JUMBO FRAMES • Why bigger is better

Overview

A properly designed AV over IP system using 10GbE uplinks between switches can easily accommodate Q-LAN audio timings with jumbo frames enabled.

The calculations (and diagrams) below show that the maximum cumulative time on the network (latency) allowable for Q-LAN Audio packets can be met on networks with jumbo frames enabled. It's important to know that jumbo frames reduce decision making workload on switches and allow for more efficient use of link bandwidth. When coupled with adequate uplink speed, jumbo frames allow for small to very large AV over IP systems meeting stringent network audio timings.

Visionary has thousands of AV over IP systems deployed using jumbo frames integrated with Q-LAN, Dante™, or other network audio.

Q-LAN Audio Packet Latency

Ref: Q-LAN Networking Overview Tech Note

QSC says the maximum cumulative time on network for Q-LAN Audio packets = 333µs (transmitter to receiver) at 1GbE under the worst QOS conditions. Due to the sub-millisecond maximum-time-allowed on the network (333µs), Q-LAN is far more time-sensitive than typical Voice, Video or VC applications. Q-LAN Audio packets must pass from Source to Destination within 333µs or they will be considered "too late". As a real-time audio system, timely delivery of Q-SYS Clock and Audio packets is critical.

Q-LAN Audio Packet Latency

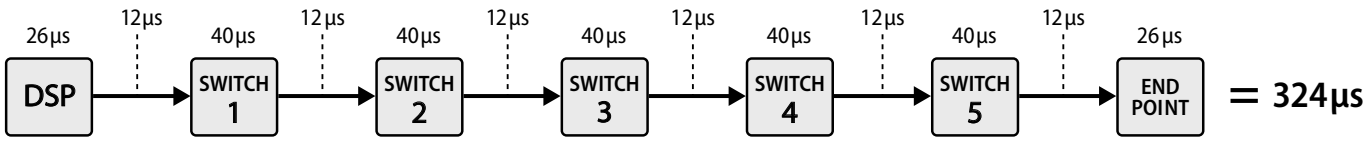
- Typical time on wire @ 1 GbE ≤ 12µs (microseconds)
- Typical time on switch @ 1 GbE ≤ 15µs (Packet Decision Time)
- Maximum time on switch @ 1 GbE with overloaded Egress Queue ≤ 40µs

The 333 µs latency budget includes:

- Time on the network 280µs or less
- + Time to serialize and de-serialize the audio (26 µs)
- + Time to get the audio to and from the internal audio .bus (26 µs)

If the total cumulative allowable latency is 333µs, the total amount of time on the network is about 280µs. Basically there are 52µs that are not related to the network (inside the endpoints).

Diagram 1 • MTU 1500 1 GbE uplinks (worst case / maximum)

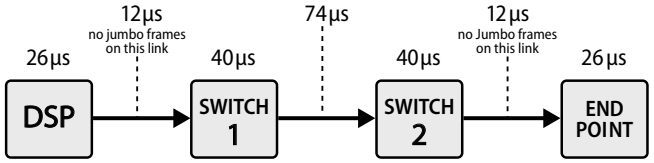


JUMBO FRAMES • Why bigger is better

Jumbo Frames

With Jumbo Frames enabled for efficient AV over IP, we can easily accommodate 3 hop networks (2 switches) with 1GbE uplinks, while ensuring that the system latency is below the 333µs limit.

Diagram 2 • MTU 9216 (jumbo frames enabled) **1 GbE uplinks** (worst case / maximum)



= 230µs

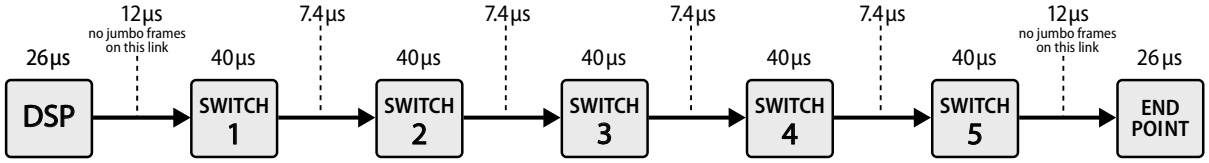
Typical time on wire @ 1 GbE ≤ 74µs (microseconds).
9216 Bytes * 8 Bits * 1ns per bit = 73.73µs

10GbE Uplinks

QSC made these allowable latency calculations in January of 2016 and has not updated their tech note on Q-LAN since then. At the time they were working with and calculating 1GbE uplinks between switches. Any modern AV over IP system design should be using 10GbE uplinks, or better. Large systems with over 1000 total endpoints using a 24 port 10GbE switch at the core, and 1GbE switches with 10GbE uplinks at the edge (24 * 48 ports) can be deployed. When 10GbE uplinks are used we can easily accommodate 6 hop networks (5 switches) while still meeting the allowable latency.

Here's what the latency calculation looks like with 10GbE uplinks:

Diagram 3 • MTU 9216 (jumbo frames enabled) **10 GbE uplinks** (worst case / maximum)



= 305.6µs

Typical time on wire @ 10 GbE ≤ 7.4µs (microseconds). 9216 Bytes * 8 Bits * 0.1ns per bit = 7.37µs

Conclusion

Proper network design is always the best way to reduce latency. Having a core switch fabric and fewer hops to the ends of the network are desirable attributes of a well-designed system. Typical AV over IP systems have between 20-200 endpoints. Since the bandwidth (for video) required for these systems is large anyway, using 10GbE uplinks is a necessity. Within a single switch or stacked switches with adequate performance, the latency is so low, that it need not be considered. Also, when using 10GbE (or greater) uplinks, the time on the wire is less than a standard MTU 1500 packet on a 1GbE uplink, this actually reduces packet queuing jitter (the variation in packet latency).

Modern AV over IP systems benefit from jumbo frames, this is due to jumbo frames being created to solve exactly the types of issues that high bandwidth full frame packets induce. When properly configured and deployed, jumbo frames ease network switch workload and allow lower power consumption by endpoints, all while ensuring that the Q-LAN latency requirements are met, resulting in more efficient AV over IP systems.

Systems with Q-LAN audio and Visionary AV over IP endpoints sending jumbo frames are being used successfully in myriad deployments around the world.