Audinate

The Future of Media Networking

WHITE PAPER

Evolving networks to Audio Video Bridging (AVB)

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Purpose Statement

In this paper, we introduce the AVB standards currently under development and show how they fit into the Dante™ media networking solution.

Audinate revolutionizes the way that AV systems are connected by transporting high quality media over standard IT networks. Audinate is a company founded by networking experts who have been developing high performance hardware and software media networking solutions since 2003. Audinate's patented media networking solution, Dante, is the world's first IP over Ethernet networking solution that meets the performance requirements of the professional Audio/Visual (AV) industry. It has been designed from the outset to leverage available standards for clock synchronization, Quality of Service (QoS) and media transport. Dante is a complete media networking solution with many features in addition to basic clock synchronization and media transport.

Standards have played a significant role in the development of networking technologies. Networking technologies and their standards are continually being updated by standards bodies such as IEEE and IETF. Over the last few years, new standards related to the lower layers of media networks have been evolving. This paper examines the emerging IEEE Audio Video Bridging (AVB) draft standards and their implications for next generation media networking solutions. The various ratified and draft AVB standards are described and the benefits they bring to media networking solutions are examined. This whitepaper also shows how the new draft AVB standards fit into the existing Dante media networking solution. This approach de-risks the design and manufacturing of networked AV equipment for Audinate's customers. It allows them to deploy an IP media networking solution today, and have confidence they will have AVB compatibility in the future.

Evolution of Digital Networking Protocols

The professional AV market is still dominated by point to point analog wiring systems to connect components and devices. There is a growing trend for digital networks to replace analog cabling and point-to-point digital cables to enable scalable, flexible and high performance AV systems. Drivers for change include the dominance of digital processing of signals, continual improvement in the price/performance of networking technologies, widespread deployment of IT networks and the increasing use of computer equipment for playback, storage and processing of media signals. Now that AV equipment can be networked without sacrificing performance, the AV and IT industries are converging, enabling new AV applications and networked collaborations solutions.

A significant milestone occurred in the mid 90s with the launch of CobraNet™ - a system which used 100Mbps Ethernet networking and Cat-5 cabling to replace masses of bulky, heavy analog copper cabling. One major benefit of networked signal distribution is the simplicity of patching signals. The physical connecting point becomes irrelevant: audio signals are available anywhere and everywhere via the network. Patching and routing are logical functions configured in software, not via physical wired links. Even better, the same cabling infrastructure can be used for control data as well as signal distribution.

While CobraNet is still one of the dominant networking technologies used today; it has recognized limitations preventing it from exploiting new networking technology:

- Latency: to ensure reliable operation in networks with several switch hops, CobraNet typically requires 5.33ms latency through the network. This latency is considered too high for many applications and use cases.
- Complicated configuration and Installation: CobraNet has a reputation for complexity and being difficult to implement, using complex ranges of numbers (bundle IDs) which have no meaning to end users. There are 65279 bundle numbers available for a CobraNet network, so needless to say, configuring and making changes to a system can be quite complex.
- CobraNet is not based on Internet Protocols, preventing it from being easily managed by IT staff using existing IP-based infrastructure and tools.
- CobraNet is limited to 100 Mbps networks and cannot make use of the increased channel capacity and reduced latency offered by gigabit technology.

The Gigabit Deployment Wave

Historically, increases in cost effective bandwidth have enabled new network services. In the case of AV systems, the shift to gigabit (1Gbps) networking creates the necessary bandwidth for truly high performance AV networking solutions. Increased bandwidth improves every aspect of AV networking solutions: lowering latency, increasing channel capacity or quality and improving synchronization.

To see the effect of increased bandwidth on latency, we can compare CobraNet on a 100Mbps network to AVB on a 100Mbps network, and compare AVB on 100Mbps/1Gbps networks. CobraNet

supports 5.33ms latency on a 6 hop 100Mbps network,[1] while AVB targets 2ms on a 7 hop 100Mbps network. Therefore, AVB support in 100Mbps Ethernet switches reduces latency by a factor of about 2.5 over existing switches. AVB support is not without cost, since the new protocols require switches to have a CPU and non-trivial software. In comparison, use of gigabit networking reduces latency by a factor of 10 (2ms -> 200us) regardless of whether AVB is present in the switches or not.

In addition to a 10x reduction in latency, gigabit Ethernet also results in a 10x increase in the capacity of the network. This directly translates to increased channel capacity or increased quality. As Figure 1 shows, gigabit ports are rapidly replacing 100Mbps ports in new equipment. This trend bodes well for the future of high performance AV networking.
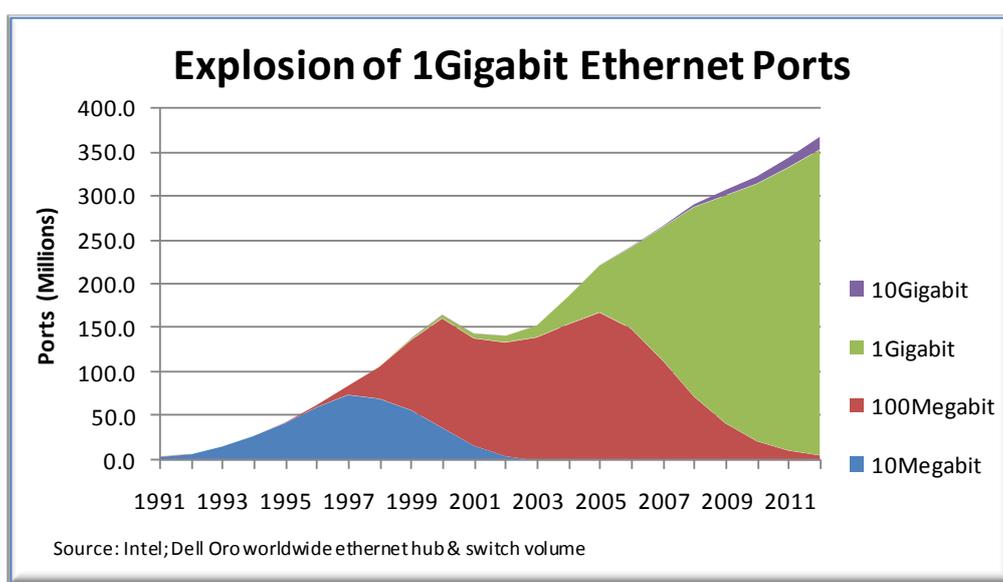

Figure 1: Growth of gigabit Ethernet ports over time

Dante - Designed with the Future in Mind

From its inception, Dante has been designed to make use of existing and emerging networking standards. Rather than side-stepping network standards, Audinate developers applied their advanced networking expertise to leverage Ethernet and Internet Protocols (IP). The architecture of Dante allows it to exploit performance improvements in networking technology, scaling with increased network bandwidth as gigabit and faster Ethernet technology is deployed. As a result, Dante networks solve problems with outstanding performance, superior flexibility and unprecedented usability. Dante enables sample accurate synchronization and industry-leading low latency whilst maintaining 100% compatibility with standard IP.

Dante is a high performance media networking system supporting:

- High quality, high bit-rate uncompressed audio
- Tight clock synchronization and time aligned playback throughout the network
- Quality of Service
- Low latency network transport

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[1] MediaMatrix documentation, "*Working with CobraNet*", Version 1.5.1.0, July 17 2009
http://www.peaveyoxford.com/kc/Working%20with%20CobraNet.pdf

Dante was built upon the IEEE 1588 Time Precision Protocol standard to derive a precise clocking mechanism for synchronization. This is the same protocol commonly used in robotics and other applications requiring extremely accurate clocking. Today's Ethernet switches provide high performance data transport and quality of service functions capable of supporting real-time Voice over IP (VoIP) telephone services.   Dante meets professional Quality of Service (QoS) requirements by making use of standards originally used to provide VoIP telephone services.

As a result of this, latency less than 1ms across ten (10) network switch hops can easily be achieved using Dante in a gigabit (1Gbps) network, even when using existing Ethernet switch technology.

Understanding Networking Concepts

Before examining the emerging AVB protocols, several networking concepts will be described briefly. These networking concepts represent the basic functions used to implement media networking today.

Networking Layers

In an Ethernet network, packets (short messages) are transmitted from one device to another through a set of cables and packet switches. Before being transmitted, the content (payload) of the message is wrapped in headers in a process called encapsulation. This is analogous to taking a letter you have written and placing it inside an envelope on which you write your address (source address) and that of the intended recipient (destination address).

The process of encapsulating messages in headers is often described as a set of network layers. Each additional layer of encapsulation adds extra information in the form of headers to the message. These headers allow a basic network transmission link like an Ethernet wire to support a wide variety of applications (e.g. web pages and email) and network functions (e.g. packet routing and Quality of Service).

Figure 2 illustrates a payload encapsulated inside several headers ready for transmission:
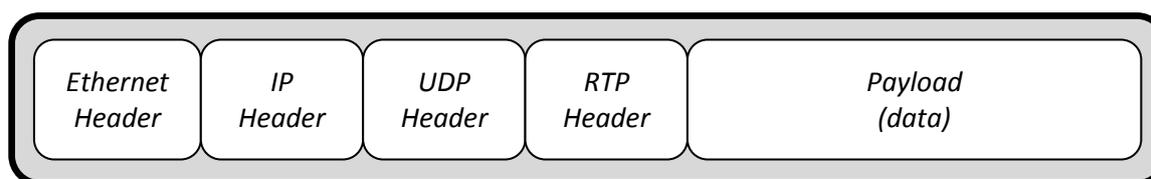
Ethernet Header	IP Header	UDP Header	RTP Header	Payload (data)

Figure 2: Encapsulation of payload data in an IP packet

Figure 3 shows the same encapsulation viewed as a stack of network layers:
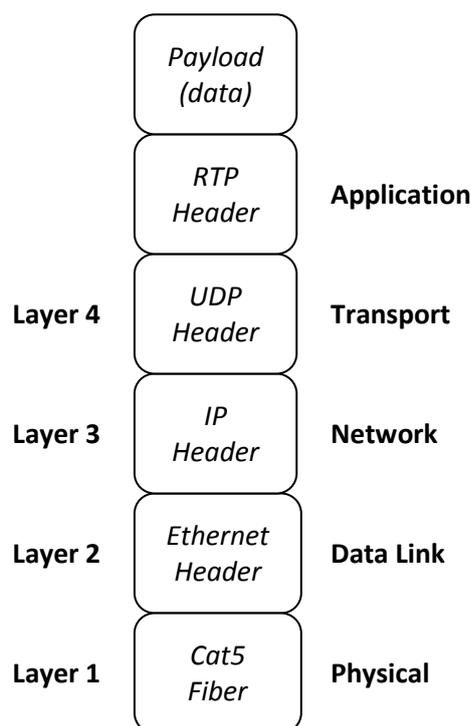

Figure 3: Encapsulation shown as a network stack

Quality of Service

A network that implements "Quality of Service (QoS)" differentiates between the multiple applications operating on the network, ensuring that applications sensitive to network congestion and latency get preferential treatment or "better service" from the network.

A typical example is a network supporting Voice over IP (VoIP) telephony. Because phone calls are real time, a QoS enabled network will prioritize the transmission of packets carrying VoIP telephone calls over other packets like email and web browsing. This is done to ensure that VoIP packets do not get delayed as they travel through the network and during congestion. Should congestion occur, non-VoIP packets are dropped by the switches to allow the VoIP packets to flow unimpeded.

Assigning Packets to Priority Classes

The basic method of implementing Quality of Service is to mark packets with a priority and require switches to prioritize packet processing according to a set of rules. For example, modern switches implementing QoS usually implement "Strict Priority" which is a rule where the next packet to be transmitted is always the highest priority packet currently queued by the switch.

Packets are commonly labeled with a priority in one of two ways:

- 802.1Q – A priority value is inserted into the Ethernet header used for Virtual LANs (VLANs). A packet without an 802.1Q VLAN header does not carry a priority value at the Ethernet layer.

- Diffserv – A priority value is inserted into the IP header of packets. This priority value is carried across VLANs and through IP routers.

Ethernet switches can use 802.1Q priority values in the VLAN header, Diffserv priority values in the IP header or even other fields such as addresses and port numbers to treat certain classes of packets preferentially. High priority media packets are transmitted in preference to lower priority packets; however a media packet might still be queued behind a lower priority packet which has already begun transmission.

Packet prioritization bounds latency in a network by ensuring that the time spent by media packets queued behind lower priority packets is limited.

Resource Reservation

The concept behind resource reservation is that devices signal their network usage requirements to the network before beginning transmission of packets. In a network where resources are limited, a device wanting to transmit additional traffic can be rejected before the additional load creates congestion on resource limited links or switches.

Resource reservation has been proposed for various networking technologies in the past. A notable example is the Resource Reservation Protocol (RSVP) used in Internet routers; however it has not been widely deployed in Ethernet switches.

Rather than track individual streams of packets, modern switches can usually only differentiate between small numbers of traffic classes (typically 4-8). Streams of traffic at the same priority level are lumped together and treated as a single, aggregated stream of packets.

In practical AV network implementations, resource limitations are dealt with by deploying sufficient bandwidth to meet the needs of the system being deployed. Regardless of whether the network supports reservations or not, sufficient network resources must be provisioned for all of the conceivable use cases. This means that under normal conditions, reservations in an adequately provisioned network will always succeed. However, if a part of the network fails and reduces the available resources or the network is unexpectedly loaded, resource reservations can allow the network to provide reliable service to a subset of devices. Whether or not reservations are in use, remedial action will likely be the same – correct the failure or deploy more bandwidth.

Clock Synchronization

Clock synchronization is conceptually simple: when we set the time on a watch we synchronize the watch to another clock at that instant. Clock synchronization protocols do something similar by exchanging messages containing timestamps so that a slave clock can track the time on a master clock connected to a network.

A widely deployed clock synchronization protocol is NTP – the Network Time Protocol, which is used to synchronize clocks such as those in your PC with time servers connected to the Internet.

A relatively new clock synchronization protocol for local area networks is the IEEE 1588 Precision Time Protocol (PTP).[2] IEEE 1588 came out of the industrial control and test/measurement fields and

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[2] http://ieee1588.nist.gov/

can run over IP, Ethernet, and other bus structures such as backplanes. A PTP master clock sends several types of synchronization packets containing timestamps to slave clocks, resulting in the slave clock accurately tracking the seconds/nanoseconds time of the master clock.

Note that clock synchronization packets are delayed as they pass through the network. Some delays are predictable and can be easily corrected for (e.g. propagation times across links), While others are statistical in nature (e.g. queuing behind other packets sharing the same path). In 100Mbps-only networks, queuing delays can be significant especially when there is a high traffic load, making tight synchronization more difficult to achieve. Increasing the speed of the network links to 1Gbps reduces queuing delays by a factor of 10 compared to 100Mbps networks, making microsecond synchronization accuracy possible with existing Ethernet switches.

PTP also supports switch participation in the synchronization protocol to compensate for variable queuing delays; this idea has been picked up on in the AVB 802.1AS synchronization and is discussed later in this whitepaper.

IEEE 802.1 Audio Video Bridging (AVB) - Understanding the Core AVB Standards

The core AVB draft standards define new functions to be added to Ethernet switches and endpoints to better support media networking. These new functions offer support for clock synchronization and Quality of Service (QoS) in Ethernet networks and introduce a new category of behavior into Ethernet networks aimed at supporting time sensitive traffic.

The three core AVB standards being drafted for Ethernet networks are:

- 802.1AS – Timing and Synchronization for Time-Sensitive Applications
- 802.1Qav – Forwarding and Queuing for Time-Sensitive Streams
- 802.1Qat – Stream Reservation Protocol (SRP)

We will now examine each of these in a little more detail.

802.1AS Clock Synchronization

802.1AS is a subset of the IEEE 1588 Precision Time Protocol which is restricted to IEEE 802 networks (e.g. Ethernet, Wi-Fi). An 802.1AS capable Ethernet switch participates in the clock synchronization protocol itself rather than just forwarding synchronization frames. 802.1AS packets entering and leaving the Ethernet switch are time-stamped allowing the switch to avoid timing variation due to queuing of packets.

An 802.1AS capable device or switch will only communicate with another 802.1AS capable device, thus forming a timing domain. Any non-802.1AS capable switch cannot be part of the timing domain and so a network may end up segmented into one or more timing domains.

802.1AS offers several benefits for AV applications:

- Improves clock synchronization performance in slower speed networks (e.g. 100Mbps)
- Improves clock synchronization performance to below the microsecond level
- Support for links like wireless where there is a lot of inherent delay variation

802.1Qav Traffic Shaping (QoS)

Earlier in this paper, the concepts of marking packets with a priority and then processing those packets so that certain classes of traffic received preferential treatment was introduced. 802.1Qav defines two new classes of time sensitive traffic in Ethernet networks and defines how switches are to behave when forwarding these new traffic classes.

The 802.1Qav priority is inserted into the Ethernet header used for VLANs and then switches use this priority information to shape the traffic being transmitted out a port at that priority level. The effect of traffic shaping is to smooth the flow of packets coming out from a switch port. In essence, shaping increases the average delay of packet flowing through the network in order to reduce the worst case delay which might be experienced.

As with other prioritization schemes, 802.1Qav switches forward higher priority traffic in preference to lower priority traffic. As mentioned previously, packet prioritization bounds latency in a network by ensuring that queuing of media packets behind lower priority packets is limited.

Current enterprise switches can offer priority in various classes and perform traffic shaping; however the features and the configuration parameters vary widely between vendors. 802.1Qav will result in a standard feature set and configuration parameters for switches.

802.1Qat Resource Reservation (QoS)

To bound latency for high priority traffic passing through an Ethernet network, the total amount of high priority traffic on each link must be limited. For AVB, this limit is set at 75% of the bandwidth on each link in the network to achieve a 2ms latency over seven 100Mbps network hops. In current networks, the requirement to limit bandwidth is met by designing the network to have sufficient capacity for the intended application and by configuring QoS parameters in the switches.

As mentioned previously, a resource reservation protocol allows devices to signal their network usage requirements to the network before beginning transmission of packets. A resource reservation protocol allows QoS parameters in a switch to be automatically configured (e.g. how much bandwidth to reserve for high priority traffic classes) so that the 75% bandwidth limit is enforced without requiring manual configuration of Ethernet switches.

The 802.1Qat reservation protocol also supplies information to 802.1Qav when registrations are made for a stream of packets. If a registration exists for a stream, packets will only be forwarded out ports where bandwidth has been successfully reserved for receivers of that stream. This has the effect that multicast messages for registered streams are not flooded throughout the network, limiting the distribution of multicast to only the receivers interested in it, much like IGMP Snooping in existing switches.

Robustness

When thinking about network guarantees for AV traffic, the issue of protection from misbehaving devices is often raised. In a similar way to existing switches, AVB switches protect high priority packet streams from lower priority interfering traffic by preferentially forwarding the higher priority traffic. This means that a measure of protection is provided against misbehaving low priority sources in the network (e.g. a PC generating lots of network traffic).

Misbehaving high priority devices are much harder to protect against, since regardless of whether 802.1Q, Diffserv or 802.1Qav is being used, all packets at the same priority are treated as equivalent. 802.1Qav switches are not required to ensure that flows *entering* a switch conform to their associated reservations and so a misbehaving device can affect other flows at the same priority passing through a directly connected switch if it transmits too much traffic. Any damage should however be limited to just the flows passing through the switch connected to the misbehaving node, since the switch will not forward high priority traffic in excess of the reservations that have been made on each output port.

Far more likely causes of problems are network loops and the misconfiguration of switches or devices. Safe default configurations for Ethernet switches will help, however larger scale networks will always require some level of knowledge from the system designer.

AVB Clouds

An AVB network is designed to be a "defended network" constructed from AVB-capable switches and end devices. AVB capable switches detect whether each port is connected to another AVB capable device or switch and build islands of connectivity in which AVB services are supported. Current Ethernet switches and devices do not implement the AVB protocols and will be prevented from becoming part of the AVB cloud. A device cannot use AVB services to communicate with another device if there is a non-AVB switch anywhere on the path between two devices.

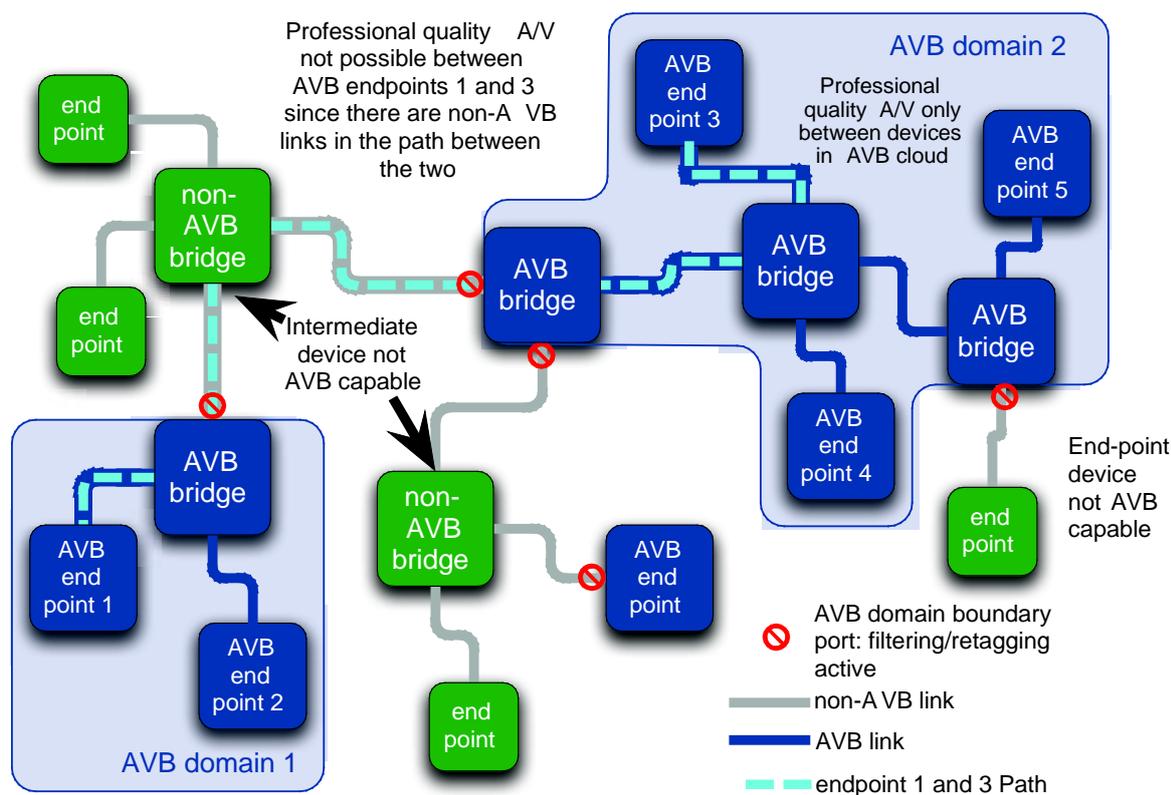Figure 4 illustrates the effect of non-AVB switches in an AVB network.

Figure 4: AVB Connections[3]

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[3] AVnu™ Alliance White Paper, "*No-excuses Audio/Video Networking: the Technology Behind AVnu*"
http://www.avnu.org/resource_library

Using AVB Network Services

Having introduced the three core AVB services related to synchronization and Quality of Service (QoS) in Ethernet, we will now examine how those services are applied to protocols that carry media from one device to another.

An audio/visual transport protocol takes signal data from a media source, divides the data into packets for transmission across the network and reassembles the packets back into the signal data at the receiver while preserving the timing characteristics of the original signal.

AVB Transport Protocols

Two approaches are being defined for media transport over networks with AVB services: IEEE 1722 and IEEE 1733. Unlike the core AVB standards, these specifications are being developed in the IEEE Microprocessor Standards Committee (MSC)[4], outside the part of the IEEE responsible for Ethernet specification. Both IEEE 1722 and IEEE 1733 build on previous standards.

IEEE 1722 is a transport protocol which runs entirely at Layer 2, limiting it to a single Ethernet LAN. This transport protocol takes Firewire/IEEE 1394 frames and puts them into Ethernet frames, using 802.1AS for synchronization and 802.1Qav/802.1Qat for QoS.

IEEE 1733 is a simple extension to the well established Real-time Transport Protocol (RTP)[5], the media transport protocol developed for the Internet. RTP supports a huge variety of media types and finds extensive use in VoIP, video conferencing and more recently IPTV. RTP streams can use AVB QoS services by reserving bandwidth with 802.1Qat and marking packets with 802.1Qav priorities. The IEEE 1733 standard specifies an extension to the RTP Control Protocol (RTCP) to support time alignment of RTP streams using the 802.1AS clock synchronization protocol.

So which protocol should be used? Although Firewire/IEEE 1394 has been declining for several years in the face of competition from USB and eSATA, it has developed a niche following in professional/prosumer audio applications. This has translated into interest in IEEE 1722 amongst professional AV companies. RTP on the other hand has a much broader following across several industries and is under active and continuing development in the IETF. The combination of RTP and IEEE 1733 appears to be a good long term choice for products which need to scale beyond a single LAN and for the AV formats of the future coming out of the IETF.

Device Discovery and Configuration

In addition to synchronization, QoS and transport, a complete AV solution requires easy-to-use device discovery and signal routing functions. The basic building block of these functions is service discovery – a broad field with a long history. Many current systems implement service discovery and automatic device configuration using standard protocols,[6,7] or bespoke solutions.

A new standard called IEEE 1722.1 is in the early stages of development and is intended to use existing zeroconf standards6 to discover IEEE 1722 endpoints.

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[4] Microprocessor Standards Committee: http://grouper.ieee.org/groups/msc/
[5] RTP: http://en.wikipedia.org/wiki/Real-time_Transport_Protocol
[6] Zeroconf DNS-SD: http://www.multicastdns.org/, http://www.dns-sd.org/
[7] UPnP SSDP: http://en.wikipedia.org/wiki/Universal_Plug_and_Play#Discovery

AVB Rollout – Transitioning to an AVB network

AVB will provide improved QoS and simplify the switch configuration process. In time, it will also expand the interoperability of AVB switches and endpoints which will expand the penetration of digital A/V networked devices. When the AVB standards are finalized and compliance certification processes are completed, there will be a transition period over the next several years until AVB switches are prevalent and OEM AV manufacturers develop new products incorporating compliant versions of AVB. During this timeframe, additional system factors need to be considered.

Switch Availability and AVB Clouds

Since AVB protocols operate only in domains where every device is AVB capable, new Ethernet switches and end points are required throughout the deployed system. AVB protocols cannot be used end-to-end through a system that contains a mixture of AVB-capable and non-AVB capable switches. In many cases, Ethernet switch product designs currently on the market will need hardware changes to support 802.1AS time-stamping and traffic shaping. It will take time for AVB hardware and software support to become available in a broad range of switch products from multiple manufacturers.

In small scale systems, increased bandwidth in the form of inexpensive gigabit switches reduces the benefits offered by AVB. For example, a dozen devices connected by a few non-AVB gigabit switches can already support 512x512 channels of 48kHz/24bit uncompressed audio with a latency of less than 1ms through the network. In networks like this, bandwidth is plentiful, the design task is simplified and QoS configuration is not essential to achieve good performance. In this scenario, implementing AVB in the switch adds cost in the form of a processor and additional software in the switch but may only provide marginal performance benefits.

In larger scale networks, it's desirable to use existing backbone infrastructure where possible. Ideally, existing infrastructure would be inexpensively upgradeable to support AVB via software and/or firmware updates; however hardware upgrades are probably required and are relatively expensive, involving swap-out of existing switches. The likely solution in this case will be parallel deployment of AVB-capable infrastructure, increasing equipment and management costs. Unfortunately, the end-to-end requirement for AVB support prevents deployment across existing infrastructure, even if that infrastructure is already QoS-capable and supports critical services like VoIP telephony.

While green field deployment of AVB equipment will be straightforward, networks with one or more islands of AVB connectivity might need to be considered, at least for the short to medium term.

Dante exploits gigabit networks and can be deployed into existing QoS-capable infrastructure. With Dante, development and deployment of networked AV services does not have to wait for the widespread availability of AVB switches – networked AV systems can be designed and deployed on today's network gear.

Interoperability

While open standards provide a common set of technical specifications, and ultimately should facilitate interoperability, it is still dependent on the software developer to implement a solid, robust software implementation. Issues often arise over differing interpretations of the standards documents. The AVnu Alliance™ is an industry forum dedicated to the advancement of professional-

quality audio video by promoting the adoption of the IEEE 802.1 Audio Video Bridging (AVB). Audinate is proud to be a Promoter Member of the AVnu Alliance. The AVnu Alliance will create compliance test procedures and processes to ensure AVB interoperability of networked A/V devices.

Summary of AVB Benefits

To summarize, the main benefits AVB Ethernet services offer are:

- Improved synchronization between devices, particularly for 100Mbps & wireless devices
- Standard definition of QoS for Ethernet switches which will simplify switch configuration
- Automatic configuration of the QoS parameters necessary to achieve bounded latency

The AVB standards under development aim to provide new time synchronization and Quality of Service (QoS) features in Ethernet switches, and to specify the use of these services in AV transport protocols. These enhanced capabilities will be instrumental in delivering improvements in Quality of Service due to traffic shaping and resource reservation, as well as simplifying switch configurations.

Status of AVB Standards

The core AVB specifications are being developed in the IEEE 802 LAN/MAN Standards Committee – the part of the IEEE that standardizes Ethernet and Wi-Fi. The initial effort began in 2005 with the "Residential Ethernet" study group. The transport protocols are being defined in the IEEE Microprocessor Standards Committee (MSC) – the part of the IEEE that standardized Firewire; and RTP is of course a set of standards from the IETF.[8]

Table 1 summarizes the versions and status of the various IEEE AVB specifications as at Aug 2010.[9]

Standard	Status	Date
IEEE 802.1Qav	Active Standard	2009
IEEE 802.1Qat	Active Standard	2010
IEEE 802.1AS	Draft Standard	2011
IEEE 802.1BA	Draft 2.3	Feb 2011
IEEE P1722	Draft Standard	2011
IEEE P1733	Draft 7.0	Feb-2011
IEEE P1722.1	Draft 0.10	Oct-2010

Table 1: Standards status as at February 2011

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[8] RTP standards status can be found at: http://tools.ietf.org/wg/avt/
[9] For current AVB standards status, see: http://standards.ieee.org/findstds/

Dante offers a migration path to AVB

Dante provides a proven high performance media networking solution which can be deployed on current networks now, and will be deployable on future AVB networks when the standards are completed and OEM manufacturers can complete the certification process.

Dante is standards-based but is more than a set of standards. It is a proven robust, feature rich end-to-end networking system. In an AVB network, Dante retains its value in delivering value added features such as performance and network monitoring, latency management, auto configuration, simple signal routing and glitch free redundancy. Dante simplifies installation because it supports automatic device and channel discovery, with easy-to-use signal routing. Dante also provides comprehensive network monitoring tools. Audinate has also introduced the Dante Virtual Soundcard and Dante PCIe card, enabling your PC to become a network audio device and communicate with other Dante enabled equipment.

The Audio Video Bridging (AVB) standards under development offer clock synchronization and Quality of Service (QoS) services to media transport protocols. Dante can run on current networks using existing standards and will incorporate AVB protocols as they become available. Future AVB networks will be based on 802.1AS for time synchronization and 802.1Qat/802.1Qav for Quality of Service and will require new Ethernet switches supporting these specifications.

Dante is AVB Ready

Many Dante solutions are already "AVB Ready": they implement accurate clock synchronization and QoS in hardware, and can support AVB standards via firmware update. Dante will incorporate support for AVB networks as part of the Dante AVB solution. Support for IEEE AVB transport protocols will be included as part of the Dante AVB solution as shown in Figure 5.
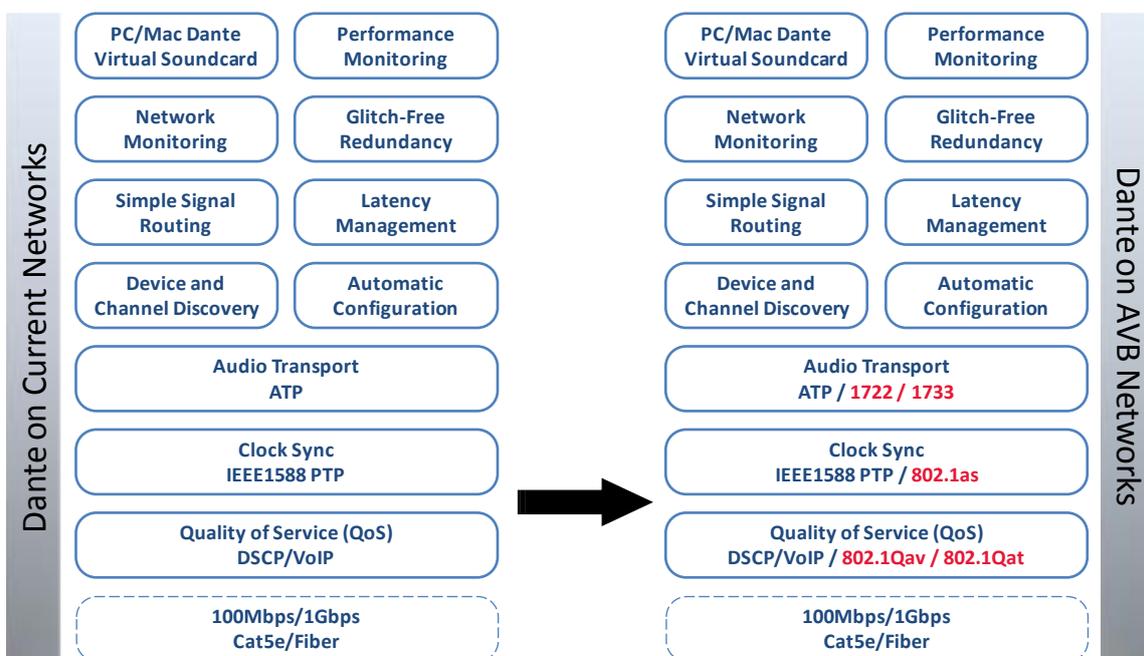

Figure 5: Dante Architecture including AVB support

Figure 5 above shows Dante's full suite of features and illustrates how the architecture can simply migrate to AVB. Dante also has an efficient and flexible UDP/IP audio transport protocol, predating IEEE 1722/IEEE 1733, which uses IEEE 1588 for clock synchronization and Diffserv QoS. As with RTP, this protocol can leverage the improvements made in AVB 802.1AS service for synchronization and 802.1Qat/802.1Qav for QoS. Today, Dante uses a robust implementation of IEEE 1588 Precision Time Protocol and DSCP/802.1Q Quality of Service to achieve tight synchronization, low latency and QoS guarantees using current Ethernet switches. The AVB standards under development are a natural evolution of the open standards already used by Dante and will be implemented in into the Dante media networking solution.

Summary of Dante Value Added Features

While Dante can and will make use of the AVB standards as they emerge, it provides much more than basic audio transport. Its rich feature set includes:

- Media transport redundancy
- Clock master failover/redundancy
- Management of latency between devices in the network
- Simple device and channel discovery
- Easy to use signal routing using meaningful labels, not magic numbers
- Simple interfacing to PC/Mac equipment (e.g. Dante Virtual Soundcard)
- Simple integration with existing IT networks (which are IP based)
- Tunneling of legacy protocols (e.g. serial protocols, MIDI) across the network
- Network monitoring
- Performance monitoring
- APIs, libraries and reference designs to enabling vendors to quickly design products
- Control interfaces providing status information upon routing changes, clock master changes or other important events in the network
- Ease-of-use at user level
- Customer friendly UI for signal routing

Conclusion

New AVB services in Ethernet switches will improve synchronization and Quality of Service (QoS), whilst reducing the complexity of switch configuration. Interoperability will drive a wider use of IP networking for A/V systems. The AVB standards under development are a natural evolution of the standards already used by Dante and are incorporated into the Dante media networking solution. Dante will encompass AVB standards while retaining its ease of use, comprehensive feature set and its ability to operate over current networks. For manufacturers, adopting Dante de-risks the design and manufacture of networked AV equipment as well as supporting deployment of high performance AV networking on today's networks and providing a path to AVB compliance. You can confidently deploy Dante on networking equipment widely available today whilst looking forward to new standards and technologies of tomorrow.

Glossary

AVB	A set of standards being developed by the IEEE. These standards add new time synchronization and Quality of Service (QoS) functions to Ethernet.
DiffServ	An IETF standard for classifying packets using a priority field in the IP header
DSCP	DiffServ Code Point – used to mark IP packets with a priority value so that switches and routes can provide preferential service to higher priority network traffic
Ethernet	A widely available networking technology using CAT5/6 cabling or fiber links joined by packet switches. Can operate at 100Mbps, 1Gbp and 10Gbps.
IEEE	The Institute of Electrical and Electronics Engineers is the organization which standardizes networking technologies like Ethernet and Firewire.
IEEE 1588	Also known as the "Precision Time Protocol". Provides highly accurate clock synchronization services in Ethernet and IP networks.
IEEE 802.1	The IEEE standards working group responsible for Ethernet protocols.
IEEE 801.1AS	An Ethernet-only profile of IEEE 1588.
IEEE 802.1Qat	A protocol for reserving bandwidth in an Ethernet network.
IEEE 802.1Qav	Specifies how Ethernet packets marked with AVB QoS priority values are processed
IEEE 802.3	The IEEE standards working group responsible for Ethernet cabling standards
IETF	The Internet Engineering Task Force standardizes Internet Protocols.
IP Networking	Networking based on the Internet Protocols
IP Routing	The ability to forward packets outside a single LAN using IP addresses
LAN	A Local Area Network (LAN) is a network (often small) where devices can communicate directly with all other devices.
Multicast DNS	A lookup mechanism used within a LAN which forms the basis of service discovery.
Multicast	Point-to-multipoint communication – packets are flooded throughout the network
PTP	See IEEE 1588
QoS	Quality of Service. A variety of techniques used to ensure that some network traffic receives preferential treatment from the network. For example, QoS ensures that Voice over IP telephone calls are not interrupted by email traffic in a local network.
TCP/IP	Often refers to the full suite of Internet Protocols. The Transmission Control Protocol (TCP) is also a specific protocol which provides reliable connections between devices. TCP is the underlying network transport for the web.
UDP/IP	The User Datagram Protocol (UDP) provides a very efficient, message oriented encapsulation for data. It is well suited to real time applications and forms the basis for the Realtime Transport Protocol (RTP).
Unicast	Point-to-point communication – packets travel along a path between the sender and receiver. Unicast avoids flooding packets throughout the network.
VLAN	Ethernet switches can create private LANs connecting one or more of their ports. VLANs are isolated from each other. Some devices can be part of more than one VLAN at a time.
VoIP	Voice over IP allows telephone calls to be carried across standard IP networks. VoIP has driven the adoption of Quality of Service (QoS) functions in switches and routers.
Zeroconf	The IETF zeroconf working group created a set of protocols to support automatic configuration of IP networks. These protocols allow IP networks to operate without network administrators or management infrastructure.

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