



Configuring Audio Video Bridging

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Finding Feature Information

Your software release might not support all the features documented in this module. For the latest caveats and feature information, see the Bug Search Tool at <https://tools.cisco.com/bugsearch/> and the release notes for your software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the “New and Changed Information” chapter or the Feature History table below.

Information About Audio Video Bridging

Overview on Audio Video Bridging

Audio Video Bridging (AVB) is set of standards that enable time-synchronized low latency streaming services on Ethernet networks, including wireline Ethernet networks shared with other data traffic and wireless LANs. AVB implements the set of standards developed by the IEEE Audio Video Bridging Task Group. AVB functions by reserving a fraction of the Ethernet bandwidth that is available for AVB traffic. AVB consists of the following specifications that are defined under the standard IEEE 802.1BA: Audio Video Bridging (AVB) Systems:

- IEEE 802.1AS – gPTP: Generalized Precision Time Protocol (gPTP).
- IEEE 802.1Qat: Multiple Stream Reservation Protocol (MSRP) that defines an end-to-end bandwidth reservation protocol within a bridged LAN.
- IEEE 802.1Qav: Forwarding and Queuing for Time-Sensitive Streams (FQTSS), which is AV traffic scheduling capability for a mainstream Ethernet and other network switches.

Time Synchronization Protocol for AVB (gPTP or IEEE 802.1AS)

Generalized Precision Time Protocol (gPTP) is a protocol used to enable synchronization of AVB end points so the listeners correctly use the timestamps carried in the video. gPTP is also required while switching the video streams from one source to another, on a video frame boundary. IEEE 802.1AS: Timing and Synchronization for Time-Sensitive Applications defines gPTP. Though IEEE 802.1AS is based on IEEE1588v2, there are some key differences between them. The following are the characteristics of gPTP:

- It mandates the use of only Layer-2 messages.
- It requires that all devices, including the vendor devices, in the AVB network have to be gPTP compliant.
- It requires the availability of boundary and ordinary clocks for end stations.
- It uses Peer Delay mechanism, 2-step clocks, and single gPTP domain.
- It uses Best Master Clock selection algorithm (BMCA).

Best Master Clock selection Algorithm:

- It is used to select master/slave state of the port, using PTP Announce messages.
- It enables that the best clock is selected as the master.
- Depends on the quality of the clock, particularly its stability, and configuration, such as PTP priority.

Peer Delay Mechanism:

- It is used to measure Link Delay. Link Delay is the delay in propagation of a packet or stream of packets from egress of an interface of a switch at stage N-1 to the ingress of the connected interface of the switch at stage N.
- It is used between two directly connected AVB switches/devices, which are two ends of the link, using the following peer delay PTP messages:
 - pDelay request
 - pDelay Response
 - pDelay Response Follow-up

Clock Synchronization:

- It is used to synchronize the clocks of slave devices with the master.
- It involves packet exchange, using synchronization and follow-up PTP messages, to send time updates from the master to the slave ports

Residence delay is the time a packet spends within a switch from the time it enters a switch through an ingress interface to the time it exits the switch through an egress interface. It is not measured but it is configured on the switch by enabling the **ptp switchlatency-estimated** *value* command. The default value is 5000 ns.

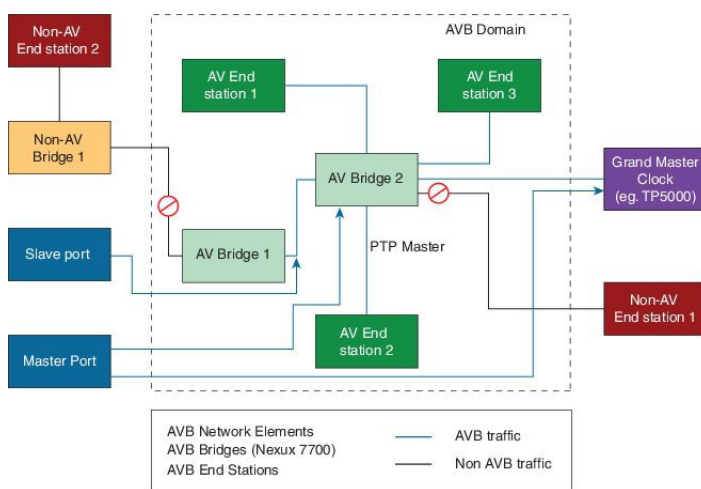
Link delay and residence delay can be used to measure end-to-end latency in an AVB network.

The latency between egress of previous node and egress of current node:

Link Delay for the link connected to egress of the previous node and ingress of the current node) + Residence delay (switch latency)

Field	Value
Announce interval 1	1 packet per 2 seconds
Announce receipt timeout	2 seconds
Sync interval 2	1 packet per 4 seconds
Peer Delay interval 1	1 packet per 2 seconds

Figure 1: gPTP Master/Slave Relationship



Multiple Stream Reservation Protocol (MSRP)

MSRP Signaling protocol is used to reserve resources for AVB streams. It helps in maintaining audio-video quality for AVB. It is defined by IEEE 802.1Qat. The following are the characteristics of MSRP:

- Manages bandwidth using call admission control (CAC) functionality to prevent congestion.
- MSRP is built on Multiple Registration Protocol (MRP). MSRP is attribute-based similar to Multiple Registration Protocol (MRP) and Multiple VLAN Registration Protocol (MVRP).
- Talker denotes the stream source and listener denotes the stream destination.
- The talker attributes describes the streams that are being offered.
- The listener attributes are used to subscribe to the streams that are being offered.
- The listener associates to the talker by using an identity that is known as the Stream ID, which comprises the MAC address of the talker and a talker-specific 16-bit unique ID and the MAC address of the listener.
- MSRP adds and removes per interface PTP or QoS configuration.
- MSRP determines the core ports, establishes AVB domains by exchanging domain attribute.

- MSRP propagates the talker advertisements, transform to TalkerFailed advertisements on their egress ports with insufficient bandwidth and back when bandwidth reservation is possible. See the Figure -3, "Talker Attribute Flow".
- MSRP manages listener reservations. See the Figure-4, "Talker Attribute Flow". Perform the following to enable reservations:
 - Adjust port shaper rate for traffic class
 - Add mroute, which is Layer 2 Multicast route, for traffic
- MSRP merges multiple listener reservations and propagates the results to the talker.
- MSRP uses standard specified defaults
- Rank preemption is not supported.
- The following are the MRP timers:
 - 200 milliseconds Join Timer (assumes P-to-P)
 - 1000 milliseconds Leave Timer (standard 600-1000; uses max for max scale)
 - 10000 milliseconds Leave All Timer
- Streams are multi-cast only as per the standard.
- MSRP PDU are NOT VLAN tagged

Bandwidth Management

Bandwidth is allocated on first come, first served basis. A maximum of 75% of bandwidth is allocated. Bandwidth is not configurable.

- A maximum of 75% of physical port bandwidth is reserved.
- SR Class A reserves up to 75% of bandwidth. The upper limit is not configurable.
- SR Class B reserves all the bandwidth that is not used by SR Class A. SR Class B can occupy total of 75%, if no SR class A is reserved.

gPTP values used by MSRP

MSRP uses the following Link Delay and Residence Delay values from gPTP.

MSRP uses Link Delay and Residence Delay values to calculate the end-to-end latency. See the figure below :

The latency between egress of the previous node and egress of the current node = Link Delay for the link connected to egress of the previous node and ingress of the current node) + Residence delay (switch latency)

Figure 2: Calculation of End-to-End Latency

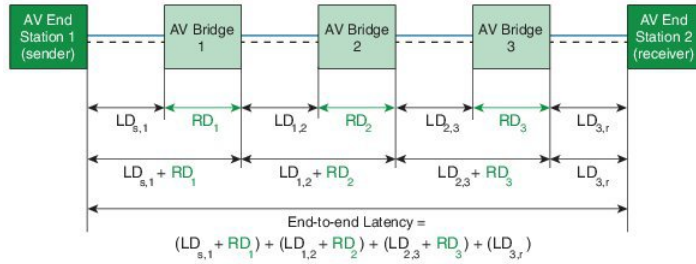


Figure 3: Talker Attribute Flow

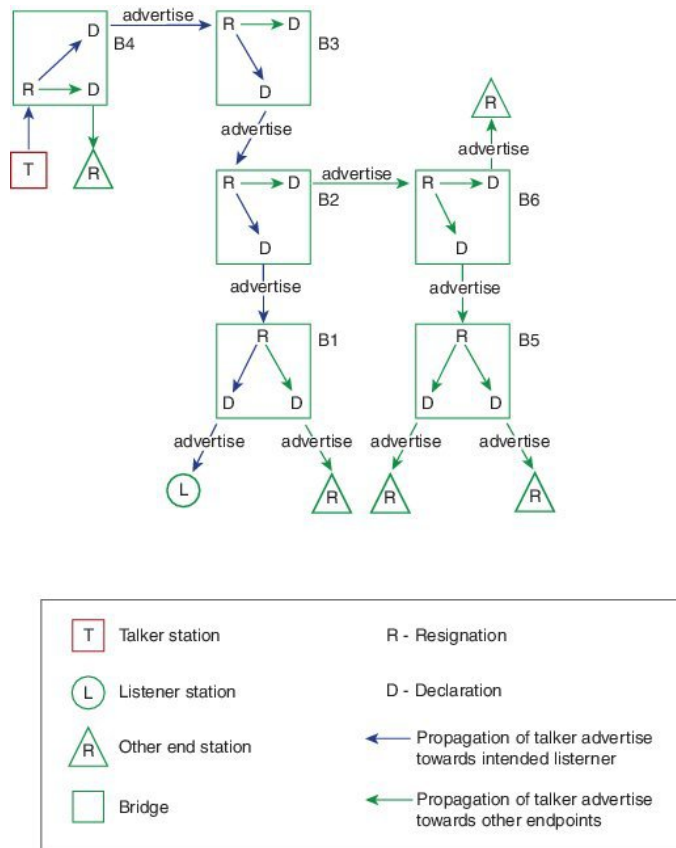
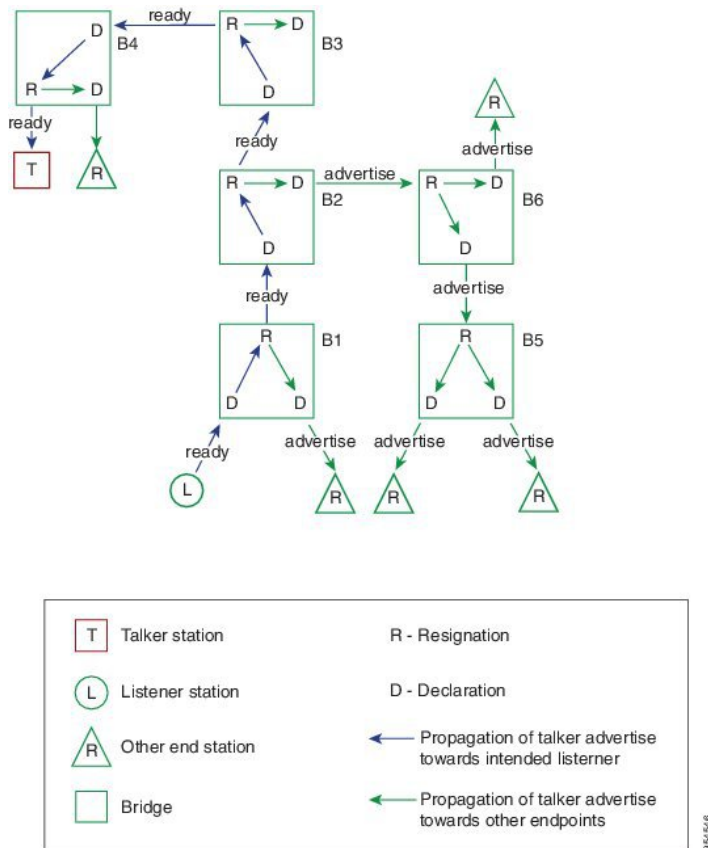


Figure 4: Listener Attribute Flow



QoS Support for AVB (802.Qav or FQTSS)

Forwarding and Queuing for Time-Sensitive Streams (FQTSS) specification defines the forwarding and queuing rules and guidelines for AVB traffic. It is defined by IEEE 802.1Qav. The following are the characteristics of FQTSS:

- Cisco NX-OS AVB implementation follows FQTSS standard.
- FQTSS supports the tables and procedures for mapping priorities to traffic classes.
- gPTP requires the availability of boundary and ordinary clocks for end stations.

Table 1: Default Priority

SR Class	Default Priority	Default Regenerated Priority for AVB Domain Boundary Ports
Class A	3	0
Class B	2	0

Classes of Traffic

QoS is applied in AVB features to:

- Protect the control and best effort traffic, where the reserved AVB stream traffic traversing an AVB bridge has forwarding precedence over non-reserved traffic, from the SR class traffic and vice versa.
- Protect the SR class traffic from itself.

The basic requirement of AVB, in compliance with FQTSS, is to have four classes of traffic with decreasing order of priorities:

- SR class A: This class has the highest priority in the network, as it requires the latency of 2 milliseconds.
- SR class B: The required latency is 50 milliseconds.
- Control traffic, including gPTP and MSRP.
- Best effort

The following QoS functions are used to achieve the QoS goals:

- Supports new network QoS template for AVB
- Defines ingress and egress queues with specific properties
- Supports ingress COS re-marking and protects AVB traffic
- Boundary or non-AVB port configuration by applying ingress QoS policy
- Core port configuration by removing ingress QoS policy
- Supporting dynamic configuration of Egress Shaper Rate, for bandwidth reservation, on per class and per port basis for core ports

Network QoS Template:

The network QOS policy, which is default-nq-8021qav-4q8q-policy) defined for AVB:

Drop COS	No drop COS
0-7	-

Ingress Queue Name	MTU	Congestion Control	Pause
Drop COS	1500 bytes	Tail-drop	Off

The below table lists the ingress queuing policy:

Table 2: Ingress Queuing Policy

Ingress Queue Name	Meant for Traffic	Ingress COS	Q-Limit
8021qav-4q8q-in-q1	Control	5-7	10%
8021qav-4q8q-in-q-default	Best Effort	0, 1, & 4	30%
8021qav-4q8q-in-q3	Class A	3	30%

Ingress Queue Name	Meant for Traffic	Ingress COS	Q-Limit
8021qav-4q8q-in-q4	Class B	2	30%

The below table lists the egress queuing policy:

Table 3: Egress Queuing Policy

Egress Queue Name	Meant for Traffic	Egress COS	Priority	Shape
8021qav-4q8q-out-q1	Control	5 - 7	3	-
8021qav-4q8q-out-q2	Best Effort	4	-	-
8021qav-4q8q-out-q3	Best Effort	1	-	
8021qav-4q8q-out-q4	Class A	3	1	\$
8021qav-4q8q-out-q5	Class B	2	2	\$
8021qav-4q8q-out-q6	-	-	-	
8021qav-4q8q-out-q7	-	-	-	
8021qav-4q8q-out-q-default	Best Effort	0	0	



Note Priority is of the order 1 > 2 > 3

Shape: \$ indicates the variable.

Guidelines and Limitations for Audio Video Bridging

Hardware Requirements:

- AVB is supported on Nexus 7700 series of switches.
- AVB is supported F3 modules.

Software Requirements:

- AVB is supported from Cisco NX-OS Release 7.3(0)D1(1).
- AVB needs configuration of new Network QoS profile (IEEE 802.1Qav)

To enable AVB functionality, the following features are required to function simultaneously:

- Layer 2 interfaces (particularly, switchports)

- MSRP
- PTP
- STP
- QoS
- Layer 2 Multicast

Restrictions

AVB is not supported on:

- Nexus 7000 Series of switches
- Non-F3 modules, such as F1/F2/F2e, M1/M2)
- Configurations with FEX ports
- Break-out ports
- Port Channel interfaces, VPC and VPC+
- FabricPath
- Multiple VDCs simultaneously
- Customized per-port input QoS policy
- Customized per-port output Queuing policy
- SNMP or XML support for MSRP

MSRP accumulates and propagates through the talker advertisement, the latency information that the receivers or listeners use.

The QoS configuration is applied system-wide and so the configuration is applied on all F3 modules in the system across all VDCs. Chassis should not contain F1 or F2 series cards.

Configuring Audio Video Bridging

How to Configure Audio Video Bridging

Configuring Audio Video Bridging

Procedure

- Step 1** Enter global configuration mode:
switch# **configure terminal**
- Step 2** Configure Ethernet interface and enter interface configuration mode.
switch(config)# **interface ethernet slot/port**

Note Perform the interface configuration (Steps 2 to 5) for all AVB-enabled ports.

- Step 3** Configure the interface as a Layer 2 Ethernet interface:
switch(config-if)# **switchport**
- Step 4** Set the interface as an Ethernet trunk port. A trunk port can carry traffic in one or more VLANs on the same physical link. VLANs are based on the trunk-allowed VLANs list:
switch(config-if)# **switchport mode trunk**
- Note** Configure all AVB interfaces in Layer 2 switchport trunk mode. Access mode is not supported.
- Step 5** Specify that only certain VLANs are allowed on the specified trunk:
switch(config-if)# **switchport trunk allowed vlan start-vlan**
- Step 6** Exit the interface configuration mode:
switch(config-if)# **exit**
- Step 7** Specify the VLAN ID:
switch(config)# **vlan**
- Step 8** Enable forwarding lookup for multicast data traffic based on destination MAC address and not based on destination IP address:
switch(config-vlan)# **layer-2 multicast lookup mac**
- Step 9** Return to the global configuration mode:
switch(config-vlan)# **exit**
- Step 10** Reset the network-wide policy map and enters system class configuration mode:
switch(config)# **system qos**
- Step 11** Configure the *default-nq-8021qav-4q8q-policy* template.
switch(config-sys-qos)# **service-policy type network-qos default-policy-name**
- Step 12** Exits the system-class configuration:
switch(config-sys-qos)# **exit**
- Step 13** Disable the DSCP to queue mapping. Because the AVB traffic is pure Layer 2, the disabling is required:
switch(config)# **no hardware qos dscp-to-queue**
- Step 14** Enable the PTP feature on the device:
switch(config)# **feature ptp**
- Step 15** Enable the MSRP feature on the device:
switch(config)# **feature msrp**

Configuring Audio Video Bridging

This example shows a running configuration.

```
configure terminal
interface ethernet 2/1
switchport
switchport mode trunk
switchport mode trunk allowed vlan 1
exit
vlan
layer-2 multicast lookup mac
exit
```

```

system qos
  service-policy type network-qos default-nq-8021qav-4q8q-policy
  exit
no hardware qos dscp-to-queue
feature ptp
feature msrp

```

Verifying Automatic Configuration of Audio Video Bridging

The following AVB configuration is automatically added by AVB subsystem.



Caution

Do not change this configuration manually or through any queueing policy.

Sample output for the **show-running configuration** command

```

switch# show running-configuration

# PTP Configuration

# Enabling gPTP

ptp mode generalized-PTP

# Enabling layer-2 PTP

ptp encapsulation layer-2

# For all L2 (switchport) interfaces

interface ethernet <>

  ptp

# Clock manager configuration (only on Default VDC)

clock protocol ptp vdc <id>

# QoS Configuration

# QoS Classification for SR Class A and B

class-map type qos match-any 802.1qav-remark-class-A
match cos 3
class-map type qos match-any 802.1qav-remark-class-B
match cos 2

# Re-marking (to COS 0) policy maps

policy-map type qos 802.1qav-remark-policy-A
class 802.1qav-remark-class-A
set cos 0
policy-map type qos 802.1qav-remark-policy-B
class 802.1qav-remark-class-B
set cos 0
policy-map type qos 802.1qav-remark-policy-AB
class 802.1qav-remark-class-A
set cos 0
class 802.1qav-remark-class-B
set cos 0

# Ingress QoS (re-marking) policy Configuration when port's Domain status is Boundary

interface Ethernet <>

...

```

```

service-policy type qos input [802.1qav-remark-policy-AB | 802.1qav-remark-policy-A |
802.1qav-remark-policy-B] no-stats

# Shaper Configuration on AVB port and queues

# (DO NOT change it manually or via any Queuing policy)

```

Troubleshooting Tips

Make sure of the following when you troubleshoot AVB issues:

- The AVB interfaces are configured in switchport trunk mode.
- MSRP and PTP features are enabled.
- The default-nq-8021qav-4q8q-policy template is applied under system qos command through the **service-policy type network-qos** command.
- Disable the DSCP to queue mapping using the **no hardware qos dscp-to-queue** command.
- The automatic QoS configuration is performed properly.
- Re-marking QoS policy is applied at the ingress as a mandatory properly under the appropriate interface using the **show run ipqos** command.
- Bandwidth reservation for each queue/port is shown properly using the **show queuing interface** command.
- Automatic PTP configuration is performed properly.
- The PTP state (master or slave) is displayed properly for each port.
- The AVB ports are correctly marked as boundary or core as displayed in the **show avb domain** command output.
- The MSRP streams are properly registered or declared at each node.
- The **lookup mac** command is configured for Layer 2 multicast.
- Layer 2 multicast routes are properly setup as displayed in the **show I2 mroute** command output.

QoS-specific Troubleshooting:

- Use **show tech-support ipqos all** command to collect all information about IP QoS manager component.
- Use **show tech-support aclqos** command to collect all information about the ACL-QoS component.
- Use **show queuing interface** command to check the queue mapping, per-queue QoS configuration for ingress and egress queues. The output will be the same in all interfaces except the shape % which may vary from interface to interface.
- If a port domain status is boundary, you should make sure that the QoS re-mark policy has been applied on that port. To verify the port domain, use the **show running ipqos** command output.

```

switch# show running ipqos
interface Ethernet 1/5
 ptp switchport
 switchport mode trunk
 switchport trunk allowed vlan 1-2

```

```
service-policy type qos input 802.1qav-remark-policy-AB no-stats
no shutdown
```

- After the status of port domain is changed from boundary to core, the re-marking QoS policy should be automatically removed from the interface.

```
switch# show running ipqos
interface Ethernet 1/5
 ptp switchport
 switchport mode trunk
 switchport trunk allowed vlan 1-2
no shutdown
```

- After the domains are learned and talker and listeners registers are complete successfully, all the streams get the requested bandwidth reserved in the system. To check whether the streams bandwidth reservations are done properly on the egress ports use the following commands. Make sure that MSRP has the appropriate reservation.

**Note**

The below sample output indicates that 10% of the interface bandwidth is reserved for SR class A.

```
switch# show msrp port bandwidth
```

Ethernet	Capacity	Assigned	Available	Reserved
Interface	(Kbit/s)	A B	A B	A B
Eth1/5	10000000	25 50	15 75	10 0
Eth1/10	10000000	25 50	25 75	0

- Use the following QOS command to confirm that the requested bandwidth has been reserved and configured in the hardware appropriately.



Note The bandwidth reservation for the corresponding class Q in QOS should be the same as the bandwidth reservation requested by MSRP.

```
Switch # show queuing interface ethernet 1/5 output
```

```
Egress Queuing for Ethernet1/5 [System]
```

```
-----  
Template: 8Q 8021QAV  
-----
```

Queue CoSMap	Group	Bandwidth%	PrioLevel	Shape%	
8021qav-4q8q-out-q4	3	-	High	10	3
8021qav-4q8q-out-q5	4	-	High	0	2
8021qav-4q8q-out-q6	5	14	-	-	
8021qav-4q8q-out-q7	6	14	-	-	
8021qav-4q8q-out-q1 5-7	0	-	Low	-	
8021qav-4q8q-out-q2	1	14	-	-	4
8021qav-4q8q-out-q3	2	14	-	-	1
8021qav-4q8q-out-q-default	7	14	-	-	0

gPTP-specific Troubleshooting:

If the PTP port states keep changing on the end device or on the switch, verify the packet intervals using **show run ptp all** command. The port states must match the values that are set on both sides of the link.

- If the clock value changes once in extended period of time, make sure that the Grand Master is a standard clock. Non-standard clocks can used for protocol testing only.
- Verify if the encapsulation and mode are Layer 2 and gPTP respectively, using the **show running-configuration** command.
- Verify the VLAN configuration under PTP port field.
- Verify the protocol configuration in the default VDC.

```
switch# show running-configuration clock_manager
```

```
clock protocol ptp vdc 2
```



Note The appropriate VDC must be displayed.

- Verify the STP states for PTP enabled ports. The PTP states must be Forwarding on both sides.

```
switch# show spanning-tree vlan 1
```

```
Interface      Role Sts Cost Prio.Nbr  Type  
-----  
-----
```

```
Ethernet 1/1 Desg FWD 2 128.129 Edge P2p
Ethernet 1/32 Desg FWD 2 128.160 P2p
```

- To verify if the clocks are in synchronization, use the following commands:
 - **show ptp clock** command to verify the local clock and delay from the Master
 - **show ptp corrections** command to verify the extent of error is present in the local clock. Normally, the extent of error is minimal.

Use the output from the **show tech-support ptp** for further analysis.

MSRP-specific Troubleshooting:

- Use the **show avb domain** command and the **show msrp port domain** command to troubleshoot domain related issues.

The below output indicates that the non-receipt of information from the peer.

```
switch# show msrp port domain
```

```
-----
Ethernet      Local  PCP/VLAN   Peer  PCP/VLAN AVB Core
Interface     A | B    A | B     A | B
-----
Ethernet 1/1 3/2 | 2/2 -/- | -/- No | No
Ethernet 1/2 3/2 | 2/2 3/2 | 2/2 Yes | Yes
Ethernet 1/3 3/2 | 2/2 -/- | -/- No | No
```

The below output indicates that the Ethernet interface is not in Core state:

```
switch# show avb domain
```

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

```
-----
Interface     State  Delay  PCP  VID  Information
-----
Ethernet 1/1 down  N/A   Oper state not up
----
Ethernet 1/2 up  376ns
```

```

Class-A core 3 2
Class-B core 2 2
----
Ethernet 1/3 down N/A Oper state not up

```

- Use the **show msrp stream** and **show msrp stream detailed** command to verify talker failures.

The below output indicates the failure of the talker propagation

```
switch# show msrp stream
```

Legend: R = Registered, D = Declared.

```

-----
Stream ID          Talker                Listener
                   Advertise Fail      Ready  ReadyFail  AskFail
                   R | D   R | D   R | D  R | D      R | D
-----
0001.0001.0001:2   1 | 0   0 | 1   0 | 0  0 | 0      0 | 0

```

- The below output indicates the reason for failure of the talker propagation:

```
switch# show msrp stream detailed
```

Stream ID: 0001.0001.0001:2

Stream Age: 00:00:05 (since Tue Jan 06 01:29:29.914 UTC)

Create Time: Tue Jan 06 01:29:29.914 UTC

Destination Address: 3333.0000.0002

VLAN Identifier: 2

Data Frame Priority: 3 (Class A)

MaxFrameSize: 1400

MaxIntervalFrames: 50000 frames/125us

Stream Bandwidth: 13234012 Kbit/s

Rank: 0

Received Accumulated Latency: 99

Stream Attributes Table:

```

-----
Interface  Attr      State  Direction Type
-----

```

```
Eth1/1      Register Talker  Advertise
```

Attribute Age: 00:00:05 (since Tue Jan 06 01:29:29.914 UTC)

MRP Applicant: Very Anxious Observer, send None

MRP Registrar: In

Accumulated Latency: 99

```
----
```



```
Eth1/2 Declare Talker Fail
Attribute Age: 00:00:05 (since Tue Jan 06 01:29:29.914 UTC)
MRP Applicant: Quiet Active, send None
MRP Registrar: In
Accumulated Latency: 5479
Failure: Insufficient bandwidth, from: 2:8c60.4f04.2441
```

◦ Use the **show tech-support msrp** and **show msrp stream detail** command to troubleshoot or collect all information about MSRP component for troubleshooting issues in talker propagation.

The output from the **show msrp stream brief** command indicates that the talker did not propagated or declared:

```
switch# show msrp stream brief
Legend: R = Registered, D = Declared.
-----
Stream ID          Destination          Bandwidth   Talkers   Listeners   Fail
                  Address              (Kbit/s)   R | D     R | D
-----
0001.0001.0001:1 3333.0000.0001      64000      1 | 0     0 | 0       No
```

```
switch# show msrp stream detail
Stream ID: 0001.0001.0001:1
Stream Age: 00:03:32 (since Tue Jan 06 02:02:04.464 UTC)
Create Time: Tue Jan 06 02:02:04.464 UTC
Destination Address: 3333.0000.0001
VLAN Identifier: 4000
Data Frame Priority: 3 (Class A)
```

Verifying the Audio Video Bridging Configuration

To display the AVB configuration, perform one or many of the following sutasks:

Command	Purpose
show avb domain	Displays details about the AVB domain.
show avb streams	Displays details of the AVB stream IDs.
show running ipqos all	Displays the QoS specific configuration.
show msrp port	Displays information about the MSRP port database.

Command	Purpose
show msrp port details	
show msrp port domain	Displays the interfaces domain information.
show msrp port bandwidth	Displays the bandwidth of the interfaces.
show msrp memory	Displays information about the MSRP memory modules.
show msrp streams	Displays information about the MSRP streams.
show policy-map interface name number input	Displays per interface input queuing policy statistics.
show queuing interface	Displays per interface queuing configuration.
show ptp brief	Displays the PTP port statistics.
show ptp delay summary	Displays the PTP delay summary.
show ptp corrections	Displays the errors that occurred in local clock
show ptp port interface	Displays the status of the PTP port interface.
show ptp clock	Displays the PTP clock details.
show ptp clock foreign-masters record	Displays the PTP clock's foreign-masters keys record.
show ptp parent	Displays parent clock information.
show ptp time-property	Displays local clock time property information.
show running-configuration	Displays the running configuration for a device.

Feature History for Audio Video Bridging

This table includes only the updates for those releases that have resulted in additions or changes to the feature.

Feature Name	Release	Feature Information
Audio Video Bridging (AVB)	7.3(0)D1(1)	This feature was introduced.