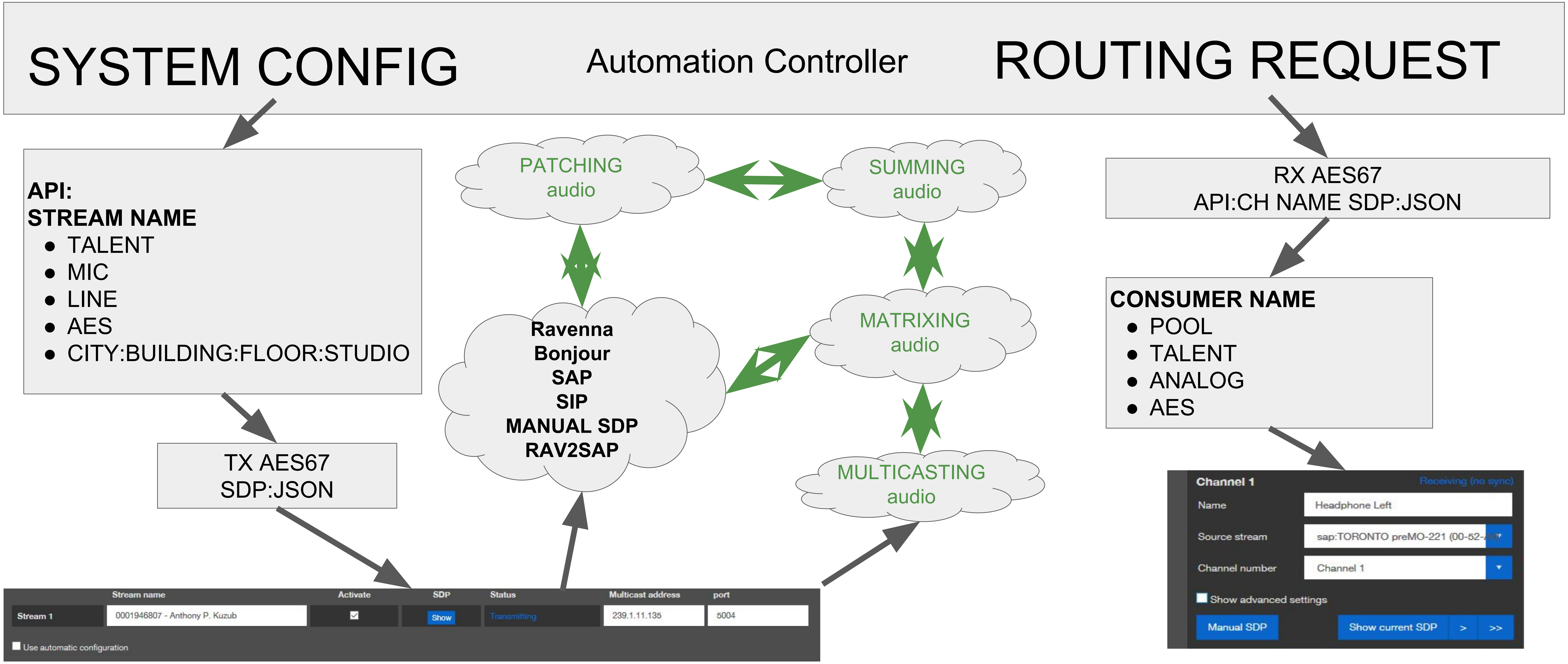
PCM AUDIO
RATE

PTP
CONFIG



SIP
CONFIG

SAP
CONFIG



WARD-BECK SYSTEMS

Remote control of device application functions

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

- device and channel names
- network settings
- sample rate, bit rate
- Status and health monitoring
- Status reporting

AES70	Copperlan
Ember+	VISA
Ember	Eucon
Midi	Mackie HUI
SNMP	JSON
RS232	Service Directory
RS485 bus	Made up - UDP / TCP

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DISCOVERY.AES67.audio

- Control & Monitoring
- **Discovery**
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

- SIP - Session Initiation Protocol
- SAP - Session Announcement Protocol
- BONJOUR - apple zeroconf
- AES70 - Connection Management MDNS
- NMOS -
- SNMP
- KLV within stream
- FAST METADATA (SDP extension)

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NMOS

Control & Monitoring
Discovery
Connection Management
Session Description
Transport
Quality of Service
Encoding & Streaming
Synchronization
Media Clock

- Stream identification
- Timing
- Relationships
- Discovery and registration
- Connection management
- JSON data structures

networked media NMOS open specifications

BBC

WBS WARD-BECK SYSTEMS

SESSION DESCRIPTION PROTOCOL

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

v=0 v= (protocol version number, currently only 0)

o=- 2 0 IN IP4 192.168.110.178 (originator and session identifier : username, id, version number, network address)

s=WardBeck 32ME s= (session name : mandatory with at least one UTF-8-encoded character)

t=0 0 t= (time the session is active)

a=clock-domain:PTPv2 **0** a=* (attribute Clock version and domain)

m=audio **50000** RTP/AVP **98** m= (media name and transport port and IP address / RTP profile 98)

c=IN IP4 **239.30.178.1/100** c=* (connection information/TTL)

a=rtpmap:98 L24/48000/8 a=* (attribute RTP profile / Bit Rate / Sample Rate / Channels)

a=framecount:48 a=* (attribute)

a=sync-time:0 a=* (attribute required by ST2110-30)

a=ptime:1 a=* (attribute: Packet Time)

a=ts-refclk:ptp=IEEE1588-2008:EC-46-70-FF-FE-00-8F-C8:0 a=* (attribute)

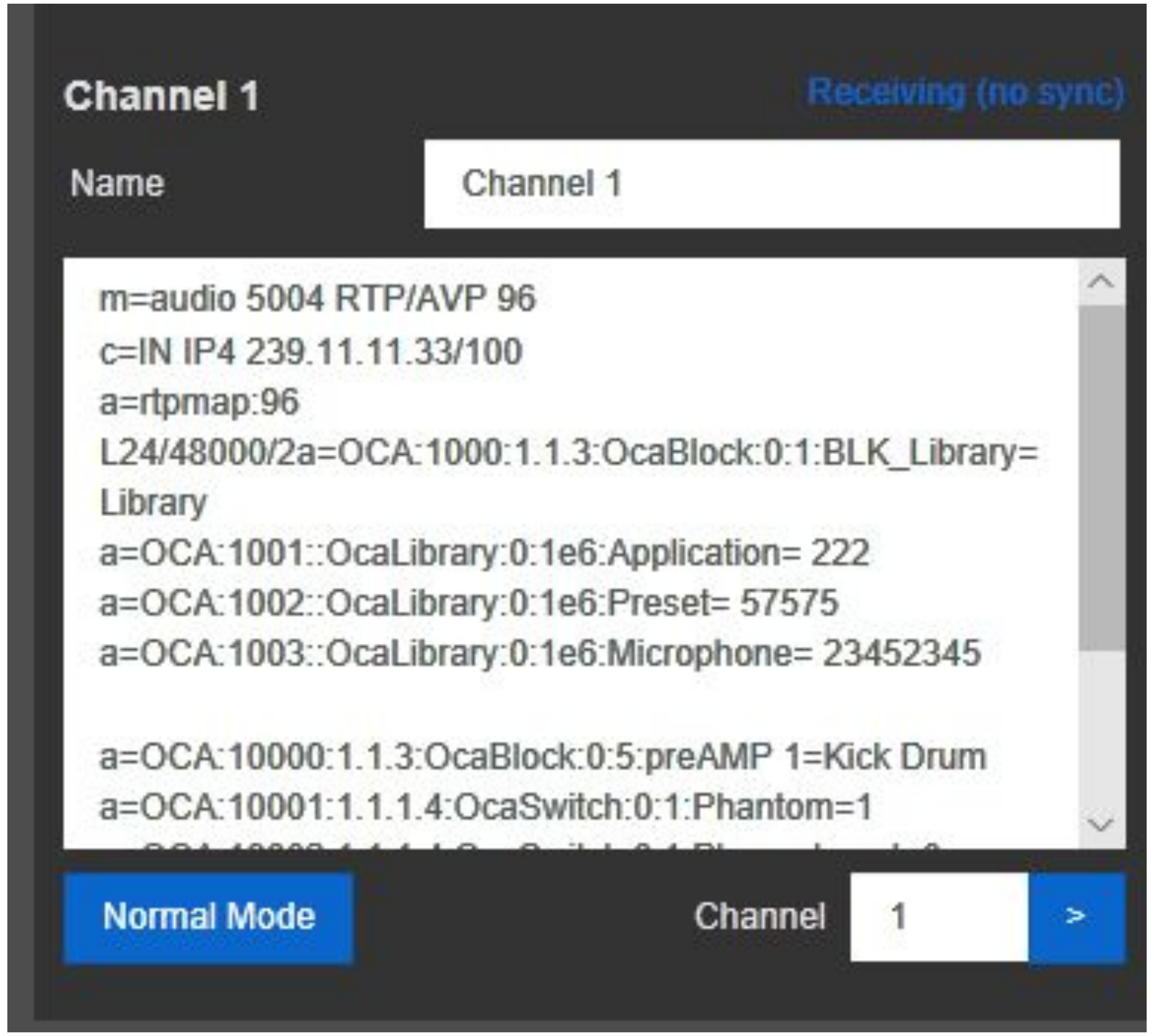
a=mediaclk:direct=0 a=* (attribute)

WBS WARD-BECK SYSTEMS

OCA EXTENDED SDP TLV - KLV

- Control & Monitoring
- Discovery
- Connection Management
- **Session Description**
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

a=OCA:1000:1.1.3:OcaBlock:0:1:BLK_Library=Library
a=OCA:1001::OcaLibrary:0:1e6:Application= 222
a=OCA:1002::OcaLibrary:0:1e6:Preset= 57575
a=OCA:1003::OcaLibrary:0:1e6:Microphone=23452345
a=OCA:10000:1.1.3:OcaBlock:0:5:preAMP 1=Kick Drum
a=OCA:10001:1.1.1.4:OcaSwitch:0:1:Phantom=1
a=OCA:10002:1.1.1.4:OcaSwitch:0:1:Phase_Invert=0
a=OCA:10003:1.1.1.4:OcaSwitch:0:1:Input(MIC/LINE)=0
a=OCA:10005:1.1.1.5:OcaGain:0:63:Pre Amp Gain=45
a=OCA:10100:1.1.3:OcaBlock:0:3:DSP Input 1=2
a=OCA:10101:1.1.1.4:OcaSwitch:0:1:HPF Enable=1



a=OCA:1000=Library
a=OCA:1001= 222
a=OCA:1002=57575
a=OCA:1003= 23452345
a=OCA:10000=Kick Drum
a=OCA:10001=1
a=OCA:10002=0
a=OCA:10003=0
a=OCA:10005=45
a=OCA:10100=2
a=OCA:10101=1

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http://MULTICASTING.audio

Control & Monitoring

Discovery

Connection Management

Session Description

Transport

Quality of Service

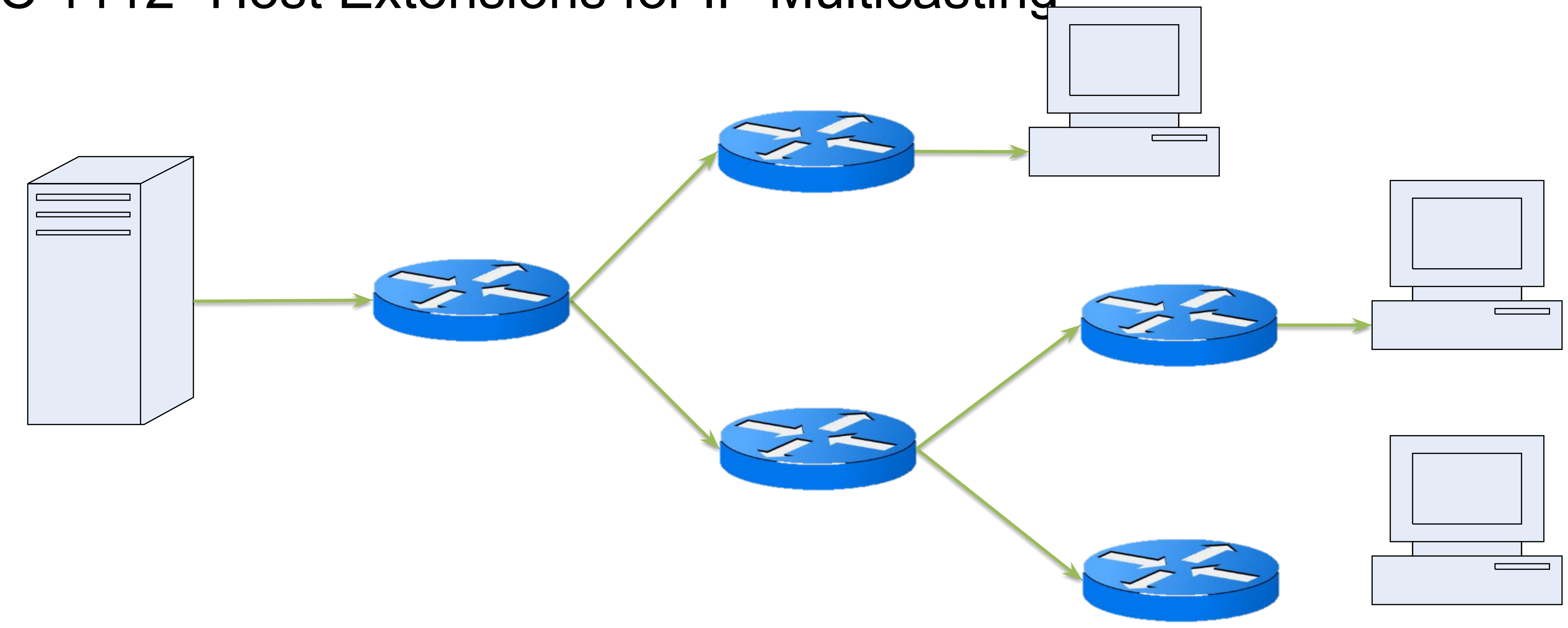
Encoding & Streaming

Synchronization

Media Clock

Network Layer(3) : (one-to-many)

- Only one connection per stream on transmitter side
- Switches copy packets as required
- Network traffic increases on last (closest to receiver) segment(s) of network path only
- IETF RFC 1112 “Host Extensions for IP Multicasting”



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QOS - Differentiated Services (DiffServ)

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- **Quality of Service**
- Encoding & Streaming
- Synchronization
- Media Clock

Class name	Traffic type	Default DiffServ class (DSCP decimal value)
Clock	IEEE 1588-2008 *Announce, Sync, Follow_Up, Delay_Req, Delay_Resp, Pdelay_Req, Pdelay_Resp* and *Pdelay_Resp_Follow_Up* packets	**EF (46)**
Media	RTP and RTCP media stream data	**AF41 (34)**
Best effort	IEEE 1588-2008 signaling and management messages. Discovery and connection management messages.	**DF (0)**

WARD-BECK SYSTEMS

IEEE1588 Precision Time Protocol (PTP)

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- **Synchronization**
- Media Clock

PTP Domain

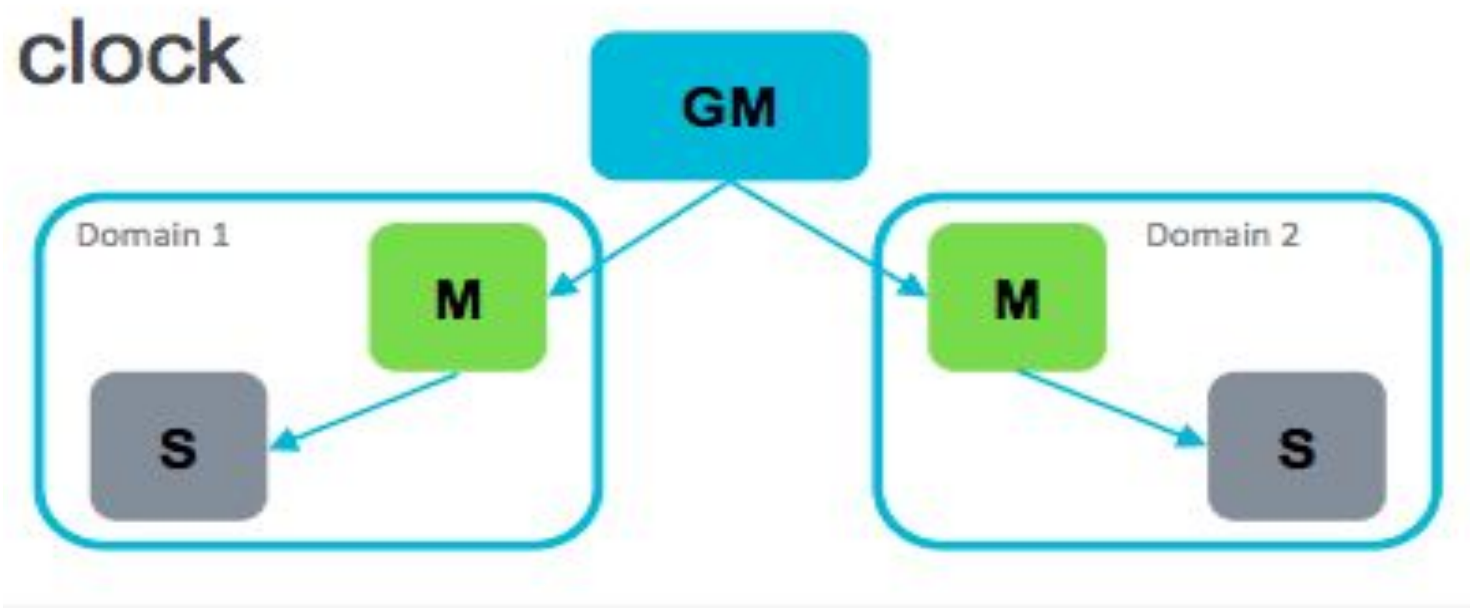
Logical grouping of clocks that are synchronised to each other using PTP, but may not be synchronised to other clocks in another domain

Grandmaster clock (GM)

A grandmaster clock is the highest-ranking clock within its PTP domain and is the primary reference source for all other PTP elements.

Master Clock (Mode)

A clock that is the source of time to which all other clocks in that domain are synchronised



Slave clock

A slave clock receives the time information from a master clock by synchronizing itself with the master clock. It does not redistribute the time to another clock. In the data center, servers are typically PTP slave clocks.

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IEEE1588 Precision Time Protocol (PTP)

Ordinary clock

An ordinary clock is a PTP clock with a single PTP port. It could be a master clock (grandmaster) or a slave clock.

Boundary clock (BC)

A boundary clock is the intermediary device between a PTP grandmaster and its PTP slave clients. It has multiple PTP ports in a domain and maintains the time scale used in the domain. Different ports on the boundary clock can be master ports or slave ports. The boundary clock terminates the PTP flow, recovers the clock and time stamp, and regenerates the PTP flow. Effectively, there is a slave port to recover the clock and master ports to regenerate the PTP packets.

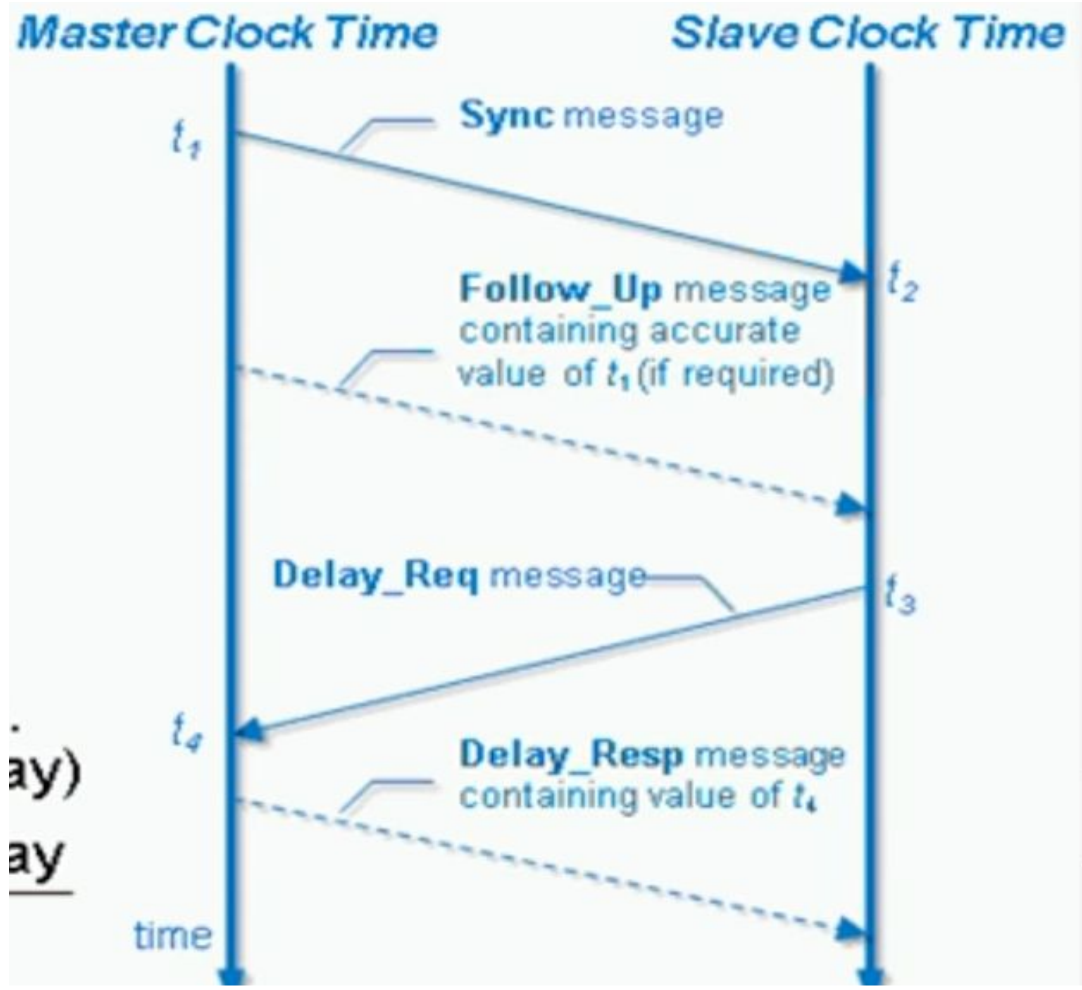
Transparent clock (TC)

A transparent clock measures the time needed for a PTP event message to transit the device and then compensates for the packet delay.

AES67 PTP Media Profile:

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- **Synchronization**
- Media Clock

Delay Mechanism: **E2E**
Announce Interval: **2 secs**
Announce Timeout: **3 secs**
Sync Interval: **1/8 sec**
Delay Req Interval: **1 sec**
Peer Delay Req Interval: **1 sec**
Priority 1: **128**
Priority 2: **128**
Domain: **0**
Slave Only: **Disabled**



Announce Timeout – time to wait for an announce message and is a multiple of announce intervals. No announce messages are received within the timeout interval, the unit will assume the role of grandmaster.

Sync Interval – Rate that one sync message is sent. The sync and follow up messages are sent from the master to the slave to determine the difference in clock frequency. This information is used in conjunction with the network delay to synchronise the clocks.

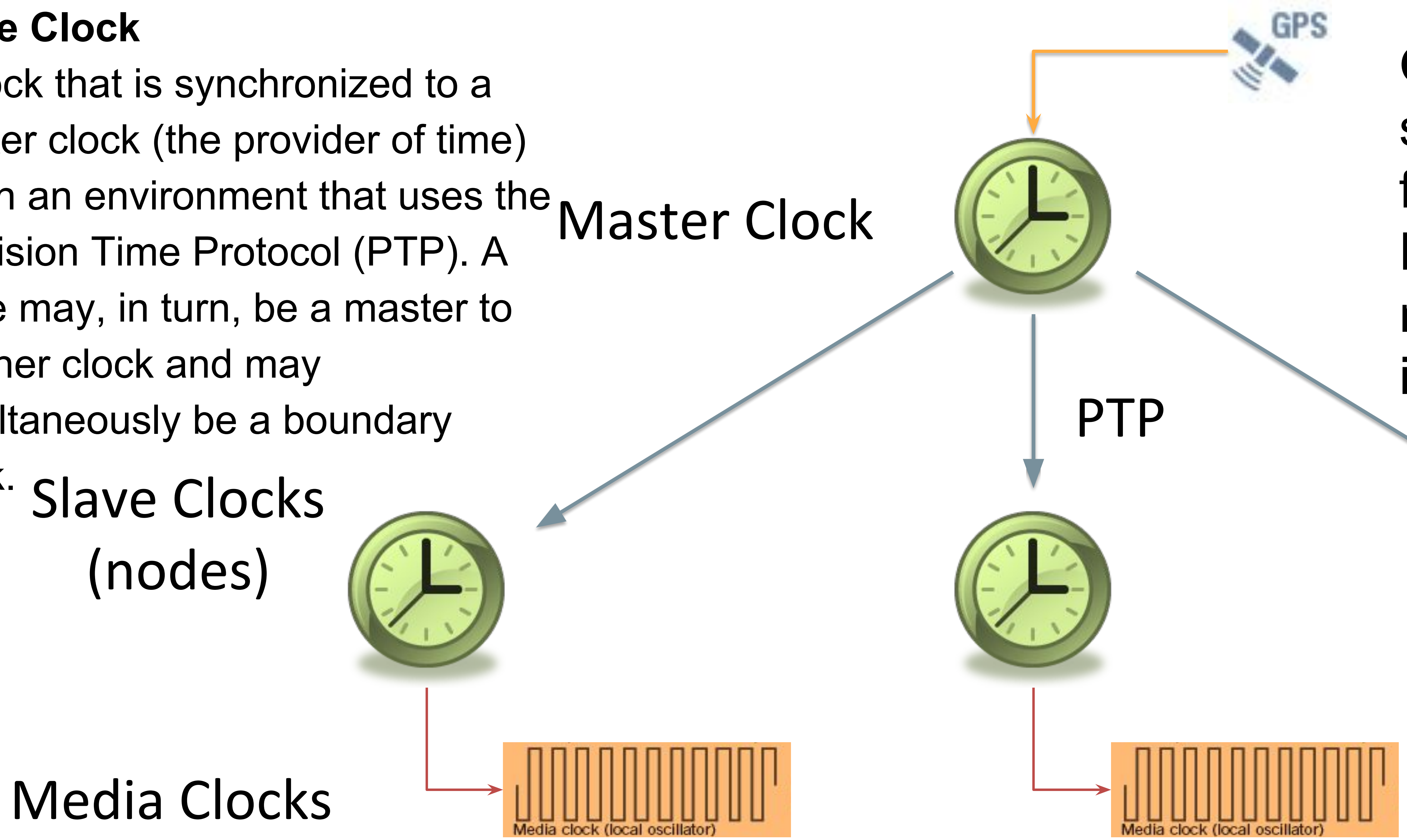
Delay Req Interval – rate at which a slave clock sends delay request messages to the master. The delay request message allows a slave device to calculate the network delay from the slave to the master. This option is only valid when using the E2E delay m

WARD-BECK SYSTEMS

SMPTE ST 2059-2:2015 "SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications"

- Control & Monitoring
- Discovery
- Connection Management
- Session Description
- Transport
- Quality of Service
- Encoding & Streaming
- Synchronization
- Media Clock

Slave Clock
A clock that is synchronized to a master clock (the provider of time) within an environment that uses the Precision Time Protocol (PTP). A slave may, in turn, be a master to another clock and may simultaneously be a boundary clock.



Grandmaster: The master source of synchronization for clock distribution via PTP. The grandmaster is a network device and is identified by an EUI-64.

Media clock: The clock used by senders to sample and receivers to play digital media streams. The media clock for audio streams reads in units of samples.

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AES70.audio

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