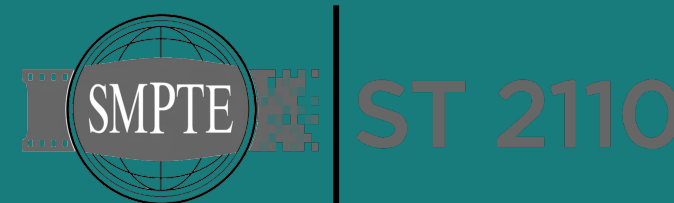


Dante Interoperability AES67/ST2110

Technical Dive

Interoperability Context

AES67



Interoperability: A Word Processing Analogy



Microsoft®
Word



Corel®
WordPerfect®

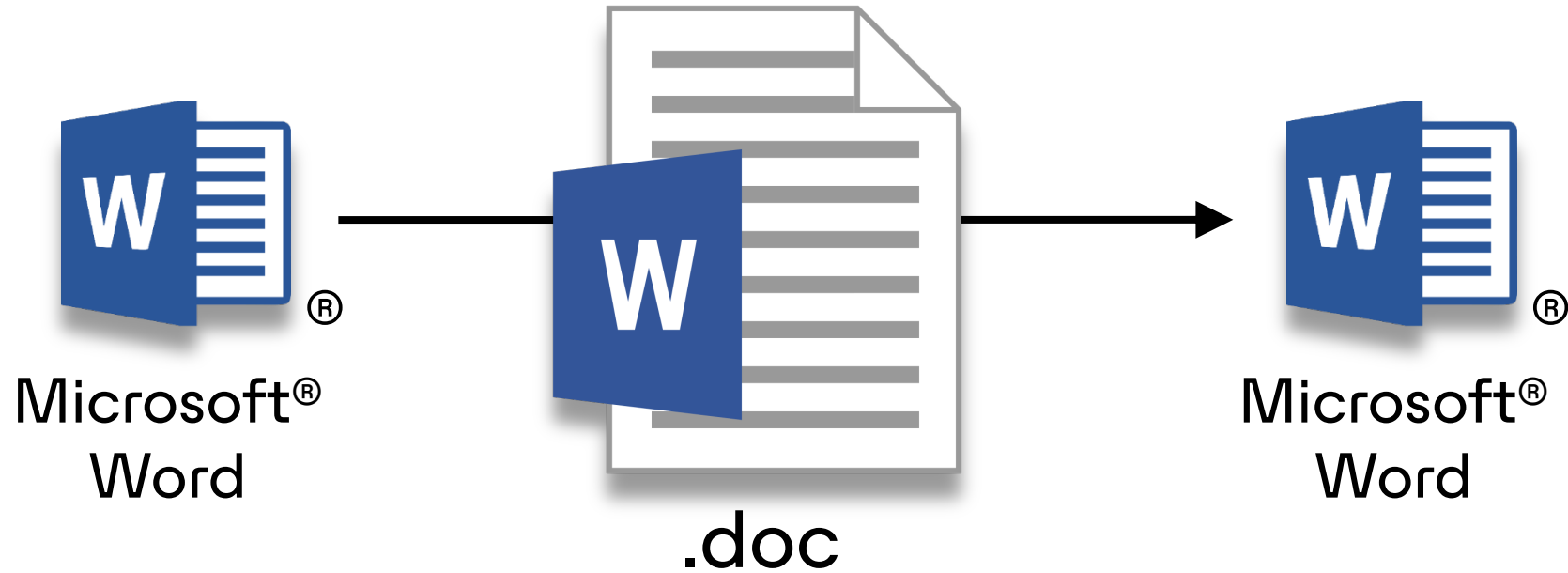


Google
Documents

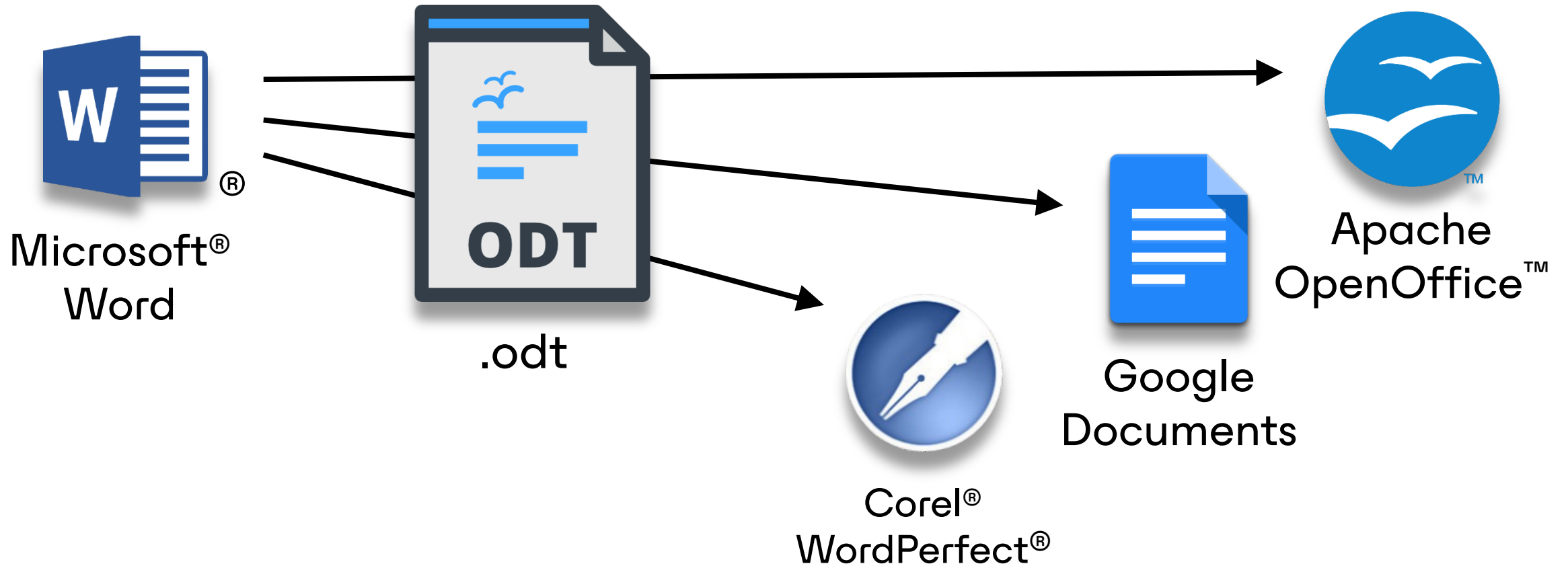


Apache
OpenOffice™

Interoperability: A Word Processing Analogy



Interoperability: A Word Processing Analogy

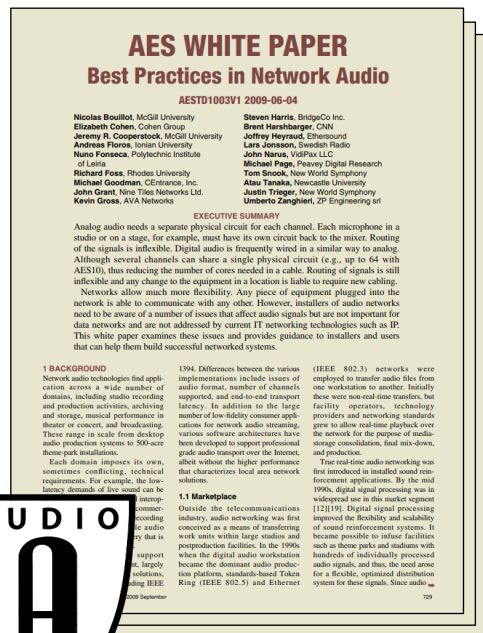


The Goal of AES67

Best Practices for Audio Networks

AES AESTD1003V1, Published June 6, 2009

<http://www.aes.org/technical/documents/AESTD1003V1.pdf>



Commonality:

“Audio networking systems are characterized by the transport of synchronized uncompressed audio in PCM format, which in principle could be reformatted as requested.”

Differences:

“In practice, there are several issues for compatibility between formats that should be addressed and solved with specific implementations.”



AES67 Ratified 2013, Updated 2014, 2015, 2018

FAQ: What is AES67?



Media Networking Alliance

Promoting the Adoption of AES67

AES67 enables interoperability between audio networking [solutions] currently available, such as Dante, Livewire+, Q-LAN, Ravenna [and WheatNet IP].

**AES67 is not a new technology,
but a bridging compliance mode.**

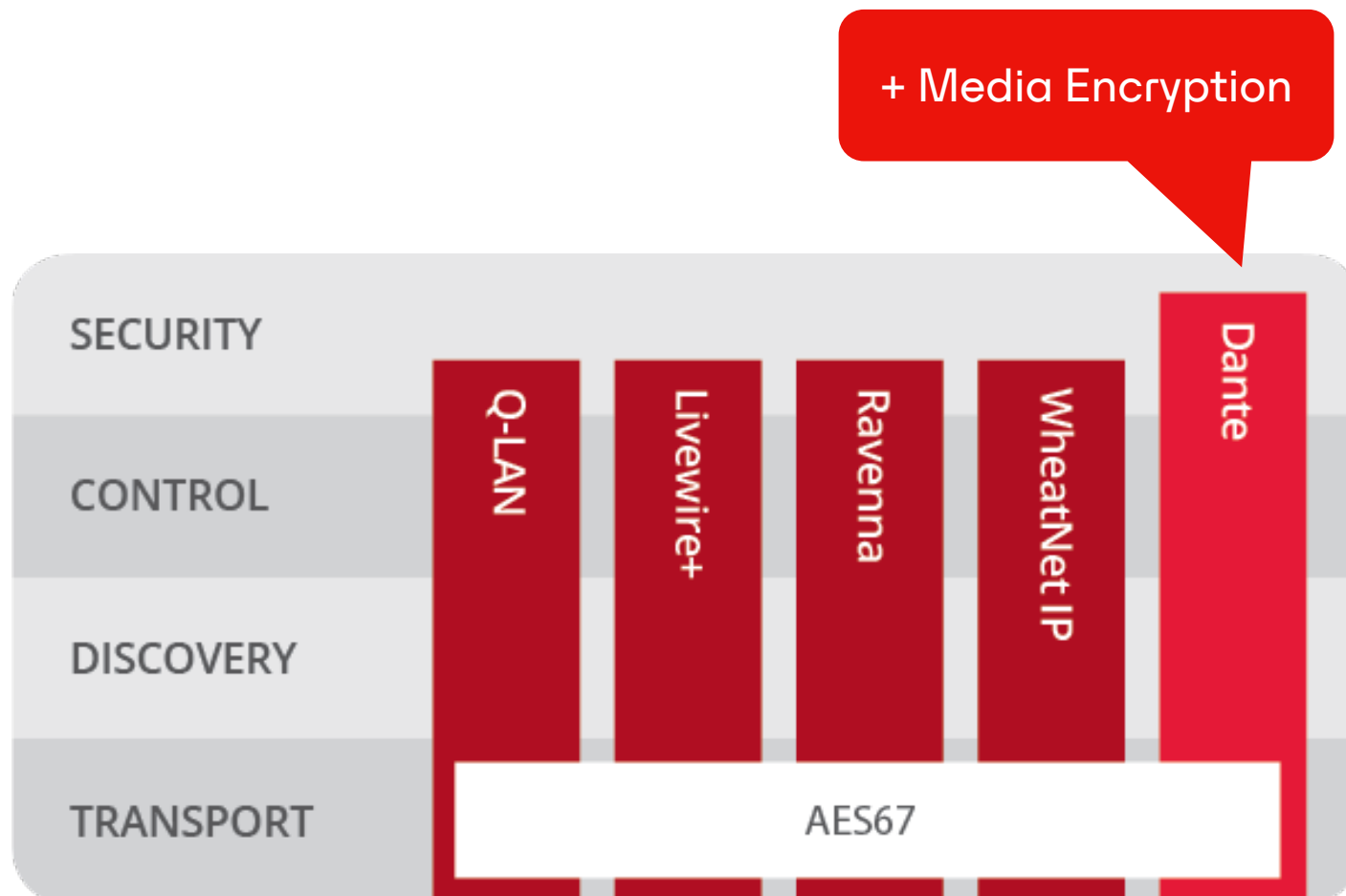
AES67

FAQ: What is AES67?

Interoperability Standard:
AES67

Network Solutions:

Dante, Livewire+, Ravenna,
Q-LAN, WheatNet IP



AES67 Scope

AES67 defines some common building blocks:

- Synchronization: PTPv2 Multicast (Domain 0)
- Stream Description: Session Description Protocol (SDP)
- Encoding & Streaming: Real-time Transport Protocol (RTP)
 - Pivot format: 48Khz / 16-24bit / 1ms packet time / 1~8 channels
- Connection Management: Multicast (IGMPv2/3)
 - Audio flows need to be Multicast
- Quality of Service (QoS): DiffServ
 - PTP EF (46) / RTP AF41 (34)

AES67 doesn't reinforce:

- Discovery: Manufacturer specific
 - mDNS, Session Announcement Protocol (SAP), SDP copy&paste
- Redundancy

AES67

What is SMPTE ST 2110?

SMPTE ST 2110 is a suite of standards and specifications primarily focused on the transport of video on professional production environments.

- **Flexibility:** Evolution from a point-to-point solution like SDI to a network-based solution.
- **More bandwidth:** Allowing uncompressed video streams
- **Efficiency:** Separating the audio, video and ancillary data streams.



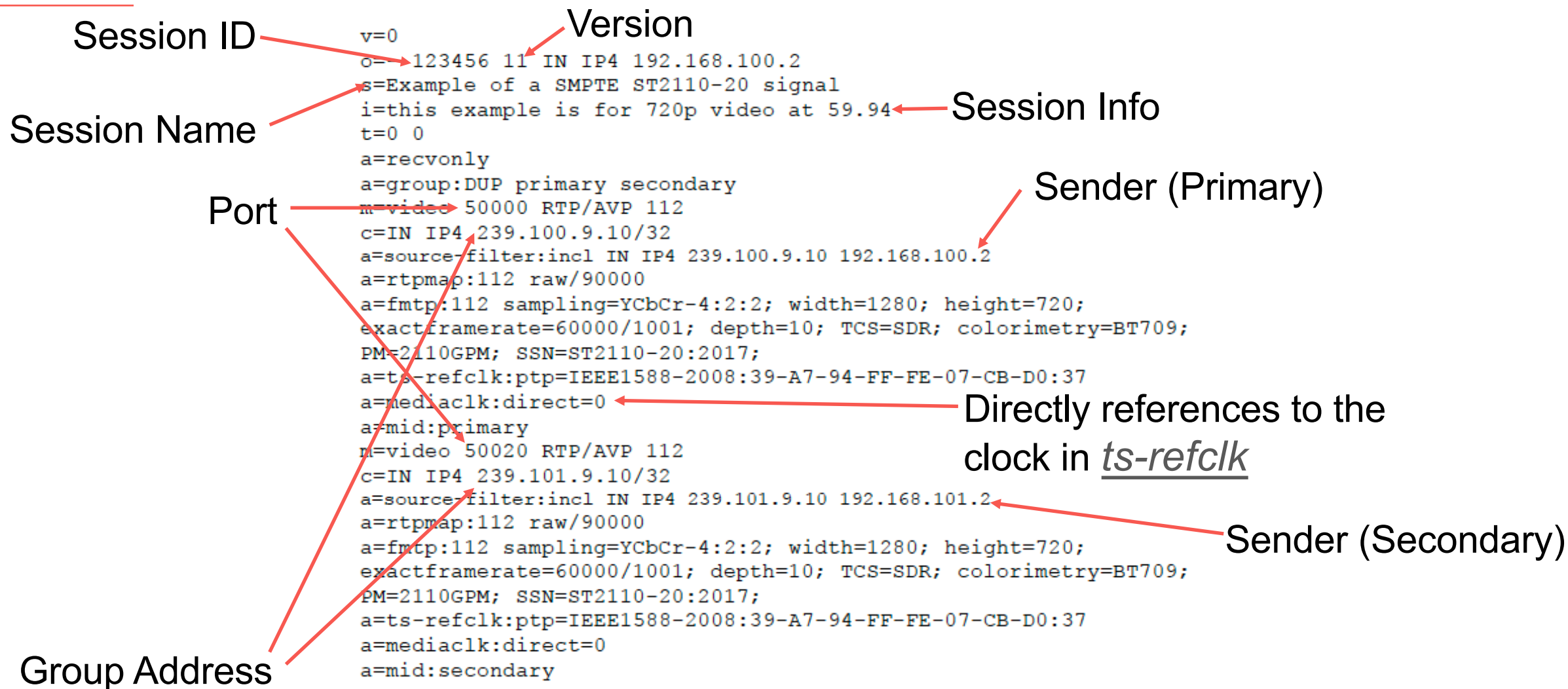
SMPTE ST 2110 Audio Scope

ST 2110 audio streams are essentially a carbon copy of AES67*

- 2110-10: Defines the timing relationships between all components in the system: Media, RTP and PTP clocks
 - Common reference clock using IEEE 1588-2008 Precision Time Protocol (PTPv2)
- 2110-30: RTP Audio transport, like AES67 (Multicast!)
Conformance levels:
 - A – 48KHz streams, 1 to 8 audio channels, 1 ms packet times
 - B – Level A plus: 1 to 8 audio channels, 125 μ s packet times
 - C – Level A plus: 1 to 64 audio channels, 125 μ s packet times
- 2059-2: PTP Media Profile (IEEE 1588-2008)
- **2022-7: Redundancy**
 - RTP headers and payloads need to be identical between the two streams



SDP Anatomy



SDP Anatomy Clock focus

- Reference Clock

“a=ts-refclk:localmac=<Ethernet MAC address of sender>”

- PTP Form

“a=ts-refclk:ptp=IEEE1588-2008:39-A7-94-FE-FE-07-CB-D0:37

a=ts-refclk:ptp=traceable

a=ts-refclk:localmac=7C-E9-D3-1B-9A-AF”

Domain

Traceable time source

Sender

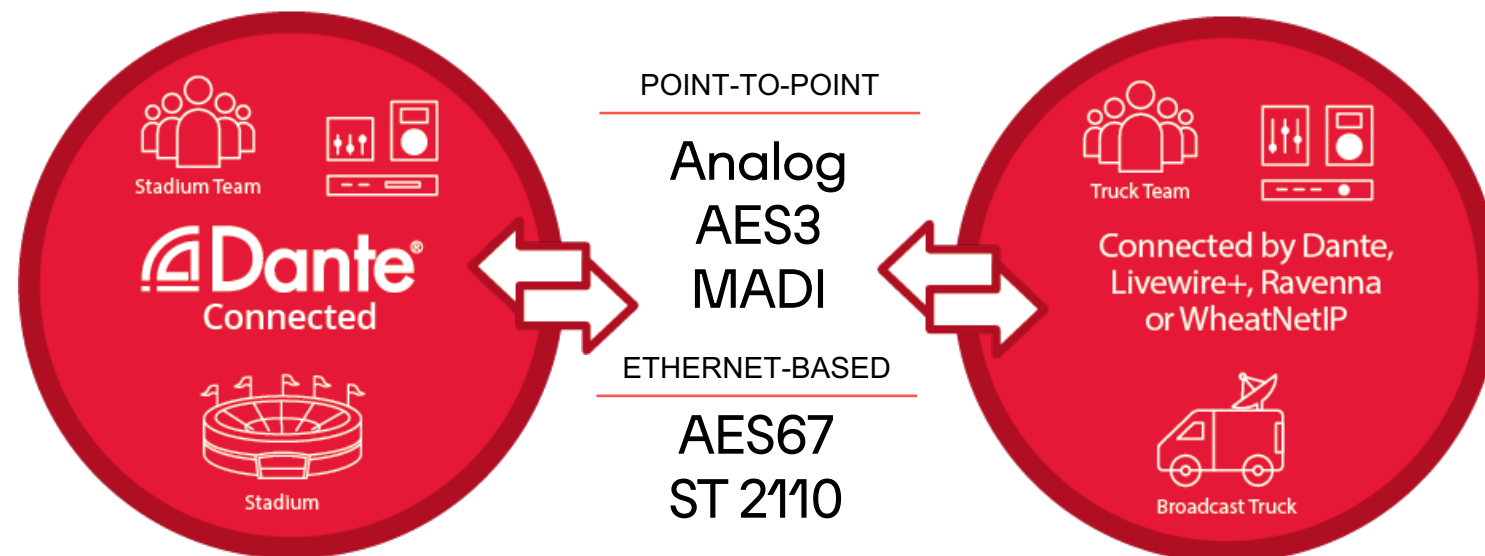
Grand Leader

The Goals of AES67 and ST 2110 in Audio

In the audio space,

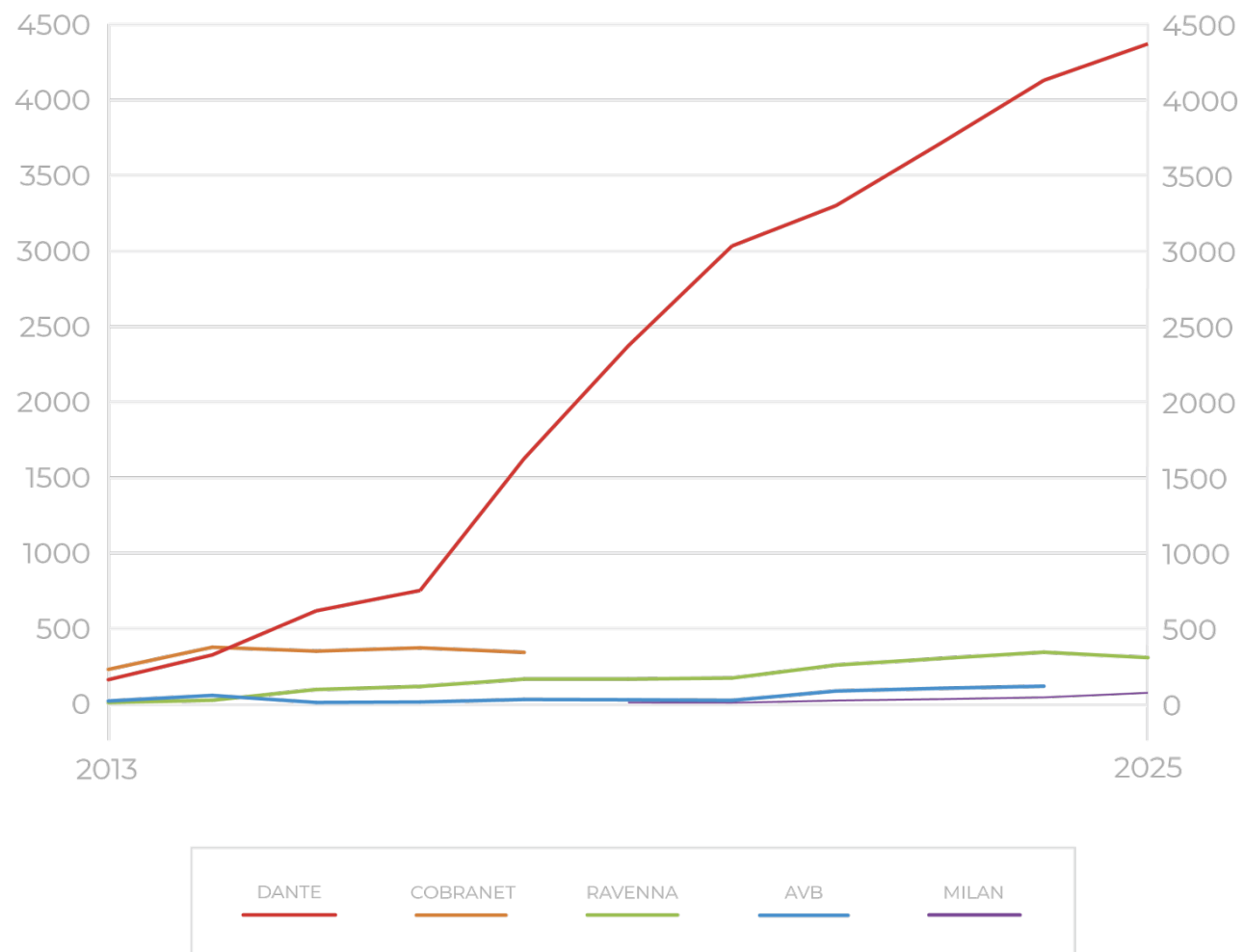
AES67 and ST 2110 replace:

- Video: SDI Embed/De-Embed
- Audio: MADI, AES3 and Analog



Market Presence

TOTAL AUDIO PRODUCTS PER PROTOCOL



Interoperability responsibility

Audinate maintains active relationships with our manufacturer partners to enable the seamless interoperability between the wide range of Dante enabled products available in the market. By positioning ourselves as the Dante experts in the partnership, we free up manufacturers to focus on their strengths.

We acknowledge the role played by standards such AES67 and SMPTE 21110 in promoting vendor agnostic device interoperability. Manufacturers implementing these standards are faced with the responsibility of not only creating standards compliant devices but are also tasked on working diligently to ensure device interoperability.

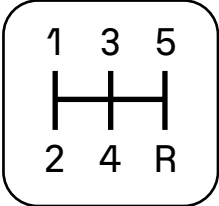
Dante Design & Implementation

AES67 vs ST 2110 Modes
Managed vs Unmanaged Dante
PTPv1 and PTPv2
QoS DSCP Markings

Dante Interoperability “modes”



 **Dante**[®]
with **AES67**



 **Dante**[®]
with  **ST 2110**

Managed
Unmanaged

Managed

Dante Software & Firmware Requirements

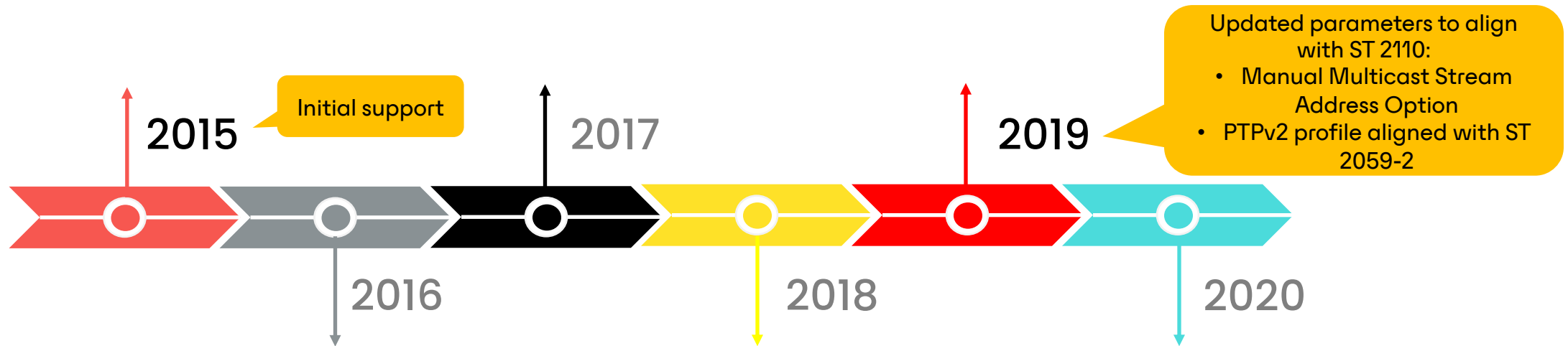


Dante Device	Unmanaged AES67 Dante Controller (v4.2)	Managed AES67 or ST2110 Dante Domain Manager (v1.1)
Brooklyn 2/3 Broadway HC PCIe IP Core	Supported (v3.9)	Supported (v4.2)
UltimoX AVIO	Supported (v4.1)	
Dante Embedded Platform	Supported (v1.2.1.1)	Unsupported
Dante AV-H Dante AV-A	Supported (v1.0.7)	
Dante AV Ultra	Supported (mk2)	Managed AES67 only (mk2)
Dante Virtual Soundcard Dante VIA Dante Studio Dante Application Library		Unsupported

Dante AES67

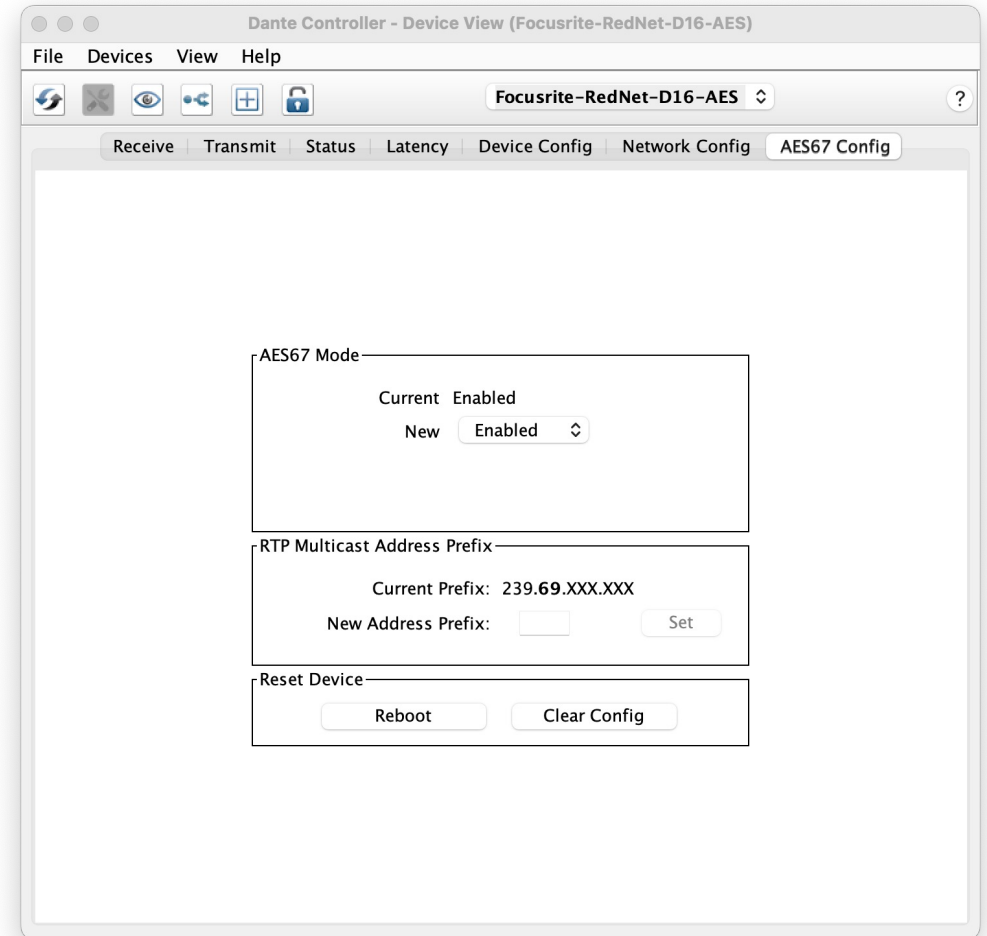


- “Simple” system configuration.
- Works Unmanaged or Managed (extra settings)
- Hardcoded to PTPv2 Domain 0 (for simplicity)
 - DDM gives extra PTP options
- Requires SAP Discovery Announcements
 - DDM allows manual SDP import



Unmanaged AES67: Enable

1. AES67 Mode needs to be Enabled in Dante Controller for each Device
2. RTP Multicast Address Prefix can be modified to:
 1. Match 3rd party incoming RTP flows*
 2. Set default Dante outgoing RTP flows range (*can be manually override*)



**Due to Hardware Limitations*

Unmanaged AES67: Subscribe to 3rd party

1. 3rd party devices need to announce their AES67 streams using the Session Announcement Protocol (SAP)
 1. Simple protocol for distributing the SDP content over multicast (239.255.255.255)
 2. Dante Controller will show the streams in Blue
2. Subscription is then possible
 1. RX Latency is fixed to 2ms

Dante Controller - Network View

Primary Leader Clock: Focusrite-RedNet-D16-AES

Routing | Device Info | Clock Status | Network Status | Events

Dante

Filter Transmitters
Filter Receivers

Transmitters (2)

- Focusrite-RedNet-D16-AES
- Anubis_Lucas_2101

Receivers (1)

- Focusrite-RedNet-D16-AES

Dante Controller - Device View

Receive | Transmit | Status | Latency | De

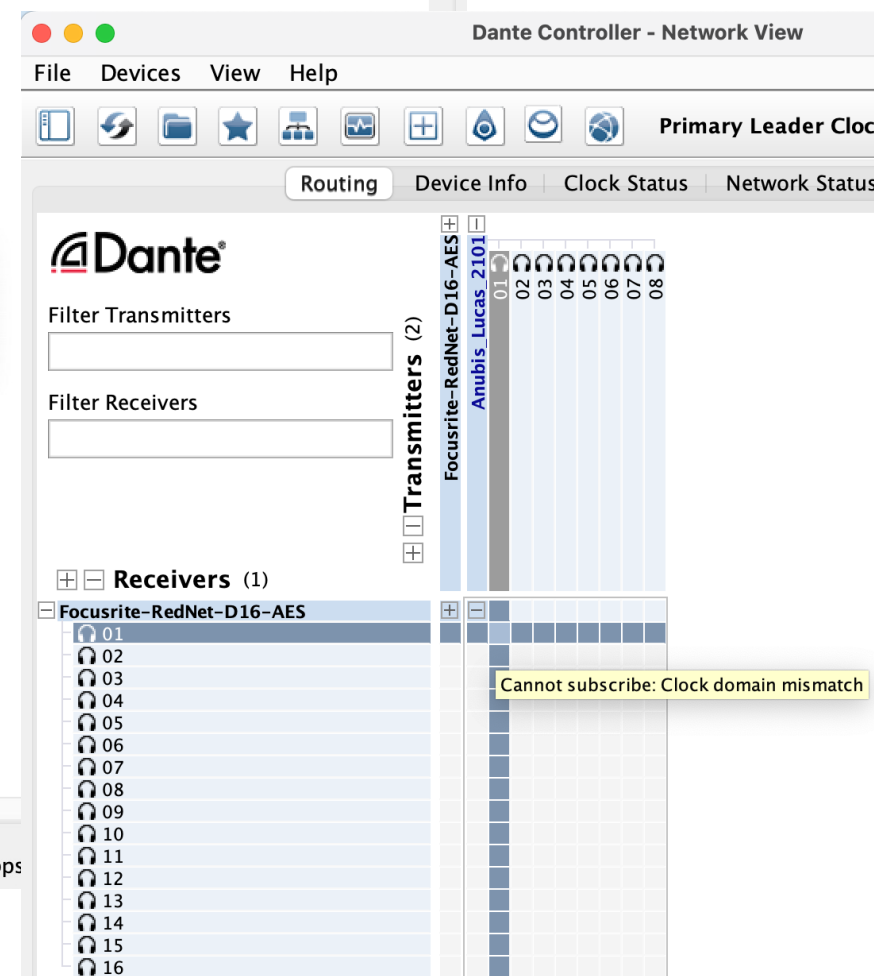
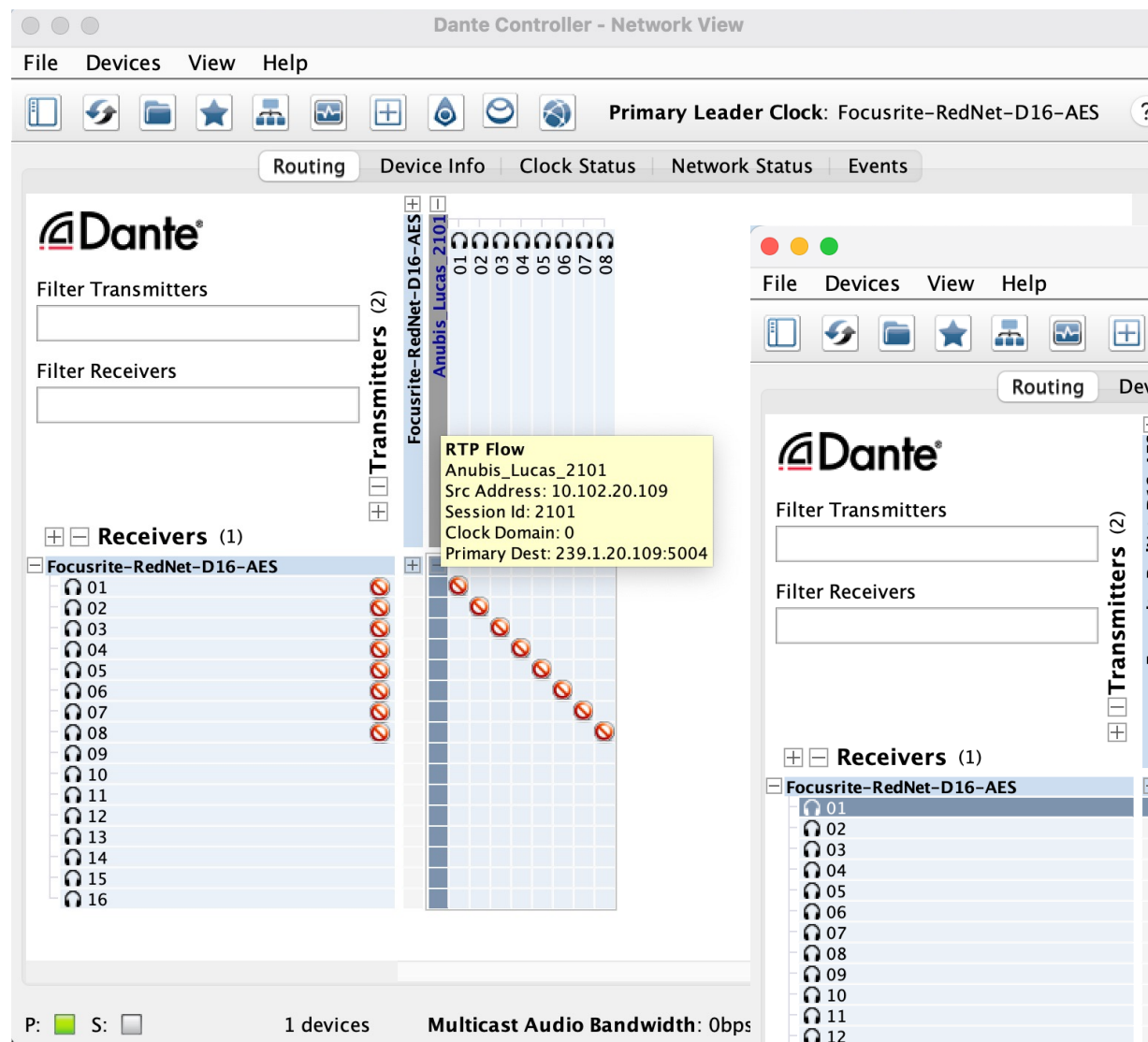
Channel	Connected To	Signal
01	01@239.69.20.109	✓
02	02@239.69.20.109	✓
03	03@239.69.20.109	✓
04	04@239.69.20.109	✓
05	05@239.69.20.109	✓
06	06@239.69.20.109	✓
07	07@239.69.20.109	✓
08	08@239.69.20.109	✓
09		
10		
11		
12		
13		
14		
15		
16		

P: S: 1 devices Multicast Audio Band

Unmanaged AES67: Subscribe to 3rd party

Troubleshooting

1. No audio data can be caused by
 1. Wrong IGMP settings
 2. Incorrect 3rd party RTP Prefix
2. Impossible subscription
 1. Wrong 3rd party PTP settings



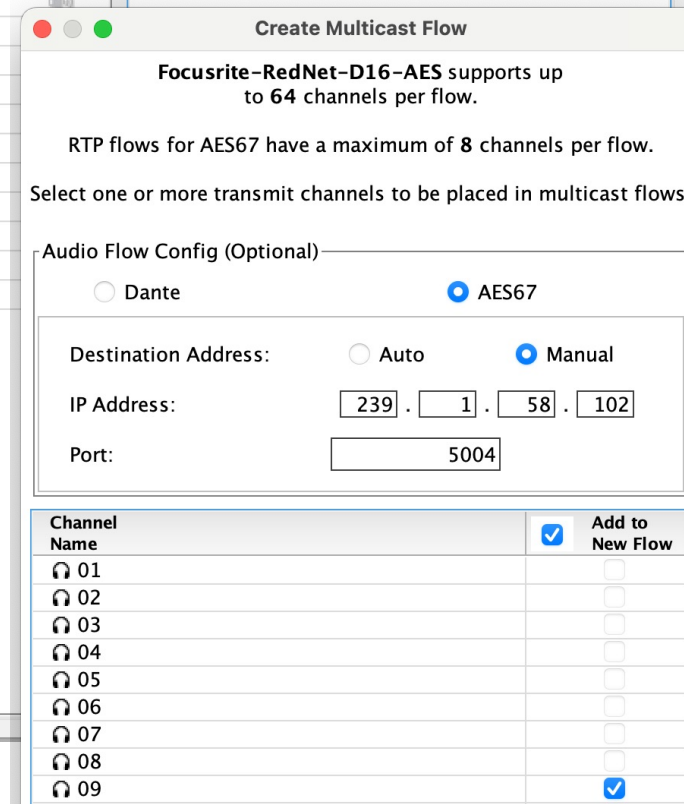
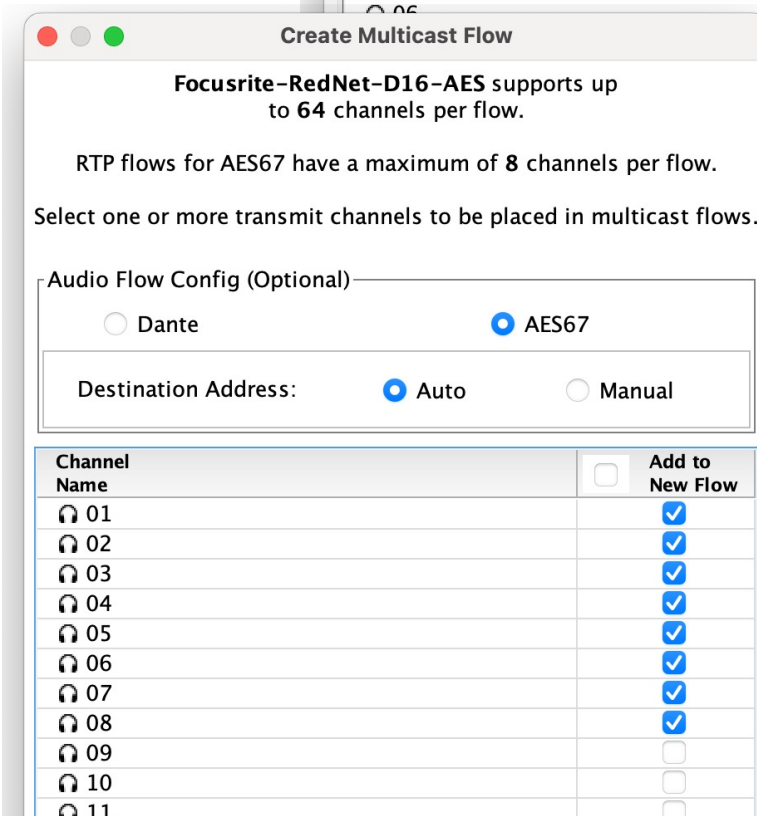
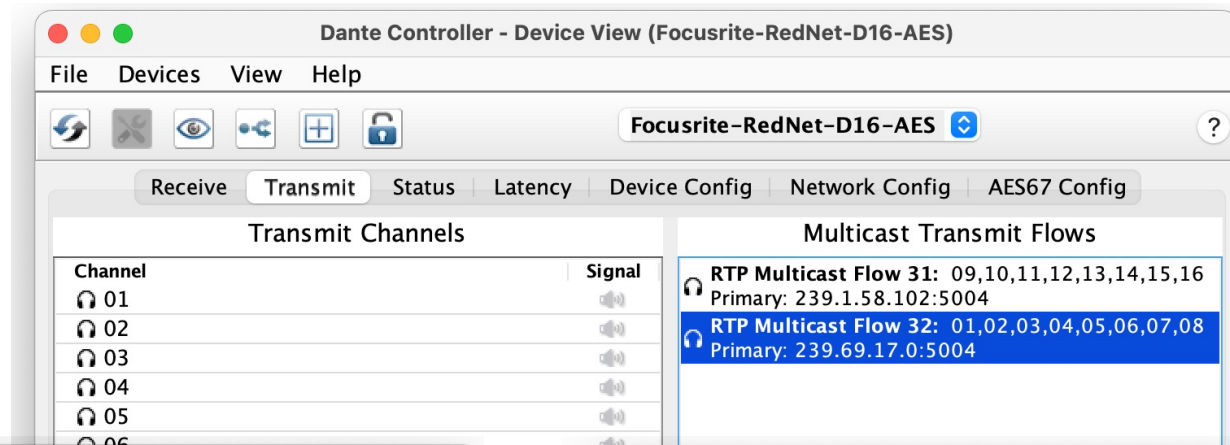
Unmanaged AES67: Create RTP Flow

1. AES67 Multicast flows can be created from Dante Controller

1. Using automatic destination addresses (based on the device RTP Prefix)
2. Manually specifying the Destination IP + Port

Audio between Dante devices will not use AES67 flows

Bandwidth = Dante flows + AES67 flows

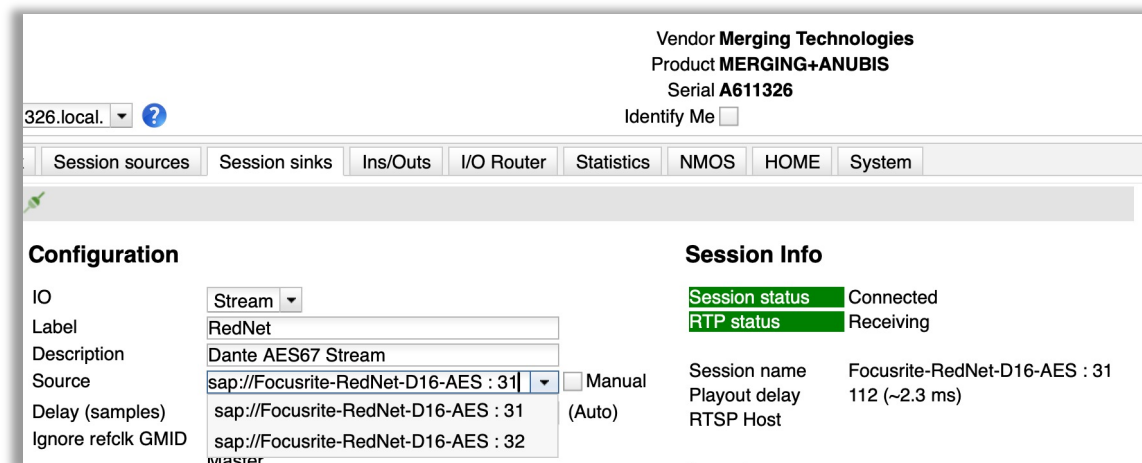


Unmanaged AES67: Create RTP Flow

- Dante devices will automatically announce the SDP session over SAP
 - *Won't be visible in Dante Controller*
- Will be automatically displayed on 3rd party devices with SAP support

```

> Frame 3058516: 402 bytes on wire (3216 bits), 402 bytes captured (3216 bits) on interface en8, id 0
> Ethernet II, Src: BKLYN-II-048556.local (00:1d:c1:04:85:56), Dst: IPv4mcast_7f:ff:ff (01:00:5e:7f:ff:ff)
> Internet Protocol Version 4, Src: BKLYN-II-048556.local (10.102.20.134), Dst: 239.255.255.255 (239.255.255.255)
> User Datagram Protocol, Src Port: 49946, Dst Port: 9875
> Session Announcement Protocol
> Session Description Protocol
  Session Description Protocol Version (v): 0
  > Owner/Creator, Session Id (o): - 37608999103 37608999103 IN IP4 10.102.20.134
  Session Name (s): Focusrite-RedNet-D16-AES : 31
  Session Information (i): 8 channels: 09, 10, 11, 12, 13, 14, 15, 16
  > Connection Information (c): IN IP4 239.1.58.102/32
  > Time Description, active time (t): 0 0
  > Session Attribute (a): keywds:Dante
  Session Attribute (a): recvonly
  > Media Description, name and address (m): audio 5004 RTP/AVP 103
  > Media Attribute (a): rtpmap:103 L24/48000/8
  > Media Attribute (a): ptime:1
  > Media Attribute (a): ts-refclk:ptp=IEEE1588-2008:00-1D-C1-FF-FE-04-85-56:0
  > Media Attribute (a): mediactk:direct=0
    
```



Vendor **Merging Technologies**
Product **MERGING+ANUBIS**
Serial **A611326**
Identify Me

326.local. ?

Session sources | Session sinks | Ins/Outs | I/O Router | Statistics | NMOS | HOME | System

Configuration		Session Info	
IO	Stream	Session status	Connected
Label	RedNet	RTP status	Receiving
Description	Dante AES67 Stream	Session name	Focusrite-RedNet-D16-AES : 31
Source	sap://Focusrite-RedNet-D16-AES : 31	Playout delay	112 (~2.3 ms)
Delay (samples)	sap://Focusrite-RedNet-D16-AES : 31	RTSP Host	
Ignore refclk GMID	sap://Focusrite-RedNet-D16-AES : 32 master		

Managed AES67 with DDM

Advanced Settings

Broadcast Studio

Advanced settings can be used to configure interoperability, site-based clocking partitioning and unicast clocking device selection.

Warning! Changing settings may interrupt audio.

Audio/Clocking Parameters

The current configuration can cause clocking problems if you use Dante devices in the unmanaged domain. Please ensure all devices in the unmanaged domain have AES67 disabled.

MODE	AES67
PTP CONFIGURATION	Custom
PTP V2 PRIORITY 1	248
PTP V2 PRIORITY 2	248
PTP V2 MULTICAST TTL	16
RTP PREFIX V4	69

- Enable AES67 mode and RTP Prefix at the Domain Level
 - Only on one Domain or Shared Audio Group
 - Can be restricted by Device
- Allow fine tuning of PTP settings
 - **PTPv2 Priorities 1 & 2:** Determines which devices in a PTPv2 clock domain will be automatically elected as clock leader
 - **Time To Live (TTL):** The range over which a PTPv2 multicast packet is propagated in your network
 - **RTP Prefix v4:** The IP address prefix for RTP flows (second octet)

UNENROLL
CHANGE DOMAIN

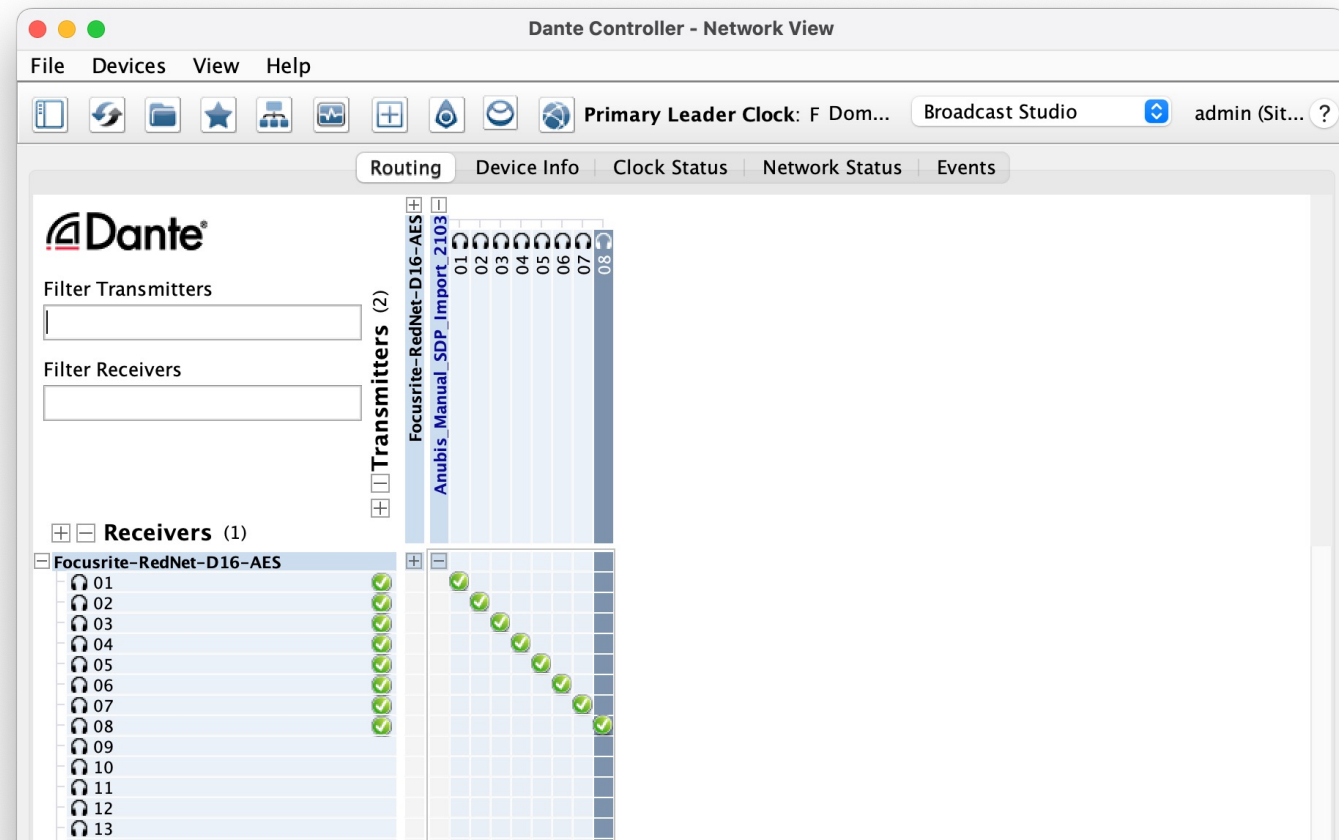
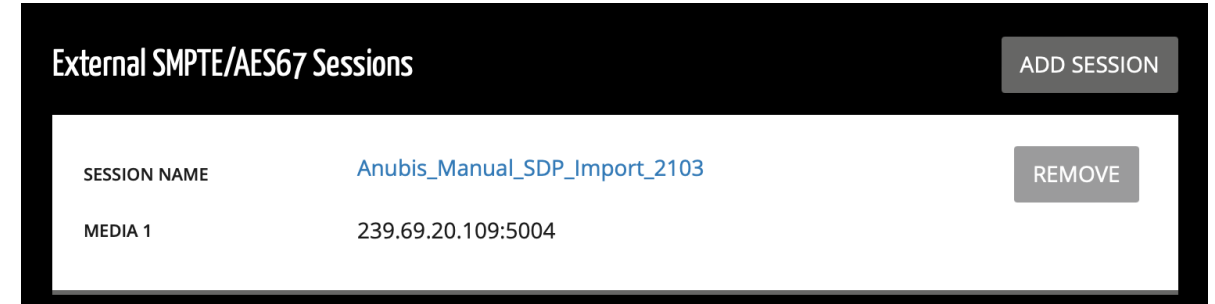
DOMAIN	Broadcast Studio
ENROLLMENT STATUS	Enrolled
CLOCK SYNC STATUS	● Locked
ALLOW SMPTE/AES67 FLOWS	Enabled ✔

Managed AES67: Import 3rd party SDP

1. Session Description Protocol (SDP) details from 3rd party devices can be imported manually at the Domain Level

1. 3rd party devices with SAP support will still be shown in Dante Controller (*if DC is in the same subnet as the device*)

2. DDM will display them as a Blue Virtual Device inside the Domain



Managed AES67: Export Dante SDP

1. Session Description Protocol (SDP) details from Dante devices can be exported manually at the Domain Level

1. Flow still needs to be created in Dante Controller
2. Dante devices will continue to announce the Flows over SAP

Dante SMPTE/AES67 Sessions

SESSION NAME	Focusrite-RedNet-D16-AES : 31
MEDIA 1	239.69.210.124:5004
SESSION NAME	Focusrite-RedNet-D16-AES : 32
MEDIA 1	

VIEW SESSION DESCRIPTOR ✕

```

v=0
o=- 37612736184 37612736184 IN IP4 10.102.20.134
s=Focusrite-RedNet-D16-AES : 32
i=8 channels: 01, 02, 03, 04, 05, 06, 07, 08
c=IN IP4 239.69.81.9/32
t=0 0
a=keywds:Dante
a=recvonly
m=audio 5004 RTP/AVP 103
a=rtpmap:103 L24/48000/8
aptime:1
a=ts-refclk:ptp=IEEE1588-2008:00-1D-C1-FF-FE-04-85-56:0
a=mediack:direct=0
                    
```

OK

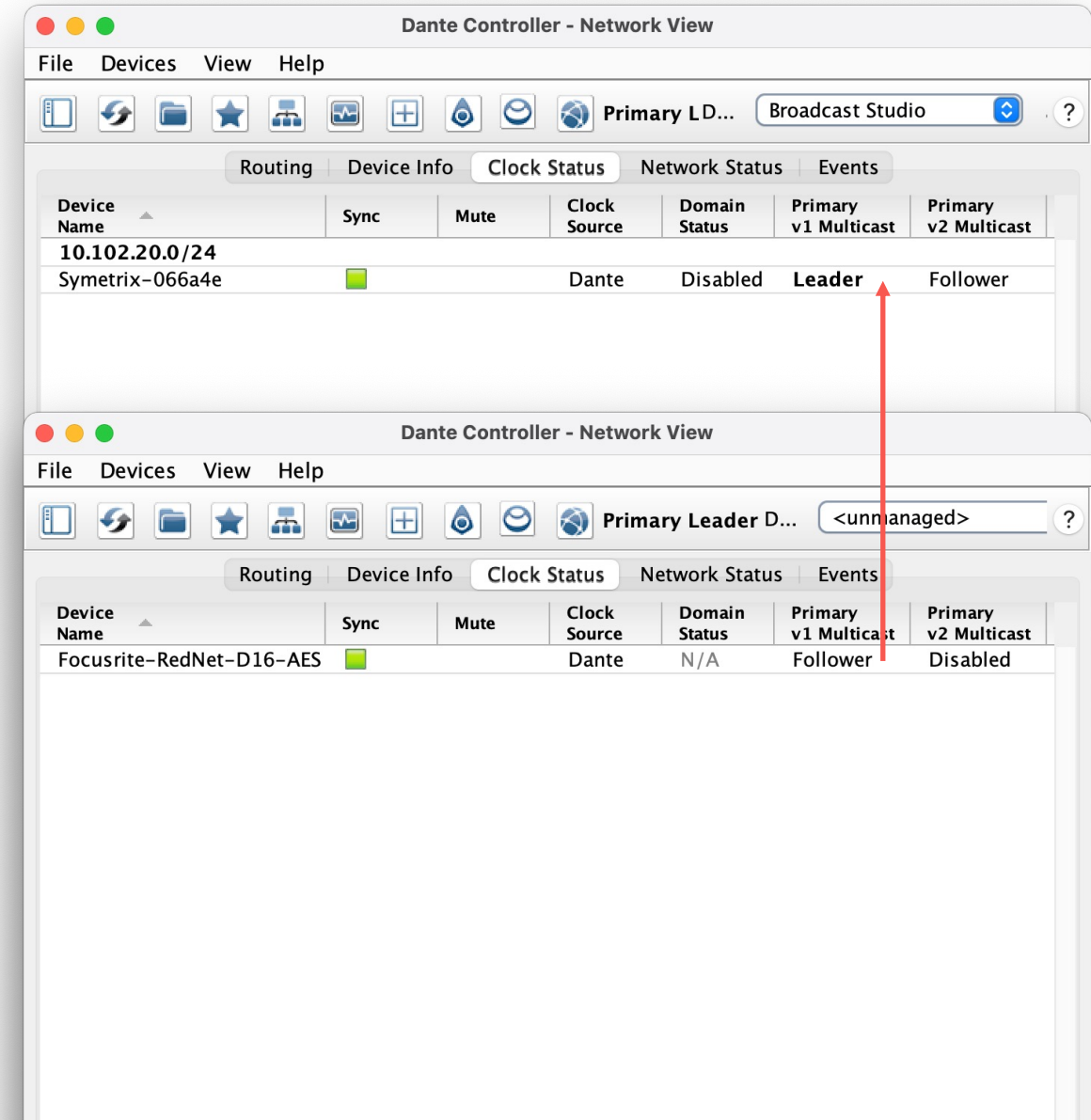
Managed AES67 and Unmanaged Devices

Managed AES67 Modes (or ST2110 or Dante PTPv2 using the PTPv2 Domain 0):

- Use the same PTPv1 Subdomain as Unmanaged Dante devices
- Use the same PTPv2 settings as Unmanaged AES67

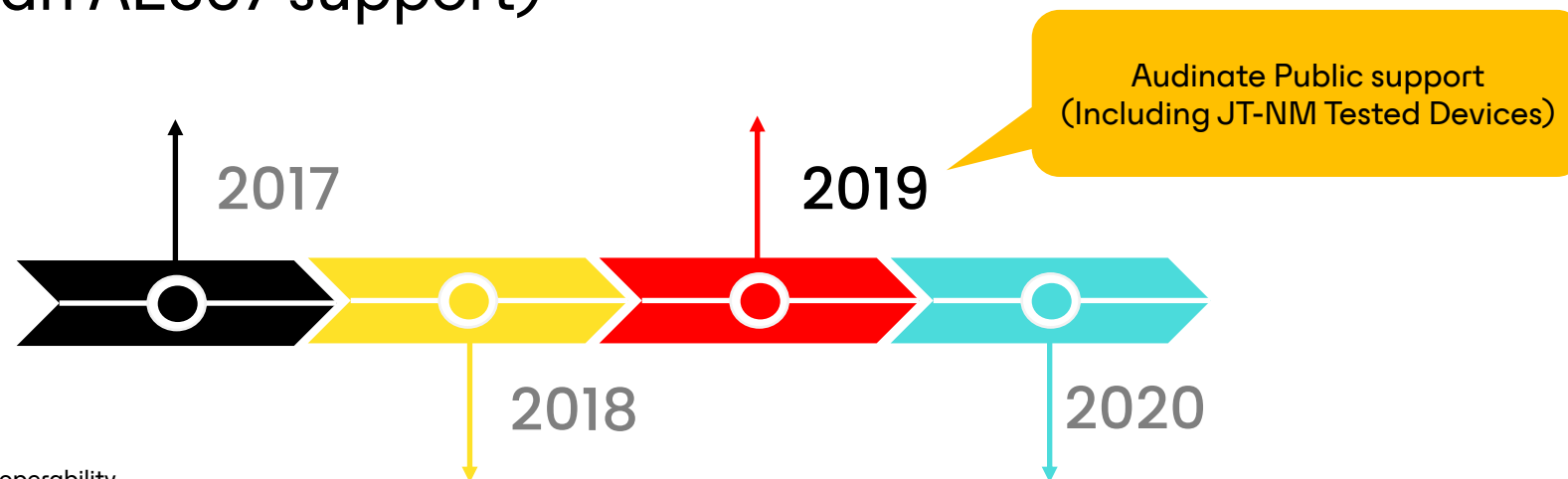
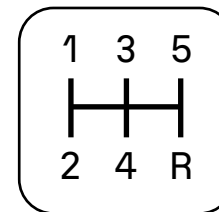
This can result in clocking interference between Managed and Unmanaged Devices

- In any case this will result in shared audio between Managed and Unmanaged



Dante ST2110 Audio

- Requires DDM which Centrally Adds:
- Consolidated Control for Whole Deployment
- Layer 3 Network Spanning, Access Control
- Device Monitoring and Logging
- Support needs to be enabled by the OEM (different setting than AES67 support)
- No NMOS support



Managed ST2110

- Enable SMPTE mode at the Domain Level
- PTP related settings:
 - **PTP v1 Multicast:** Disabling PTP v1 multicast can prevent instability in non-Dante SMPTE devices
 - Requires that all Dante devices must be PTPv2 compatible.
 - PTP v2 Domain Number
 - PTP v2 Priority 1 / 2
 - PTP v2 Sync / Announce Interval
 - PTP v2 Multicast TTL
 - PTP follower Only: Devices in domain will not be elected as clock leader

Advanced Settings

Broadcast Studio

Advanced settings can be used to configure interoperability, site-based clocking partitioning and unicast clocking device selection.

Warning! Changing settings may interrupt audio.

SAVE CHANGES
CANCEL EDITING

Audio/Clocking Parameters

MODE	SMPTE
PTP V1 MULTICAST	<input checked="" type="checkbox"/>
PTP V2 DOMAIN NUMBER	127
PTP V2 PRIORITY 1	128
PTP V2 PRIORITY 2	128
PTP V2 SYNC INTERVAL	-3
PTP V2 ANNOUNCE INTERVAL	-2
PTP V2 MULTICAST TTL	1
PTP SLAVE ONLY	<input type="checkbox"/>
RTP TRANSMIT PORT	5004
SYSTEM PACKET TIME	1ms
RX LATENCY	2ms
RTP PREFIX V4	69

Managed ST2110

- RTP related settings:
 - **RTP Transport Port:** Transmit port number for RTP packets.
 - **System Packet Time:** Transmit time of the RTP stream expressed as the number of samples of each channel in one packet (1ms or 125us)
 - **Rx Latency:** Receive latency for SMPTE flows in the domain (2ms or 3ms)
 - **RTP Prefix v4:** The IP address prefix for RTP flows (second octet)

Advanced Settings

Broadcast Studio

Advanced settings can be used to configure interoperability, site-based clocking partitioning and unicast clocking device selection.

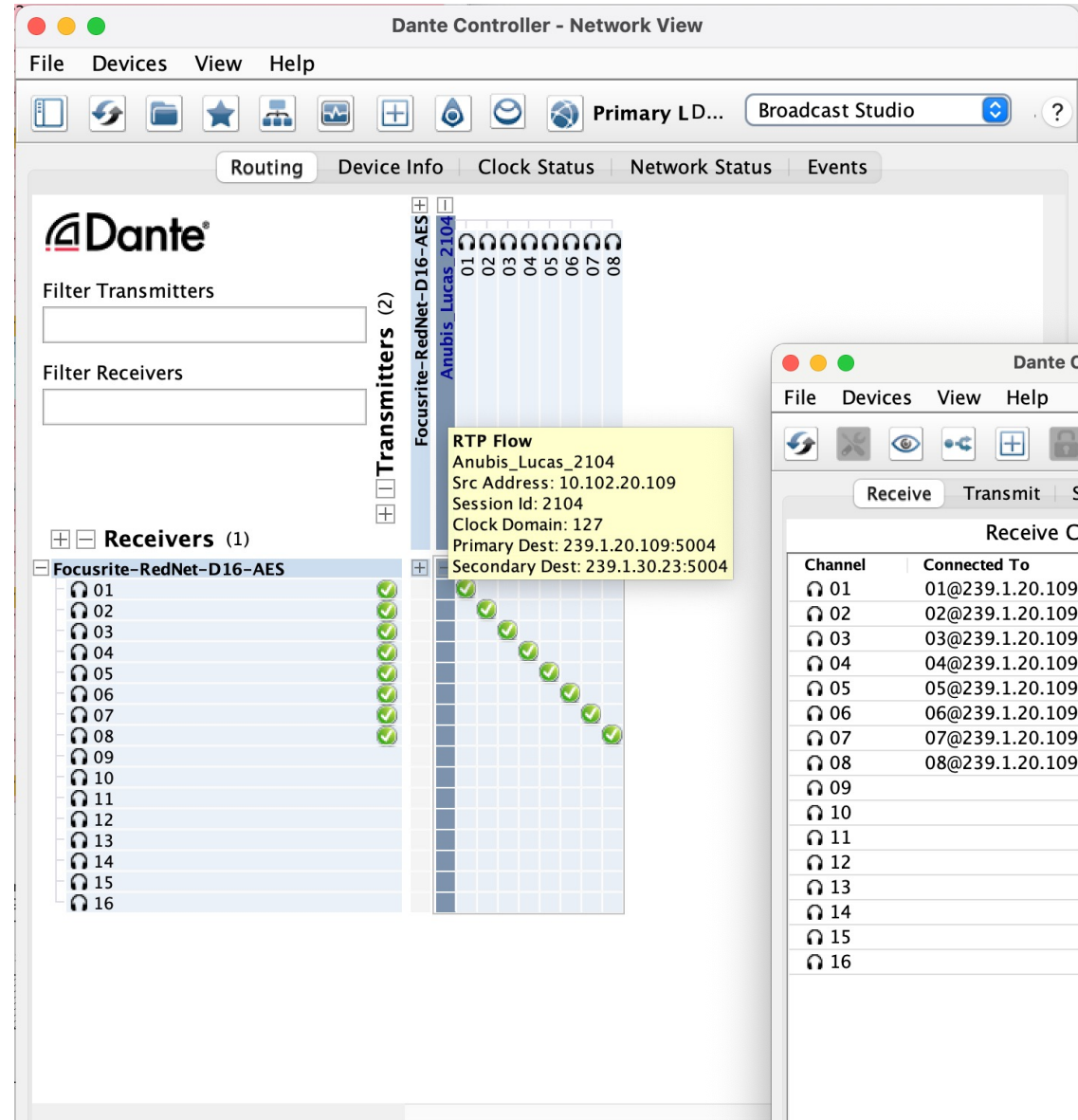
Warning! Changing settings may interrupt audio.

Audio/Clocking Parameters SAVE CHANGES CANCEL EDITING

MODE	SMPTE
PTP V1 MULTICAST	<input checked="" type="checkbox"/>
PTP V2 DOMAIN NUMBER	127
PTP V2 PRIORITY 1	128
PTP V2 PRIORITY 2	128
PTP V2 SYNC INTERVAL	-3
PTP V2 ANNOUNCE INTERVAL	-2
PTP V2 MULTICAST TTL	1
PTP SLAVE ONLY	<input type="checkbox"/>
RTP TRANSMIT PORT	5004
SYSTEM PACKET TIME	1ms
RX LATENCY	2ms
RTP PREFIX V4	69

Managed ST2110: Subscribe to 3rd party

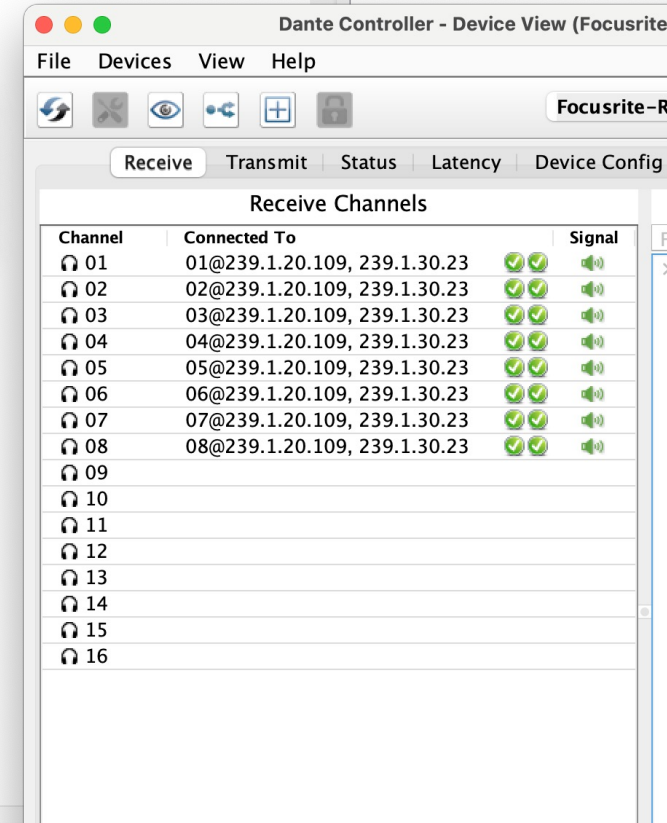
1. 3rd party devices flows will be shown in Blue in Dante Controller
 1. If the 3rd party device supports SAP (*and DC is in the same subnet*)
 2. If the SDP has been manually imported to DDM
2. Subscription is then possible
 1. Be sure RTP Prefix Match!
3. Flow redundancy (ST2022-7) will be used if available



The screenshot shows the Dante Controller interface in Network View. The main window displays a routing matrix with a yellow tooltip for an RTP flow. The tooltip contains the following information:

- RTP Flow
- Anubis_Lucas_2104
- Src Address: 10.102.20.109
- Session Id: 2104
- Clock Domain: 127
- Primary Dest: 239.1.20.109:5004
- Secondary Dest: 239.1.30.23:5004

The routing matrix shows connections between transmitters and receivers. The transmitter 'Anubis_Lucas_2104' is connected to receivers 01 through 08. The receiver 'Focusrite-RedNet-D16-AES' is connected to transmitters 01 through 08.



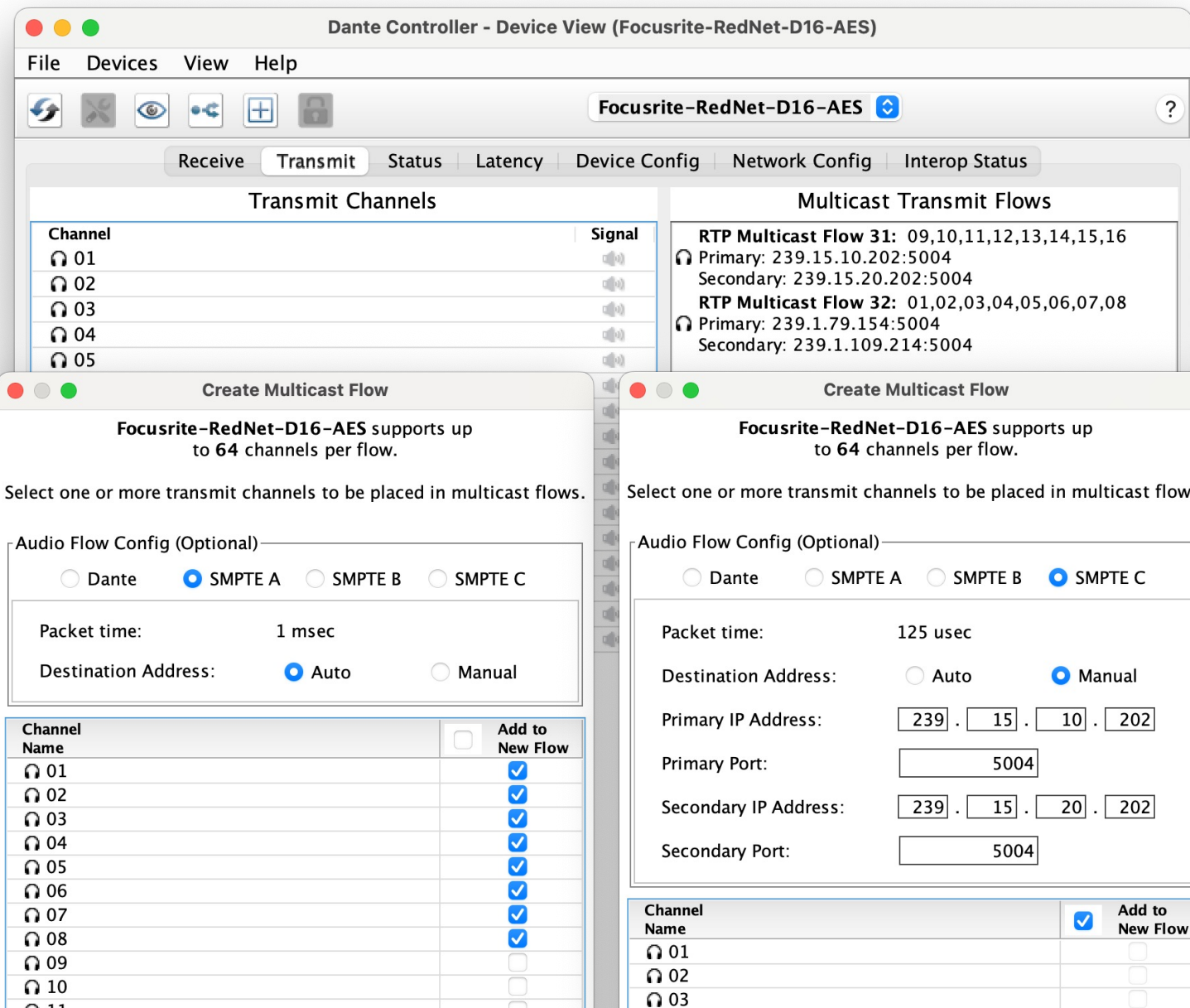
The screenshot shows the Dante Controller interface in Device View for the Focusrite-RedNet-D16-AES device. The 'Receive Channels' table is visible, showing the following data:

Channel	Connected To	Signal
01	01@239.1.20.109, 239.1.30.23	✓✓✓
02	02@239.1.20.109, 239.1.30.23	✓✓✓
03	03@239.1.20.109, 239.1.30.23	✓✓✓
04	04@239.1.20.109, 239.1.30.23	✓✓✓
05	05@239.1.20.109, 239.1.30.23	✓✓✓
06	06@239.1.20.109, 239.1.30.23	✓✓✓
07	07@239.1.20.109, 239.1.30.23	✓✓✓
08	08@239.1.20.109, 239.1.30.23	✓✓✓
09		
10		
11		
12		
13		
14		
15		
16		

Managed ST2110: Create Redundant Flow

- SMPTE 2110 Multicast flows can be created from Dante Controller
 - With the desired Conformance Level
 - Using automatic destination addresses (based on the device RTP Prefix)
 - Manually specifying the Destination IP + Port

Conformance Level	Sample Rate	Audio Channels	Packet Times
SMPTE A	48 KHz	1~8	1 ms
SMPTE B	48 KHz	1~8	125 us
SMPTE C	48 KHz	1~64	125 us



Managed ST2110: Import/Export SDP

- Dante Controller will still show 3rd party flows using SAP
- Dante Devices will still announce their 2110 flows using SAP
- Dante Domain Manager will also allow to:
 - Import 3rd party SDP files manually
 - Export Dante SDP flows content

Dante SMPTE/AES67 Sessions

SESSION NAME	Focusrite-RedNet-D16-AES : 31
MEDIA 1	239.15.10.202:5004
MEDIA 2	239.15.20.202:5004

SESSION NAME	Focusrite-RedNet-D16-AES : 32
MEDIA 1	239.1.79.154:5004
MEDIA 2	239.1.109.214:5004

External SMPTE/AES67 Sessions

ADD SESSION

SESSION NAME	Anubis_Manual_Flow		
MEDIA 1	239.1.20.109:5004		
MEDIA 2	239.1.30.23:5004		

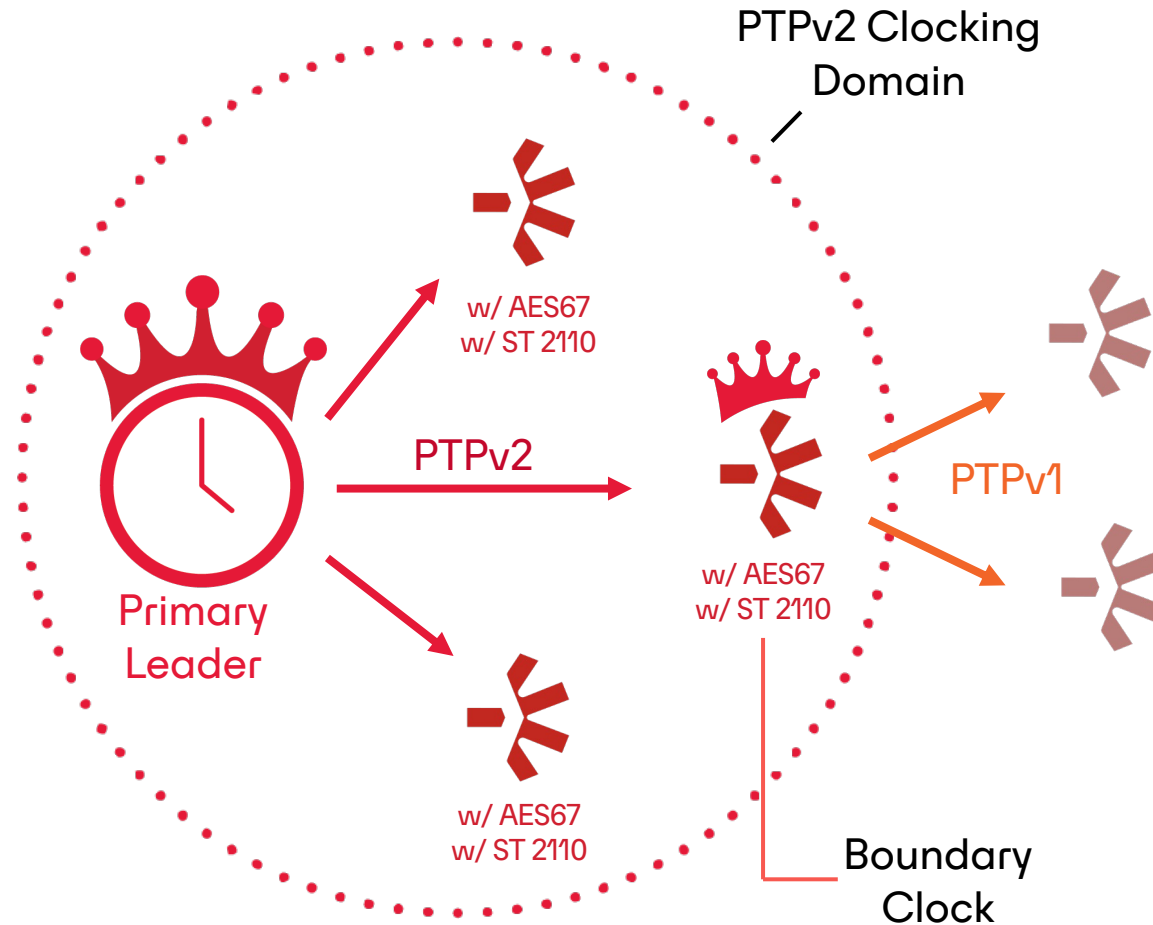
REMOVE

Precision Time Protocol (PTP): v1 & v2

Dante devices with AES67 or ST 2110 engaged can chase PTPv2 master clocks.

Options:

1. Prefer PTPv2 (BMCA)
2. PTPv2 Follower Only (ST 2110 Compliant)



Dante Interoperability PTPv2 options

	AES67	SMPTE
Domain	0	0 ~ 127
Priority 1 & 2	Device Specific 0 ~ 248 ~ 255 (<i>Custom Managed AES67</i>)	0 ~ 128 ~ 255
Announce Interval	0 (1 sec)	-3 ~ -2 ~ 1 (0,125 ~ 0,25 ~ 2 sec)
Announce Timeout Interval	3 (8 sec)	
Sync Interval	-2 (0,25 sec)	-7 ~ -3 ~ -1 (0,0078125 ~ 0,125 ~ 0,5 sec)
Delay-Req Interval	0 (1 sec)	
Timestamp Mechanism	One or Two Step	
Delay Mechanism	End to End (E2E)	
Time To Live (TTL)	16	1 ~ 16 ~ 63

QoS DSCP Queues

Audinate's markings when sending

AES67 &  ST 2110

QoS Priority	Data Type	Recommended DSCP Values
High	PTPv2	46 (EF)
Medium	RTP Media	34 (AF41)

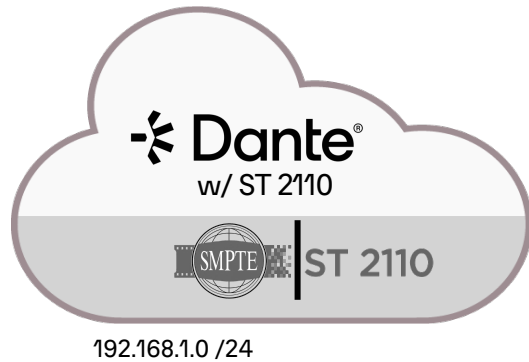
Audinate implements AES67-recommended DSCP values

for AES67 and ST 2110 clocking packets and media streams as of v4.2 in 2019.

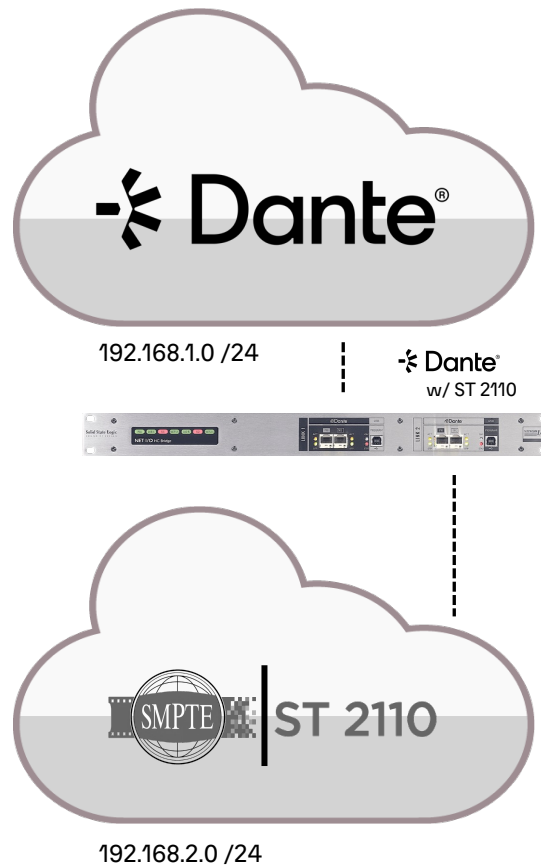
Design Topology

Topology Options

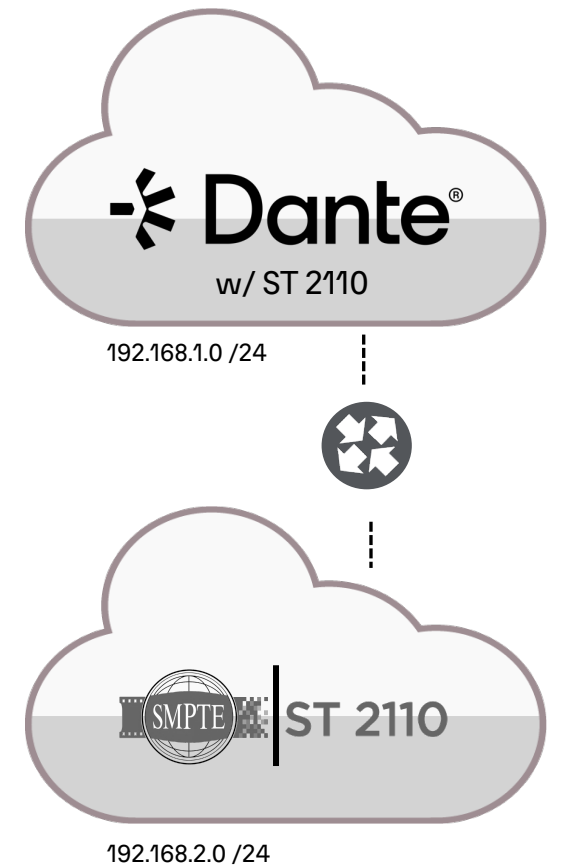
Option 1:
Complete Coexistence



Option 2:
Bridge Device

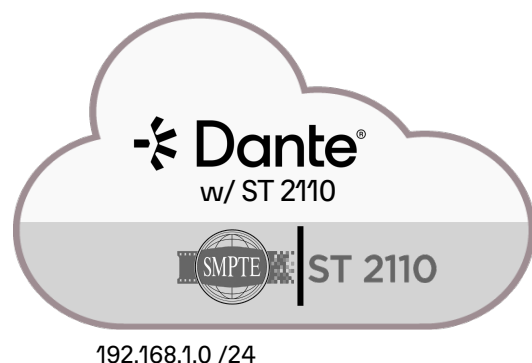


Option 3:
Multicast Routing (PIM)



Topology Options: Coexistence

Option 1: Complete Coexistence

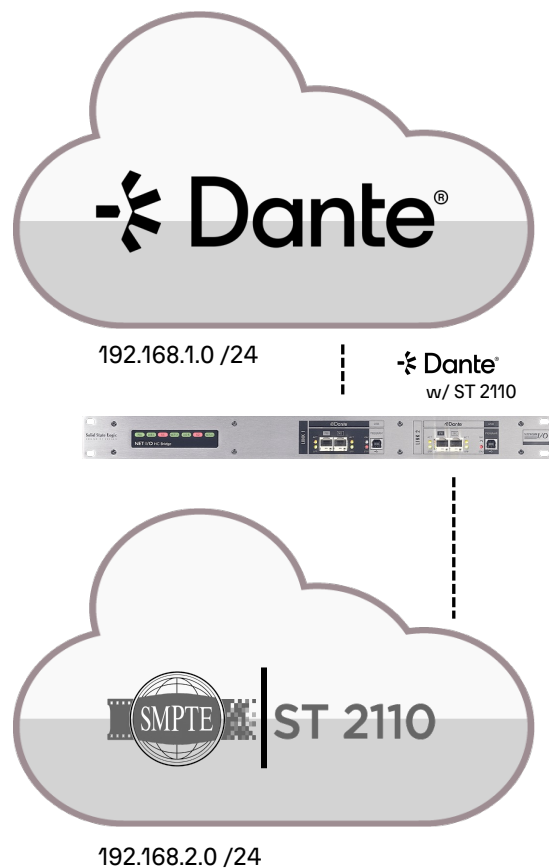


- Basic Principles:
 - Dante devices will be managed by Dante Domain Manager
- Special notes if QoS is engaged
 - PTPv1 uses DSCP 56 (CS7) - Higher than PTPv2
 - PTPv1 Multicast can be Disabled in DDM
 - Requires all Dante devices to support ST 2110



Topology Options: Bridge Device

Option 2: Bridge Device



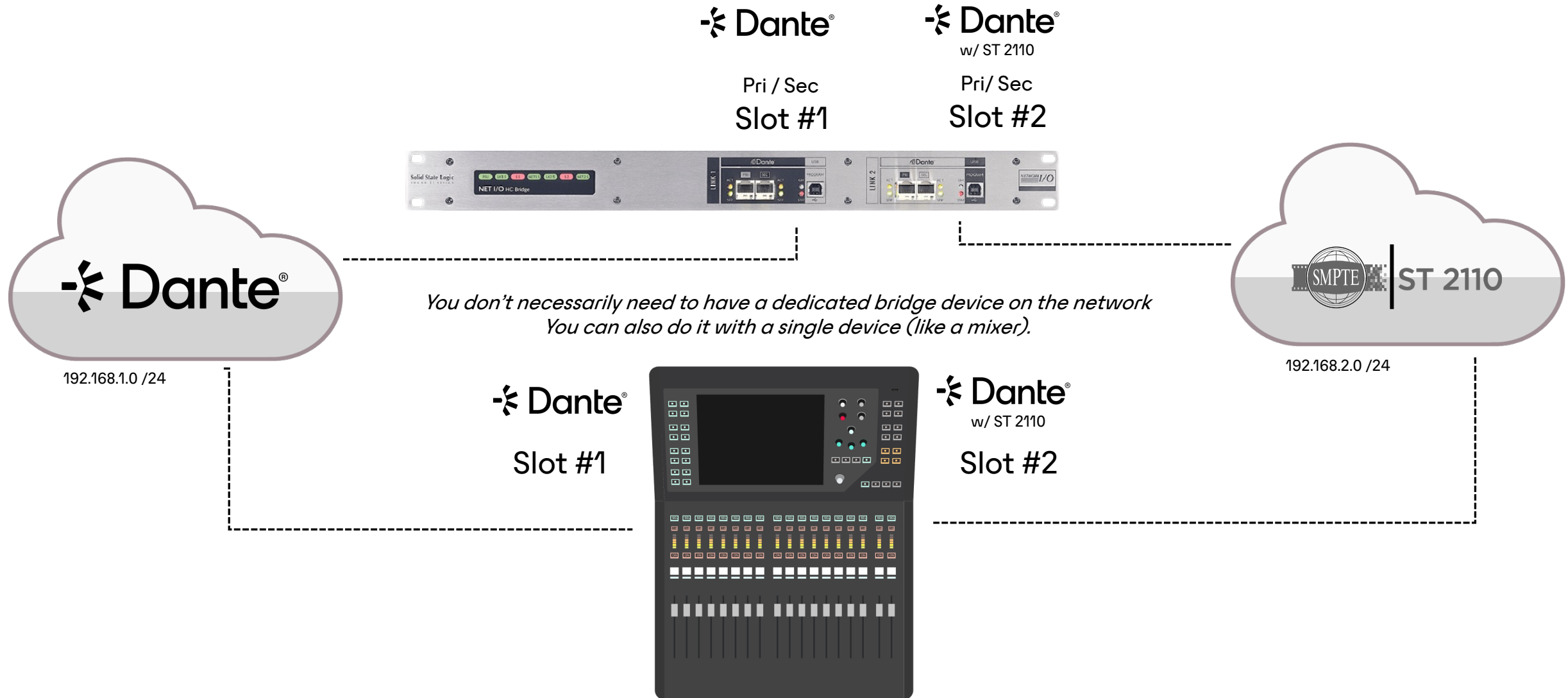
- Basic Principles:

- Dante Domain Manager only required for the Dante devices in ST 2110 mode
- Separate VLANs simplifies separate Dante traffic optimization

- Special notes:

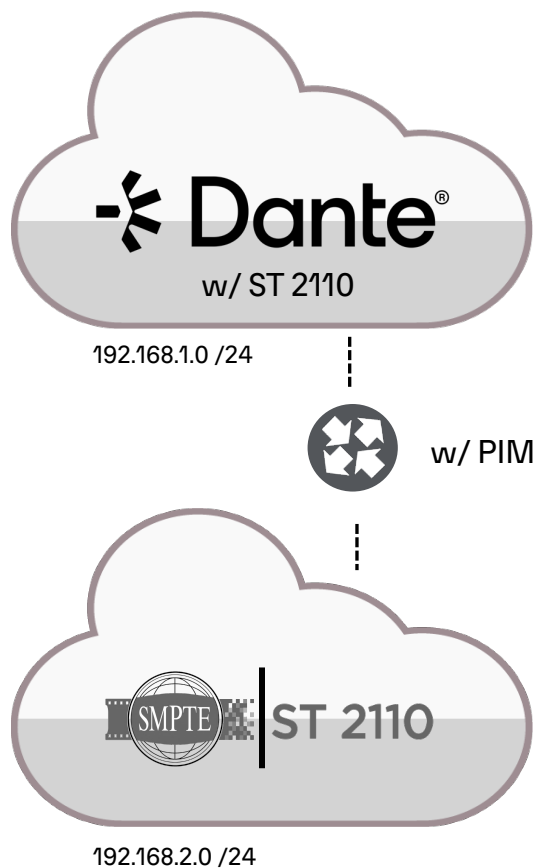
- Default Dante and PTPv1 are completely isolated from the ST2110 Network
- Bridge device can manage sample rate conversion if production and network sample rates are different.

Topology Options: Bridge Device



Topology Options: Multicast Routing

Option 3: Multicast Routing (PIM)



- Basic Principles:
 - Dante devices will be managed by Dante Domain Manager
 - Network infrastructure needs to be PIM capable
 - To be implemented by a network specialist
- Special notes:
 - RTP Multicast flows from/to Dante/ST2110 devices need to be declared on the Network
 - Dante does NOT support Source Specific Multicast (SSM)
 - PIM allows range forwarding. Ex: 239.69.xx.yy/16
 - Need to be configured in DDM

A dark, high-contrast background image showing a hand resting on a mixing console with numerous faders and knobs.

“Audio and video quality is exceptional,
and the flexibility to route audio and
video around the facility on just a few
cables was very liberating”.

Dennis Cham, Founding Partner and Chief Technology
Officer of HIT Productions