Implementing Dante AV-over-IP from an IT Manager's Perspective

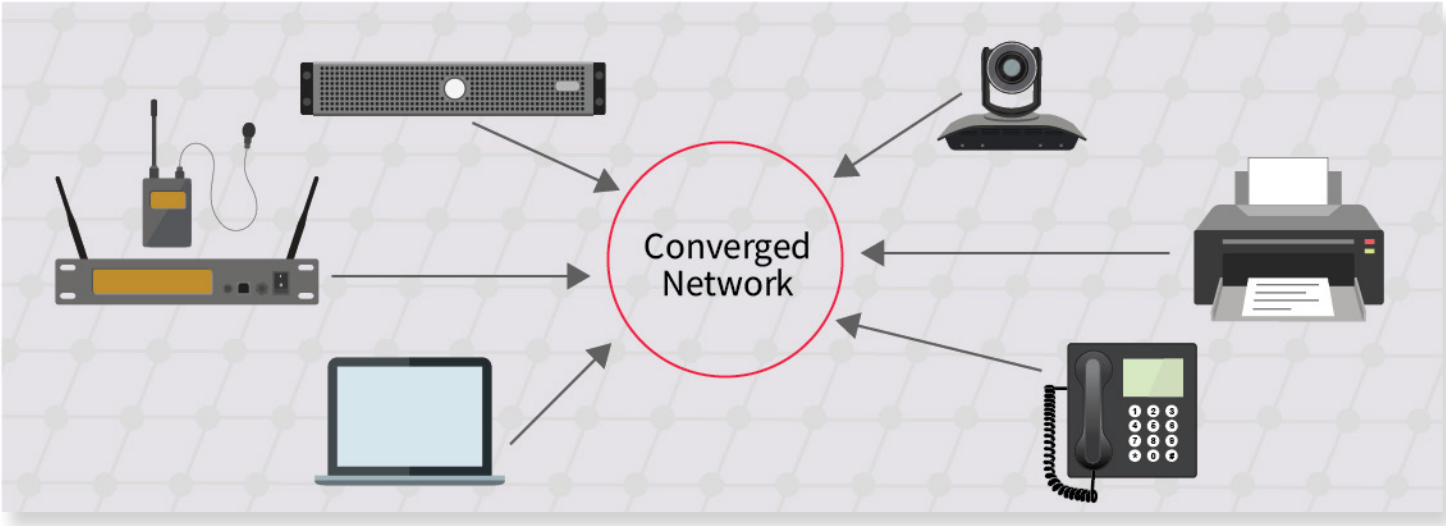
AV systems are increasingly expected to be integrated with enterprise data networks, but IT Managers may not be familiar with the specific requirements of Audio-Visual over IP (AV-over-IP) systems and common AV practices. Conversely, AV professionals may not be aware of the issues that concern IT managers or know how best to achieve their goals in this context. This technical paper highlights lessons learned during the implementation of AV-over-IP networking on mixed-use IT infrastructures within individual buildings and across campuses.

Networks Converge As It Meets AV

As increasing numbers of audio-visual systems are built on network technology, IT and AV departments are starting to learn how to work together. As AV experts come to grips with the terminology and technology of AV-over-IP, IT specialists—gatekeepers of enterprise networks—are beginning to appreciate the benefits that networked AV brings to their enterprises, including centralized administration, flexible deployment of AV endpoints and the ability to scale with virtually no limits. This shift means that the IT department of any reasonably sized enterprise— commercial, educational, financial, governmental, or otherwise—is now ultimately responsible for the implementation and management of the AV systems within the environment. IT managers may even make purchasing decisions for that equipment, in consultation with AV experts.

While AV and IT professionals may understand each other's technologies well enough to interact and collaborate on a project or even daily, neither is expected to be an expert in the other's discipline. AV experts clearly benefit from having a basic working knowledge of IT, and many are availing themselves of training and certification opportunities from trade bodies such as CompTIA and AVIXA, as well as from manufacturers such as Cisco and Microsoft. AV experts do not need to become IT managers to do their jobs, as audio networking relies only on a small subset of network capabilities and configurations.

Similarly, IT managers are beginning to acquaint themselves with the issues associated with the integration and implementation of one or more networked AV systems into enterprise-wide converged networks. Once armed with a clear understanding of the goals and uses of these systems, IT managers quickly discover that audio networking can be easily integrated with the networks for which they are responsible.



AV devices join traditional networked devices on the converged network.

AV over IP: What IT Managers Need To Know

Early AV-over-IP technologies were designed to overcome limitations in bandwidth and a lack of adequate standards for real-time media delivery, resulting in systems that were deliberately not compatible with data networks. Fortunately, those days are long past. Modern AV-over-IP solutions such as Dante are based on common IT standards, enabling them to run alongside data traffic on networks comprised of readily available conventional switches and cabling. To the other network members and components, these audio devices behave like any other node, making implementation, operation, and management of such a network a familiar task to the IT staff.

Standards

While countless standards and common methods exist for many aspects of enterprise networking, AV-over-IP generally relies on a small subset of standards that can easily be understood and utilized by IT managers.

IP Addressing

Early AV-over-IP solutions sometimes required static IP addresses, but this is no longer the case. Modern AV-over-IP solutions, like Dante, all respect DHCP, and most are designed to function with self-assigned IP addresses as well, allowing the easy creation of "stand-alone" audio networks where no DHCP server is present. Just as with other common network endpoints, DHCP is strongly recommended. Static IP addresses are rarely necessary for installed AV-over-IP systems and are likely to cause problems due to human error. If permanent IP addresses are desired DHCP reservations can be utilized.

Multicast, Unicast, and IGMP Snooping

Many network managers are wary of excessive use of multicast, and for good reason. Left unmanaged, multicast traffic will hit every node in a broadcast domain at all times, potentially overloading devices with slower link speeds. Contrast this with unicast, in which network messages and data are simply sent from one device to another.

Multicast is necessary as a part of Dante and all other AV-over-IP solutions, as it is used to send clock sync, timing, and discovery messages to all devices at once within broadcast domains. While by default Dante uses unicast for audio, multicast may also be used to carry audio or video traffic when that media is going to multiple destinations simultaneously.

Knowing that multicast is required, an IT manager can easily configure IGMP on the switches connected to audio devices. That said, IGMP is not a requirement for Dante audio only networks with little or no multicast audio in use. If Dante resides on mixed networks, especially those where IP video is on the same network segment, or a significant amount of multicast audio is used IGMP should be implemented. IGMP Snooping ensures that only devices that request multicast traffic receive it, thus reducing unwanted traffic.

Synchronization with PTP

Digital audio requires synchronization for accurate playback of audio samples. Dante uses Precision Time Protocol (PTP) for time synchronization. By default, Dante uses PTP version 1. This generates a few small packets, a few times per second. One Dante device is elected clock leader on a per broadcast domain basis that sends multicast sync and follow up messages to all follower devices. Follower devices send delay requests back to the leader to determine network delay. A Dante device with a 1 Gbps connection acting as clock leader can keep about 250-300 Dante devices in sync.

QoS (Quality of Service)

Dante as a real time media streaming service benefits from low latency and jitter on the network, and for this reason Dante Audio and Video cannot be sent over Wi-Fi. For proper prioritization of Dante clock and audio, QoS should be used on mixed-use networks (including those with Dante Video) or networks with mixed 100 Mbps/1 Gbps infrastructure or devices. Dante makes use of DiffServ QoS, tags packets, and its tags can be integrated into an existing network QoS scheme.

VLANs

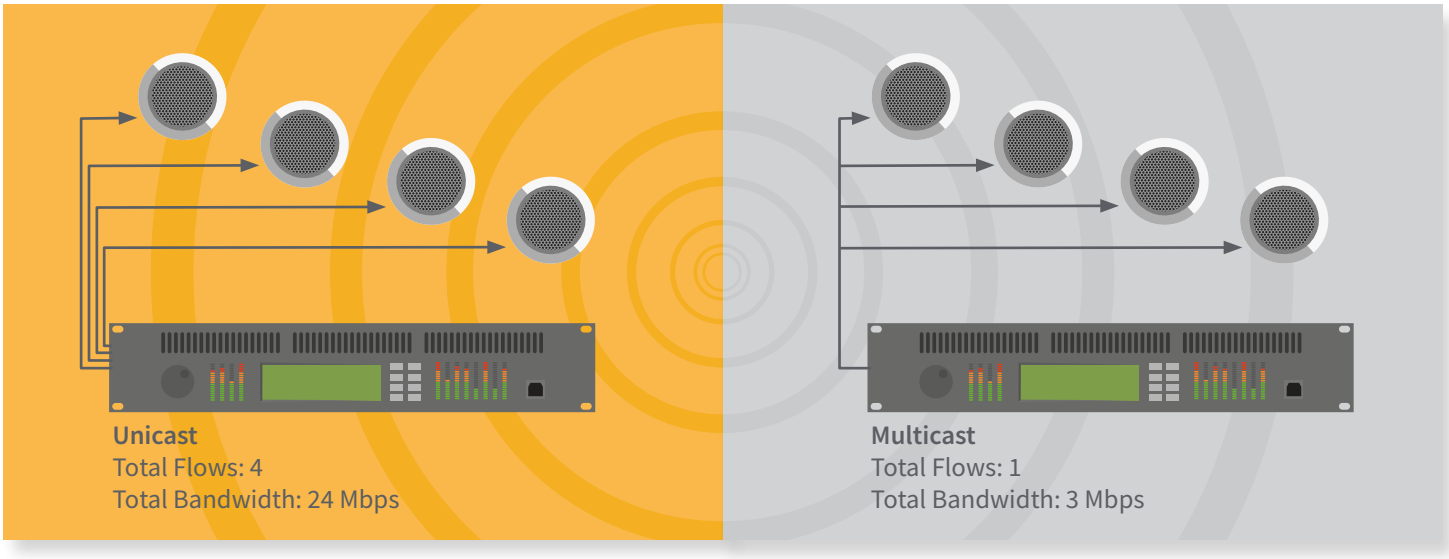
Virtual Local Area Networks (VLANs) are an uncomplicated way to keep traffic segregated while still allowing an AV-over-IP network to share physical infrastructure with an existing IP network. While in the past a single AV VLAN on the enterprise network was sufficient, as AV systems grow breaking them into multiple VLANs should be considered. Ideally no more than 250-300 AV devices reside in a single broadcast domain as the amount of multicast and broadcast traffic created as well as synchronization limitations can cause audio dropouts. Systems may be divided into VLANs by responsibility, function, department, building, floor, or room. To avoid complexity devices that must communicate with one another frequently should be placed in the same VLAN.

Green Ethernet

Energy Efficient Ethernet (EEE) or 'Green ethernet' (IEEE802.3az) should be disabled on all ports used for Dante traffic. EEE can result in poor synchronization performance and occasional audio dropouts.

Audio Bandwidth

IT managers, of course, need to understand the real bandwidth requirements of AV-over-IP, especially if they are new to the technology. This knowledge will help them to configure systems with adequate headroom in the most effective manner. The majority of audio used in professional settings is PCM (uncompressed), sampled at 48 kHz and a bit depth (word length) of 24 bits. AV-over-IP systems add some necessary overhead as this data is packetized into efficient streams. In a Dante network, audio is packaged into UDP audio "flows" of up to 4-channels each that consume approximately 6 Mbps, leading to an easy "rule of thumb" for approximations. For example, 64 channels of audio, the maximum channel count for many Dante devices, sent unicast from one device to another would use 16 flows and require about 100 Mbps of bandwidth or 1/10 of a gigabit link. Bandwidth may also be managed with the selective use of multicast where devices are sending one-to-many destinations such as distribution audio systems. Bandwidth for multicast flows is dependent on the number of audio channels with a bandwidth of about 1.5 Mbps per channel.



Flow and Bandwidth comparison for 2 channels of audio sent from a Dante-enabled DSP to 4 Dante-enabled speakers unicast vs. multicast.

Video Bandwidth

Video bandwidth is a bit more complex depending on resolution, frame rate, chroma sampling, color bit depth, and codec used and varies with content shown. Due to flow and bandwidth limitations Dante video must be multicast if video is being sent to more than one destination. The chart below gives typical bandwidth at common resolutions, frame rates, and bit depths.

Resolution	1080p	1080p	1080p	1080p	4K	4K	4K	4K
Chroma	4:4:2	4:4:4	4:4:2	4:4:4	4:4:2	4:4:4	4:4:2	4:4:4
Frame Rate	30	30	60	60	30	30	60	60
Bit Depth	10	10	10	10	10	10	10	10
	85 Mbps	126 Mbps	135 Mbps	253 Mbps	337 Mbps	506 Mbps	675 Mbps	911 Mbps

Chart from: https://bolintechnology.com/dante-av-ptz-camera-video-streaming-bandwidth

Dante across the WAN

Traditionally AV-over-IP systems have been limited to operating within a single LAN due to the required use of multicast for synchronization (PTP) and device discovery (mDNS) as per standards. With the introduction of Dante Domain Manager this limitation is overcome, enabling Dante to operate over routed networks.

Dante Domain Manager is a server-based centralized monitoring and management application for Dante networks that automatically configures Dante devices to use unicast traffic to cross routers, so no PIM routing protocol configurations are required. Multicast traffic for PTP and media is still used within each subnet. Enrolling devices in Dante Domain Manager using IP addresses or unicast DNS-SD replaces mDNS as the discovery mechanism. The result is a seamless Dante network that can be deployed over nearly any network topology, still employing familiar Dante Controller software to manage subscriptions. That said, Dante media and clocking are not routable over public internet connections. In addition to supporting routed networks, Dante Domain Manager is recommended for Dante installations to provide user authentication, access control and system auditing.

Dante Domain Manager also allows managers to organize Dante devices into non-interfering groups called Domains. This logical separation achieves some of the goals of VLANs without requiring special switch configuration.

Conclusion

As AV moves toward networking as a commonly accepted practice, AV professionals and IT specialists will find themselves working together more closely. People coming from AV will develop a toolkit of networking skills, and those in IT will become familiar with the needs of AV services. Both parties have a stake in success for the enterprise. Fortunately, the development of audio and video networking on top of robust standards means that technical barriers are few, and only a mutual understanding of goals is required to overcome those obstacles.

For more information about Dante, please visit https://www.audinate.com