Audio Video Bridging

Introduction to Audio Video Bridging Networks

Information about Audio Video Bridging (AVB)

Audio and video equipment deployments have traditionally been analog single-purpose point-to-point one-way links. Migration to digital transmission also continued to retain the point-to-point one-way links architecture. The dedicated connection model resulted in a mass of cabling in professional and consumer applications, which was hard to manage and operate.

In order to accelerate the adoption to Ethernet based audio/video deployments in an interoperable way IEEE came up with the IEEE Audio Video Bridging standards - IEEE 802.1BA. This defines a mechanism where endpoints and the network will function as a whole to enable high quality A/V streaming across consumer applications to professional audio-video over an Ethernet infrastructure.

Note

- AVB is not supported on stacked systems
- AVB is not supported on Etherchannel interfaces.
- AVB is supported only on STP-enabled network.

Licenses Supporting AVB

AVB is supported on the Network Advantage license.

Benefits of AVB

AVB is a standard based mechanism to enable Ethernet based audio-video transmission which has the following benefits:

- Guaranteed max Latency
- Time Synchronized
- Bandwidth Guaranteed
- Professional Grade

Components of Auio Video Bridging Network

AVB protocols operate only in domains where every device is AVB capable. The AVB network comprises of AVB talkers, AVB listeners, AVB switches and the grandmaster clock source.

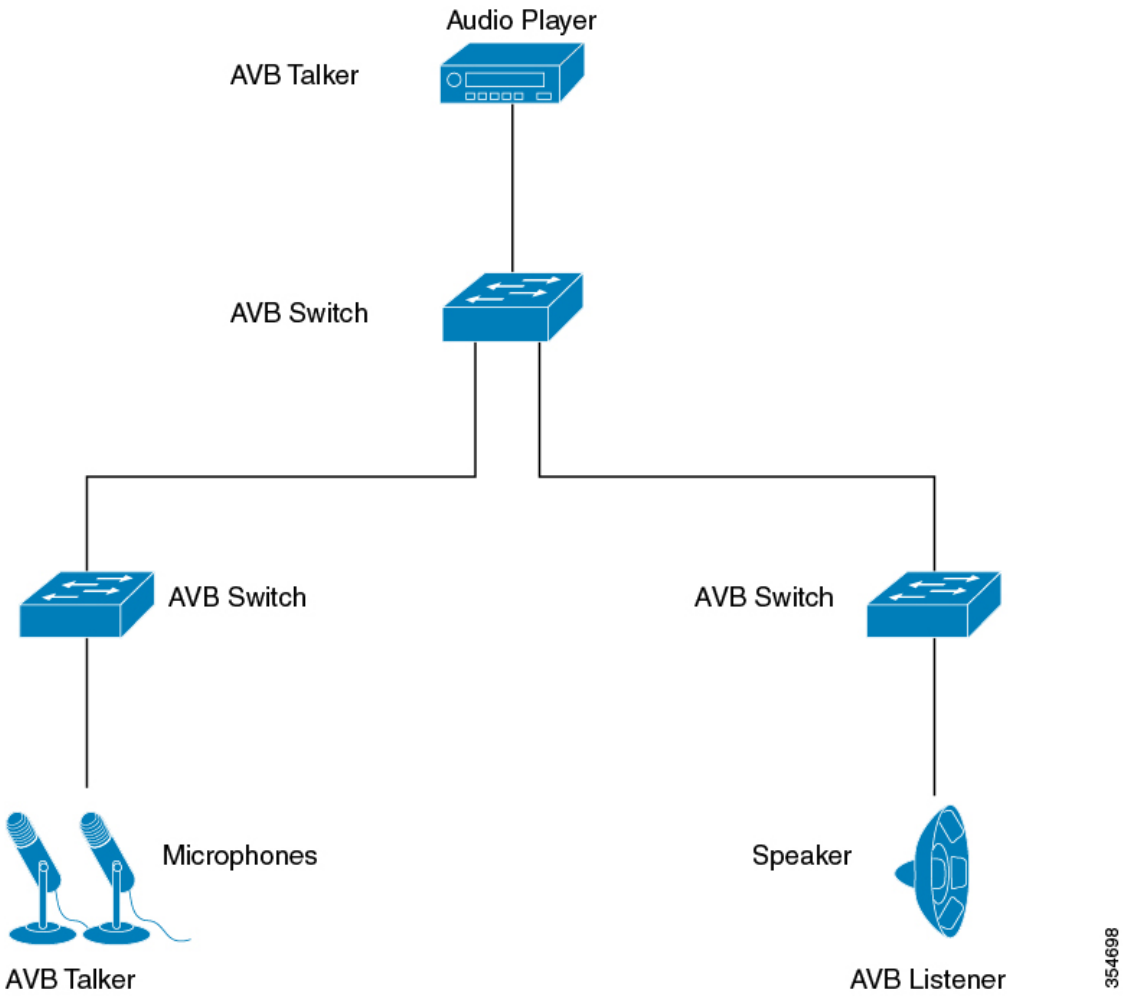
- AVB Talker - An AVB end station that is the source or producer of a stream, i.e. microphones, video camera, and so on.
- AVB Listener - An AVB end station that is the destination or consumer of a stream, i.e. speaker, video screen, and so on.
- AVB Switch - An Ethernet switch that complies with IEEE802.1 AVB standards.
- AVB stream: A data stream associated with a stream reservation compliant with the Stream Reservation Protocol (SRP).

Note In some instances, the word “bridge” is used. In this context, it references to a switch.

The IEEE 802.1BA specification requires that an AVB talker must be grandmaster capable. In a typical deployment a network node can also be the grandmaster, provided it can either source or derive timing from a grandmaster capable device and provide the timing to the AVB network using IEEE 802.1AS.

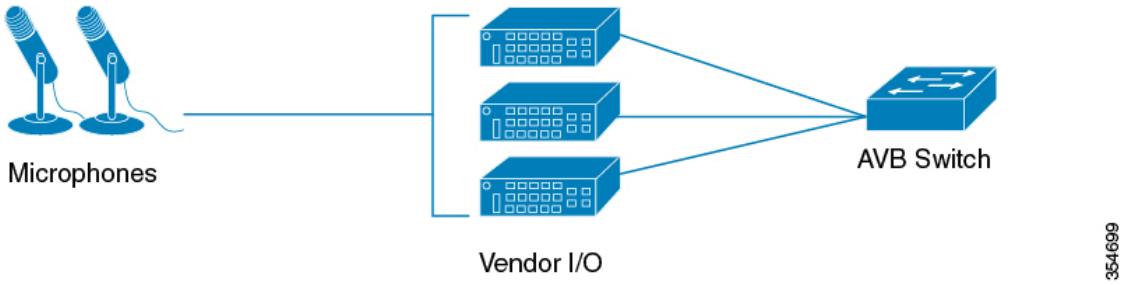
Figure 1: AVB Network shows a simple illustration of AVB network with different components.

Figure 1: AVB Network



In many instances, the Audio/Video end points (Microphone, Speaker, and so on) are analog devices. AVB end-point vendors introduce Digital Signal Processors (DSP) and I/O devices that provide extensive audio/video processing and aggregate the end-points into an AVB Ethernet interface, as shown in Figure 2: Vendor Audio I/O System, on page 3.

Figure 2: Vendor Audio I/O System



Supported SKUs for Audio Video Bridging

AVB is supported on the following Catalyst 9500 SKUs.

- C9500-24Q
- C9500-12Q
- C9500-40X
- C9500-16X

Information About Generalized Precision Time Protocol

Generalized Precision Time Protocol (gPTP) is an IEEE 802.1AS standard, which provides a mechanism to synchronize clocks of the bridges and end point devices in an AVB network. It defines the mechanism to elect the grandmaster clock (BMCA) among the time-aware bridges and talker and listener. The grandmaster is the root of the timing hierarchy that gets established in the time-aware network and distributes time to nodes below to enable synchronization.

Time synchronization also requires determining the link delay and switch delays in the network nodes. A gPTP switch is an IEEE 1588 boundary clock, which also determines the link delay using the peer-to-peer delay mechanism. The delays computed are included in the correction field of the PTP messages and relayed to the end-points. The talker and listener use this gPTP time as a shared clock reference, which is used to relay and recover the media clock. gPTP currently defines only domain 0, which is what the switch supports.

The peer to peer delay mechanism runs on STP blocked ports as well. No other PTP messages are sent over blocked ports.

In a PTP domain, Best Master Clock (BMC) algorithm organizes Clocks and Ports into a hierarchical fashion, which includes clocks and port states:

Clocks

- Grandmaster (GM/GMC)
- Boundary Clock (BC)

Port States

- Master (M)
- Slave (S)
- Passive (P)

Information about Multiple Stream Reservation Protocol (MSRP)

Multiple Stream Reservation Protocol (MSRP) provides a mechanism for end stations to reserve network resources that will guarantee the transmission and reception of data streams across a network with the requested QoS. It is one of the core protocols required on an AVB device (talker, listener and switches). It allows talkers to advertise streams across a network of AVB switches and listeners to register for receiving the streams.

MSRP is the key software protocol module for supporting AVB. It enables stream establishment and teardown. It interfaces with gPTP to update the latency information for the streams. It interfaces with the QoS module

to setup the hardware resources that would guarantee requested bandwidth for the streams. It also provides the QoS shaping parameters required for the credit based shaper.

Functions of Multiple Stream Reservation Protocol

MSRP performs the following functions:

- Allows Talkers to advertise Streams and Listeners to discover and register for Streams.
- Establishes a path through an Ethernet between a Talker and one or more Listeners.
- Provides guaranteed bandwidth for AVB Streams.
- Guarantees an upper bound on latency.
- Discovers and reports the worst case end-to-end latency between the Talker and each of its Listeners.
- Reports failure reason and location when a path between the Talker and a Listener cannot satisfy bandwidth requirements.
- Supports multiple classes of traffic with different latency targets.
- Protects best effort traffic from starvation by limiting AVB traffic.
- MSRP Talker declarations are not forwarded along the STP blocked ports.
- MSRP listens to the STP TCN notification to generate MSRP declarations tear /modify / establish streams.

Information about Hierarchical QoS

AVB networks guarantee bandwidth and minimum bounded latency for the time-sensitive audio and video streams. AVB defines Class A and Class B as the time-sensitive streams, based on the worst-case latency targets of the traffic from talker to listener.

The latency targets for the two streams are listed as below:

- SR-Class A: 2ms
- SR-Class B: 50ms

The sum of the worst-case latency contributions per hop should result in an overall end-to-end latency of 2 ms or less for SR-Class A and 50ms or less for SR-Class B. A typical AVB deployment of 7 hops from talker to listener meets these latency requirements.

The priority code points map the traffic to the specific stream. Frame forwarding behavior is based on this priority. A credit-based shaper is used to shape the transmission of these streams in accordance with the bandwidth that has been reserved on a given outbound queue so that the latency targets are met.

AVB supports hierarchical QoS. AVB Hierarchical QoS policy is two level Parent-Child Policy. AVB Parent policy segregates audio, video traffic streams(SR-Class A , SR-Class B) and Network Control packets from standard best-effort Ethernet traffic (Non-SR) and manage streams accordingly. Hierarchical QoS allows you to specify QoS behavior at multiple policy levels, which provides a high degree of granularity in traffic management. You can use hierarchical policies to:

- Allow a parent class to shape multiple queues in a child policy.
- Apply specific policy map actions on the aggregate traffic.

- Apply class-specific policy map actions.

You can modify only ingress and egress HQoS child policy's class-map and its actions using **policy-map** *AVB-Output-Child-Policy* and **policy-map** *AVB-Input-Child-Policy* command.

Note You should not modify the PCP in child policy to map with PCP configured in Parent Policy, for example SR Class A Cos 3 and SR Class B Cos 2.

Hierarchical Policing

Hierarchical policing is supported on ingress and egress interfaces. Hierarchical QoS separates the SR and Non-SR class related rules into parent and child policies respectively. AVB SR classes are completely controlled by MSRP client and hence, parent policies containing SR class attributes are governed by MSRP. The end user has complete control over child policies which contain Non-SR class attributes and can modify only the child policies.

AVB HQoS child policies are user modifiable and NVGENed to preserve the configuration if user saves the configuration to the startup-config. So, AVB HQoS child policy configurations are retained even after reload.

Information about Multiple VLAN Registration Protocol (MVRP)

Multiple VLAN Registration Protocol (MVRP) is an application based on MRP. MVRP provides a mechanism for dynamic maintenance of the contents of Dynamic VLAN Registration Entries for each vlan ids, and for propagating the information they contain to other Bridges. This information allows MVRP-aware devices to dynamically establish and update their knowledge of the set of vlan ids associated with VLANs that currently have active members, and through which Ports those members can be reached.

MVRP, from an AVB perspective, is mandatory on the talkers and the listeners. Independent of AVB, MVRP is an IEEE 802.1Q requirement on the VLAN-aware switches. However, manual configuration of VLANS on the switches is sufficient for AVB.

Note VTP should be in the disabled mode or transparent mode for MVRP to work.

Configuring the AVB Network

Configuring AVB

This section describes the various configurations available for AVB.

Enabling Audio Video Bridging

You can enable AVB using the below command on the switch.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**avb** **Example:** `Device(config)# avb`	Enables AVB on the switch.
Step 4	**avb strict** **Example:** `Device(config)# avb strict`	Enables AVB on the switch. This command is used in combination with the **avb** command to enable AVB. **Note** This command will be deprecated in the future releases.
Step 5	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

What to do next

To disable AVB on the switch, use the **no** form of the command.

Configuring Audio Video Bridging

You can configure the interfaces along the connectivity path for AVB devices as dot1q trunk ports by using the below commands.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:**	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
	`Device> enable`	
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface te1/1/1`	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 4	**switchport mode trunk** **Example:** `Device(config-if)# switchport mode trunk`	Configures the port as a trunk port.
Step 5	**exit** **Example:** `Device(config-if)# exit`	Returns to global configuration mode.
Step 6	**vlan 2** **Example:** `Device(config)# vlan 2`	Configures VLAN 2 on the switch. **Note** VLAN 2 is the default AVB VLAN. If you need to configure another VLAN as the default AVB VLAN, use the command in Step 7.
Step 7	**avb vlan** *vlan-id* **Example:** `Device(config)# avb vlan 10`	(Optional) Sets the specified VLAN as the default AVB VLAN on the switch. Use this command when you need to set the default AVB VLAN other than VLAN 2. The range for *vlan-id* varies from 2 to 4094.
Step 8	**avb** **Example:** `Device(config-vlan)# avb`	Configures AVB on the specified interface.

	Command or Action	Purpose
Step 9	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

What to do next

To disable AVB on the switch, use the "**no**" form of the command.

Configuring gPTP

This section describes the various configurations available for gPTP.

Enabling gPTP

When AVB is enabled on the switch, gPTP for AVB also gets enabled.

You can also enable gPTP globally using the command given below:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device>enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**[no]ptp profile dot1as** **Example:** `Device(config)# ptp profile dot1as`	gPTP is enabled globallywhen you enable AVB. Use the **no** form of this command to disable gPTP globally.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

Enabling gPTP on an interface

You can also enable gPTP on an interface using the command given below:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters the global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface te1/1/1`	Defines the interface to be configured as a trunk, and enters interface configuration mode. The interface that you specify can be part of an EtherChannel.
Step 4	**ptp enable** **Example:** `Device(config-if)# ptp enable`	Enables gPTP on all the interfaces. To disable gPTP on a port, use the no form of this command as shown below: `Device(config-if)# no ptp enable`
Step 5	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.

Configuring the Values of Precision Time Protocol Clocks

Follow these steps to configure the values of PTP clock priority1 and priority2:

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password, if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ptp priority1** *value* **Example:** `Device(config)# ptp priority1 120`	Sets the value of PTP clock priority1. The range is from 0 to 255. The default value is 128. **Note** If the value of priority1 is configured as 255, the clock cannot be considered as Grandmaster.

	Command or Action	Purpose
Step 4	**ptp priority2** *value* **Example:** `Device(config)# ptp priority2 120`	Sets the value of PTP clock priority2. The range is from 0 to 255. The default value is 128.
Step 5	**exit** **Example:** `Device(config)# exit`	Returns to global configuration mode.

Configuring HQoS

This section describes the various configurations available for HQoS.

Enabling HQoS

When AVB is enabled on the switch, HQoS for AVB also gets enabled.

Hierarchical QoS Policy Formats

This following example shows hierarchical remarking policy at the ingress interface:

```
policy-map AVB-Input-Child-Policy
 class VOIP-DATA-CLASS
    set dscp EF
 class MULTIMEDIA-CONF-CLASS
    set dscp AF41
 class BULK-DATA-CLASS
    set dscp AF11
 class TRANSACTIONAL-DATA-CLASS
    set dscp AF21
 class SCAVENGER-DATA-CLASS
    set dscp CS1
 class SIGNALING-CLASS
    set dscp CS3
 class class-default
    set dscp default

policy-map AVB-Input-Policy-Remark-AB
 class AVB-SR-A-CLASS
    set cos 0 (set 0 for boundary & SR class A PCP value for core port)
 class AVB-SR-B-CLASS
    set cos 0 (set 0 for boundary & SR class B PCP value for core port)
 class class-default
    service-policy AVB-Input-Child-Policy

policy-map AVB-Input-Policy-Remark-A
 class AVB-SR-A-CLASS
    set cos 0 (set 0 for boundary & SR class A PCP value for core port)
 class class-default
    service-policy AVB-Input-Child-Policy

policy-map AVB-Input-Policy-Remark-B
 class AVB-SR-B-CLASS
    set cos 0 (set 0 for boundary & SR class B PCP value for core port)
 class class-default
    service-policy AVB-Input-Child-Policy
```

```
policy-map AVB-Input-Policy-Remark-None
 class class-default
    service-policy AVB-Input-Child-Policy
```

This following example shows hierarchical queuing policy at the egress interface:

```
policy-map AVB-Output-Child-Policy
 class VOIP-PRIORITY-QUEUE
   bandwidth remaining percent 30
   queue-buffers ratio 10
 class MULTIMEDIA-CONFERENCING-STREAMING-QUEUE
   bandwidth remaining percent 15
   queue-limit dscp AF41 percent 80
   queue-limit dscp AF31 percent 80
   queue-limit dscp AF42 percent 90
   queue-limit dscp AF32 percent 90
   queue-buffers ratio 10
 class TRANSACTIONAL-DATA-QUEUE
   bandwidth remaining percent 15
   queue-limit dscp AF21 percent 80
   queue-limit dscp AF22 percent 90
   queue-buffers ratio 10
 class BULK-SCAVENGER-DATA-QUEUE
   bandwidth remaining percent 15
   queue-limit dscp AF11 percent 80
   queue-limit dscp AF12 percent 90
   queue-limit dscp CS1 percent 80
   queue-buffers ratio 15
 class class-default
   bandwidth remaining percent 25
   queue-buffers ratio 25

policy-map AVB-Output-Policy
 class AVB-SR-A-CLASS
   priority level 1 (Shaper value based on stream registration)
 class AVB-SR-B-CLASS
   priority level 2 (Shaper value based on stream registration)
 class CONTROL-MGMT-QUEUE
   priority level 3 percent 15
 class class-default
   bandwidth remaining percent 100
   queue-buffers ratio 80
   service-policy AVB-Output-Child-Policy
```

Configuring MVRP

This section describes the various configurations available for MVRP.

Enabling Multiple VLAN Registration Protocol

You can enable MVRP on the switches in the topology to enable VLAN propagation using the below command.

Note You must change VTP mode to **transparent** or **off** , before enabling dynamic vlan creation via MVRP.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**mvrp global** **Example:** `Device(config)# mvrp global`	Enters the MVRP Global configuration mode.

Step 4	**vtp mode** {**transparent** | **off**}
	Example:
	`Device(config)# vtp mode transparent`
	Example:
	`Device(config)# vtp mode off`
		Sets the VTP to **transparent** or **off** mode.

Step 5	**mvrp vlan create** **Example:** `Device(config)# mvrp vlan create`	Enables MVRP on the switches.

Configuring Multiple VLAN Registration Protocol on an Interface

You can configure MVRP on the switch interfaces using the below commands.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *interface-id* **Example:** `Device(config)# interface te1/1/1`	Defines the interface to be configured as a trunk, and enters interface configuration mode.
Step 4	**mvrp registration** {*fixed* | *forbidden* | *normal*} **Example:** `Device(config-if)# mvrp registration fixed`	Registers MVRP with the MAD instance. • fixed - Fixed registration • forbidden - Forbidden registration • normal - Normal registration
Step 5	**mvrp timer** {*join* | *leave* | *leave-all* | *periodic*} **Example:** `Device(config-if)# mvrp timer join`	Configures the MVRP timer. • join - Timer controls the interval between transmit opportunities that are applied to the ASM • leave - The timer controls the RSM waits in the LV state before transiting to the MT state • leave-all - The timer control the frequency with which the LeaveAll SM generates LeaveAll PDUs • periodic - Periodic timer
Step 6	**exit** **Example:** `Device(config-if)# exit`	Returns to global configuration mode.

Monitoring the AVB Network

Monitoring Audio Video Bridging

To display the AVB details, use the commands in the following table:

Command	Purpose
show avb domain	Displays the AVB domain.
show avb stream	Displays the AVB stream information.

Monitoring gPTP

To display the gPTP protocol details, use the commands in the following table:

Command	Purpose
show ptp brief	Displays a brief status of ptp on the interfaces.
show ptp clock	Displays ptp clock information.
show ptp parent	Displays the parent clock information.
show ptp port	Displays the ptp port information.
show platform software fed switch active ptp if-id {interface-id}	Displays details info about ptp status on the port.

Monitoring Multiple Stream Reservation Protocol

To display the MSRP details, use the commands in the following table:

Command	Purpose
show msrp streams	Displays MSRP stream information.
show msrp streams detailed	Displays detailed MSRP stream information.
show msrp streams brief	Displays MSRP stream information in brief.
show msrp port bandwidth	Displays MSRP port bandwidth information.

Monitoring Hierarchical QoS

To display the HQoS details, use the commands in the following table:

Command	Purpose
show run	Displays all the child policy map details.
show policy-map	Displays the details of the policy map configuration.
show platform hardware fed switch active qos queue stats interface *interface-id*	Displays the QoS statistics for different queue mappings in AVB.

Command	Purpose
show platform hardware fed switch active qos queue config interface *interface-id*	Displays the QoS queue configurations.
show policy-map interface *interface-id* [**input** | **output**]	Displays the AVB QoS statistics. Packet counters for ingress and bytes counters for egress are accounted for QoS Statistics.

Monitoring Multiple VLAN Registration Protocol

To display the MVRP details, use the commands in the following table:

Command	Purpose
show mvrp summary	Displays MVRP summary information.
show mvrp interface	Displays interface MVRP information.

Examples of AVB Configurations and Monitoring

Examples for Audio Video Bridging

This example shows how you can view the AVB domain.

```
Device#show avb domain

AVB Class-A
    Priority Code Point     : 3
    VLAN                    : 2
    Core ports              : 1
    Boundary ports          : 67

AVB Class-B
    Priority Code Point     : 2
    VLAN                    : 2
    Core ports              : 1
    Boundary ports          : 67

-------------------------------------------------------------------------------
Interface    State       Delay    PCP  VID  Information
-------------------------------------------------------------------------------
Te1/0/1        down      N/A                      Oper state not up
Te1/0/2        down      N/A                      Oper state not up
Te1/0/3        down      N/A                      Oper state not up
Te1/0/4        down      N/A                      Oper state not up
Te1/0/5          up      N/A                   Port is not asCapable
Te1/0/6        down      N/A                      Oper state not up
```

```
Te1/0/7         down      N/A                       Oper state not up
Te1/0/8         down      N/A                       Oper state not up
Te1/0/9         down      N/A                       Oper state not up
Te1/0/10        down      N/A                       Oper state not up
Te1/0/11        down      N/A                       Oper state not up
Te1/0/12        down      N/A                       Oper state not up
Te1/0/13        down      N/A                       Oper state not up
Te1/0/14        down      N/A                       Oper state not up
Te1/0/15        down      N/A                       Oper state not up
Te1/0/16        down      N/A                       Oper state not up
 Te1/0/17       down      N/A                       Oper state not up
Te1/0/18        down      N/A                       Oper state not up
Te1/0/19          up      N/A                     Port is not asCapable
Te1/0/20        down      N/A                       Oper state not up
Te1/0/21        down      N/A                       Oper state not up
Te1/0/22        down      N/A                       Oper state not up
Te1/0/23          up      N/A                     Port is not asCapable
Te1/0/24        down      N/A                       Oper state not up
Te1/0/25        down      N/A                       Oper state not up
Te1/0/26        down      N/A                       Oper state not up
Te1/0/27        down      N/A                       Oper state not up
Te1/0/28        down      N/A                       Oper state not up
Te1/0/29          up      N/A                     Port is not asCapable
Te1/0/30        down      N/A                       Oper state not up
Te1/0/31        down      N/A                       Oper state not up
Te1/0/32        down      N/A                       Oper state not up
Te1/0/33        down      N/A                       Oper state not up
Te1/0/34        down      N/A                       Oper state not up
Te1/0/35          up      N/A                     Port is not asCapable
Te1/0/36        down      N/A                       Oper state not up
Te1/0/37        down      N/A                       Oper state not up
Te1/0/38        down      N/A                       Oper state not up
Te1/0/39          up    507ns
   Class-  A        core             3    2

   Class-  B        core             2    2

Te1/0/40        down      N/A                       Oper state not up
Te1/0/41        down      N/A                       Oper state not up
Te1/0/42        down      N/A                       Oper state not up
Te1/0/43        down      N/A                       Oper state not up
Te1/0/44        down      N/A                       Oper state not up
Te1/0/45        down      N/A                       Oper state not up
Te1/0/46        down      N/A                       Oper state not up
Te1/0/47        down      N/A                       Oper state not up
Te1/0/48        down      N/A                       Oper state not up
Te1/1/1         down      N/A                       Oper state not up
Te1/1/2         down      N/A                       Oper state not up
Te1/1/3         down      N/A                       Oper state not up
Te1/1/4         down      N/A                       Oper state not up
Te1/1/5         down      N/A                       Oper state not up
```

```
Te1/1/6         down      N/A                          Oper state not up
Te1/1/7         down      N/A                          Oper state not up
Te1/1/8         down      N/A                          Oper state not up
Te1/1/9         down      N/A                          Oper state not up
Te1/1/10        down      N/A                          Oper state not up
Te1/1/11        down      N/A                          Oper state not up
Te1/1/12        down      N/A                          Oper state not up
Te1/1/13        down      N/A                          Oper state not up
Te1/1/14        down      N/A                          Oper state not up
Te1/1/15        down      N/A                          Oper state not up
Te1/1/16        down      N/A                          Oper state not up
Fo1/1/1         down      N/A                          Oper state not up
Fo1/1/2         down      N/A                          Oper state not up
Fo1/1/3         down      N/A                          Oper state not up
Fo1/1/4         down      N/A                          Oper state not up
```

This example shows how you can view the AVB stream information.

```
Device#show avb stream

Stream ID:          0011.0100.0001:1    Incoming Interface:    Te1/1/1
    Destination  : 91E0.F000.FE00
    Class        : A
    Rank         : 1
    Bandwidth    : 6400 Kbit/s

    Outgoing Interfaces:

-------------------------------------------------------------------------------

    Interface         State      Time of Last Update         Information

-------------------------------------------------------------------------------

    Te1/1/1           Ready      Tue Apr 26 01:25:40.634


Stream ID:          0011.0100.0002:2    Incoming Interface:    Te1/1/1
    Destination  : 91E0.F000.FE01
    Class        : A
    Rank         : 1
    Bandwidth    : 6400 Kbit/s

    Outgoing Interfaces:

-------------------------------------------------------------------------------

    Interface         State      Time of Last Update         Information

-------------------------------------------------------------------------------
```

```
Te1/1/1           Ready      Tue Apr 26 01:25:40.634
```

Examples for gPTP

Example: Verifying Generalized Precision Time Protocol

This command can be used to see a brief status of ptp on the interfaces.

```
Device# show ptp brief

Interface                      Domain    PTP State
FortyGigabitEthernet1/1/1      0         FAULTY
FortyGigabitEthernet1/1/2      0         SLAVE
GigabitEthernet1/1/1           0         FAULTY
GigabitEthernet1/1/2           0         FAULTY
GigabitEthernet1/1/3           0         FAULTY
GigabitEthernet1/1/4           0         FAULTY
TenGigabitEthernet1/0/1        0         FAULTY
TenGigabitEthernet1/0/2        0         FAULTY
TenGigabitEthernet1/0/3        0         MASTER
TenGigabitEthernet1/0/4        0         FAULTY
TenGigabitEthernet1/0/5        0         FAULTY
TenGigabitEthernet1/0/6        0         FAULTY
TenGigabitEthernet1/0/7        0         MASTER
TenGigabitEthernet1/0/8        0         FAULTY
TenGigabitEthernet1/0/9        0         FAULTY
TenGigabitEthernet1/0/10       0         FAULTY
TenGigabitEthernet1/0/11       0         MASTER
TenGigabitEthernet1/0/12       0         FAULTY
TenGigabitEthernet1/0/13       0         FAULTY
TenGigabitEthernet1/0/14       0         FAULTY
TenGigabitEthernet1/0/15       0         FAULTY
TenGigabitEthernet1/0/16       0         FAULTY
TenGigabitEthernet1/0/17       0         FAULTY
TenGigabitEthernet1/0/18       0         FAULTY
TenGigabitEthernet1/0/19       0         MASTER
TenGigabitEthernet1/0/20       0         FAULTY
TenGigabitEthernet1/0/21       0         FAULTY
TenGigabitEthernet1/0/22       0         FAULTY
TenGigabitEthernet1/0/23       0         FAULTY
TenGigabitEthernet1/0/24       0         FAULTY
TenGigabitEthernet1/1/1        0         FAULTY
TenGigabitEthernet1/1/2        0         FAULTY
TenGigabitEthernet1/1/3        0         FAULTY
TenGigabitEthernet1/1/4        0         FAULTY
TenGigabitEthernet1/1/5        0         FAULTY
TenGigabitEthernet1/1/6        0         FAULTY
TenGigabitEthernet1/1/7        0         FAULTY
TenGigabitEthernet1/1/8        0         FAULTY
```

This command can be used to view ptp clock information.

```
Device# show ptp clock

PTP CLOCK INFO
  PTP Device Type: Boundary clock
  PTP Device Profile: IEEE 802/1AS Profile
  Clock Identity: 0x4:6C:9D:FF:FE:4F:95:0
  Clock Domain: 0
  Number of PTP ports: 38
  PTP Packet priority: 4
  Priority1: 128
  Priority2: 128
  Clock Quality:
        Class: 248
        Accuracy: Unknown
        Offset (log variance): 16640
  Offset From Master(ns): 0
  Mean Path Delay(ns): 0
  Steps Removed: 3
  Local clock time: 00:12:13 UTC Jan 1 1970
```

This command can be used to view the parent clock information.

```
Device# show ptp parent

PTP PARENT PROPERTIES
  Parent Clock:
  Parent Clock Identity: 0xB0:7D:47:FF:FE:9E:B6:80
  Parent Port Number: 3
  Observed Parent Offset (log variance): 16640
  Observed Parent Clock Phase Change Rate: N/A

  Grandmaster Clock:
  Grandmaster Clock Identity: 0x4:6C:9D:FF:FE:67:3A:80
  Grandmaster Clock Quality:
        Class: 248
        Accuracy: Unknown
        Offset (log variance): 16640
        Priority1: 0
        Priority2: 128
```

This command can be used to view the ptp port information.

```
Device# show ptp port

PTP PORT DATASET: FortyGigabitEthernet1/1/1
```

```
  Port identity: clock identity: 0x4:6C:9D:FF:FE:4E:3A:80
  Port identity: port number: 1
  PTP version: 2
  Port state: FAULTY
  Delay request interval(log mean): 5
  Announce receipt time out: 3
  Peer mean path delay(ns): 0
  Announce interval(log mean): 1
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000

 PTP PORT DATASET: FortyGigabitEthernet1/1/2
  Port identity: clock identity: 0x4:6C:9D:FF:FE:4E:3A:80
  Port identity: port number: 2
  PTP version: 2
  Port state: FAULTY
  Delay request interval(log mean): 5
  Announce receipt time out: 3
  Peer mean path delay(ns): 0
  Announce interval(log mean): 1
 --More—
```

This command can be used to view the port information for a particular interface.

```
Device# show ptp port gi1/0/26

PTP PORT DATASET: GigabitEthernet1/0/26
  Port identity: clock identity: 0x4:6C:9D:FF:FE:4E:3A:80
  Port identity: port number: 28
  PTP version: 2
  Port state: MASTER
  Delay request interval(log mean): 5
  Announce receipt time out: 3
  Peer mean path delay(ns): 0
  Announce interval(log mean): 1
  Sync interval(log mean): 0
  Delay Mechanism: Peer to Peer
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000
```

This command can be used to view the

```
Device# show platform software fed switch active ptp if-id 0x20

Displaying port data for if_id 20
=========================================
```

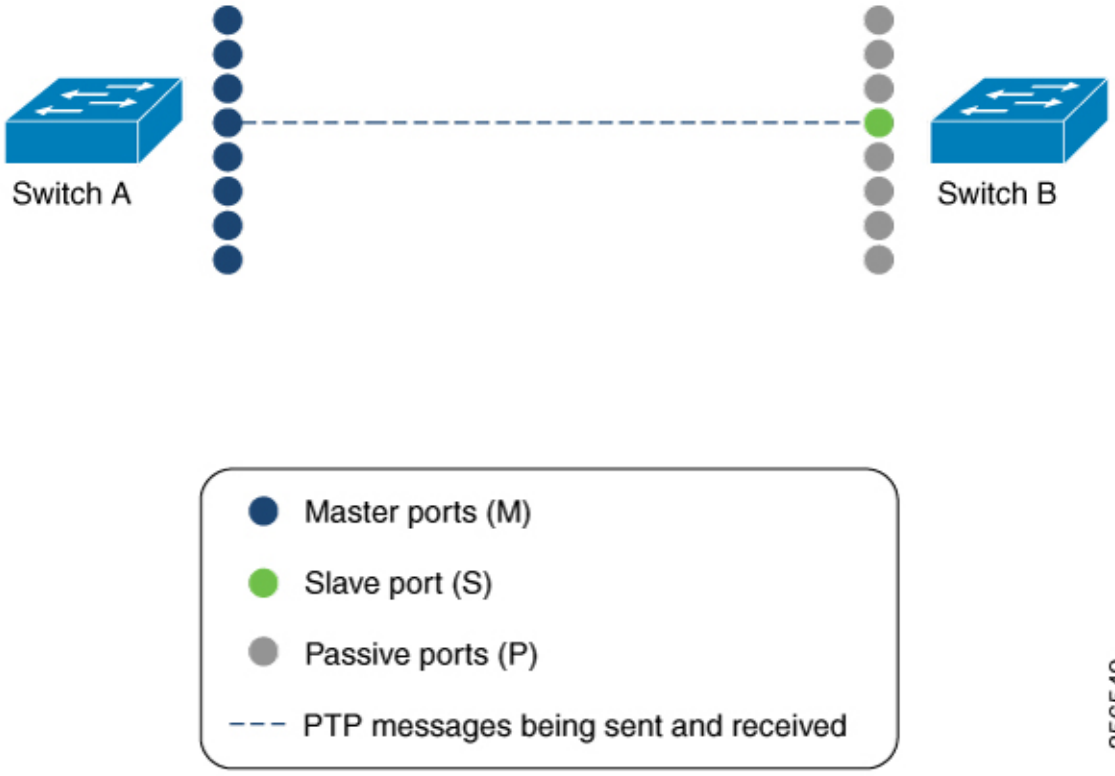
```
Port Mac Address 04:6C:9D:4E:3A:9A
Port Clock Identity 04:6C:9D:FF:FE:4E:3A:80
Port number 28
PTP Version 2
domain_value 0
dot1as capable: FALSE
sync_recpt_timeout_time_interval 375000000 nanoseconds
sync_interval 125000000 nanoseconds
neighbor_rate_ratio 0.000000
neighbor_prop_delay 0 nanoseconds
compute_neighbor_rate_ratio: TRUE
compute_neighbor_prop_delay: TRUE
port_enabled: TRUE
ptt_port_enabled: TRUE
current_log_pdelay_req_interval 0
pdelay_req_interval 0 nanoseconds
allowed_lost_responses 3
neighbor_prop_delay_threshold 2000 nanoseconds
is_measuring_delay : FALSE
Port state: : MASTER
sync_seq_num 22023
delay_req_seq_num 23857
num sync messages transmitted  0
num sync messages received  0
num followup messages transmitted  0
num followup messages received  0
num pdelay requests transmitted  285695
num pdelay requests received  0
num pdelay responses transmitted  0
num pdelay responses received 0
num pdelay followup responses transmitted  0
num pdelay followup responses received  0
```

Example: Configuring gPTP on an EtherChannel Interface

An EtherChannel interface allows multiple physical Ethernet links to combine into one logical channel. Configuring EtherChannel interface allows load sharing of traffic among the links in the channel as well as redundancy if one or more links in the EtherChannel fail. This behaviour of an EtherChannel interface does not change when gPTP is configured. The example below illustrates how gPTP works when it is configured on an EtherChannel interface.

For example, in the figure below there are two switches (Switch A and Switch B) connected through an eight member EtherChannel. If you consider Switch A as the master clock, all the ports that are a part of the EtherChannel are master ports. Similarly, Switch B is the slave clock and one of the ports from the EtherChannel bundle becomes the slave port while all other ports become passive ports. It is always the port with the lowest port number in the Etherchannel bundle that is designated as the slave port. If that slave port is disabled or shut down for any reason, the next port with the lowest port number is designated as the slave port.

The master and slave relationship is established when the feature is configured on an EtherChannel interface as well. The master ports from Switch A sends and receives gPTP messages. In Switch B only the slave port exchanges gPTP messages. There is no exchange of gPTP messages in the passive ports.



Master Clock

The following command can be used to verify the PTP state on an interface:

```
Device# show ptp brief | exclude FAULTY
Interface                Domain     PTP State
TenGigE1/0/39              0         MASTER
TenGigE1/0/44              0         MASTER
TenGigE1/0/48              0         MASTER
```

The following command can be used to verify if the interface configured on each port is an EtherChannel interface:

```
Device# show  etherchannel 1  summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG
Number of channel-groups in use: 3
Number of aggregators:           3

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
```

```
1      Po1(SU)         LACP        Hu1/0/39(P)     Hu1/0/44(P)
                                   Hu1/0/48(P)
```

The following command can be used to verify the port state of each interface:

```
Device# show ptp port tengigabitethernet 1/0/39
PTP PORT DATASET: TenGigE1/0/39
  Port identity: clock identity: 0x0:A7:42:FF:FE:8A:84:C0
  Port identity: port number: 39
  PTP version: 2
  Port state: MASTER
  Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000

Device# show ptp port tengigabitethernet 1/0/44
PTP PORT DATASET: TenGigE1/0/44
  Port identity: clock identity: 0x0:A7:42:FF:FE:8A:84:C0
  Port identity: port number: 44
  PTP version: 2
  Port state: MASTER
  Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000

Device# show ptp port tengigabitethernet 1/0/48
PTP PORT DATASET: TenGigE1/0/48
  Port identity: clock identity: 0x0:A7:42:FF:FE:8A:84:C0
  Port identity: port number: 48
  PTP version: 2
  Port state: MASTER
 Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000
```

Slave Clock

The following command can be used to verify the PTP state on the interfaces:

```
Device# show ptp brief | exclude FAULTY
Interface                       Domain    PTP State
tenGigE1/0/12                     0         SLAVE
TenGigE1/0/20                     0         PASSIVE
TenGigE1/0/23                     0         PASSIVE
```

The following command can be used to verify if the interface configured on each port is an EtherChannel interface:

```
Device# show etherchannel 1 summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
```

```
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port
        A - formed by Auto LAG


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP        Hu1/0/12(P)     Hu1/0/20(P)
                                   Hu1/0/23(P)
```

The following command can be used to verify the port state of each interface:

```
Device# show ptp port tengigabitethernet 1/0/12
PTP PORT DATASET: TenGigE1/0/12
  Port identity: clock identity: 0x0:A7:42:FF:FE:9B:DA:E0
  Port identity: port number: 12
  PTP version: 2
  PTP port number: 12
  PTP slot number: 0
  Port state: SLAVE
  Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000

Device# show ptp port tengigabitethernet 1/0/20
PTP PORT DATASET: TenGigE1/0/20
  Port identity: clock identity: 0x0:A7:42:FF:FE:9B:DA:E0
  Port identity: port number: 20
  PTP version: 2
  PTP port number: 20
  PTP slot number: 0
  Port state: PASSIVE
  Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000

Device# show ptp port tengigabitethernet 1/0/23
PTP PORT DATASET: TenGigE1/0/23
  Port identity: clock identity: 0x0:A7:42:FF:FE:9B:DA:E0
  Port identity: port number: 23
  PTP version: 2
  PTP port number: 23
  PTP slot number: 0
  Port state: PASSIVE
  Delay request interval(log mean): 0
  Announce receipt time out: 3
  Announce interval(log mean): 0
  Sync interval(log mean): 0
  Delay Mechanism: End to End
```

```
  Peer delay request interval(log mean): 0
  Sync fault limit: 500000000
```

Example: Verifying Multiple Stream Reservation Protocol

This example shows how you can view the MSRP stream information.

```
Device# show msrp streams

-------------------------------------------------------------------------------
Stream ID Talker Listener
Advertise Fail Ready ReadyFail AskFail
R | D R | D R | D R | D R | D
-------------------------------------------------------------------------------
yy:yy:yy:yy:yy:yy:0001 1 | 2 0 | 0 1 | 0 0 | 1 1 | 0
zz:zz:zz:zz:zz:zz:0002 1 | 0 0 | 1 1 | 0 0 | 0 0 | 1

-------------------------------------------------------------------------------------------------------------------------
```

This example shows how you can view the detailed MSRP stream information.

```
Device# show msrp streams detail

Stream ID:          0011.0100.0001:1
    Stream Age: 01:57:46 (since Mon Apr 25 23:41:11.413)
    Create Time: Mon Apr 25 23:41:11.413
    Destination Address: 91E0.F000.FE00
    VLAN Identifier: 1
    Data Frame Priority: 3 (Class A)
    MaxFrameSize: 100
    MaxIntervalFrames: 1 frames/125us
    Stream Bandwidth: 6400 Kbit/s
    Rank: 1
    Received Accumulated Latency: 20
    Stream Attributes Table:

-------------------------------------------------------------------------

    Interface          Attr State    Direction    Type

-------------------------------------------------------------------------

      Gi1/0/1          Register       Talker      Advertise
      Attribute Age: 01:57:46 (since Mon Apr 25 23:41:11.413)
      MRP Applicant: Very Anxious Observer, send None
      MRP Registrar: In
      Accumulated Latency: 20
    ----
      Te1/1/1         Declare         Talker      Advertise
      Attribute Age: 00:19:52 (since Tue Apr 26 01:19:05.525)
      MRP Applicant: Quiet Active, send None
```

```
  MRP Registrar: In
  Accumulated Latency: 20
----
  Te1/1/1         Register        Listener    Ready
  Attribute Age: 00:13:17 (since Tue Apr 26 01:25:40.635)
  MRP Applicant: Very Anxious Observer, send None
  MRP Registrar: In
----
  Gi1/0/1         Declare         Listener    Ready
  Attribute Age: 00:13:17 (since Tue Apr 26 01:25:40.649)
  MRP Applicant: Quiet Active, send None
  MRP Registrar: In
```

This example shows how you can view the MSRP stream information in brief.

```
Device# show msrp streams brief

Legend: R = Registered, D = Declared.
-------------------------------------------------------------------------------
Stream ID             Destination         Bandwidth   Talkers   Listeners
  Fail
                       Address               (Kbit/s)    R | D      R | D
-------------------------------------------------------------------------------
0011.0100.0001:1      91E0.F000.FE00     6400          1 | 1      1 | 1
    No
0011.0100.0002:2      91E0.F000.FE01     6400          1 | 1      1 | 1
    No
0011.0100.0003:3      91E0.F000.FE02     6400          1 | 1      1 | 1
    No
0011.0100.0004:4      91E0.F000.FE03     6400          1 | 1      1 | 1
    No
0011.0100.0005:5      91E0.F000.FE04     6400          1 | 1      1 | 1
    No
0011.0100.0006:6      91E0.F000.FE05     6400          1 | 1      1 | 1
    No
0011.0100.0007:7      91E0.F000.FE06     6400          1 | 1      1 | 1
    No
0011.0100.0008:8      91E0.F000.FE07     6400          1 | 1      1 | 1
    No
0011.0100.0009:9      91E0.F000.FE08     6400          1 | 1      1 | 1
    No
0011.0100.000A:10     91E0.F000.FE09     6400          1 | 1      1 | 1
    No
```

This example shows how you can view the MSRP port bandwidth information.

```
Device# show msrp port bandwidth
```

```
-------------------------------------------------------------------------------
Ethernet      Capacity       Assigned       Available       Reserved
Interface     (Kbit/s)        A | B          A | B           A | B
-------------------------------------------------------------------------------
Te1/0/1     10000000         75 | 0         75 | 75          0 | 0
Te1/0/2     10000000         75 | 0         75 | 75          0 | 0
Te1/0/3     1000000          75 | 0         75 | 75          0 | 0
Te1/0/4     10000000         75 | 0         75 | 75          0 | 0
Te1/0/5     10000000         75 | 0         75 | 75          0 | 0
Te1/0/6     10000000         75 | 0         75 | 75          0 | 0
Te1/0/8     10000000         75 | 0         75 | 75          0 | 0
Te1/0/9     10000000         75 | 0         75 | 75          0 | 0
Te1/0/10    10000000         75 | 0         75 | 75          0 | 0
Te1/0/11    10000000         75 | 0         75 | 75          0 | 0
Te1/0/12    10000000         75 | 0         75 | 75          0 | 0
Te1/0/13    1000000          75 | 0         75 | 75          0 | 0
Te1/0/14    10000000         75 | 0         75 | 75          0 | 0
Te1/0/15    10000000         75 | 0         75 | 75          0 | 0
Te1/0/16    10000000         75 | 0         75 | 75          0 | 0
Te1/0/17    10000000         75 | 0         75 | 75          0 | 0
Te1/0/18    10000000         75 | 0         75 | 75          0 | 0
Te1/0/19    1000000          75 | 0         75 | 75          0 | 0
Te1/0/20    10000000         75 | 0         75 | 75          0 | 0
Te1/0/21    10000000         75 | 0         75 | 75          0 | 0
Te1/0/22    10000000         75 | 0         75 | 75          0 | 0
Te1/0/23    10000000         75 | 0         75 | 75          0 | 0
Te1/0/24    10000000         75 | 0         75 | 75          0 | 0
Gi1/1/1     1000000          75 | 0         75 | 75          0 | 0
Gi1/1/2     1000000          75 | 0         75 | 75          0 | 0
Gi1/1/3     1000000          75 | 0         75 | 75          0 | 0
Gi1/1/4     1000000          75 | 0         75 | 75          0 | 0
Te1/1/1     10000000         75 | 0         75 | 75          0 | 0
Te1/1/2     10000000         75 | 0         75 | 75          0 | 0
Te1/1/3     10000000         75 | 0         75 | 75          0 | 0
Te1/1/4     10000000         75 | 0         75 | 75          0 | 0
Te1/1/5     10000000         75 | 0         75 | 75          0 | 0
Te1/1/6     10000000         75 | 0         75 | 75          0 | 0
Te1/1/7     10000000         75 | 0         75 | 75          0 | 0
Te1/1/8     10000000         75 | 0         75 | 75          0 | 0
Fo1/1/1     40000000         75 | 0         75 | 75          0 | 0
Fo1/1/2     40000000         75 | 0         75 | 75          0 | 0
```

Example: Verifying Hierarchical QoS

This example shows how you can view all the policy-map configuration details when AVB is enabled.

```
Device# show policy-map

  Policy Map AVB-Input-Policy-Remark-B
    Class AVB-SR-CLASS-A
```

```
    set cos 3
  Class AVB-SR-CLASS-B
    set cos 0
  Class class-default
    service-policy AVB-Input-Child-Policy

Policy Map AVB-Input-Policy-Remark-A
  Class AVB-SR-CLASS-A
    set cos 0
  Class AVB-SR-CLASS-B
    set cos 2
  Class class-default
    service-policy AVB-Input-Child-Policy

Policy Map AVB-Output-Policy-Default
  Class AVB-SR-CLASS-A
    priority level 1 1 (%)
  Class AVB-SR-CLASS-B
    priority level 2 1 (%)
  Class AVB-CONTROL-MGMT-QUEUE
    priority level 3 15 (%)
  Class class-default
    bandwidth remaining 100 (%)
    queue-buffers ratio 70
    service-policy AVB-Output-Child-Policy

Policy Map AVB-Input-Policy-Remark-AB
  Class AVB-SR-CLASS-A
    set cos 0
  Class AVB-SR-CLASS-B
    set cos 0
  Class class-default
    service-policy AVB-Input-Child-Policy

Policy Map AVB-Input-Policy-Remark-None
  Class AVB-SR-CLASS-A
    set cos 3
  Class AVB-SR-CLASS-B
    set cos 2
  Class class-default
    service-policy AVB-Input-Child-Policy

Policy Map AVB-Input-Child-Policy
  Class AVB-VOIP-DATA-CLASS
    set dscp ef
  Class AVB-MULTIMEDIA-CONF-CLASS
    set dscp af41
  Class AVB-BULK-DATA-CLASS
   set dscp af11
  Class AVB-TRANSACTIONAL-DATA-CLASS
    set dscp af21
```

```
    Class AVB-SCAVENGER-DATA-CLASS
      set dscp cs1
    Class AVB-SIGNALING-CLASS
      set dscp cs3
    Class class-default
      set dscp default

  Policy Map AVB-Output-Child-Policy
    Class AVB-VOIP-PRIORITY-QUEUE
      bandwidth remaining 30 (%)
      queue-buffers ratio 30
    Class AVB-MULTIMEDIA-CONF-STREAMING-QUEUE
      bandwidth remaining 15 (%)
      queue-limit dscp af41 percent 80
      queue-limit dscp af31 percent 80
      queue-limit dscp af42 percent 90
      queue-limit dscp af32 percent 90
      queue-buffers ratio 15
    Class AVB-TRANSACTIONAL-DATA-QUEUE
      bandwidth remaining 15 (%)
      queue-limit dscp af21 percent 80
      queue-limit dscp af22 percent 90
      queue-buffers ratio 15
    Class AVB-BULK-SCAVENGER-DATA-QUEUE
      bandwidth remaining 15 (%)
      queue-limit dscp af11 percent 80
      queue-limit dscp af12 percent 90
      queue-limit dscp cs1 percent 80
      queue-buffers ratio 15
    Class class-default
      bandwidth remaining 25 (%)
      queue-buffers ratio 25
```

This example shows how you can view all the policy-map configuration details when AVB is disabled.

```
Device# show policy-map

Building configuration...

Current configuration : 2079 bytes
!
policy-map AVB-Input-Child-Policy
class AVB-VOIP-DATA-CLASS
  set dscp ef
class AVB-MULTIMEDIA-CONF-CLASS
  set dscp af41
class AVB-BULK-DATA-CLASS
  set dscp af11
```

```
class AVB-TRANSACTIONAL-DATA-CLASS
  set dscp af21
class AVB-SCAVENGER-DATA-CLASS
  set dscp cs1
class AVB-SIGNALING-CLASS
  set dscp cs3
class class-default
  set dscp default
policy-map AVB-Output-Child-Policy
class AVB-VOIP-PRIORITY-QUEUE
  bandwidth remaining percent 30
  queue-buffers ratio 30
class AVB-MULTIMEDIA-CONF-STREAMING-QUEUE
  bandwidth remaining percent 15
  queue-limit dscp af41 percent 80
  queue-limit dscp af31 percent 80
  queue-limit dscp af42 percent 90
  queue-limit dscp af32 percent 90
  queue-buffers ratio 15
class AVB-TRANSACTIONAL-DATA-QUEUE
  bandwidth remaining percent 15
  queue-limit dscp af21 percent 80
  queue-limit dscp af22 percent 90
  queue-buffers ratio 15
class AVB-BULK-SCAVENGER-DATA-QUEUE
  bandwidth remaining percent 15
  queue-limit dscp af11 percent 80
  queue-limit dscp af12 percent 90
  queue-limit dscp cs1 percent 80
  queue-buffers ratio 15
class class-default
  bandwidth remaining percent 25
  queue-buffers ratio 25
!
end
```

This example shows how you can view all the class-map configuration details when AVB is enabled.

```
Device# show class-map

Class Map match-any AVB-VOIP-DATA-CLASS (id 31)
   Match   dscp ef (46)
   Match cos  5

Class Map match-any AVB-BULK-DATA-CLASS (id 33)
   Match access-group name AVB-BULK-DATA-CLASS-ACL

Class Map match-any AVB-VOIP-PRIORITY-QUEUE (id 37)
```

```
   Match   dscp cs4 (32) cs5 (40) ef (46)
   Match   precedence 4  5
   Match cos  5

Class Map match-any AVB-MULTIMEDIA-CONF-CLASS (id 32)
   Match access-group name AVB-MULTIMEDIA-CONF-CLASS-ACL

Class Map match-any AVB-SIGNALING-CLASS (id 36)
   Match access-group name AVB-SIGNALING-CLASS-ACL

Class Map match-any AVB-MULTIMEDIA-CONF-STREAMING-QUEUE (id 38)
   Match   dscp af41 (34) af42 (36) af43 (38)
   Match   dscp af31 (26) af32 (28) af33 (30)
   Match cos  4

Class Map match-any AVB-BULK-SCAVENGER-DATA-QUEUE (id 40)
   Match   dscp cs1 (8) af11 (10) af12 (12) af13 (14)
   Match   precedence 1
   Match cos  1

Class Map match-any AVB-TRANSACTIONAL-DATA-CLASS (id 34)
   Match access-group name AVB-TRANSACTIONAL-DATA-CLASS-ACL

Class Map match-any AVB-TRANSACTIONAL-DATA-QUEUE (id 39)
   Match   dscp af21 (18) af22 (20) af23 (22)

Class Map match-any AVB-SR-CLASS-B (id 42)
   Match cos  2

Class Map match-any AVB-SR-CLASS-A (id 41)
   Match cos  3

Class Map match-any AVB-SCAVENGER-DATA-CLASS (id 35)
   Match access-group name AVB-SCAVENGER-DATA-CLASS-ACL

Class Map match-any AVB-CONTROL-MGMT-QUEUE (id 43)
   Match ip  dscp cs2 (16)
   Match ip  dscp cs3 (24)
   Match ip  dscp cs6 (48)
   Match ip  dscp cs7 (56)
   Match ip  precedence 6
   Match ip  precedence 7
   Match ip  precedence 3
   Match ip  precedence 2
   Match cos  6
   Match cos  7
```

This example shows how you can view all the class-map configuration details when AVB is disabled.

```
Device# show class-map

Building configuration...

Current configuration : 2650 bytes
!
class-map match-any AVB-VOIP-DATA-CLASS
match dscp ef
 match cos  5
class-map match-any AVB-BULK-DATA-CLASS
match access-group name AVB-BULK-DATA-CLASS-ACL
class-map match-any AVB-VOIP-PRIORITY-QUEUE
match dscp cs4  cs5  ef
 match precedence 4  5
 match cos  5
class-map match-any AVB-MULTIMEDIA-CONF-CLASS
match access-group name AVB-MULTIMEDIA-CONF-CLASS-ACL
class-map match-any AVB-SIGNALING-CLASS
match access-group name AVB-SIGNALING-CLASS-ACL
class-map match-any AVB-MULTIMEDIA-CONF-STREAMING-QUEUE
match dscp af41  af42  af43
 match dscp af31  af32  af33
 match cos  4
class-map match-any AVB-BULK-SCAVENGER-DATA-QUEUE
match dscp cs1  af11  af12  af13
 match precedence 1
 match cos  1
class-map match-any AVB-TRANSACTIONAL-DATA-CLASS
match access-group name AVB-TRANSACTIONAL-DATA-CLASS-ACL
class-map match-any AVB-TRANSACTIONAL-DATA-QUEUE
match dscp af21  af22  af23
class-map match-any AVB-SCAVENGER-DATA-CLASS
match access-group name AVB-SCAVENGER-DATA-CLASS-ACL
end
```

This example shows how you can view all the AVB QoS statistics.

```
Device# show policy-map interface gigabitEthernet 1/0/15

GigabitEthernet1/0/15

  Service-policy input: AVB-Input-Policy-Remark-AB

    Class-map: AVB-SR-CLASS-A (match-any)
      0 packets
      Match: cos  3
        0 packets, 0 bytes
        5 minute rate 0 bps
      QoS Set
```

```
    cos 0

Class-map: AVB-SR-CLASS-B (match-any)
  0 packets
  Match: cos  2
    0 packets, 0 bytes
    5 minute rate 0 bps
  QoS Set
    cos 0

Class-map: class-default (match-any)
  0 packets
  Match: any

  Service-policy : AVB-Input-Child-Policy

    Class-map: AVB-VOIP-DATA-CLASS (match-any)
      0 packets
      Match:  dscp ef (46)
        0 packets, 0 bytes
        5 minute rate 0 bps
      Match: cos  5
        0 packets, 0 bytes
        5 minute rate 0 bps
      QoS Set
        cos 3

    Class-map: AVB-MULTIMEDIA-CONF-CLASS (match-any)
      0 packets
      Match: access-group name AVB-MULTIMEDIA-CONF-CLASS-ACL
        0 packets, 0 bytes
        5 minute rate 0 bps
      QoS Set
        dscp af41

    Class-map: AVB-BULK-DATA-CLASS (match-any)
      0 packets
      Match: access-group name AVB-BULK-DATA-CLASS-ACL
        0 packets, 0 bytes
        5 minute rate 0 bps
      QoS Set
        dscp af11

    Class-map: AVB-TRANSACTIONAL-DATA-CLASS (match-any)
      0 packets
      Match: access-group name AVB-TRANSACTIONAL-DATA-CLASS-ACL
        0 packets, 0 bytes
        5 minute rate 0 bps
      QoS Set
        dscp af21
```

```
      Class-map: AVB-SCAVENGER-DATA-CLASS (match-any)
        0 packets
        Match: access-group name AVB-SCAVENGER-DATA-CLASS-ACL
          0 packets, 0 bytes
          5 minute rate 0 bps
        QoS Set
          dscp cs1

      Class-map: AVB-SIGNALING-CLASS (match-any)
        0 packets
        Match: access-group name AVB-SIGNALING-CLASS-ACL
          0 packets, 0 bytes
          5 minute rate 0 bps
        QoS Set
          dscp cs3

      Class-map: class-default (match-any)
        0 packets
        Match: any
        QoS Set
          dscp default

Service-policy output: AVB-Output-Policy-Default

  queue stats for all priority classes:
    Queueing
    priority level 3

    (total drops) 0
    (bytes output) 7595

  queue stats for all priority classes:
    Queueing
    priority level 2

    (total drops) 0
    (bytes output) 0

  queue stats for all priority classes:
    Queueing
    priority level 1

    (total drops) 0
    (bytes output) 0

  Class-map: AVB-SR-CLASS-A (match-any)
    0 packets
    Match: cos  3
      0 packets, 0 bytes
      5 minute rate 0 bps
    Priority: 1% (10000 kbps), burst bytes 250000,
```

```
  Priority Level: 1

Class-map: AVB-SR-CLASS-B (match-any)
  0 packets
  Match: cos  2
    0 packets, 0 bytes
    5 minute rate 0 bps
  Priority: 1% (10000 kbps), burst bytes 250000,

  Priority Level: 2

Class-map: AVB-CONTROL-MGMT-QUEUE (match-any)
  0 packets
  Match: ip dscp cs2 (16)
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip dscp cs3 (24)
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip dscp cs6 (48)
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip dscp cs7 (56)
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip precedence 6
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip precedence 7
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip precedence 3
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: ip precedence 2
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: cos  6
    0 packets, 0 bytes
    5 minute rate 0 bps
  Match: cos  7
    0 packets, 0 bytes
    5 minute rate 0 bps
  Priority: 15% (150000 kbps), burst bytes 3750000,

  Priority Level: 3

Class-map: class-default (match-any)
  0 packets
  Match: any
```

```
Queueing

(total drops) 0
(bytes output) 0
bandwidth remaining 80%
queue-buffers ratio 70

Service-policy : AVB-Output-Child-Policy

  Class-map: AVB-VOIP-PRIORITY-QUEUE (match-any)
    0 packets
    Match:  dscp cs4 (32) cs5 (40) ef (46)
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match:  precedence 4  5
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match: cos  5
      0 packets, 0 bytes
      5 minute rate 0 bps
    Queueing

    (total drops) 0
    (bytes output) 0
    bandwidth remaining 30%
    queue-buffers ratio 30

  Class-map: AVB-MULTIMEDIA-CONF-STREAMING-QUEUE (match-any)
    0 packets
    Match:  dscp af41 (34) af42 (36) af43 (38)
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match:  dscp af31 (26) af32 (28) af33 (30)
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match: cos  4
      0 packets, 0 bytes
      5 minute rate 0 bps
    Queueing

    queue-limit dscp 26 percent 80
    queue-limit dscp 28 percent 90
    queue-limit dscp 34 percent 80
    queue-limit dscp 36 percent 90
    (total drops) 0
    (bytes output) 0
    bandwidth remaining 15%

    queue-buffers ratio 15

  Class-map: AVB-TRANSACTIONAL-DATA-QUEUE (match-any)
```

```
    0 packets
    Match:  dscp af21 (18) af22 (20) af23 (22)
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match: cos  0
      0 packets, 0 bytes
      5 minute rate 0 bps
    Queueing

    queue-limit dscp 18 percent 80
    queue-limit dscp 20 percent 90
    (total drops) 0
    (bytes output) 0
    bandwidth remaining 15%

    queue-buffers ratio 15

  Class-map: AVB-BULK-SCAVENGER-DATA-QUEUE (match-any)
    0 packets
    Match:  dscp cs1 (8) af11 (10) af12 (12) af13 (14)
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match:  precedence 1
      0 packets, 0 bytes
      5 minute rate 0 bps
    Match: cos  1
      0 packets, 0 bytes
      5 minute rate 0 bps
    Queueing

    queue-limit dscp 8 percent 80
    queue-limit dscp 10 percent 80
    queue-limit dscp 12 percent 90
    (total drops) 0
    (bytes output) 0
    bandwidth remaining 15%

    queue-buffers ratio 15

  Class-map: class-default (match-any)
    0 packets
    Match: any
    Queueing

    (total drops) 0
    (bytes output) 0
    bandwidth remaining 25%
    queue-buffers ratio 25
```

The following is a sample output from the **show platform hardware fed switch active qos queue config interface** *interface-id* command.

```
Device# show platform hardware fed switch active qos queue config interface t1/0/11
DATA Port:2 GPN:11 AFD:Disabled QoSMap:2 HW Queues: 16 - 23
  DrainFast:Disabled PortSoftStart:1 - 3600
------------------------------------------------------------
   DTS  Hardmax  Softmax   PortSMin  GlblSMin  PortStEnd
  ----- --------  --------  --------  --------  ---------
 0   0  9    33   3    33    0    0   0     0   1  4800
 1   0  9    33   4  2400   99   99   0     0   1  4800
 2   1  6    30   4  2400   90   90   0     0   1  4800
 3   1  5     0   4  2400  189  189  63    63   1  4800
 4   1  5     0   4  2400   90   90  30    30   1  4800
 5   1  5     0   4  2400   90   90  30    30   1  4800
 6   1  5     0   4  2400   90   90  30    30   1  4800
 7   1  5     0   4  2400  153  153  51    51   1  4800
 Priority   Shaped/shared   weight  shaping_step
 --------   -------------   ------  ------------
 0      1     Shaped         16383         163
 1      2     Shaped         16383         163
 2      3     Shaped           125         153
 3      7     Shared            50           0
 4      7     Shared           100           0
 5      7     Shared           100           0
 6      7     Shared           100           0
 7      7     Shared            60           0
```

The following is a sample output from the **show platform hardware fed switch active qos queue stats interface** *interface-id* command.

```
Device# show platform hardware fed switch active qos queue stats interface t1/0/15
DATA Port:8 Enqueue Counters
--------------------------------
Queue Buffers Enqueue-TH0 Enqueue-TH1 Enqueue-TH2
----- ------- ----------- ----------- -----------
    0       1           0           0 23788459506
    1       0           0           0 30973507838
    2       0           0    12616270    13164040
    3       0           0           0           0
    4       0           0           0           0
    5       0           0           0           0
    6       0           0           0           0
    7       0           0           0      119616

DATA Port:8 Drop Counters
--------------------------------
Queue Drop-TH0    Drop-TH1    Drop-TH2    SBufDrop    QebDrop
----- ----------- ----------- ----------- ----------- -----------
    0           0           0           0           0           0
    1           0           0           0           0           0
```

```
2           0           0           0           0           0
3           0           0           0           0           0
4           0           0           0           0           0
```

Example: Verifying Multiple VLAN Registration Protocol

This example shows how you can view the MVRP summary information.

```
Device# show mvrp summary

MVRP global state           : enabled
MVRP VLAN creation          : enabled
VLANs created via MVRP      : 2,567
MAC learning auto provision : disabled
Learning disabled on VLANs  : none
```

This example shows how you can view the interface MVRP information.

```
Device# show mvrp interface

Port         Status    Registrar State
Te1/0/47     on              normal
Te1/1/3      off             normal

Port        Join Timeout      Leave Timeout   Leaveall Timeout   Periodic

                                                                 Timeout
Te1/0/47     20                 60              1000               100
Te1/1/3      20                 60              1000               100

Port         Vlans Declared
Te1/0/47     1-2,567,900
Te1/1/3      none

Port         Vlans Registered
Te1/0/47     2,567
Te1/1/3      none

Port         Vlans Registered and in Spanning Tree Forwarding State
Te1/0/47     2,567
Te1/1/3      none
```

Feature History for Audio Video Bridging

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Fuji 16.8.1a	Audio Video Bridging (AVB): IEEE 802.1BA	AVB is a standard based mechanism where endpoints and the network will function as a whole to enable high quality A/V streaming across consumer applications to professional audio-video over an Ethernet infrastructure. Support for this feature was introduced on all the models of the Cisco Catalyst 9500 Series Switches.
Cisco IOS XE Gibraltar 16.12.5	AVB MSRP	MSRP commands have been introduced to configure MSRP timer values.
Cisco IOS XE Amsterdam 17.2.1	IEEE802.1AS (gPTP) support on EtherChannel Interfaces	Starting with this release the interface on which you configure gPTP can be part of an EtherChannel. Support for this feature was introduced on all the models of the Cisco Catalyst 9500 Series Switches.

Use Cisco Feature Navigator to find information about platform and software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn.