Audio Video Bridging (AVB)

Audio Video Bridging, AVB, is a method for transport of audio and video streams over Ethernet-based networks. It is based on ratified IEEE standards for Ethernet networks that define signaling, transport and synchronization of the audio and video streams.

A critical component in a converged, universal network that is shared by legacy data traffic and AV streams is Quality of Service (QoS) because it allows voice and video traffic to be prioritized over data traffic ensuring timely and reliable delivery. AVB takes this concept to a new level by adding stream signaling, automatic bandwidth reservation and traffic prioritization, as well as time synchronization thus allowing high quality digital audio and video streams to be reliably transported over Ethernet.

The standard QoS needs to be manually implemented on every device and interface in the path between the sender and receiver. This includes identifying traffic, tagging it with QoS priority values, and then configuring queuing and/or shaping policies that are applied per interface. This approach labor-intensive and static, i.e. it does not allow for dynamic, on-demand updates.. AVB, on the other hand, has a fully automated end-to-end QoS. As the AV streams are setup all devices along the path automatically and on-demand implement queuing, shaping, and prioritization for each AV stream. When the stream stops, the policies are automatically removed and bandwidth freed up. At the same time, AVB QoS mechanism limits the total amount of interface bandwidth that can be reserved for AV streams, so that other applications get their fair share of the available bandwidth.

Implementing AVB puts demanding requirements on network switches. Arista Ethernet switches provide extensible and programmable OS, low latency, wire speed throughput, and port speeds of 100Mb and 1/10/40/100Gb, providing the ideal platform for demanding applications leveraging a shared network infrastructure.

AVB Advantages

Audio Video Bridging, AVB, allows businesses to take advantage of a shared Ethernet network infrastructure. This can imply shared cost model and savings in addition to unification and simplification of the overall network infrastructure. Ethernet is the de-facto standard used everywhere today, so that businesses can take advantage of networks and cabling that is already in place. Being so widely deployed, Ethernet is a well known, mature, and well-supported technology. The cost per port and bandwidth keeps going down for Ethernet switches, while port speed, transport latency, and overall switch throughput keep improving.

Ethernet is inherently very scalable and flexible and also the standard used in the largest data centers today. It is an ideal technology for all sizes AVB deployments. All kinds of communication streams are supported by default: one-to-one, one-to-many, and many-to-one. With just one connection to a single Ethernet switch, an AVB end point can setup any of the above communications with any of the other AVB end points connected to the same AVB domain. An AVB domain can be a single switch or many Ethernet switches connected together allowing thousands of AVB end points to communicate. Expanding an AVB domain can be as simple as connecting additional Ethernet switches with zero impact to the existing AVB end points and network connectivity.

To ensure interoperability between different vendors, AVB is based on a set of ratified IEEE standards. In addition, AVnu alliance is an industry alliance that has been formed in order to promote AVB and ensure compatibility. AVnu Alliance is also responsible for the certifications of AVB devices, which are conducted at the University of New Hampshire Interoperability Lab.

Delay-sensitive digital AV traffic requires a low latency, low jitter network. Per the standards, latency end-to-end for a Class-A AV stream must be within 2 ms. Arista Ethernet switches belong to the category of ultra low latency, best in breed, high-end data center products.

Time synchronization between all devices within an AVB domain allows for deterministic delivery of AVB streams. One of the important concerns that is addressed by the Generalized Precision Time Protocol (gPT) is "lip synching", i.e. synchronization between audio and video streams. A gPTP master clock becomes a reference clock for all devices in the AVB domain - this allows the AVB end points to present the AV frames at the receiving end at the correct time. Because of built-in high precision IEEE 1588 PTP clocks, Arista switches can act as gPTP masters or serve as backup for external gPTP master in cases where the primary gPTP master becomes unavailable.

AVB was designed to be "plug and play" allowing for rapid deployment of an AVB network. End points and AVB- capable switches automatically and dynamically implement stream signaling, quality of service, time synchronization, and stream delivery. A third party central AVB controller can be used for automatic discovery and enumeration of end points, and for stream setup and tear down.

How Audio Video Bridging Works

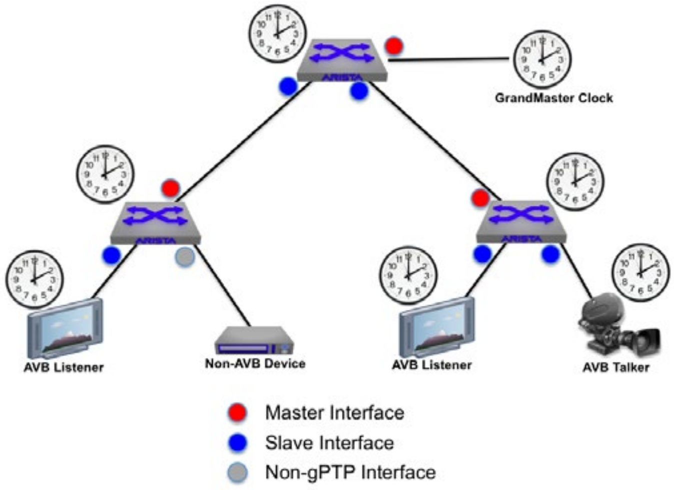
Core components of AVB are Time Synchronization, Signaling, Transport Protocol, AVB Systems, Quality of Service, and Control Protocol. This white paper will focus on the operation of Time Synchronization, Signaling, and Transport Protocol in order to illustrate the basic AVB operation.

Time Synchronization

gPTP ensures that all devices in the AVB domain have synchronized clocks to ensure consistent delivery of time- sensitive AV streams. Having synchronized clocks helps prevent "out of sync" issues, such as "lip sync" problem where audio and video are not synchronized.

- If an external gPTP device is not available, the Arista switch can act as the gPTP master for the domain
- Switch interfaces towards the gPTP Grand Master are called master interfaces, and interfaces toward the gPTP devices that are not Grand Masters are called slave interfaces
- gPTP device priority can be manually set to predictably decide primary and backup gPTP Grand Masters

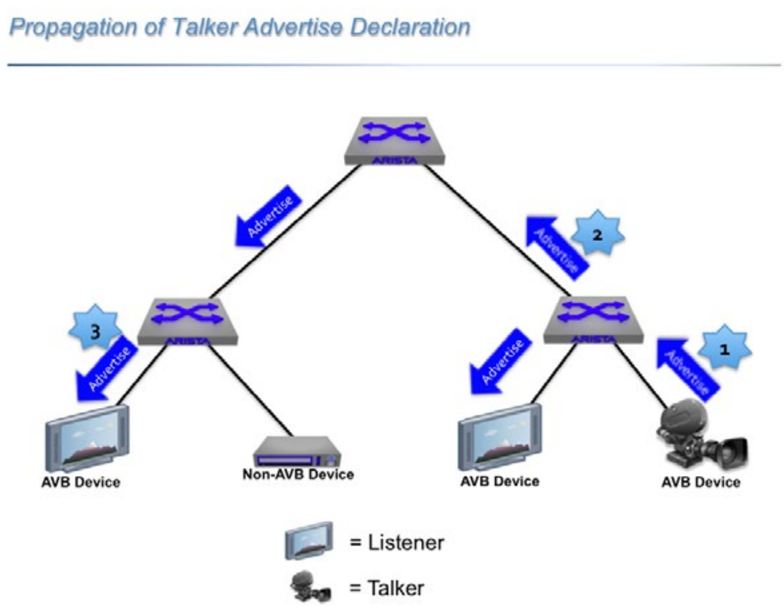
- Initial and all subsequent gPTP Grand Master elections are completed automatically
- Switch's interface must run gPTP in order to be declared capable of forwarding AVB traffic



Signaling

AVB operation is efficient because only stream signaling is send to all AVB interfaces within the AVB domain. The AV stream itself doesn't start until the negotiation between the Talker and Listener is completed. The AV stream is then transported only between those two end points.

1. AVB signaling and stream setup are accomplished using Multiple Stream Reservation Protocol (MSRP). To allow all other end points to automatically learn about available streams, the Talker sends advertisements of all locally available streams, each with a unique stream ID. These advertisements include data rate required, class, stream priority, and other parameters
2. The switch forwards the Talker advertisements out all AVB capable interfaces that have enough available bandwidth to accommodate these streams
3. The Talker advertisements are received by the Listeners



1. The Listener needs a way of communicating to the Talker what streams it's interested in receiving. It uses the same signaling protocol as the Talker - Multiple Stream Reservation Protocol (MSRP). After learning about the available streams, the Listener sends Listener advertisements for specific streams it wants to receive.

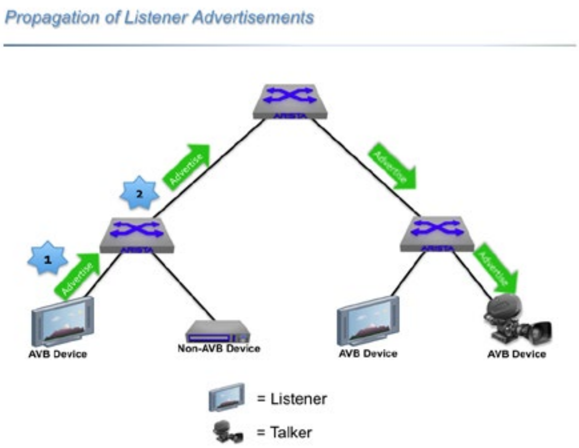
2. The switches will forward the Listener advertisements back to the Talker on the interface where the Talker advertise was originally seen, and also reserve bandwidth along the path for the stream specified

- The switch connected to the Listener will also map the stream's unique multicast MAC address to Listener's interface
- The Listener also sends "Listener Ready" advertisement back to the Talker

3. After learning about available streams, the Listener sends its own advertisements for the specific streams it wants to receive

4. The switches will forward the Listener advertisements back to the Talker on the interface where the Talker advertise was originally seen, and also reserve bandwidth along the path for the stream specified

- The switch connected to the Listener will also map the stream's unique multicast MAC address to Listener's interface
- The Listener also sends "Listener Ready" advertisement back to the Talker



Transport

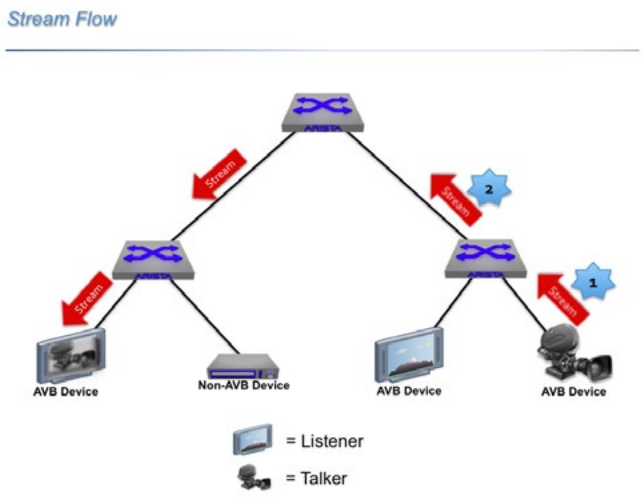
Stream Transport Protocol converts AV frames in different format, such as Firewire/IEEE 1394 to Ethernet frames that can then be transported over Ethernet networks.

1. The Talker starts streaming the requested stream using the stream transport protocol.

- The Talker and Listener will also send periodic advertisements during stream transmission to ensure the endpoints are still reachable.

2. The switches in the AVB domain will forward the Talker's stream only toward the Listener's port.

- Multiple Listeners can subscribe to the same Talker stream
- A single Listener can also subscribe to multiple streams
- Smart AVB switches along the stream's path automatically reserve bandwidth and prioritize AVB traffic ensuring reliable and predictable end-to-end transport of the streams



AVB and Arista

AVB is supported on Arista 7150 and 7500E switches. Arista switches offer low latency and wire speed performance, making the switches ideal for delay-sensitive applications such as digital audio and video. Arista Extensible Operating System (EOS) software is an extensible and programmable switch OS. JSON-based eAPI, SDK, and Python Scripting are available to allow for advanced integration and network visibility, automation, and for building tools for operations teams. By leveraging Arista's EOS extensibility and programmability, operations teams with minimum network experience can monitor and troubleshoot networks and AVB. A single Arista switch can provide between 24 - 1152 AVB interfaces at speeds of 100Mb and 1/10/40/100Gb per interface.

Arista is a member of the AVnu Alliance http://www.avnu.org/about_us/our_members, which promotes AVB standards, the adoption of the standards, and interoperability testing.

Arista 7100

- 100Mb, 1/10/40Gb Ethernet ports
- Ultra Low Latency: 350 – 380ns
- 960 Million Packets per second
- Low Jitter for Unicast and Multicast
- IEEE 1588 PTP with high precision clock

Arista 7500E

- 100Mb, 1/10/40/100Gb Ethernet ports
- Class leading latency from 3.5us
- 14.4 Billion Packets per second
- 3.84Tb of capacity for each line card slot
- IEEE 1588 PTP with high precision clock

Summary

The trend is to deploy a universal network for all applications including Voice over IP, Video over IP, and Audio Video Bridging (AVB) in order to take advantage of a shared network infrastructure and shared cost. The flexibility and scalability of Ethernet allow for small and large AVB deployments and seamless expansion without down time. The combination of low latency, high throughput Ethernet switches, and fully automated end-to-end Quality of Service ensures timely and reliable delivery of delay-sensitive AVB streams. Generalized Precision Time Protocol (gPTP) ensures that all devices within the AVB domain are time-synchronized. A 3rd party central AVB controller can be used to discover and manage the AVB end points, while also allowing the operations teams to setup and tear down AVB streams within the domain. AVB is standards-based ensuring interoperability between different vendors.

Arista offers both fixed configuration and modular switches that support AVB. The Arista AVB Ethernet switches provide low latency, wire speed performance, and also have built-in, high precision PTP clocks. Arista's Extensible Operating System (EOS) provides tools for automation, visibility, and integration with external controllers and monitoring tools. Arista's AVB switches still have all of the capabilities and features of non-AVB Ethernet switches, allowing other applications to coexist with AVB running on the switches.

Santa Clara—Corporate Headquarters
5453 Great America Parkway,
Santa Clara, CA 95054

Phone: +1-408-547-5500
Fax: +1-408-538-8920
Email: info@arista.com

Ireland—International Headquarters
3130 Atlantic Avenue
Westpark Business Campus
Shannon, Co. Clare
Ireland

Vancouver—R&D Office
9200 Glenlyon Pkwy, Unit 300
Burnaby, British Columbia
Canada V5J 5J8

San Francisco—R&D and Sales Office
1390 Market Street, Suite 800
San Francisco, CA 94102

India—R&D Office
Global Tech Park, Tower A & B, 11th Floor
Marathahalli Outer Ring Road
Devarabeesanahalli Village, Varthur Hobli
Bangalore, India 560103

Singapore—APAC Administrative Office
9 Temasek Boulevard
#29-01, Suntec Tower Two
Singapore 038989

Nashua—R&D Office
10 Tara Boulevard
Nashua, NH 03062

Copyright © 2016 Arista Networks, Inc. All rights reserved. CloudVision, and EOS are registered trademarks and Arista Networks is a trademark of Arista Networks, Inc. All other company names are trademarks of their respective holders. Information in this document is subject to change without notice. Certain features may not yet be available. Arista Networks, Inc. assumes no responsibility for any errors that may appear in this document. 08/14