Using AVB with Extreme Switches

Contents

AVB Overview

Audio Video Bridging (AVB) supports the deployment of professional quality audio and/or video (AV) over an Ethernet network while coexisting with other non-AV Ethernet traffic. This supports "Network Convergence," or using one simple standard Ethernet network for all communication needs.

To support AV applications, it is necessary for AVB systems to provide time synchronization and quality of service (QoS).

Time synchronization allows multiple streams may be synchronized with respect to each other. For example:

- Voice & video
- Multiple audio streams for a multi-digital speaker deployment in a large venue
- Multiple video streams in a security surveillance application

QoS is needed to ensure:

- Bandwidth guarantees sufficient for each application.
- Worst Case Delay Bounds – particularly for interactive applications.
- Traffic shaping to limit traffic burstiness and reduce buffering requirements.

The time synchronization and QoS requirements for AVB systems are defined in the following set of IEEE Standards:

- IEEE 802.1AS: Timing and Synchronization for Time-Sensitive Applications in Bridged Local Area Networks (gPTP)
- IEEE 802.1Q
  - o Clause 10: Multiple Registration Protocol (MRP) and Multiple MAC Registration Protocol (MMRP)
  - o Clause 11: VLAN Topology Management (MVRP)
  - o Clause 34: Forwarding and Queuing for Time-Sensitive Streams (FQTSS)
  - o Clause 35: Stream Reservation Protocol (SRP)
- IEEE 802.1BA: Audio Video Bridging (AVB) Systems

AVB Feature Pack License

The AVB support (including AVB, gPTP, and MSRP commands) requires the AVB Feature Pack; a license is required to activate this feature pack. After obtaining the AVB Feature Pack license, use the `enable license` command to install it.

NOTE
MRP and MVRP do not require the AVB Feature Pack.

Configuring and Managing AVB

Details for the following commands can be found in the *ExtremeXOS User Guide*, which can be viewed or downloaded from the Extreme Networks website at: www.extremenetworks.com/go/documentation.

AVB Quick Start

Switch Basics

By default, the switch has no IP address configured. Start with a connection to the console port using a serial cable and a terminal emulator, such as HyperTerminal for Windows or ZTerm for Mac.

You will need a TFTP server on your network, or you can use any computer. MacOSX has a TFTP server built in, and free programs exist for Windows, such as Tftpd32.

You will also likely need a USB-to-Serial adapter. Serial port settings are 9600 baud, 8,n,1.

1. Log into the switch using the default user `admin` with no password (just press [Enter]).

2. To configure the management IP address execute one of the following commands

   o   Automatic IP address assignment via DHCP, enter the following command:
   ```
   enable dhcp vlan mgmt
   ```

   o   In this example, the management IP address is 192.168.1.10/24. For manual IP address assignment, enter:
   ```
   configure vlan "Mgmt" ipaddress 192.168.1.10/24
   ```

   o   If you need to change the management IP address, you must first unconfigure it using the following command:
   ```
   unconfigure vlan "Mgmt" ipaddress
   ```

   o   To add a default gateway (needed if your PC is on a different subnet), enter the following command. In this particular case, the default gateway is 192.168.1.1.
   ```
   configure iproute add default 192.168.1.1 vr vr-mgmt
   ```

3. Connect the management port to the network.

4. AVB is supported in ExtremeXOS version 15.3 or higher. To see what version is loaded on the switch, enter the following command to see primary and secondary image version:

```
show switch
```

5. If required, load the software image onto the switch using TFTP via the following command:

```
download image tftp_server_ip_address image_name
```

For example: `download image 192.168.1.2 summitX-15.3.1.4.xos`

6. Answer "yes" to the prompts.

7. If you are unsure of the current configuration on the switch, clear the configuration with:

```
unconfigure switch all
```

Using AVB

AVB is not enabled in the default configuration and must be enabled both globally on the switch and on the ports where AVB will be used. When starting with a default switch configuration, AVB is enabled by executing the following two commands:

```
enable avb
enable avb ports all
```

If an error message appears indicating the command does not exist, enable the license as explained above.

If more than one switch is being used and there is a possibility of loops in the network, we recommend enabling spanning tree. The following two commands can be used to set the spanning tree mode to rapid spanning tree (RSTP) and also enable spanning tree for the default spanning tree domain:

```
configure stpd s0 mode dot1w
enable stpd s0
```

It is important that AVB devices do not use flow control. By default, Extreme switches have transmit IEEE 802.3x PAUSE frames disabled, but will respond to PAUSE frames if they are received. To ensure that both the receiving and transmitting of PAUSE frames are disabled, enter the following two commands:

```
disable flow-control tx-pause ports all
disable flow-control rx-pause ports all
```

The status of AVB can be seen by using the `show avb` command with the following sample output:

```
# show avb
gPTP status          : Enabled
```

```
gPTP enabled ports   : *1s       *2m       *10m      *11m      *12m
                       *13m      *14m      *15m      *16m      *17m
                       *18m      *19m      *20m      *21m

MSRP status          : Enabled
MSRP enabled ports   : *1ab      *2ab      *10ab     *11ab     *12ab
                       *13ab     *14ab     *15ab     *16ab     *17ab
                       *18ab     *19ab     *20ab     *21ab

MVRP status          : Enabled
MVRP enabled ports   : *1        *2        *10       *11       *12
                       *13       *14       *15       *16       *17
                       *18       *19       *20       *21

Flags:          (*)  Active,                    (!)  Administratively disabled,
                (a)  SR Class A allowed,        (b)  SR Class B allowed,
                (d)  Disabled gPTP port role,   (m)  Master gPTP port role,
                (p)  Passive gPTP port role,    (s)  Slave gPTP port role
```

The `show avb` command displays high-level information about each of the three main protocols (gPTP, MSRP, and MVRP). Each protocol section indicates that all protocols are enabled, both globally and on ports 1-2 and 10-21. The "*" indicates that each of the ports is active.

The gPTP status indicates that port 1 is a slave port, which means that the Grand Master Clock (GMC) is reachable through port 1. The gPTP status also indicates that the rest of the ports are master ports. Because no ports are shown to be in the disabled role, gPTP is operational on all the ports.

The "ab" on the MSRP status indicates that all ports are members of both the class A and class B domains.

The MVRP status shows which ports are enabled and active.

More Detailed Configuration

The user interface for AVB includes the following five protocols (in addition to the AVB macro commands):

- gPTP
- MRP
- MVRP
- MSRP
- FQTSS

AVB

The "avb" commands shown in "AVB Quick Start" above are part of a set of AVB macro commands provided to simplify the process of enabling and disabling AVB. The AVB macro commands have the form:

```
[ enable | disable | unconfigure ] avb { ports [ all | port_list ] }
```

Using one of the macro commands is the same as executing the following three commands:

```
[ enable | disable | unconfigure ] network-clock gptp { ports [ all |
port_list ] }
[ enable | disable | unconfigure ] mvrp { ports [ all | port_list ] }
[ enable | disable | unconfigure ] msrp { ports [ all | port_list ] }
```

The disable commands disable the AVB protocols globally or per port without changing any other configured settings. The unconfigure commands reset all AVB settings to the initial states and release all switch resources that were allocated when the protocols were enabled.

gPTP

Not much configuration is required for gPTP; however, there is one attribute that you may want to change. The Priority1 value is the key factor in determining which device in the network is elected the Grand Master Clock (GMC). A lower value is a higher priority.

Bridges have a default Priority1 of 246, while endpoints have a default Priority1 of 248. It is more likely that one of the bridges will become the GMC by default. It might be useful to manually determine which device is the GMC for the network. For example, in a large network, it may be good to have a central switch be the GMC to reduce the number of hops between the GMC and each device.

Whether a given switch is selected as the GMC for the network can be controlled via setting the Priority1 value. For example, the following command will make it more likely that a given switch will become the GMC:

```
configure network-clock gptp default-set priority1 100
```

MRP

MRP does not need to be enabled or disabled, only configured using `configure mrp`. The only MRP properties that may be configured are timer values. The defaults should be sufficient for most deployments, though it may be necessary to increase the leave-all and leave time values when supporting a large number of streams.

For example, the following two commands can be used to increase the leave-all and leave timers to 20 seconds and 3 seconds, respectively.

```
configure mrp ports all timers leave-all 20000
configure mrp ports all timers leave 3000
```

MSRP

There is typically no configuration required for MSRP.

MVRP

There is typically no configuration required for MVRP. By default, any non-AVB tagged VLANs created on the switch are advertised along with the AVB VLAN(s). AVB devices do not need to know about these non-AVB VLANs, and there are some devices that get confused by them. It is possible to prevent the advertisement of these non-AVB VLANs by turning transmit option off.

The following example command prevents the switch from advertising the VLAN with tag 10:

```
configure mvrp tag 10 ports all transmit off
```

FQTSS

The FQTSS settings are generally managed by MSRP and may not be configured directly.

The one FQTSS attribute that is configurable is the amount of bandwidth (BW) allowed for AVB. By default, AVB traffic is allowed to use 75% of the bandwidth of each link. This amount can be increased or decreased and controlled separately for class A and class B traffic.

The settings are called "delta bandwidth" values because class A traffic uses the class A percentage, but class B traffic uses class A percentage plus the class B percentage. This property is illustrated in the table below.

Table 1. Delta Bandwidth (BW)

Class	Default		Example	
	Delta BW	Effective BW	Delta BW	Effective BW
A	75%	75%	25%	25%
B	0%	75%	25%	50%

The commands to configure the delta bandwidth settings in the example shown in Table 1 for all ports are:

```
configure msrp ports all traffic-class A delta-bandwidth 25
configure msrp ports all traffic-class B delta-bandwidth 25
```

Displaying AVB Information

The complete set of show commands are detailed in the *ExtremeXOS User Guide.* Some of the more commonly used commands are outlined here.

gPTP

Detailed information about gPTP can be displayed using the following set of commands:

```
show network-clock gptp …
```

For example, the `show network-clock gptp ports` command can be used to view the gPTP properties of a given port and is useful for debugging when the `summary avb` command shows that the port is not operational for gPTP.

```
# show network-clock gptp ports 1
Physical port number              : 1
gPTP port status                  : Enabled
Clock Identity                    : 00:04:96:ff:fe:51:ba:ea
gPTP Port Number                  : 1
IEEE 802.1AS Capable              : Yes
Port Role                         : 9 (Slave)
Announce Initial Interval         : 0 (1.000 secs)
Announce Current Interval         : 0 (1.000 secs)
Announce Receipt Timeout          : 3
Sync Initial Interval             : -3 (0.125 secs)
Sync Current Interval             : -3 (0.125 secs)
Sync Receipt Timeout              : 3
Sync Receipt Timeout Interval     : 375000000 ns
Measuring Propagation Delay       : Yes
Propagation Delay                 : 623 ns
Propagation Delay Threshold       : 3800 ns (auto)
Propagation Delay Asymmetry       : 0
Peer Delay Initial Interval       : 0 (1.000 secs)
Peer Delay Current Interval       : 0 (1.000 secs)
Peer Delay Allowed Lost Responses : 3
Neighbor Rate Ratio               : 1.000020
PTP Version                       : 2
```

MSRP

Detailed information about MSRP can be displayed using the following set of commands:

```
show msrp …
```

Several of the commonly used commands are:

```
show msrp
show msrp streams
show msrp listeners
show msrp streams propagation
```

Examples of these commands are shown below.

The `show msrp` command displays the summary information included in the `show avb` command, but also displays the total number of streams and reservations on the switch.

```
# show msrp
MSRP Status                    : Enabled
MSRP Max Latency Frame Size    : 1522
MSRP Max Fan-in Ports          : No limit
MSRP Enabled Ports             : *1ab     *2ab     *10ab    *11ab     12
                                  13       14       15       16        17
                                  18       19       20       21
Total MSRP streams             : 2
Total MSRP reservations        : 6

Flags:  (*) Active,                  (!) Administratively disabled,
        (a) SR Class A allowed,  (b) SR Class B allowed
```

The `show msrp streams` command displays all of the streams that the switch is aware of.

```
# show msrp streams
     Stream Id                 Destination      Port  Dec    Vid  Cls/Rn     BW
----------------------- ----------------- ---- ---- ---- ------
00:50:c2:4e:db:02:00:00  91:e0:f0:00:ce:00    1  Adv    2  A/1      6.336
Mb
00:50:c2:4e:db:06:00:00  91:e0:f0:00:0e:82    2  Adv    2  A/1      6.336
Mb

Total Streams: 2

----------------------------------------------------------------------
BW       : Bandwidth,                 Cls      : Traffic Class,
Dec      : Prop. Declaration Types,   Rn       : Rank

MSRP Declaration Types:
   Adv   : Talker Advertise,        AskFail  : Listener Asking Failed,
   Fail  : Talker Fail,             RdyFail  : Listener Ready Failed,
   Ready : Listener Ready
```

The `show msrp listeners` command displays all of the listeners the switch is aware of. If the declaration type is either Ready or RdyFail, a reservation has been made and the Stream Age will show the length of time this reservation has been active.

```
# show msrp listeners
     Stream Id                Port   Dec       Dir      State       Stream Age
                                                       App   Reg   (days, hr:mm:ss)
----------------------   -----  -------   -------   ---   ---   -----------
00:50:c2:4e:db:02:00:00      2   Ready     Ingress   VO    IN        0, 01:40:23
                            10   Ready     Ingress   VO    IN        0, 01:27:05
                            11   Ready     Ingress   VO    IN        0, 01:27:05
00:50:c2:4e:db:06:00:00      1   Ready     Ingress   VO    IN        0, 01:40:15
                            10   Ready     Ingress   VO    IN        0, 01:27:05
                            11   Ready     Ingress   VO    IN        0, 01:27:05
-----------------------------------------------------------------
App      : Applicant State,                Dec      : MSRP Declaration Types
Dir      : Direction of MSRP attributes,   Reg      : Registrar State

MSRP Declaration Types:
AskFail  : Listener Asking Failed,         RdyFail : Listener Ready Failed,
Ready    : Listener Ready

Applicant States:
   AA    : Anxious active,                 AN       : Anxious new,
   AO    : Anxious observer,               AP       : Anxious passive,
   LA    : Leaving active,                 LO       : Leaving observer,
   QA    : Quiet active,                   QO       : Quiet observer,
   QP    : Quiet passive,                  VN       : Very anxious new,
   VO    : Very anxious observer,          VP       : Very anxious passive

Registrar States:
   IN    : In - Registered,                LV       : Leaving - Timing out
   MT    : Empty - Not Registered
```

The `show msrp streams propagation` command is useful for debugging the propagation of talkers and listeners for each stream.

```
# show msrp streams propagation stream-id 00:50:c2:4e:db:02:00:00
     Stream Id                Destination        Port  Dec    Vid  Cls/Rn     BW
-----------------------   -----------------  ----  ----  ----  ------  -------
--
00:50:c2:4e:db:02:00:00  91:e0:f0:00:ce:00     1  Adv      2  A/1      6.336
Mb

    Talker Propagation:
         Ingress      Ingress       Propagated      Propagated        Egress
         DecType      Port          DecType         Ports             DecType
         -------      -------       ----------      ----------        -------
         Adv     -->      1  -->  Adv        -->          2  -->  Adv
                                                         10  -->  Adv
                                                         11  -->  Adv

    Listener Propagation:
         Egress       Egress        Propagated      Listener          Ingress
         DecType      Port          DecType         Ports             DecType
         -------      -------       ----------      ----------        -------
         Ready   <--      1  <--  Ready      <--          2  <--  Ready
                          <--  Ready      <--         10  <--  Ready
```

```
                              <--   Ready       <--         11  <--   Ready


Total Streams: 1


------------------------------------------------------------------------
BW        : Bandwidth,                 Cls       : Traffic Class,
Dec       : Prop. Declaration Types,   Rn        : Rank

MSRP Declaration Types:
   Adv   : Talker Advertise,           AskFail  : Listener Asking Failed,
   Fail  : Talker Fail,                RdyFail  : Listener Ready Failed,
   Ready : Listener Ready
```

MVRP

Other than the MVRP summary information displayed in the `show avb` command, information about dynamically created VLANs is shown using the VLAN commands as follows.

VLANs created by MVRP are named SYS_VLAN_XXXX, where XXXX is the VLAN ID. In the `show vlan` command output, the "d" flag indicates that SYS_VLAN_0002 is a dynamically created VLAN.

```
# show vlan
-------------------------------------------------------------------------------
Name            VID   Protocol Addr       Flags          Proto  Ports  Virtual
                                                                Active router
                                                                /Total
-------------------------------------------------------------------------------
Default      1     -------------------T--------------- ANY  4 /33  VR-
Default
Mgmt         4095 ------------------------------------ ANY  1 /1   VR-Mgmt
SYS_VLAN_0002 2    -------------------T------d-------- ANY  4 /4   VR-
Default
-------------------------------------------------------------------------------
Flags : (B) BFD Enabled, (c) 802.1ad customer VLAN, (C) EAPS Control VLAN,
        (d) Dynamically created VLAN, (D) VLAN Admin Disabled,
        (e) CES Configured, (E) ESRP Enabled, (f) IP Forwarding Enabled,
        (F) Learning Disabled, (i) ISIS Enabled, (I) Inter-Switch Connection
            VLAN for MLAG,
        (k) PTP Configured, (l) MPLS Enabled, (L) Loopback Enabled,
        (m) IPmc Forwarding Enabled, (M) Translation Member VLAN or
Subscriber
            VLAN,
        (n) IP Multinetting Enabled, (N) Network Login VLAN, (o) OSPF
Enabled,
        (O) Flooding Disabled, (p) PIM Enabled, (P) EAPS protected VLAN,
        (r) RIP Enabled, (R) Sub-VLAN IP Range Configured,
        (s) Sub-VLAN, (S) Super-VLAN, (t) Translation VLAN or Network VLAN,
        (T) Member of STP Domain, (v) VRRP Enabled, (V) VPLS Enabled, (W)
VPWS
            Enabled,
        (Z) OpenFlow Enabled
Total number of VLAN(s) : 3
```

Details about SYS_VLAN_0002 can be displayed using the following command:

```
# show SYS_VLAN_0002
VLAN Interface with name SYS_VLAN_0002 created dynamically
    Admin State:     Enabled     Tagging: 802.1Q Tag 2
    Description:     None
    Virtual router: VR-Default
    IPv4 Forwarding:      Disabled
    IPv4 MC Forwarding: Disabled
    IPv6 Forwarding:      Disabled
    IPv6 MC Forwarding: Disabled
    IPv6:                 None
    STPD:                  s0(Enabled)
    Protocol:           Match all unfiltered protocols
    Loopback:           Disabled
    NetLogin:           Disabled
    OpenFlow:           Disabled
    QosProfile:            None configured
    Flood Rate Limit QosProfile:       None configured
    Ports:   4.        (Number of active ports=4)
       Tag:      *1H,     *2H,    *10H,    *11H
  Flags:     (*) Active, (!) Disabled, (g) Load Sharing port
                 (b) Port blocked on the vlan, (m) Mac-Based port
                 (a) Egress traffic allowed for NetLogin
                 (u) Egress traffic unallowed for NetLogin
                 (t) Translate VLAN tag for Private-VLAN
                 (s) Private-VLAN System Port, (L) Loopback port
                 (e) Private-VLAN End Point Port
                 (x) VMAN Tag Translated port
                 (G) Multi-switch LAG Group port
                 (H) Dynamically added by MVRP
                 (U) Dynamically added uplink port
                 (V) Dynamically added by VM Tracking
```

Configuration Considerations While Using AVB

If you start with a default switch configuration and use the commands shown in "AVB Quick Start," then all of these considerations will be satisfied and you can ignore this section. However, if you are working with a more advanced configuration, some important considerations are outlined here.

MSRP Considerations

All ports connected directly to an AVB end point need to be an untagged member of VLAN Default because IEEE 1722 and IEEE 1722.1 control packets are transmitted as untagged frames. It is acceptable for VLAN Default to be tagged on trunk ports connecting switches; however, it is best to leave VLAN Default untagged on these ports as well so it can serve as the carrier VLAN for Spanning Tree. (Note: this is the default configuration.)

MVRP Considerations

• Transmit must be set to "on" for all VLAN IDs being used for AVB. (Default is ON.)

```
configure mvrp tag 2 ports all transmit on
```

• Transmit may be set to "off" for non-AVB VLAN IDs to prevent them from being propagated to the rest of the network.

AVB Scaling Considerations

By default, MSRP advertises all streams on all ports on which MSRP is enabled. This can cause scaling challenges in large networks with many streams.

Extreme provides some options to help AVB scale better in these situations; these are "Talker VLAN Pruning" and "Extended Refresh."

Talker VLAN Pruning (TVP) is similar to the Talker Pruning described in 802.1Q, except that it uses the VLAN of the stream to limit the scope of stream advertisements instead of the MAC DA. When TVP is enabled on a switch, Talker attributes are only advertised over ports that belong to the VLAN identified in the Talker attribute DataFrameParameters.

So, any attributes that contain a VLAN ID for which a port is not a member are not sent on that port. This act of limiting the distribution of information is referred to as "pruning." When used in conjunction with MVRP, the Listeners interested in a particular VLAN dynamically "join" these VLANs.

The best option is to have the listeners dynamically join the VLAN(s) of interest themselves. If the listeners cannot do this automatically, it is possible to configure the bridge edge port connecting the listeners to the network, and then the edge switch can use MVRP to advertise the VLAN into the core of the network.

Talker VLAN Puruning can be enabled on Extreme switches using the following command:

```
configure msrp talker-vlan-pruning on
```

When MSRP is advertising many streams, it is sometimes not possible to "refresh" the streams quickly enough. Extended Refresh uses a different timer behavior and Registrar State to extend the amount of time available to refresh attributes while preserving the faster reaction time when intentionally removing a stream. The Leave All mechanism is used as a "garbage collection" mechanism that adds or removes streams whose join or leave messages have been lost. This should not happen often, so it is not critical that it works quickly.

Extended refresh can be enabled on using the following command:

```
configure mrp ports all timers refresh auto-refresh
```

> **NOTE**
>
> If enough streams are being advertised that it becomes necessary to use the above option on the switches, it may also be necessary to increase the Leave All and Leave timers on the attached endpoints.

Common Mistakes to Avoid

1. Do not modify QoS Profiles being used by AVB. MSRP manages the QoS Profiles being used for AVB based on reservations, and user configuration may prevent this from working correctly.

2. Do not set the minbw on any QoS profile because it will interfere with the AVB priorities and, if set on a lower priority QoS profile, will make lower priority traffic higher priority than AVB until the minbw setting is satisfied.

```
# show qosprofile port 1 2

Port: 1
        QP1   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP6   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP7   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP8   MinBw =      0% PR    = 17088K MaxBuf =    100%

Port: 2
        QP1   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP6   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP7   MinBw =      0% MaxBw =    100% MaxBuf =    100%
        QP8   MinBw =      0% PR    =  6336K MaxBuf =    100%
```

3. Do not add a port rate limiter on AVB ports. Rate limiting and shaping are part of the auto configuration of AVB. Adding other rate limiting or shaping profiles will interfere with this auto configuration.

4. Be very careful about ACLs. ACLs are used to allow AVB frames with valid reservations onto AVB queues and to prevent other frames from getting onto these AVB queues. It may be possible to add an ACL that interferes with the existing AVB ACLs.

5. Do not change dot1p or dscp mapping to map traffic to the AVB QoS profiles. AVB is responsible for ensuring that only frames with a valid reservation are allowed on AVB

queues. If the switch is configured to send other frames to these same queues, the other frames will interfere with the AVB traffic.

6. All ports running AVB must be members of VLAN Default with Tag = 1.

   a. All ports connected to an endpoint must be untagged in VLAN Default.
   b. Default VLAN must be added to the default stpd for all ports (autobind). (This is the default configuration.)

7. Rx and Tx pause must be disabled on AVB ports per IEEE 802.1Q-2011. While not strictly allowed by IEEE 802.1Q-2011, AVB will still work if priority-based flow control (PFC) is used on non-AVB queues.

8. VLAN ID translation must not be used for AVB VLANs because it is not supported by MVRP.