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ADTRAN®

Configuration Guide

Configuring Bridging in AOS

This guide provides an overview of bridging and its operation in ADTRAN Operating System (AOS) products. Included in this guide are an overview of bridging functionality, the types of bridging supported by AOS, and how to configure AOS bridging using both the Web-based graphical user interface (GUI) and the command line interface (CLI). Also, included in this guide are bridging configuration examples and troubleshooting information.

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Bridging Overview

Traditionally, an AOS device functioning as a bridge creates a connection between two or more local area network (LAN) or wide area network (WAN) segments, and sends traffic between the network segments over the data link layer (Layer 2) of the Open Systems Interconnection (OSI) network model. AOS bridges can be either switches or routers that are configured to act as bridges. Using a bridged network can be used to connect network segments of dissimilar media and extend a broadcast domain over a WAN to a remote site.

Types of Bridging in AOS

AOS supports two main types of bridging: legacy bridging and integrated routing and bridging (IRB). The type of bridging supported by your unit is dependent upon the specific firmware used on your unit. The following sections describe the differences in the types of AOS bridging.

Legacy Bridging

Legacy bridging describes the bridging type used by AOS before the implementation of IRB. This type of bridging is generally used on AOS devices running AOS firmware prior to AOS 15. Legacy bridging is bridging between two networks. This can be used for connecting two sites that use addresses on the same network. When using legacy bridging, no traffic can be routed. If you want to bridge some traffic, and route other traffic, IRB must be used.

*To tell which version of AOS firmware is running on your unit, you can issue the **show version** command from the Enable mode in the CLI, or refer to the **System Summary** page in the GUI.*

Because legacy bridging only bridges traffic, its bridging system is simplistic. To configure legacy bridging, only the four following steps are necessary: creating a bridge group, setting a default gateway, disabling IP routing, and assigning interfaces to the bridge group (from the interface's configuration mode).

IRB

IRB can both route and bridge traffic simultaneously. IRB is available in AOS products running AOS firmware 15 or later. This type of bridging allows you to configure what type of traffic is routed, and what type of traffic is bridged. IRB applications include connections between multiple networks and situations where remote networks need to access the same subnet in bridge mode but also require access to the Internet.

There are two levels of IRB in AOS. Units running AOS firmware release 15 or later, but before AOS release 17.07.00, can be configured to use either legacy or IRB bridging. After AOS release 17.07.00, IRB is the only bridging type supported by AOS, and certain options that were previously configurable are now assumed and no longer necessary to configure.

> NOTE *ADTRAN recommends that legacy bridging be used only if you are running firmware prior to AOS release 15. If you have AOS firmware release 15 or later, it is recommended that you only use IRB.*

Because IRB encompasses both routing and bridging, its bridging system is slightly more complex than legacy bridging. IRB requires the use of a bridged virtual interface (BVI), which is the virtual interface that allows traffic from a bridge to be routed. The BVI interface is the Layer 3 interface through which IP traffic flows to the AOS unit, and it is this interface that contains the IP address for the entire group of bridged interfaces. This IP address should be configured as the default gateway for hosts on the bridged network, and can also be used to manage the AOS unit.

> NOTE *If IRB is used to pass 802.1Q encapsulated Ethernet frames, the BVI interface IP address can only be used for management of the AOS unit from the native (untagged) VLAN.*

To configure IRB when using AOS firmware prior to release 17.07.00, you must configure the bridge group, configure the IRB interface, and assign interfaces to the bridge group (in that order). When configuring IRB using AOS firmware release 17.07.00 or later, you configure the interfaces you want to bridge and configure the BVI interface (in any order).

How Bridging Functions

In all types of AOS bridging, bridged parts of the network function essentially as extended LANs through WAN connections. This functionality creates a WAN that functions as a single LAN, which connects segments of a single network. Bridges can be used to connect local networks or to connect remote networks. The following diagrams describe these connections.

Figure 1. Bridging Two Local Networks

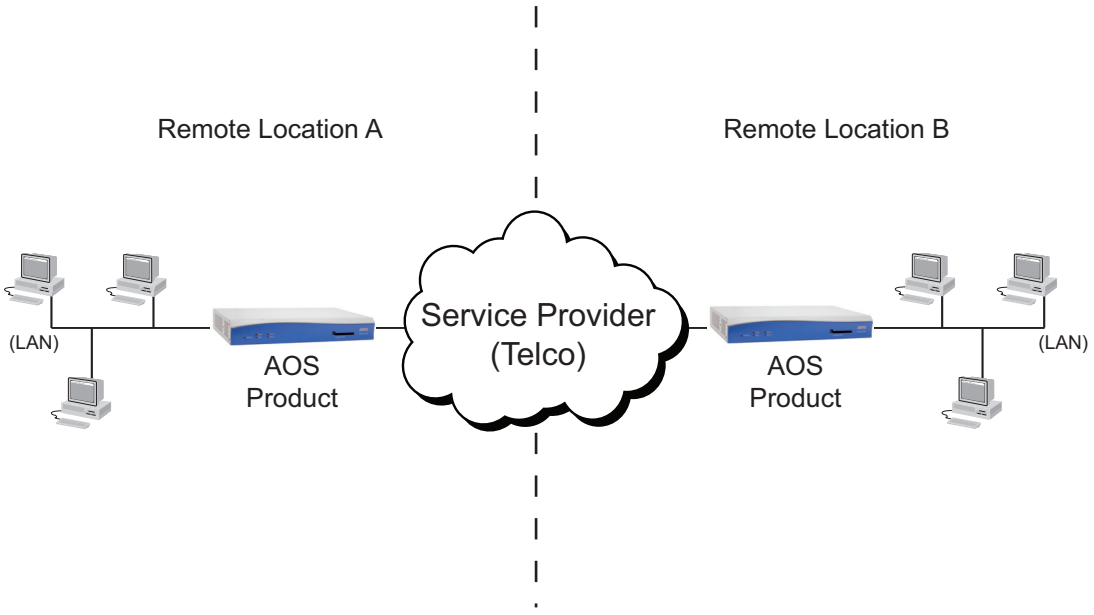


Figure 2. Bridging Two Remote Networks

Bridges function by examining and storing the source media access control (MAC) addresses of each incoming frame. This address, along with the sending interface, is stored by the bridge in the MAC address table. By storing this information, the AOS unit effectively learns how to forward traffic. When a frame arrives on a bridged interface, the source MAC address of the frame is recorded and added to the MAC address table. This table is essentially a map of which MAC addresses correspond to which interfaces. In addition to the source MAC addresses being noted, the destination MAC addresses are inspected and used to compare with MAC addresses stored in the MAC address table. If a match is found, the frame is switched out the corresponding interface to reach the intended destination MAC address. If a match is not found, the frame is flooded out all bridged interfaces except for the interface on which the frame was received.

Because bridges use MAC addresses for forwarding, each device connected by a bridge must be on the same logical network. Bridges make forwarding and filtering decisions based on these MAC addresses and upper layer protocols, such as IP, are transparent to them.

Bridge Groups

Bridge groups are necessary for bridging to function properly in AOS. A bridge group is a logical grouping of multiple physical interfaces with an AOS unit. This grouping extends a single subnet and broadcast domain to encompass the physical interfaces contained within. Bridge groups specify which interfaces are considered for bridging, and help the AOS unit know which interfaces to consider when forwarding bridge traffic.

Bridging and VLANs

Both legacy bridging and IRB can support the forwarding of virtual local area network (VLAN) traffic over the bridge link. Each AOS unit can pass 802.1Q VLAN tagged traffic, allowing multiple VLANs to pass across the bridged interface.

VLAN traffic can be passed in one of two ways. Each interface added to the bridge group is allowed to pass VLAN traffic transparently. This is done from the interface's configuration mode with an additional CLI command after the interface has already been added to the bridge group. In addition, VLAN interfaces themselves can be added to a bridge group and thus pass VLAN traffic. For more information about configuring bridge groups to pass VLAN traffic, refer to *Configuring Legacy Bridging Using the CLI on page 11*.

Common Applications of Bridging

The most common applications of the bridging feature are to transmit non-IP traffic and to merge two remote networks. An AOS product only routes IP traffic, and if one or more of the networks in a WAN uses a different Layer 3 protocol, the router must be configured to bridge this traffic. In this case, the traffic is simply passed through the interfaces in the bridge group without the router examining or modifying the Layer 3 header. Layer 3 protocols that must be bridged include: NetBIOS, IPX, AppleTalk, and DecNet.

When you are merging two remote networks, bridges are used to extend a LAN through WAN connections. The distance between the bridges does not matter; they connect segments of a single network.

Hardware and Software Requirements and Limitations

Certain types of bridging are available depending on the AOS unit and the firmware used. Legacy bridging is available on supported AOS units running firmware prior to release 17.07.00. IRB is available on supported AOS units running firmware release 15.00.00 or later. In AOS firmware release 17.07.00, IRB is the only bridging type supported. For more details and an exact listing of the types of bridging supported by particular AOS platforms, refer to the *Product Feature Matrix* available online at http://kb.adtran.com (article number 2272).

Legacy bridging is only available in AOS units running firmware prior to AOS release 17.07.00. However, ADTRAN recommends that legacy bridging not be used if you are running firmware that supports IRB (AOS firmware release 15.00 or later).

VLAN Transparency Support

VLAN transparency support for particular interfaces is also determined by AOS firmware. To use VLAN transparency on a Point-to-Point Protocol (PPP) interface, you must have AOS firmware release 12 or later. To use VLAN transparency on a Frame Relay or High-level Data Link Control (HDLC) interface, you must have AOS firmware release 14 or later.

Bridging Protocol

AOS bridging uses only the IEEE protocol to bridge traffic.

Bridging and IP Routing

AOS devices cannot both route and bridge IP traffic on the same subnet when using legacy bridging. When using legacy bridging to join two sites using addresses on the same network, IP routing must be disabled. IRB, however, routes or bridges depending on the location of the destination and the traffic type. For IP traffic, an IRB bridge acts like a Layer 2 switch with a router connected via the BVI interface. Non-IP traffic cannot be routed and is only bridged.

When configuring bridging, each bridge group must have only one IP address for the entire group of interfaces. In legacy bridging, the same IP address is assigned to all interfaces in the bridge group. In IRB, the BVI interface keeps the IP address, and all other interfaces in the bridge group must have the IP address removed.

Bridging and Interfaces

The following interfaces support bridging in AOS products:

- VLAN interfaces
- Ethernet interfaces
- PPP interfaces (but does not support spanning tree)
- Frame Relay interfaces
- HDLC interfaces
- Asynchronous Transfer Mode (ATM) interfaces

BVI Interface

BVI interfaces are created prior to creating a bridge group. BVI interfaces are attached to specific bridge groups, so when creating a BVI interface you should use the same identifier for the BVI interface and the bridge group. The BVI interface number always corresponds to the bridge group to which the BVI interface is attached.

Bridge Ports

When a port is in a bridge group, it cannot be assigned an IP address. Attempting to do so results in an error message. In AOS firmware release 17.07.00 or later, if a port has an IP address, it cannot be placed in a bridge group. The IP address must be removed from the port before the port can be added to a bridge group.

VLAN Interface Support

VLAN interfaces can be directly added to a bridge group. When VLAN interfaces are added to the bridge group in AOS switch/routers, the spanning tree instance for the bridge group is deleted and the ports in the bridge group are managed by the spanning tree instance that manages the switch. If a bridge is in this state, and the VLAN is removed so that no VLAN is part of the bridge, the ports on the bridge are disconnected from the switch spanning tree instance and are attached to a new instance of spanning tree dedicated to the bridge group.

Configuring Legacy Bridging Using the GUI

Configuring legacy bridging requires the completion of the following tasks:

- Creating a bridge group
- Assigning interfaces to the bridge group
- Disabling IP routing

> *Legacy bridging is only available in AOS units running firmware prior to AOS release 17.07.00. However, ADTRAN recommends that legacy bridging not be used if you are running firmware that supports IRB (AOS firmware release 15.00 or later).*

To configure legacy bridging using the GUI, follow these steps:

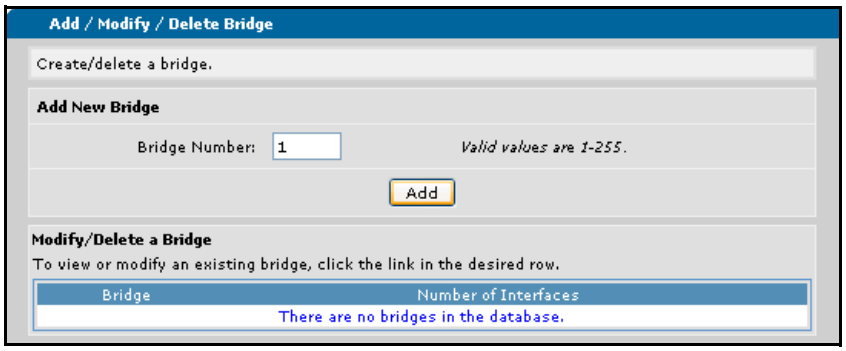
1. Open a new Web page in your Internet browser.
2. Enter your AOS product's IP address in the Internet browser's address field in the following form: **http://**<*ip address*>. For example:

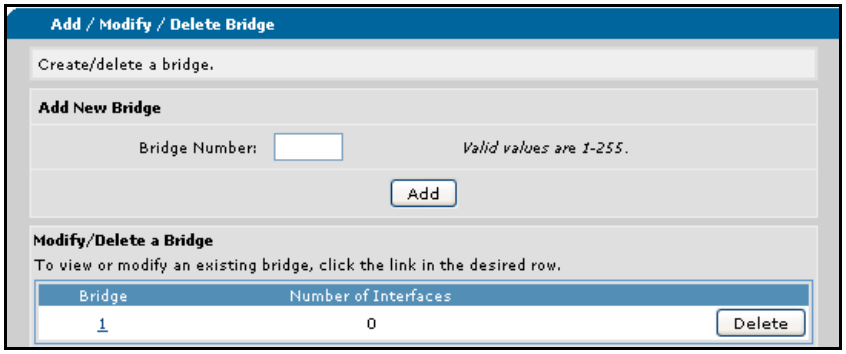
   http://65.162.109.200
3. At the prompt, enter your **User name** and **Password** and select **OK**.

> *The default user name is **admin** and the default password is **password**.*

4. Navigate to **Router/Bridge** > **Bridging**.

5. Create the bridge group by entering the bridge group number in the **Bridge Number** field and selecting **Add**. Bridge group numbers are the unique identifier for the bridge group, and can be any number between **1** and **255**. Once the group is created, it appears in the list of created bridge groups.





If you are using AOS firmware 15.00 or later, you will see this message:

Bridge has been created. However, if you would like to configure an IP address for this bridge interface, you must first enable IRB. To do so, click on the Back button and enable IRB.

For more information about enabling IRB and IRB configuration, refer to *Configuring IRB Using the GUI (prior to AOS 17.07.00) on page 13*.

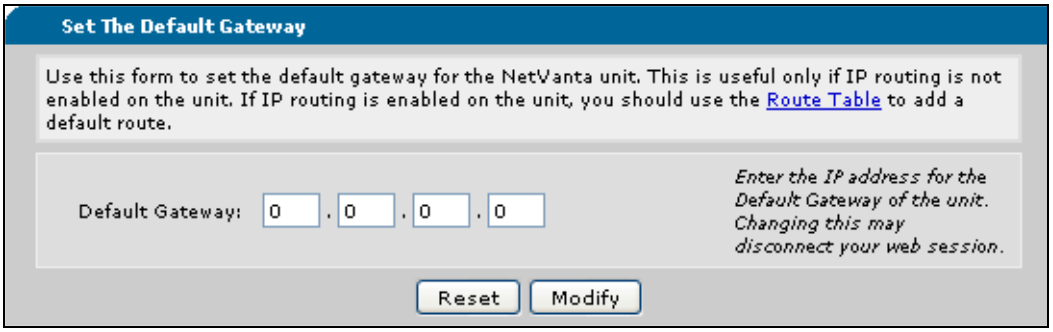
If you are using AOS firmware prior to AOS release 15.00, you will see this warning:

The IP address cannot be assigned until the following steps are completed. Each step has a link that needs to be configured.
WARNING: Not following the steps in the sequence listed may result in loss of your HTTP and telnet connection.

Step 1 - Configure the IP address for the 'Default Gateway' of the unit.
Step 2 - Disable 'IP Routing'.
Step 3 - On the 'Bridging' page, assign the required interfaces to the bridge. Once the configuration is applied, there may be a slight delay in accessing the unit.

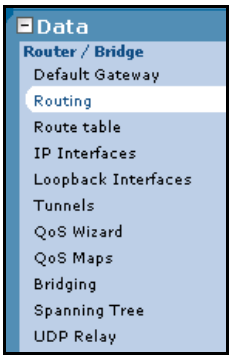
You should follow the steps as outlined in the message, and then move on to Step 6 of this configuration process.

6. Create a default gateway. You can access the default gateway by navigating to **Data** > **Router/Bridge** > **Default Gateway**. Enter the IP address of the default gateway and select **Modify**.

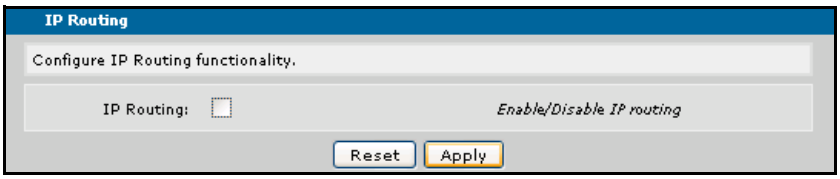


If you are disconnected with the unit after changing the default gateway, reconnect using the instructions on page 7.

7. AOS devices using legacy bridging cannot both route and bridge IP traffic on the same subnet. Therefore, IP routing must be disabled so the unit can act as a remote bridge to join two sites using addresses on the same network. To disable IP routing, navigate to **Data** > **Router/Bridge** and select **Routing**.



Next, deselect the **IP Routing** check box and select **Apply**.



8. Next, add interfaces to the bridge group.

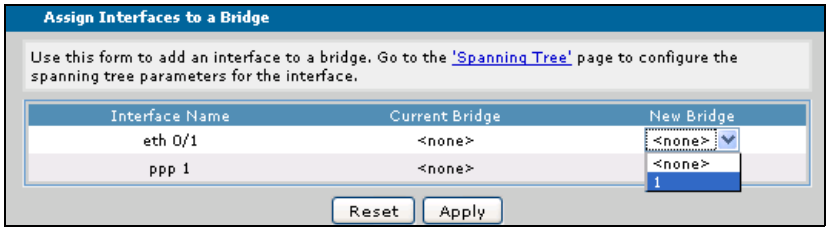
> *Only one interface in the bridge group should have an IP address. All IP addresses should be removed from other interfaces before configuring the bridge group. You can remove IP addresses from an interface by navigating to **Data** > **IP Interfaces** and selecting the interface from the list. Scroll down the resulting interface configuration to find the **IP Settings** section and then change the **Address Type** to **None** using the drop-down menu. After selecting the **Apply** button, the IP address is removed from the interface. Repeat this process to remove all IP addresses from the necessary interfaces.*

Interfaces added to the bridge group should include at least one LAN and one WAN interface. LAN interfaces include Ethernet or VLAN interfaces, and WAN interfaces include PPP interfaces, HDLC interfaces, Frame Relay subinterfaces, and ATM subinterfaces.

If the WAN interfaces do not yet exist, they will need to be created and cross-connected to the corresponding physical interface. This can be accomplished by navigating to **System** > **Physical Interfaces**, selecting the appropriate Layer 1 interface (T1, Serial, etc.), configuring the necessary parameters, selecting the appropriate encapsulation (PPP, Frame Relay, or HDLC), and selecting **Apply**. Next, change the IP address type to **None** by selecting it from the drop-down menu in the **IP Settings** menu that appears and then select **Apply**.

> *All Ethernet interfaces being bridged should be assigned to the same bridge group. If the AOS device is bridging to more than one remote site, all applicable WAN interfaces should be assigned to the bridge group.*

Add the necessary interfaces to the bridge group by selecting the appropriate interfaces from the drop-down list in the **Assign Interfaces to a Bridge** dialog box.



In this case, both the **eth 0/1** and **ppp 1** interfaces are added to the bridge group so that one LAN and one WAN interface are in the group. When you have assigned the appropriate interfaces to the appropriate bridge group (in this case, **1**), select **Apply**.

Every host in a bridged network must be on the same subnet. If you want to bridge traffic between hosts on multiple subnets, you should change the subnet mask so that all hosts are on the same subnet. You can do this by navigating to ***Data*** *>* ***Router/Bridge*** *>* ***IP Interfaces*** *and selecting the interface from the list. Scroll down the resulting interface configuration to find the* ***IP Settings*** *section and then change the* ***Subnet Mask*** *field to the appropriate subnet. After selecting the* ***Apply*** *button, the IP address is updated with the new subnet mask.*

Alternatively, you can enable a different bridge group on each Ethernet interface connecting to a different subnet. However, if you use this method, be aware that these subnets will not communicate with each other.

If you want to include VLAN tagged traffic in the bridge link, you can optionally configure the bridge group to include this traffic using the ***bridge-group*** *<number>* ***vlan-transparent*** *command in the CLI from the interface's configuration mode. Refer to the command* ***bridge-group*** *<number>* ***vlan-transparent*** *on page 13 for more information.This option is not available in the GUI; it must be entered in the CLI.*

9. Verify that the MTU of the PPP interface is set to **1520**. Depending on your version of code and/or your platform, this value may differ. Navigate to **IP Interfaces** > **PPP Interface** and verify the MTU is value **1520**. Once the correct value is entered, select **Apply**.
10. Legacy bridging is now configured, and you should save the configuration by selecting **Save** from the top right of the GUI.

Configuring Legacy Bridging Using the CLI

Configuring legacy bridging requires the completion of the following tasks:

- Setting the IP default gateway
- Removing extra IP addresses from bridged interfaces and/or create interfaces to be placed in the bridge group
- Disabling IP routing
- Creating a bridge group
- Assigning interfaces to the bridge group

Legacy bridging is only available in AOS units running firmware prior to AOS release 17.07.00. However, ADTRAN recommends that legacy bridging not be used if you are running firmware that supports IRB (AOS firmware release 15 or later).

To configure legacy bridging using the CLI, follow these steps:

1. Set the IP default gateway using the **ip default-gateway** <*ip address*> command from the Global Configuration mode prompt. IP addresses are expressed in dotted decimal notation. For example, **192.168.4.1**. Enter the command as follows:

   (config)**#ip default-gateway 192.168.4.1**

2. Remove extra IP addresses from the WAN interfaces that are to be bridged, or create the interfaces if you have not already done so. To remove an IP address, enter the interface's configuration mode and use the **no ip address** command. Alternatively, you can create the WAN interfaces that you want to bridge without an IP address by entering the interface's configuration mode and including the **no ip address** command in the interface's configuration. For example, the following command creates and configures the PPP interface without an IP address:

   (config)**#interface ppp 1**
   (config-ppp 1)**#no ip address**

   *If you are creating a new interface, the **cross-connect** command might also be required in order to associate the Layer 2 interface with a Layer 1 WAN interface. For example:*
   (config-ppp 1)**#cross-connect 1 t1 1/1 1 ppp 1**

3. Disable IP routing. IP routing must be disabled because the AOS unit cannot route and bridge traffic when legacy bridging is used. To disable IP routing, enter the **no ip routing** command from the Global Configuration mode. For example:

   (config)**#no ip routing**

4. Create a bridge group using the **bridge** <*number*> **protocol ieee** command from the Global Configuration mode prompt. The <*number*> parameter specifies the unique identifier for the bridge group and can be a number between **1** and **255**. The **protocol ieee** parameter specifies that the IEEE protocol is used by the bridge group. IEEE is the only bridging protocol supported by AOS products. To create a bridge group, enter the command as follows:

   (config)**#bridge 1 protocol ieee**

   Using the **no** form of this command in legacy bridging removes the specified bridge group.

5. After creating the bridge group, you must assign interfaces to the bridge group. Before adding interfaces to the bridge group, you should make sure only one interface you are adding has an IP address. If you did not leave an IP address assigned to at least one interface in the bridge group, you will have to add it to one using the **ip address** <*ip address*> command from the interface's configuration mode. This address should then be copied into each interface that will be part of the bridge group. Once you have configured the IP address for one of the interfaces you intend to add to the bridge group, and removed the IP address from all of the other interfaces that will also be in the bridge group, use the **bridge-group** <*number*> command from the interface configuration mode to assign the interface to the appropriate bridge group. The <*number*> parameter indicates the bridge group to which you are adding the interface. For example, to add the Ethernet interface to bridge group **1**, enter the command as follows:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#bridge-group 1**

If you want to include VLAN tagged traffic in the bridge link, you must place the applicable WAN and LAN interfaces in the appropriate bridge group and then configure the interfaces in VLAN transparent mode. To add an interface in VLAN transparent mode, enter the **bridge-group** <*number*> command from the interface configuration mode prompt and then enter the **bridge-group** <*number*> **vlan-transparent** command. Using the **no** form of the **bridge-group** <*number*> **[vlan-transparent]** command in legacy bridging removes the interface from the bridge group. For example, the following commands configure the eth 0/1 interface for VLAN transparent bridging:

```
(config)#interface eth 0/1
(config-eth 0/1)#bridge-group 1
(config-eth 0/1)#bridge-group 1 vlan-transparent
```

*When passing VLAN tagged traffic over a bridged PPP link, the link must be negotiated in Bridging Control Protocol (BCP). The command **ppp bcp tagged-frame** must be issued with the **bridge-group** <number> and **bridge-group** <number> **vlan-transparent** commands from the PPP Interface Configuration mode. For example:*

```
(config)#interface ppp 1
(config-ppp 1)#bridge-group 1
(config-ppp 1)#bridge-group 1 vlan-transparent
(config-ppp 1)#ppp bcp tagged-frame
```

When using the **bridge-group** <*number*> **vlan-transparent** command, the MTU of the WAN interface should be set to **1524** to account for the 4 extra bytes of overhead contained in an 802.1Q tagged Ethernet frame. This happens automatically on PPP interfaces starting with AOS firmware release 16.01.00.

Repeat Step 5 for each interface you want to add to the bridge group.

Configuring IRB Using the GUI (prior to AOS 17.07.00)

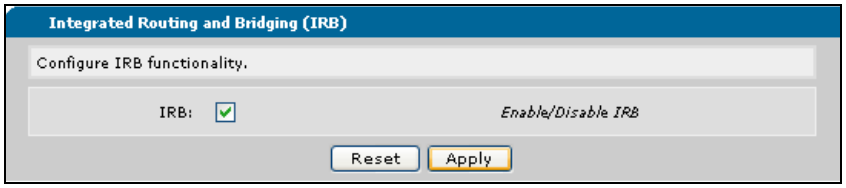
Configuring IRB in AOS firmware releases prior to 17.07.00 requires the completion of the following tasks:

- Enabling IRB
- Configuring the BVI interface
- Configuring a bridge group
- Assigning interfaces to the bridge group

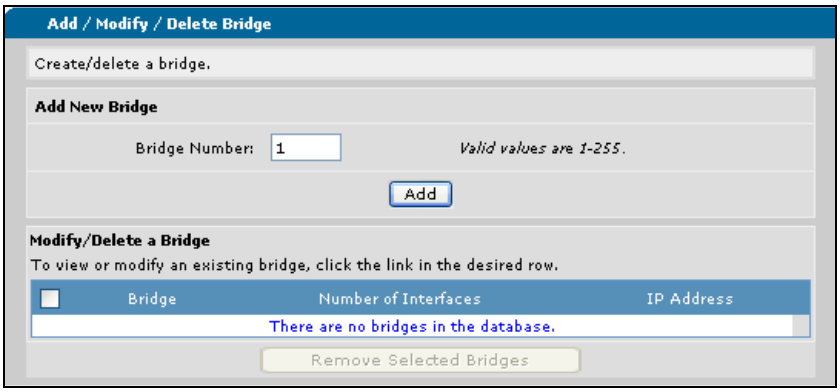
To configure IRB using the GUI, follow these steps:

1. Connect to the GUI and navigate to **Router/Bridge** > **Bridging**.

2. Enable IRB by checking the **IRB** check box and selecting **Apply**.



3. Create the bridge group by entering the bridge group number in the **Bridge Number** field and selecting **Add**.

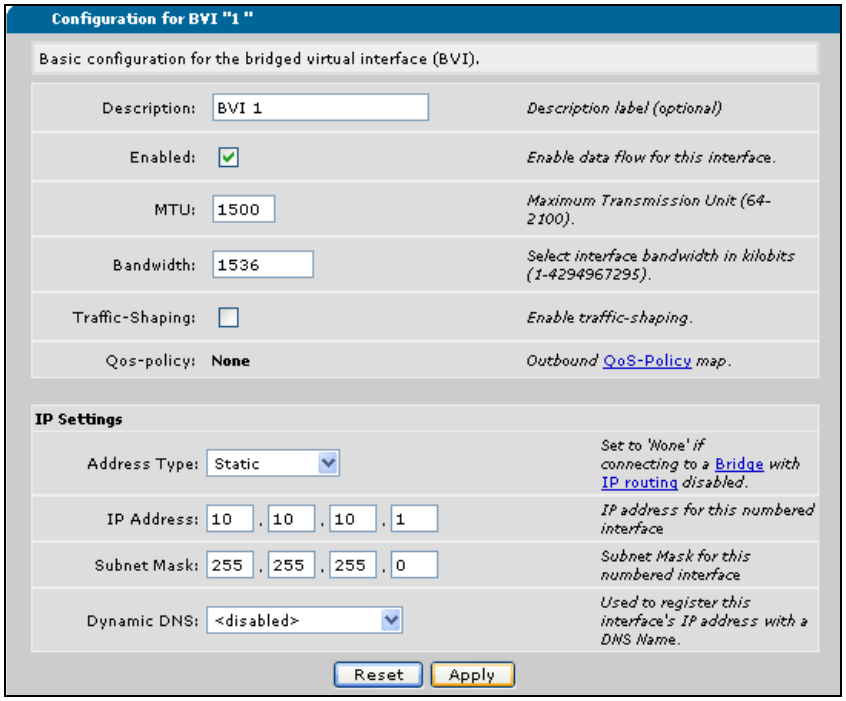


4. After adding the bridge group, the router will automatically direct you to the BVI interface configuration menu. Configure the BVI interface by enabling the interface, specifying the maximum transmission unit (MTU), the interface bandwidth, and whether or not traffic shaping will be used. MTU range is **64** to **2100**, with a default value of **1500**. Bandwidth range is **1** to **4294967295** kilobits, with a default value of **1536000** kb. By default, traffic shaping is disabled.

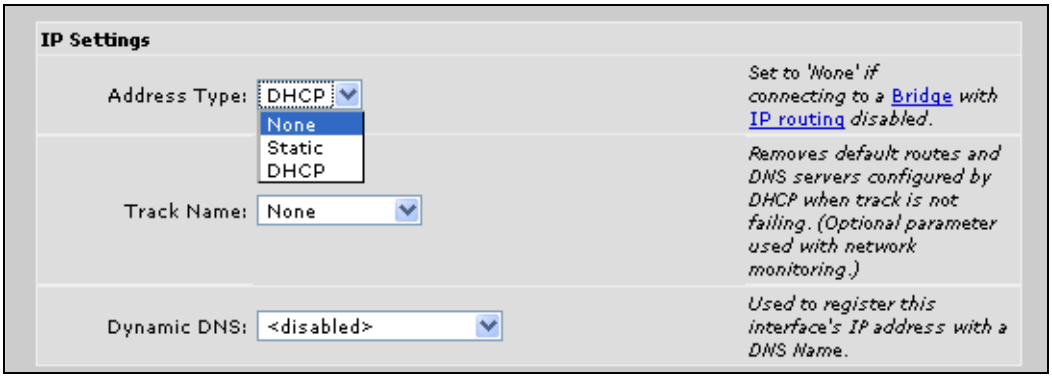
   You can then specify the IP address type used by the bridge by selecting from the drop-down menu. Choices include **None**, **Static**, **Unnumbered**, and **Negotiated** addresses. For basic bridging, select **Static**. You will then be prompted to enter the IP address and subnet mask for the bridge (remember, the BVI interface holds the IP address for the bridge group). This IP address should be configured as the default gateway for hosts on the bridged network, and can also be used to manage the AOS unit.

> **NOTE** *If IRB is used to pass 802.1Q encapsulated Ethernet frames, the BVI interface IP address can only be used for management of the AOS unit from the native (untagged) VLAN.*

If you are going to use a dynamic domain name server (DNS), make the appropriate selection from the drop-down menu. By default, dynamic DNS is disabled. Dynamic DNS is not necessary for basic bridging configurations. Once you have entered all the parameters, select **Apply**.



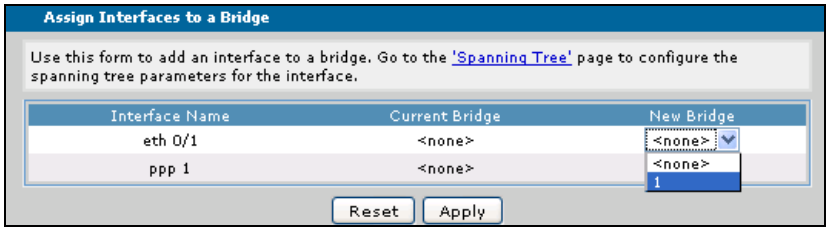
5. After you have configured the BVI interface, you must remove all IP addresses from any interfaces you will be adding to the bridge group before you configure the bridge group. None of the interfaces in the bridge group should have an IP address. You can remove IP addresses from an interface by navigating to **Data** > **Router/Bridge** > **IP Interfaces** and selecting the interface from the list. The interface configuration menu appears. Scroll to the **IP Settings** section and change the **Address Type** to **None** using the drop-down menu. After selecting **Apply**, the IP address is removed from the interface. Repeat this process to remove all IP addresses from the necessary interfaces (the BVI interface is the only interface that should have an IP address assigned).



6. After you have removed all necessary IP addresses, return to the main bridging menu (**Data** > **Router/Bridge** > **Bridging**) and apply the appropriate interfaces to the bridge group. Interfaces added to the bridge group should include at least one LAN and one WAN interface. LAN interfaces include Ethernet or VLAN interfaces, and WAN interfaces include PPP interfaces, HDLC interfaces, Frame Relay subinterfaces, and ATM subinterfaces.

> NOTE *If the AOS device is bridging between multiple devices, the Ethernet interfaces for each device should be assigned to the bridge group. If the AOS device is bridging to more than one remote site, all applicable WAN interfaces should be assigned to the bridge group.*

Add the necessary interfaces to the bridge group by selecting the appropriate interfaces from the drop-down list in the **Assign Interfaces to a Bridge** dialog box.



In this case, both the **eth 0/1** and **ppp 1** interfaces are added to the bridge group so that one LAN and one WAN interface are in the group. When you have assigned the appropriate interfaces to the appropriate bridge group (in this case, **1**), select **Apply**.

> NOTE *Every host in a bridged network must be on the same subnet. If you want to bridge traffic between hosts on multiple subnets, you should change the subnet mask so that all hosts are on the same subnet. You can do this by navigating to **Data** > **Router/Bridge** > **IP Interfaces** and selecting the interface from the list. Scroll down the resulting interface configuration to find the **IP Settings** section and then change the **Subnet Mask** field to the appropriate subnet. After selecting the **Apply** button, the IP address is updated with the new subnet mask.*
>
> *Alternatively, you can enable a different bridge group on each Ethernet interface connecting to a different subnet. However, if you use this method, be aware that these subnets will not communicate with each other.*

> NOTE *If you want to include VLAN tagged traffic in the bridge link, you can optionally configure the bridge group to include this traffic using the **bridge-group** <number> **command** in the CLI from the interface's configuration mode. Refer to the **bridge-group** <number> **vlan-transparent** command on page 13 for more information. This option is not available in the GUI; it must be entered in the CLI.*

7. Save your configuration by selecting **Save** from the top right of the GUI.

Configuring IRB Using the CLI (prior to AOS 17.07.00)

Configuring IRB in AOS firmware release prior to 17.07.00 requires the completion of the following tasks:

- Enabling IRB
- Configuring the bridge group
- Configuring the BVI interface
- Removing IP addresses from all interfaces that will be added to the bridge group
- Assigning interfaces to the bridge group

To configure IRB using the CLI, follow these steps:

1. Enable IRB using the **bridge irb** command from the Global Configuration mode prompt. Enter the command as follows:

   (config)**#bridge irb**

   Use the **no** form of this command to disable IRB.

2. Create a bridge group using the **bridge** <*number*> **protocol ieee** command from the Global Configuration mode prompt. The <*number*> parameter specifies the unique identifier for the bridge group and can be a number between **1** and **255**. The **protocol ieee** parameter specifies that the IEEE protocol is used by the bridge group. IEEE is the only bridging protocol supported by AOS products. To create a bridge group, enter the command as follows:

   (config)**#bridge 1 protocol ieee**

   Using the **no** form of this command in firmware prior to AOS 17.07.00 removes the specified bridge group.

3. Enter the BVI interface configuration mode using the **interface bvi** <*number*> command from the Global Configuration mode prompt. The <*number*> parameter is the bridge group number, and it must match the bridge group number you are working with. The number that you specify causes the BVI interface to be associated with all physical interfaces assigned to that bridge group. To enter the BVI Interface Configuration mode, enter the command as follows:

   (config)**#interface bvi 1**
   (config-bvi 1)**#**

   Use the **no** form of this command to remove the association between the BVI interface and the specified bridge group.

4. While in the BVI Interface Configuration mode, specify the IP address and subnet mask for the interface (and subsequently the bridge group) using the **ip address** <*ip address*> <*subnet mask*> command. IP addresses are expressed in dotted decimal notation. For example, **10.10.10.1**. Subnet masks can be expressed in dotted decimal notation (for example, **255.255.255.0**) or as a prefix length (for example, **/24**). Also, enable the interface by using the **no shutdown** command. Enter the commands as follows:

   (config-bvi 1)**#ip address 10.10.10.1 255.255.255.0**
   (config-bvi 1)**#no shutdown**

This IP address should be configured as the default gateway for hosts on the bridged network, and can also be used to manage the AOS unit.

> NOTE *If IRB is used to pass 802.1Q encapsulated Ethernet frames, the BVI interface IP address can only be used for management of the AOS unit from the native (untagged) VLAN.*

Using the **no** form of the **ip address** command removes that IP address from the BVI interface and the bridge group.

5. After creating the bridge group, you must make sure none of the interfaces you are adding has an IP address. You can remove IP addresses from interfaces by issuing the **no ip address** command from the interface's configuration mode. For example, to remove the IP address from the eth 0/1 interface, enter the command as follows:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#no ip address**

   Repeat this process for each interface you intend to add to the bridge group.

   Alternatively, you can create the WAN interfaces that you want to bridge without an IP address by entering the interface's configuration mode and including the **no ip address** command in the interface's configuration. For example, the following command creates and configures the PPP interface without an IP address:

   (config)**#interface ppp 1**
   (config-ppp 1)**#no ip address**

> NOTE *If you are creating a new interface, the **cross-connect** command might also be required in order to associate the Layer 2 interface with a Layer 1 WAN interface. For example:*
> (config-ppp 1)**#cross-connect 1 t1 1/1 1 ppp 1**

6. Once you have removed the IP address from all of the interfaces that will be in the bridge group, use the **bridge-group** <*number*> command from the interface configuration mode to assign the interface to the appropriate bridge group. The <*number*> parameter indicates the bridge group to which you are adding the interface. For example, to add the Ethernet interface to bridge group **1**, enter the command as follows:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#bridge-group 1**

   If you want to include VLAN tagged traffic in the bridge link, you must place the applicable WAN and LAN interfaces in the appropriate bridge group and then configure the interfaces in VLAN transparent mode. To add an interface in VLAN transparent mode, enter the **bridge-group** <*number*> command from the interface configuration mode prompt and then enter the **bridge-group** <*number*> **vlan-transparent** command. Using the **no** form of the **bridge-group** <*number*> **[vlan-transparent]** command in legacy bridging removes the interface from the bridge group. For example, the following commands configure the eth 0/1 interface for VLAN transparent bridging:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#bridge-group 1**
   (config-eth 0/1)**#bridge-group 1 vlan-transparent**

When passing VLAN tagged traffic over a bridged PPP link, the link must be negotiated in BCP. The command ***ppp bcp tagged-frame*** *must be issued with the* ***bridge-group*** *<number> and* ***bridge-group*** *<number>* ***vlan-transparent*** *commands from the PPP Interface Configuration mode. For example:*

(config)**#interface ppp 1**
(config-ppp 1)**#bridge-group 1**
(config-ppp 1)**#bridge-group 1 vlan-transparent**
(config-ppp 1)**#ppp bcp tagged-frame**

When using the **bridge-group** <*number*> **vlan-transparent** command, the MTU of the WAN interface should be set to **1524** (using the **mtu** <*value*> command from the interface's configuration mode) to account for the 4 extra bytes of overhead contained in an 802.1Q tagged Ethernet frame. This happens automatically on PPP interfaces starting with AOS firmware release 16.01.00. To change the MTU value, enter the command as follows:

(config)**#interface ppp 1**
(config-ppp 1)**#mtu 1524**

Repeat Step 5 for each interface you want to add to the bridge group.

Configuring IRB Using the GUI (later than AOS 17.07.00)

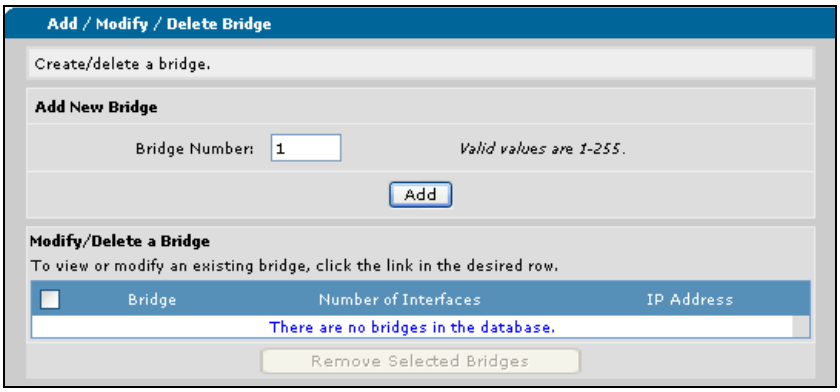
Configuring IRB in AOS firmware releases later than 17.07.00 requires the completion of the following tasks:

- Creating a bridge group
- Configuring the BVI interface
- Assigning interfaces to the bridge group

To configure IRB using AOS firmware 17.07.00 or later using the GUI, follow these steps:

1. Connect to the GUI and navigate to **Data** > **Router/Bridge** > **Bridging**.

2. Create the bridge group by entering the bridge group number in the **Bridge Number** field and selecting **Add**. Bridge group numbers are the unique identifier for the bridge group, and can be any number between **1** and **255**. Once the group is created, it appears in the list of created bridge groups.



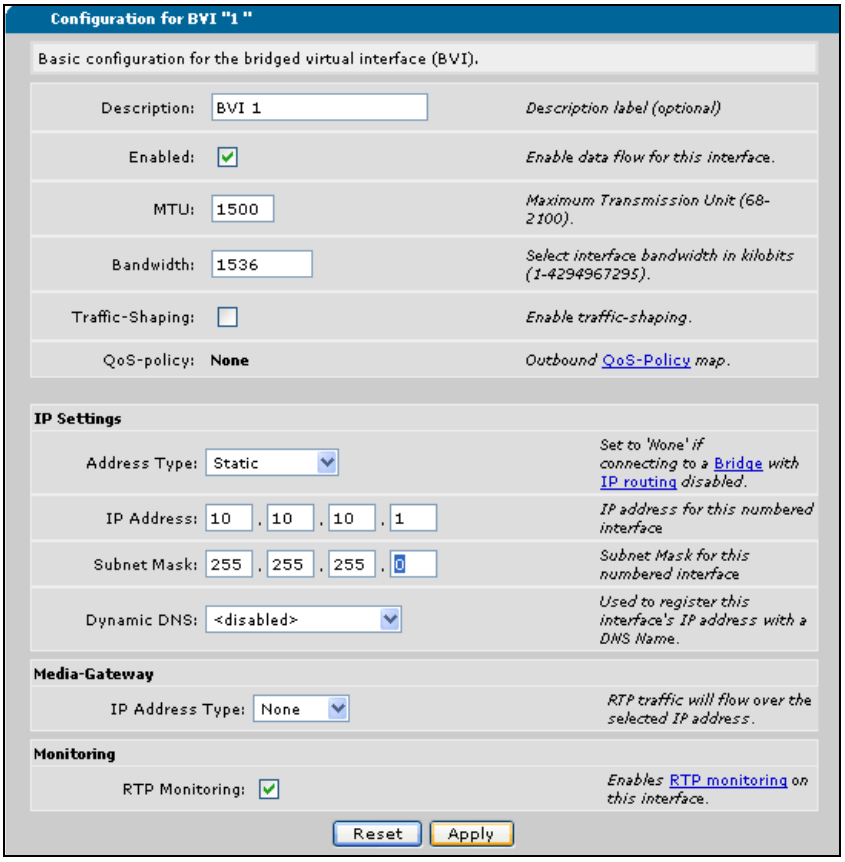
3. After adding the bridge group, the router will automatically direct you to the BVI interface configuration menu. Configure the BVI interface by enabling the interface, specifying the MTU, the interface bandwidth, and whether or not traffic shaping will be used. MTU range is **64** to **2100**, with a default value of **1500**. Bandwidth range is **1** to **4294967295** kilobits, with a default value of **1536** Kb. By default, traffic shaping is disabled.

   You can then specify the IP address type used by the bridge by selecting from the drop-down menu. Choices include **None**, **Static**, **Unnumbered**, and **Negotiated** addresses. For basic bridging, select **Static**. You will then be prompted to enter the IP address and subnet mask for the bridge (remember, the BVI interface holds the IP address for the bridge group). This IP address should be configured as the default gateway for hosts on the bridged network and can also be used to manage the AOS unit.

> NOTE *If IRB is used to pass 802.1Q encapsulated Ethernet frames, the BVI interface IP address can only be used for management of the AOS unit from the native (untagged) VLAN.*

   If you are going to use a dynamic DNS, make the appropriate selection from the drop-down menu. By default, dynamic DNS is disabled. Dynamic DNS is not necessary for basic bridging configurations.

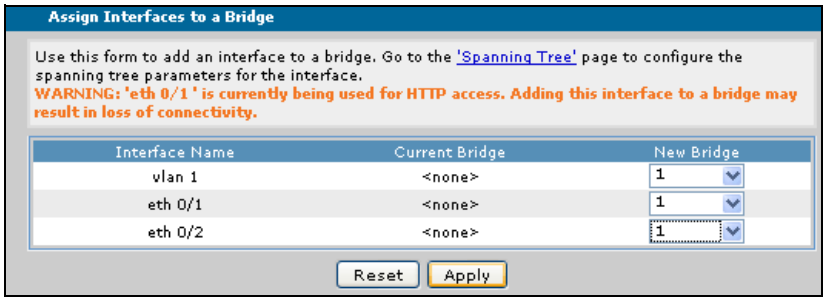
Once you have entered all the parameters, select **Apply**.



4. After you have configured the BVI interface, return to the main bridging menu (**Data** > **Routing/Bridge** > **Bridging**) and apply the appropriate interfaces to the bridge group. Interfaces added to the bridge group should include at least one LAN and one WAN interface. LAN interfaces include Ethernet interfaces, and WAN interfaces include PPP interfaces, HDLC interfaces, Frame Relay subinterfaces, and ATM subinterfaces.

> NOTE
>
> *If the AOS device is bridging between multiple devices, the Ethernet interfaces for each device should be assigned to the bridge group. If the AOS device is bridging to more than one remote site, all applicable WAN interfaces should be assigned to the bridge group.*

Add the necessary interfaces to the bridge group by selecting the appropriate interfaces from the drop-down menu in the **Assign Interfaces to a Bridge** dialog box.



When you have assigned the appropriate interfaces to the appropriate bridge group (in this case, **1**), select **Apply**.

5. Save your configuration by selecting **Save** from the top right of the GUI.

Configuring IRB Using the CLI (later than AOS 17.07.00)

Configuring IRB in AOS firmware releases later than 17.07.00 and later requires the completion of the following tasks:

- Configuring the BVI interface
- Assigning interfaces to the bridge group

To configure IRB using the CLI, follow these steps:

1. In AOS firmware 17.07.00 and later, configuring the BVI interface automatically creates a bridge group, and removes the need for the **bridge** <*number*> **protocol ieee** command. IRB is also the only option for bridging protocol, so there is no need to enter the **bridge irb** command. So, to begin configuring bridging in this, or later, versions of AOS firmware, enter the **interface bvi** <*number*> command from the Global Configuration mode prompt. The <*number*> parameter is the bridge group number, and automatically creates the group when it is entered in the BVI Interface Configuration mode. To enter the BVI Interface Configuration mode and create a bridge group **3**, enter the command as follows:

   (config)**#interface bvi 3**
   2009.11.17 14:43:41 BRIDGE.Interface NOTE: A BVI MAC address of 00:00:00:00:02:50 has been chosen for Bridge Group 3 since there is no mac address associated with the selected interface. Please make sure this is unique.
   (config-bvi 3)#

2. While in the BVI Interface Configuration mode, specify the IP address and subnet mask for the interface (and subsequently the bridge group) using the **ip address** <*ip address*> <*subnet mask*> command. IP addresses are expressed in dotted decimal notation. For example, **10.10.10.1**. Subnet masks can be expressed in dotted decimal notation (for example, **255.255.255.0**) or as a prefix length (for example, **/24**). Also, enable the interface by using the **no shutdown** command. Enter the commands as follows:

   (config-bvi 3)**#ip address 10.10.10.1 255.255.255.0**
   (config-bvi 3)**#no shutdown**

Using the **no** form of the **ip address** command removes that IP address from the BVI interface and the bridge group.

3. You must make sure none of the interfaces you will be adding to the bridge group have an IP address. You can remove IP addresses from interfaces by issuing the **no ip address** command from the interface's configuration mode. For example, to remove the IP address from the eth 0/1 interface, enter the command as follows:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#no ip address**

   Repeat this process for each interface you intend to add to the bridge group.

   Alternatively, you can create the WAN interfaces that you want to bridge without an IP address by entering the interface's configuration mode and including the **no ip address** command in the interface's configuration. For example, the following command creates and configures the PPP interface without an IP address:

   (config)**#interface ppp 1**
   (config-ppp 1)**#no ip address**

   *If you are creating a new interface, the **cross-connect** command might also be required in order to associate the Layer 2 interface with a Layer 1 WAN interface. For example:*
   (config-ppp 1)**#cross-connect 1 t1 1/1 1 ppp 1**

4. Once you have removed the IP address from all of the interfaces that will be in the bridge group, use the **bridge-group** <*number*> command from the interface configuration mode to assign the interface to the appropriate bridge group. The <*number*> parameter indicates the bridge group to which you are adding the interface. For example, to add the Ethernet interface to bridge group **1**, enter the command as follows:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#bridge-group 1**

   If you want to include VLAN tagged traffic in the bridge link, you must place the applicable WAN and LAN interfaces in the appropriate bridge group and then configure the interfaces in VLAN transparent mode. To add an interface in VLAN transparent mode, enter the **bridge-group** <*number*> command from the interface configuration mode prompt and then enter the **bridge-group** <*number*> **vlan-transparent** command. Using the **no** form of the **bridge-group** <*number*> **[vlan-transparent]** command in legacy bridging removes the interface from the bridge group. For example, the following commands configure the eth 0/1 interface for VLAN transparent bridging:

   (config)**#interface eth 0/1**
   (config-eth 0/1)**#bridge-group 1**
   (config-eth 0/1)**#bridge-group 1 vlan-transparent**

When passing VLAN tagged traffic over a bridged PPP link, the link must be negotiated in BCP. The command ***ppp bcp tagged-frame*** *must be issued with the* ***bridge-group*** *<number> and* ***bridge-group*** *<number>* ***vlan-transparent*** *commands from the PPP Interface Configuration mode. For example:*

(config)**#interface ppp 1**
(config-ppp 1)**#bridge-group 1**
(config-ppp 1)**#bridge-group 1 vlan-transparent**
(config-ppp 1)**#ppp bcp tagged-frame**

When using the **bridge-group** <*number*> **vlan-transparent** command, the MTU of the WAN interface should be set to **1524** (using the **mtu** <*value*> command from the interface's configuration mode) to account for the 4 extra bytes of overhead contained in an 802.1Q tagged Ethernet frame. This happens automatically on PPP interfaces starting with AOS firmware release 16.01.00. To change the MTU value, enter the command as follows:

(config)**#interface ppp 1**
(config-ppp 1)**#mtu 1524**

Repeat Step 4 for each interface you want to add to the bridge group.

Sample Bridging Configurations

The following example describes some of the common real-world applications of AOS bridging. All sample configurations provided use the CLI. The configuration parameters entered in these examples are sample configurations only. You should configure these applications in a manner consistent with the needs of your particular network. CLI prompts have been removed from the configuration examples to provide you with a method of copying and pasting configurations directly into the CLI. Before copying this configuration into your CLI, you should first make the necessary adjustments to ensure they will function properly in your network.

PPP Bridging Configuration Example Using Legacy Bridging (prior to AOS 15.01.00)

In this example, there are two sites that must be in the same subnet. The sites are connected by a point-to-point T1 using the PPP protocol. This is one of the simplest implementations of bridging, and in this example, legacy bridging is used to bridge the networks. The diagram below describes the network connection for this example.

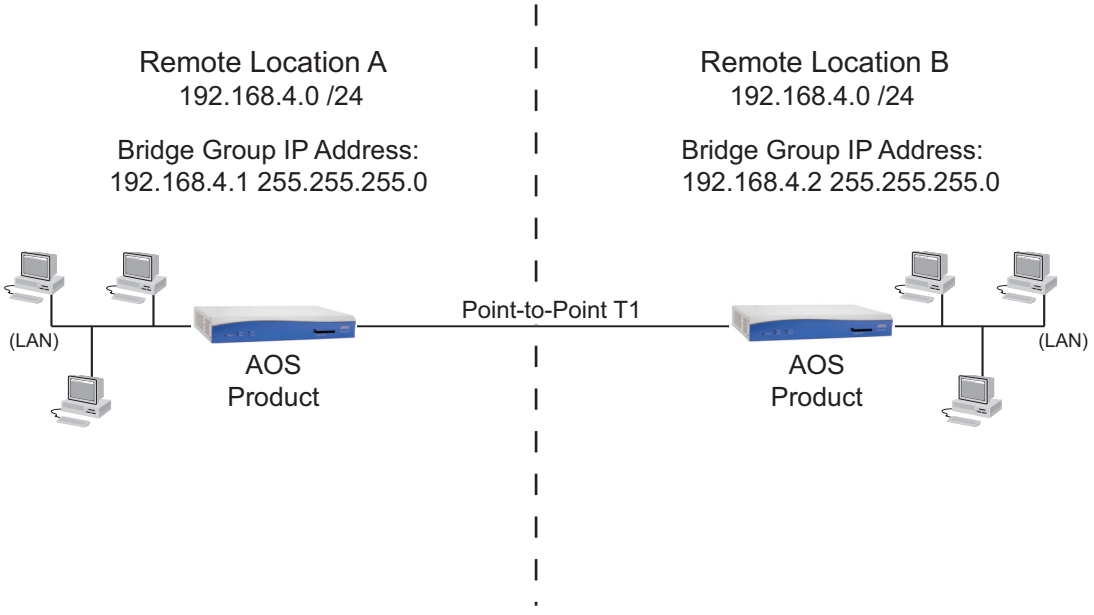


Figure 3. Point-to-Point Bridging Network Diagram

Remote Location A:

```
!
no ip routing
bridge 1 protocol ieee
!
interface eth 0/1
    ip address 192.168.4.1 255.255.255.0
    bridge-group 1
    no shutdown
!
interface t1 1/1
```



```
    clock source internal
    tdm-group 1 timeslots 1-24
    no shutdown
!
interface ppp 1
    bridge-group 1
    ip address 192.168.4.1 255.255.255.0
    mtu 1520
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
```

*The command **clock source internal** is used on this router. Typically, on point-to-point T1 circuits connecting two sites, the T1 service provider will not supply a clock and it will have to be provided by the AOS router. The AOS router at the remote site is configured for **clock source line**. You need to ensure that your T1 service provider does not supply the clock before setting the AOS router to **clock source internal**. If the T1 service provider supplies the timing for the circuit, both locations need to be configured for **clock source line**.*

Remote Location B:

```
!
no ip routing
bridge 1 protocol ieee
!
interface eth 0/1
    ip address 192.168.4.2 255.255.255.0
    bridge-group 1
    no shutdown
!
interface t1 1/1
    tdm-group 1 timeslots 1-24
    no shutdown
!
interface ppp 1
    bridge-group 1
    ip address 192.168.4.2 255.255.255.0
    mtu 1520
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
```


PPP Bridging Configuration Example Using Legacy Bridging with VLAN Transparency (prior to AOS 15.01.00)

In this example, there are two sites that must be in the same subnet. The sites are connected by a point-to-point T1 using the PPP protocol. This is one of the simplest implementations of bridging, and in this example, legacy bridging is used to bridge the networks. In this example, the bridge carries 802.1Q VLAN tagged traffic. The diagram below describes the network connection for this example.

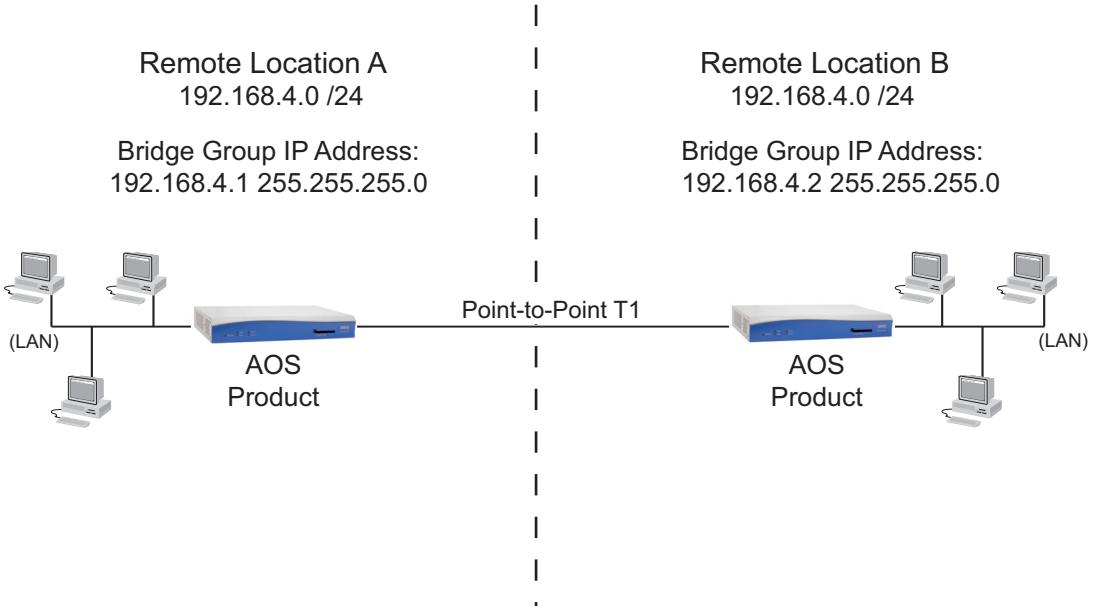


Figure 4. Point-to-Point Bridging Network Diagram

Remote Location A:

```
!
no ip routing
bridge 1 protocol ieee
!
interface eth 0/1
    ip address 192.168.4.1 255.255.255.0
    bridge-group 1
    bridge-group 1 vlan-transparent
    no shutdown
!
interface t1 1/1
    clock source internal
    tdm-group 1 timeslots 1-24
    no shutdown
!
interface ppp 1
    bridge-group 1
    bridge-group 1 vlan-transparent
    ip address 192.168.4.1 255.255.255.0
    ppp bcp tagged-frame
```



```
    mtu 1524
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
```

> NOTE
>
> *The command **clock source internal** is used on this router. Typically, on point-to-point T1 circuits connecting two sites, the T1 service provider will not supply a clock and it will have to be provided by the AOS router. The AOS router at the remote site is configured for **clock source line**. You need to ensure that your T1 service provider does not supply the clock before setting the AOS router to clock source internal. If the T1 service provider supplies the timing for the circuit, both locations need to be configured for clock source line.*

Remote Location B:

```
!
no ip routing
bridge 1 protocol ieee
!
interface eth 0/1
    ip address 192.168.4.2 255.255.255.0
    bridge-group 1
    bridge-group 1 vlan-transparent
    no shutdown
!
interface t1 1/1
    tdm-group 1 timeslots 1-24
    no shutdown
!
interface ppp 1
    bridge-group 1
    bridge-group 1 vlan transparent
    ip address 192.168.4.2 255.255.255.0
    ppp bcp tagged-frame
    mtu 1524
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
```

IRB Configuration Example (AOS 15.01.00 or later)

This application involves two sites. At one site, there is a connection to the Internet. Both sites contain a point-to-point T1 using PPP. Because both sites need access to the same subnet in bridge mode, but also need access to the Internet, IRB must be used. In this configuration, all traffic not destined for the BVI interface is bridged between the two sites. All traffic destined for the BVI interface is routed, which includes Internet traffic because the hosts on the LAN use the BVI interface IP address as their default

gateway. Switches that support multiple VLANs with 802.1Q trunking are used at each site. To allow the tagged frames to pass, the **bridge-group 1 vlan-transparent** command is configured on the applicable interface of each AOS unit, as well as the **mtu 1524** and **ppp bcp tagged-frame** commands on the PPP interface. The following diagram describes this network configuration.

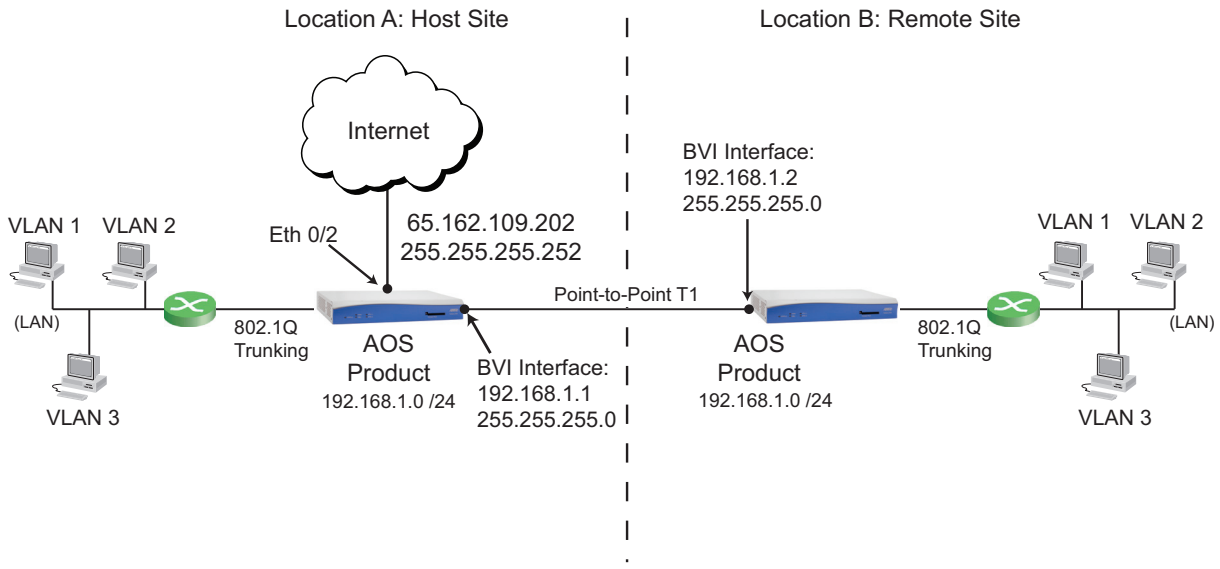


Figure 5. IRB Network Diagram

Host Site:

```
!
ip routing
!
ip firewall
!
bridge irb
!
bridge 1 protocol ieee
!
interface eth 0/1
    bridge-group 1
    bridge-group 1 vlan-transparent
    no ip address
    no shutdown
!
interface eth 0/2
    ip address 65.162.109.202 255.255.255.252
    access-policy Public
    no shutdown
!
interface t1 1/1
    clock source internal
    tdm-group 1 timeslots 1-24 speed 64
```



```
    no shutdown
!
interface ppp 1
    bridge-group 1
    bridge-group 1 vlan-transparent
    no ip address
    ppp bcp tagged-frame
    mtu 1524
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
interface bvi 1
    ip address 192.168.1.1 255.255.255.0
    access-policy Private
    no shutdown
!
ip access-list standard wizard-ics
    permit any
!
ip access-list extended self
    permit ip any any
!
ip policy-class Private
    allow list self self
    nat source list wizard-ics interface eth 0/2 overload
!
ip policy-class Public
    ! Implicit discard
!
ip route 0.0.0.0 0.0.0.0 65.162.109.201
!
```

> NOTE
>
> *The command **clock source internal** is used on this router. Typically, on point-to-point T1 circuits connecting two sites, the T1 service provider will not supply a clock and it will have to be provided by the AOS router. The AOS router at the remote site is configured for **clock source line**. You need to ensure that your T1 service provider does not supply the clock before setting the AOS router to clock source internal. If the T1 service provider supplies the timing for the circuit, both locations need to be configured for clock source line.*

Remote Site:

```
!
ip routing
!
bridge irb
!
bridge 1 protocol ieee
!
```



```
interface eth 0/1
    bridge-group 1
    bridge-group 1 vlan-transparent
    no ip address
    no shutdown
!
interface t1 1/1
    tdm-group 1 timeslots 1-24
    no shutdown
!
interface t1 1/2
    tdm-group 1 timeslots 1-24 speed 64
    no shutdown
!
interface ppp 1
    bridge-group 1
    bridge-group 1 vlan-transparent
    no ip address
    ppp bcp tagged-frame
    mtu 1524
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
interface bvi 1
    ip address 192.168.1.2 255.255.255.0
    no shutdown
!
```


IRB Configuration Example (later than AOS 17.07.00)

This application involves two sites. Both sites contain a point-to-point T1 using PPP. In this configuration, all traffic not destined for the BVI interface is bridged between the two sites. All traffic destined for the BVI interface is routed. In this example, all users are on the same VLAN so there is no need for transporting 802.1Q frames across the bridge. The following diagram describes this network configuration.

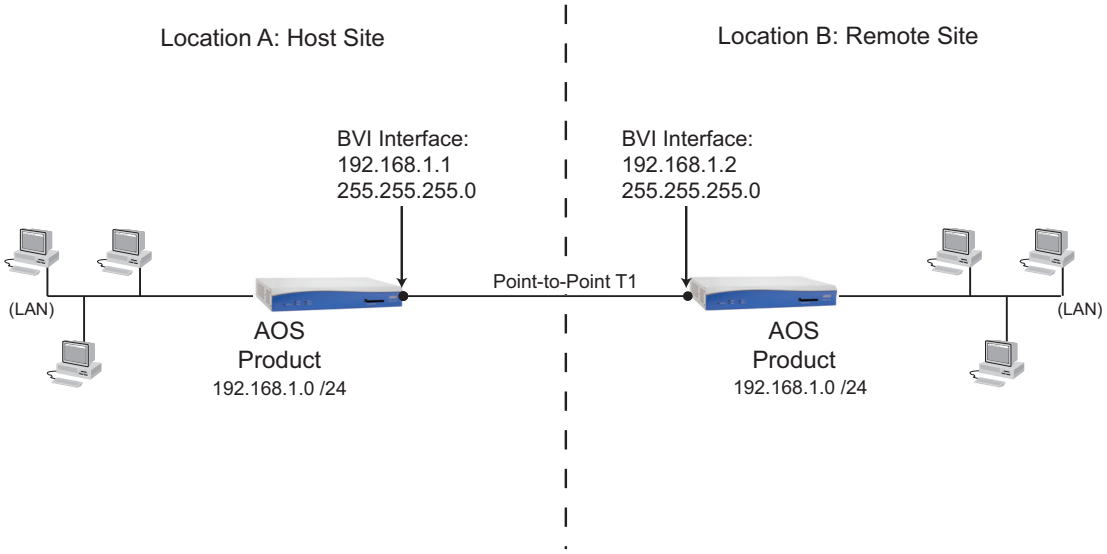


Figure 6. IRB Network Diagram

The following configuration is similar to the previous example, except that it is not necessary to specify IRB is used or that the bridging protocol is IEEE.

Host Site:

```
!
ip routing
!
bridge irb
!
bridge 1 protocol ieee
!
interface eth 0/1
    bridge-group 1
    no ip address
    no shutdown
!
interface t1 1/1
    clock source internal
    tdm-group 1 timeslots 1-24 speed 64
    no shutdown
!
interface ppp 1
    bridge-group 1
```



```
    no ip address
    mtu 1520
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
interface bvi 1
    ip address 192.168.1.1 255.255.255.0
    no shutdown
!
```

*The command **clock source internal** is used on this router. Typically, on point-to-point T1 circuits connecting two sites, the T1 service provider will not supply a clock and it will have to be provided by the AOS router. The AOS router at the remote site is configured for **clock source line**. You need to ensure that your T1 service provider does not supply the clock before setting the AOS router to clock source internal. If the T1 service provider supplies the timing for the circuit, both locations need to be configured for clock source line.*

*Although they are not requried because they are added automatically, the **bridge irb** and **bridge protocol ieee** commands are shown in this configuration and will appear in the output of a **show run**.*

Remote Site:

```
!
ip routing
!
bridge irb
!
bridge 1 protocol ieee
!
interface eth 0/1
    bridge-group 1
    no ip address
    no shutdown
!
interface t1 1/1
    tdm-group 1 timeslots 1-24 speed 64
    no shutdown
!
interface ppp 1
    bridge-group 1
    no ip address
    mtu 1520
    no shutdown
    cross-connect 1 t1 1/1 1 ppp 1
!
interface bvi 1
    ip address 192.168.1.2 255.255.255.0
```


no shutdown

!

*Although they are not requried because they are added automatically, the **bridge irb** and **bridge protocol ieee** commands are shown in this configuration and will appear in the output of a **show run**.*

Multipoint Legacy Bridging Configuration Example (prior to AOS 15.01.00)

This application involves Frame Relay multipoint bridging using legacy bridging. Multipoint bridging applications are useful for two remote offices that have small traffic requirements and need to access local office resources (desiring minimal changes to the local and main office servers). If all resources are using NetBEUI protocol, bridging is the only option. There are minimal differences when configuring point-to-point and multipoint application (including Frame Relay interface configurations and assigning all subinterfaces to the bridge group). The only new concept in this example is that the bridge group is applied to multiple Frame Relay subinterfaces. The following diagram illustrates the network configuration for this example.

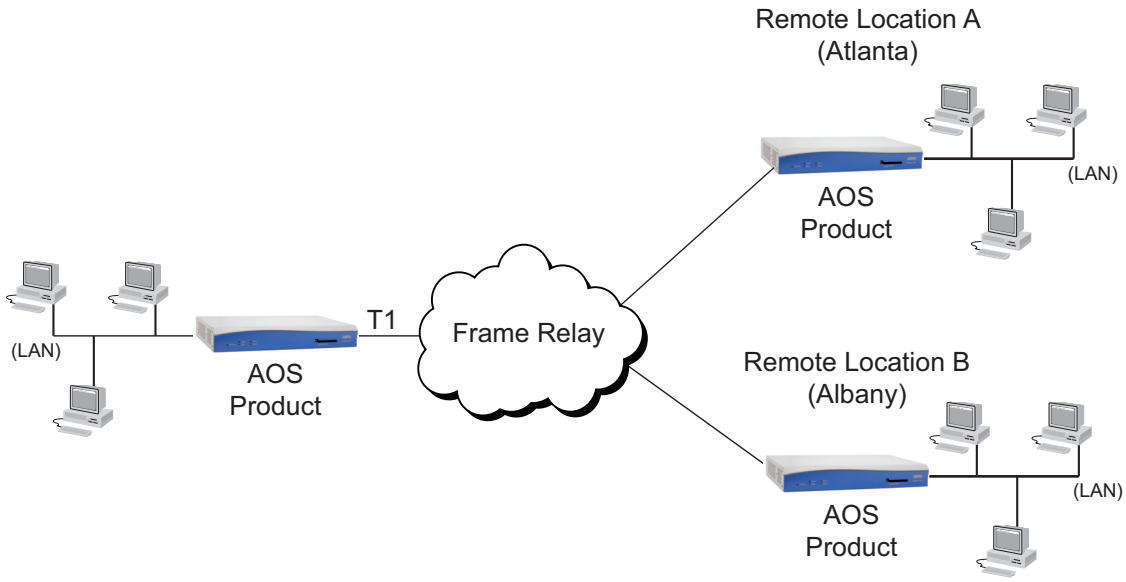


Figure 7. Frame Relay Multipoint Legacy Bridging Network Diagram

```
!
no ip routing
bridge 1 protocol ieee
!
interface eth 0/1
     ip address 192.168.4.1 255.255.255.0
     bridge-group 1
     no shutdown
!
interface t1 1/1
     tdm-group 1 timeslots 1-24
     no shutdown
!
interface frame relay 1
     no shutdown
     cross-connect 1 t1 1/1 1 fr 1
!
interface frame relay 1.16
```



```
    ip address 192.168.4.1 255.255.255.0
    no shutdown
    frame-relay interface dlci 16
    bridge-group 1
!
interface frame relay 1.17
    ip address 192.168.4.1 255.255.255.0
    no shutdown
    frame-relay interface-dlci 17
    bridge-group 1
!
```

Command Summary

The following tables summarize the CLI commands necessary to configure legacy bridging, IRB prior to AOS firmware release 17.07.00, and IRB for AOS firmware release 17.07.00 and later. Each table displays the command prompt, the command syntax, and the command description.

Table 1. Legacy Bridging Configuration Commands

Prompt	Command	Description
(config)#	**no ip routing**	Disables IP routing on the AOS product.
(config)#	**bridge** <*number*> **protocol ieee**	Creates a bridge group and specifies the group uses the IEEE protocol. The <*number*> parameter is a unique identifier for the bridge group and is a number between **1** and **255**.
(config-<*interface*>)#	**bridge-group** <*number*> **[vlan-transparent]**	Specifies the interface is assigned to a particular bridge group. The <*number*> parameter is the bridge group's identifier and is a number between **1** and **255**. The optional **vlan-transparent** parameter specifies that VLAN tagged traffic is passed through the interface.
(config-ppp 1)#	**ppp bcp tagged-frame**	Specifies that a bridged PPP link negotiates passing 802.1Q tagged Ethernet frames. This command must be used in conjunction with the **bridge-group** <*number*> **vlan-transparent** command on PPP interfaces for VLAN tagged traffic to be forwarded.
(config-ppp 1)#	**mtu 1524**	Sets the MTU to accommodate the extra overhead when passing 802.1Q tagged Ethernet frames.

Table 2. IRB Configuration Commands (prior to AOS 17.07.00)

Prompt	Command	Description
(config)#	**bridge irb**	Enables IRB.

Table 2. IRB Configuration Commands (prior to AOS 17.07.00) *(Continued)*

Prompt	Command	Description
(config)#	**bridge** <*number*> **protocol ieee**	Creates a bridge group and specifies the bridge protocol is IEEE. The <*number*> parameter is the unique identifier for the bridge group and can be a number between **1** and **255**. This number should match the number of the BVI interface.
(config)#	**interface bvi** <*number*>	Creates the BVI interface and assigns it a bridge group number. This number should match the bridge group number.
(config-bvi <*number*>)#	**ip address** <*ip address*> <*subnet mask*>	Specifies the IP address used by the BVI interface and the entire bridge group. IP addresses should be expressed in dotted decimal notation (for example, **10.10.10.1**). Subnet masks can be expressed in dotted decimal notation (for example, **255.255.255.0**) or as a prefix length (for example, **/24**).
(config-bvi <*number*>)#	**no shutdown**	Enables the BVI interface.
(config-<*interface*>)#	**bridge-group** <*number*> **[vlan-transparent]**	Specifies the interface is assigned to a particular bridge group. The <*number*> parameter is the bridge group's identifier and is a number between **1** and **255**. The optional **vlan-transparent** parameter specifies that VLAN tagged traffic is passed through the interface.
(config-ppp 1)#	**ppp bcp tagged-frame**	Specifies that a bridged PPP link negotiates passing 802.1Q tagged Ethernet frames. This command must be used in conjunction with the **bridge-group** <*number*> **vlan-transparent** command on PPP interfaces for VLAN tagged traffic to be forwarded.

Table 2. IRB Configuration Commands (prior to AOS 17.07.00) *(Continued)*

Prompt	Command	Description
(config-ppp 1)#	**mtu 1524**	Sets the MTU to accommodate the extra overhead when passing 802.1Q tagged Ethernet frames.

Table 3. IRB Commands (later than AOS 17.07.00)

Prompt	Command	Description
(config)#	**interface bvi** <*number*>	Creates the BVI interface and assigns it a bridge group number.
(config-bvi <*number*>)#	**ip address** <*ip address*> <*subnet mask*>	Specifies the IP address used by the BVI interface and the entire bridge group. IP addresses should be expressed in dotted decimal notation (for example, **10.10.10.1**). Subnet masks can be expressed in dotted decimal notation (for example, **255.255.255.0**) or as a prefix length (for example, **/24**).
(config-bvi <*number*>)#	**no shutdown**	Enables the BVI interface.
(config-<*interface*>)#	**bridge-group** <*number*> **[vlan-transparent]**	Specifies the interface is assigned to a particular bridge group. The <*number*> parameter is the bridge group's identifier and is a number between **1** and **255**. The optional **vlan-transparent** parameter specifies that VLAN tagged traffic is passed through the interface.
(config-ppp 1)#	**ppp bcp tagged-frame**	Specifies that a bridged PPP link negotiates passing 802.1Q tagged Ethernet frames. This command must be used in conjunction with the **bridge-group** <*number*> **vlan-transparent** command on PPP interfaces for VLAN tagged traffic to be forwarded.

Table 3. IRB Commands (later than AOS 17.07.00) *(Continued)*

Prompt	Command	Description
(config-ppp 1)#	**mtu 1524**	Sets the MTU to accommodate the extra overhead when passing 802.1Q tagged Ethernet frames.

Troubleshooting

This troubleshooting section focuses on troubleshooting bridging functionality using the CLI. For the recommended basic troubleshooting, follow the steps as outlined below. For additional troubleshooting commands, refer to the commands at the end of this section.

Basic Troubleshooting

In order to best troubleshoot a bridging application, it is recommended to begin at Layer 1 of the OSI model and work upwards. To begin basic troubleshooting, follow these steps:

1. Check the status of your Layer 1 interface (T1, serial, DDS interfaces) with the **show interface** <*interface*> command. This command is issued from the Enable mode prompt and allows you to specify which interface statistics to view. Interfaces are specified in the format <*interface type [slot/port | slot/port.subinterface id]*>. For example, for a T1 interface, use **t1 1/1**. Type **show interface ?** for a list of valid interfaces.

   The following is sample output from the **show interface t1 1/1** command:

```
>enable
#show interface t1 1/1
    t1 1/1 is UP
        Receiver has no alarms
        T1 coding is B8ZS, framing is ESF
        Clock source is line, FDL type is ANSI
        Line build-out is 0dB
        No remote loopbacks, No network loopbacks
        Acceptance of remote loopback requests enabled
        Tx Alarm Enable: rai
        Last clearing of counters 00:03:35
                loss of frame : 0
                loss of signal : 0
                AIS alarm : 0
                Remote alarm : 1, last occurred 00:02:14

        DS0 Status: 12345678901234567890123
                NNNNNNNNNNNNNNNNNNNNNNN

        Status Legend: '-' = DS0 is unallocated
                'N' = DS0 is dedicated (nailed)

        Line Status: --No Alarms--
        5 minute input rate 5 bits/sec, 10 packets/sec
        5 minute output rate 5 bits/sec, 3 packets/sec
        Current Performance Statistics:
                0 Errored Seconds, 0 Bursty Errored Seconds
                0 Severely Errored Seconds, 0 Severly Errored Frame Seconds
                0 Unavailable Seconds, 0 Path Code Violations
                0 Line Code Violations, 0 Controlled Slip Seconds
                0 Line Errored Seconds, 0 Degraded Minutes
```


2. Once you have confirmed that your physical interface is functioning properly, check the status of your Layer 2 interface (PPP, HDLC, or Frame Relay interfaces) with the **show interface** <*interface*> command.

   The following is sample output from the **show interface ppp 1** command:

```
>enable
#show interface ppp 1
ppp 1 is UP
    Configuration:
        Keep-alive is set (10 sec).
        No multilink
                MTU = 1520
        No authentication
        Bridge group 1 is configured
    Link thru t1 1/1 is UP; LCP state is OPENED, negotiated MTU is 1520
        Receive: bytes=370, pkts=19, errors=0
        Transmit: bytes=500, pkts=30, errors=0
        5 minute input rate 24 bits/sec, 0 packets/sec
        5 minute output rate 16 bits/sec, 0 packets/sec
    Bundle information
        Queueing method: weighted fair
        HDLC tx ring limit: 2
        Output queue: 0/1/428/64/0 (size/highest/max total/threshold/drops)
                Conversations 0/1/256 (active/max active/max total)
                Available Bandwidth 1152 kilobits/sec
    Bridging is UP, BCP state is OPENED
        Bridge group 1
    LLDPCP State is OPENED
```

3. After determining that the Layer 2 interface is operating properly, you can check the status of your bridge using the **show bridge** <*number*> command. The <*number*> parameter is the bridge group number, and specifies which bridge you wish to view information about. Enter the command from the Enable mode prompt as follows:

```
>enable
#show bridge 1
Bridge Group 1:
Total of 1024 station blocks, 1022 free
Code: P - permanent

Address            Interface   Age         RX Count    TX Count
00:a0:c8:12:c0:3b  ppp 1       3           8           5
```


In AOS firmware release 17.07.00 and later, the **show bridge** command displays the contents of the bridge cache. The following is sample output from the **show bridge** command in AOS 17.07.00:

```
>enable
#show bridge
Bridge Group 1:
Total of 1024 station blocks, 1022 free
Code: P - permanent

Address            Interface   Age   RX Count   TX Count
00:00:00:00:69:d7  bvi 1       P     12         11
00:00:00:00:12:2f  hdlc 1      205   11         10
```

In this output, the **Age** field indicates the age of the entry, not the time to live. This value represents the lapsed time since the entry was last used. When an entry is used, it becomes fresh again, so the age value becomes zero. An entry that stays at zero is being used frequently. It should also be noted that permanent entries might not appear in the **show bridge** output.

If a permanent entry does not appear in the command output, enter the command again. Permanent entries are stored in another list, which is examined when entering the command again. If an entry match is found, the entry is moved from the hidden list to the bridge cache. Once in the cache, the entry is displayed by entering the show command.

Additional Troubleshooting Commands

There are two other main troubleshooting commands available for troubleshooting the bridging feature. These are the **debug bridge** and **clear bridge** commands.

The **debug bridge** command displays messages associated with bridge events. Debug messages can provide information about the type of events that have occurred in the bridge link and the time that they occurred. The following is sample output from the **debug bridge** command:

```
>enable
#debug bridge
Bridge 1 aging out cache entry for destination 00:00:00:00:69:D7
Bridge 1 aging out cache entry for destination 00:00:00:00:12:2F
```

The **clear bridge [**<*number*>**]** command clears the content of the bridge cache. The optional <*number*> parameter specifies that only the bridge cache of a certain bridge group is cleared. To clear the cache for all bridge groups, enter the command from the Enable mode prompt as follows:

```
#clear bridge
```

> NOTE *If you are using a PPP WAN interface, the **debug ppp negotiation** command might also be useful to you. For more detailed information about debugging PPP interfaces and BCP negotiations, refer to the **Point-to-Point Protocol** configuration guide available online at http://kb.adtran.com (article number 2523).*

