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Configuration Guide

IPv4 VRRPv2 for AOS

This configuration guide will aid in the setup of the Internet Protocol version 4 (IPv4) Virtual Router Redundancy Protocol version 2 (VRRPv2) for ADTRAN Operating System (AOS) products. An overview of VRRPv2 general concepts combined with detailed command descriptions provide step-by-step assistance for configuration. The troubleshooting section outlines proper use of **show** and **debug** commands to verify that VRRPv2 has been configured properly on the AOS product(s).

This guide consists of the following sections:

IPv4 VRRPv2 Overview

IPv4 VRRPv2 is a standard protocol that allows load sharing and provides seamless redundancy to networked end-host devices. The result is a fault tolerant, easily managed system where the responsibility for availability is managed exclusively by the routers.

There are several different ways for hosts on a local area network (LAN) to determine the best path to a destination. Dynamic routing protocols, such as Routing Information Protocol (RIP) and open shortest path first (OSPF), rely on routing table updates from neighboring routers to establish the best route and for automatic recovery when there is a network failure. However, implementing a dynamic routing protocol on every host is often not feasible. High overhead and lack of protocol implementation on some platforms can result in a considerable delay in the detection of a downed path.

A statically configured default route is a simpler method for directing end-host communication to its destination. The use of Dynamic Host Configuration Protocol (DHCP) to automatically assign an IPv4 address and default gateway to end hosts further simplifies the use of these default routes in networked environments of any size. One drawback to the use of statically configured dynamic routes is that the default router becomes a single point of failure for all of the end hosts assigned to it. VRRPv2 is designed to eliminate this single point of failure by allowing multiple physical routers to act as a single virtual router. Routers running VRRPv2 can be set up to perform both load sharing and network redundancy.

The basis of VRRPv2 is an abstract object called a virtual router. The virtual router is comprised of two or more physical routers running VRRPv2, and acts as a single virtual router for hosts on a shared LAN (see *Figure 1*). One of the physical routers will be designated as the virtual router master. The virtual router master is responsible for forwarding packets sent to the IPv4 address associated with the virtual router, and answering Address Resolution Protocol (ARP) requests for these IPv4 addresses. The other VRRPv2 routers are designated as virtual router backups and will only assume forwarding responsibility for the virtual router should the current master fail.

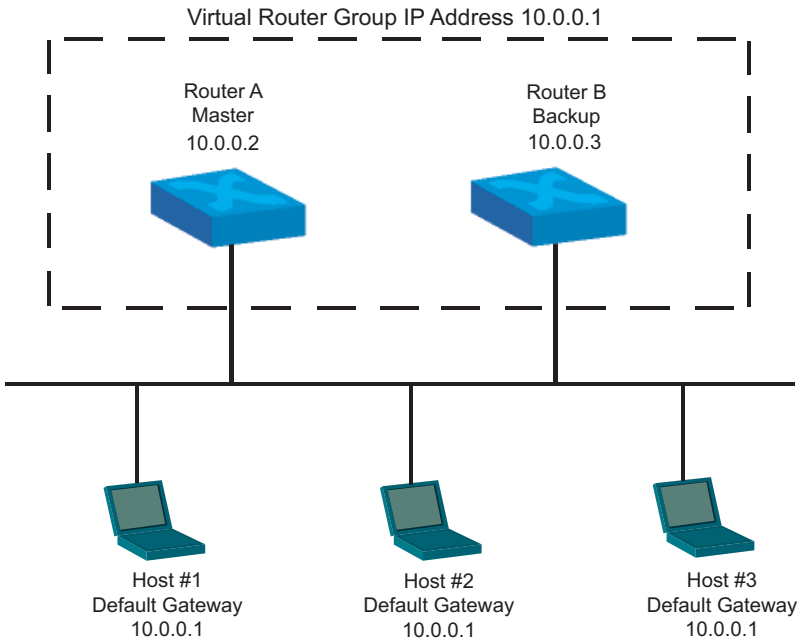


Figure 1. Typical VRRPv2 Topology

A group ID is a virtual ID number used to associate a group of physical routers running VRRPv2. The virtual router master in the group will periodically send out VRRPv2 packets to all other routers within the virtual router group. These packets communicate the priority and state of the virtual router master. Since these periodic packets are only sent by the virtual router master to the other VRRPv2 routers in the group, protocol overhead remains very low.

An IEEE-assigned MAC address has been set aside for use in VRRPv2. This MAC address is 00-00-5E-00-01-[group ID], where the group ID is the virtual ID number that has been assigned to a virtual router group. The MAC address is exclusively associated with the virtual router and is used as the source in VRRPv2 messages, as well as any ARP responses to hosts on the LAN. The virtual router's IPv4 address can be an IPv4 address that is assigned to a real interface on one of the VRRPv2 routers. In this case, the VRRPv2 router is considered to be the IPv4 address owner. When the IPv4 address owner is available, it always serves as the virtual router master. Alternatively, the virtual router's IPv4 address can be different from any interfaces on the physical VRRPv2 routers. The virtual router master in this scenario is based on its priority setting. The VRRPv2 router with the highest priority setting becomes the master.

VRRPv2 is an excellent solution for redundancy issues in networks where statically configured default routes are used. Network setup and configuration is fairly simple compared to dynamic routing protocols, and VRRPv2 offers less overhead and faster backup transitions. In addition to redundancy, load balancing can also be used to streamline traffic loads on a shared LAN.

Hardware and Software Requirements and Limitations

VRRPv2 was introduced in AOS 16.01.00 and is available on AOS products as outlined in the *AOS Feature Matrix*, available online at https://supportforums.adtran.com.

The maximum number of VRRPv2 routers supported per interface is two.

Typically, VRRPv2 applications use independent wide area network (WAN) connections for each router.

VRRPv2 provides VRRP functionality using IPv4. As of AOS firmware release R10.7.00, ADTRAN supports VRRP over IPv6 using VRRP version 3 (VRRPv3). For more information about configuring IPv6 VRRPv3, refer to the configuration guide *IPv6 VRRPv3 for AOS*, available online at https://supportforums.adtran.com.

CLI Configuration

VRRPv2 is supported on Ethernet and VLAN broadcast domain interfaces. Therefore, VRRPv2 commands can be issued on either Ethernet or VLAN interfaces in the AOS products. For illustrative purposes, Ethernet interface 0/1 (**eth 0/1**) will be used throughout this tutorial.

When configuring VRRPv2, each command begins with **vrrp** followed by the virtual router ID (VRID) number for the virtual router group to be configured. To create a new virtual router group, any VRID that is not already in use on the LAN may be chosen within the range of **1** to **255**. The AOS product may be added to an existing virtual router group by specifying the group's VRID.

A VRRPv2 router may be part of more than one virtual router group.

A complete list of all VRRPv2 commands is available using the question mark CLI shortcut:

(config-eth 0/1)#**vrrp** <*number*> **?**

<*number*> specifies the VRID for the virtual router group to be joined or created. The number range is **1** to **255**.

*Although the valid range for a VRRPv2 VRID is **1** to **255**, only two VRRPv2 routers per interface are supported.*

The following is the minimum configuration required to activate VRRPv2 on an AOS product:

1. Specify the IPv4 address to be used by the virtual router.
2. Examine the priority level of this VRRPv2 router.
3. Exit the interface and save the configuration to memory.

Step 1: Specify the IPv4 address to be used by the virtual router

When the virtual router's specified IPv4 address is independent of the IPv4 addresses assigned to real interfaces on the VRRPv2 routers, there is no IPv4 address owner. This addressing method is necessary if object tracking will be used to monitor the network connection (refer to *Track on page 7*). The IPv4 address used for the virtual router must be on the same subnet as either the primary or secondary IPv4 addresses assigned to the VRRPv2 router's real interface.

If it is necessary to conserve IPv4 addresses, then the virtual router's specified IPv4 address may also be the same as the IPv4 address assigned to a VRRPv2 router's real interface. In this case, the VRRPv2 router is the IPv4 address owner. Whenever the IPv4 address owner is online, it is always the virtual router master. One disadvantage to having an IPv4 address owner is that its priority level is not affected by object tracking. Therefore, failover protection for an interface or network connection is lost. For example, an Internet Control Message Protocol (ICMP) echo probe from the master VRRPv2 router is tracked and the **vrrp track** command is used to decrement the master router's priority level when the track fails. If the connection to corporate goes down, the track will fail, causing the priority level of the master router to be decremented by a specified amount. A backup router, whose network connection to corporate is still viable, will now have the highest priority level and take over as master router. This type of object tracking only works when there is no IPv4 address owner. If the master router is the IPv4 address owner, the priority level cannot be decremented. Hence, even if the master router's path to corporate fails, its priority level will remain at the highest setting and a transition to a backup router with a viable network connection is not possible.

Additional IPv4 addresses supported by the virtual router can be entered using the **secondary** keyword.

(config-eth 0/1)#**vrrp** <*number*> **ip** <*ipv4 address*> [**secondary**]

<*ipv4 address*> specifies the IPv4 address to be used by the virtual router. IPv4 addresses should be expressed in dotted decimal notation (for example, **10.10.10.1**).

Step 2: Examine the priority level of the VRRPv2 router

It is possible for VRRPv2 to operate based on default priority level settings. However, it is important to understand and verify the election process to ensure the desired VRRPv2 router is ultimately selected as the master.

The virtual router master is selected via an election process that is based on the priority level setting in each VRRPv2 router. There are two types of priority levels: configured priority level and actual priority level. The configured priority level is the numerical value originally assigned to the VRRPv2 router. For example, the default configured priority for a VRRPv2 router that is either a backup router or not the IPv4 address owner is **100**. The actual priority level is the value that takes into account any adjustments resulting from a track event. For example, the actual priority level of a master router whose network path is down may be **90** versus the configured priority of **100**. The actual priority of a VRRPv2 router that is the IPv4 address owner is always **255**. The VRRPv2 router with the highest actual priority level is the virtual router master. If there is a tie, the actual priority level will be used along with the interface IPv4 address to determine the master.

If the IPv4 address of the virtual router is the same as the interface address on the VRRPv2 router (IPv4 address owner), then the default priority level will be **255**. This is the highest possible priority level and means that when the IPv4 address owner is available, it will be the virtual router master.

Object tracking can be used to decrement the priority level in a VRRPv2 router. Refer to *Additional Settings on page 6* *and* *Example 3: Load Sharing, Redundancy, and Object Tracking with VRRPv2 on page 15* *for more details on object tracking.*

(config-eth 0/1)#**vrrp** <*number*> **priority** <*level*>

<*level*> specifies the configured priority level of this VRRPv2 router. The level range is **1** to **254**.

Step 3: Exit the interface and save the configuration to memory

Enter the following commands to exit the interface and save the configuration to memory:

(config-eth 0/1)#**exit**
(config)#**do copy run start**

or

(config-eth 0/1)#**exit**
(config)#**do write**

Additional Settings

Depending on the LAN environment, additional VRRPv2 settings may need to be configured.

Preempt

Whenever a VRRPv2 router with a higher actual priority level than the current master is added to a virtual router group, it will attempt to take over or preempt the master router. This behavior may be desired, for example, when the new router is more powerful than the existing master router. An optional **delay** keyword may be added to the command, which will cause the VRRPv2 router to wait a specified amount of time before it attempts to preempt the master. By default, a VRRPv2 router will preempt with no additional delay. Note that when using virtual private network (VPN) and/or firewall, it may be desirable to turn off preemption to prevent loss of state/session, especially if the application uses long-term Transmission Control Protocol (TCP) connections, such as Telnet/SSL.

(config-eth 0/1)#**vrrp** <*number*> **preempt delay minimum** <*time*>

delay minimum <*time*> parameter is optional, and specifies a delay in seconds before this VRRPv2 router will attempt to preempt. The range of seconds is **0** to **255**.

*If the master router is the IPv4 address owner, it will ignore the preempt commands (both **no preempt** and **delay**).*

Text Description

An optional text description may be added to provide details about the VRRPv2 group.

(config-eth 0/1)#**vrrp** <*number*> **description** <*text*>

<*text*> describes this virtual router group.

Timers Advertise

The master router sends VRRPv2 advertisements at the interval specified in the **timers advertise** command. Backup routers in the virtual router group use the value specified in **timers advertise** command as a timeout interval.

It is imperative that all routers in the virtual router group are configured with the same value for the advertisement interval since the same interval that is used by the master router for sending VRRPv2 advertisements is also used by the backup routers to compute the timeout interval. If the advertise times are not the same, backup VRRPv2 routers will attempt (and become) another master on the same VRRPv2 router.

There are two ways to accomplish configuration of the advertisement interval on all routers in the virtual router group, although it is recommended to use the default timer values. The first method is to configure the **timers advertise** value on the master router. Then, turn on the **timers learn** option on all VRRPv2 routers in the virtual router group (refer to *Timers Learn on page 7*). The second method is to manually configure the **timers advertise** command with the same value on every VRRPv2 router in the virtual router group.

The default value for the **timers advertise** interval is **1** second. If three intervals pass with no VRRPv2 advertisement received from the master router, the backup router determines that the master router has failed and the election process for a new master router will be initiated. Based on the default value, the failover time is **3** seconds plus a random skew time.

(config-eth 0/1)#**vrrp** <*number*> **timers advertise** <*interval*>

<*interval*> specifies the time (in seconds) between advertisements sent by the master router. The range of seconds is **1** to **255**.

*It is recommended that the **timers advertise** setting is kept at the default value. If it is necessary to change this setting, ensure that all VRRPv2 routers are configured with the new value.*

Timers Learn

The **timers learn** command enables a backup VRRPv2 router to learn the advertisement interval of the master router. The advertisement interval is used as a timeout interval by the backup routers in the virtual router group. Therefore, it is important that the advertisement interval is the same value on all routers in the virtual router group, whether through **timers advertise** configuration or through the **timers learn** feature. For more information, refer to *Timers Advertise on page 6*.

(config-eth 0/1)#**vrrp** <*number*> **timers learn**

*It is recommended that if the **timers learn** function is enabled on one router in a virtual router group, then the **timers learn** function should be enabled on all routers in the group.*

Track

Object tracking may be used to change the priority level of a VRRPv2 router. The purpose of object tracking for VRRPv2 is to detect failure of the interface or main path connected to the master router. The object that is tracked is typically an interface (up and IPv4 configured) or an ICMP echo probe directed towards corporate or the far end of the main path. Depending on the object type specified, as long as the line protocol for the interface is up or the ICMP echo probe is returned, the track will remain in a PASS state and nothing will change. However, if the line protocol for an interface goes down or if the ICMP echo probe fails, then the track will transition to a FAIL state. This transition will cause the priority level of the VRRPv2 router to be decremented by the numerical amount specified in the command.

(config-eth 0/1)#**vrrp** <*number*> **track** <*name*> [**decrement** <*value*>]

<*name*> specifies the name of the track.

decrement <*value*> parameter is optional parameter and specifies the numerical amount to decrement the priority level if the track transitions to a FAIL state. The decrement value range is **1** to **254**, and the default value is **10**.

*A track must be created before the **vrrp track** command can be issued. If an ICMP echo probe is to be used, the probe must first be created and then associated with a track. Refer to Example 3: Load Sharing, Redundancy, and Object Tracking with VRRPv2 on page 15 for an example showing basic implementation of the **vrrp track** command. For detailed information on creating probes and track, refer to the **Network Monitor Probe Configuration Command Set** and the **Network Monitor Track Configuration Command Set** sections of the AOS Command Reference Guide available online at https://supportforums.adtran.com.*

*If a VRRPv2 router owns the virtual router IPv4 address, then the VRRPv2 router's priority level cannot be decremented as a result of the **track** command. Therefore, if object tracking is used to monitor paths and effectively decrement priority levels in case of interface or path failure, then it is important that no VRRPv2 router own the virtual router IPv4 address.*

Shutdown

The **shutdown** command disables the VRRPv2 router and the **no shutdown** command enables the VRRPv2 router. If the VRRPv2 router is currently the master, entering the **shutdown** command causes the router to advertise a priority level of **0**, thus relinquishing its role as the master and allowing a backup router to take over. By default, VRRPv2 is enabled (**no shutdown**).

(config-eth 0/1)#**vrrp** <*number*> **shutdown**

Startup Delay

VRRPv2 **startup delay** is a hold down timer that prevents an initializing VRRPv2 router from joining the virtual router group before spanning tree has had an opportunity to converge. This delay keeps a new router that has been added to the virtual router group from interfering with an existing router that is processing traffic. The startup delay command is enabled by default.

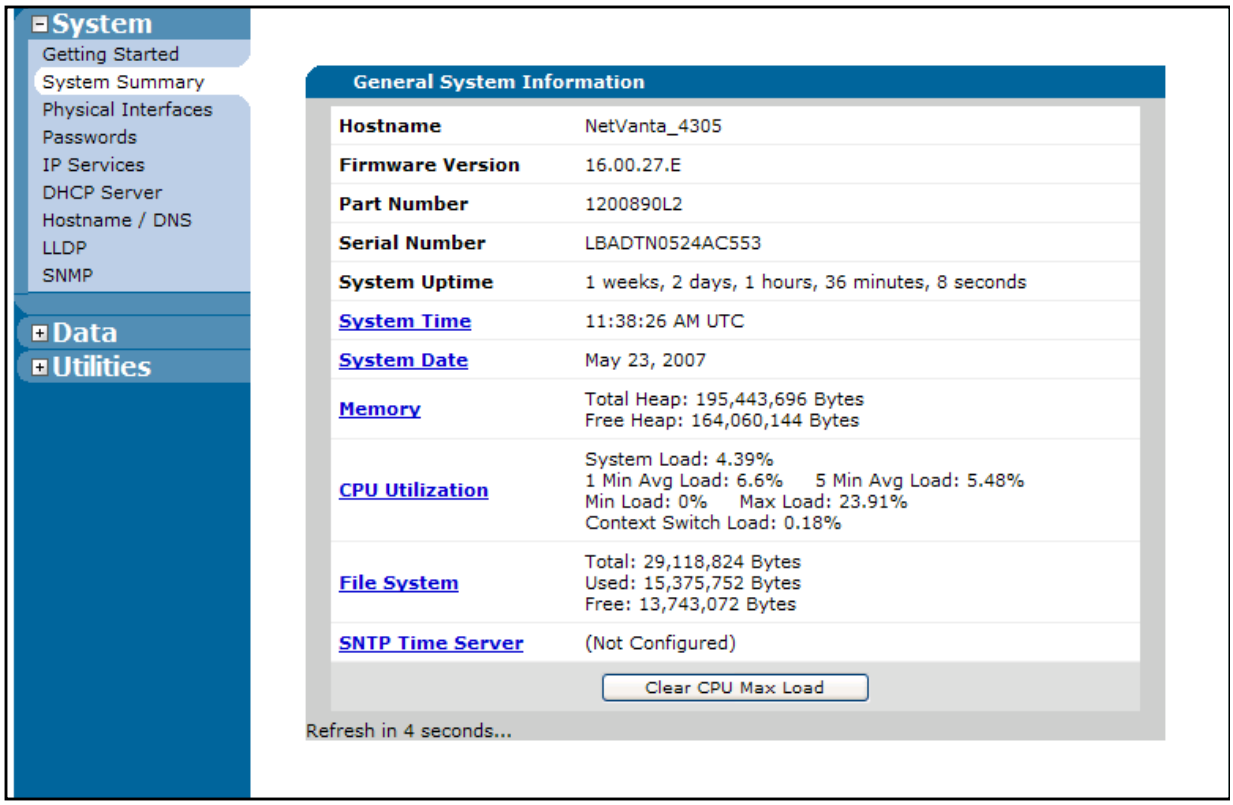
(config-eth 0/1)#**vrrp** <*number*> **startup-delay** <*delay*>

<*delay*> specifies the time (in seconds) to delay the VRRPv2 router. The range is **0** to **255** seconds, with a default delay value of **35** seconds.

GUI Configuration

The Web-based graphical user interface (GUI) is an especially useful tool for those who are less familiar with command line interface (CLI) configuration. AOS products ship with a user-friendly GUI that can be used to perform many basic management and configuration functions on the AOS product. Some advanced options can be configured using the GUI as well.

Open a GUI session.



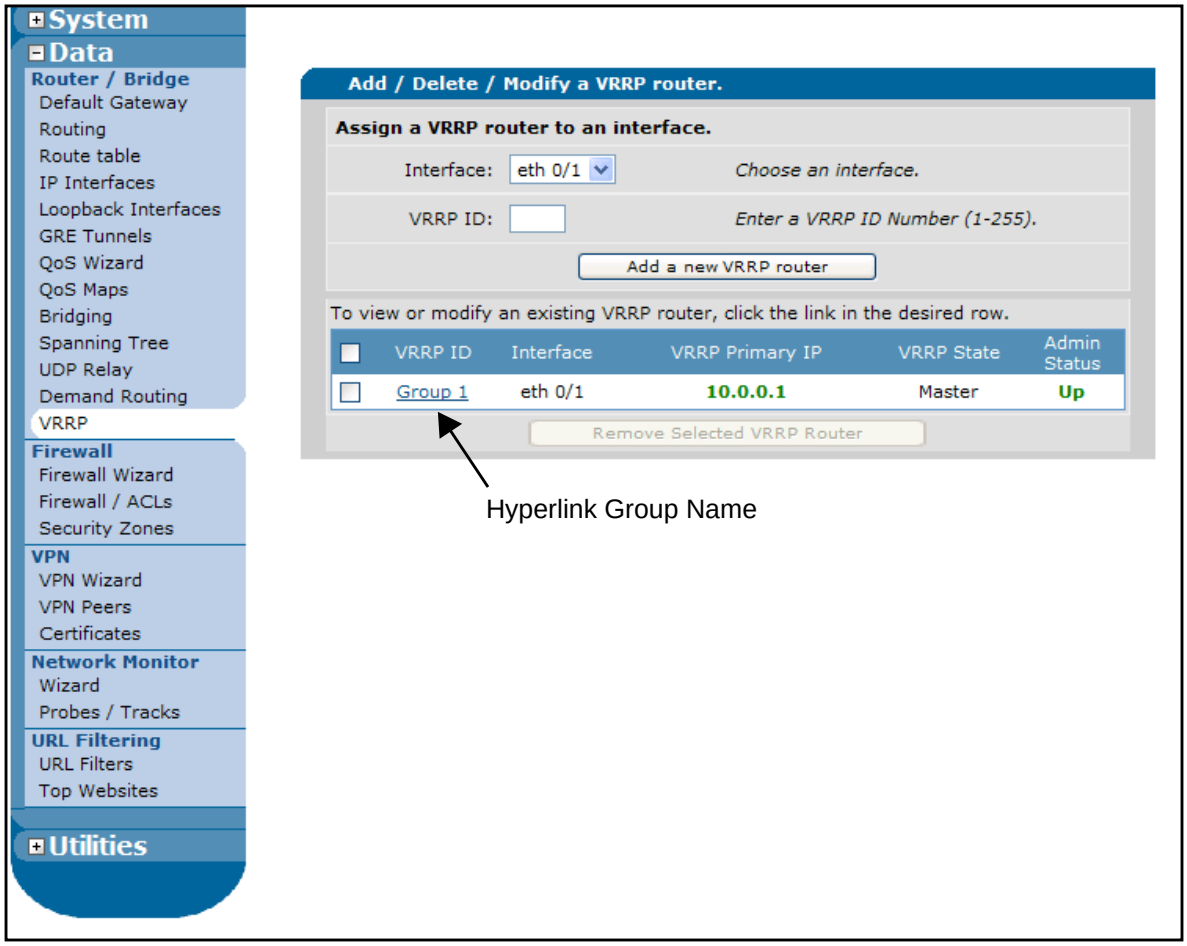
Once a successful connection to the GUI has been established, the main menu appears.

NOTE

While navigating the GUI you will notice question mark (?) symbols that indicate additional information is available. Simply place your cursor over the symbol to view the additional information.

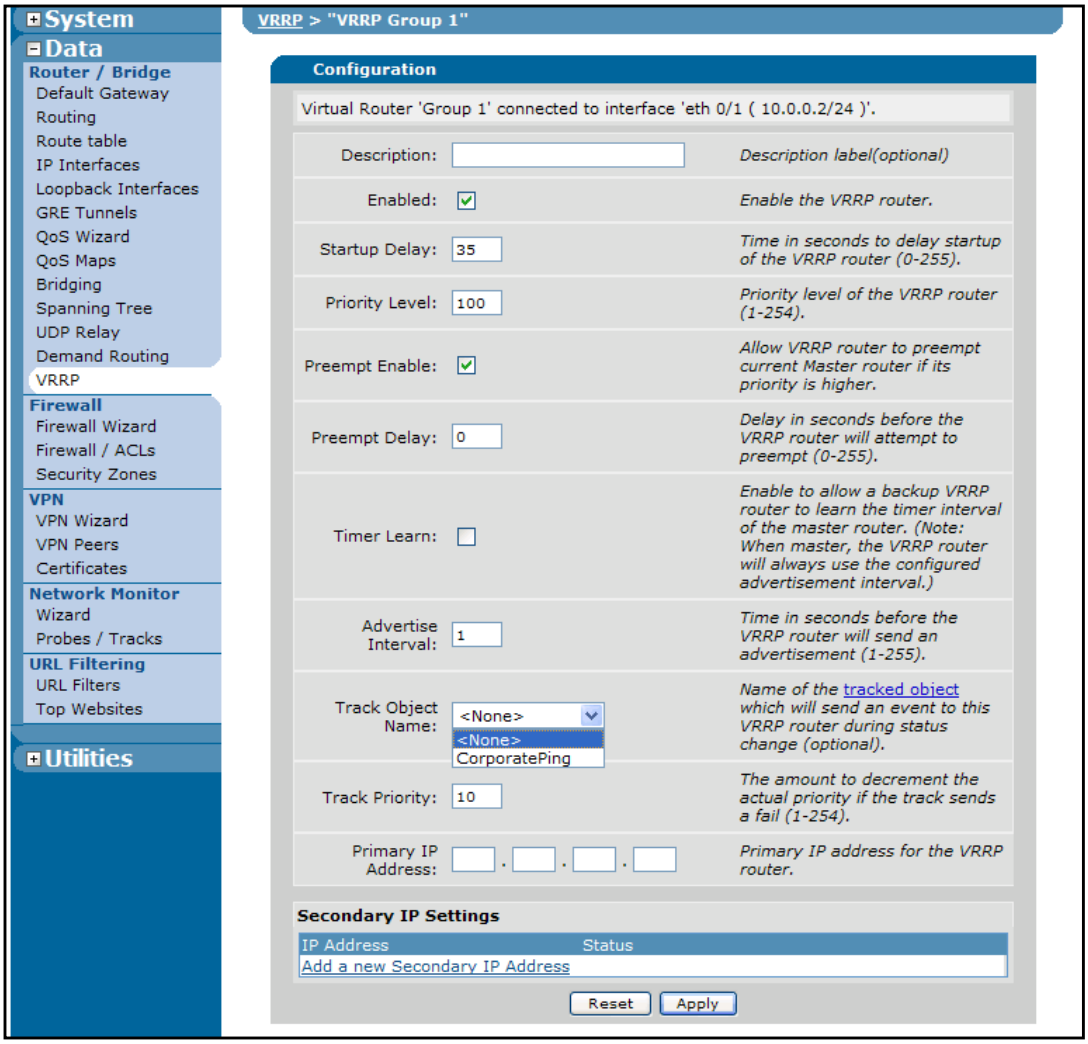
Step 1: Accessing VRRPv2 configuration

Select the **Data** tab on the left-hand side of the screen to expand the **Data** menu. Select **VRRP** to display the **Add/Delete/Modify a VRRP router** screen. Add a new virtual router group by choosing an interface to be configured for VRRPv2 and specifying the **VRRP ID** number. Select **Add a new VRRP router**. Modify an existing VRRPv2 router by selecting the blue hyperlink name of the group you want to modify.



Step 2: VRRPv2 configuration

The VRRPv2 group **Configuration** menu displays all available AOS VRRPv2 options. The **Startup Delay** and **Priority Level** are prepopulated with default values when configuring an AOS virtual router group on an AOS product for the first time. If an existing virtual router group is being modified, the current setting for the items is displayed.



At a minimum, the VRRPv2 group's **Primary IP Address** must be specified. The **Priority Level** should also be double-checked to ensure the desired router is the master for this VRRPv2 group. Refer to Steps 1 and 2 of *CLI Configuration on page 3* for detailed information on selecting and IPv4 address and choosing the priority level for a VRRPv2 group.

By default, VRRPv2 and preempting are enabled, so green check marks appear next to the **Enabled** and **Preempt Enable** check boxes. If desired, disable these features by clicking on the check mark. The check mark will disappear, indicating that the item is now disabled.

A name will only appear in the **Track Object Name** drop-down menu if a probe has been established and associated with a track. The value in the **Track Priority** box will only be used if an object for tracking has been selected in the previous box. Probes and tracks can be configured via the GUI by selecting **Probes/Tracks** from the **Data** tab. For more information on object tracking, refer to *Track on page 7* of this document.

Upon completing all of the desired settings for the VRRPv2 group, select **Apply** to apply the changes to the configuration. Save the configuration to memory by selecting **Save** in the upper right-hand corner of the menu.

Detailed information on all VRRPv2 options can be found in the Additional Settings on page 6 of this document.

Example Configurations

The following example scenarios are designed to enhance understanding of VRRPv2 configuration on AOS products.

Example 1: Grouping Multiple Routers into a Single Virtual Router (no IPv4 address owner)

A common implementation of VRRPv2 is when the virtual router IPv4 address is not owned; in other words, the virtual router IPv4 address is not assigned to any actual interfaces on the routers that are a part of the virtual router group.

Two routers, Router A and Router B, running a routing protocol (i.e., OSPF or RIP) on the same LAN have independent paths back to a corporate facility (see *Figure 2 on page 13*). These routers are grouped together to form a single virtual router (Virtual Router Group 1). The virtual router IPv4 address (10.0.0.1), is different from the Ethernet interface IPv4 addresses of Router A (10.0.0.2) and Router B (10.0.0.3). The priority level of router A is manually configured to **254** to ensure this router is the master for the virtual router group. Router B is a backup router for the virtual router group, thus its priority level is left at the default value of **100**. The **description** command is used to specify that Router A is the master router and Router B is a backup router for Virtual Router Group 1. The virtual router's IPv4 address is configured as the default gateway for the clients on the LAN. Under normal circumstances, Router A will route packets and send ARP responses on behalf of the virtual router. If Router A fails, Router B will assume the master role for the virtual router. The transition is transparent to the clients on the LAN.

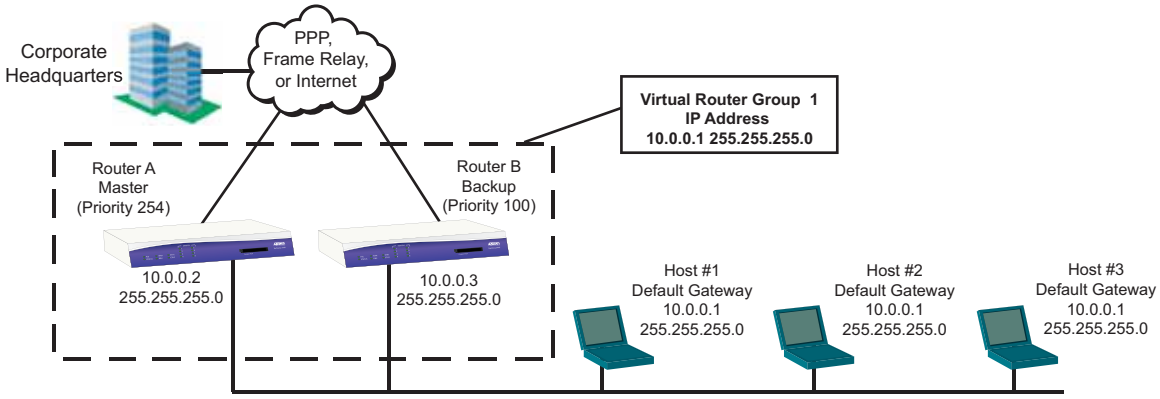


Figure 2. A Single Virtual Router with no IPv4 Address Owner

> NOTE *A dynamic routing protocol (i.e., RIP or OSPF) must be configured on the WAN for this application.*

The following commands are entered to configure VRRPv2 for Example 1:

Router A
(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.2 255.255.255.0**
(config-eth 0/1)#**vrrp 1 description Master Router**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**vrrp 1 priority 254**
(config-eth 0/1)#**exit**
(config)#**copy run start**

Router B
(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.3 255.255.255.0**
(config-eth 0/1)#**vrrp 1 description Backup Router**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**exit**
(config)#**copy run start**

Example 2: Grouping Multiple Routers into a Single Virtual Router (IPv4 address owner)

If it is necessary to conserve IPv4 addresses, then the IPv4 address assigned to the virtual router can be the same as the IPv4 address of an actual interface on a VRRPv2 router. The VRRPv2 router is called the IPv4 address owner in this scenario. Whenever the IPv4 address owner is online, it will always be the master router of the virtual router group.

Two routers, Router A and Router B, running a routing protocol (i.e., OSPF or RIP) on the same LAN have independent paths back to a corporate facility (see *Figure 3*). These routers are grouped together to form a single virtual router (Virtual Router Group 1). Since the virtual router IPv4 address (10.0.0.1) is the same as the IPv4 address assigned to Ethernet interface 0/1 on Router A (10.0.0.1), Router A is the IPv4 address owner for Virtual Router Group 1. The priority level of Router A defaults to the highest value of **255**. Router B, whose IPv4 address is 10.0.0.2, is a backup router for the virtual router group. The **description** command is used to specify that Router A is the default master router and Router B is a backup router for Virtual Router Group 1. The virtual router's IPv4 address is configured as the default gateway for the clients on the LAN. Under normal circumstances, Router A will route packets and send ARP responses on behalf of the virtual router. If Router A fails, Router B will assume the master role for the virtual router. The transition is transparent to the clients on the LAN.

Perhaps due to concerns about too much traffic on the LAN, the VRRPv2 advertisement interval is adjusted from the default value of **1** second to **3** seconds. The **timers advertise** command is issued on Router A to change the advertisement interval to **3** seconds. The **timers learn** command is issued on Router B so that it will learn the new advertisement interval from Router A. Note that lengthening the VRRPv2 advertisement interval will cause longer failover times.

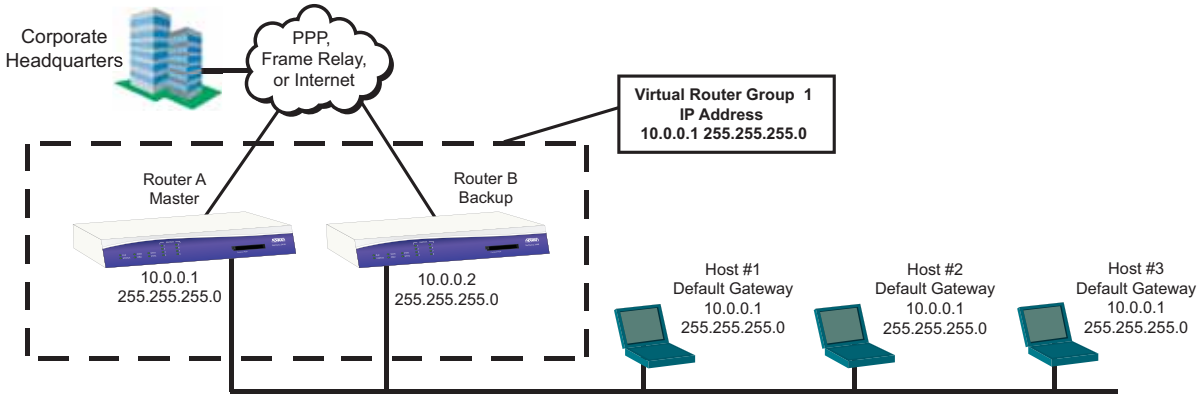


Figure 3. A Single Virtual Router Where Router A is the IPv4 Address Owner

The following commands are entered to configure VRRPv2 for Example 2:

Router A
(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.1 255.255.255.0**
(config-eth 0/1)#**vrrp 1 description Default Master Router**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**vrrp 1 timers advertise 3**
(config-eth 0/1)#**exit**

(config)#**copy run start**

Router B
(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.2 255.255.255.0**
(config-eth 0/1)#**vrrp 1 description Backup Router**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**vrrp 1 timers learn**
(config-eth 0/1)#**exit**
(config)#**copy run start**

When Router A fails, Router B becomes the master router and sends advertisements at one second intervals.This is because the timers advertise value for Router B is still at the default value of one second.

Example 3: Load Sharing, Redundancy, and Object Tracking with VRRPv2

VRRPv2 can be configured so that routers will perform load sharing under normal network conditions and provide redundancy when failure occurs in a router or network connection. Object tracking can be used to monitor the viability of a network path, and provide failure protection at Layer 3 of the Open Systems Interconnection (OSI) model.

The branch office for a business has two routers, Router A and Router B, with independent WAN connections running a routing protocol (i.e., OSPF or RIP) to the corporate headquarters (see *Figure 4 on page 16*). To make the best use of the available bandwidth, the routers perform load sharing for traffic that passes between the branch office and corporate headquarters. The routers also back each other up if a hardware failure occurs. Object tracking is used to monitor failure of the network connections to the corporate facility. An ICMP echo probe is established from each router across their respective WAN connection to the corporate headquarters. This probe is associated with a track that is used by VRRPv2 to decrement the configured priority level of the router on which object-tracking has been set up. As long as the probe is successful, the track will remain in a passing state and the router's configured priority level will remain unchanged. However, if the network path goes down, the ICMP echo will stop; causing the track associated with the probe to fail. When the track fails, the configured priority level of the router will be decremented by a specified amount. By decrementing the configured priority level of the master router, the backup router (whose WAN connection should still be viable) will take over routing all traffic between corporate headquarters and the branch office.

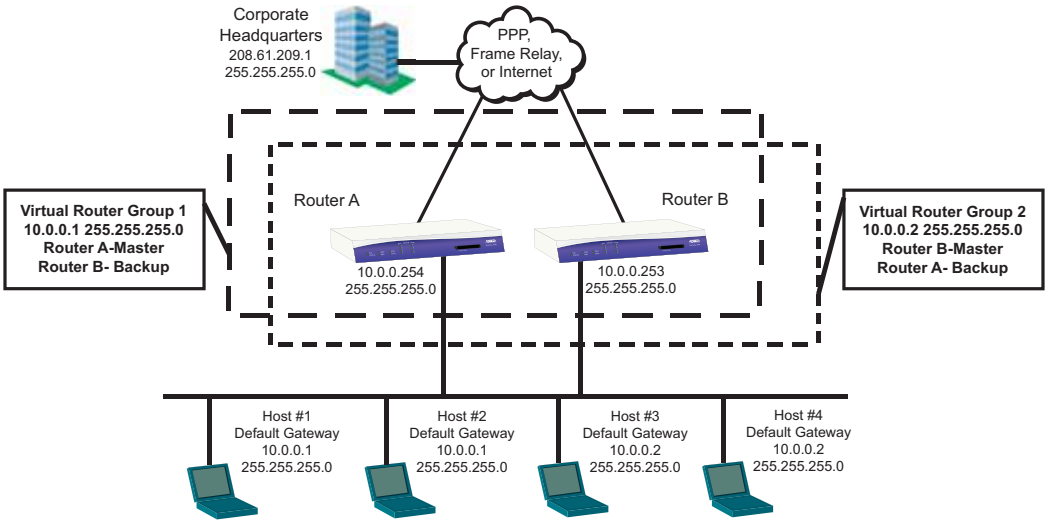


Figure 4. Two Virtual Routers Configured to Perform Load Sharing and Redundancy

Two virtual router groups are created: Virtual Router Group 1 and Virtual Router Group 2. Routers A and B will comprise each virtual router group. Router A is the master router for Virtual Router Group 1 and the backup router for Virtual Router Group 2. Router B is the master router for Virtual Router Group 2 and the backup router for Virtual Router Group 1. The priority level for the master router is set to 125. The priority level for the backup router is left at the default of **100**. Each virtual router group will be assigned its own IPv4 address, so no router will be an IPv4 address owner. The IPv4 address for Virtual Router Group 1 is 10.0.0.1. The IPv4 address for Virtual Router Group 2 is 10.0.0.2. Half of the clients on the LAN are configured with the default gateway address of Virtual Router Group 1 (10.0.0.1) and the other half of the clients on the LAN are configured with the default gateway address of Virtual Router Group 2 (10.0.0.2). The default gateways are assigned in this manner to facilitate load sharing. If a hardware failure occurs in Router A, Router B will become the master router for Virtual Router Group 1 and will begin forwarding packets and answering ARP requests sent to the IPv4 address 10.0.0.1. At the same time Router B will remain the master router for Virtual Router Group 2, forwarding packets and answering ARP requests sent to the IPv4 address 10.0.0.2. As soon as Router A is back online, it will resume master router responsibility for Virtual Router Group 1. If Router B fails, Router A will provide redundancy in the same manner as previously described.

An ICMP echo probe will be established across each individual WAN connection from Router A and Router B to Corporate Headquarters (208.61.209.1). In each router, the respective probe will be associated with a track named **CorporatePing**, which will be referenced in the **vrrp track** command. As long as the ICMP echo probe is successful, the track will remain in a passing state and the router's configured priority level will remain unchanged. However, if the network connection fails, the ICMP echo probe will become unsuccessful, and the track will move to a failure state. When this occurs, the configured priority level of the router (Router A or Router B depending on which network path is no longer viable) will be decremented by a value of **60**. By decrementing the master router's (Router A) configured priority level from **125** to an actual priority level of **75**, the backup router (Router B), whose actual priority level is **100**, will now have a higher actual priority level than the master router. Thus, the backup router will transition into the master router role for the virtual router group.

The following commands are entered to configure VRRPv2 and object tracking for Example 3:

Router A (VRRPv2)

(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.254 255.255.255.0**
(config-eth 0/1)#**vrrp 1 description Master Router Group 1**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**vrrp 1 priority 125**
(config-eth 0/1)#**vrrp 1 track CorporatePing decrement 50**
(config-eth 0/1)#**vrrp 2 description Backup Router Group 2**
(config-eth 0/1)#**vrrp 2 ip 10.0.0.2**
(config-eth 0/1)#**exit**
(config)#**do copy run start**

Router B (VRRPv2)

(config)#**interface ethernet 0/1**
(config-eth 0/1)#**ip address 10.0.0.253 255.255.255.0**
(config-eth 0/1)#**vrrp 2 description Master Router Group 2**
(config-eth 0/1)#**vrrp 2 ip 10.0.0.2**
(config-eth 0/1)#**vrrp 2 priority 125**
(config-eth 0/1)#**vrrp 2 track CorporatePing decrement 50**
(config-eth 0/1)#**vrrp 1 description Backup Router Group 1**
(config-eth 0/1)#**vrrp 1 ip 10.0.0.1**
(config-eth 0/1)#**exit**
(config)#**do copy run start**

Router A and B (Probe and Track)

(config)#**probe CorporatePing icmp-echo**
(config-probe-CorporatePing)#**destination 208.61.209.1**
(config-probe-CorporatePing)#**tolerance consecutive fail 2 pass 4**
(config-probe-CorporatePing)#**no shutdown**
(config-probe-CorporatePing)#**exit**
(config)#**track CorporatePing**
(config-track-CorporatePing)#**test if probe CorporatePing**
(config-track-CorporatePing)#**exit**
(config)#**exit**
#**copy run start**

Quick Configuration Guide

VRRPv2 is supported on Ethernet and VLAN broadcast domain interfaces. Therefore, VRRPv2 commands are issued on either Ethernet or VLAN interfaces in the AOS products. For illustrative purposes, Ethernet interface 0/1 (**eth 0/1**) will be used throughout this tutorial.

When configuring VRRPv2, each command begins with the **vrrp** parameter followed by the VRID number for the virtual router group to be configured. To create a new virtual router group, any VRID that is not already in use on the LAN may be chosen within the range of **1** to **255**. The AOS product can be added to an existing virtual router group by specifying the group's VRID.

Step 1: Specify the IPv4 address to be used by the virtual router

(config-eth 0/1)#**vrrp** <*number*> **ip** <*ipv4 address*> [**secondary]**

Additional IPv4 addresses supported by the virtual router are entered using the **secondary** keyword.

Step 2: Set the priority level of the VRRPv2 router

It is possible for VRRPv2 to operate based on default priority-level settings. However, it is important to understand and verify the election process to ensure the desired VRRPv2 router is ultimately selected as the master.

(config-eth 0/1)#**vrrp** <*number*> **priority** <*level*>

Object tracking can be used to decrement the priority level in a VRRPv2 router. Refer toAdditional Settings on page 6 and Example 3: Load Sharing, Redundancy, and Object Tracking with VRRPv2 on page 15 for more details on object tracking.

Step 3: Exit the interface and save the configuration to memory

(config-eth 0/1)#**exit**
(config)#**do copy run start**

or

(config-eth 0/1)#**exit**
(config)#**do write**

Command Summary

The following tables summarize the minimum steps and additional settings required to configure VRRPv2 on an AOS product.

Table 1. VRRPv2 Configuration Steps

Step	Command	Description
Step 1	(config-eth 0/1)#**vrrp** <*number*> **ip** <*ipv4 address*> **[secondary]**	Specifies the IPv4 address to be used by the virtual router. A secondary IPv4 address supported by this virtual router can be added using the **secondary** keyword.
Step 2	(config-eth 0/1)#**vrrp** <*number*> **priority** <*level*>	Optional. Examine the configured priority level of the VRRPv2 router. Modify if needed. Level range is **1** to **254**.
Step 3	(config-eth 0/1)#**exit** (config)#**do copy run start**	Exits the interface and saves the configuration to memory.

Table 2. Additional VRRPv2 Configuration Settings

Command	Description
(config-eth 0/1)#**vrrp** <*number*> **preempt delay minimum** <*time*>	Allows a VRRPv2 router to preempt the current master router if its priority level is higher than the current master's. The optional **delay minimum** keywords specify the amount of time (in seconds) the router will wait before attempting to preempt the current master router. Range is **0** to **255** seconds.
(config-eth 0/1)#**vrrp** <*number*> **description** <*text*>	Specifies a textual description for a virtual router group.
(config-eth 0/1)#**vrrp** <*number*> **timers advertise** <*interval*>	Specifies the time (in seconds) between advertisements sent by the master router. Range is **1** to **255** seconds.
(config-eth 0/1)#**vrrp** <*number*> **timers learn**	Specifies the backup VRRPv2 router learns the advertisement interval of the master router.
(config-eth 0/1)#**vrrp** <*number*> **track** <*name*> **[decrement** <*value*>**]**	Associates a track with the VRRPv2 group and, upon failure of this track, decrements the priority level of the router by the specified amount. Decrement value range is **1** to **254**.
(config-eth 0/1)#**vrrp** <*number*> **shutdown**	Disables the VRRPv2 router.
(config-eth 0/1)#**vrrp** <*number*> **startup-delay** <*delay*>	Configures the router with a hold down timer that prevents it from becoming active. Delay range is **0** to **255** seconds.

Troubleshooting

After configuring VRRPv2, several different commands can be issued from Enable mode in the CLI to assist in troubleshooting. The following table contains the AOS troubleshooting commands that are implemented specifically for VRRPv2.

Table 3. Enable Mode Troubleshooting Commands

Command	Description
show vrrp [brief]	Displays configuration and operating data for all VRRPv2 groups on all interfaces. The optional **brief** keyword limits the amount of data shown per group.
show vrrp statistics	Displays VRRPv2 statistics for all VRRPv2 groups on all interfaces.
clear vrrp counters	Clears the VRRPv2 statistics counters for all VRRPv2 groups on all interfaces.
debug vrrp	Displays all VRRPv2 debug messages for all groups on all interfaces.
debug vrrp error	Displays VRRPv2 debug error messages for all groups on all interfaces.
debug vrrp packet	Displays VRRPv2 debug packet messages for all groups on all interfaces.

Table 4. Interface Level Troubleshooting Commands

Command	Description
show vrrp interface <*interface*>	Displays configuration and operating data for all VRRPv2 groups on the specified interface.
show vrrp statistics interface <*interface*>	Displays VRRPv2 statistics for all VRRPv2 groups on the specified interface.
clear vrrp counters interface <*interface*>	Clears the VRRPv2 statistics counters for all VRRPv2 groups on the specified interface.
debug vrrp interface <*interface*> **error**	Displays the VRRPv2 debug error messages for all groups on the specified interface.
debug vrrp interface <*interface*> **packet**	Displays the VRRPv2 debug packet messages for all groups on the specified interface.

Table 5. Group Level Troubleshooting Commands

Command	Description
show vrrp interface <*interface*> **group** <*number*>	Displays configuration and operating data for the specified VRRPv2 group on the specified interface.
show vrrp statistics interface <*interface*> **group** <*number*>	Displays VRRPv2 statistics for the specified VRRPv2 group on the specified interface.
clear vrrp counters interface <*interface*> **group** <*number*>	Clears the VRRPv2 statistics counters for the specified VRRPv2 group on the specified interface.
debug vrrp interface <*interface*> **group** <*number*>	Displays the VRRPv2 debug messages associated with both the specified group and interface.
debug vrrp interface <*interface*> **group** <*number*> **error**	Displays the VRRPv2 debug error messages associated with both the specified group and interface.
debug vrrp interface <*interface*> **group** <*number*> **packet**	Displays the VRRPv2 debug packet messages associated with both the specified group and interface.

State messages are displayed on the console whenever there is a change in the state of the VRRPv2 router for any of the virtual router groups. The output follows the format below:

[time stamp] VRRP.[interface] grp [VRID] changed state [MASTER->BACKUP/BACKUP->MASTER]

The following example state message shows that a VRRPv2 router has transitioned from master router to backup for Virtual Router Group 1:

2007.05.26 16:19:59 VRRP.eth 0/1 grp 1 changed state MASTER->BACKUP

Show Commands

The **show** commands are used to display configuration, operating, and statistical data for VRRPv2 routers. When issued at the router Enable level (i.e., #**show vrrp**), information is displayed for all VRRPv2 groups configured on all interfaces in the AOS product. Each **show** command can be issued for a specific interface and even a specific VRRPv2 group on that interface. Specifying interfaces and groups when issuing a **show** command reduces the amount of information displayed and allows an administrator to view precise information quickly and easily.

The **show vrrp** command displays detailed information pertinent to VRRPv2 configuration and operation. The following example output shows that this VRRPv2 router has an actual priority of **125** and is the master for Virtual Router Group 1. The IPv4 address for the virtual router is 10.0.0.1. Virtual Router Group 1 is also associated with the track called **CorporatePing** and, upon failure of this track, this router's priority will be decremented by the numerical value of **50**. The output also shows that this router is a backup router for Virtual Router Group 2. The IPv4 address for Virtual Router Group 2 is 10.0.0.2. A different router with IPv4 address 10.0.0.253 is the master router for this group.The **Master down**

Interval displayed is the maximum amount of time this unit will wait for an advertisement before it tries to become master. This router will wait 3.609 seconds for an advertisement from the master router of VRRPv2 group 2. There are 2.634 seconds remaining during this wait period. The countdown timer will continue to be restarted at 3.609 seconds every time a new VRRPv2 advertisement is received from the master router.

```
#show vrrp
eth 0/1
Group 1
        State: Master
        Administrative state: UP
        Description: Master Router Group 1
        Configured Priority: 125,  Actual Priority: 125
        Number of IP Addresses: 1
        Virtual IP Address: 10.0.0.1
        Virtual MAC Address: 00:00:5E:00:01:01
        Advertisement interval: 1 second(s)
        Preemption: Enabled - delay 0 second(s)
        Last Transition: 0:00:19:53
        Tracks: CorporatePing, Decrement: 50
        Master IP Address: 10.0.0.254 (local)  Priority: 125
Group 2
        State: Backup
        Administrative state: UP
        Description: Backup Router Group 2
        Configured Priority: 100,  Actual Priority: 100
        Number of IP Addresses: 1
        Virtual IP Address: 10.0.0.2
        Virtual MAC Address: 00:00:5E:00:01:02
        Advertisement interval: 1 second(s)
        Preemption: Enabled - delay 0 second(s)
        Last Transition: 0:00:03:31
        Tracks: None
       Master down Interval: 3.609 second(s), 2.634 second(s)    remaining
        Master IP Address: 10.0.0.253  Priority: 125
```


Add the optional **brief** keyword to the **show vrrp** command to limit the amount of data shown per group.

```
#show vrrp brief
eth 0/1
Group 1
    State: Master
    Actual Priority: 125
    Virtual IP: 10.23.197.234
    Preemption: Enabled
    Tracks: CorporatePing
Group 2
    State: Backup
    Actual Priority: 100
    Virtual IP: 10.23.197.235
    Preemption: Enabled
    Tracks: None
```

The **show vrrp statistics** command displays statistical information for VRRPv2 groups. One of the line items shows how many times this VRRPv2 router became master router for a particular VRRPv2 group. The number of VRRPv2 advertisements sent and received is also displayed. Note that the number of advertisements sent will be zero for a group if this router has never been master of that group. Information on the number of times various errors have occurred is also displayed in the output of this command. Use the **clear vrrp counters** command to reset all statistic values back to zero. The **clear** command can also be issued to only clear counters at specified interface and group levels.

```
#show vrrp statistics
eth 0/1
Group 1
    Became Master: 3
    Priority Zero Packets Sent: 1
    Priority Zero Packets Received: 0
    Advertisements Sent: 105134
    Advertisements Received: 241
        Advertisements Interval Errors: 0
        Advertisements TTL Errors: 0
        Advertisements Address List Errors: 0
        Advertisements Packet Length Errors: 0
Group 2
    Became Master: 1
    Priority Zero Packets Sent: 0
    Priority Zero Packets Received: 0
    Advertisements Sent: 897
    Advertisements Received: 1628
        Advertisements Interval Errors: 0
        Advertisements TTL Errors: 0
        Advertisements Address List Errors: 0
        Advertisements Packet Length Errors: 0
```


Debug Commands

The **debug** commands are used to provide insight into the operation of VRRPv2 routers. When issued at the router Enable level (i.e., #**debug vrrp**), debug messages are displayed for all VRRPv2 groups configured on all interfaces in the AOS product. Debug commands can be issued for a specific interface and a specific VRRPv2 group on that interface. It is recommended that **debug** commands be as specific as possible. Debug messages can be numerous, making it a tedious task to sort through all of the information displayed. The more specific the **debug** command, the easier it will be to pinpoint pertinent data.

*Some **debug** commands will produce data that will quickly fill up the screen. Due to continuous scrolling of incoming debug messages, it may become difficult to execute the **no** form of the **debug** command to turn debug messages off. A shortcut command can be issued to turn all debug messages off. This command is **#undebug all** or #**u all** for short.*

Turning on a large amount of debug information can adversely affect the performance of your unit.

The **debug vrrp packet** command displays packet messages related to VRRPv2. The output follows the format below:

[time stamp] VRRP.PKT [interface] grp [VRID] [Received Advertisement] pri: [actual priority of the router the advertisement was received from] from [IP address of the router the advertisement was received from]

or

[time stamp] VRRP.PKT [interface] grp [VRID] [Sent Advertisement] pri: [actual priority of this router] ipCnt: [total number of IP addresses configured for the VRRP group]

Consider the following sample output for the **debug vrrp packet** command:

2007.05.26 15:48:57 VRRP.PKT eth 0/1 grp 1 Sent Advertisement pri: 125, ipCnt: 1
2007.05.26 15:48:57 VRRP.PKT eth 0/1 grp 2 Received Advertisement pri: 125 from 10.23.197.236

The first message indicates that this router, whose actual priority is 125, sent a VRRPv2 advertisement for Virtual Router Group 1 on Ethernet interface 0/1 at 15:48:57 on May 26, 2007. The **ipCnt** field indicates that there is currently one configured IPv4 address for this VRRPv2 group. Note that the **ipCnt** includes the primary IPv4 address plus all secondary IPv4 addresses that have been configured for a group.

The second message indicates that this router received a VRRPv2 advertisement at 15:48:57 on May 26, 2007 for Virtual Router Group 2 on Ethernet interface 0/1 from a router with an actual priority of 125 and IPv4 address of 10.23.197.236.

The **debug vrrp error** command displays error messages related to VRRPv2. Situations that will generate error messages include when advertisement intervals do not match or when the virtual router IPv4 address for a group is not the same on every router.

The **debug vrrp** command displays all messages related to VRRPv2, including packet, error, and state messages. Consider the following sample output from the **debug vrrp** command:

```
2007.05.26 15:48:56 VRRP.PKT eth 0/1 grp 1 Received Advertisement pri: 100 from 10.23.197.236
2007.05.26 15:48:56 VRRP.PKT eth 0/1 grp 2 Received Advertisement pri: 125 from 10.23.197.236
2007.05.26 15:48:57 VRRP.eth 0/1 grp 1 changed state BACKUP->MASTER
2007.05.26 15:48:57 VRRP.PKT eth 0/1 grp 1 Sent Advertisement pri: 125, ipCnt: 1
2007.05.26 15:48:57 VRRP.PKT eth 0/1 grp 2 Received Advertisement pri: 125 from 10.23.197.236
```

Initial packet messages show that this router is receiving VRRPv2 advertisements for both Virtual Router Groups 1 and 2 on Ethernet interface 0/1. Next, the state message (in bold) indicates that this router transitions from backup to master router for Virtual Router Group 1. The packet message that follows the state message shows that this router is now sending VRRPv2 advertisements for Virtual Router Group 1. The last packet message displayed shows that this router is still receiving VRRPv2 advertisements for Virtual Router Group 2.

