AVnu Alliance™ White Paper

AVB for Home/Consumer Electronics Use

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Executive Summary

The Audio Video Bridging (AVB) standards from the IEEE 802.1 AVB group provide professional quality capabilities to networks for time-sensitive media streaming, e.g., to enable standards-based network attached audio systems to play audio in synchronized fashion (i.e., no annoying stereo image shift or phasing). Furthermore, networks constructed from devices which implement the AVB standards can offer assurance that a media stream which is granted a reservation request, passes exclusively through AVB-capable devices that provide sufficient resources to transport that stream. The AVB standards complement and rely on higher layer discovery and streaming protocols and also take advantage of lower layer MAC/PHY features of the heterogeneous LAN found in homes.

About AVnu Alliance

The AVnu Alliance is an industry forum dedicated to the advancement of professional-quality audio video transport by promoting the adoption of the IEEE 802.1 Audio Video Bridging (AVB), and the related IEEE 1722 and IEEE 1733, standards over various networking link-layers. The organization will create compliance test procedures and processes that help ensure AVB interoperability of networked A/V devices, helping to provide high quality streaming A/V experience. The Alliance will promote awareness of the benefits of AVB technologies and intends to collaborate with other organizations and entities to make use of this work in their respective efforts to provide a better end-user A/V experience.

The Alliance is focused on applications of these technologies in the Automotive, Professional, and Consumer Electronics markets.

Introduction

Over the past decade, significant effort has been invested to enable CE devices to utilize home networks to stream audio and video from one device to another. These efforts have advanced the state of the art for discovery, interoperability, media format compatibility, and stream quality. These efforts also have something else in common: each is layered on top of the Internet Protocol (IP), and each relies on the services provided by the underlying layer-2 bridged Local Area Network (LAN), which includes bandwidth, Quality of Service (QoS) features, latency, reliability of packet delivery, etc.

When the underlying services provided by the LAN are enhanced, applications have the opportunity to take advantage of those enhancements.

The IEEE 802 standards organization has subgroups that define various well-known link types, both wired and wireless. In addition to these, the 802.1 subgroup defines how to *bridge* between the various link types. The 802.1 working group is adding standards that enable time sensitive streams to bridge across heterogeneous home LANs in addition to new kinds of services of the lower-layers (e.g., highly accurate time synchronization) to further improve the user experience when enjoying networked audio and/or video. The base standards are collectively called the Audio/Video Bridging (AVB) standards, and are developed by the 802.1 AVB Task Group. While these bridging enhancements allow applications to operate with the reliability, resilience, and time accuracy required in professional studios and for live concerts (see companion whitepaper on the use of AVB in professional applications at http://www.avnu.org/resourcelibrary), they are also specified in a way that their implementation complexity can be low, allowing them to be deployed in mass market home/CE applications.

The goal of the AVnu Alliance is to promote the broad adoption of the AVB standards and other relevant standards through technical and marketing efforts, compliance and interoperability programs, and liaison relationships with relevant industry and standards bodies.

Better networking for home media streaming

Below are some examples of how AVB technology benefits media streaming within the home:

1. Home theatre: In a home theatre, the paths traveled by video and audio between equipment and around the room are often very different. In such cases it is important to maintain lip sync between audio and video by explicitly communicating the time at which the renderers must present the audio and video and by ensuring that the latency of the various network paths is sufficiently low.

2. Whole-home audio, network-attached surround-sound speakers: Distribution of music within the home using a wired and/or wireless network is an interesting use case which has received increasing attention in recent years. However, if the audio packets played by two or more network-attached speakers are not synchronized (e.g. for multichannel or surround sound), one speaker will play the audio ahead of another speaker, making proper stereo "imaging" impossible (and even worse than a fixed delay is an inter-speaker delay that changes over time). Network-attached speakers using the IEEE 802.1AS time-synchronization standard will play in sync even if the speakers and the 802.1AS-capable source of the audio content are attached to different network technologies if all the bridges along the path are configured for AVB.

3. Glitch-free media streaming over wired networks: A common problem today is that it is difficult to configure a network such that a media stream always plays glitch-free—even if wired Ethernet is installed. AVB addresses this by ensuring that stream

bandwidth can be reserved and that stream packets are thereafter appropriately scheduled along the entire network path of AVB devices. For example, imagine that you are watching a home movie on your television that is being streamed from your computer when, in another part of the house, someone else is surfing the web on a second computer. AVB provides the means to help assure that the home movie cannot be interrupted by a file download. Networked devices in the stream's path that do not support the AVB reservation protocol are detected and marked "not AVB capable" by the AVB devices (and the reservation declined over that network path) ensuring that when a reservation succeeds, every device in the path voted "Yes" to the reservation.

Brief Technology Overview

For a thorough treatment of AVB technology see http://www.AVnu.org/resourcelibrary.

Four IEEE 802.1 AVB draft standards form the foundation of the technology promoted by the AVnu Alliance and—like other 802.1 standards—are not specific to any one network link technology, but rather describe interworking/bridging between various network link technologies. It's important to note, however, that this is not intended to imply that the services provided by the AVB standards over every kind of network link are identical, since each link technology has different characteristics.

Below are the four foundational standards. As of August 2009 all were in draft form:

- IEEE 802.1AS: "Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks." The protocol defined by 802.1AS automatically selects a device to be the master clock, and then distributes this clock throughout the bridged LAN / IP subnet to all other network devices using link-specific transmit/receive timestamping. Note: The 802.1AS-distributed clock is not used as a media clock. Rather, the shared 802.1AS clock reference is used to regenerate the media clock at the listener/renderer. Such a reference removes the need to force the latency of the network to be constant, or compute long running averages in order to estimate the actual media rate of the transmitter in the presence of substantial network jitter. IEEE 802.1AS is based on the ratified IEEE 1588-2008 standard.

- IEEE 802.1Qat: "Virtual Bridged Local Area Networks - Amendment 9: Stream Reservation Protocol (SRP)." The protocol defined by 802.1Qat allows a stream reservation to be established along the network path between a talker (e.g. source or server) and listener (e.g. sink or renderer) in a bridged LAN / IP subnet.

- IEEE 802.1Qav: "Virtual Bridged Local Area Networks - Amendment 11: Forwarding and Queuing for Time-Sensitive Streams." This draft standard describes a token-bucket method of shaping network traffic at talkers and bridges such that the latency and bandwidth of reserved streams can be controlled.

- IEEE 802.1BA: "Audio/Video Bridging (AVB) Systems"

There are also two draft standards that rely on IEEE 802.1 AVB to provide professional quality Audio/Video.

- IEEE 1733: extends RTCP for RTP streaming over AVB-supported networks.
- IEEE 1722: "Layer 2 Transport Protocol for Time-Sensitive Streams." Allows easier porting of applications currently using IEEE 1394 (FireWire®) to AVB

The big picture: How AVB fits in

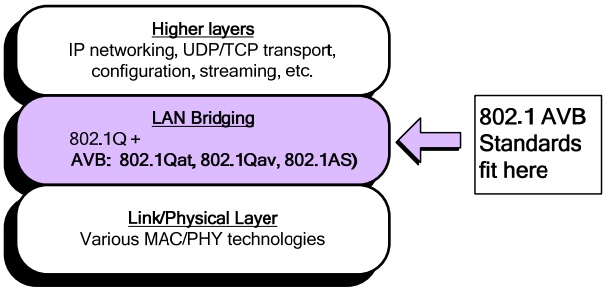

Figure 1- AVB's place in the networking stack

Layers above AVB: Device discovery, control, and streaming:

As mentioned in the introduction, other standards and industry bodies have defined a variety of networking protocols and formats for device discovery, configuration, and streaming. With the introduction of AVB standards to the underlying network on which these efforts rely, the AVnu Alliance sees the possibility of compelling new use cases and improved quality of media experience delivered into the home. AVnu Alliance intends to establish liaison relationships to help turn these possibilities into reality.

Layers below AVB: Networking links:

The AVB standards, as part of "*bridging*", were designed to work over a variety of network link technologies, including Ethernet, wireless, and Coordinated-Shared-Networks (CSNs), all of which are relevant in the home but which also have unique characteristics. The reader is referred to the AVnu technology whitepaper, available at the AVnu.org website for details on specific link technologies.

Summary

Raw bandwidth enhancements in a network yield speed improvements for applications which send data over that network. While these provide incremental benefit, the core 802.1 AVB standards bring new kinds of services to the network which bring different kinds of improvements for media streaming applications. These new network services include 1) accurate time synchronization, making it possible for multiple devices to render audio and/or video in-sync in a standard way, 2) a reservation protocol which ensures that all devices in the path of a stream have agreed to allow the stream, and 3) a mechanism for ensuring that the requested latency and bandwidth of reserved streams is achieved (over links which do not significantly degrade). AVnu Alliance promotes these standards and compliance and interoperability programs in order to help usher in a new generation of professional quality audio/video streaming within the home.

For more information about AVnu please see http://www.AVnu.org.