Audinate Dante™

WHITE PAPER

Dante™

Digital Audio Networking Just Got Easy

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ABSTRACT

When the computer industry adopted Ethernet and Internet Protocols (IP) as networking standards, it entered a prolonged period of exponential growth. Audinate has developed a patent-pending innovative approach to networking audio that is fully compliant with current Ethernet and Internet Protocol networking standards, bringing these same benefits to the audio industry.

This white paper addresses the case for shifting from an analog distribution network to digital networking. The paper discusses the benefits of digital networking, the weaknesses and limitations of products by other vendors, and the unsurpassed quality advantages that can be provided by Audinate's Dante™ technology.

Audinate's Dante networking technology was developed to make professional audio networking easily accessible for both AV and IT professionals. Dante adds significant value to installed sound, live sound and professional audio products of every type and category. Running on standard Ethernet/IP networks, Dante's powerful network configuration and management functions make plug-and-play networking a reality.

CHALLENGES OF DESIGNING ANALOG AUDIO NETWORKS

Analog audio distribution systems still dominate audio installations in the live and installed sound markets. Most audio professionals are still using point-to-point wiring, even though it is cumbersome, error-prone and expensive. Implementing a complex audio system based on analog distribution requires careful design which must be undertaken in advance. This creates challenges for both the designer and the system installer. Designing to meet the needs of the initial project, as well as future proofing for anticipated and un-anticipated changes cannot always be achieved technically or economically. Analog audio requires a physical copper cable for routing each signal, and offers little flexibility to accommodate unplanned changes. Moving or adding equipment in a location will add significant costs as AV system integrators need to run separate conduits for signals of differing voltages and pull heavy copper wire through them.

In professional live sound systems, production rental houses are still trucking multi-core "snakes" that weigh hundreds of pounds. Analog wiring is noisy and long runs degrade signal quality noticeably. At the end of those runs, connections have to be made - and checked, and often re-checked and re-made.

Certainly low latency is an important requirement in high quality audio. Although analog audio transmission involves virtually no latency, other factors can adversely affect sound quality. Analog wires act as antennas carrying low-voltage signals — radio signals can become audible. "Ground loops" can introduce hum induced by AC power lines. Long cables are capacitors that attenuate high frequencies. These effects combine to raise the noise floor of the system, making it harder to deliver high quality sound to the audience and the performers.

Of course the production of audio has gone digital. Most pro audio products digitally process audio data — digital audio networking eliminates multiple and sequential A/D (analog-to-digital) or D/A (digital-to-analog) converters that are required when digital devices are connected with analog copper wiring. Each converter delays and adds distortion to the signal and the cumulative effect may be audibly noticeable. Digital networks are largely immune to these problems. On a digital system, the input signals can be pre-amplified and converted to the digital domain as close as possible to the actual source. The signals are then processed and transmitted digitally throughout the network. The result is a much cleaner audio signal with a lower noise floor.

Benefits Of Digital Audio Networking

Digital audio distribution significantly reduces implementation costs saving time and money, while providing better performance than analog wiring. By allowing many signals to be carried over the same link, digital audio distribution eliminates masses of bulky, heavy, expensive, and inflexible copper wires. Installation is made simple using digital networking; a single lightweight, inexpensive CAT5 cable connected to a piece of audio equipment can carry all the required inputs and outputs as digital audio data.

IP (Internet Protocol) over Ethernet is the technology used for computer networks and the Internet. Often referred to as TCP/IP networking, it is the most widely deployed approach to networking and represents the best available foundation technology for media networking. Switches, CAT5 cable and other hardware components used to build such networks are mass-market items. Their costs are continually falling at the same time as their feature sets and performance are growing. IP over Ethernet has many practical advantages that can be applied to audio networks. With Dante, existing infrastructure can be used for high performance audio as well as for ordinary control, monitoring or business data traffic. Digital networks utilize standard Ethernet over IP offering high bandwidth capable of transporting hundreds of high quality channels over 100 Mbps or 1 Gbps Ethernet. Set-up and configuring the system is made easy as well, saving enormous installation costs and long term cost of ownership on a digital network. The physical connecting point is irrelevant: audio signals can be made available anywhere and everywhere. Patching and routing are logical functions configured in software, not via physical wired links.

Not All Digital Networking Solutions Are Equal

When Audinate developed Dante technology, we focused on ensuring that the platform could solve the inherent limitations designed in other networking technologies. Some of the challenges and limitations presented by other vendors networking solutions include:

Complicated Network Set-up

For analog networks connecting, checking and re-checking multiple point-to-point cabling is a time-consuming and tedious task. First-generation digital distribution technologies offered by other audio network companies replace this process with one that can be just as complicated, if not more so: assigning numerical addresses to each input and output on the network. Numerical addressing leaves no room for information about the device's location or function. Internal send/receive parameters must be set on each device before it will pass audio. Manual controls on the device may be the only way to this — not an easy task if that device happens to be installed at the end of 100 meters or more of cable. Manual configuration is inherently prone to operator error, even for trained technology specialists, resulting in added installation costs.

Separate Networks – Run Two Where One Would Do

First-generation digital audio networks don't use standard Ethernet data packets, so they must run on a separate physical layer (cable and switches) or through a 100 Mbps VLAN (Virtual LAN) tunnel on a Gigabit network. Either method is subject to the topology restrictions of the specific audio networking technology. The cables and switches must be configured in certain ways or the network will not function. This requirement increases complexity along with material and operating costs.

Device Control Is Separate From Audio Distribution

Data communication with and control of networked devices such as amplifiers and signal processors is a pre-requisite for efficient, centralized operation and management, but on first-generation networks this type of data typically has to travel separately from the audio. A technology specialist may be able to set up a tunnel for data and control information: if not, yet another wiring and switching path will have to be created. The difficulties aren't over once the devices have been connected, either. Different vendors implement control in different ways, which makes designing an installation harder.

Technology Restrictions Force "Design-Arounds"

As a mature technology, TCP/IP networking allows the designer to build a network around user requirements. Digital audio networking technologies that cannot share or operate on standard IP networks force the designer to work around their limitations. These include restrictive topologies, limitations on link speed, and scalability issues such as channel count and bit depth limitations as well as network latency.

Perhaps the most significant limitation on the design of digital audio networks today is the lack of standardization. Two digital audio devices using the same networking technology may implement it in conflicting ways. The system designer may have a very limited set of options in order to adapt the network to specific customer requirements.

Compromised Clocking And Synchronization

Earlier technologies do not account for differing path delays between slave devices and master clocks. This introduces significant clock errors between devices connected to different parts of the network. Most media networking technologies attempt to control only the rates of local clocks, without compensating for offsets, so they cannot guarantee tight timing between audio network devices.

First-generation technologies also lock the whole network to a single sample rate — usually adequate for point-to-point "digital snake" applications, but lacking the flexibility needed for a genuine network.

Dante Media Networking Offers Improved Performance Over Other Audio Networking Solutions

Dante is a patent-pending technology, developed by networking experts. Rather than side-stepping network standards as earlier development teams did, Audinate developers applied their expertise to leverage Ethernet and IP standards. As a result, Dante networks solve problems with outstanding performance, superior flexibility and unprecedented usability.

Dante appears to an Ethernet switch or an IP router exactly like any other standards-compliant data, because it carries media data in standard UDP (User Datagram Protocol)/IP packets. All computers use IP and can be easily connected to Dante networks. Because it works within the standards framework, Dante is the first solution to fully leverage the price and performance benefits of both 100 Mbps and 1 Gbps switched Ethernet networks. Control data and media data can travel on the same network - in fact, Dante can deliver high-bandwidth, uncompressed digital media streams over existing networks that are simultaneously carrying TCP (Transmission Control Protocol)/IP traffic such as Email, Internet browsing and other office data.

Zero Configuration Networking: Plug-and-Play Networking With Professional Performance

To radically simplify network set-up and configuration Audinate built on its deep expertise in Zero Configuration Networking, which was originally developed to allow people without special networking expertise to connect computers and printers over TCP/IP networks. It removes the need for special infrastructure, like Dynamic Host Configuration Protocol (DHCP) servers and Domain Name System (DNS) servers, or having to set up each computer's network settings manually, which would be difficult and laborious, especially for non-technical users.

By extending the capabilities of Zero Configuration networking (also known as Zeroconf) into the audio application domain, Audinate has made it possible for all Dante-enabled devices on the network to automatically discover each other and configure themselves, as soon as they are connected to the network. This self-discovery technology makes Dante networking a true plug-and-play experience.

Each audio channel can be labeled with a logical, descriptive name instead of an incomprehensible number. Text labeling makes it easy to assign the correct signal to any mixer or signal processor input. Labels are stored in devices and persist when the power is turned off; network components can carry default labels that can be overwritten or augmented.

Truly Distributed Systems Make Splits Easy

On a true network (as opposed to a digital point-to-point connection), every signal can be made available anywhere on the network and all inputs and outputs can be available at the same time. In practice, this can place extreme demands on network bandwidth. Signal processing can be distributed throughout a true network, instead of being concentrated at a central device. For example, performers can assemble and adjust their own monitor mixes without special attention from the monitor engineer. Many performers shy away from complex technology, so it is critical to make audio networking simple for these end users. Zen makes plug-and-play networking available to anyone, even non-technicians.

Easy Integration Of Computer-Based Audio Equipment

Dante is built on IP over Ethernet — the technology your computer already uses to network with other computers, printers, etc. With Dante Virtual Soundcard for Windows or Mac OS, a software DAW (Digital Audio Workstation) running on a laptop computer can be connected to a Dante network without additional hardware and used to add effects or EQ, or as a multi-track recorder. Input and output channels to and from the DAW are assigned in software - again, no patching is required.

Sample-Accurate Playback Timing

Dante synchronizes local clocks in each networked device to a master clock with very high accuracy. Dante clock synchronization is completely independent of the audio data and the sample rates being used on the network. The local clock is used to timestamp network packets and to control the rate at which audio samples are transmitted and received. Audinate's FPGA Dante implementations can achieve unparalleled accuracy: clock synchronization within as little as 1 µs (microsecond: one-millionth of a second), enabling sample-by-sample synchronization of audio playout from different devices on the network.

Dante: Meeting The Needs For Today And The Future

Audinate's patent-pending Dante technology has been designed, since its inception in 2003, to be fully compliant with global networking standards including IEEE Ethernet and clock synchronization standards and Internet Quality of Service (QoS) and media transport protocols. Dante also offers a future-proof migration path to support emerging networking standards.

The Audio Video Bridging (AVB) group in the IEEE is in the process of developing standards that are closely aligned to the transport technologies that Dante already uses today. Audinate supports the adoption of AVB standards and is a Promoter Member of the AVnu Alliance, an industry forum dedicated to promoting the adoption of the IEEE AVB standards.

As they are ratified, AVB standards will be incorporated into the Dante media networking solution. Many Dante products are upgradable in the field so that they can track these standards as they evolve. Dante will incorporate AVB whilst retaining its ease of use, comprehensive feature set and its ability to operate over current networks. This approach de-risks the design and manufacture of networked AV equipment as well as supporting deployment of high performance AV networking on today's networks.

DANTE NETWORKING ADVANTAGES

DANTE REDUCES:

- **Costs of cabling, switch and routing** by using standard Ethernet/IP media and hardware
- **Configuration time** by using Zeroconf networking protocols for automatic IP configuration, service discovery and simple audio routing
- **Resource risk and costs** by tapping the large pool of skilled Ethernet and IP technicians
- **Cost and complexity of system reconfigurations** by making signal routing independent of network layout and enabling devices to remember audio channel labels and routes
- **Difficulty, time and cost of operator training** by using Zeroconf's user-friendly, informative and logical channel naming
- **Network latency** to imperceptible levels, with multiple latency zones possible on the same network
- **Cost and complexity of system management and control** by transmitting both audio and control data over the same easily configured network
- **Risk of evolving Ethernet standards** with planned upgrade paths for continued compliance

DANTE INCREASES:

- **Audio quality** by enabling lossless digital audio transport, eliminating redundant conversions between analog and digital formats and reducing the subjective quality degradation attributable to latency
- **Network flexibility** by transporting many audio channels at different sample rates and bit depths on one network
- **Channel capacity** by supporting Gigabit Ethernet, decoupling the overall system capacity from the capacity of a single link, and allowing mixed speed networks
- **Playback timing integrity** by delivering low jitter and sample-accurate synchronization via high quality, high availability master/slave clocking that is independent of audio data packets and sample rates
- **System-wide interoperability** with Mac and PC applications: Dante Routing for channel naming and matrixing, Dante Virtual Soundcard for connecting audio workstation software via the computer's Ethernet port
- **Value of existing infrastructure** by using standard Ethernet/IP networking to co-exist with ordinary data traffic on installed networks
- **Audio network versatility** by making multiple sample rates (e. g. 48, 96 kHz) and bit depths (e. g. 16, 24 bits) always available