White Paper

AUDIO OVER ETHERNET: COBRANET® AND IEEE / AVB NETWORK BRIDGING SOLUTIONS

The Convergence of IT Networks and Professional Audio Distribution

October 2013

ClearOne
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Executive Summary

Professional audio, including recording, public address systems, sound reinforcement for live events and performances – and more recently – group conferencing and collaboration, have a rich history dating back to the mid 1870’s. The first digital “networks” began with Morse telegraphs about 50 or 60 years prior to that time, and gradually advanced to silicon processors and computer-based networks in the 1960’s and 70’s.

As these technologies have evolved and the domains of sound transmission and information technology have converged, the transition from analog cabling into complex digital network infrastructures has not been without its challenges. But the professional audio community has produced a number of practical innovations to solve many of the most difficult issues.

This paper describes some of these innovations, including the emergence of Audio over Ethernet, CobraNet, IEEE Audio Video Bridging (AVB), and other industry standards. It discusses how pro audio and computer networking have come together to harness the power of IP networks for the distribution of digital audio over greater distances, with simplified network configurations, lower costs of implementation, easier system management, and clearer upgrade paths into future technologies.

Audio Over Ethernet & CobraNet

First developed in 1973, patented in 1975, commercialized in 1980, and standardized in 1980 as IEEE 802.3, Ethernet is the world’s dominant wired local area computer networking technology, currently capable of operating at speeds up to 100 Gbps.

With the convergence of IT systems and professional audio technologies, high fidelity, low-latency, digital audio can be efficiently distributed over Ethernet using one of many available protocols. Layer 1 protocols generally do not utilize Ethernet’s native frame structure, and are often not compatible with other traffic on IT networks. Thus, a number of Layer 2 protocols have gained wider acceptance due to their ability to make use of standard Ethernet hubs and switches.

One of the first commercially successful Layer 2 implementations of Audio over Ethernet was CobraNet, developed in 1996 by Peak Audio, and acquired in 2001 by Cirrus Logic, which reports that more than 1,000,000 channels of uncompressed, low-latency, real time professional-grade audio have been installed worldwide.

Using common Ethernet cabling and hardware, CobraNet reduces the cost of designing and building audio distribution systems. Most organizations that use business sound systems also operate IT networks that transmit computer traffic, financial transactions, building controls, and even video security data. Transmitting digital audio over the same infrastructure makes sense to both sound engineers and IT specialists, provided that any conflicts in bandwidth usage can be resolved, which CobraNet was specifically designed to do.

Despite its early emergence and popularity, as mentioned previously, CobraNet is a proprietary technology owned and controlled by a single organization, and there are factors considered by professionals to be technical disadvantages. For example, CobraNet has a latency ranging from 1.33 to 5.33 milliseconds per network traversal, according to a chart provided by the Audio Engineering Society. This level of delay may be

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1 CobraNet is a Registered Trademark of Cirrus Logic, Inc.
2 Source: Cirrus Logic Inc., www.cobranet.info/technology
unacceptable to some applications, especially when combined with other delays caused by digital signal processing, conversions between analog and digital, and propagation times. There are also hardware costs associated with interfaces needed to encode and decode CobraNet signals.

“A number of industry leaders have initiated collaborative efforts to develop consistent standards to enable High performance professional A/V networks to be deployed more easily and more cost effectively.”

Although Audio over Ethernet offers substantial potential cost savings in cabling and other infrastructure over analog cable, there has traditionally been a high per-node cost, and significant technical expertise required to implement networked audio systems. Proprietary solutions have been unable to fully solve those issues, and a number of industry leaders have initiated collaborative efforts to develop consistent standards to enable High-performance professional AV networks to be deployed more easily and more cost effectively.

Audio Video Bridging / IEEE Standards

AVB (Audio Video Bridging) is a new set of technical standards under development (starting in 2005) by the Audio Video Bridging Task Group of the IEEE 802.1 standards committee. The mission of the Task Group is to create specifications to enable time-synchronized, low-latency, audio and video streaming services through IEEE 802 networks.

The AVB standards from IEEE include:

+ IEEE 802.1AS: Timing and Synchronization for Time-Sensitive Applications (gPTP)
+ IEEE 802.1Qat: Stream Reservation Protocol (SRP)
+ IEEE 802.1Qav: Forwarding and Queuing for Time-Sensitive Streams (FQTSS)
+ IEEE 802.1BA: AVB Systems
+ IEEE 1722: Layer 2 transport protocol for time-sensitive applications in bridged networks
+ IEEE 1722.1: AVB device discovery, connection management, and control for IEEE 1722-based devices
+ IEEE 1733: Layer 3 transport protocol for time-sensitive network applications

Another organization, the AVnu Alliance, is an industry forum dedicated to the advancement of professional-quality audio video transport by promoting IEEE AVB and related standards over various networking link-layers, and enabling an ecosystem of affordable, professional-quality streaming for networked audio and video content.

4 AVnu Alliance resource documents are available at: www.avnu.org
Audio over Ethernet / Leading Layer 2 Protocols

CobraNet® (Cirrus Logic)
+ Mature technology, market proven over a decade, more than one million channels installed worldwide – more nodes than any other protocol
+ Transport mechanism for real-time, high-quality digital Audio over Ethernet
+ Audio delivered in standard packets over 100Mbps Fast Ethernet
+ Standard distance is 100 meters (328 ft) over Cat 5, and two kilometers over fiber
+ Proprietary technology, owned by Cirrus Logic
+ Heterogeneous data tolerant, 5.25 ms latency
+ No migration path beyond 100MB networks

Audio Video Bridging (AVB)
+ New set of standards developed by the IEEE AVB Task Group and promoted by the AVnu Alliance
+ Time-synchronized delivery of audio and video media through networks
+ Focused on pro audio, automotive, and consumer electronics markets
+ Works with 100/1000 Mbps networks
+ Nominal distance is 100 meters (328 ft) over Cat 5 and two kilometers over optical fiber
+ Precision time protocol
+ Traffic shaping
+ Stream reservation protocol
+ Packet formats for audio and video

AVB has been specifically designed for pro audio use and addresses the unique requirements of distributing high-quality audio and video signals over a standard Ethernet network. To achieve this, it is necessary to synchronize multiple streams so they are rendered correctly in time with respect to each other. This ensures lip sync, keeps multiple digital speakers in phase, and helps maintain tight time sync of 40 or more microphone channels feeding a live mixing desk in a live studio or audio conferencing environment.

To maintain quality of service, audio video streams must be closely synchronized, which is difficult for a typical switched network to achieve using regular 802 architecture without AVB implemented. Applications must also be assured that required network resources are available and will remain available as long as the application needs them. This is known as a “reservation,” or “admission control,” which allows an application to notify the network of the requirements for a stream ahead of time. The network will lock down the resources needed for that stream and, if they are not available, will notify the application so that the stream may be stopped or an error message delivered.

IT networks count on higher-level protocols to handle congestion such as TCP, which works by throttling transmission and retransmitting dropped packets. This is adequate when long delays are acceptable, but will not work where low deterministic delays are required.

Time synchronization is critical when audio and video signals are distributed over Ethernet. To achieve this, AVB devices periodically exchange timing information to allow synchronization of multiple streams, provide a common time base for sampling and receiving data streams at a source device, and present those streams at the destination device with the same relative timing.
The vision of AVB is to implement and promote technical standards that enable no-compromise streaming of AV signals over modern Ethernet-based networks.

Traffic shaping is the process of smoothing out the traffic stream so digital packets within the stream are evenly distributed in time. If traffic shaping is not performed at sources and bridges, then the packets tend to “bunch-up” into bursts of traffic that may overwhelm buffers in subsequent bridges, switches, or other network infrastructure devices. The AVB architecture implements traffic shaping using existing 802.1Q forwarding and priority mechanisms, and also defines a particular relationship between priority tags and frame forwarding behavior at endpoints and bridges.

In summary, the vision of AVB is to implement and promote technical standards that enable no-compromise streaming of AV signals over modern Ethernet-based networks. ClearOne is a member of all the AVB industry groups, and a strong supporter of AVB adoption.

ClearOne Audio Networking Solutions / CONNECT™ Network Bridges

ClearOne has taken a modular approach to add audio over Ethernet capabilities to its flagship CONVERGE® Pro audio conferencing systems and CONVERGE® SR sound reinforcement mixers. Professional HDConference® audio can be transmitted through an Ethernet network by plugging one side of a ClearOne CONNECT Network Bridge into the expansion bus of the CONVERGE chassis, and connecting the other side to an Ethernet router.

+ For CobraNet connections, a ClearOne CONNECT CobraNet bridge should be used. CobraNet is a decades-old mature audio networking technology that is widely used in professional audio

+ For AVB-compliant connections, a ClearOne CONNECT AVB bridge should be used. AVB (audio video bridging) is the emerging IEEE set of standards that most pro audio environments are eventually expected to adopt

+ Bridges work with: CONVERGE Pro: 840T, 880, 880T, 880TA, 8i, TH20, VH20, CONVERGE SR: SR1212, SR1212A

ClearOne CONNECT bridges interface with ClearOne CONVERGE series products via expansion ports, and are easily configurable through the CONVERGE unit using ClearOne’s familiar console software. If the latest firmware version and software are installed, as network standards evolve and are updated, the CONNECT bridges ensure that audio streams associated with ClearOne’s products comply with the latest standards without requiring any changes to the conferencing system hardware.

Users can select different protocols and add more bridges whenever needed. Systems can be upgraded at any time without changing main mixer hardware. It’s easy to add, change, or update bridges to future-proof any audio network by accommodating current and future networking protocols and emerging standards.
Enterprises can depend on the ClearOne CONVERGE Pro and CONVERGE SR lines of professional conferencing solutions, knowing that they are future-proof, and will never become obsolete as a result of changing standards.

**Networked Audio Application Examples**

Using a CONNECT bridge connected to Ethernet (CobraNet or AVB), CONVERGE series devices can be separated by the maximum distance supported by Ethernet, typically 100 meters (328 feet) by Cat 5 cable or 2,000 meters (1.25 miles) over fiber. No hardware changes are required for the CONVERGE units when interfacing with a CONNECT bridge. Digital audio can be distributed over Ethernet to enable local area networked audio conferencing and collaboration.

The CONVERGE product family and CONNECT bridges provide scalable conferencing solutions for venues of any size. Common applications include:

- Boardrooms / conference rooms
- Meeting rooms / training rooms
- Telepresence centers
- Courtrooms / justice centers / annexes / jails
- Multimedia rooms
- Higher education and distance learning facilities
- Expo / convention centers
- Auditoriums, stadiums and theme parks
- Studios / production rooms
- Houses of worship / faith-based facilities
- Sound reinforcement
- Large meeting venues
- Paging / emergency notification

One example of a robust CONVERGE networked installation is a dispersed justice system campus, consisting of a primary courtroom, court annexes, and jail holding areas. Key court personnel including judges, attorneys, witnesses, court reporters, clerks, juries, media representatives, and citizens can be located in a main courtroom, while remote participants can be located in anterooms or annexes – on different floors or in nearby conference rooms.
buildings – and incarcerated prisoners can remain in a secure cell or holding area. Everyone in any connected location can listen, comment, and participate in the proceedings. Digital recordings can be made in a central location or connected media center.

Medium distance local area networks can be deployed to support large, distributed audiences in convention complexes, stadiums, theme parks, multi-room auditorium facilities, educational campuses, faith-based places of worship, and virtually any other distributed environment where existing IT networks have been installed and widespread group or public participation is needed.

ClearOne’s current generation of CONVERGE products and network bridges can easily support all of these applications today, off-the-shelf, with a relatively easy setup and configuration process.

At the present time, CobraNet and AVB equipment are not directly interoperable. However, it is possible to install both a CONNECT CobraNet bridge and a CONNECT AVB bridge to the same CONVERGE stack, allowing bridging between normally non-interoperable CobraNet and AVB networks and equipment.

While CobraNet was first-to-market and is dominant today, it is expected that most Audio over Ethernet traffic eventually will migrate to AVB, and that all new devices at some point will support AVB and related standards.

ClearOne supports both of these popular networking protocols to deliver maximum flexibility to our customers, and enable them to future-proof their investments in ClearOne professional conferencing solutions without requiring any changes to the CONVERGE series hardware.

Without using Ethernet, multiple CONVERGE systems can interface to each other through the ClearOne expansion bus at distances up to 200 feet between units, by daisy-chaining multiple CONVERGE units and bridges.

Frequently Asked Questions About CONNECT Network Bridges

**Q:** Where should ClearOne CONNECT Network Bridges be used?

**A:** Anywhere you need to transmit audio through an Ethernet network, using ClearOne CONVERGE Pro and CONVERGE SR systems. This can include corporate buildings with multiple conference rooms connected through Ethernet, court facilities with multiple court rooms and centralized recording though an Ethernet network, multiple conference/teaching rooms connected via Ethernet, localized sound reinforcement and networked audio, stadiums, auditoriums, airports, transit stations, retail facilities, convention centers, houses of worship, and virtually any other venue that employs audio conferencing.
Q: What is the distance limitation for Ethernet cables when the project uses these bridges for networked audio?
A: Cat 5 Ethernet cables can extend a maximum of 100 meters (328 feet) between any two Ethernet devices. Some Ethernet switches are available with fiber optic ports that can extend the distance up to 2 kilometers using multi-mode fiber, and the distance can be even greater with single-mode fiber.

Q: Can multiple CONVERGE units be connected in the same room without using these new network bridges?
A: Yes, there is no change to the method of stacking CONVERGE units. You can continue using the ClearOne expansion port to connect multiple CONVERGE units without CONNECT bridges. A bridge device is needed only when your project requires networked audio transmission.

Q: Can a CONNECT bridge be used with both a single CONVERGE unit and a stack of CONVERGE units?
A: Yes, you can connect one bridge to one CONVERGE unit or a stack of CONVERGE units, to carry eight audio channels through the network.

Q: Do CONNECT bridges do any audio processing?
A: No, CONNECT bridges will not perform audio signal processing. They are used only for routing audio signals between CobraNet/AVB networks and CONVERGE units.

Q: Do these network bridges carry both audio and control signals?
A: The network bridges carry only digital audio signals.

Q: Do CONNECT CobraNet bridges require an IP address?
A: There is no need to set the IP address. The DID (Device Identification) switch is used to set the Device ID.

Q: Can I daisy-chain several CONNECT bridges to increase the channel count above eight?
A: No, the eight channels are fixed. CobraNet/AVB channels 1 to 8 are mapped to the CONVERGE expansion bus channels S to Z.

About ClearOne

ClearOne is a global company that designs, develops and sells conferencing, collaboration, streaming and digital signage solutions for voice and visual communications. The performance and simplicity of its advanced comprehensive solutions offer unprecedented levels of functionality, reliability and scalability. More information about the company can be found at www.clearone.com