Dante Over Distance

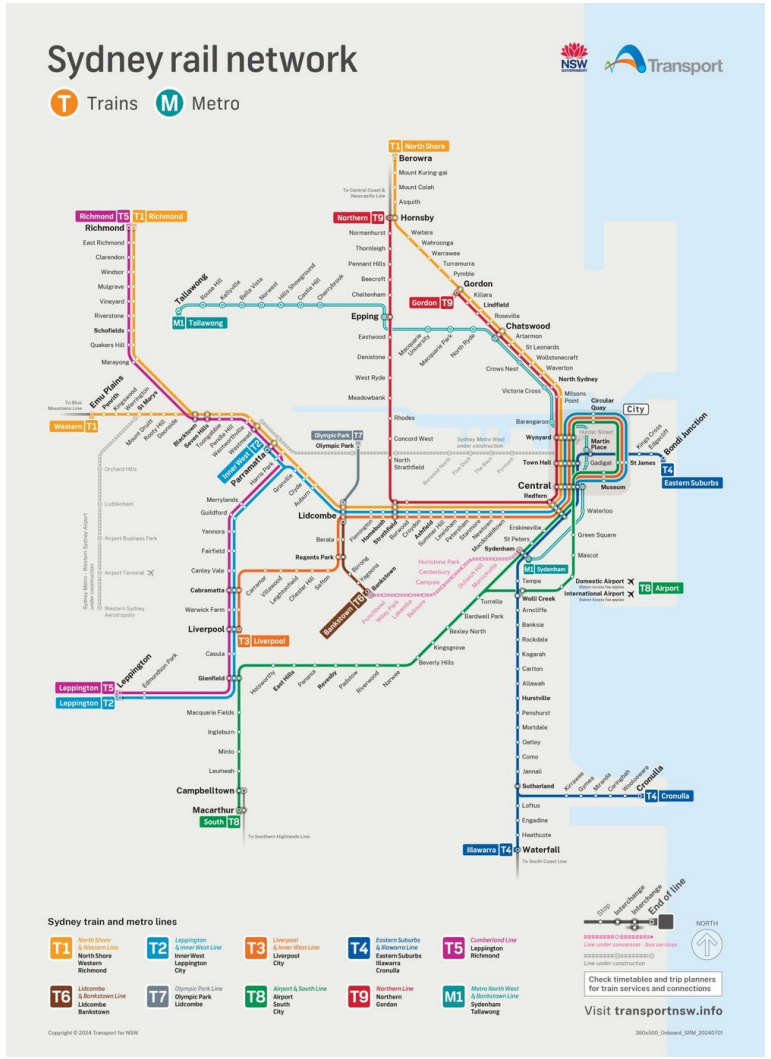
Technical Dive

Dante Over Distance Successes

Sydney Trains Rail Network

- Geographically the project spans over an area the size of France
- 178 stations on the Sydney Trains network plus 63 on the New South Wales Trains network
- Use of MPLS Network Design.
- Achieved goal : Latency < 2ms


Sydney's Central Station

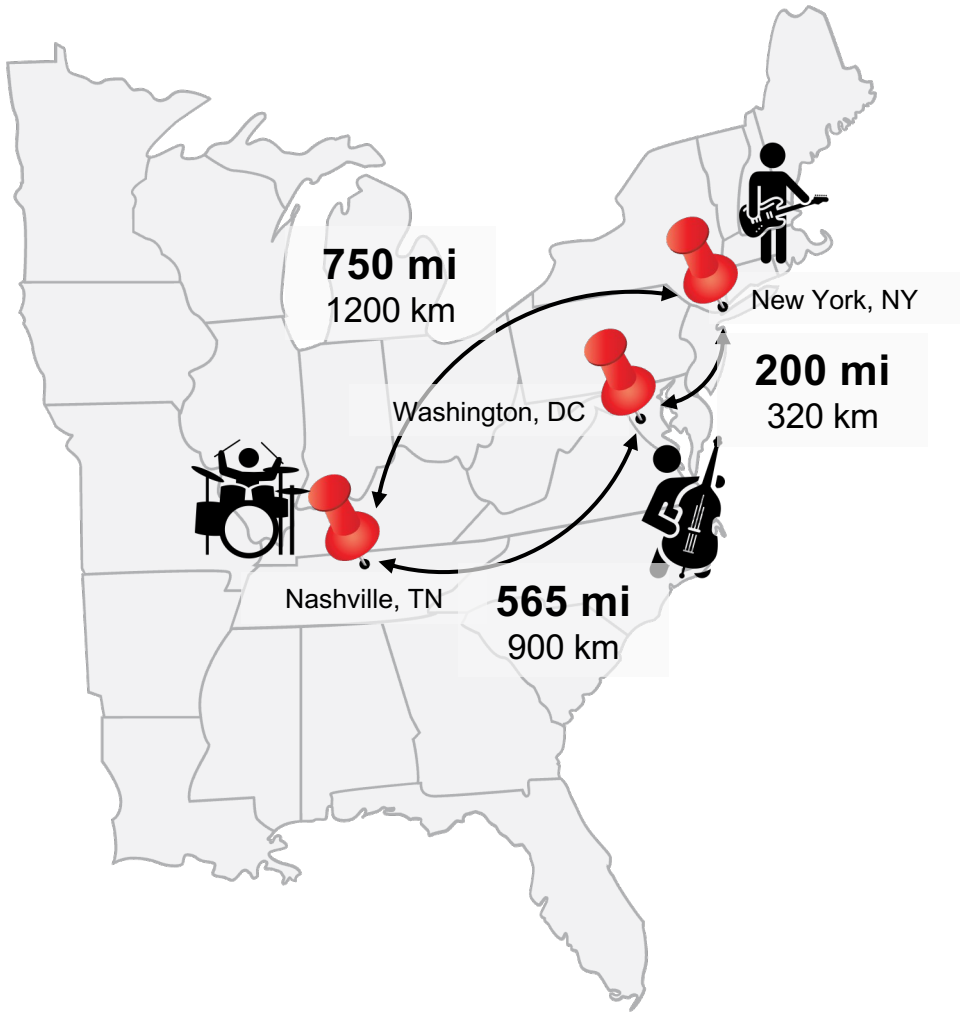


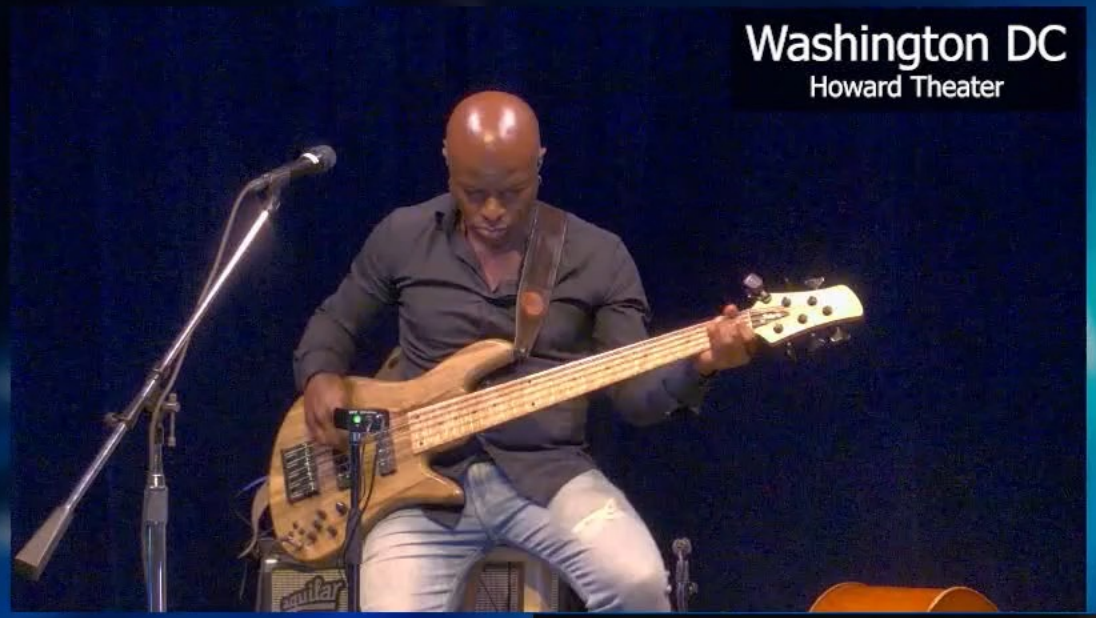
Dante Over Distance Successes

Dante & Blue Note Entertainment Group

- Three Locations, 750 miles (1200 km) span
  New York, NY - Washington DC - Nashville, TN
- Affordable 1Gbps Layer 3 Shared Fiber
  Common Network to All Locations
  Full Access to All Sources on All Properties
- High Quality Production
  Low Latency for Seamless Musical Production
  Uncompressed Audio and Broadcast-Quality Video

Dante + Dante AV™ + Dante Domain Manager™




Washington DC
Howard Theater


Nashville, TN
SIR Production Studios

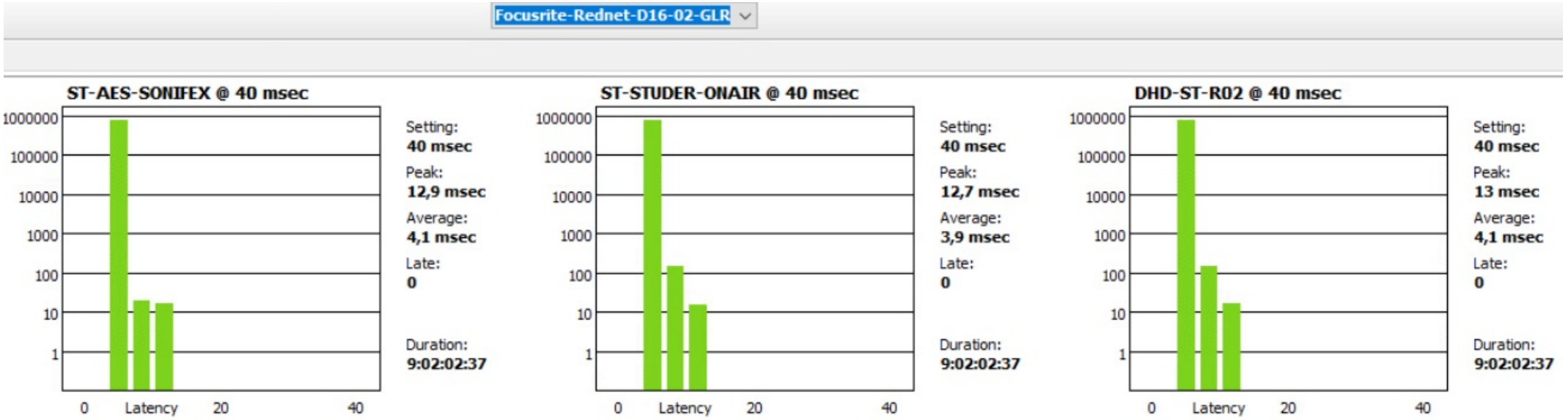

New York, NY
Sony Hall

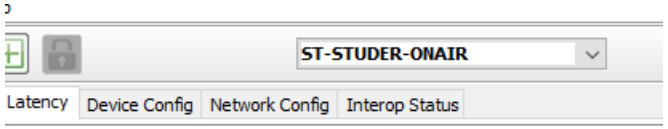
Dante Over Distance Successes

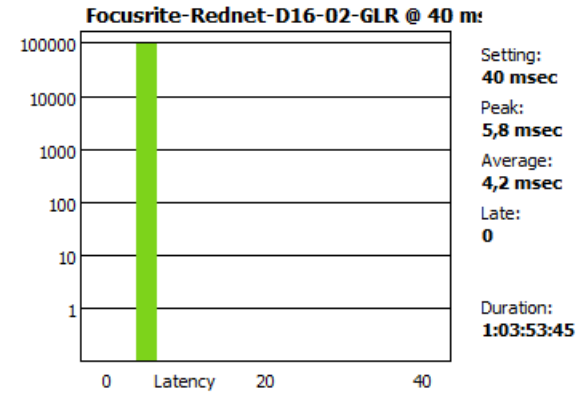
HRT Broadcaster in Croatia

- 12 terrestrial radio channels and number of online channels.
- Main location is in Zagreb with DDM.
- Minimum there are 4 channels both way, up to 16 for some events.
- Each location with a GPS synced master clock.
- Dedicated network connections provided by T-Com, using MPLS technology.
- QoS in place.
- Bandwidth for Split is 500Mbps and for Knin is 50Mbps.
- Physical distance between Zagreb and Split is around 400km, Knin is geographically closer to Zagreb, but physical path is a bit longer than Split – around 500km.

Dante Over Distance Successes



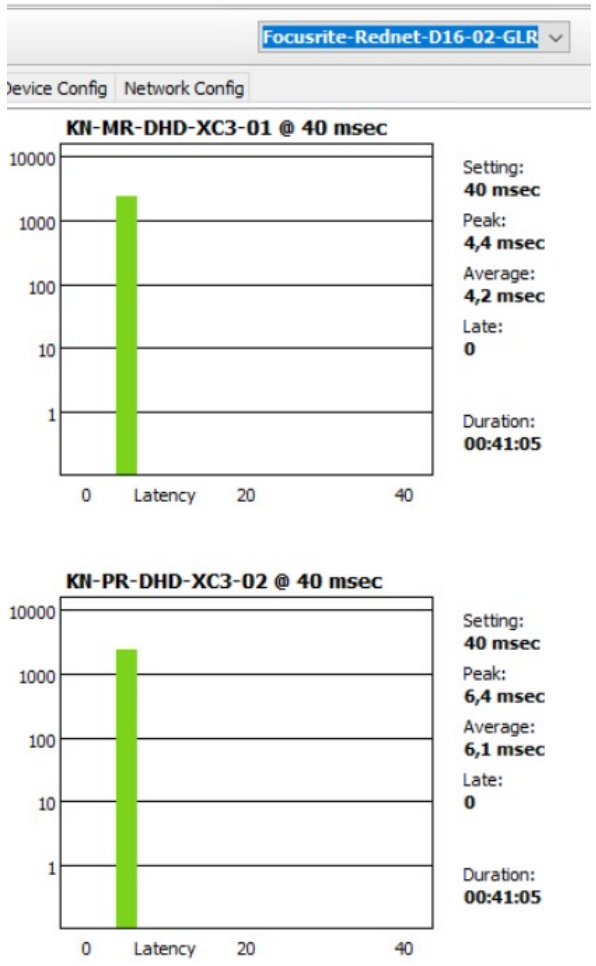




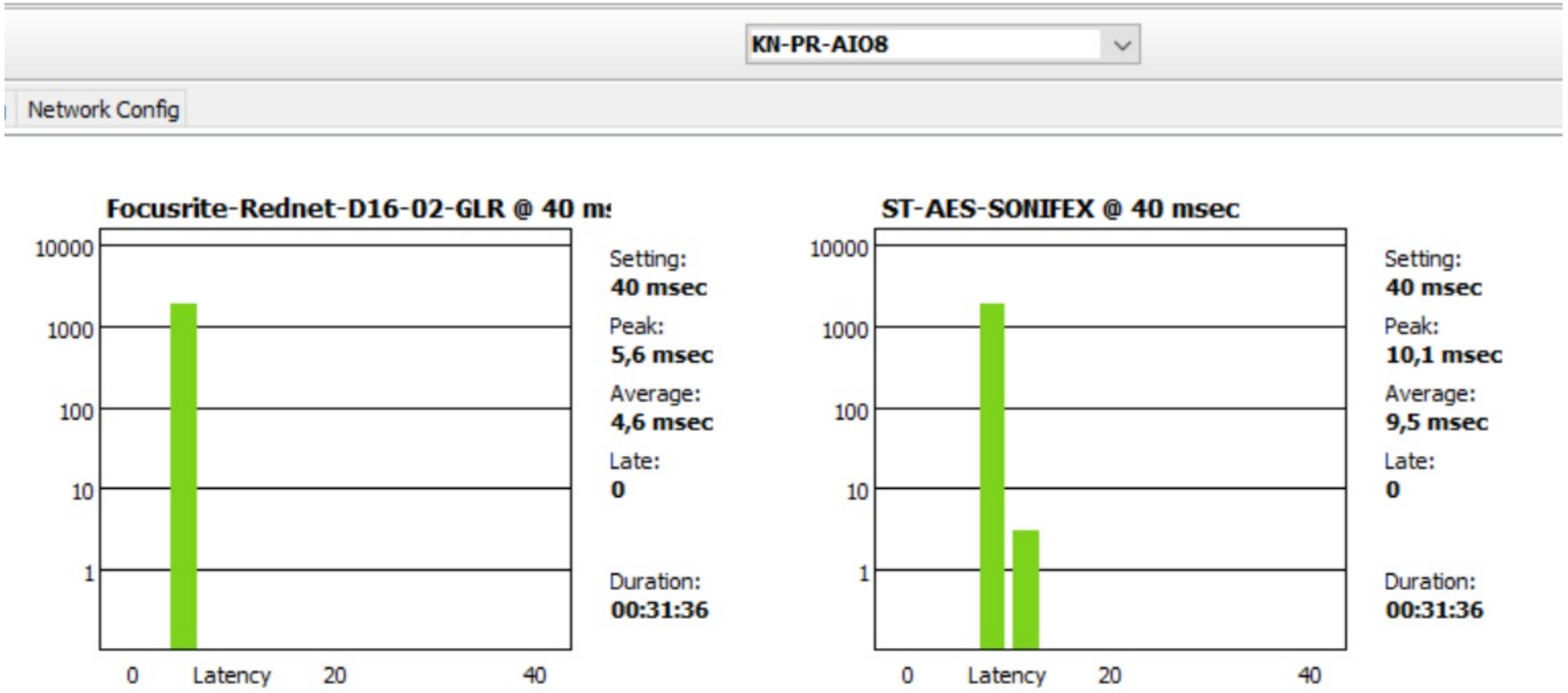
- First 3 charts are the Latency measured for 9 days, from a device that is in Zagreb which receives audio from 3 devices from Split.
- Chart below is in Split location.

Dante Over Distance Successes

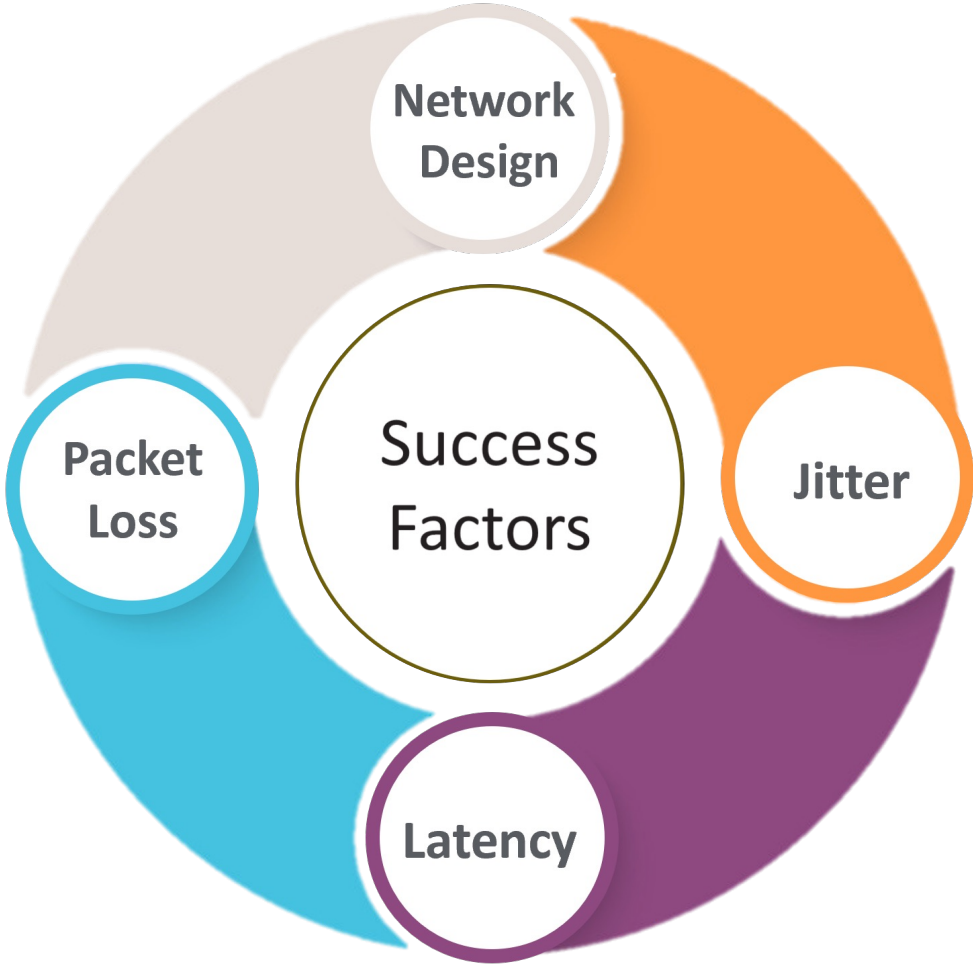
- From Knin to Zagreb.



- From Zagreb (left) and from Split (right), note that audio connection from Split to Knin is made via Zagreb, some 900km, so overall latency is around 9,5 ms

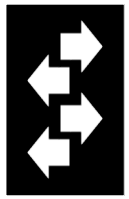


Dante Over Distance Success Factors



Network Design

- The distant locations might be part of the same VLAN or be on different routed Network Subnets.

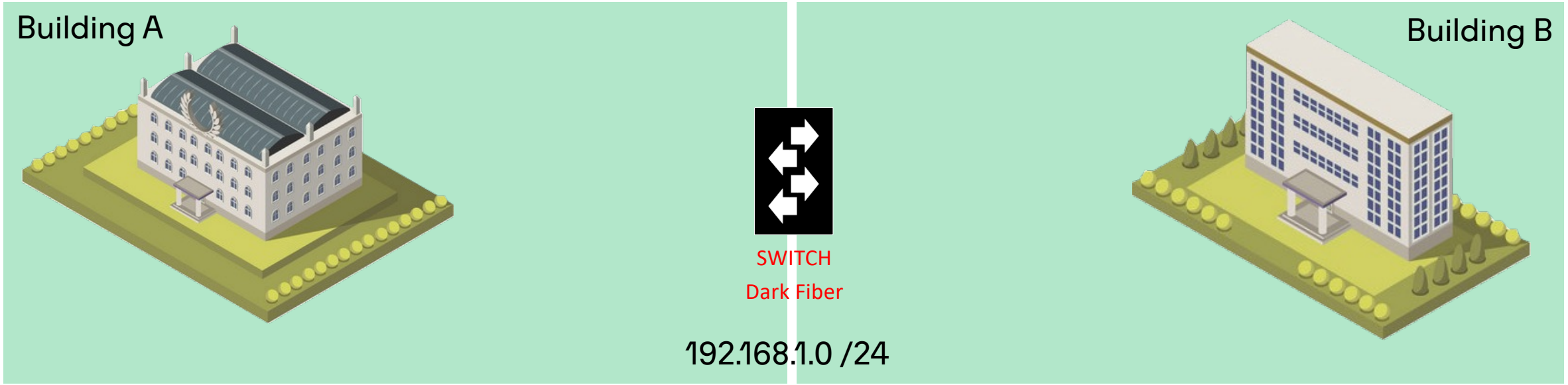


Layer 2
interface

Layer 3
interface

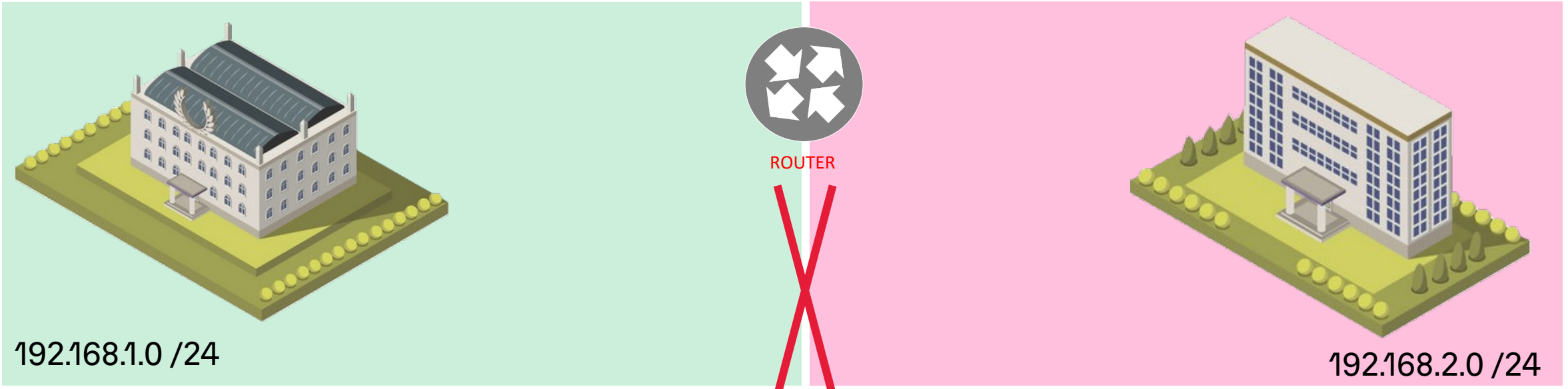
Network Design: Layer 2

- Distant locations are on the same Layer 2 network (Ex: dark fiber)
- Latency and Jitter might exceed default tolerated values on un-managed networks
  - DDM/Director will allow better management of Latency for this specific network design



Network Design: Layer 3

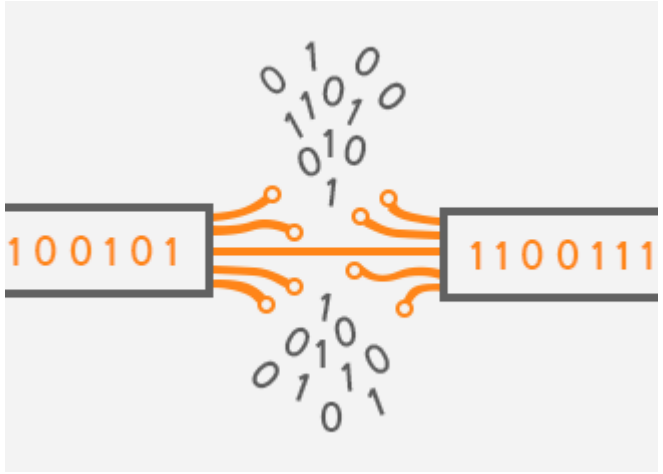
- Distant locations are on different routed subnets
- DDM/Director is a requirement to run Dante over a Layer 3 environment
  - DDM/Director will allow better management of Latency
  - DDM will give you more flexibility in coping against Jitter

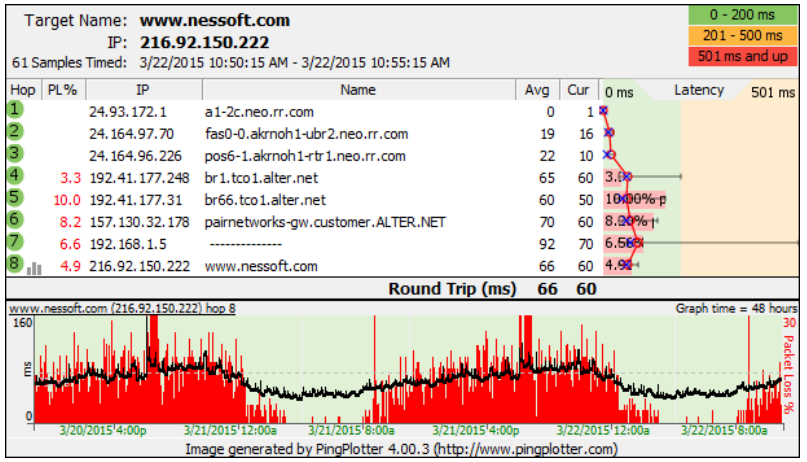


Multicast does not cross routers by default.

Packet Loss

- Dante assumes that there is no packet loss on the network (which is usually the case over a LAN) and has no recovery mechanisms to cope against this.
- This will result in audio artefacts because of Audio Sample loss.
- Links over the Public Internet are inherently prone to packet loss.





Human Perceived Latency

Speed of Sound = 343 m/sec (1125 ft/sec)*

13.3msec
(1-way)

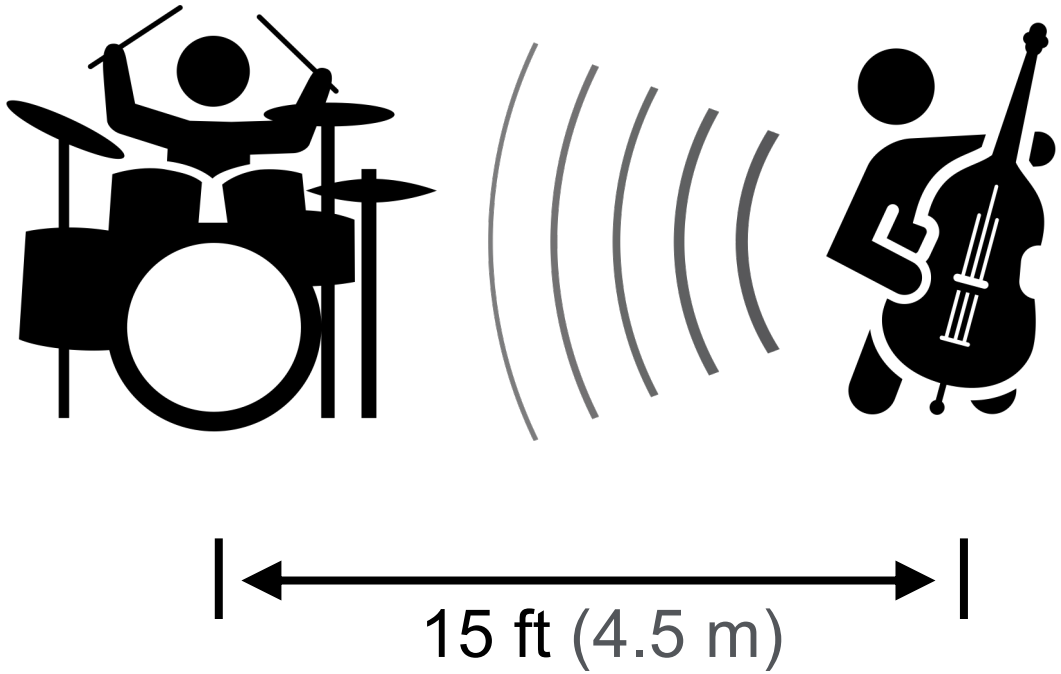
15 ft (4.5 m)

Speed of sound changes with temperature, humidity and other factors, but the given speed works for ballpark estimates in 20°C (68°F) at sea level.

Human Perceived Latency

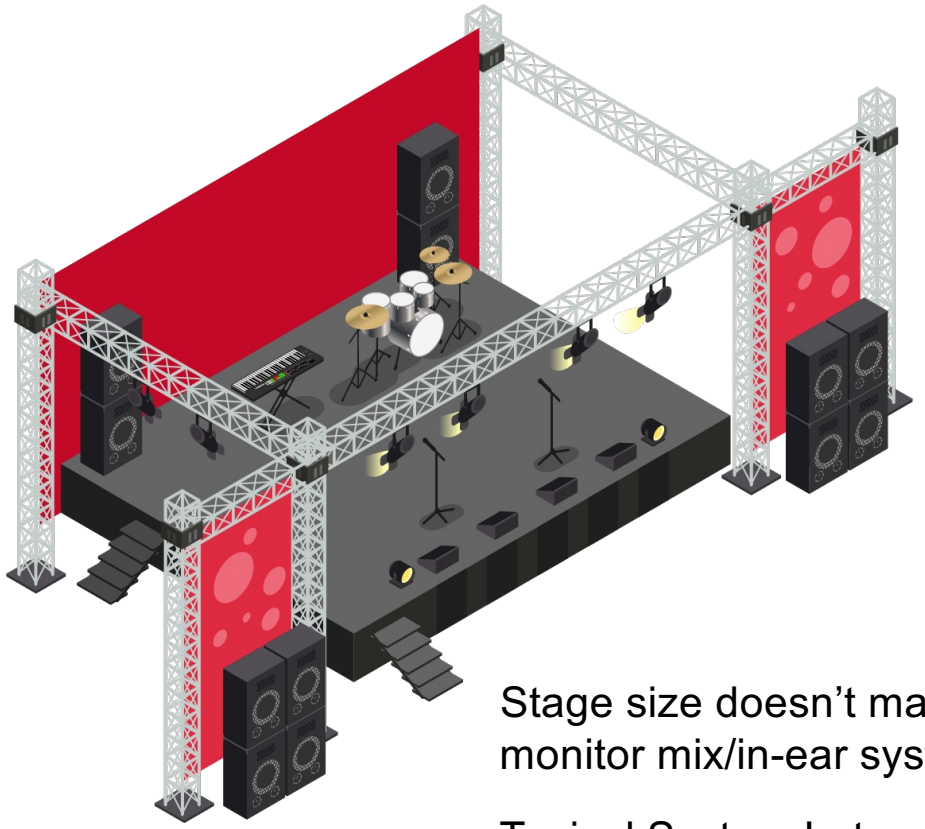
Speed of Sound = 343 m/sec (1125 ft/sec)*

26.6msec
(Round-Trip)



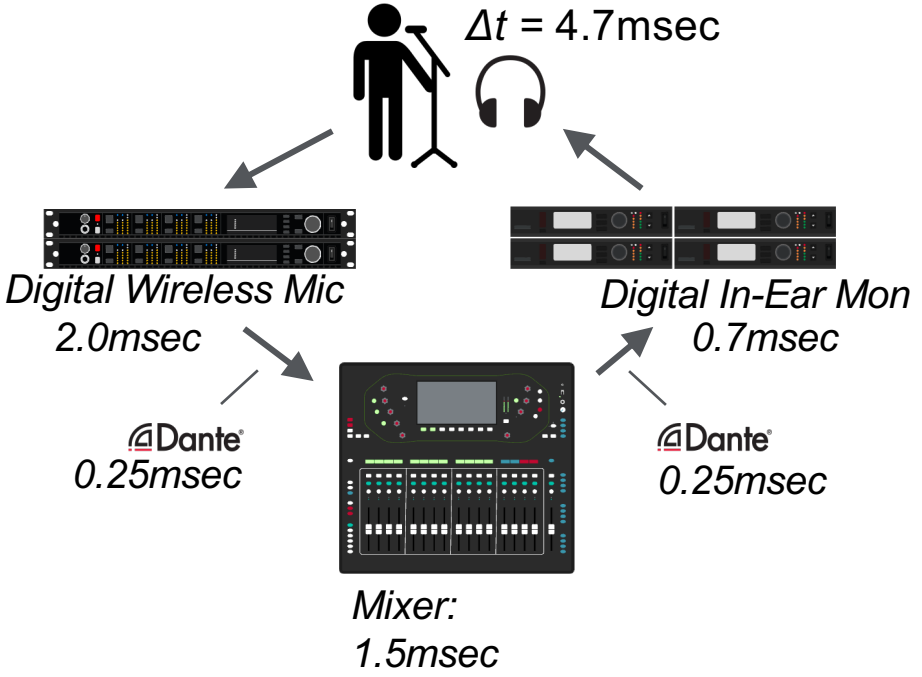
13.3msec
(1-way)

Human Perceived Latency



Stage size doesn't matter due to monitor mix/in-ear system.

Typical System Latency: 10msec
(2-passes in system. 5msec single pass.)



Human Perceived Latency

Humans start noticing latency by 5~7ms

Maximum tolerated latency to play along others is ~40ms

Audio/Video out of sync detectability thresholds are

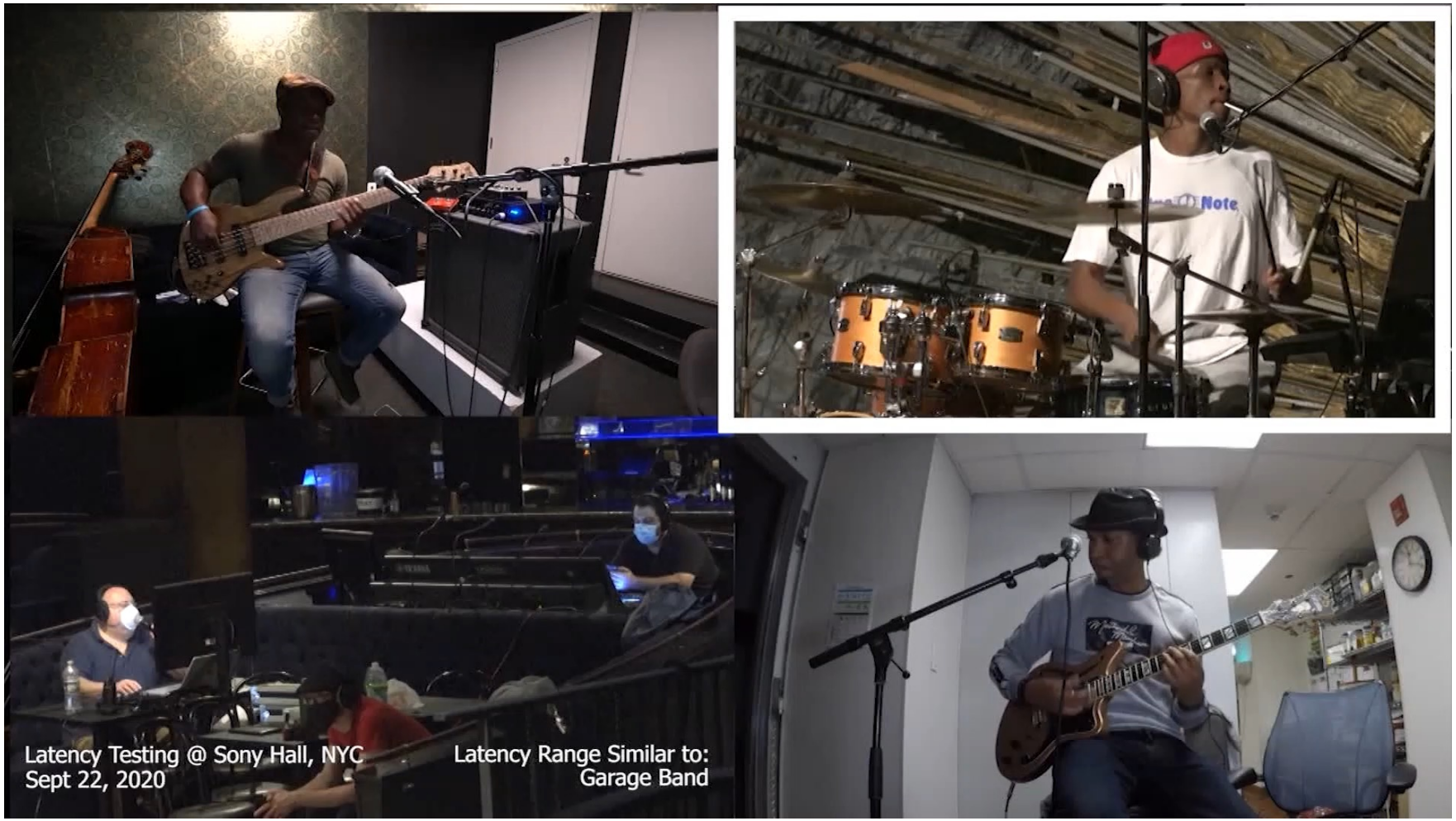
- 45 ms audio before video
- 125 ms audio after video

Values can vary depending on ear training, age, etc

Human Perceived Latency

Musicians hearing each other with 30ms of latency

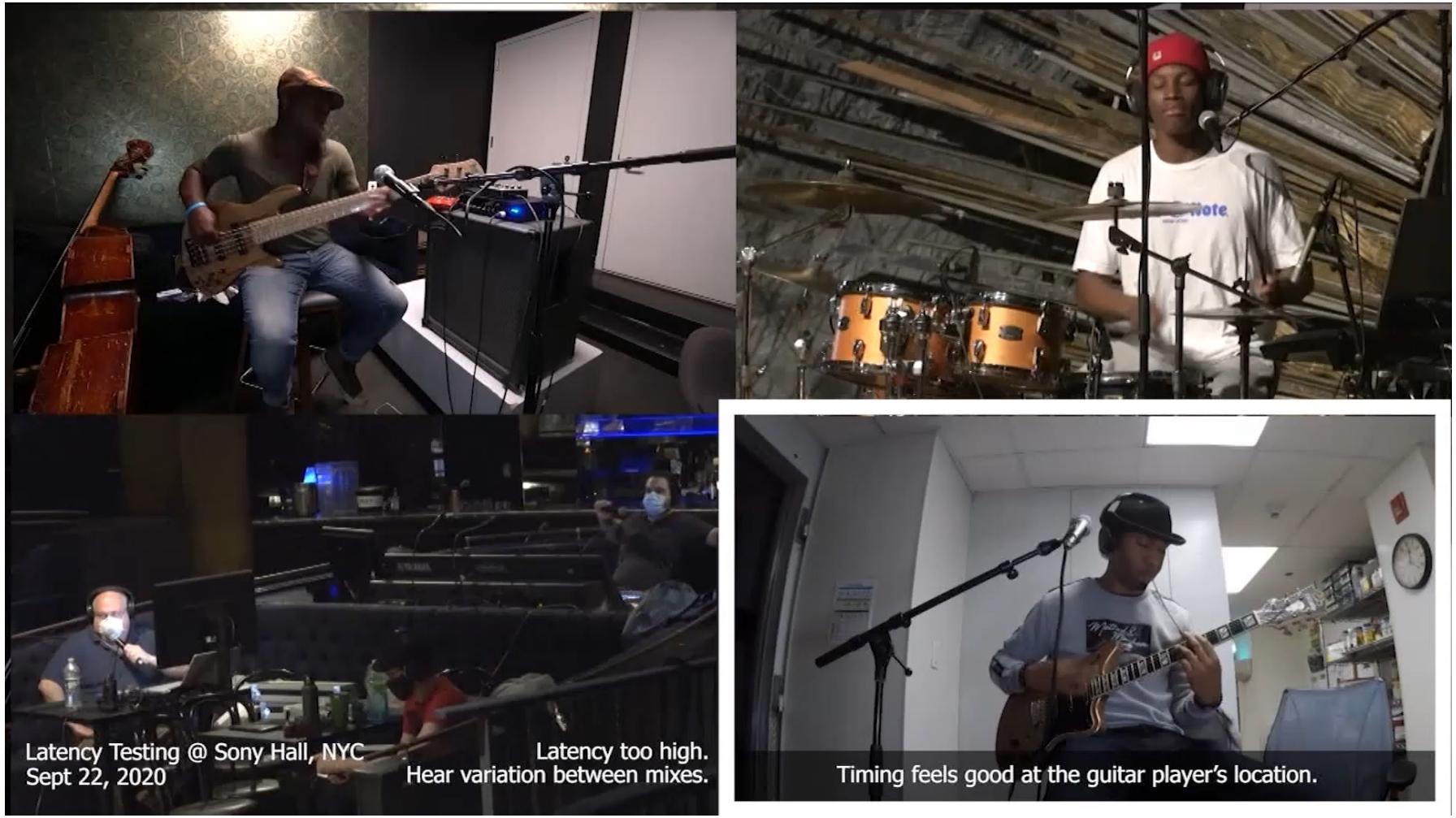
Musicians can maintain sync



Human Perceived Latency

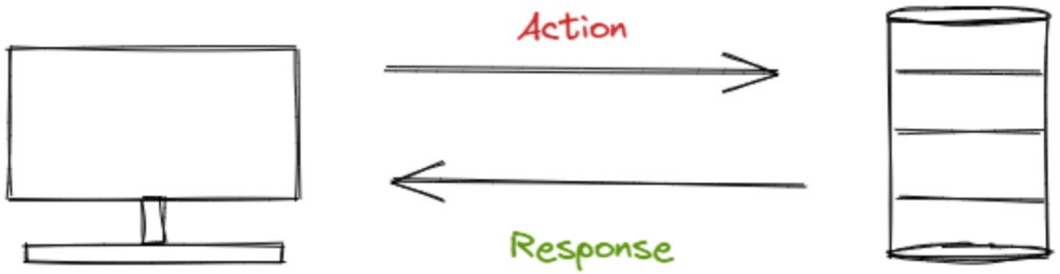
Musicians hearing each other with 60ms of latency

Timekeeper (drummer) can NOT maintain sync



Latency (Network propagation time)

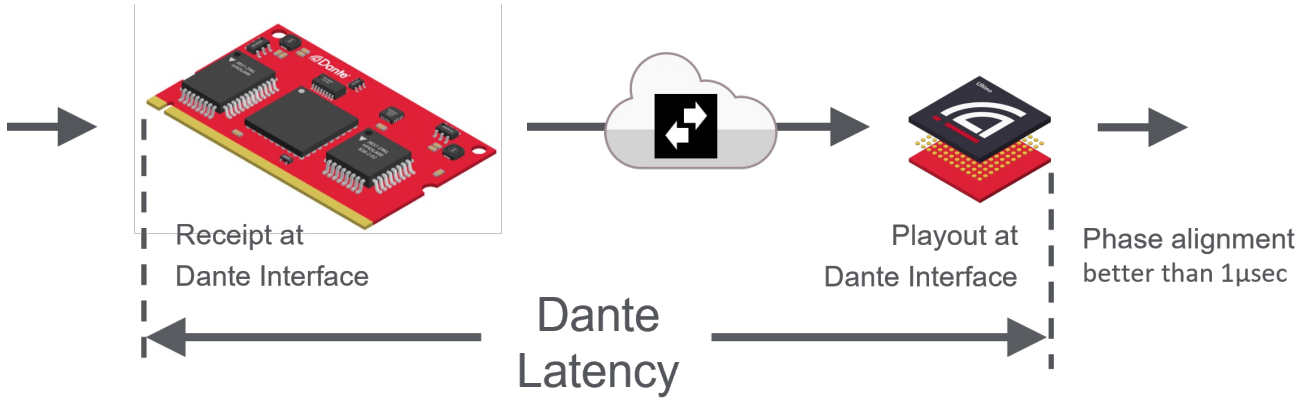
- This is the average time it takes for the packets to get from location A to location B on the network.
- Minimum one-way Network Latency is 5ms/1000km*
- Network communication usually relies on Action and Response (round-trip)
- Dante flow communication is one-way



*Light propagation speed

Latency Management in Dante

- Dante Latency is a deterministic value per device
- Network Latency is going to be compensated by the Dante devices thanks to the Device Latency setting

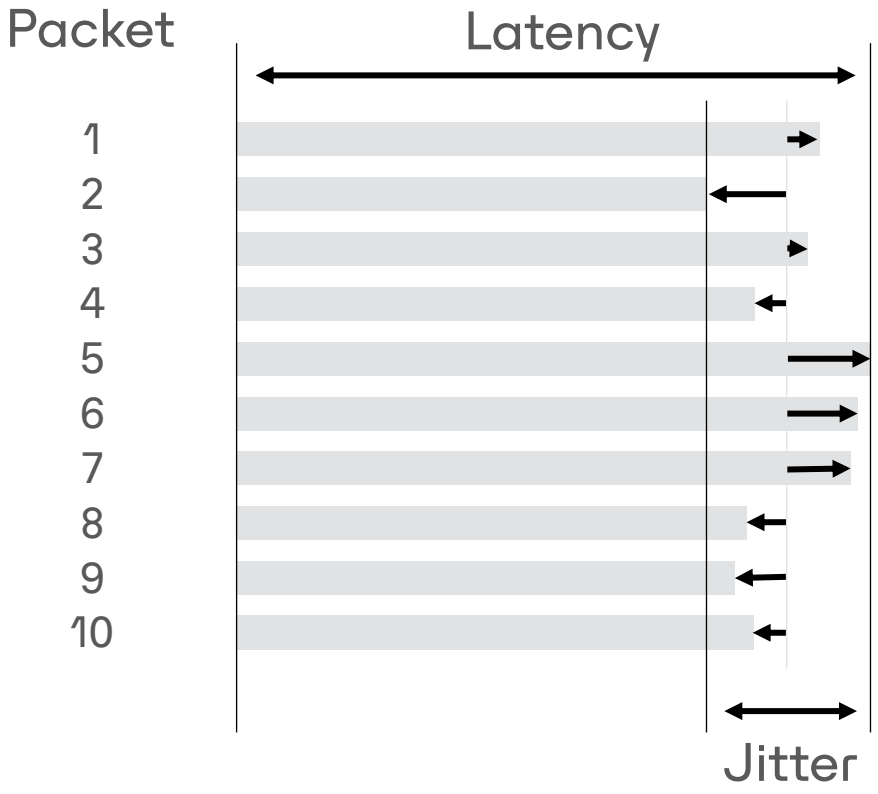


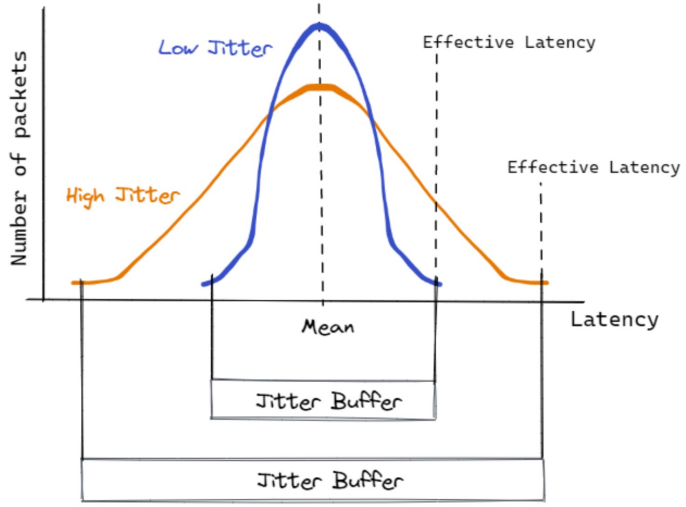
Max Latency	Unmanaged Dante	Managed Dante
Dante Devices	5ms	20ms / 40ms
Dante Software*	10ms	

*Except if using Dante Connect

Network Jitter

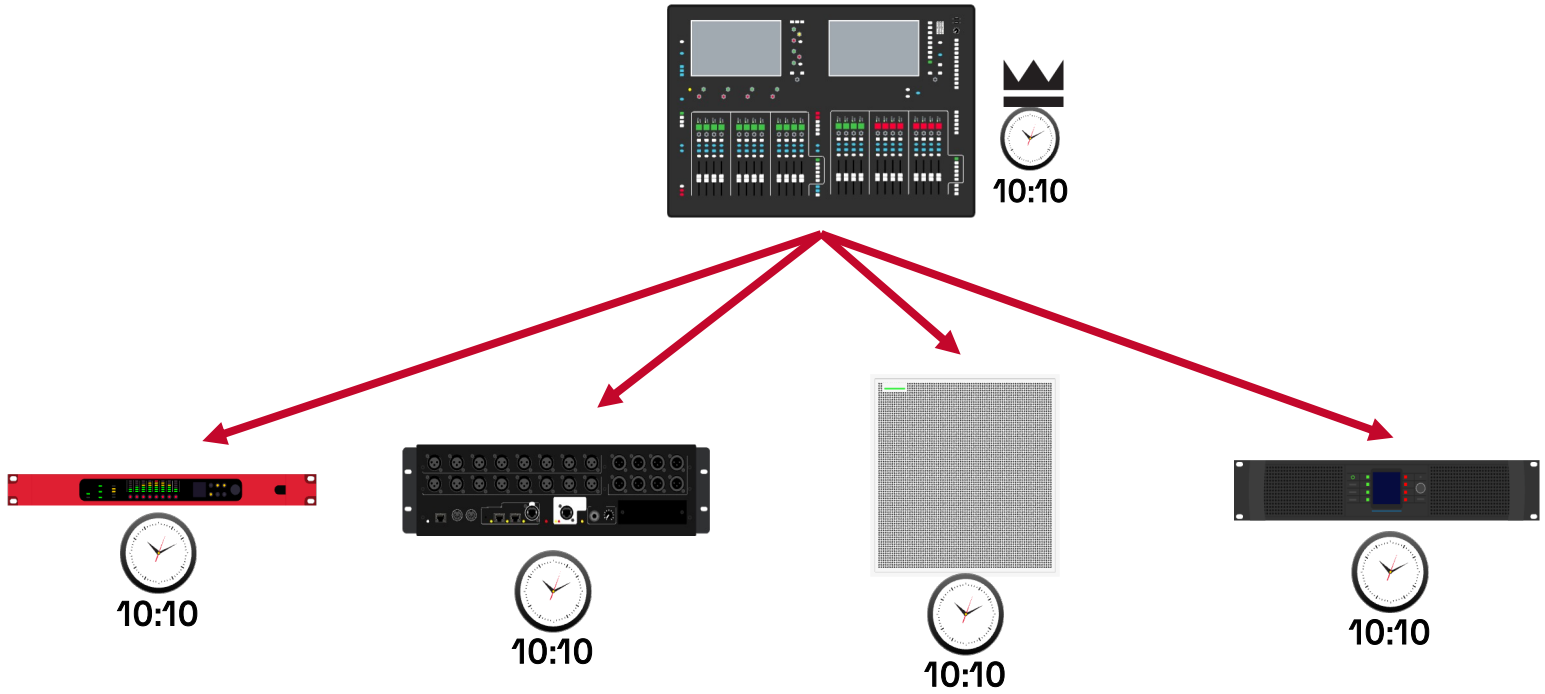
- Jitter is the latency delta for network packets traveling between the locations.

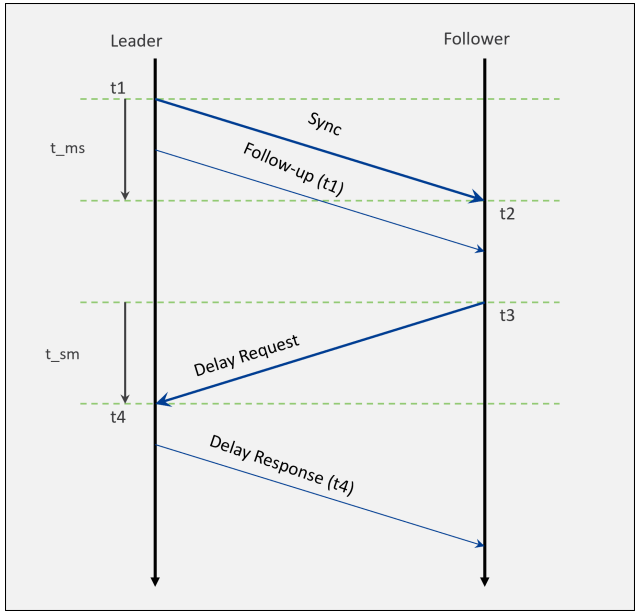




Jitter and Clocking: PTP

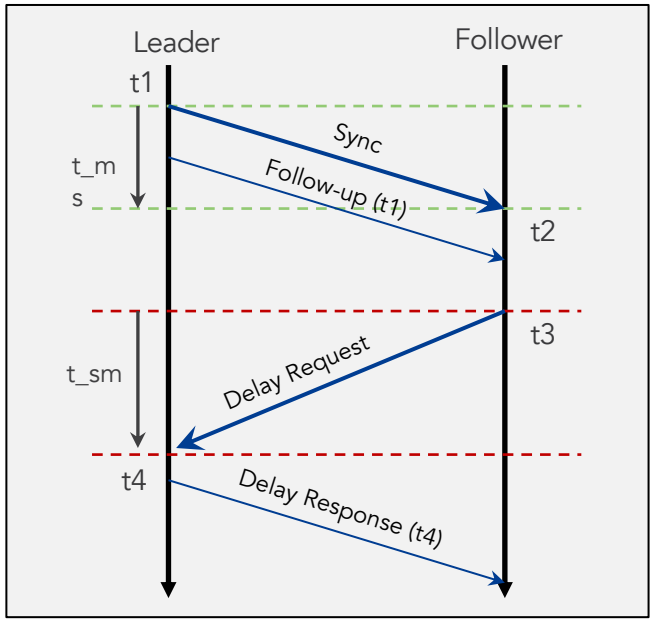
- Jitter is going to have a direct impact on the PTP synchronization.
- Dante clocking mechanism is PTP based.



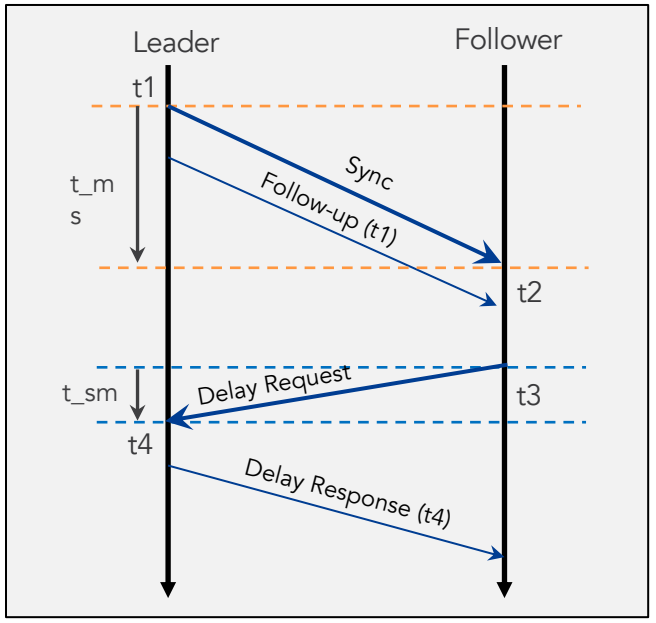


Jitter and Clocking

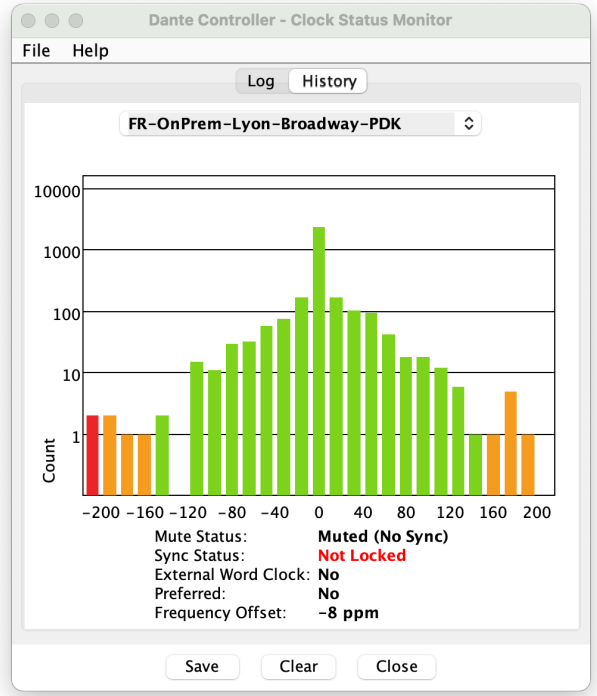
- If there's too much jitter, calculated times (t_ms and t_sm) will vary too much resulting in irregular clock offset adjustments.



Sequence 1



Sequence 2



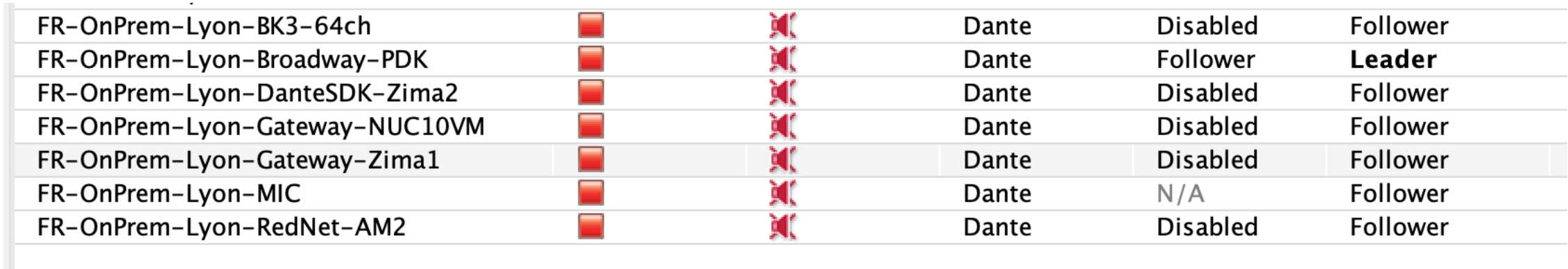
IEEE 1588 (PTP) Clock Synchronization Mechanism

Jitter and Clocking

When PTP fails to achieve synchronization, Dante devices will mute.

- This can be the case over encrypted VPN links or locations connected with intermediate firewalls.

	Jitter Tolerances
Dante Hardware*	Up to 250us
Dante Software	Up to 1ms



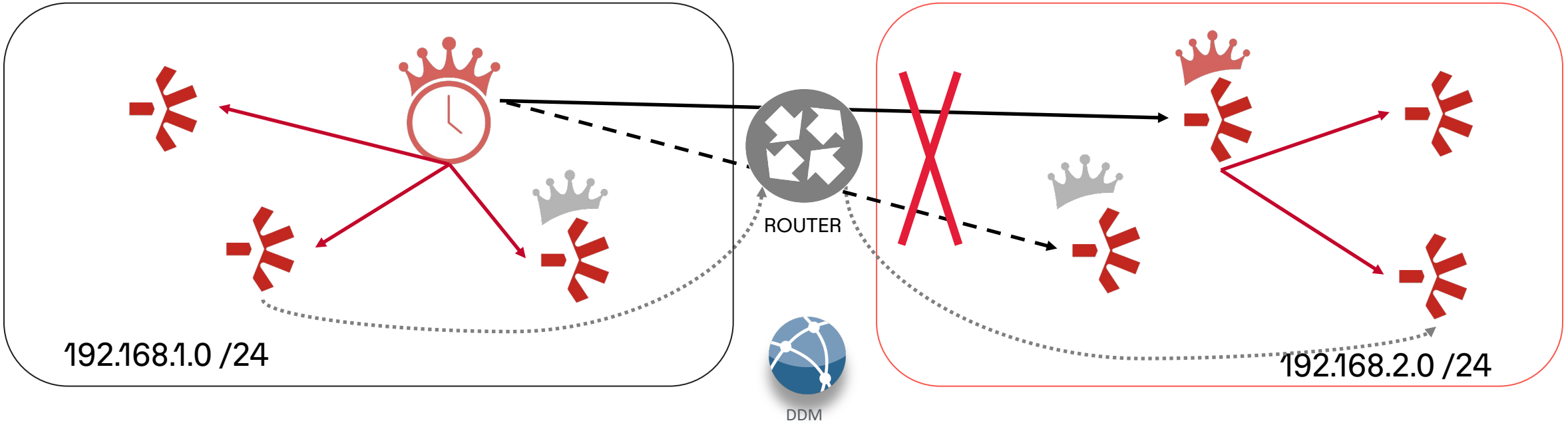
FR-OnPrem-Lyon-BK3-64ch			Dante	Disabled	Follower
FR-OnPrem-Lyon-Broadway-PDK			Dante	Follower	**Leader**
FR-OnPrem-Lyon-DanteSDK-Zima2			Dante	Disabled	Follower
FR-OnPrem-Lyon-Gateway-NUC10VM			Dante	Disabled	Follower
FR-OnPrem-Lyon-Gateway-Zima1			Dante	Disabled	Follower
FR-OnPrem-Lyon-MIC			Dante	N/A	Follower
FR-OnPrem-Lyon-RedNet-AM2			Dante	Disabled	Follower

*OEM can modify this value

Jitter and Clocking

PTPv2 Unicast
PTPv1 Multicast
Audio

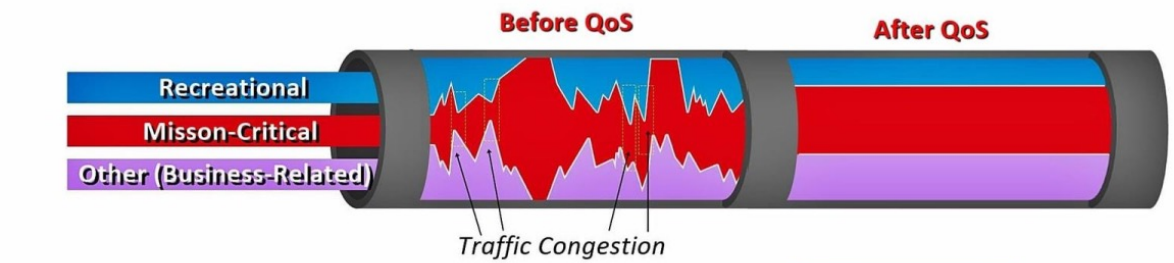
Network Jitter can break Unicast clocking across locations



Overcoming Jitter

To overcome jitter:

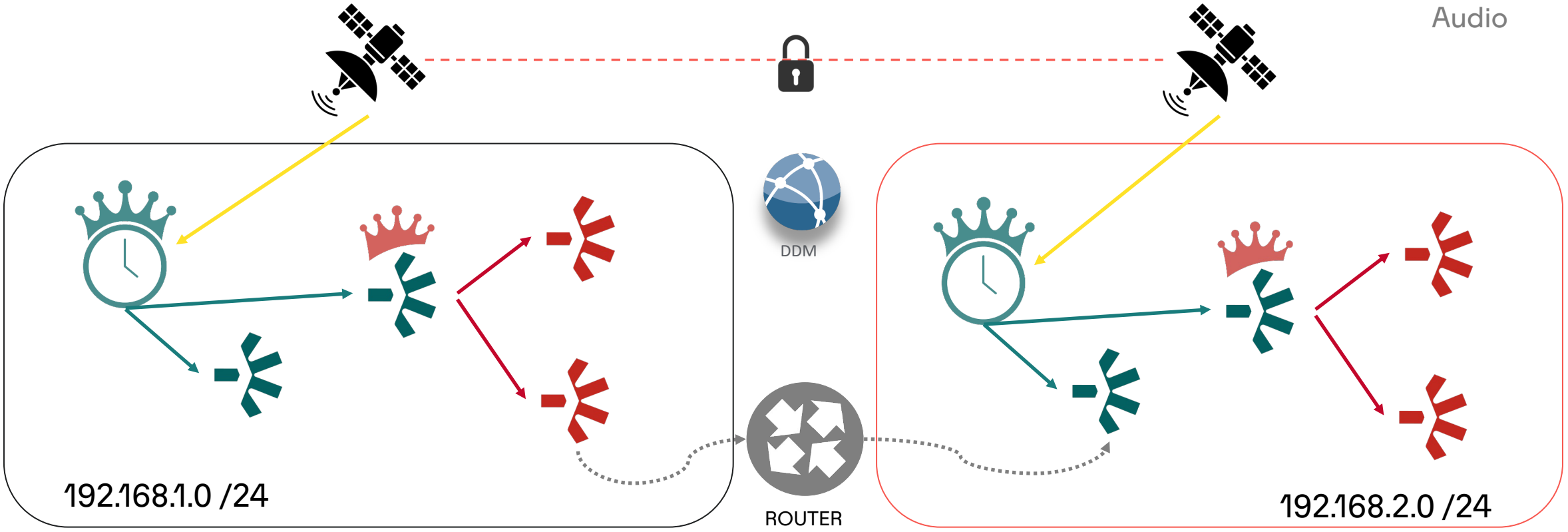
1. You can enable QoS over the long-distance link, but it might not be sufficient in some cases.
2. You can use PTPv2 capable GPS clocks on the different locations to break the clocking dependency between sites.
    1. DDM will be required for creating multiple Clocking Zones over the different locations Subnets.



DDM Clock Zoning: GPS distribution

GPS enabled Grand Master devices on each Zone:

GPS
PTPv2 Multicast
PTPv1 Multicast
Audio



*Audio packets still go through the routed network

Dante Over Distance Conclusions

- Use dark fiber or Private Links (MPLS, WDM…) between the different locations to ensure no Packet Loss and to have more control over the Latency and Jitter.
- Locations linked using VPN over the Public Internet will likely fail to achieve Dante Over Distance.
- The use of DDM or Director will simplify Dante Over Distance Deployments in regards of Management, Clocking and Latency.


Thank you very much
Q&A