Configuring OSPF and RIP on Avaya Virtual Services Platform 4000

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Contents

Chapter 1: Introduction

Purpose

This document provides information on features in VSP Operating System Software (VOSS). VOSS runs on the following product families:

- Avaya Virtual Services Platform 4000 Series
- Avaya Virtual Services Platform 7200 Series
- Avaya Virtual Services Platform 8000 Series

This document provides procedures and conceptual information that you can use to configure the Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) on the Avaya Virtual Services Platform 4000 Series. The router uses these protocols to determine the best routes for data forwarding.

For information about the Border Gateway Protocol, see *Configuring BGP Services on VSP Operating System Software*, NN47227-508.

For information on configuring RIP and OSPF on Avaya Virtual Services Platform 7200 Series and 8000 Series switches, see *Configuring OSPF and RIP on Avaya Virtual Services Platform 7200 Series and 8000 Series*, NN47227-506.

Related resources

Documentation

See the *Documentation Roadmap for Avaya Virtual Services Platform 4000 Series*, NN46251-100 for a list of the documentation for this product.

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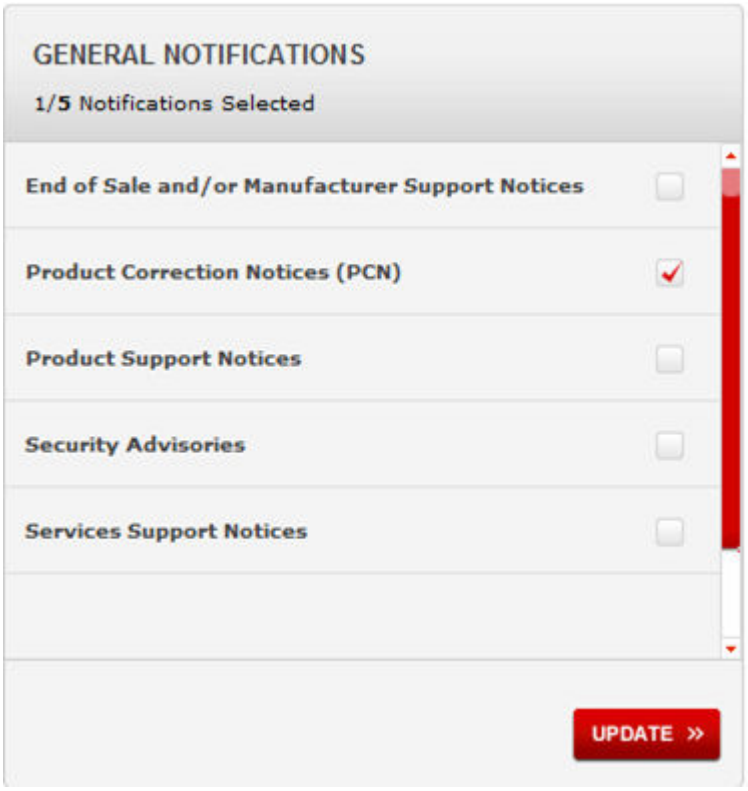

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7. In the PRODUCT NOTIFICATIONS area, click **Add More Products**.

8. Scroll through the list, and then select the product name.
9. Select a release version.
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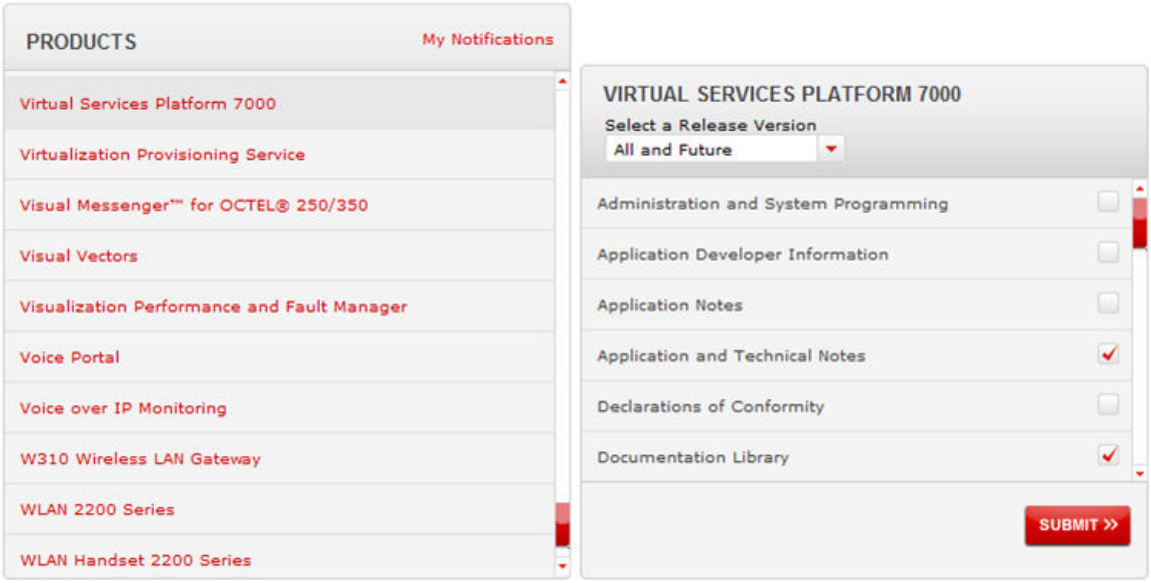

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   The search results show the number of documents and instances found. You can sort the search results by Relevance Ranking, Date Modified, Filename, or Location. The default is Relevance Ranking.

Chapter 2: New in this document

The following sections detail what is new in the *Configuring OSPF and RIP on Avaya Virtual Services Platform 4000 Series*, NN46251-506.

OSPFv2 and OSPFv3 route metric value updates

VLAN parameter added for configuring default-cost under router OSPF configuration, for both ACLI and EDM. For more information, see:

- Configuring OSPF globally on page 53
- Viewing the OSPF default cost information on page 75

Chapter 3: Routing fundamentals

Use the information in this section to help you understand IP routing.

For more information about how to use the Avaya command line interface (ACLI), see *Using ACLI and EDM on VSP Operating System Software*, NN47227-103.

Routing protocols

Routers and routing switches use routing protocols to exchange reachability information. Routers use a routing protocol to advertise available paths on which the router can forward data. The routers use the protocol to determine the most efficient path to use. Routers use dynamic routing protocols to avoid sending data to inoperable links, and to send data to links that generally result in the fastest transmission times.

The Avaya Virtual Services Platform 4000 supports wire-speed IP routing of frames using one of the following dynamic unicast IP routing protocols for path selection:

- Routing Information Protocol version 1 (RIPv1) (RFC 1058)
- RIPv2 (RFC 2453)
- Open Shortest Path First version 2 (OSPFv2) (RFC 2328)
- Border Gateway Protocol version 4 (BGPv4) (RFC 1771)

Unlike static IP routing, where you must create a manual entry in the routing table to specify a routing path, dynamic IP routing uses a learning approach to determine the paths and routes to other routers. Dynamic routing uses two basic types of routing: distance vector and link-state. Routing Information Protocol (RIP) is a distance vector protocol and Open Shortest Path First (OSPF) is a link-state protocol.

The VSP 4000 uses routing protocols like OSPF and RIP to populate routing tables. Routers use a routing protocol to exchange network topology information. A router uses the IP address of an incoming data packet to send the packet according to the routing tables.

The most commonly used unicast routing protocols include OSPF, RIP, and BGP. For more information about BGP, see *Configuring BGP Services on VSP Operating System Software*, NN47227-508. For information about multicast routing protocols, see *Configuring IP Multicast Routing Protocols on Avaya Virtual Services Platform 4000 Series* , NN46251-504.

IP addresses

An IP version 4 (IPv4) address consists of 32 bits expressed in dotted-decimal format (x.x.x.x). The IPv4 address space divides into classes, with classes A, B, and C reserved for unicast addresses. Class A, B, and C account for 87.5 percent of the 32-bit IP address space. Class D is reserved for multicast addressing. The following table describes IP address space by address range and mask.

Table 1: IP addresses

Class	Address range	Mask	Number of addresses
A	1.0.0.0—126.0.0.0	255.0.0.0	126
B	128.0.0.0—191.0.0.0	255.255.0.0	127 * 255
C	192.0.0.0—223.0.0.0	255.255.255.0	31 * 255 * 255
D	224.0.0.0—239.0.0.0	—	—

To express an IP address in dotted-decimal notation, convert each octet of the IP address to a decimal number and separate the numbers by decimal points. For example, specify the 32-bit IP address 10000000 00100000 00001010 10100111 in dotted-decimal notation as 128.32.10.167.

Each IP address class, when expressed in binary, has a different boundary point between the network and host portions of the address as illustrated in the following figure. The network portion is a network number from 8 to 24 bits. The remaining bits identify a specific host on the network.

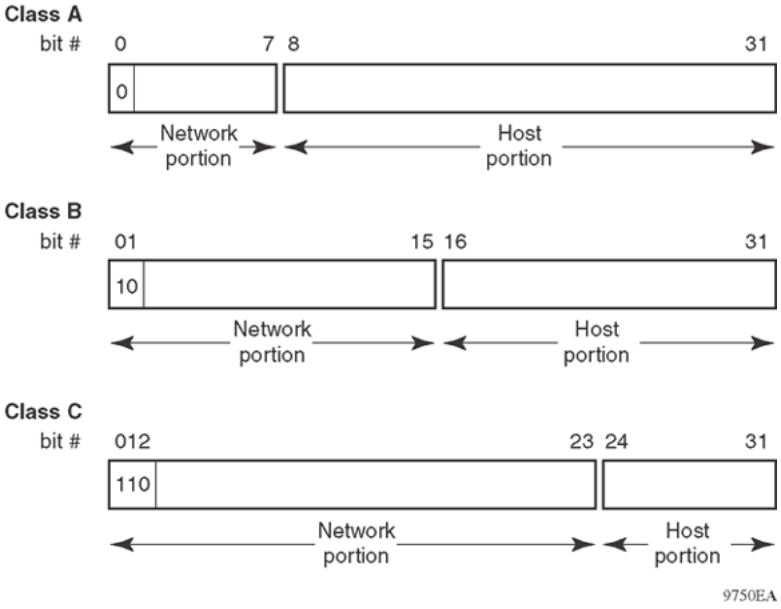

Figure 1: Network and host boundaries in IP address classes

IPv4 addresses are 32 bits long and expressed in decimal format.

Subnet addressing

Subnetworks (or subnets) extend the IP addressing scheme used by an organization to one with an IP address range for multiple networks. Subnets are two or more physical networks that share a common network-identification field (the network portion of the 32-bit IP address).

Create a subnet address by increasing the network portion to include a subnet address, thus decreasing the host portion of the IP address. For example, in the address 128.32.10.0, the network portion is 128.32, while the subnet is in the first octet of the host portion (10). A subnet mask applies to the IP address and identifies the network and host portions of the address.

The following table illustrates how subnet masks can create different numbers of subnets and hosts. This example includes using the zero subnet, which Virtual Services Platform 4000 supports.

Table 2: Subnet masks for class B and class C IP addresses

Number of bits	Subnet mask	Number of subnets (recommended)	Number of hosts for each subnet
Class B			
2	255.255.192.0	2	16 382
3	255.255.224.0	6	8 190
4	255.255.240.0	14	4 094
5	255.255.248.0	30	2 046
6	255.255.252.0	62	1 022
7	255.255.254.0	126	510
8	255.255.255.0	254	254
9	255.255.255.128	510	126
10	255.255.255.192	1 022	62
11	255.255.255.224	2 046	30
12	255.255.255.240	4 094	14
13	255.255.255.248	8 190	6
14	255.255.255.252	16 382	2
Class C			
1	255.255.255.128	0	126
2	255.255.255.192	2	62
3	255.255.255.224	6	30
4	255.255.255.240	14	14
5	255.255.255.248	30	6
6	255.255.255.252	62	2

With variable-length subnet masking (VLSM), you can divide your intranet into pieces that match your requirements. Routing is based on the longest subnet mask or network that matches. RIPv2 and OSPF both support VLSM.

Supernet addressing and CIDR

A supernet, or classless interdomain routing (CIDR) address, is a group of networks identified by contiguous network addresses. IP service providers can assign customers blocks of contiguous addresses to define supernets as needed. Using supernetting, you can address an entire block of class C addresses and avoid using large routing tables to track the addresses.

Each supernet has a unique supernet address that consists of the upper bits shared by all addresses in the contiguous block. For example, consider the class C addresses shown in the following figure. By adding the mask 255.255.128.0 to IP address 192.32.128.0, you aggregate the addresses 192.32.128.0 through 192.32.255.255, and 128 class C addresses use a single routing advertisement. As shown in the following figure, you use the address 192.32.0.0/17 to aggregate 128 addresses (192.32.0.0/24 to 192.32.127.0/24).

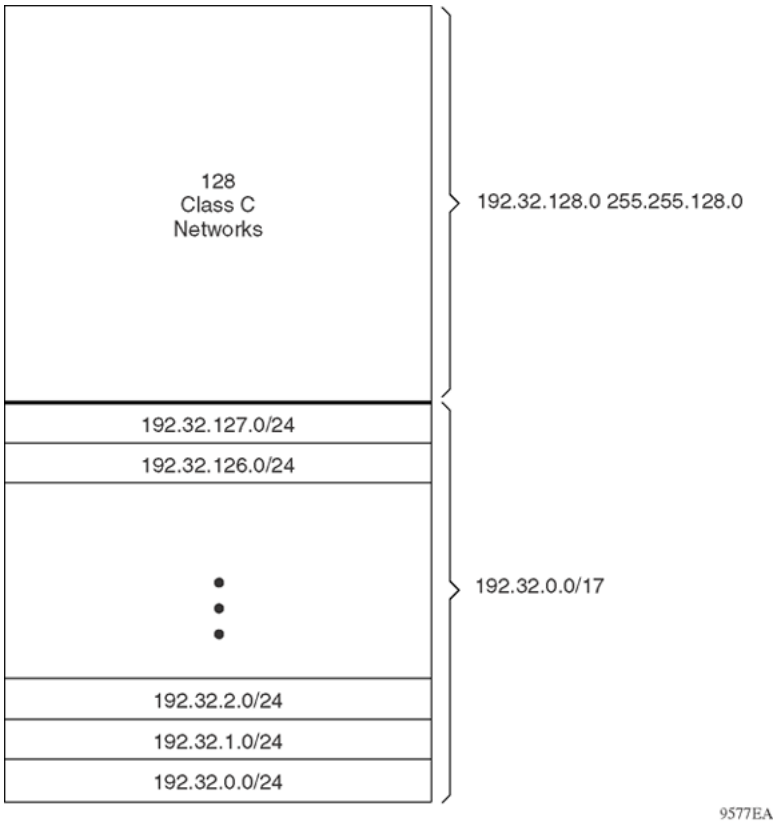

Figure 2: Class C address supernet

Another example is the block of addresses 192.32.0.0 to 192.32.7.0. The supernet address for this block is 11000000 00100000 00000, with the 21 upper bits shared by the 32-bit addresses.

A complete supernet address consists of an address–mask pair:

- The address is the first 32-bit IP address in the contiguous block. In this example, the address is 11000000 00100000 00000000 00000000 (192.32.0.0 in dotted-decimal notation).
- The mask is a 32-bit string that contains a set bit for each bit position in the supernet part of the address. The mask for the supernet address in this example is 11111111 11111111 11111000 00000000 (255.255.248.0 in dotted-decimal notation).

The complete supernet address in this example is 192.32.0.0/21.

Although classes prohibit using an address mask with the IP address, you can use CIDR to create networks of various sizes using the address mask. You can also divide your address space using VLSM; however, the division is not used outside your network. With CIDR, routers outside your network use your addresses.

VLANs and routing

To route traffic on a virtual local area network (VLAN), you assign an IP address to the VLAN and not with a particular physical port. Brouter ports use single-port VLANs to route IP packets and bridge nonroutable traffic in specifically assigned VLANs.

Virtual routing between VLANs

The Avaya Virtual Services Platform 4000 supports wire-speed IP routing between VLANs. As shown in the following figure, although VLAN 1 and VLAN 2 are on the same switch, for traffic to flow from VLAN 1 to VLAN 2, the traffic must be routed.

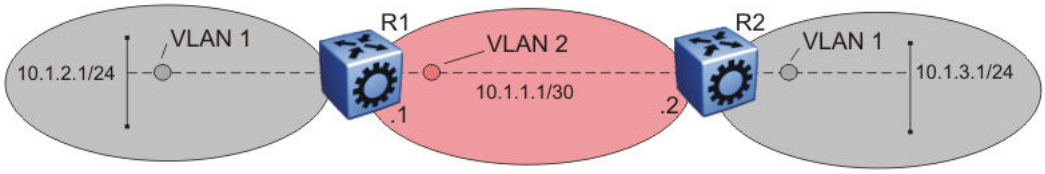

Figure 3: IP routing between VLANs

To configure routing on a VLAN, you assign an IP address to the VLAN, which acts as a virtual router interface address for the VLAN (a virtual router interface is so named because it is associated with no particular port). Through a VLAN port, you can reach the VLAN IP address, and the VLAN routes frames through the gateway IP address. The system forwards routed traffic to another VLAN within the switch.

If you use a spanning tree protocol on a VLAN, spanning tree convergence must be stable before the routing protocol begins. This requirement can lead to an additional delay in forwarding IP traffic.

Because a port can belong to multiple VLANs (some of which are routed on the switch and some of which are not), a one-to-one correspondence no longer exists between the physical port and the router interface.

As with an IP address, you can also use virtual router interface addresses for device management. For Simple Network Management Protocol (SNMP) or Telnet management, you can use a virtual router interface address to access the switch if you enable routing on the VLAN.

Brouter ports

The Virtual Services Platform 4000 supports brouter ports. A brouter port is a single-port VLAN that can route IP packets and bridge all nonroutable traffic. The difference between a brouter port and a standard IP protocol-based VLAN that performs routing is that the routing interface of the brouter port is not subject to the spanning tree state of the port. A brouter port can be in the blocking state for nonroutable traffic and can still route IP traffic. This feature removes interruptions caused by spanning tree recalculations in routed traffic.

Because a brouter port is a single-port VLAN, each brouter port decreases the number of available VLANs by one and uses one VLAN ID.

Static routes

You can use static routes to manually create routes to a destination IP address.

You can use a static default route to specify a route to all networks for which no explicit routes exist in the forwarding information base (FIB) or the routing table. This route is, by definition, a route with the prefix length of zero (RFC1812). You can configure the Virtual Services Platform 4000 with a route by using the IP static routing table.

To create a default static route, you must configure the destination address and subnet mask to 0.0.0.0.

You can configure a static route with a next-hop that does not directly connect, but that hop must be reachable. Otherwise, the static route is disabled.

Black hole static routes

A black hole static route is a route with an invalid next hop. The switch drops packets destined for this network.

While it aggregates or injects routes to other routers, the router itself cannot have a path to the aggregated destination. In such cases, the result is a black hole or a routing loop. To avoid such loops, configure a black hole static route to the advertised destination.

You can configure a preference value for a black hole route. Configure that preference value so that the route is elected as the best route.

Before you add a black hole static route, ensure that no other static route to the same destination is enabled. If such a route exists, you cannot add the black hole route.

If you enable a black hole route, you cannot add another static route to that destination. You must delete or disable the black hole route before you add a regular static route to that destination.

Circuitless IP

Circuitless IP (CLIP) is a virtual (or loopback) interface that is not associated with a physical port. You can use the CLIP interface to provide uninterrupted connectivity to your switch if a path is available to reach the device.

A CLIP address, or a loopback address, is an IP address that is not tied to a specific interface. Because the CLIP address is not tied to a physical port or VLAN, the CLIP state is always active.

You can use a CLIP address as the OSPF router ID. If you use BGP with OSPF, the OSPF router ID becomes the BGP identifier automatically. Therefore, in this case, Avaya recommends that you use the CLIP address as the OSPF router ID. By doing so, the OSPF router ID is always active regardless of the port state (up or down).

Note:

You can configure only one CLIP interface with an IPv6 address, which can be only used as a source IPV6 address for IS-IS.

For example, as shown in the following figure, a physical point-to-point link exists between R1 and R2 along with the associated addresses (195.39.1.1/30 and 195.39.1.2/30). An interior Border Gateway Protocol (iBGP) session exists between two additional addresses, 195.39.128.1/30 (CLIP 1) and 195.39.281.2/30 (CLIP 2).

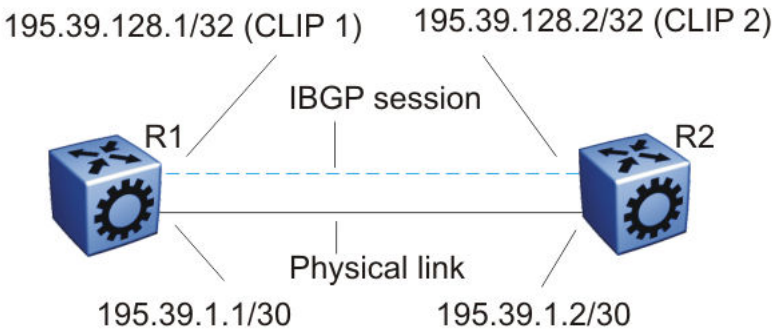

Figure 4: Routers with iBGP connections

CLIP 1 and CLIP 2 represent the virtual CLIP addresses between R1 and R2. These virtual interfaces are not associated with the physical link or hardware interface. The iBGP session can continue as long as a path exists between R1 and R2. An Interior Gateway Protocol (IGP), for example, OSPF, routes addresses that correspond to the CLIP addresses. After the routers in the autonomous system (AS) learn all the CLIP addresses, the routers establish the iBGP session and exchange routes.

The router treats the CLIP interface like an IP interface. The router treats the network associated with the CLIP as a local network attached to the device. This route always exists and the circuit is always up because no physical attachment exists.

The router advertises routes to other routers in the domain either as external routes using the route redistribution process or after you enable OSPF in a passive mode to advertise an OSPF internal route. You can configure only the OSPF protocol on the circuitless IP interface.

After you create a CLIP interface, the system software programs a local route with the CPU as the destination ID. The CPU processes all packets destined to the CLIP interface address. The system treats other packets with destination addresses associated with this network (but not with the interface address) as if they are from an unknown host.

You can use a CLIP address as the source IP address in the IP header to send remote monitoring (RMON) traps.

Route policies

When the Virtual Services Platform 4000 routes IP traffic, you can apply a number of route policies (filters) to manage, accept, redistribute, and announce policies for unicast routing table information. The filtering process relies on the IP prefix lists in the common routing table manager infrastructure. Filters apply in different ways to various unicast routing protocols.

The following figure shows how filters apply to the BGP, RIP, and OSPF protocols.

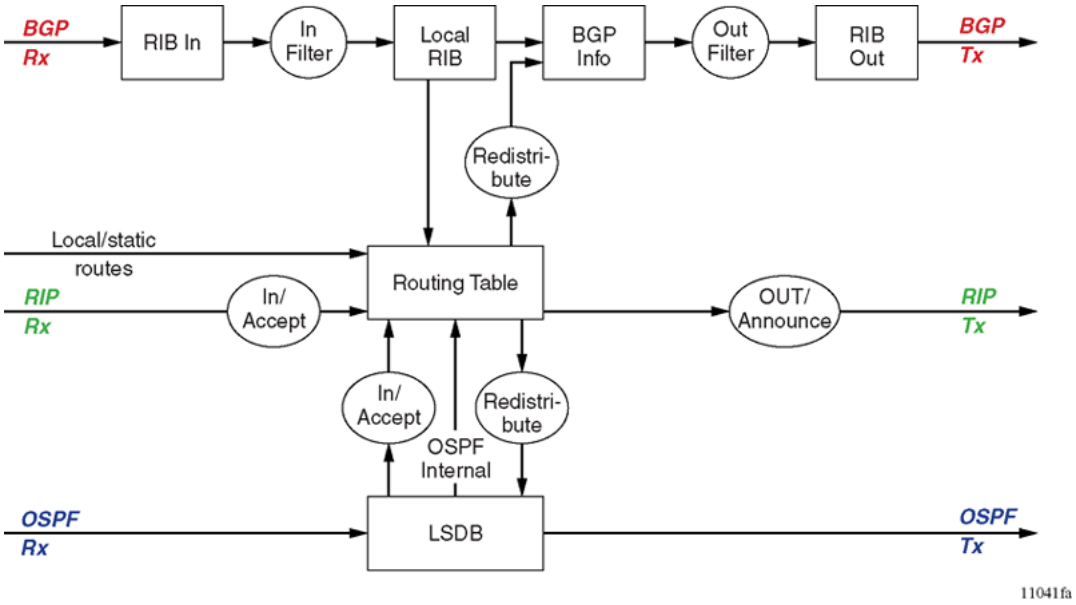

Figure 5: Route filtering for unicast routing protocols

Accept policies

Accept policies (or in filters) apply to incoming traffic to determine whether to add the route to the routing table. Accept policies apply in different ways to different protocols, as follows:

- RIP and BGP—filters apply to all incoming route information
- OSPF—filters apply only to external route information. Filters do not apply to internal routing information because other routers in the OSPF domain can have inconsistent databases that can affect the router view of the network topology.

In a network with multiple routing protocols, you can prefer specific routes from RIP instead of from OSPF. The network prefix is a commonly used match criterion for accept policies and ingress filters.

Use RIP accept policies to selectively accept routes from RIP updates. If you do not define policies, the default behavior applies, which adds all learned routes to the route table.

Use RIP accept policies to:

- Listen to RIP updates only from certain gateways.
- Listen only to specific networks.
- Assign a specific mask included with a network in the routing table (such as a network summary).

Redistribution and redistribution filters

Redistribution imports routes from one protocol to another. Redistribution sends route updates for a protocol-based route through another protocol. For example, if RIP routes exist in a router and they must travel through a BGP network, configure redistribution of RIP routes through BGP. This function sends RIP routes to a router using BGP.

Redistribution filters (policies) notify the routing protocol (within the device) of changes in the route table. In Virtual Services Platform 4000 software, announce policies performed interface-based redistribution. You must strictly apply announce policies to link-state advertisements (LSA), RIP updates, or BGP Network Layer Reachability Information (NLRI) to their respective domains. With redistribution filters, if you do not breach the protocol rules, you can choose not to advertise everything in the protocol database, or you can summarize or suppress route information. On the Virtual Services Platform 4000, by default, external routes do not leak to protocols you do not configure.

Announce policies

Announce policies (or out filters) apply to outgoing advertisements to neighbors and peers in the protocol domain to determine whether to announce specific route information. Out filtering applies to RIP updates and BGP NLRI updates.

In contrast, out filtering does not apply to OSPF information because OSPF routing information must always be consistent across the domain. To restrict the flow of external route information in the OSPF protocol database, apply redistribution filters instead of out filters.

Filter and policy application

The following figure shows the three distinct filtering stages that apply to IP routing protocol updates.

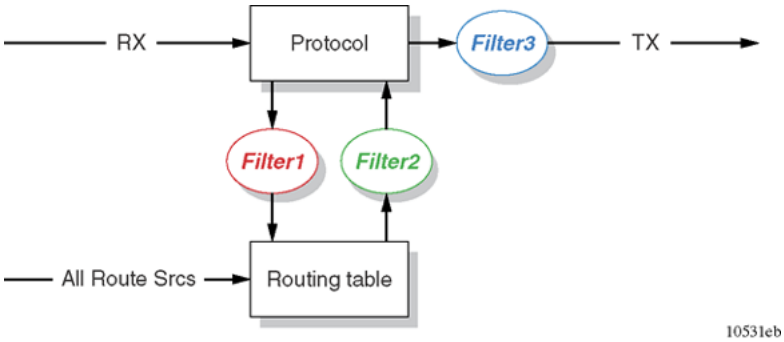

Figure 6: Route filtering stages

These stages are

1. Filter stage 1 is the accept policy or in filter. This filter applies to incoming routing protocol updates to detect changes in the dynamic (protocol-learned) routing information, which are submitted to the routing table.
2. Filter stage 2 is the redistribution filter. This filter applies to the entries in the protocol routing table during the route leak process.
3. Filter stage 3 is the announce policy or out filter. This filter applies to outgoing routing protocol updates within a protocol domain.

The following figure shows the logical operations that occur during the route-filtering process in the Virtual Services Platform 4000.

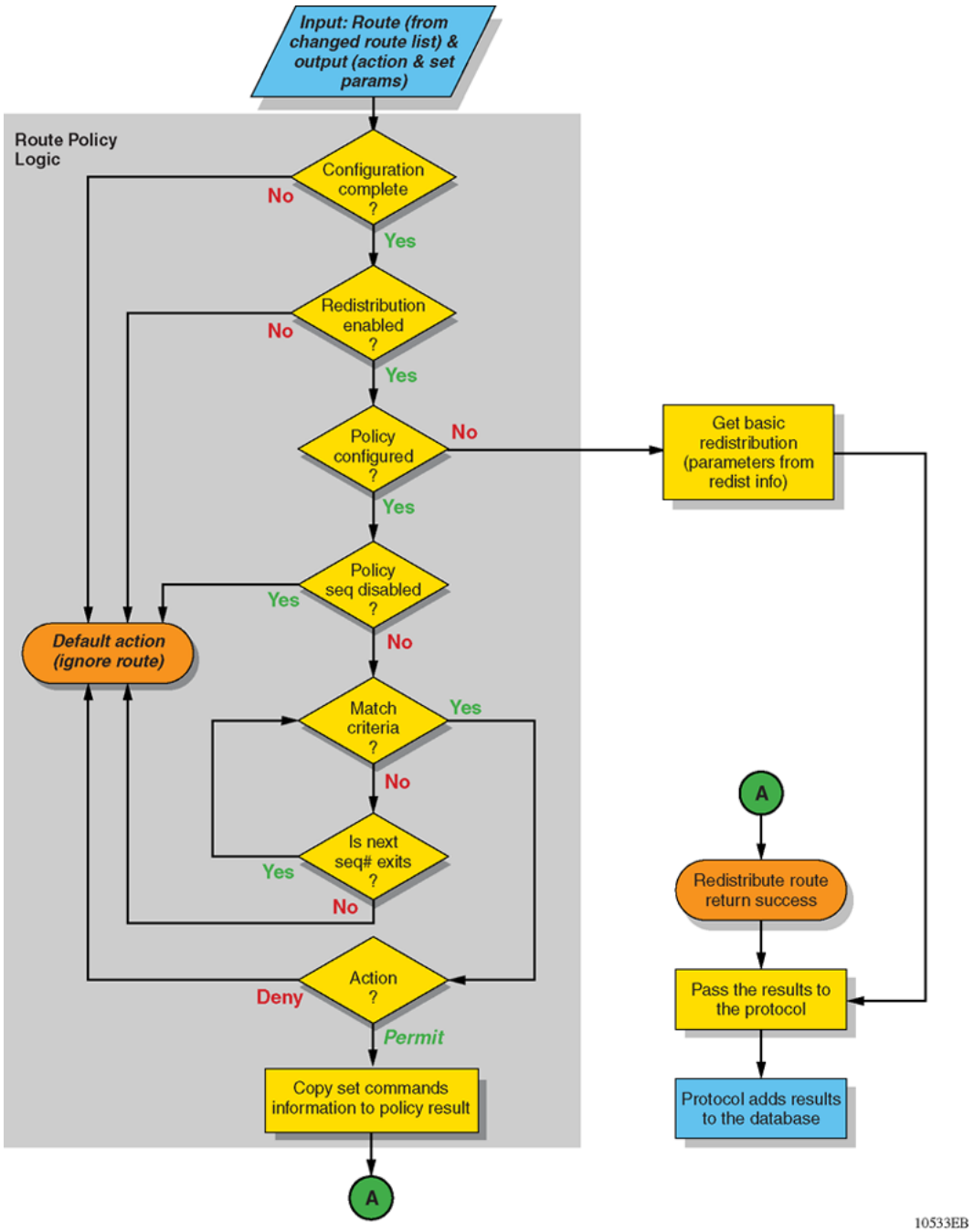

Figure 7: Route filtering logic

For information about how to configure policies, see *Configuration - IP Routing for Avaya Virtual Services Platform 4000 Series*, NN46251-505.

IP routing features and considerations

The Virtual Services Platform 4000 provides features that you can use to maximize routing efficiency. This section contains information that you can use to help you configure IP routing.

Equal Cost Multipath

You can use multiple paths for load sharing of traffic. These multiple paths provide fast convergence to other active paths if the network fails. By maximizing load sharing among equal-cost paths, you can use your links between routers to efficiently send IP traffic. Equal Cost Multipath (ECMP) supports and complements the following protocols and route types:

- OSPF
- RIP
- BGP
- static routes
- default routes

For more information about ECMP, see *Configuration - IP Routing for Avaya Virtual Services Platform 4000 Series*, NN46251-505.

Alternative routes and route preferences

Routers can learn several routes to a destination network through several protocols. In the Virtual Services Platform 4000 software, if you enable the alternative route function, the switch stores the alternative routes, sorted in order of network mask, cost, and route preference. The first route on this list is the best route. The hardware uses the best route. Other routes are alternative routes.

To avoid traffic interruption, you can globally enable alternative routes to replace the best route with the next-best route if the best route becomes unavailable. Alternative routes apply between routing protocols. For example, if an OSPF route becomes unavailable and an alternate RIP route is available, the router immediately activates the alternate route without waiting for an update interval to expire.

The internal routing table manager (RTM) records the route changes for protocols. The RTM maintains separate tables of static (user-configured) and dynamic (protocol-learned) routes. You can configure preferences that determine the precedence assigned to one type of route over another.

If a router learns a route with the same network mask and cost values from multiple sources (protocols), the router uses preferences to select the best route. The router holds up to four other routes for each destination as alternative routes.

You can configure route preferences for static routes and routing protocols. When you configure a static route, you can specify a preference for the route. To modify the preference for a static route, disable the route before you edit the configuration, and then reenable the route.

Important:

Changing route preferences is a process-intensive operation that can affect system performance and network reachability while you perform route preference procedures. Avaya recommends that if you want to change preferences for static routes or routing protocols, do so when you configure routes or during a maintenance window.

All standard routing protocols use a default preferences. You can modify the default preference for a protocol to give it higher or lower priority than other protocols. After you change the preference for a

route, if all best routes remain best routes, only the local route tables change. However, if a change in the protocol preference causes best routes to no longer be best routes, this change can affect neighboring route tables.

In addition, you can modify the preference value for dynamic routes through route filters or IP policies, and this value overrides the global preference for the protocol. You can use alternative mechanisms to change the behavior of specific routes to have a different preference rather than by acquiring the global protocol preference. For a static route, you can specify an individual route preference that overrides the global static route preference. The preference value can be a number from 0 to 255, with 0 reserved for local routes. 255 represents an unreachable route.

Reverse path checking

Reverse path checking prevents packet forwarding for incoming IP packets that have incorrect or forged (spoofed) IP addresses. Reverse path checking guarantees that traffic received on one interface was sent by a station from a specific interface (which prevents address spoofing). With this mode enabled, the Virtual Services Platform 4000 performs a reverse path check to verify the packet source IP address. If the switch cannot verify the source, the switch discards the packet.

Configure reverse path checking as required for each IP interface. When enabled, the Virtual Services Platform 4000 checks all routing packets that enter the interface. Reverse path checking ensures that the source address and source interface appear in the routing table, and that the address matches the interface that receives the packet.

You can use one of two modes for reverse path checking:

- Exist-only mode: Reverse path checking checks whether the source IP address for the incoming packet exists in the routing table. If the switch finds the source IP entry, the switch forwards the packet as usual; otherwise, the switch discards the packet.
- Strict mode: Reverse path checking checks that the source IP address exists in the routing table, and is reachable through the incoming IP interface (and not through other interfaces). If these conditions are not met, the switch discards the packet.

For more information about how to configure Reverse path checking, see *Security for Avaya Virtual Services Platform 4000 Series*, NN46251-601.

The following example illustrates how strict mode works.

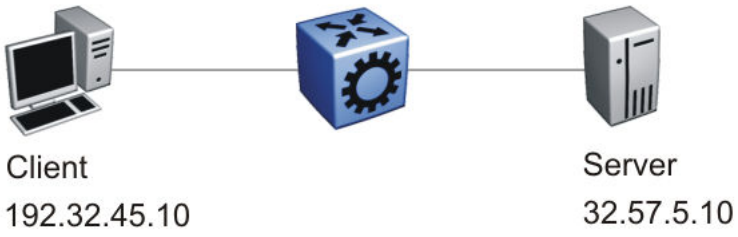

Figure 8: Reverse path checking network configuration

Consider the following parameters:

- A router connects a server (32.57.5.10) to a client (192.32.45.10).
- The router uses reverse path checking.
- The router has the following entries in the routing table:

Table 3: Routing table

Destination address	Next-hop address	Forward through port
32.57.5.10	173.56.42.2	3/7
192.32.45.10	145.34.87.2	7/2
192.32.46.10	145.34.88.2	7/1

If the client sends a legitimate packet, the following actions occur:

- The client sends packet to the server. The packet has a source IP address of 192.32.45.10 and a destination IP address of 32.57.5.10.
- The packet arrives at router port 7/2 (brouter). The routing engine performs a destination IP address lookup and finds the destination port is 3/7.
- Reverse path checking begins. The routing engine searches for the source IP address of 192.32.45.10. The routing engine finds an entry in the routing table that specifies the next-hop port as 7/2, which matches the packet incoming port. Because the address and port information matches, the switch forwards the packet as usual.

If the client sends a spoofed packet, the following actions occur:

- The client sends a packet to the server with a forged IP address of 192.32.46.10 through port 7/2.
- Reverse path checking finds that the source IP address next-hop port is 7/1, which does not match the packet incoming port of 7/2. In this case, the switch discards the packet.

You can think about reverse path checking as follows. If A sends packets to B through route X ingress port Y, then the return packets from B to A must egress X through the same port Y. If returning packets take a different path, the switch drops them.

Virtual Router Redundancy Protocol

Because end stations often use a static default gateway IP address, a loss of the default gateway router causes a loss of connectivity to the remote networks.

The Virtual Router Redundancy Protocol (VRRP) (RFC 2338) eliminates the single point of failure that can occur when the single static default gateway router for an end station is lost. VRRP introduces a virtual IP address (transparent to users) shared between two or more routers that connect the common subnet to the enterprise network. With the virtual IP address as the default gateway on end hosts, VRRP provides dynamic default gateway redundancy in the event of failover.

Note:

Avaya does not support a VRRP virtual IP address to be the same as the local physical address of the device.

The VRRP router that controls the IP addresses associated with a virtual router is the primary router and it forwards packets to these IP addresses. The election process provides a dynamic transition of forwarding responsibility if the primary router becomes unavailable.

In the following figure, the first three hosts install a default route to the R1 (virtual router 1) IP address and the other three hosts install a default route to the R2 (virtual router 2) IP address.

This configuration not only shares the load of the outgoing traffic, but it also provides full redundancy. If either router fails, the other router assumes responsibility for both addresses.

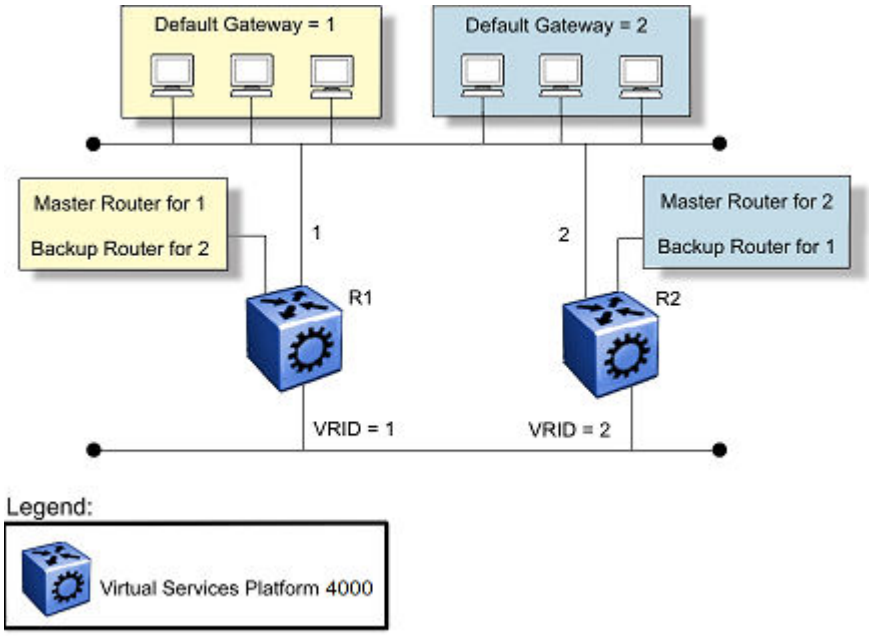

Figure 9: Virtual Router Redundancy Protocol configuration

The Avaya Virtual Services Platform 4000 Series supports 64 VRRP interfaces for each VRF and 64 VRRP interfaces for each system. The following terms are specific to VRRP:

- VRRP router—a router running the VRRP protocol
- Virtual router—an abstract object acting as the default router for one or more hosts, consisting of a virtual router ID and a set of addresses
- IP address owner—the VRRP router that has virtual router IP addresses as real interface addresses (This router responds to packets sent to this IP address.)
- Primary IP address—an IP address selected from the real addresses and used as the source address of packets sent from the router interface (The virtual primary router sends VRRP advertisements using this IP address as the source.)
- Virtual primary router—the router that assumes responsibility to forward packets sent to the IP address associated with the virtual router and answer ARP requests for these IP addresses
- Virtual router backup—the virtual router that becomes the primary router if the current primary router fails

When a VRRP router is initialized, if it is the IP address owner, its priority is 255 and it sends a VRRP advertisement. The VRRP router also broadcasts a gratuitous ARP request that contains the virtual router MAC address for each IP address associated with the virtual router. The VRRP router then transitions to the controlling state.

In the controlling state, the VRRP router functions as the forwarding router for the IP addresses associated with the virtual router. The VRRP router responds to ARP requests for these IP addresses, forwards packets with a destination MAC address equal to the virtual router MAC

address, and accepts only packets addressed to IP addresses associated with the virtual router if it is the IP address owner. If the priority is not 255, the router transitions to the backup state to ensure that all Layer 2 switches in the downstream path relearn the new origin of the VRRP MAC addresses.

In the backup state, a VRRP router monitors the availability and state of the primary router. The backup router does not respond to ARP requests and must discard packets with a MAC address equal to the virtual router MAC address. The backup router does not accept packets addressed to IP addresses associated with the virtual router. If a shutdown occurs, the backup router transitions back to the initialize state. If the primary router goes down, the backup router sends the VRRP advertisement and ARP request described in the preceding paragraph and transitions to the controlling state.

Whenever a packet is redirected on the same IP subnet on which it is received, Virtual Services Platform 4000 sends an Internet Control Message Protocol (ICMP) redirect packet data unit (PDU) to the IP address source of the packet. ICMP redirect uses the VRRP IP subnet as the source IP address for the end stations using the VRRP IP address as the next hop.

If an advertisement timer becomes active, the router sends an advertisement. If an advertisement is received with a 0 priority, the router sends an advertisement. The router transitions to the backup state in the following situations:

- If the priority is greater than the local priority
- If the priority is the same as the local priority and the primary IP address of the sender is greater than the local primary IP address

Otherwise, the router discards the advertisement. If a shutdown occurs, the primary router sends a VRRP advertisement with a priority of 0 and transitions to the initialize state.

Critical IP address

Within a VRRP VLAN, one link can go down while the remaining links in the VLAN remain operational. Because the VRRP VLAN continues to function, a virtual router associated with that VLAN does not register a master router failure.

As a result, if the local router IP interface connecting the virtual router to the external network fails, this does not automatically trigger a master router failover.

The critical IP address resolves this issue. If the critical IP address fails, it triggers a failover of the master router.

You can specify the local router IP interface uplink from the VRRP router to the network as the critical IP address. This ensures that, if the local uplink interface fails, VRRP initiates a master router failover to one of the backup routers.

In VRRP, the local network uplink interface on router 1 is shown as the critical IP address for router 1. As well, the same network uplink is shown as the critical IP address for router 2. Router 2 also requires a critical IP address for cases in which it assumes the role of the master router.

With the support of VRRP and the critical IP interface linked to VRRP, you can build reliable small core networks that provide support for converged applications, such as voice and multimedia.

VRRP and RSMLT

VRRP and RSMLTThe standard implementation of VRRP supports only one active master device for each IP subnet. All other VRRP interfaces in a network are in backup mode.

A deficiency occurs when VRRP-enabled switches use Routed Split MultiLink Trunking (RSMLT). If VRRP switches are aggregated into two Routed Split MultiLink Trunk switches, the end host traffic is load-shared on all uplinks to the aggregation switches (based on the Multilink Trunk traffic distribution algorithm).

However, VRRP usually has only one active routing interface enabled. All other VRRP routers are in backup mode. Therefore, all traffic that reaches the backup VRRP router is forwarded over the vIST towards the master VRRP router. In this case, the vIST does not have enough bandwidth to carry all the aggregated traffic.

To resolve this issue, assign the backup router as the backup master router. The backup master router can actively load-share the routing traffic with a master router.

When the backup master router is enabled, the incoming host traffic is forwarded over the RSMLT links as usual. When the backup master router is configured along with the critical IP interface and the critical IP interface goes down, the VRRP router transitions to be the backup router with the backup master state down. In this state, the VRRP router does not forward traffic.

VRRP fast hello timers

With the current implementation of VRRP, you can configure the advertisement time interval (in seconds) between sending advertisement messages. This interval permits fast network convergence with standardized VRRP failover. However, losing connections to servers for more than a second can result in missing critical failures. Customer network uptime in many cases requires faster network convergence, which means network problems must be detected within hundreds of milliseconds.

To meet these requirements, Avaya has two enhancements: Fast Advertisement Enable and Fast Advertisement Interval.

Fast Advertisement Enable acts like a toggle device for the Advertisement Interval and the Fast Advertisement Interval. When Fast Advertisement Enable is enabled, the Fast Advertisement Interval is used instead of the Advertisement Interval.

The Fast Advertisement Interval is similar to the current Advertisement Interval parameter except for the unit of measure and the range. The Fast Advertisement Interval is expressed in milliseconds and the range is from 200 to 1000 milliseconds. This unit of measure must be in multiples of 200 milliseconds, otherwise an error appears.

When you enable the fast advertisement interval, VRRP can communicate with other Avaya Virtual Services Platform 4000 Series modules and Avaya Networking products, such as ERS 8800 and VSP 9000, with the same settings.

Chapter 4: OSPF

This chapter provides concepts and configuration procedures for Open Shortest Path First (OSPF).

OSPF fundamentals

Use the information in these sections to help you understand Open Shortest Path First (OSPF).

OSPF is an Interior Gateway Protocol (IGP) that distributes routing information between routers that belong to a single autonomous system (AS). Intended for use in large networks, OSPF is a link-state protocol that supports IP subnets, Type of Service (TOS)-based routing, and tagging of externally-derived routing information.

For information about the Border Gateway Protocol (BGP), see *Configuring BGP Services on VSP Operating System Software*, NN47227-508.

OSPF overview

In an OSPF network, each router maintains a link-state database that describes the topology of the AS. The database contains the local state for each router in the AS, including its usable interfaces and reachable neighbors. Each router periodically checks for changes in its local state and shares detected changes by flooding link-state advertisements (LSA) throughout the AS. Routers synchronize their topological databases based on the sharing of information from LSAs.

From the topological database, each router constructs a shortest-path tree, with itself as the root. The shortest-path tree provides the optimal route to each destination in the AS. Routing information from outside the AS appears on the tree as leaves.

OSPF routes IP traffic based on the destination IP address, and subnet mask.

In large networks, OSPF offers the following benefits:

- fast convergence

  After network topology changes, OSPF recalculates routes quickly.

- minimal routing protocol traffic

  Unlike distance vector routing protocols, such as Routing Information Protocol (RIP), OSPF generates a minimum of routing protocol traffic.

- load sharing

OSPF provides support for Equal Cost Multipath (ECMP) routing. If several equal-cost routes to a destination exist, ECMP distributes traffic equally among them.

Dijkstras algorithm

A separate copy of the OSPF routing algorithm (Dijkstra's algorithm) runs in each area. Routers that connect to multiple areas run multiple copies of the algorithm. The sequence of processes governed by the routing algorithm is as follows:

1. After a router starts, it initializes the OSPF data structures, and then waits for indications from lower-level protocols that the router interfaces are functional.
2. A router then uses the Hello protocol to discover neighbors. On point-to-point and broadcast networks the router dynamically detects neighbors by sending hello packets to the multicast address AllSPFRouters. On Non-Broadcast Multiple Access (NBMA) networks, you must provide some configuration information to discover neighbors.
3. On all multiaccess networks (broadcast or nonbroadcast), the Hello protocol elects a designated router (DR) for the network.
4. The router attempts to form adjacencies with some of its neighbors. On multiaccess networks, the DR determines which routers become adjacent. This behavior does not occur if you configure a router as a passive interface because passive interfaces do not form adjacencies.
5. Adjacent neighbors synchronize their topological databases.
6. The router periodically advertises its link state, and does so after its local state changes. LSAs include information about adjacencies, enabling quick detection of dead routers on the network.
7. LSAs flood throughout the area to ensure that all routers in an area have an identical topological database.
8. From this database each router calculates a shortest-path tree, with itself as the root. This shortest-path tree in turn yields a routing table for the protocol.

Autonomous system and areas

The AS subdivides into areas that group contiguous networks, routers that connect to these networks, and attached hosts. Each area has a topological database, which is invisible from outside the area. Routers within an area know nothing of the detailed topology of other areas. Subdividing the AS into areas significantly reduces the amount of routing protocol traffic compared to treating the entire AS like a single link-state domain.

You can attach a router to more than one area. When you perform this action, you can maintain a separate topological database for each connected area. Two routers within the same area maintain an identical topological database for that area. Each area uses a unique area ID and the area ID 0.0.0.0 is reserved for the backbone area.

The router routes packets in the AS based on their source and destination addresses. If the source and destination of a packet reside in the same area, the router uses intra-area routing. If the source

and destination of a packet reside in different areas, the router uses inter-area routing. Intra-area routing protects the area from bad routing information because it does not use routing information obtained from outside the area. Inter-area routing must pass through the backbone area. For more information about the backbone area, see Backbone area on page 32.

In large networks with many routers and networks, the link-state database (LSDB) and routing table can become excessively large. Large route tables and LSDBs consume memory. The processing of link-state advertisements results in additional CPU cycles to make forwarding decisions. To reduce these undesired effects, you can divide an OSPF network into subdomains called areas.

An area comprises a number of OSPF routers that have the same area identification (ID).

By dividing a network into multiple areas, the router maintains a separate LSDB, which consists of router LSAs and network LSAs, for each area. Each router within an area maintains an LSDB only for the area to which it belongs. Area router LSAs and network LSAs do not flood beyond the area borders.

The impact of a topology change is localized to the area in which it occurs. The only exception is for the area border router (ABR), which must maintain an LSDB for each area to which they belong. The area border routers advertise changes in topology to the remainder of the network by advertising summary LSAs.

A 32-bit area ID, expressed in IP address format (x.x.x.x), identifies areas. Area 0 is the backbone area and distributes routing information to all other areas.

If you use multiple areas, they must all attach to the backbone through an ABR, which connects area 0.0.0.0 to the nonbackbone areas. If you cannot physically and directly connect an area through an ABR to area 0, you must configure a virtual link to logically connect the area to the backbone area.

Backbone area

The backbone area consists of the following network types:

- networks and attached routers that do not exist in other areas
- routers that belong to multiple areas

The backbone is usually contiguous but you can create a noncontiguous area by configuring virtual links.

You can configure virtual links between two backbone routers that have an interface to a nonbackbone area. Virtual links belong to the backbone and use intra-area routing only.

The backbone distributes routing information between areas. The topology of the backbone area is invisible to other areas, while it knows nothing of the topology of those areas.

In inter-area routing, a packet travels along three contiguous paths in a point-to-multipoint configuration:

- an intra-area path from the source to an ABR
- a backbone path between the source and destination areas
- another intra-area path to the destination

The OSPF routing algorithm finds the set of paths that has the smallest cost. The topology of the backbone dictates the backbone paths used between areas. OSPF selects inter-area paths by examining the routing table summaries for each connected ABR. The router cannot learn OSPF routes through an ABR unless it connects to the backbone or through a virtual link.

Stub area

Configure a stub area at the edge of the OSPF routing domain. A stub area has only one ABR. A stub area does not receive LSAs for routes outside its area, which reduces the size of its link-state database. A packet destined outside the stub area is routed to the ABR, which examines it before forwarding the packet to the destination. The network behind a passive interface is treated as a stub area and does not form adjacencies. The network is advertised into the OSPF area as an internal route.

Not so stubby area

A not-so-stubby area (NSSA) prevents the flooding of external LSAs into the area by replacing them with a default route. An NSSA can import small stub (non-OSPF) routing domains into OSPF. Like stub areas, NSSAs are at the edge of an OSPF routing domain. Non-OSPF routing domains attach to the NSSAs to form NSSA transit areas. Accessing the addressing scheme of small stub domains permits the NSSA border router to also perform manual aggregation.

In an OSPF NSSA, the NSSA N/P bit notifies the ABR which external routes to advertise to other areas. If the NSSA N/P bit is set (the value is 1), the ABR exports the external route. This configuration is the default for the Avaya Virtual Services Platform 4000. When the NSSA N/P bit is not set (the value is 0), the ABR drops the external route. You can create a route policy on the Virtual Services Platform 4000 to manipulate the N/P bit.

Multiarea OSPF configuration

The following figure shows five Virtual Services Platform 4000 devices (R1 to R5) in a multi-area configuration.

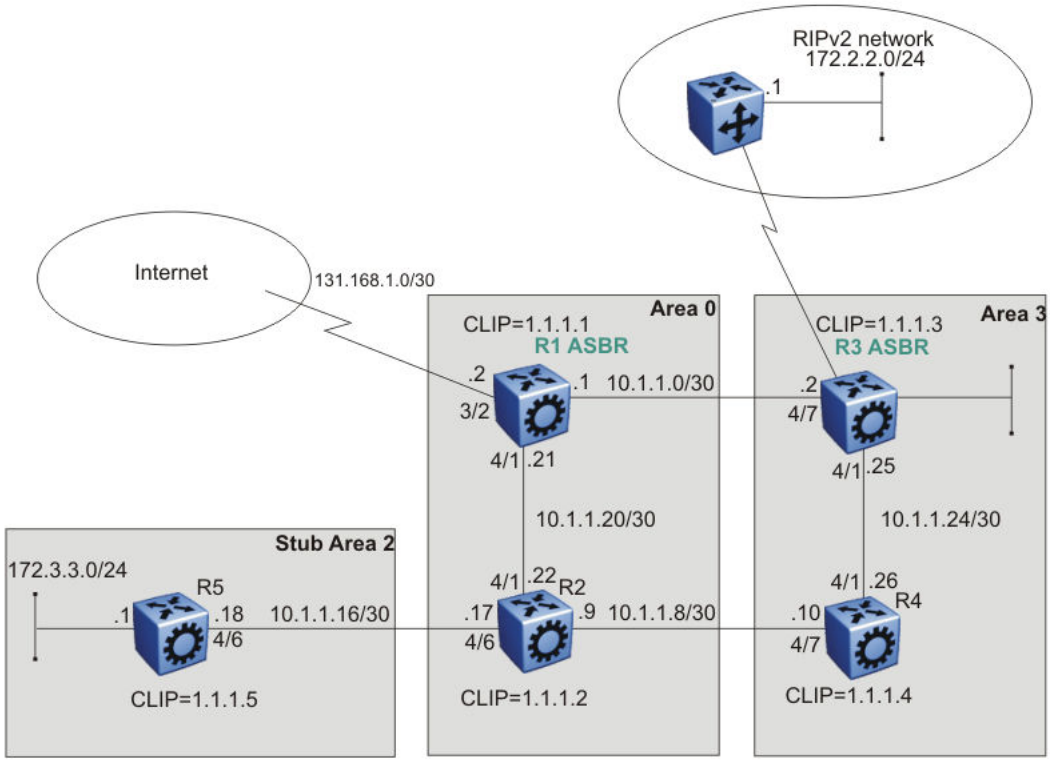

Figure 10: Multiarea configuration example

The following list explains the configuration for the Virtual Services Platform 4000 devices R1 through R5:

- R1 is an OSPF AS boundary router (ASBR) that is associated with OSPF Area 0 and OSPF Area 3. R1 distributes a default route for Internet traffic.
- R2 is an OSPF stub ABR for OSPF Area 2 and ABR to OSPF Area 3.
- R3 is an OSPF ASBR and distributes OSPF to RIP and RIP to OSPF.
- R4 is an OSPF internal router in Area 3.
- All OSPF interfaces are brouter ports except R5.

  Network 172.3.3.0/24 on R5 uses a VLAN configuration instead of a brouter port. This example uses brouter ports rather than VLANs because the spanning tree algorithm is disabled by default if you use brouter interfaces.
- All interfaces are Ethernet; therefore, the OSPF interfaces are broadcast, except the circuitless IP (CLIP) interfaces, which are passive.
- The interface priority on R5 is 0; therefore, R5 cannot become a DR.
- Configure the OSPF router priority so that R1 becomes the DR (priority 100) and R2 becomes the backup designated router (BDR) with a priority value of 50.

Use stub or NSSA areas to reduce the LSDB size by excluding external LSAs. The stub ABR advertises a default route into the stub area for all external routes.

OSPF neighbors

In an OSPF network, two routers that have an interface to the same network are neighbors. Routers use the Hello protocol to discover their neighbors and to maintain neighbor relationships. On a broadcast or point-to-point network, the Hello protocol dynamically discovers neighbors. On an NBMA network, you must manually configure neighbors for the network.

The Hello protocol provides bidirectional communication between neighbors. Periodically, OSPF routers send hello packets over all interfaces. Included in these hello packets is the following information:

- router priority
- router hello timer and dead timer values
- list of routers that sent the router hello packet on this interface
- router choice for DR and backup designated router (BDR)

Bidirectional communication is determined after one router discovers itself listed in the hello packet of its neighbor.

NBMA interfaces whose router priority is a positive, nonzero value are eligible to become DRs for the NBMA network and are configured with a list of all attached routers. The neighbors list includes each neighbor IP address and router priority. In an NBMA network, a router with a priority other than zero is eligible to become the DR for the NBMA network. You must manually configure the IP address, mask, and router priority of neighbors on routers that are eligible to become the DR or BDR for the network.

Log messages indicate when an OSPF neighbor state change occurs. Each log message indicates the previous state and the new state of the OSPF neighbor. The log message generated for system traps also indicates the previous state and the current state of the OSPF neighbor.

Neighbors can form an adjacency to exchange routing information. After two routers form an adjacency, they perform a database exchange process to synchronize their topological databases. After the databases synchronize, the routers are fully adjacent. Adjacency conserves bandwidth because, from this point, the adjacent routers pass only routing change information.

All routers connected by a point-to-point network or a virtual link always form an adjacency. All routers on a broadcast or NBMA network form an adjacency with the DR and the BDR.

In an NBMA network, before the routers elect a DR, the router sends hello packets only to those neighbors eligible to become a DR. The NBMA DR forms adjacencies only with its configured neighbors and drops all packets from other sources. The neighbor configuration also notifies the router of the expected hello behavior for each neighbor.

If a router receives a hello packet from a neighbor with a priority different from that which is already configured for the neighbor, the router can automatically change the configured priority to match the dynamically learned priority.

Router types

To limit the amount of routing protocol traffic, the Hello protocol elects a DR and a BDR on each multiaccess network. Instead of neighboring routers forming adjacencies and swapping link-state information, which on a large network can mean significant routing protocol traffic, all routers on the network form adjacencies with the DR and the BDR only, and send link-state information to them. The DR redistributes this information to every other adjacent router.

If the BDR operates in backup mode, it receives link-state information from all routers on the network and listens for acknowledgements. If the DR fails, the BDR can transition quickly to the role of DR because its routing tables are up-to-date.

Routers in an OSPF network can have various roles depending on how you configure them. The following table describes the router types you can configure in an OSPF network.

Table 4: Router types in an OSPF network

Router type	Description
AS boundary router	A router that attaches at the edge of an OSPF network is an ASBR. An ASBR generally has one or more interfaces that run an interdomain routing protocol such as Border Gateway Protocol. In addition, a router that distributes static routes or RIP routes into OSPF is an ASBR. The ASBR forwards external routes into the OSPF domain. In this way, routers inside the OSPF network learn about destinations outside their domain.
Area border router	A router that attaches to two or more areas inside an OSPF network is an ABR. ABRs play an important role in OSPF networks by condensing the amount of disseminated OSPF information.

Table continues…

Router type	Description
Internal router (IR)	A router that has interfaces only within a single area inside an OSPF network is an IR. Unlike ABRs, IRs have topological information only about the area in which they reside.
Designated router	In a broadcast or NBMA network, the routers elect a single router as the DR for that network. A DR makes sure that all routers on the network synchronize and advertises the network to the rest of the AS.
Backup designated router	A BDR is elected in addition to the DR and, if the DR fails, can assume the DR role quickly.

OSPF interfaces

Configure an OSPF interface, or link, on an IP interface. In the Virtual Services Platform 4000, an IP interface can be either a single link (brouter port) or a logical interface configured on a VLAN (multiple ports). The state information associated with the interface is obtained from the underlying lower-level protocols and the routing protocol itself.

Important:

To change the interface type of an enabled OSPF interface, you must first disable it, change the type, and then reenable it. For an NBMA interface, you must first delete manually configured neighbors.

OSPF network types allow OSPF-neighboring between routers over various types of network infrastructures. You can configure each interface to support various network types. The following table describes the OSPF network interface types supported by the Virtual Services Platform 4000.

Table 5: OSPF network types

Network interface type	Description
Broadcast interfaces on page 37	Broadcast interfaces automatically discover every OSPF router on the network by sending OSPF hello packets to the multicast group AllSPFRouters (224.0.0.5). Neighboring is automatic and requires no configuration.
Non-Broadcast Multiple Access interfaces on page 37	The NBMA network type models network environments that do not have native Layer 2 broadcast or multicast capabilities, such as Frame Relay and X.25. OSPF hello packets are unicast to manually configured neighbors.
Passive interfaces on page 40	A passive interface is an interfacing network in OSPF that does not generate LSAs or form adjacencies. Use a passive interface on an access network or on an interface used for BGP peering. Using passive interfaces limits the amount of CPU cycles required to perform the OSPF routing algorithm.

Broadcast interfaces

Broadcast interfaces support many attached routers and can address a single physical message to all attached broadcast routers (sent to AllSPFRouters and AllDRouters).

Broadcast interfaces dynamically discover neighboring routers using the OSPF Hello protocol. Each pair of routers on a broadcast network, such as an Ethernet, communicate directly.

Non-Broadcast Multiple Access interfaces

An NBMA network interconnects multiple devices through point-to-point links. NBMA does not use broadcast and multicast data transmission.

NBMA interfaces support many routers, but cannot broadcast. NBMA networks perform the following activities:

- statically establish OSPF neighbor relationships

  You must establish neighbor relationships because hub-and-spoke Wide Area Network (WAN) topologies do not support any-to-any broadcasting.

- control meshed WAN connections

In contrast to a broadcast network, where some OSPF protocol packets are multicast (sent to AllSPFRouters and AllDRouters), OSPF packets on an NBMA interface are replicated and sent in turn to each neighboring router as unicast. NBMA networks drop all OSPF packets with destination address AllSPFRouters and AllDRouters.

The following figure shows an example of four routers attached to an NBMA subnet. The NBMA segment uses a single IP subnet and each router uses an IP address within the subnet.

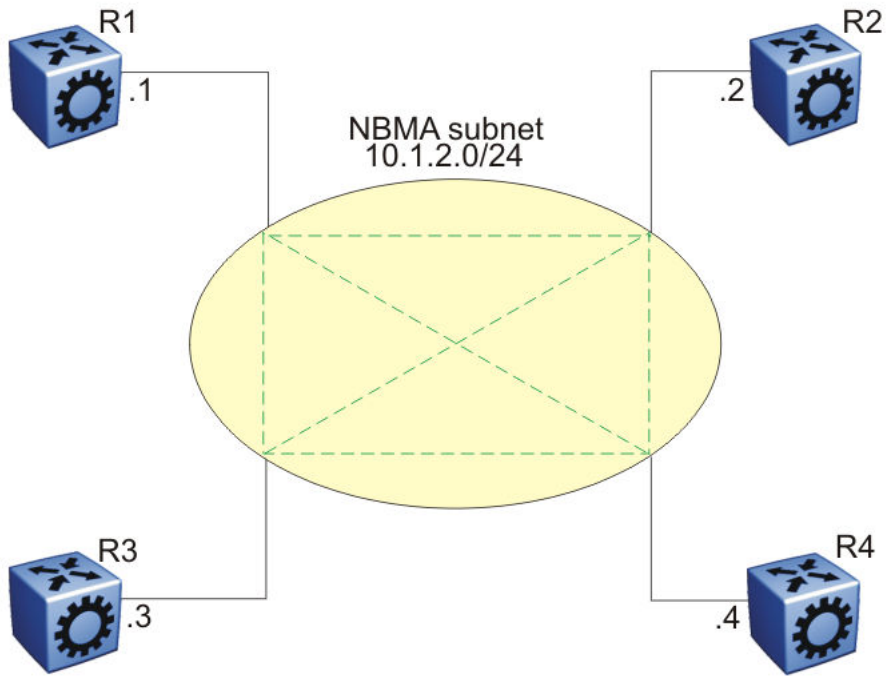

Figure 11: NBMA subnet

NBMA interface operations and parameters

OSPF treats an NBMA network much like it treats a broadcast network. Because many routers attach to the network, the Hello protocol elects a DR to generate the network link-state advertisements.

Because the NBMA network does not broadcast, you must manually configure neighbors for each router eligible to become DR (those networks with a positive, nonzero router priority value). You must also configure a poll interval for the network.

NBMA interfaces with a positive, nonzero router priority can become DR for the NBMA network and contain a list of all attached routers, or neighbors. This neighbors list includes each neighbor IP address and router priority.

The router uses neighbor information both during and after the DR election process. After an interface to a nonbroadcast network with a nonzero priority initializes, and before the Hello protocol elects a DR, the router sends hello packets only to those neighbors eligible to become DR. After the Hello protocol elects a DR, it forms adjacencies only with its configured neighbors and drops all packets from other sources. This neighbor configuration also notifies the router of the expected hello behavior of each neighbor.

If a router eligible to become the DR receives a hello packet from a neighbor that shows a different priority from that which is already configured for this neighbor, the DR changes the configured priority to match the dynamically learned priority.

Configure an NBMA interface with a poll interval. The poll interval designates the interval at which the router sends hello packets to inactive neighboring routers. The router typically sends hello packets at the Hello interval, for example, every 10 seconds. If a neighboring router becomes inactive, or if the router does not receive hello packets for the established RouterDeadInterval period, the router sends hello packets at the specified poll interval, for example, every 120 seconds.

You must configure a neighbors list for the DR to allow an NBMA network to send hello packets. If the router is eligible to become a DR, it periodically sends hello packets to all neighbors that are also eligible. The effect of this action is that two eligible routers always exchange hello packets, which is necessary for the correct DR election. You can minimize the number of hello packets by minimizing the number of eligible routers on a nonbroadcast network.

After the Hello protocol elects a DR, it sends hello packets to all manually configured neighbors to synchronize their link-state databases, establish itself as the DR, and identify the BDR.

If a router is not eligible to become DR, it periodically sends hello packets to both the DR and the BDR. The router also sends a hello packet in reply to a hello packet received from an eligible neighbor (other than the current DR and BDR). This process establishes an initial bidirectional relationship with a potential DR.

When a router sends hello packets to a neighbor, the neighbor state determines the interval between hello packets. If the neighbor is in the down state, the router sends hello packets at the designated poll interval, for example, every 120 seconds. Otherwise, the router sends hello packets at the designated hello interval, for example, every 10 seconds.

OSPF and NBMA example: adjacency formation

In an NBMA network, as in a broadcast network, all routers become adjacent to the DR and the BDR. The adjacencies form after you assign the router priorities, configure the neighbors, and the Hello protocol elects the network DR.

The following figure shows an NBMA subnet with router priorities and manually configured neighbors.

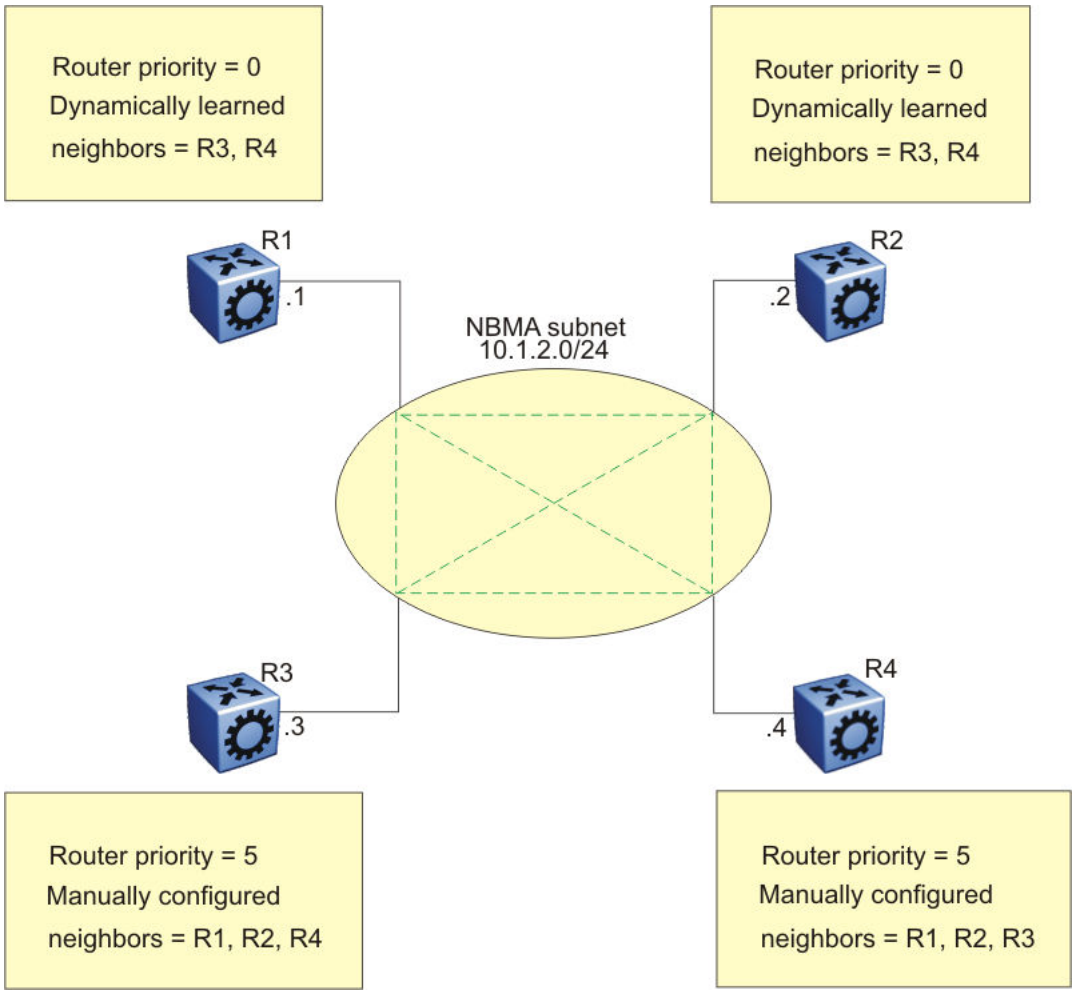

Figure 12: NBMA subnet configuration example

Because R1 and R2 have a router priority of 0, they are not eligible to become the DR. Also, R1 and R2 do not require configuration of a neighbors list; R1 and R2 discover neighbors dynamically through the Hello protocol.

R3 and R4 both have a positive, nonzero priority and are eligible to become the DR. Manually configure neighbor lists on R3 and R4.

To create this NBMA network, configure the following parameters:

1. On each router: NBMA interface type, poll interval, router priority
2. On R3: R1, R2, and R4 as neighbors
3. On R4: R1, R2, and R3 as neighbors

If all routers start at the same time, the routers perform the following steps:

1. R3 and R4 send each other a hello packet to elect a DR.
2. The Hello protocol elects R3 as the DR, and R4 as the BDR.

3. R3 (DR) and R4 (BDR) send hello packets to all other routers on the NBMA subnet to synchronize their link-state databases and establish themselves as DR and BDR.
4. R1 and R2 reply to R3 and R4.
5. R3 and R4 each form three adjacencies (one with each router on the NBMA subnet).
6. R1 and R2 each form two adjacencies (one with the DR and one with the BDR).

Passive interfaces

Use a passive interface to enable an interface to advertise into an OSPF domain while limiting its adjacencies.

After you change the interface type to passive, the router advertises the interface into the OSPF domain as an internal stub network with the following behaviors:

- does not send hello packets to the OSPF domain
- does not receive hello packets from the OSPF domain
- does not form adjacencies in the OSPF domain

If you configure an interface as passive, the router advertises it as an OSPF internal route. If the interface is not a passive interface, to advertise a network into OSPF and not form OSPF adjacencies, you must configure the interface as nonOSPF, and the router must redistribute the local network as an autonomous system external (ASE) LSA.

OSPF and IP

OSPF runs over IP, which means that an OSPF packet transmits with an IP data packet header. The protocol field in the IP header is 89, which identifies it as an OSPF packet and distinguishes it from other packets that use an IP header.

An OSPF route advertisement expresses a destination as an IP address and a variable-length mask. Together, the address and the mask indicate the range of destinations to which the advertisement applies.

Because OSPF can specify a range of networks, it can send one summary advertisement that represents multiple destinations. For example, a summary advertisement for the destination 128.185.0.0 with a mask of 255.255.0.0 describes a single route to destinations 128.185.0.0 to 128.185.255.255.

OSPF packets

All OSPF packets start with a 24-octet header that contains information about the OSPF version, the packet type and length, the ID of the router that transmits the packet, and the ID of the OSPF area that sends the packet. An OSPF packet is one of the following types:

- The router transmitted hello packets between neighbors and never forwards them. The Hello protocol requires routers to send hello packets to neighbors at predefined hello intervals. A neighbor router that does not receive a hello packet declares the other router dead.

- The router exchanges DD packets after neighboring routers establish a link, which synchronizes their LSDBs.
- Link-state request packets describe one or more link-state advertisements that a router requests from its neighbor. Routers send link-state requests if the information received in DD packets from a neighbor is not consistent with its own link-state database.
- Link-state update packets contain one or more LSAs and the router sends them following a change in network conditions.
- The router sends link-state acknowledgement packets to acknowledge receipt of link-state updates. Link-state acknowledgement packets contain the headers of the received LSAs.

Intra-area link-state advertisements

OSPF does not require each router to send its entire routing table to its neighbors. Instead, each OSPF router floods only link-state change information in the form of LSAs throughout the area or AS. LSAs in OSPF are one of the following five types:

- A router links advertisement is flooded only within the area and contains information about neighbor routers and the LANs to which the router attaches. A backbone router can flood router link advertisements within the backbone area.
- A DR on a LAN generates network links advertisement to list all routers on that LAN, and floods network links advertisements only within the area. A backbone DR can flood network links advertisements within the backbone area.
- An ABR floods a network summary link advertisement into an area and describes networks that are reachable outside the area. An ABR attached to two areas generates a different network summary link advertisement for each area. ABRs also generate area summary link advertisements that contain information about destinations within an area that are flooded to the backbone area.
- An ASBR summary link advertisement describes the cost of the path to an ASBR from the router that generates the advertisement.
- An ASBR sends an ASE link advertisement to describe the cost of the path to a destination outside the AS from the ASBR that generates the advertisement. This information is flooded to all routers in the AS.

ASE routes

OSPF considers the following routes as ASE routes:

- a route to a destination outside the AS
- a static route
- a default route
- a route derived by RIP

- a directly connected network that does not run OSPF

OSPF virtual links

On an OSPF network, a Virtual Services Platform 4000 that acts as an ABR must connect directly to the backbone. If no physical connection is available, you can automatically or manually configure a virtual link.

An automatic virtual link can provide redundancy support for critical network connections. Automatic virtual linking creates virtual paths for vital traffic paths in your OSPF network. If a connection fails on the network, such as after an interface cable that provides connection to the backbone (either directly or indirectly) disconnects from the switch, the virtual link is available to maintain connectivity.

Use automatic virtual linking to ensure that a link is created to another router. If automatic virtual linking uses more resources than you want to expend, creating a manual virtual link can be the better solution. Use this approach to conserve resources and control virtual links in the OSPF configuration.

On the Virtual Services Platform 4000, OSPF behavior follows OSPF standards; the router cannot learn OSPF routes through an ABR unless the ABR connects to the backbone or through a virtual link.

The following figure shows how to configure a virtual link between the ABR in area 2.2.2.2 and the ABR in area 0.0.0.0.

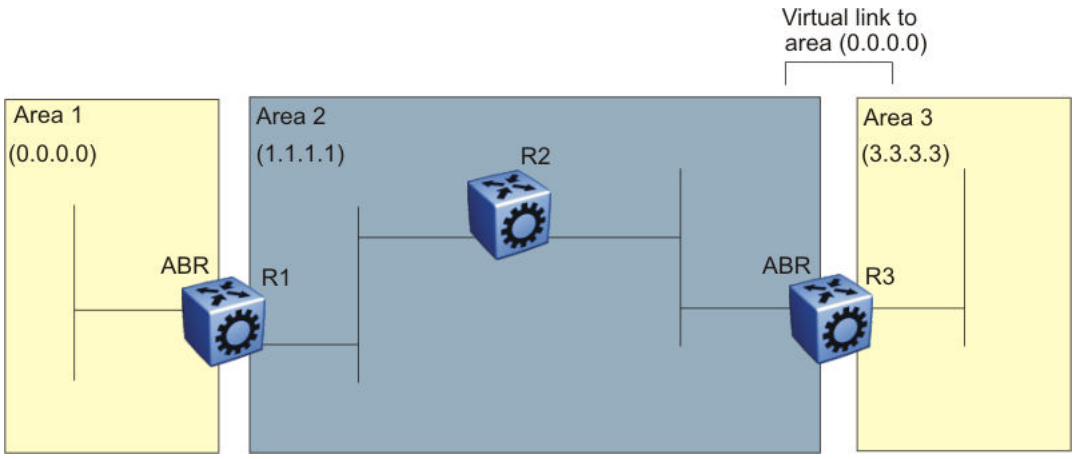

Figure 13: Virtual link between ABRs through a transit area

To configure a virtual link between the ABRs in area 1 and area 3, define area 2 as the transit area between the other two areas, and identify R2 as the neighbor router through which R2 must send information to reach the backbone through R1.

OSPF ASBRs

ASBRs advertise nonOSPF routes into OSPF domains so that they can pass through the OSPF routing domain. A router can function as an ASBR if one or more interfaces connects to a nonOSPF network, for example, RIP, BGP, or Exterior Gateway Protocol (EGP).

An ASBR imports external routes into the OSPF domain by using ASE LSAs (LSA type 5) originated by the ASBR.

ASE LSAs flood across area borders. When an ASBR imports external routes, it imports OSPF route information using external type 1 or type 2 metrics. The result is a four-level routing hierarchy, as shown in the following table, according to routing preference.

Table 6: ASBR routing hierarchy

Level	Description
1	Intra-area routing
2	Inter-area routing
3	External type 1 metrics
4	External type 2 metrics

The use of these metrics results in a routing preference from most preferred to least preferred of

- routing within an OSPF area
- routing within the OSPF domain
- routing within the OSPF domain and external routes with external type 1 metrics
- routing within the OSPF domain and external routes with external type 2 metrics

For example, an ASBR can import RIP routes into OSPF with external type 1 metrics. Another ASBR can import Internet routes and advertise a default route with an external type 2 metric. This results in RIP-imported routes that have a higher preference than the Internet-imported default routes. In reality, BGP Internet routes must use external type 2 metrics, whereas RIP imported routes must use external type 1 metrics.

Routes imported into OSPF as external type 1 are from IGPs whose external metric is comparable to OSPF metrics. With external type 1 metrics, OSPF adds the internal cost of the ASBR to the external metric. EGPs, whose metric is not comparable to OSPF metrics, use external type 2 metrics. External type 2 metrics use only the internal OSPF cost to the ASBR in the routing decision.

To conserve resources, you can limit the number of ASBRs in your network or specifically control which routers perform as ASBRs to control traffic flow.

Area link-state advertisements

The following table explains the seven LSA types exchanged between areas. LSAs share link-state information among routers. LSAs typically contain information about the router and its neighbors. OSPF generates LSAs periodically to ensure connectivity or after a change in state of a router or link (that is, up or down).

Table 7: OSPF LSA types

LSA type	Description	Area of distribution
1	A router originates type 1 LSAs (router LSAs) to describe its set of active interfaces and neighbors.	Passed only within the same area
2	Type 2 LSAs (network LSAs) describe a network segment such as broadcast or NBMA. In a broadcast network, the DR originates network LSAs.	Passed only within the same area
3	The ABR originates type 3 LSAs (network-summary LSAs) to describe the networks within an area.	Passed between areas
4	Type 4 LSAs (ASBR-summary LSAs) advertise the location of the ASBRs from area to area.	Passed between areas
5	Type 5 LSAs (ASE LSAs) describe networks outside of the OSPF domain. The ASBR originates type 5 LSAs. In stub and NSSA areas, a single default route replaces type 5 LSA routes.	Passed between areas
6	Type 6 LSAs (group membership LSAs) identify the location of multicast group members in multicast OSPF.	Passed between areas
7	Type 7 LSAs import external routes in OSPF NSSAs.	Translated between areas

OSPF metrics

For OSPF, the best path to a destination is the path that offers the least-cost metric (least-cost delay). You can configure OSPF cost metrics to specify preferred paths. You can configure metric speed globally or for specific ports and interfaces on the network. In addition, you can control redistribution options between nonOSPF interfaces and OSPF interfaces.

Assign default metric speeds for different port types, such as 10 Mb/s or 1 Mb/s ports. On Virtual Services Platform 4000, you can specify a new metric speed for an IP interface. An IP interface can be a brouter port or a VLAN.

RFC1583 states the following:

"OSPF supports two types of external metrics. Type 1 external metrics are equivalent to the link state metric. Type 2 external metrics are greater than the cost of path internal to the AS. Use of Type 2 external metrics assumes that routing between ASs is the major cost of routing a packet, and eliminates the need for conversion of external costs to internal link state metrics."

"Both Type 1 and Type 2 external metrics can be present in the AS at the same time. In that event, Type 1 external metrics always take precedence."

OSPF security mechanisms

The Virtual Services Platform 4000 implementation of OSPF includes security mechanisms to prevent unauthorized routers from attacking the OSPF routing domain. These security mechanisms

prevent a malicious person from joining an OSPF domain and advertising false information in the OSPF LSAs. Likewise, security prevents a misconfigured router from joining an OSPF domain.

Simple password

The simple password security mechanism is a simple-text password; only routers that contain the same authentication ID in their LSA headers can communicate with each other.

Avaya recommends that you do not use this security mechanism because the system stores the password in plain text. A user or system can read the password from the configuration file or from the LSA packet.

Message Digest 5

Message Digest 5 (MD5) for OSPF security provides standards-based (RFC1321) authentication using 128-bit encryption. When you use MD5 for OSPF security, it is almost impossible for a malicious user to compute or extrapolate the decrypting codes from the OSPF packets.

If you use MD5, each OSPF packet has a message digest appended to it. The digest must match between sending and receiving routers. Both the sending and receiving routers calculate the message digest based on the MD5 key and padding, and then compare the results. If the message digest computed at the sender and receiver does not match, the receiver rejects the packet.

Secure hash algorithm 1

The secure hash algorithm 1 (SHA-1) is a cryptographic hash function that uses 160-bit encryption, usually given in a 40 digit hexadecimal number. SHA-1 is one of the most widely used of the existing SHA hash functions and is more secure than MD5.

SHA-1 takes a variable length input message and SHA-1 creates a fixed length output message referred to as the hash, or message digest, of the original message. If you use SHA-1 with OSPF, each OSPF packet has a message digest appended to it.

The message digest or hash must match between the sending and receiving routers. If the message digest computed at the sender and receiver does not match, the receiver rejects the packet. The hash functions produce a type of checksum or summary of the input.

It is almost impossible to determine the original input message based on the output hash message.

A cryptographic hash function is fully defined and uses no secret key.

Secure hash algorithm 2

Secure hash algorithm 2 (SHA-2) is also a cryptographic hash function. SHA-2 updates SHA-1 and offers six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits message digest size values. Output size depends on the hash function, so, for instance, SHA-256 is 256 bits.

SHA-2 is more secure than SHA-1 and MD5.

SHA-2 works similarly to SHA-1, in that SHA-2 takes a variable length input message and creates a fixed length output message referred to as the hash, or message digest, of the original message. If you use SHA-2 with OSPF, each OSPF packet has a message digest appended to it. Among the differences in SHA-2 from SHA-1 are an increased bit encryption length.

Similarly with other hash functions, for SHA-2, the message digest or hash must match between the sending and receiving routers. If the message digest computed at the sender and receiver does not match, the receiver rejects the packet. The hash functions produce a type of checksum or summary of the input.

OSPF and route redistribution

Redistribution imports routes from one protocol to another. Redistribution sends route updates for a protocol-based route through another protocol. For example, if OSPF routes exist in a router and they must travel through a BGP network, then configure redistribution of OSPF routes through BGP. This configuration sends OSPF routes to a router that uses BGP.

You can redistribute routes

- on an interface basis
- on a global basis between protocols on a single VRF instance (intraVRF)
- between the same or different protocols on different VRF instances (interVRF)

To configure interface-based redistribution, configure a route policy, and then apply it to the interface. Configure the match parameter to the protocol from which to learn routes.

You can redistribute routes on a global basis, rather than for every interface. Use the **`ip ospf redistribute`** command to accomplish the (intraVRF) redistribution of routes through RIP, so that RIP redistribution occurs globally on all RIP-enabled interfaces. This redistribution does not require a route policy, but you can use one for more control.

If you configure redistribution globally and on an interface, redistribution through the route policy takes precedence.

You can redistribute routes from a protocol in one VRF to RIP in another VRF. You can use a route policy for redistribution control. If you enable route redistribution between VRF instances, ensure that IP addresses do not overlap.

OSPF configuration considerations

This section describes considerations to keep in mind as you configure OSPF.

OSPF host route advertisements and nonbackbone areas

The Virtual Services Platform 4000 does not associate a host route with a specific area. Therefore, if you create a host route in a nonbackbone area, nonbackbone (nonOSPF core) areas do not advertise it.

For example, in an OSPF network with multiple areas, including areas not adjacent to the core, which use virtual links, a host route on a router that belongs to a nonOSPF core area is not advertised on noncore routers.

To ensure host route advertisement, disable and enable OSPF on the noncore routers.

OSPF with switch clustering

If the network loses the DR, the BDR immediately becomes the new DR on the broadcast segment. After OSPF elects the new DR, all routers perform an SPF run and issue new LSAs for the segment. The new DR generates a new network LSA for the segment and every router on the segment must refresh the router LSA.

Each router performs the SPF run as soon as it detects a new DR. Depending on the speed of the router, the router can perform the SPF run before it receives the new LSAs for the segments, which requires a second SPF run to update and continue routing across the segment. The OSPF hold-down timer does not permit 2 consecutive SPF runs within the value of the timer. This limitation can lead to traffic interruption of up to 10 seconds.

In a classical OSPF routed design, this situation never causes a problem because OSPF runs over multiple segments so even if a segment is not usable, routes are recalculated over alternative segments Typical Routed Split MultiLink Trunnking (RSMLT) designs only deploy a single OSPF routed vlan, which constitutes a single segment.

You can use RSMLT in a configuration with dual core VLANs to minimize traffic interruption when the network loses the DR. This configuration creates a second OSPF core VLAN, forcing different nodes to become the DR for each VLAN. Each OSPF core VLAN has a DR (priority of 100) and no BDRs. This configuration does not require a BDR because the two VLANs provide backup for each other from a routing perspective. See the following figure for a network example.

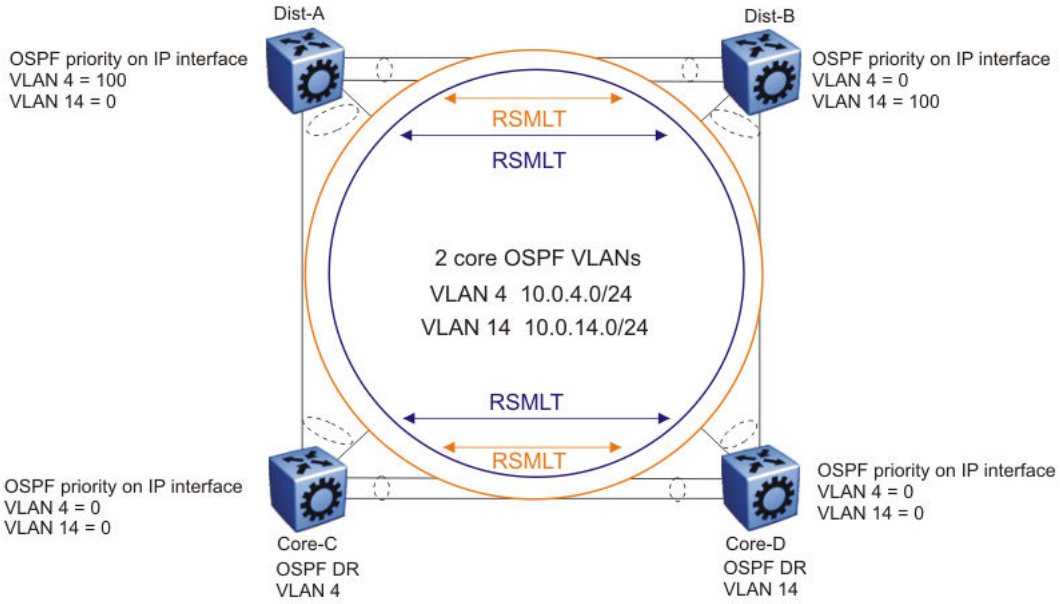

Figure 14: RSMLT with dual core VLANs

OSPF Graceful Restart

In the current OSPF networks, OSPF routers removes a restarting OSPF router from the network topology, if the router is restarted. This causes all OSPF routers to re-converge and route around the restarting router. The OSPF Graceful Restart feature is an enhancement to allow an OSPF router to stay on the forwarding path when the software is restarting.

This feature is documented under RFC 3623 for OSPFv2 (IPv4) and RFC 5187 for OSPFv3 (IPv6). The current release supports only helper mode for both OSPFv2 and OSPFv3 protocols.

Helper mode

Helper mode is a part of OSPF Graceful restart feature. It uses the OSPF routers to help other OSPF routers on the network, to stay on the forwarding path while the software is restarting. The OSPF router sends a new type of LSA called a GRACE-LSA to inform the other OSPF routers that it is restarting it's software. When an OSPF router receives a GRACE-LSA from a neighbor OSPF Router, it enters the Helper mode for that neighbor on that network. An OSPF router supports Helper mode by default.

Operations of Helper mode

The following section describes the operations in the Helper mode:

- Entering Helper mode — An OSPF router enters the Helper mode provided the following conditions are true:
  - It is fully adjacent with the neighbor already
  - No changes made in the LSDB, since the neighbor router started
  - The grace period has not expired
  - Local policy configured parameters allow it to help the neighbor
  - It is not in the process of restarting itself

  The OSPF router will not help the neighbor, if any of the above conditions are not met.

  If the OSPF router is already helping a neighbor, and receives another GRACE-LSA from the neighbor, it should accept the latest GRACE-LSA, and update the grace period accordingly. The OSPF router in Helper mode will continue to advertise its LSAs like the neighbor it is helping is still full, until any changes are made on the network during the grace period.
- Exiting Helper mode — An OSPF router exits the Helper mode, under the following conditions:
  - The GRACE-LSA is flushed. It means graceful restart has successfully terminated
  - The GRACE-LSA's grace period expires
  - There is a network topology change

  When an OSPF router exits Helper mode:
  - It recalculates the DR for the network
  - It re-originates its router LSA
  - If it is the DR, it re-originates the network LSA for the network
  - If it is a virtual link, it re-originates it's router LSA for the virtual link's transit area

Open Shortest Path First guidelines

Use OSPF to ensure that the switch can communicate with other OSPF routers. This section describes some general design considerations and presents a number of design scenarios for OSPF.

OSPF LSA limits

To determine OSPF link-state advertisement (LSA) limits:

1. Use the command **`show ip ospf area`** to determine the LSA_CNT and to obtain the number of LSAs for a given area.
2. Use the following formula to determine the number of areas. Ensure the total is less than 16,000 (16K):

   $$\sum \mathrm{Adj}_N * \mathrm{LSA\_CNT}_N < 16\mathrm{k}$$

   N = 1 to the number of areas for each switch

   Adj_N = number of adjacencies for each Area N

   $\mathrm{LSA\_CNT}_N$ = number of LSAs for each Area N

For example, assume that a switch has a configuration of three areas with a total of 18 adjacencies and 1000 routes. This includes:

- 3 adjacencies with an LSA_CNT of 500 (Area 1)
- 10 adjacencies with an LSA_CNT of 1000 (Area 2)
- 5 adjacencies with an LSA_CNT of 200 (Area 3)

Calculate the number as follows:

3*500+10*1000+5*200=12.5K < 16K

This configuration ensures that the switch operates within accepted scalability limits.

OSPF design guidelines

Follow these additional OSPF guidelines:

- OSPF timers must be consistent across the entire network.
- Use OSPF area summarization to reduce routing table sizes.
- Use OSPF passive interfaces to reduce the number of active neighbor adjacencies.
- Use OSPF active interfaces only on intended route paths.

  Configure wiring-closet subnets as OSPF passive interfaces unless they form a legitimate routing path for other routes.
- Minimize the number of OSPF areas for each switch to avoid excessive shortest-path calculations.

  The switch executes the Djikstra algorithm for each area separately.
- Ensure that the OSPF dead interval is at least four times the OSPF hello-interval.

- Use MD5 authentication on untrusted OSPF links.
- Use stub or NSSAs as much as possible to reduce CPU overhead.

OSPF and CPU utilization

After you create an OSPF area route summary on an area border router, the summary route can attract traffic to the area border router for which the router does not have a specific destination route. Enabling ICMP unreachable-message generation on the switch can result in a high CPU utilization rate.

To avoid high CPU utilization, Avaya recommends that you use a black-hole static route configuration. The black-hole static route is a route (equal to the OSPF summary route) with a next hop of 255.255.255.255. This configuration ensures that all traffic that does not have a specific next-hop destination route is dropped.

OSPF network design examples

You can use OSPF routing in the core of a network.

The following figure describes a simple implementation of an OSPF network: enabling OSPF on two switches (S1 and S2) that are in the same subnet in one OSPF area.

Figure 15: Example 1: OSPF on one subnet in one area

The routers in the preceding figure use the following configuration:

- S1 has an OSPF router ID of 1.1.1.1, and the OSPF port uses an IP address of 192.168.10.1.
- S2 has an OSPF router ID of 1.1.1.2, and the OSPF port uses an IP address of 192.168.10.2.

The general method to configure OSPF on each routing switch is:

1. Enable OSPF globally.
2. Enable IP forwarding on the switch.
3. Configure the IP address, subnet mask, and VLAN ID for the port.
4. Disable RIP on the port, if you do not need it.
5. Enable OSPF for the port.

After you configure S2, the two switches elect a designated router and a backup designated router. They exchange hello packets to synchronize their link state databases.

The following figure shows a configuration in which OSPF operates on three switches. OSPF performs routing on two subnets in one OSPF area. In this example, S1 directly connects to S2, and S3 directly connects to S2, but traffic between S1 and S3 is indirect, and passes through S2.

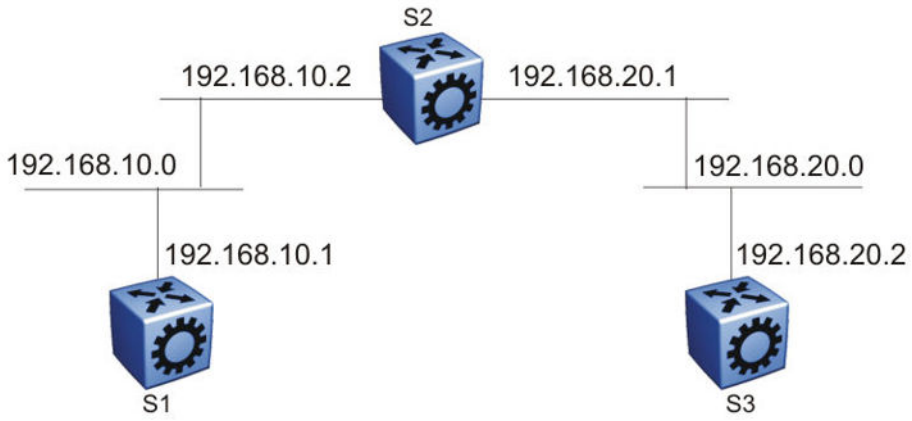

Figure 16: Example 2: OSPF on two subnets in one area

The routers in example 2 use the following configuration:

- S1 has an OSPF router ID of 1.1.1.1, and the OSPF port uses an IP address of 192.168.10.1.
- S2 has an OSPF router ID of 1.1.1.2, and two OSPF ports use IP addresses of 192.168.10.2 and 192.168.20.1.
- S3 has an OSPF router ID of 1.1.1.3, and the OSPF port uses an IP address of 192.168.20.2.

The general method to configure OSPF on each routing switch is:

1. Enable OSPF globally.
2. Insert IP addresses, subnet masks, and VLAN IDs for the OSPF ports on S1 and S3, and for the two OSPF ports on S2. The two ports on S2 enable routing and establish the IP addresses related to the two networks.
3. Enable OSPF for each OSPF port allocated with an IP address.

After you configure all three switches for OSPF, they elect a designated router and a backup designated router for each subnet and exchange hello packets to synchronize their link-state databases.

The following figure shows an example where OSPF operates on two subnets in two OSPF areas. S2 becomes the area border router for both networks.

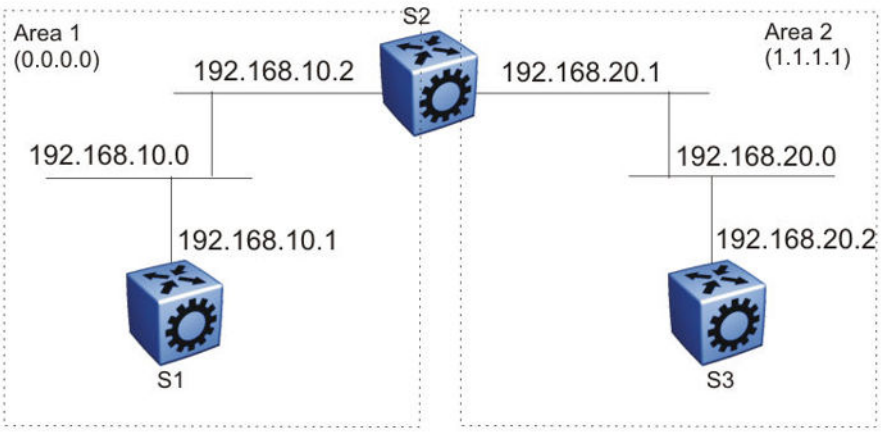

Figure 17: Example 3: OSPF on two subnets in two areas

The routers in scenario 3 use the following configuration:

- S1 has an OSPF router ID of 1.1.1.1. The OSPF port uses an IP address of 192.168.10.1, which is in OSPF area 1.
- S2 has an OSPF router ID of 1.1.1.2. One port uses an IP address of 192.168.10.2, which is in OSPF area 1. The second OSPF port on S2 uses an IP address of 192.168.20.1, which is in OSPF area 2.
- S3 has an OSPF router ID of 1.1.1.3. The OSPF port uses an IP address of 192.168.20.2, which is in OSPF area 2.

The general method to configure OSPF for this three-switch network is:

1. On all three switches, enable OSPF globally.
2. Configure OSPF on one network.

   On S1, insert the IP address, subnet mask, and VLAN ID for the OSPF port. Enable OSPF on the port. On S2, insert the IP address, subnet mask, and VLAN ID for the OSPF port in area 1, and enable OSPF on the port. Both routable ports belong to the same network. Therefore, by default, both ports are in the same area.
3. Configure three OSPF areas for the network.
4. Configure OSPF on two additional ports in a second subnet.

   Configure additional ports and verify that IP forwarding is enabled for each switch to ensure that routing can occur. On S2, insert the IP address, subnet mask, and VLAN ID for the OSPF port in area 2, and enable OSPF on the port. On S3, insert the IP address, subnet mask, and VLAN ID for the OSPF port, and enable OSPF on the port.

The three switches exchange hello packets.

In an environment with a mix of non-Avaya and Avaya switches and routers, you may need to manually modify the OSPF parameter RtrDeadInterval to 40 seconds.

OSPF configuration using ACLI

Configure Open Shortest Path First (OSPF) so that the Avaya Virtual Services Platform 4000 can use OSPF routing to communicate with other OSPF routers and to participate in OSPF routing.

Configuring OSPF globally

Configure OSPF parameters on the switch so you can control OSPF behavior on the system. The Avaya Virtual Services Platform 4000 uses global parameters to communicate with other OSPF routers. Globally configure OSPF before you configure OSPF for an interface, port, or VLAN.

Before you begin

- Ensure that the Virtual Services Platform 4000 has an IP address.
- You configure OSPF on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`** to commands. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Configure the OSPF router ID:

   ```
   router-id {A.B.C.D}
   ```

   Important:

   Each router in an OSPF network must have a unique OSPF router ID.

4. Configure the router as an autonomous system boundary router (ASBR):

   ```
   as-boundary-router enable
   ```

   Note:

   Enable this command if the switch is used as ASBR.

5. Enable the automatic creation of OSPF virtual links:

   ```
   auto-vlink
   ```

6. Configure the OSPF default metrics:

   ```
   default-cost [{ethernet|fast-ethernet|gig-ethernet|ten-gig-ethernet|
   vlan} <1-65535>]
   ```

7. Configure the network:

```
network [{A.B.C.D}] [area {A.B.C.D}]
```

8. Configure the OSPF hold-down timer value:

   ```
   timers basic holddown <3-60>
   ```

9. Enable the RFC1583 compatibility mode:

   ```
   rfc1583-compatibility enable
   ```

10. Enable the router to issue OSPF traps:

    ```
    trap enable
    ```

11. Verify the OSPF configuration:

    ```
    show ip ospf [vrf WORD<0-16>] [vrfids WORD<0-512>]
    ```

12. Exit OSPF Router Configuration mode:

    ```
    exit
    ```

    You return to Global Configuration mode.

13. Enable OSPF for the switch:

    ```
    router ospf enable
    ```

Variable definitions

Use the data in the following table to use the **router-id** command.

Variable	Value
<A.B.C.D>	Configures the OSPF router ID IP address, where A.B.C.D is the IP address.

Use the data in the following table to use the **default-cost** command.

Variable	Value
ethernet <1-65535>	Configures the OSPF default metrics. The range is 1–65535. ethernet is for 10 Mb/s Ethernet (default is 100).
fast-ethernet <1-65535>	Configures the OSPF default metrics. The range is 1–65535. fast-ethernet is for 100 Mb/s (Fast) Ethernet (default is 10).
gig-ethernet <1-65535>	Configures the OSPF default metrics. The range is 1–65535. gig-ethernet is for Gigabit Ethernet (default is 1).
ten-gig-ethernet <1-65535>	Configures the OSPF default metrics. The range is 1–65535. ten-gig-ethernet is for 10 Gigabit Ethernet (default is 1).
vlan <1-65535>	Configures the OSPF default metrics. The range is 1–65535. vlan is for VLAN (default is 10).

Use the data in the following table to use the **network** command.

Variable	Value
<A.B.C.D>	Adds the OSPF interface IP address to the OSPF domain. A.B.C.D is the OSPF interface IP address.
area <A.B.C.D>	Adds the OSPF interface IP address to the OSPF network area. A.B.C.D is the network area IP address.

Use the data in the following table to use the **`timers basic holddown`** command.

Variable	Value
<3-60>	Configures the OSPF hold-down timer value in seconds. The range is 3–60; the default is 10.

Use the data in the following table to use the **`show ip ospf`** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Configuring OSPF for a port or VLAN

Configure OSPF parameters on a port or VLAN so you can control OSPF behavior on the port or VLAN.

Before you begin

- Enable OSPF globally.
- Ensure that the VLAN exists.
- Ensure that the port or VLAN uses an IP address.
- Ensure that you know the network OSPF password to use password authentication or that you know the Message Digest 5 (MD5) key to use MD5 authentication.
- You must log on to the Interface Configuration mode for the port or VLAN in ACLI.

About this task

To configure OSPF on a VRF instance for a port or VLAN, you configure OSPF on the port or VLAN, and then associate the port or VLAN with the VRF.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Enter the VLAN Interface Configuration mode:

   ```
   interface vlan <1-4084>
   ```

3. Configure the OSPF interface area ID:

```
ip ospf area {A.B.C.D}
```

4. Enable OSPF routing:

   ```
   ip ospf enable
   ```

5. Choose the OSPF update authentication method:

   ```
   ip ospf authentication-type <message-digest|none|sha-1|sha-2|simple>
   ```

   Both sides of an OSPF connection must use the same authentication type and key.

6. If you choose simple, you must configure the password. If you choose MD5, you must configure the MD5 key:

   ```
   ip ospf authentication-key WORD<0-8>
   ```

   OR

   ```
   ip ospf message-digest-key <1-255> md5 WORD<0-16>
   ```

7. Specify the interface type:

   ```
   ip ospf network <broadcast|nbma|passive>
   ```

8. Configure the remaining parameters as required, or accept their default values. View the following variable definitions table for more information.

Variable definitions

Use the data in the following table to use the **ip ospf** commands.

Variable	Value
advertise-when-down enable	Enables or disables AdvertiseWhenDown. If enabled, OSPF advertises the network on this interface as up, even if the port is down. The default is disabled. After you configure a port with no link and enable advertise-when-down, OSPF does not advertise the route until the port is active. OSPF advertises the route even when the link is down. To disable advertising based on link status, you must disable this parameter.
area {A.B.C.D}	Configures the OSPF identification number for the area, typically formatted as an IP address.
authentication-key WORD<0-8>	Configures the eight-character simple password authentication key for the port or VLAN.
authentication-type <message-digest|none|sha-1|sha-2|simple>	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required. • simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter. • MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key.

Table continues…

Variable	Value
	• sha-1—Specifies secure hash algorithm 1 (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha-2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
cost <0-65535>	Configures the OSPF cost associated with this interface and advertised in router link advertisements. The default is 0.
dead-interval <0-2147483647>	Configures the router OSPF dead interval—the number of seconds the OSPF neighbors of a switch must wait before they assume the OSPF router is down. The default is 40. The value must be at least four times the hello interval.
enable	Enables OSPF on the port or VLAN.
hello-interval <1-65535>	Configures the OSPF hello interval, which is the number of seconds between hello packets sent on this interface. The default is 10.
message-digest-key <1-255> md5 WORD<0-16>	Configures the MD5 key. You can configure a maximum of two MD5 keys for an interface. If you configure two keys, the interface uses only the first key. To transition to the second key, configure a primary-md5–key to use the ID of the second configured key, and then delete the first key. **Important:** Use the correct key ID when two keys are configured. The key ID and MD5 password must match with the other OSFP routers, to form the OSPF adjacencies. *<1-255>* is the ID for the MD5 key. *WORD<0-16>* is an alphanumeric password of up to 16 bytes {string length 0–16}.
mtu-ignore enable	Enables maximum transmission unit (MTU) ignore. To allow the Virtual Services Platform 4000 to accept OSPF database description (DD) packets with a different MTU size, enable mtu-ignore. The interface drops incoming OSPF DD packets if their MTU is greater than 1500 bytes.
network <broadcast|nbma|passive>	Specifies the type of OSPF interface.
poll-interval <0-2147483647>	Configures the OSPF poll interval in seconds. The default is 120.
primary-digest-key <1-255>	Changes the primary key used to encrypt outgoing packets. Use this parameter to transition to a new MD5 key. *<1-255>* is the ID for the new MD5 key.
priority <0-255>	Configures the OSPF priority for the port during the election process for the designated router. The port with the highest priority number is

Table continues…

Variable	Value
	the best candidate for the designated router. If you configure the priority to 0, the port cannot become either the designated router or a backup designated router. The default is 1.
retransmit-interval <0-3600>	Configures the retransmit interval for the virtual interface, the number of seconds between link-state advertisement retransmissions.
transit-delay <0-3600>	Configures the transit delay for the virtual interface, which is the estimated number of seconds required to transmit a link-state update over the interface.
vlan <1-4084>	Specifies the VLAN ID. This variable applies only to VLAN interfaces, not ports.

Viewing OSPF errors on a port

Check OSPF errors for administrative and troubleshooting purposes.

Procedure

Display extended information about OSPF errors for the specified port or for all ports:

```
show ip ospf port-error [port {slot/port[-slot/port][,...]}] [vrf WORD<0-16>] [vrfids WORD<0-512>]
```

Variable definitions

Use the data in the following table to use the **`show ip ospf port-error`** command.

Variable	Value
{slot/port[-slot/port][,...]}	Identifies the slot and port in one of the following formats: a single slot and port (3/1), a range of slots and ports (3/2-3/4), or a series of slots and ports (3/2,5/3,6/2).
vrf WORD<0-16>	Specifies the VRF by name.
vrfids WORD<0-512>	Specifies a range of VRFs by ID number.

Configuring OSPF areas on the router

Import information from other areas to learn their OSPF relationships. Perform this procedure to create normal, stubby, or not-so-stubby areas (NSSA).

Before you begin

- Ensure that the VLAN exists if you configure OSPF on a VLAN.
- You configure OSPF on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

Place stubby or NSSAs at the edge of an OSPF routing domain. Ensure that you configure all routers in a stubby or NSSA as stubby or NSSA, respectively.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Create an OSPF area:

   ```
   area {A.B.C.D}
   ```

4. Specify the area type:

   ```
   area {A.B.C.D} import <external|noexternal|nssa>
   ```

5. Configure other OSPF area parameters as required.

6. Ensure that the configuration is correct:

   ```
   show ip ospf area [vrf WORD<0-16>] [vrfids WORD<0-255>]
   ```

Variable definitions

Use the data in the following table to use the **`area {A.B.C.D}`** command.

Variable	Value
default-cost <0-16777215>	Specifies the stub area default metric for this stub area, which is the cost from 0–16777215. This metric value applies at the indicated type of service.
import <external|noexternal|nssa>	Specifies the type of area: • external—stub and NSSA are both false • noexternal—configures the area as stub area. • nssa—configures the area as NSSA.
import-summaries enable	Configures the area support to import summary advertisements into a stub area. Use this variable only if the area is a stub area.
stub	Configures the import external option for this area as stub. A stub area has only one exit point (router interface) from the area.

Use the data in the following table to use the **`show ip ospf area`** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Configuring OSPF aggregate area ranges on the router

Use aggregate area ranges to reduce the number of link-state advertisements required within the area. You can also control advertisements.

Before you begin

- Enable OSPF globally.
- Ensure that an area exists.
- You configure OSPF area ranges on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Configure an OSPF area range:

   ```
   area range {A.B.C.D} {A.B.C.D/X} <summary-link|nssa-extlink>
   ```

4. Configure the advertised metric cost:

   ```
   area range {A.B.C.D} {A.B.C.D/X} <summary-link|nssa-extlink>
   advertise-metric <0-65535>
   ```

5. Configure the advertisement mode:

   ```
   area range {A.B.C.D} {A.B.C.D/X} <summary-link|nssa-extlink>
   advertise-mode <summarize|suppress|no-summarize>
   ```

6. Ensure that the configuration is correct:

   ```
   show ip ospf area-range [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

Variable definitions

Use the data in the following table to use the **`area range`** command.

Variable	Value
{A.B.C.D} {A.B.C.D/X}	{A.B.C.D} identifies an OSPF area and {A.B.C.D/X} is the IP address and subnet mask of the range, respectively.
advertise-metric <0-65535>	Changes the advertised metric cost of the OSPF area range.

Table continues…

Variable	Value
advertise-mode <summarize|suppress|no-summarize>	Changes the advertisement mode of the range.
<summary-link|nssa-extlink>	Specifies the link-state advertisement (LSA) type. If you configure the range as type nssa-extlink, you cannot configure the advertise-metric.

Use the data in the following table to help you use the **`show ip ospf area-range`** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Enabling automatic virtual links

Use automatic virtual links to provide an automatic, dynamic backup link for vital OSPF traffic. Automatic virtual links require more system resources than manually configured virtual links.

Before you begin

- You configure automatic virtual links on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Enable the automatic virtual links feature for the router:

   ```
   auto-vlink
   ```

Configuring an OSPF area virtual interface

Use manual virtual interfaces to provide a backup link for vital OSPF traffic with a minimum of resource use.

Before you begin

- Enable OSPF globally.
- You configure an OSPF area virtual interface on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip`**

ospf. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

Both sides of the OSPF connection must use the same authentication type and key.

You cannot configure a virtual link using a stub area or an NSSA.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Create an OSPF area virtual interface:

   ```
   area virtual-link {A.B.C.D} {A.B.C.D}
   ```

4. Choose the OSPF update authentication method:

   ```
   area virtual-link {A.B.C.D} {A.B.C.D} authentication-type <message-digest|none|sha-1|sha-2|simple>
   ```

   Both sides of an OSPF connection must use the same authentication type and key.

5. If required, configure an MD5 key for the virtual interface:

   ```
   area virtual-link message-digest-key {A.B.C.D} {A.B.C.D} <1-255> md5-key WORD<1-16>
   ```

6. Configure optional parameters, as required.

7. Ensure that the configuration is correct:

   ```
   show ip ospf virtual-link {A.B.C.D} {A.B.C.D} [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

Variable definitions

Use the data in the following table to use the **area virtual-link** command.

Variable	Value
{A.B.C.D} {A.B.C.D}	Specifies the area ID and the virtual interface ID.
authentication-key WORD<0-8>	Configures the authentication key of up to eight characters.
authentication-type <message-digest|none|sha-1|sha-2|simple>	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required.

Table continues…

Variable	Value
	• simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter. • MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key. • sha-1—Specifies secure hash algorithm 1 (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha-2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
dead-interval <0-2147483647>	Configures the number of seconds between router hello packets before neighbors declare the router down. This value must be at least four times the hello interval value. The default is 40.
hello-interval <1-65535>	Configures the hello interval, in seconds, on the virtual interface for the length of time (in seconds) between the hello packets that the router sends on the interface. The default is 10.
primary-digest-key <1-255>	Changes the primary key used to encrypt outgoing packets. Use this parameter to transition to a new MD5 key. *<1-255>* is the ID for the new MD5 key.
retransmit-interval <0-3600>	Configures the retransmit interval for the virtual interface, the number of seconds between LSA retransmissions. The range is from 1–3600.
transit-delay <0-3600>	Configures the transit delay for the virtual interface, the estimated number of seconds required to transmit a link-state update over the interface. The range is from 1–3600.

Use the data in the following table to use the **`area virtual-link message-digest-key`** command.

Variable	Value
{A.B.C.D} {A.B.C.D}	Specifies the area ID and the virtual interface ID.
<1-255>	Specifies the ID for the message digest key
md5-key WORD<1–16>	Configures the MD5 key. You can configure a maximum of two MD5 keys for an interface. If you configure two keys, the interface uses only the first key. To transition to the second key, configure a primary-md5–key to use the ID of the second configured key, and then delete the first key.

Table continues…

Variable	Value
	Important: Use the correct key ID when two keys are configured. The key ID and MD5 password must match with the other OSFP routers, to form the OSPF adjacencies. *<1-255>* is the ID for the MD5 key *WORD<0-16>* is an alphanumeric password of up to 16 bytes {string length 0–16}

Use the data in the following table to use the **`show ip ospf virtual-link`** command.

Variable	Value
<A.B.C.D> <A.B.C.D>	Specifies the area ID and the virtual interface ID.
vrf WORD<0-16>	Specifies a VRF.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Configuring an OSPF area on a VLAN or port

Import information from other areas to learn their OSPF relationships. Perform this procedure to create normal, stubby, or NSSA. Place stubby or NSSAs at the edge of an OSPF routing domain.

Before you begin

- Enable OSPF globally.
- Ensure that the VLAN exists.

About this task

Ensure that you configure all routers in a stubby or NSSA as stubby or NSSA, respectively.

To configure OSPF areas on a VRF instance for a port or VLAN, you configure OSPF on the port or VLAN, and then associate the port or VLAN with the VRF.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access VLAN Interface Configuration mode:

   ```
   interface vlan <1-4084>
   ```

3. Create an OSPF area on the VLAN or port:

   ```
   ip ospf area {A.B.C.D}
   ```

4. Specify the type of network:

```
ip ospf network <broadcast|nbma|passive>
```

5. Configure other OSPF area parameters as required.

Variable definitions

Use the data in the following table to help you use the **ip ospf** command.

Variable	Value
vlan <1-4084>	Specifies the VLAN ID. This variable applies only to VLAN interfaces, not ports.
{A.B.C.D}	Specifies the area ID.
authentication-key WORD<0-8>	Configures the eight-character simple password authentication key for the port or VLAN.
authentication-type <message-digest|none|simple>	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required. • simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter. • MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key. • sha-1—Specifies secure hash algorithm 1 (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha-2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
cost <0-65535>	Configures the OSPF cost associated with this interface and advertised in router link advertisements. The default is 0.
dead-interval <0-2147483647>	Configures the the number of seconds between router hello packets before neighbors declare the router down. This value must be at least four times the hello interval value. The default is 40.
hello-interval <1-65535>	Configures the hello interval, in seconds, on the virtual interface for the length of time (in seconds) between the hello packets that the router sends on the interface. The default is 10.
mtu-ignore enable	Enables MTU ignore. To allow the Virtual Services Platform 4000 to accept OSPF database description (DD) packets with a different MTU size, enable mtu-ignore. The interface drops incoming OSPF DD packets if their MTU is greater than 1500 bytes.
network <broadcast|nbma|passive>	Specifies the type of OSPF interface.
poll-interval <0-2147483647>	Configures the OSPF poll interval in seconds. The default is 120.
primary-digest-key <1-255>	Changes the primary key used to encrypt outgoing packets. Use this parameter to transition to a new MD5 key.

Table continues…

Variable	Value
	<1-255> is the ID for the new MD5 key.
priority <0-255>	Configures the OSPF priority for the port during the election process for the designated router. The port with the highest priority number is the best candidate for the designated router. If you set the priority to 0, the port cannot become either the designated router or a backup designated router. The default is 1.
retransmit-interval <0-3600>	Configures the retransmit interval: the number of seconds between LSA retransmissions. The range is from 1–3600.
transit-delay <0-3600>	Configures the transit delay: the estimated number of seconds it takes to transmit a link-state update over the interface. The range is from 1–3600.

Configuring an OSPF host route

Configure host routes when the Avaya Virtual Services Platform 4000 resides in a network that uses routing protocols other than OSPF. A host route is a more-specific route and is used even if it is higher cost than a network route.

Before you begin

- Globally enable OSPF.
- You configure an OSPF host route on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

Use a host route to create a custom route to a specific host to control network traffic.

You can specify which hosts directly attach to the router, and the metrics and types of service to advertise for the hosts.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Create a host route:

   ```
   host-route {A.B.C.D} [metric <0-65535>]
   ```

4. Ensure that the configuration is correct:

```
show ip ospf host-route [vrf WORD<0-16>] [vrfids WORD<0-512>]
```

Variable definitions

Use the data in the following table to use the **host-route** command.

Variable	Value
{A.B.C.D}	Specifies the IP address of the host router in a.b.c.d format.
metric <0-65535>	Configures the metric (cost) for the host route.

Use the data in the following table to use the **show ip ospf host-route** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Configuring OSPF NBMA neighbors

Configure NBMA neighbors so that the interface can participate in designated router election. All OSPF neighbors that you manually configure are NBMA neighbors.

Before you begin

- Enable OSPF globally.
- Ensure that the interface uses an IP address.
- Ensure that the interface is NBMA.
- You configure OSPF NBMA neighbors on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **ip ospf**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Create an NBMA OSPF neighbor:

   ```
   neighbor {A.B.C.D} priority <0-255>
   ```

4. Ensure that the configuration is correct:

   ```
   show ip ospf neighbors [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

Variable definitions

Use the data in the following table to use the **neighbor** command.

Variable	Value
{A.B.C.D}	Identifies an OSPF area in IP address format a.b.c.d.
priority <0-255>	Changes the priority level of the neighbor.

Use the data in the following table to use the **show ip ospf neighbors** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Disabling Helper mode for OSPFv2

About this task

By default, OSPF Helper mode is enabled when OSPF is configured. You can disable helper mode by the following command and re-enable it again by using “no” or “default” commands.

Procedure

1. Enter OSPF Router Configuration mode:

   ```
   enable
   configure terminal
   router ospf
   ```

2. Enter the following command to disable Helper mode:

   ```
   helper-mode-disable
   ```

3. Enter the following command to enable Helper mode:

   ```
   no helper-mode-disable
   ```

   Or

   ```
   default helper-mode disable
   ```

Example

Disabling Helper mode:

```
Switch:1>enable
Switch:1#configure terminal
Switch:1(config)#router ospf
Switch:1(config-ospf)#helper-mode-disable
```

Enabling Helper mode:

```
Switch:1>enable
Switch:1#configure terminal
Switch:1(config)#router ospf
Switch:1(config-ospf)#no helper-mode-disable
```

Applying OSPF route acceptance policies

Use a route policy to define how the switch redistributes external routes from a specified source into an OSPF domain. The policy defines which route types the switch accepts and redistributes.

Before you begin

- Enable OSPF globally.
- Ensure that a route policy exists.
- Ensure that the area exists.
- You apply OSPF route acceptance policies on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **`ip ospf`**. The VRF must have an RP Trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access Router OSPF Configuration mode:

   ```
   router ospf
   ```

3. Create an acceptance policy instance:

   ```
   accept adv-rtr {A.B.C.D}
   ```

4. Configure the type of metric to accept:

   ```
   accept adv-rtr {A.B.C.D} metric-type <type1|type2|any>
   ```

5. Indicate the route policy:

   ```
   accept adv-rtr {A.B.C.D} route-policy WORD<0-64>
   ```

6. Enable a configured OSPF route acceptance instance:

   ```
   accept adv-rtr {A.B.C.D} enable
   ```

7. Apply the acceptance policy.

   ```
   ip ospf apply accept adv-rtr {A.B.C.D} vrf WORD<0-16>
   ```

8. Ensure that the configuration is correct:

   ```
   show ip ospf accept [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

Variable definitions

Use the data in the following table to use the **accept adv-rtr** command.

Variable	Value
<A.B.C.D>	Specifies the IP address.
enable	Enables an OSPF acceptance policy.
metric-type <type1|type2|any>	Configures the metric type as type 1, type 2, or any.
route-policy WORD<0-64>	Configures the route policy by name.

Use the data in the following table to use the **ip ospf accept** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Viewing the OSPF link-state database

View the area advertisements and other information in the LSDB to ensure correct OSPF operations.

Procedure

View the OSPF link-state database:

```
show ip ospf lsdb [adv_rtr {A.B.C.D}] [area {A.B.C.D}>] [lsa-type <0-7>]
[lsid {A.B.C.D}] [vrf WORD<0-16>] [vrfids WORD<0-512>] [detail]
```

Variable definitions

Use the data in the following table to use the **show ip ospf lsdb** command.

Variable	Value
adv_rtr {A.B.C.D}	Specifies the advertising router.
area {A.B.C.D}	Specifies the OSPF area.
detail	Provides detailed output.
lsa-type <0-7>	Specifies the link-state advertisement type in the range of 0–7.
lsid {A.B.C.D}	Specifies the link-state ID.
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Viewing the OSPF external link-state database

View the LSDB to determine externally learned routing information. Information appears for all metric types or for the type you specify.

Procedure

View the OSPF autonomous system external (ASE) link-state advertisements:

```
show ip ospf ase [metric-type <1-2>] [vrf WORD<0-16>] [vrfids
WORD<0-512>]
```

Variable definitions

Use the data in the following table to use the **`show ip ospf ase`** command.

Variable	Value
metric-type *<1-2>*	Specifies the metric type.
vrf *WORD<0-16>*	Identifies the VRF by name.
vrfids *WORD<0-512>*	Specifies a VRF by ID.

Configuring route redistribution to OSPF

Configure a redistribute entry to announce certain routes into the OSPF domain, including static routes, direct routes, Routing Information Protocol (RIP), OSPF, or Border Gateway Protocol (BGP). Optionally, use a route policy to control the redistribution of routes.

Before you begin

- Enable OSPF globally.
- Ensure that a route policy exists.

Procedure

1. Enter OSPF Router Configuration mode:

   ```
   enable
   configure terminal
   router ospf
   ```

2. Create the redistribution instance:

   ```
   redistribute <bgp|ospf|isis|static|direct|rip> [vrf-src WORD<0-16>]
   ```

3. Apply a route policy if required:

   ```
   redistribute <bgp|ospf|isis|static|direct|rip> route-policy
   WORD<0-64> [vrf-src WORD<0-16>]
   ```

4. Configure other parameters, as required.

5. Enable the redistribution.

   ```
   redistribute WORD<0-32> enable [vrf-src WORD<0-16>]
   ```

6. Ensure that the configuration is correct:

   ```
   show ip ospf redistribute [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

7. Exit OSPF Router Configuration mode.

   ```
   exit
   ```

   You are now in Global Configuration mode.

8. Apply the redistribution.

   ```
   ip ospf apply redistribute <bgp|ospf|isis|static|direct|rip> [vrf
   WORD<0-16>] [vrf-src WORD<0-16>]
   ```

   Changes do not take effect until you apply them.

Variable definitions

Use the data in the following table to use the **`redistribute`** command.

Variable	Value
enable	Enables the OSPF route redistribution instance.
metric <0–65535>	Configures the metric to apply to redistributed routes.
metric-type <type1|type2>	Specifies a type 1 or a type 2 metric. For metric type 1, the cost of the external routes is equal to the sum of all internal costs and the external cost. For metric type 2, the cost of the external routes is equal to the external cost alone.
route-policy WORD<0-64>	Configures the route policy to apply to redistributed routes.
subnets <allow|suppress>	Allows or suppresses external subnet route advertisements when routes are redistributed into an OSPF domain.
vrf-src WORD<0-16>	Specifies the optional source VRF instance. You can use this variable with the other command variables.
<bgp|direct|isis|ospf|rip|static>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, isis, rip, ospf, or static.

Use the data in the following table to use the **`ip ospf apply redistribute`** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrf-src WORD<0-16>	Specifies the source VRF instance. You do not need to configure this parameter for redistribution within the same VRF.
<bgp|direct|isis|ospf|rip|static>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, isis, rip, ospf, or static.

Configuring interVRF route redistribution for OSPF

Use route redistribution so that a VRF interface can announce routes learned by other protocols, for example, OSPF or BGP. The Avaya Virtual Services Platform 4000 supports interVRF route redistribution. Use a route policy to control the redistribution of routes.

Before you begin

- Enable OSPF globally.
- Ensure that a route policy exists.
- Ensure that the VRFs exist.

Procedure

1. Enter VRF Router Configuration mode for a specific VRF context:

   ```
   enable
   configure terminal
   router vrf WORD<1-16>
   ```

2. Create the redistribution instance:

   ```
   ip ospf redistribute <bgp|ospf|isis|static|direct|rip>
   ```

3. Apply a route policy if required:

   ```
   ip ospf redistribute <bgp|ospf|isis|static|direct|rip> route-policy
   WORD<0-64> [vrf-src WORD<0-16>]
   ```

4. Configure other parameters, as required.
5. Enable the redistribution:

   ```
   ip ospf redistribute <bgp|ospf|isis|static|direct|rip> enable [vrf-
   src WORD<0-16>]
   ```

6. Ensure that the configuration is correct:

   ```
   show ip ospf redistribute [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

7. Exit VRF Router Configuration mode.

   ```
   exit
   ```

   You are now in Global Configuration mode.

8. Apply the redistribution:

   ```
   ip ospf apply redistribute <bgp|ospf|isis|static|direct|rip> [vrf
   WORD<0-16>] [vrf-src WORD<0-16>]
   ```

Variable definitions

Use the data in the following table to use the **`ip ospf redistribute`** command.

Variable	Value
enable	Enables the OSPF route redistribution instance.
metric <0–65535>	Configures the metric to apply to redistributed routes.
metric-type <type1|type2|any>	Specifies a metric. For metric type 1, the cost of the external routes is equal to the sum of all internal costs and the external cost. For metric type 2, the cost of the external routes is equal to the external cost alone.
route-policy WORD<0-64>	Configures the route policy to apply to redistributed routes.
subnets <allow|suppress>	Allows or suppresses external subnet route advertisements when routes are redistributed into an OSPF domain.
vrf-src WORD<0-16>	Specifies the optional source VRF instance. You can use this variable with the other command variables.
<*bgp*|*ospf*|*isis*|*static*|*direct*|*rip*>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, rip, isis, ospf, or static.

Use the data in the following table to use the **`ip ospf apply redistribute`** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrf-src WORD<0-16>	Specifies the source VRF instance. You do not need to configure this parameter for redistribution within the same VRF.
<*bgp*|*ospf*|*isis*|*static*|*direct*|*rip*>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, rip, isis, ospf, or static.

Forcing shortest-path calculation updates

Force the switch to update its shortest-path calculations so that the switch uses the latest OSPF routing information. Manually initiate a shortest path first (SPF) run, or calculation, to immediately update the OSPF LSDB. This action is useful in the following circumstances:

- when you need to immediately restore a deleted OSPF-learned route
- when the routing table entries and the LSDB do not synchronize

Before you begin

- You can perform this procedure in one of the following ACLI modes: User EXEC, Privileged EXEC, or Global Configuration.

About this task

This process is computationally intensive. Use this command only if required.

Procedure

Force the router to update its shortest-path calculations:

```
ip ospf spf-run [vrf WORD<0-16>]
```

Variable definitions

Use the data in the following table to use the **ip ospf spf-run** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF instance by name.

Viewing the OSPF default cost information

View the OSPF default cost information to ensure accuracy.

Procedure

1. Enter Privileged EXEC mode:

   ```
   enable
   ```

2. View the OSPF cost information:

   ```
   show ip ospf default—cost [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

Example

View the OSPF cost information:

```
Switch:1#show ip ospf default-cost

================================================================================
                        OSPF Default Metric - GlobalRouter
================================================================================
   10MbpsPortDefaultMetric: 100
  100MbpsPortDefaultMetric: 10
 1000MbpsPortDefaultMetric: 1
10000MbpsPortDefaultMetric: 1
         VlanDefaultMetric: 10
```

Variable definitions

Use the data in the following table to use the **show ip ospf default-cost** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

OSPF configuration using EDM

Configure Open Shortest Path First (OSPF) parameters so that the switch can participate in OSPF routing operations. The following section describes procedures that you use while you configure OSPF on the Avaya Virtual Services Platform 4000 using Enterprise Device Manager (EDM).

Configuring OSPF globally

Configure OSPF parameters, such as automatic virtual links and OSPF metrics, so you can control OSPF behavior on the system.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.
- Assign an IP address to the switch.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **General** tab.
4. Specify the OSPF router ID.

   Important:

   Each router in an OSPF network must have a unique OSPF router ID.
5. In AdminStat click the **enabled** option button.
6. If required, configure the metrics that OSPF uses for 10, 100, 1000, and 10 000 Mb/s links.

   The lower the metric, the more likely that OSPF chooses the link to route an OSPF packet.
7. To enable the switch to use OSPF SNMP traps, select the **TrapEnable** check box.
8. To enable the automatic creation of virtual links, select the **AutoVirtLinkEnable** check box.
9. Configure the OSPF holddown timer as required.
10. Click **Apply**.

General field descriptions

Use the data in the following table to use the **General** tab.

Name	Description
RouterId	Specifies the OSPF router ID. This variable has the same format as an IP address but distinguishes this router from other routers in the OSPF domain.
AdminStat	Shows the administrative status of OSPF for the router. Enabled denotes that the OSPF process is active on at least one interface; disabled disables it for all interfaces. The default is disabled.
VersionNumber	Specifies the OSPF version.
AreaBdrRtrStatus	Denotes if this router is an area border router (ABR).

Table continues…

Name	Description
	AreaBdrRtrStatus value must be true to create a virtual router interface.
ASBdrRtrStatus	Specifies ASBR status. If you select the ASBdrRtrStatus check box, the router is an autonomous system boundary router (ASBR).
ExternLsaCount	Shows the number of external (LS type 5) link-state advertisements in the link-state database.
ExternLsaCksumSum	Shows the 32-bit unsigned sum of the link-state checksums of the external link-state advertisements in the link-state database. This sum determines if a change occurred in a router link-state database and compares the link-state databases of two routers.
OriginateNewLsas	Shows the number of new link-state advertisements originated from this router. This number increments each time the router originates a new link-state advertisement (LSA).
RxNewLsas	Shows the number of received link-state advertisements that are new instances. This number does not include new instances of self-originated link-state advertisements.
10MbpsPortDefaultMetric	Indicates the default cost applied to 10 Mb/s interfaces (ports). The default is 100.
100MbpsPortDefaultMetric	Indicates the default cost applied to 100 Mb/s interfaces (ports). The default is 10.
1000MbpsPortDefaultMetric	Indicates the default cost applied to 1000 Mb/s interfaces (ports). The default is 1.
10000MbpsPortDefaultMetric	Indicates the default cost applied to 10 000 Mb/s interfaces (ports). The default is 1.
TrapEnable	Indicates whether to enable traps for OSPF. The default is false.
AutoVirtLinkEnable	Enables or disables the automatic creation of virtual links. The default is false.
SpfHoldDownTime	Specifies the OSPF holddown timer (3–60 seconds). The default is 10 seconds. The holddown timer delays a metric change due to a routing table update by x seconds. If you configure the timer to 0, OSPF accepts a new metric change immediately.
OspfAction	Initiates a new Shortest Path First (SPF) run to update the routing table. The default is none.
Rfc1583Compatability	Controls the preference rules used when the router chooses among multiple autonomous system external (ASE) LSAs which advertise the same destination. If enabled, the preference rule is the same as that specified by RFC1583. If disabled, the preference rule is as described in RFC2328, which can prevent routing loops when ASE LSAs for the same destination originate from different areas. The default is disable.
LastSpfRun	Indicates the time since the last SPF calculation made by OSPF.

Enabling OSPF globally

Enable OSPF globally enabled to use the protocol on the router. If you disable OSPF globally, all OSPF actions cease.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **General** tab.
4. For **AdminStat** , select the **enabled** or **disabled** option button, as required.
5. Click **Apply**.

Configuring global default metrics

Configure the metrics that OSPF uses for 10, 100, 1000, and 10 000 Mb/s links. The lower the metric, the more likely that OSPF chooses the link to route an OSPF packet.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **General** tab.
4. Change the metric for one or all of the following:
   - 10MbpsPortDefaultMetric
   - 100MbpsPortDefaultMetric
   - 1000MbpsPortDefaultMetric
   - 10000MbpsPortDefaultMetric
5. Click **Apply**.

Configuring an OSPF interface

Configure OSPF parameters, such as authentication and priority, so you can control OSPF interface behavior. You can specify the interface as passive, broadcast, or Non-Broadcast Multiple Access (NBMA).

Before you begin

- Enable OSPF globally.
- Ensure that the interface exists (the port or VLAN has an IP address).
- You must know the network OSPF password to use password authentication.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Interfaces** tab.
4. Click **Insert**.
5. Select the IP address for the interface from the IP Address list.
6. To designate a router priority, in the **RtrPriority** box, type a new value.
7. In the **Type** area, select the type of OSPF interface you want to create.
8. Select an authentication type, in the **AuthType** field.
9. If you chose **simplePassword**, in the **AuthKey** box, type a password of up to eight characters.
10. To change their values, select the current value in the **HelloInterval**, **RtrDeadInterval**, or **PollInterval** boxes, and then type new values.
11. Click **Insert**.
12. On the **Interfaces** tab, click **Apply**.

Interfaces field descriptions

Use the data in the following table to use the **Interfaces** tab.

Name	Description
IP Address	Specifies the IP address of the current OSPF interface
AddressLessIf	Designates whether an interface has an IP address: Interfaces with an IP address = 0 Interfaces without IP address = ifIndex

Table continues…

Name	Description
AreaId	Specifies the OSPF area name in dotted-decimal format. For VLANs, keeping the default area setting on the interface causes link-state database (LSDB) inconsistencies. The area name is not related to an IP address. You can use a suitable value for the OSPF area name (for example, 1.1.1.1 or 200.200.200.200).
AdminStat	Specifies the current administrative status of the OSPF interface (enabled or disabled).
State	Specifies the current state of the OSPF interface. The value can be one of the following: • down • loopback • waiting • pointToPoint • designatedRouter • backupDesignatedRouter • otherDesignatedRouter
RtrPriority	Specifies the OSPF priority to use during the election process for the designated router. The interface with the highest priority becomes the designated router. The interface with the second-highest priority becomes the backup designated router. If the priority is 0, the interface cannot become the designated router or the backup. The range is 0–255. The default is 1.
DesignatedRouter	Specifies the IP address of the designated router.
BackupDesignatedRouter	Specifies the IP address of the backup designated router.
Type	Specifies the type of OSPF interface (broadcast or NBMA). **Important:** To make it passive, first create the interface. After interface creation, click **VLAN** > **VLANs** to select the VLAN that is created with the OSPF interface. Click the **IP** tab and select the IP interface that is created with the OSPF interface. Lastly, click the **OSPF** tab and select **Passive** for the **IfType**.
AuthType	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required. • simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter.

Table continues…

Name	Description
	• MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key. • sha1—Specifies secure hash algorithm 1 (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
AuthKey	Specifies the key (up to 8 characters) required when you specify simple password authentication in the AuthType parameter.
HelloInterval	Specifies the length of time, in seconds, between hello packets. This value must be the same for all routers attached to a common network. The default is 10 seconds. After you change the hello interval values, you must save the configuration file, and then restart the switch. After the switch restarts, it restores the values and checks for consistency.
TransitDelay	Specifies the length of time, in seconds, required to transmit an LSA update packet over the interface. The default is 1.
RetransInterval	Specifies the length of time, in seconds, required between LSA retransmissions. The default is 5.
RtrDeadInterval	Specifies the interval used by adjacent routers to determine if the router was removed from the network. This interval must be identical on all routers on the subnet and a minimum of four times the Hello interval. To avoid interpretability issues, the RtrDeadInterval value for the OSPF interface must match with the RtrDeadInterval value for the OSPF virtual interface. The default is 40 seconds.
PollInterval	Specifies the length of time, in seconds, between hello packets sent to an inactive OSPF router. The default is 120.
Events	Indicates the number of times this OSPF interface has changed state, or an error has occurred.

Changing an OSPF interface type

Change the interface type to designate the interface as either passive, NBMA, or broadcast.

Before you begin

- Enable OSPF globally.
- Ensure that the interface uses an IP address.
- If the interface is currently an NBMA interface with manually configured neighbors, you must first delete all manually configured neighbors.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Interfaces** tab.
4. To disable the interface, double-click the **AdminStat** cell, and then select **disabled**.
5. Click **Apply**.
6. To change the interface type, double-click the **Type** cell, and then choose the new interface type.
7. Click **Apply**.
8. To enable the interface, double-click the **AdminStat** cell, and then select **enabled**.
9. Click **Apply**.

Important:

The procedure above details the creation of a non-passive interface. Perform the following steps to create a passive interface:

a. In the navigation tree, open the following folders: **Configuration** > **VLAN**.
b. Click **VLANs**.
c. Click on the VLAN where the OSPF interface is created.
d. Click **IP**.
e. Select the IP Address where the OSPF interface is created.
f. Click the **OSPF** tab.
g. Clear the **Enable** check box to disable the OSPF interface.
h. Click **Apply**.
i. Modify the interface type to passive.
j. Select the **Enable** check box.
k. Click **Apply**.

Viewing the OSPF advanced interface

View the OSPF advanced interface.

Procedure

1. In the navigation tree, expand the following folders: **Configuration**> **IP**.
2. Click **OSPF**.
3. Click the **Interface Advanced** tab.

Interface Advanced field description

Use the data in the following table to use the OSPF Interface Advanced tab.

Name	Description
Index	Indicates the Index of the OSPF interface.
Metric	Specifies the metric for the type of service (TOS) on this port. The value of the TOS metric is (10^9 / interface speed). The default is 1. • FFFF—No route exists for this TOS. • IPCP links—Defaults to 0. • 0—Use the interface speed as the metric value when the state of the interface is up.
AdvertiseWhenDown	Advertises the network on this port as up, even if the port is down. The default is false. After you configure a port with no link and enable AdvertiseWhenDown, it does not advertise the route until the port is active. Then, OSPF advertises the route even if the link is down. To disable advertising based on linkstates, disable AdvertiseWhenDown.
IfMtuIgnore	Specifies whether the interface ignores the global maximum transmission unit (MTU) configuration. To allow the Virtual Services Platform 4000 to accept OSPF database description (DD) packets with a different MTU size, enable MtuIgnore. The interface drops incoming OSPF DD packets if their MTU is greater than 1500 bytes.

Configuring NBMA interface neighbors

Configure NBMA neighbors so that the interface can participate in designated router election. All neighbors that you manually insert on the Neighbors tab are NBMA neighbors.

Before you begin

- Enable OSPF globally.
- Ensure that the interface uses an IP address.
- Ensure that the interface type is NBMA.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Neighbors** tab.

4. Click **Insert**.
5. Enter the IP address and priority for the first neighbor.
6. Click **Insert**.
7. Add all required neighbors.
8. Click **Apply**.

Neighbors field descriptions

Use the data in the following table to use the **Neighbors** tab.

Name	Description
NbrIpAddr	Specifies the neighbor IP address.
AddressLessIndex	Indicates addressed and addressless interfaces. This value is 0 on an interface with an IP address. On addressless interfaces, the corresponding value of ifIndex in the Internet standard management information base (MIB).
NbrRtrId	Specifies the router ID of the neighboring router. The router ID has the same format as an IP address but identifies the router independent of its IP address.
Options	Specifies the bit mask that corresponds to the neighbor options parameter.
Priority	Specifies the priority.
State	Specifies the OSPF interface state.
Events	Specifies the number of state changes or error events that occur between the OSPF router and the neighbor router.
Retransmission Queue Length	Specifies the number of elapsed seconds between advertising retransmissions of the same packet to a neighbor.
ospfNbmaNbrPermanence	Indicates whether the neighbor is a manually configured NBMA neighbor; permanent indicates it is an NBMA neighbor.
HelloSuppressed	Indicates whether hello packets to a neighbor are suppressed.

Configuring OSPF interface metrics

Configure the metrics associated with the peer layer interface to control OSPF behavior. For finer control over port-specific metric speed, you can specify the metric speed when you configure OSPF on a port.

Before you begin

- Enable OSPF globally.
- Ensure that the interface uses an IP address.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **If Metrics** tab.
4. Double-click the value cell, and type a new value.
5. Click **Apply**.

   When you enable a port for OSPF routing, the default metric in the port tab is 0. A value of 0 means that the port uses the default metrics for port types that you specify on the OSPF General tab.

If Metrics field descriptions

Use the data in the following table to use the **If Metrics** tab.

Name	Description
IP Address	Specifies the IP address of the device used to represent a point of attachment in a TCP/IP internetwork.
AddressLessIf	Indicates addressed and addressless interfaces. This variable is 0 on interfaces with IP addresses and equals ifIndex for interfaces that have no IP address.
TOS	Specifies the type of service (TOS). The TOS is a mapping to the IP type of service flags as defined in the IP forwarding table management information base (MIB).
Value	Indicates the metric from the OSPF router to a network in the range.
Status	Specifies the status of the interface as active or not active. This variable is read-only.

Viewing all OSPF-enabled interfaces

View all OSPF-enabled interfaces to determine which interfaces use OSPF routing.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Interfaces** tab.
4. To ensure the latest information appears, click **Refresh**.

Configuring OSPF on a port

Configure OSPF parameters on a port so you can control OSPF behavior on the port.

Before you begin

- Enable OSPF globally .
- Ensure that the port uses an IP address.
- Ensure that the ospf_md5key.txt file is on the switch to use MD5 authentication.
- You must know the network OSPF password to use password authentication.

Procedure

1. In the Device Physical View tab, select a port.
2. In the navigation tree, expand the following folders: **Configuration** > **Edit** > **Port**.
3. Click **IP**.
4. Click the **OSPF** tab.
5. Select the **Enable** check box.
6. Specify the hello interval.
7. Specify the router dead interval.
8. Designate a router priority.
9. Configure a metric.
10. If you want, select an authentication type.
11. If you select **simplePassword** authentication, type a password in the **AuthKey** box.
12. Configure the area ID.
13. If desired, select the **AdvertiseWhenDown** check box.
14. Select an interface type.
15. Type a value in the **PollInterval** box.
16. In the IfMtuIgnore area, select either **enable** or **disable**.
17. Click **Apply**.

OSPF field descriptions

Use the data in the following table to use the **OSPF** tab.

Name	Description
Enable	Enables or disables OSPF routing on the specified port. The default is false.
HelloInterval	Specifies the length of time, in seconds, between the transmission of hello packets. This value must be the same for all routers attached to a common network. The default is 10 seconds.

Table continues…

Name	Description
	After you change the hello interval values, you must save the configuration file, and then restart the switch. After the switch restarts, it restores the values and checks for consistency.
RtrDeadInterval	Specifies the interval used by adjacent routers to determine if the router was removed from the network. This interval must be identical on all routers on the subnet, and a minimum of four times the hello interval. To avoid interoperability issues, the RtrDeadInterval value for the OSPF interface needs to match with the RtrDeadInterval value for the OSPF virtual interface. The default is 40 seconds.
DesigRtrPriority	Specifies the priority of this port in multiaccess networks to use in the designated router election algorithm. The value 0 indicates the router is not eligible to become the designated router on this particular network. If a tie occurs, routers use their router ID as a tie breaker. The default is 1.
Metric	Specifies the metric for the type of service (TOS) on this port. The value of the TOS metric is (10^9 / interface speed). The default is 1. • FFFF—No route exists for this TOS. • IPCP links—Defaults to 0. • 0—Use the interface speed as the metric value when the state of the interface is up.
AuthType	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required. • simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter. • MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key. • sha1—Specifies secure hash algorithm 1 (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
AuthKey	Specifies the key (up to 8 characters) when you specify simple password authentication in the port AuthType variable.
AreaId	Specifies the OSPF area name in dotted-decimal format. The area name is not related to an IP address. You can use a suitable value for the OSPF area name (for example, 1.1.1.1 or 200.200.200.200).

Table continues…

Name	Description
AdvertiseWhenDown	Advertises the network on this port as up, even if the port is down. The default is false. After you configure a port with no link and enable AdvertiseWhenDown, it does not advertise the route until the port is active. Then, OSPF advertises the route even if the link is down. To disable advertising based on link-states, disable AdvertiseWhenDown.
IfType	Specifies the type of OSPF interface (broadcast, NBMA, or passive). Before you change an OSPF interface type, you must first disable the interface. If the interface is an NBMA interface, you must also delete all configured neighbors.
PollInterval	Specifies the length of time, in seconds, between hello packets sent to an inactive OSPF router. Neighbors must have the same poll interval.
IfMtuIgnore	Specifies whether the interface ignores the global maximum transmission unit (MTU) configuration. To allow the Virtual Services Platform 4000 to accept OSPF database description (DD) packets with a different MTU size, enable MtuIgnore. The interface drops incoming OSPF DD packets if their MTU is greater than 1500 bytes.

Configuring OSPF on a VLAN

Configure OSPF parameters on a VLAN so you can control OSPF behavior on the VLAN.

Before you begin

- Enable OSPF globally.
- Ensure that the VLAN uses an IP address.
- Ensure that the ospf_md5key.txt file is on the switch to use MD5 authentication.
- Ensure that you know the network OSPF to use password authentication, .
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **VLAN**.
2. Click **VLANs**.
3. Click the **Basic** tab.
4. Select a VLAN.
5. Click **IP**.
6. Click the **OSPF** tab.

The information on the OSPF tab applies only to a routed port or VLAN; that is, it uses an IP address.

7. To enable OSPF on the VLAN interface, select the **Enable** check box.
8. To change their values, select the current value in the **HelloInterval**, **RtrDeadInterval**, or **PollInterval** boxes, and then type new values.
9. To designate a router priority, in the **DesigRtrPriority** box, type the new value.
10. Select an authentication type, in the **AuthType** field.
11. If you chose **simplePassword**, in the **AuthKey** box, type a password of up to eight characters.
12. Select the interface type you want to create.
13. Click **Apply**.

OSPF field descriptions

Use the data in the following table to use the **OSPF** tab.

Name	Description
Enable	Enables or disables OSPF routing on the specified VLAN. The default is false.
HelloInterval	Specifies the length of time, in seconds, between the transmission of hello packets. This value must be the same for all routers attached to a common network. The default is 10 seconds. After you change the hello interval values, you must save the configuration file, and then restart the switch. After the switch restarts, it restores the values and checks for consistency.
RtrDeadInterval	Specifies the interval used by adjacent routers to determine if the router was removed from the network. This interval must be identical on all routers on the subnet and a minimum of four times the hello interval. To avoid interoperability issues, the RtrDeadInterval value for the OSPF interface needs to match with the RtrDeadInterval value for the OSPF virtual interface. The default is 40 seconds.
DesigRtrPriority	Specifies the priority of this VLAN in multiaccess networks to use in the designated router election algorithm. The value 0 indicates the router is not eligible to become the designated router on this particular network. If a tie occurs, routers use their router ID as a tie breaker. The default is 1.
Metric	Specifies the metric for this TOS on this VLAN. The value of the TOS metric is (10^9 / interface speed). The default is 1. • FFFF—No route exists for this TOS. • IPCP links—Defaults to 0. • 0—Use the interface speed as the metric value when the state of the interface is up.

Table continues…

Name	Description
AuthType	Specifies the type of authentication required for the interface. • none—Specifies that no authentication required. • simple password—Specifies that all OSPF updates received by the interface must contain the authentication key specified in the interface AuthKey parameter. • MD5 authentication—Specifies that all OSPF updates received by the interface must contain the MD5 key. • sha1—Specifies secure hash algorithm (SHA-1), which is a cryptographic hash function that produces a 160-bit hash value, usually given in a hexadecimal number, 40 digits long. • sha2—Specifies SHA-2, which is an update of SHA-1, offering six hash functions that include SHA-224, SHA-256, SHA-384, SHA-512, SHA-512/224, SHA 512/256, with hash values that are 224, 256, 384, or 512 bits.
AuthKey	Specifies the key (up to eight characters) when you specify simple password authentication in the VLAN AuthType variable.
AreaId	Specifies the OSPF area name in dotted-decimal format. The area name is not related to an IP address. You can use a suitable value for the OSPF area name (for example, 1.1.1.1 or 200.200.200.200).
AdvertiseWhenDown	Advertises the network even if the port is down. If true, OSPF advertises the network on this VLAN as up, even if the port is down. The default is false. After you configure a port without a link and enable AdvertiseWhenDown, it does not advertise the route until the port is active. Then, OSPF advertises the route even when the link is down. To disable advertising based on link states, disable AdvertiseWhenDown.
IfType	Specifies the type of OSPF interface (broadcast, NBMA, or passive). Before you change an OSPF interface type, you must first disable the interface. If the interface is an NBMA interface, you must also delete all configured neighbors.
PollInterval	Specifies the length of time, in seconds, between hello packets sent to an inactive OSPF router. Neighbors must use the same poll interval.
IfMtuIgnore	Specifies whether the VLAN ignores the MTU configuration. To allow the Virtual Services Platform 4000 to accept OSPF DD packets with a different MTU size, enable MtuIgnore. The interface drops incoming OSPF DD packets if their MTU is greater than 1500 bytes.

Viewing graphs for OSPF on a VLAN

View graphs for OSPF on a VLAN. The graph formats available are: line chart, area chart, bar chart, and pie chart.

Before you begin

- OSPF must be enabled.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **VLAN** > **VLANs**.
2. Click the **Basic**tab.
3. Select a VLAN, and then click **IP**.
4. Click the **OSPF** tab.
5. Click **Graph**.
6. (Optional) To refresh the values in the table, click **Clear Counters**.
7. To specify the polling interval, from the **Poll Interval** drop down menu, select a value. The options are:

Choice Option	Choice Description
5s	The polling interval is 5 seconds.
10s	The polling interval is 10 seconds.
30s	The polling interval is 30 seconds.
1m	The polling interval is 1 minute.
5m	The polling interval is 5 minutes.
30m	The polling interval is 30 minutes.
1h	The polling interval is 1 hour.

8. Select one value; for example, AbsoluteValue or Cumulative.
   - Or, select two values; for example, AbsoluteValue and Cumulative.

   To select a second value, press the **Ctrl** key, then select the second value. You cannot select more than two values.
9. From the toolbar, click a chart icon. The options are:

Choice Option	Choice Description
Line Chart	Displays a line chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.
Area Chart	Displays an area chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.

Choice Option	Choice Description
Bar Chart	Displays a bar chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.
Pie Chart	Displays a pie chart for the values you selected against the polling interval.

The Chart Legend uses different colors to identify the values you selected that are plotted on the graph.

10. To switch the horizontal and vertical axes values, on the chart toolbar, click **Horizontal**.
11. To switch views of the log scale from high to low values, or low to high values, on the chart toolbar, click **Log Scale**.
12. To switch to another chart using the same values, on the chart toolbar, click a chart icon.

OSPF graph field descriptions

Use the data in the following table to use the OSPF graph tab.

Name	Description
AbsoluteValue	Displays the counter value.
Cumulative	Displays the total value since you opened the OSPF-Graph tab.
Average/sec	Displays the average value for each second.
Minimum/sec	Displays the minimum value for each second.
Maximum/sec	Displays the maximum value for each second.
LastVal/sec	Displays the last value for each second.
VersionMismatches	Displays the number version mismatches received by this interface.
AreaMismatches	Displays the number area mismatches received by this interface.
AuthTypeMismatches	Displays the number AuthType mismatches received by this interface.
AuthFailures	Displays the number Authentication failures.
NetMaskMismatches	Displays the number net mask mismatches received by this interface.
HelloIntervalMismatches	Displays the number hello interval mismatches received by this interface.
DeadIntervalMismatches	Displays the number dead interval mismatches received by this interface.
OptionMismatches	Displays the number options mismatches received by this interface.
RxHellos	Displays the number hello packets received by this interface.

Table continues…

Name	Description
RxDBDescrs	Displays the number database descriptor packets received by this interface.
RxLSUpdates	Displays the number Link state update packets received by this interface.
RxLSReqs	Displays the number Link state request packets received by this interface.
RxLSAcks	Displays the number Link state acknowledge packets received by this interface.
TxHellos	Displays the number hello packets transmitted by this interface.
TxDBDescrs	Displays the number database descriptor packets transmitted by this interface.
TxLSUpdates	Displays the number Link state update packets transmitted by this interface.
TxLSReqs	Displays the number Link state request packets transmitted by this interface.
TxLSAcks	Displays the number Link state acknowledge packets transmitted by this interface.

Creating stubby or not-so-stubby OSPF areas

Import information from other areas to learn their OSPF relationships. Perform this procedure to create normal, stubby, or not-so-stubby areas (NSSA).

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

Place stubby areas or NSSAs at the edge of an OSPF routing domain. Ensure that you configure all routers in the stubby or NSSA as stubby or NSSA, respectively.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Areas** tab.

   The backbone ID has an area ID of 0.0.0.0.
4. Click **Insert**.
5. Configure the area ID.
6. Select an option in the ImportAsExtern area.

To add a not-so-stubby (NSSA) area, select **importNssa**. To import external LSAs (create a normal OSPF area), select **importExternal**. To not import external LSAs (create a stubby area), select **importNoExternal**.

7. Click **Apply**.

Areas field descriptions

Use the data in the following table to use the **Areas** tab.

Name	Description
AreaId	Specifies a 32-bit integer that uniquely identifies an area. Area ID 0.0.0.0 is the OSPF backbone. For VLANs, using the default area on the interface causes LSDB inconsistencies.
ImportAsExtern	Specifies the method to import ASE link-state advertisements. The value can be importExternal (default), importNoExternal, or importNssa.
SpfRuns	Specifies the number of SPF calculations performed by OSPF.
AreaBdrRtrCount	Specifies the number of area border routers reachable within this area. Each SPF pass calculates this value, initially zero.
AsBdrRtrCount	Specifies the number of autonomous system border routers reachable within this area. Each SPF pass calculates this value, initially zero.
AreaLsaCount	Specifies the total number of link state advertisements in this area LSDB, excluding AS-external LSAs.
AreaLsaCksumSum	Specifies the number of link-state advertisements. This sum excludes external (LS type 5) link-state advertisements. The sum determines if a change occurred in a router LSDB and compares the LSDB of two routers.
AreaSummary	Specifies whether to send summary advertisements in a stub area.
ActiveifCount	Specifies the number of active interfaces in this area.

Configuring stub area metrics advertised by an ABR

Configure metrics to control the use of routes in a routing domain.

Before you begin

- Enable OSPF globally.
- Ensure that the port uses an IP address.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.

2. Click **OSPF**.
3. Click the **Stub Area Metrics** tab.
4. Double-click the metric value to edit it and specify a new metric speed for the required stub areas.
5. Click **Apply**.

Stub Area Metrics field descriptions

Use the data in the following table to use the **Stub Area Metrics** tab.

Name	Description
AreaId	Specifies the 32-bit identifier for the stub area.
TOS	Specifies the type of service associated with the metric.
Metric	Specifies the metric value applied at the indicated type of service. By default, the value equals the lowest metric value at the type of service among the interfaces to other areas.
Status	Specifies the status of the stub area. This variable is read-only.

Inserting OSPF area aggregate ranges

Use aggregate area ranges to reduce the number of link-state advertisements required within the area. You can also control advertisements.

Before you begin

- Enable OSPF globally.
- Ensure that the port uses an IP address.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Area Aggregate** tab.
4. Click **Insert**.
5. Type the area ID.
6. Select the type of link-state database.
7. Type the IP address of the network.
8. Type the subnet mask.
9. Select the effect.
10. In the **AdvertiseMetric** box, type a cost to advertise for the OSPF area range.

11. Click **Insert**.

Area Aggregate field descriptions

Use the data in the following table to use the **Area Aggregate** tab.

Name	Description
AreaID	Specifies the area in which the address exists.
LsdbType	Specifies the LSDB type: • summaryLink—aggregated summary link • nssaExternalLink—not so stubby area link
IP Address	Specifies the IP address of the network or subnetwork indicated by the range.
Mask	Specifies the network mask for the area range.
Effect	Specifies advertisement methods: • advertiseMatching means advertise the aggregate summary LSA with the same LSID. • doNotAdvertiseMatching means suppress all networks that fall within the entire range. • advertiseDoNotAggregate means advertise individual networks.
AdvertiseMetric	Changes the advertised metric cost for the OSPF area range.

Enabling automatic virtual links

Use automatic virtual links to provide an automatic, dynamic backup link for vital OSPF traffic.

Before you begin

- Enable OSPF globally.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **General** tab.
4. Select the **AutoVirtLinkEnable** check box.
5. Click **Apply**.

Configuring a manual virtual interface

Use manual virtual links (interfaces) to provide a backup link for vital OSPF traffic with a minimum of resource use.

Before you begin

- Enable OSPF globally.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Virtual If** tab.
4. Click **Insert**.
5. Specify the area ID of the transit area.

   The transit area is the common area between two ABRs.
6. Specify the neighbor ID.

   The neighbor ID is the IP router ID of the ABR that the other ABR needs to reach the backbone.
7. Click **Insert**.
8. To verify that the virtual link is active, click **Refresh** and check the **State** column.

   If the state is point-to-point, the virtual link is active. If the state is down, the virtual link configuration is incorrect.

Virtual If field descriptions

Use the data in the following table to use the **Virtual If** tab.

Name	Description
AreaId	Specifies the transit area ID that the virtual link traverses.
Neighbor	Specifies the router ID of the virtual neighbor.
TransitDelay	Specifies the estimated number of seconds required to transmit a link-state update packet over this interface. The default is 1.
RetransInterval	Specifies the number of seconds between link-state advertisement, and retransmissions for adjacencies that belong to this interface. This variable also applies to DD and link-state request packets. This value must exceed the expected round-trip time. The default is 5.

Table continues…

Name	Description
HelloInterval	Specifies the length of time, in seconds, between the hello packets that the router sends on the interface. This value must be the same for the virtual neighbor. The default is 10.
RtrDeadInterval	Specifies the number of seconds that expires before neighbors declare the router down. This value must be a multiple of the hello interval. This value must be the same for the virtual neighbor. The default is 60.
State	Specifies the OSPF virtual interface state.
Events	Specifies the number of state changes or error events on this virtual Link.
AuthType	Specifies the authentication type specified for a virtual interface. You can locally assign additional authentication types. The default is none.
AuthKey	Specifies the authentication password. If AuthType is a simple password, the device adjusts and zeros fill the eight octets. Unauthenticated interfaces need no authentication key, and simple password authentication cannot use a key with more than eight octets.

Viewing virtual neighbors

View virtual neighbors to view the area and virtual link configuration for the neighboring device.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Virtual Neighbors** tab.

Virtual Neighbors field descriptions

Use the data in the following table to use the **Virtual Neighbors** tab.

Name	Description
Area	Specifies the subnetwork in which the virtual neighbor resides.
RtrId	Specifies the 32-bit integer (represented as an IP address) that uniquely identifies the neighbor router in the autonomous system.
IP Address	Specifies the IP address of the virtual neighboring router.

Table continues…

Name	Description
Options	Specifies the bit mask that corresponds to the neighbor options parameter.
State	Specifies the OSPF interface state.
Events	Specifies the number of state changes or error events that occurred between the OSPF router and the neighbor router.
LsRetransQLen	Specifies the number of elapsed seconds between advertising retransmissions of the same packet to a neighbor.
HelloSuppressed	Specifies whether hello packets from the neighbor are suppressed.

Configuring host routes

Configure host routes when the Avaya Virtual Services Platform 4000 resides in a network that uses routing protocols other than OSPF. A host route is a more-specific route and is used even if it is higher cost than a network route.

Before you begin

- Enable OSPF globally.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

You can specify which hosts directly connect to the router and the metrics and types of service to advertise for the hosts.

Use a host route to create a custom route to a specific host to control network traffic.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Hosts** tab.
4. To insert a new host, click **Insert**.
5. In the **IP Address** box , type the area IP address of the new host.
6. In the **Metric** box, type the metric to advertise.
7. Click **Insert**.
8. Click **Apply**.

Hosts field descriptions

Use the data in the following table to use the **Hosts** tab.

Name	Description
IpAddress	Specifies the IP address of the host that represents a point of attachment in a TCP/IP internetwork.
TOS	Specifies the type of service of the route.
Metric	Specifies the metric advertised to other areas. The value indicates the distance from the OSPF router to a network in the range.
AreaID	Specifies the area where the host is found. By default, the area that submits the OSPF interface is in 0.0.0.0.

Enabling ASBR status

Enable the ASBR status to make the Avaya Virtual Services Platform 4000 an autonomous system boundary router (ASBR). Use ASBRs to advertise nonOSPF routes into OSPF domains so that the routes pass through the domain. A router can function as an ASBR if one or more of its interfaces connects to a non-OSPF network, for example, Routing Information Protocol (RIP), BGP, or Exterior Gateway Protocol (EGP).

Before you begin

- Enable OSPF globally.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

To conserve resources, you can limit the number of ASBRs on your network or specifically control which routers perform as ASBRs to control traffic flow.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **General** tab.
4. Select the **ASBdrRtrStatus** check box.
5. Click **Apply**.

Managing OSPF neighbors

View or delete OSPF neighbors to control OSPF operations.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

The OSPF Hello protocol initiates and maintains neighbor relationships. The exception is that, in an NBMA network, you must manually configure permanent neighbors on each router eligible to become the DR. You can add neighbors for NBMA interfaces, but all other neighbors are dynamically learned.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Neighbors** tab.
4. To delete a manually configured neighbor, select the neighbors with a value of **permanent** in the **ospfNbmaNbrPermanence** column.
5. Click **Delete**.
6. Click **Apply**.

Viewing the link-state database

View the area advertisements and other information in the LSDB to ensure correct OSPF operations.

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **OSPF**.
3. Click the **Link State Database** tab.

Link State Database field descriptions

Use the data in the following table to use the **Link State Database** tab.

Name	Description
AreaId	Identifies the area. The OSPF backbone uses the area ID 0.0.0.0.
Type	Specifies the OSPF interface type. Broadcast LANs, such as Ethernet and IEEE 802.5, use broadcast; X.25 and similar technologies use NBMA; and links that are point-to-point use pointToPoint.
Lsid	Identifies the piece of the routing domain that the advertisement describes.
RouterId	Identifies the router in the autonomous system.

Table continues…

Name	Description
Sequence	Identifies old and duplicate link-state advertisements.
Age	Specifies the age, in seconds, of the link-state advertisement.
Checksum	Contains the checksum of the complete contents of the advertisement, except for the age parameter. The checksum does not include the age parameter so that advertisement age increments without updating the checksum.

Configuring interVRF route redistribution policies

Configure interVRF route redistribution so that a VRF interface can announce routes that other protocols learn, for example, OSPF or BGP. Use a route policy to control the redistribution of routes.

Before you begin

- VRF instances exist.
- Configure route policies, if required.
- Change the VRF instance as required.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **Policy**.
3. Click the **Route Redistribution** tab.
4. Click **Insert**.
5. Click the ellipsis (**...**) button near the **DstVrfId** box to select the source and destination VRF IDs.
6. Click the ellipsis (**...**) button near the **SrcVrfId** box to select the source and destination VRF IDs.
7. In the **Protocol** option box, select the protocol.
8. In the **RouteSource** option box, select the route source.
9. Select **enable**.
10. Click the ellipsis (**...**) button near the **RoutePolicy** box to choose the route policy to apply to the redistributed routes.
11. Configure other parameters as required.
12. Click **Insert**.
13. Click the **Applying Policy** tab.
14. Select **RedistributeApply**.
15. Click **Apply**.

Route Redistribution field descriptions

Use the data in the following table to use the **Route Redistribution** tab.

Name	Description
DstVrfId	Specifies the destination VRF ID to use in the redistribution.
Protocol	Specifies the protocols for which you want to receive external routing information.
SrcVrfId	Specifies the source VRF ID to use in the redistribution.
RouteSource	Indicates if the protocol receives notification about the routes this source learns. The route source is equivalent to the owner in the routing table.
Enable	Enables or disables route redistribution.
RoutePolicy	Specifies the route policies to apply to the redistributed routes from the source VRF. Use the route policy to determine whether the system advertises a specific route to the specified protocol.
Metric	Specifies the metric announced in advertisements.
MetricType	Specifies the metric type (applies to OSPF and BGP only). Specifies a type 1 or a type 2 metric. For metric type 1, the cost of the external routes is equal to the sum of all internal costs and the external cost. For metric type 2, the cost of the external routes is equal to the external cost alone.
Subnets	Indicates that subnets must be advertised individually (applies to OSPF only).

Configuring route redistribution to OSPF

Configure a redistribute entry to announce routes of a certain source protocol type into the OSPF domain, for example, static, RIP, or direct. Optionally, use a route policy to control the redistribution of routes.

Before you begin

- Enable OSPF globally.
- Ensure that a route policy exists.
- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

Important:

Changing the OSPF redistribute context is a process-oriented operation that can affect system performance and network reachability while you perform this procedure. Avaya recommends that if you want to change default preferences for an OSPF redistribute context, you must do so before you enable the protocols.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.

2. Click **OSPF**.
3. Click the **Redistribute** tab.
4. Click **Insert**.
5. Select an option for the route source.
6. Select the **enable** option button.
7. Select a route policy.
8. Configure the metric type.
9. Configure the subnet.
10. Click **Insert**.

Redistribute field descriptions

Use the data in the following table to use the **Redistribute** tab.

Name	Description
DstVrfId	Specifies the destination virtual router forwarding instance. You cannot configure this variable.
Protocol	Specifies the dynamic routing protocol that receives the external routing information.
SrcVrfId	Specifies the source VRF instance. You cannot configure this variable.
RouteSource	Specifies the route source protocol for the redistribution entry.
Enable	Enables (or disables) an OSPF redistribute entry for a specified source type.
RoutePolicy	Configures the route policy (by name) to use for detailed redistribution of external routes from a specified source into an OSPF domain. Click the ellipsis (...) button and choose from the list in the dialog box.
Metric	Configures the OSPF route redistribution metric for basic redistribution. The value can be a range from 0–65535. A value of 0 indicates to use the original cost of the route.
MetricType	Configures the OSPF route redistribution metric type. The default is type 2. The cost of a type 2 route is the external cost, regardless of the interior cost. A type 1 cost is the sum of both the internal and external costs.
Subnets	Allows or suppresses external subnet route advertisements when routes are redistributed into an OSPF domain.

Viewing OSPF status

View OSPF status.

Procedure

1. In the navigation tree, expand the following folders: **Configuration**> **IP**.
2. Click **OSPF**.
3. Click the **Stats** tab.

Viewing OSPF status graphs

View OSPF status graphs. The graph formats available are: line chart, area chart, bar chart, and pie chart.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**
2. Click **OSPF**.
3. Click the **Stats** tab.
4. (Optional) To refresh the values in the table, click **Clear Counters**.
5. To specify the polling interval, from the **Poll Interval** drop down menu, select a value. The options are:

Choice Option	Choice Description
5s	The polling interval is 5 seconds.
10s	The polling interval is 10 seconds.
30s	The polling interval is 30 seconds.
1m	The polling interval is 1 minute.
5m	The polling interval is 5 minutes.
30m	The polling interval is 30 minutes.
1h	The polling interval is 1 hour.

6. Select one value; for example, AbsoluteValue or Cumulative.
   - Or, select two values; for example, AbsoluteValue and Cumulative.

   To select a second value, press the **Ctrl** key, then select the second value. You cannot select more than two values.
7. From the toolbar, click a chart icon. The options are:

Choice Option	Choice Description
Line Chart	Displays a line chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.
Area Chart	Displays an area chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.
Bar Chart	Displays a bar chart for the values you selected against the polling interval. The X axis represents time. The vertical axis represents the logging scale.

Choice Option	Choice Description
Pie Chart	Displays a pie chart for the values you selected against the polling interval.

The Chart Legend uses different colors to identify the values you selected that are plotted on the graph.

8. To switch the horizontal and vertical axes values, on the chart toolbar, click **Horizontal**.
9. To switch views of the log scale from high to low values, or low to high values, on the chart toolbar, click **Log Scale**.
10. To switch to another chart using the same values, on the chart toolbar, click a chart icon.

Stats field descriptions

Use the data in the following table to use the OSPF Stats tab.

Name	Description
AbsoluteValue	Displays the counter value.
Cumulative	Displays the total value since you opened the Stats tab.
Average/sec	Displays the average value for each second.
Minimum/sec	Displays the minimum value for each second.
Maximum/sec	Displays the maximum value for each second.
LastVal/sec	Displays the last value for each second.
LsdbTblSize	Displays the number of entries in the linkstate database table.
TxPackets	Displays the number of packets transmitted by OSPF.
RxPackets	Displays the number of packets received by OSPF.
TxDropPackets	Displays the number of packets dropped before transmitted by OSPF.
RxDropPackets	Displays the number of packets dropped before received by OSPF.
RxBadPackets	Displays the number of packets received by OSPF that are bad.
SpfRuns	Displays the total number of SPF calculations performed by OSPF, which includes the number of partial route table calculation for incremental updates.
BuffersAllocated	Displays the number of buffers allocated for OSPF.
BuffersFreed	Displays the number of buffers that are freed by the OSPF.

Table continues…

Name	Description
BufferAllocFailures	Displays the number of times that OSPF has failed to allocate buffers.
BufferFreeFailures	Displays the number of times that OSPF has failed to free buffers.
Routes	Displays the number of OSPF routes added to RTM.
Adjacencies	Displays how many adjacencies are learned through the interface.
Areas	Displays the number of areas configured.

Forcing shortest-path calculation updates

Manually initiate an SPF run, or calculation, to immediately update the OSPF LSDB. This configuration is useful if

- you need to immediately restore a deleted OSPF-learned route
- the routing table entries and the LSDBs do not synchronize

Before you begin

- Change the VRF instance as required to configure OSPF on a specific VRF instance. The VRF must have an RP trigger of OSPF. Not all parameters are configurable on non0 VRFs.

About this task

This process is computationally intensive. Use this command only if required.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Double-click **OSPF**.
3. Click the **General** tab.
4. In the **OspfAction** area, select the **runSpf** option button.
5. Click **Apply**.
6. Click **Yes** to force an SPF run.

   After you initiate an SPF run, wait at least 10 seconds before you initiate another SPF run.

Chapter 5: RIP

This chapter provides concepts and configuration procedures for Routing Information Protocol (RIP).

RIP fundamentals

Use the information in these sections to help you understand the Routing Information Protocol (RIP) .

For more information about the Border Gateway Protocol (BGP), see *Configuring BGP Services on VSP Operating System Software*, NN47227-508.

Routing Information Protocol

In routed environments, routers communicate with one another to track available routes. Routers can dynamically learn about available routes using the RIP. The Avaya Virtual Services Platform 4000 software implements standard RIP to exchange IP route information with other routers.

RIP uses broadcast User Datagram Protocol (UDP) data packets to exchange routing information. Each router advertises routing information by sending a routing information update every 30 seconds (one interval). If RIP does not receive information about a network for 180 seconds, the metric associated with the network rises to infinity (U); that is, the metric resets to 16, which means the network becomes unreachable. If RIP does not receive information about a network for 120 seconds, it removes the network from the routing table.

RIP is a distance vector protocol. The vector is the network number and next hop, and the distance is the cost associated with the network number. RIP identifies network reachability based on cost, and cost is defined as hop count. One hop is the distance from one router to the next. This cost or hop count is the metric (see the following figure).

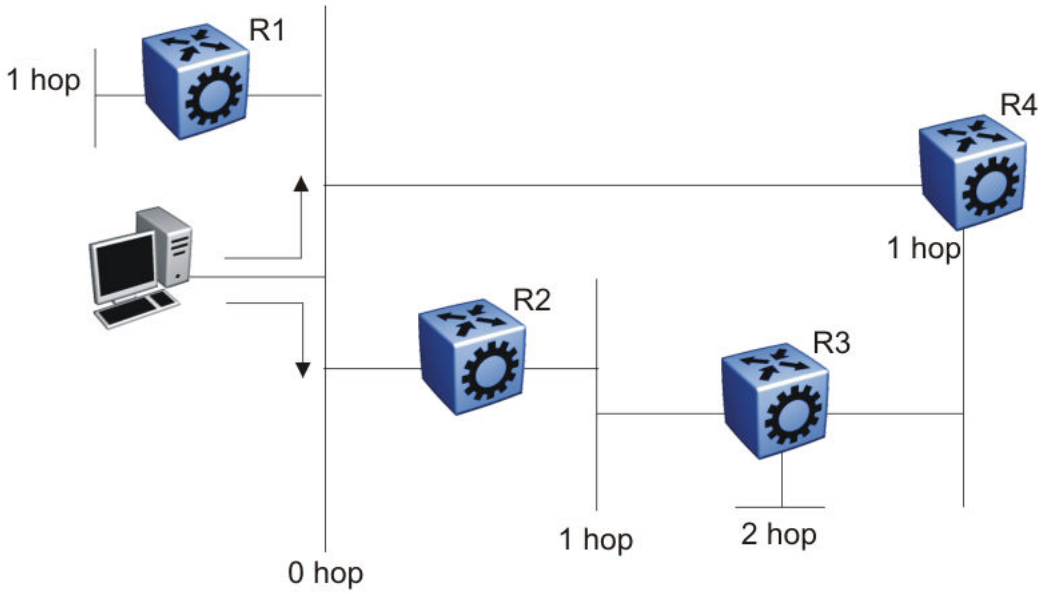

Figure 18: Hop count or metric in RIP

RIP version 1 (RIPv1) advertises default class addresses without subnet masking. RIP version 2 (RIPv2) advertises class addresses explicitly, based on the subnet mask.

The Virtual Services Platform 4000 supports RIPv2, which advertises routing table updates using multicast instead of broadcasting. RIPv2 supports variable length subnet masks (VLSM) and triggered router updates. RIPv2 sends mask information. If RIP does not receive information about a network for 90 seconds, the metric associated with the network rises to infinity (U); that is, the metric resets to 16, which means the network becomes unreachable. If RIP does not receive information about a network for 180 seconds (six update intervals), it removes the network from the routing table. You can change the default timers by configuring the RIP interface timeout timer and the holddown timer.

A directly connected network has a metric of zero. An unreachable network has a metric of 16. Therefore, the highest metric between two networks can be 15 hops or 15 routers.

RIP and route redistribution

Redistribution imports routes from one protocol to another. Redistribution sends route updates for a protocol-based route through another protocol. For example, if RIP routes exist in a router and they must travel through a BGP network, configure redistribution of RIP routes through BGP. Redistribution sends RIP routes to a router that uses BGP.

You can redistribute routes

- on an interface basis
- on a global basis between protocols on a single VRF instance (intraVRF)
- between the same or different protocols on different VRF instances (interVRF)

To configure interface-based redistribution, configure a route policy, and then apply it to the interface. Configure the match parameter to the protocol from which to learn routes.

You can redistribute routes on a global basis, rather than for every interface. Virtual Services Platform 4000 adds support for global RIP redistribution. Use the **ip rip redistribute** command to accomplish the (intraVRF) redistribution of routes through RIP, so that RIP redistribution occurs globally on all RIP-enabled interfaces. Use the command **ipv6 redistribute** for RIPng route distribution. This redistribution does not require a route policy, but you can use one for more control.

If you configure redistribution globally and on an interface, redistribution through the route policy takes precedence.

You can redistribute routes from a protocol in one VRF to RIP in another VRF. You can use a route policy for redistribution control. If you enable route redistribution between VRF instances, ensure that IP addresses do not overlap.

RIP configuration using ACLI

Use Routing Information Protocol (RIP) to perform dynamic routing within an autonomous system. This section describes how you use the Avaya command line interface (ACLI) to configure and manage RIP on an Avaya Virtual Services Platform 4000.

Note:

The default prompt for the non-PowerPlus chassis is VSP-4850GTS. The default prompt for the PowerPlus chassis is VSP-4850GTS-PWR+. The default prompt for the PowerPlus chassis with additional fiber ports is VSP-4450GSX-PWR+. For consistency, this document uses the VSP-4850GTS prompt.

Configuring RIP globally

Configure RIP parameters on the switch so you can control RIP behavior on the system.

Before you begin

- You configure RIP on a VRF instance the same way you configure the GlobalRouter, except that you must use VRF Router Configuration mode and the prefix **ip rip**. The VRF must have an RP Trigger of RIP. Not all parameters are configurable on non0 VRFs.

About this task

In the Avaya Virtual Services Platform 4000, all router interfaces that use RIP use the RIP global parameters. Both brouter ports and VLAN virtual routing interfaces use the same RIP global parameters.

You can configure RIP on interfaces while RIP is globally disabled. This way, you can configure all interfaces before you enable RIP for the switch.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access RIP Router Configuration mode:

   ```
   router rip
   ```

3. Define the default-import-metric for the switch:

   ```
   default-metric <0-15>
   ```

4. **(Optional)** Configure one or more timer values:

   ```
   timers basic timeout <15-259200> [holddown <0-360>] [update <1-360>]
   ```

5. Enable RIP on an IP network:

   ```
   network {A.B.C.D}
   ```

6. Exit RIP Router Configuration mode.

   ```
   exit
   ```

   You are now in Global Configuration mode.

7. After the configuration is complete, enable RIP globally:

   ```
   router rip enable
   ```

   Note:

   To enable RIPng globally, enter `router rip ipv6-enable`

8. Check that your configuration is correct:

   ```
   show ip rip [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

   For RIPng, enter the following:`show ipv6 rip`

Variable definitions

Use the data in the following table to use the RIP commands in this procedure.

Variable	Value
default-metric <0-15>	Configures the value of default import metric to import a route into a RIP domain. To announce OSPF internal routes into RIP domain, if the policy does not specify a metric value, the default is used. For OSPF external routes, the external cost is used. The default is 8.
domain <0-39321>	Specifies the RIP domain from 0–39321. The default is 0.

Table continues…

Variable	Value
holddown <0-360>	Configures the RIP hold-down timer value, the length of time (in seconds) that RIP continues to advertise a network after it determines that the network is unreachable. The default is 120.
network {A.B.C.D}	Enables RIP on an IP network.
timeout <15-259200>	Configures the RIP timeout interval. The default is 180.
update <1-360>	Configures the RIP update timer. The update time is the time interval, in seconds, between RIP updates. The default is 30.

Use the data in the following table to use the **`show ip rip`** command.

Variable	Value
vrf WORD<0-16>	Specifies a VRF by name.
vrfids WORD<0-512>	Specifies a range of VRF IDs.

Configuring RIP on an interface

Configure RIP on Ethernet ports and VLANs so that they can participate in RIP routing.

Before you begin

- Assign an IP address to the port or VLAN.
- Configure RIP and enable it globally.
- Configure in and out policies.

About this task

RIP does not operate on a port or VLAN until you enable it both globally and on the port or VLAN.

To configure RIP on a VRF instance for a port or VLAN, you configure RIP on the port or VLAN, and then associate the port or VLAN with the VRF.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access one of the following Interface Configuration modes:

   - `interface gigabitEthernet` *`{slot/port[-slot/port][,...]}`*
   - `interface vlan` *`<1-4084>`*

3. Define the cost:

   `ip rip cost` *`<1-15>`*

   For RIPng, use `ipv6 rip cost` *`<1-15>`*

4. Specify an in policy for filtering inbound RIP packets:

```
ip rip in-policy WORD<0-64>
```

5. Specify an out policy for filtering outbound RIP packets:

   ```
   ip rip out-policy WORD<0-64>
   ```

6. Enable RIP:

   ```
   ip rip enable
   ```

   For RIPng, use `ipv6 rip enable`

7. Specify the send mode:

   ```
   ip rip send version <notsend|rip1|rip1comp|rip2>
   ```

8. Specify the receive mode:

   ```
   ip rip receive version <rip1|rip2|rip1orrip2>
   ```

9. Change other RIP parameters from their default values as required.

Example

This configuration example shows how to configure Virtual Services Platform (R1 in the following figure) to operate only in RIP version 2 mode.

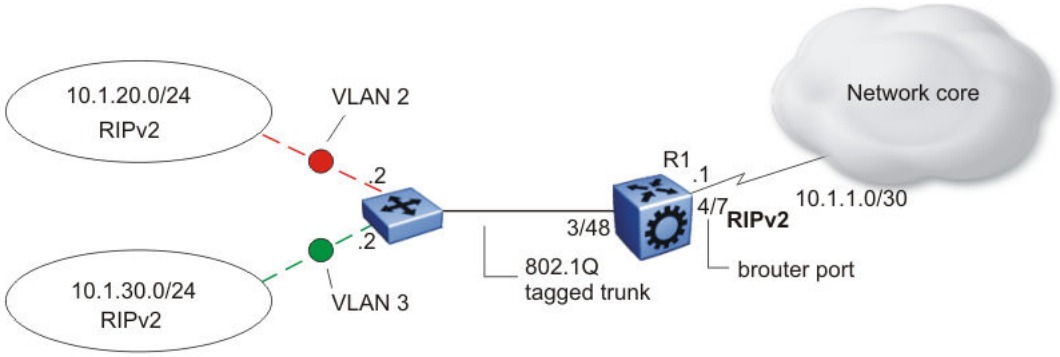

Figure 19: Configuration example-RIPv2 only

Enable RIPv2 send mode on VLAN 2:

```
VSP-4850GTS(config-if)# ip rip send version rip2
```

Enable RIPv2 receive mode on VLAN 2:

```
VSP-4850GTS(config-if)# ip rip receive version rip2
```

Repeat these commands on VLAN 3 and the port interfaces.

Variable definitions

Use the data in the following table to use the **`ip rip`** command.

Variable	Value
vlan <1-4084>	Specifies the VLAN ID.
advertise-when-down enable	Enables or disables AdvertiseWhenDown. If enabled, RIP advertises the network on this interface as up, even if the port is down. The default is disabled. If you configure a port with no link and enable advertise-when-down, it does not advertise the route until the port is active. RIP advertises the route even when the link is down. To disable advertising based on link status, you must disable this parameter.
auto-aggregation enable	Enables or disables automatic route aggregation on the port. If enabled, the switch automatically aggregates routes to their natural mask when an interface in a different class network advertises them. The default is disable.
cost <1-15>	Configures the RIP cost for this port (link).
default-listen enable	Enables DefaultListen. The switch accepts the default route learned through RIP on this interface. The default is disabled.
default-supply enable	Enables DefaultSupply. If enabled, this interface must advertise a default route. The default is false. RIP advertises the default route only if it exists in the routing table.
enable	Enables RIP routing on the port.
holddown <0-360>	Configures the RIP holddown timer value, the length of time (in seconds) that RIP continues to advertise a network after it determines that the network is unreachable. The default is 120.
in-policy WORD<0-64>	Configures the policy name for inbound filtering on this RIP interface. This policy determines whether to learn a route on this interface and specifies the parameters of the route when RIP adds it to the routing table.
listen enable	Specifies that the routing switch learns RIP routes through this interface. If enabled, the switch listens for a default route without listening for all routes. The default is enable.
out-policy WORD<0-64>	Configures the policy name for outbound filtering on this RIP interface. This policy determines whether to advertise a route from the routing table on this interface. This policy also specifies the parameters of the advertisement. *WORD<0-64>* is a string of length 0–64 characters.
poison enable	Enables Poison Reverse. If you disable Poison Reverse (`no poison enable`). Split Horizon is enabled. By default, Split Horizon is enabled. If you enable Split Horizon, the interface does not advertise IP routes learned from an immediate neighbor back to the neighbor. If you enable Poison Reverse, the RIP updates sent to a neighbor from which a route is learned are poisoned with a metric of 16. Therefore, the receiver neighbor ignores this route because the metric 16 indicates infinite hops in the network. These mechanisms prevent routing loops.

Table continues…

Variable	Value
port {slot/port[-slot/port][,...]}	Identifies the slot and port in one of the following formats: a single slot and port (3/1), a range of slots and ports (3/2-3/4), or a series of slots and ports (3/2,5/3,6/2).
`receive version <rip1|rip2|rip1orrip2>`	Indicates which RIP update version to accept on this interface. The default is rip1orrip2.
`send version <notsend|rip1|rip1comp|rip2>`	Indicates which RIP update version the router sends from this interface. ripVersion1 implies sending RIP updates that comply with RFC1058. rip1comp implies broadcasting RIP2 updates using RFC1058 route subassumption rules. The default is rip1Compatible.
`supply enable`	Specifies that the switch advertises RIP routes through the port. The default is enable.
`timeout <15-259200>`	Configures the RIP timeout interval in seconds. The default is 180.
`triggered enable`	Enables automatic triggered updates for RIP.

Configuring route redistribution to RIP

Configure a redistribute entry to announce certain routes into the RIP domain, including static routes, direct routes, RIP, Open Shortest Path First (OSPF), or Border Gateway Protocol (BGP). Optionally, use a route policy to control the redistribution of routes.

Before you begin

- Enable RIP globally.
- Configure a route policy.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access RIP Router Configuration mode:

   ```
   router rip
   ```

3. Create the redistribution instance:

   ```
   redistribute <bgp|ospf|isis|static|direct|rip> [vrf-src WORD<0-16>]
   ```

4. Apply a route policy, if required:

   ```
   redistribute <bgp|ospf|isis|static|direct|rip> route-map WORD<0-64>
   [vrf-src WORD<0-16>]
   ```

5. Configure other parameters.
6. Enable the redistribution:

```
redistribute <bgp|ospf|isis|static|direct|rip> enable [vrf-src
WORD<0-16>]
```

For RIPng, use `ipv6 redistribute <bgp|ospf|isis|static|direct|rip> enable`.

7. Ensure that the configuration is correct:

   ```
   show ip rip redistribute [vrf WORD<0-16>] [vrfids WORD<0-512>]
   ```

   For RIPng, use `show ipv6 rip redistribute`.

8. Exit RIP Router Configuration mode.

   ```
   exit
   ```

   You are now in Global Configuration mode.

9. Apply the redistribution:

   ```
   ip rip apply redistribute <bgp|ospf|isis|static|direct|rip> [vrf
   WORD<0-16>] [vrf-src WORD<0-16>]
   ```

Variable definitions

Use the data in the following table to help you use the **`redistribute`** command.

Variable	Value
metric <0-65535>	Configures the metric to apply to redistributed routes.
route-map WORD<0-64>	Configures the route policy to apply to redistributed routes.
[vrf-src WORD<0-16>]	Specifies the optional source VRF instance. You can use this variable with the other command variables.
<bgp|ospf|isis|static|direct|rip>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, rip, ospf, isis, or static.

Use the data in the following table to use the **`show ip rip redistribute`** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrfids WORD<1-512>	Specifies a range of VRF IDs.

Use the data in the following table to use the **`ip rip apply redistribute`** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrf-src WORD<0-16>	Specifies the source VRF instance. You do not need to configure this parameter for redistribution within the same VRF.
<bgp|ospf|isis|static|direct|rip>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, rip, ospf, isis, or static.

Configuring interVRF route redistribution for RIP

Configure a redistribute entry to announce certain routes into the RIP domain, including static routes, direct routes, RIP, OSPF, or BGP. Use a route policy to control the redistribution of routes.

Before you begin

- Enable RIP globally.
- Configure a route policy.
- Configure the VRFs.
- You must log on to VRF Router Configuration mode in ACLI.

Procedure

1. Enter Global Configuration mode:

   ```
   enable
   configure terminal
   ```

2. Access RIP Router Configuration mode:

   ```
   router vrf WORD<1-16>
   ```

3. Create the redistribution instance:

   ```
   ip rip redistribute <bgp|ospf|isis|static|direct|rip>
   ```

4. Apply a route policy, if required:

   ```
   ip rip redistribute <bgp|ospf|isis|static|direct|rip> route-map
   WORD<0-64> [vrf-src WORD<0-16>]
   ```

5. Configure other parameters.

6. Enable the redistribution:

   ```
   ip rip redistribute <bgp|ospf|isis|static|direct|rip> enable [vrf-
   src WORD<0-16>]
   ```

7. Ensure that the configuration is correct:

   ```
   show ip rip redistribute [vrf WORD<0-16>] [vrfids WORD<1-512>]
   ```

   For RIPng, use `show ipv6 rip redistribute`.

8. Exit VRF Router Configuration mode:

   ```
   exit
   ```

   You are now in Global Configuration mode.

9. Apply the redistribution:

   ```
   ip rip apply redistribute <bgp|ospf|isis|static|direct|rip> [vrf
   WORD<0-16>] [vrf-src WORD<0-16>]
   ```

Variable definitions

Use the data in the following table to use the **ip rip redistribute <ospf|bgp|static|direct|rip>** command.

Variable	Value
<bgp|ospf|isis|static|direct|rip>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, isis, rip, ospf, or static.
vrf-src WORD<0-16>	Specifies the source VRF instance. You do not need to configure this parameter for redistribution within the same VRF.
metric <0-65535>	Configures the metric to apply to redistributed routes.
route-map <WORD 0-64>	Configures the route policy to apply to redistributed routes.

Use the data in the following table to use the **show ip rip redistribute** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrfids WORD<1-512>	Specifies a range of VRF IDs.

Use the data in the following table to use the **ip rip apply redistribute** command.

Variable	Value
vrf WORD<0-16>	Specifies the VRF instance.
vrf-src WORD<0-16>	Specifies the source VRF instance. You do not need to configure this parameter for redistribution within the same VRF.
<bgp|ospf|isis|static|direct|rip>	Specifies the type of routes to redistribute (the protocol source). Valid options are bgp, direct, isis, rip, ospf, or static.

Forcing a RIP update for a port or VLAN

Force RIP to update the routing table so that the port or VLAN uses the latest routing information.

Before you begin

- You must log on to Interface Configuration mode in ACLI. You can enable the flag in either the GigabitEthernet or VLAN Interface Configuration mode. You can update the RIP routes in only the GigabitEthernet Interface Configuration mode.

About this task

If you perform this procedure, you also update the tables for all VRFs associated with the port or VLAN.

Procedure

1. Enable the triggered-update flag:

   ```
   ip rip triggered enable
   ```

2. Update the routing table:

   ```
   action triggerRipUpdate
   ```

RIP configuration using EDM

Use Routing Information Protocol (RIP) to perform dynamic routing within an autonomous system. This section describes how you use Enterprise Device Manager (EDM) to configure and manage the RIP on an Avaya Virtual Services Platform 4000.

Configuring RIP globally

Configure RIP global parameters on the switch so you can control RIP behavior on the system.

Before you begin

- Change the VRF instance as required to configure RIP on a specific VRF instance. The VRF must have an RP trigger of RIP. Not all parameters are configurable on non0 VRFs.

About this task

In the Avaya Virtual Services Platform 4000, all router interfaces that use RIP use the RIP global parameters. Both brouter ports and VLAN virtual routing interfaces use the same RIP global parameters.

You can configure RIP on interfaces while RIP is globally disabled. This way, you can configure all interfaces before you enable RIP for the switch.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **RIP**.
3. Click the **Globals** tab.
4. Select the **enable** option button.
5. Configure other global RIP parameters as required.
6. Click **Apply**.

Globals field descriptions

Use the data in the following table to use the **Globals** tab.

Name	Description
Operation	Enables or disables RIP on all interfaces. The default is disabled.

Table continues…

Name	Description
UpdateTime	Specifies the time interval between RIP updates for all interfaces. The default is 30 seconds, and the range is 0–360.
RouteChanges	Specifies the number of route changes RIP made to the IP route database. RouteChanges does not include the refresh of a route age.
Queries	Specifies the number of responses sent to RIP queries received from other systems.
HoldDownTime	Configures the length of time that RIP continues to advertise a network after the network is unreachable. The range is 0–360 seconds. The default is 120 seconds.
TimeOutInterval	Configures the RIP timeout interval. The range is 15–259200 seconds. The default is 180 seconds.
DefImportMetric	Configures the default import metric used to import a route into a RIP domain. To announce OSPF internal routes into a RIP domain, if the policy does not specify a metric, you must use the default import metric. OSPF external routes use the external cost. The range is 0–15 and the default is 1.

Viewing RIP status

View RIP status.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **RIP**.
3. Click the **Status** tab.

Status field description

Use the following table to use the RIP Status tab.

Name	Description
Address	Specifies the IP address of the router interface.
RcvBadPackets	Specifies the number of RIP response packets received by the RIP process which were subsequently discarded; for example, version 0 packet, or an unknown command type.
RcvBadRoutes	Specifies the number of routes, in valid RIP packets, that are ignored; for example, unknown address family, or invalid metric.
SentUpdates	Specifies the number of triggered RIP updates sent on this interface, that do not include full updates sent containing new information.

Configuring RIP interface compatibility

Configure RIP parameters on an interface so you can control RIP behavior on the interface. You can specify the RIP version to use on interfaces that you configure to send (supply) or receive (listen to) RIP updates.

Before you begin

- Configure a routing interface (either a router port or a virtual routing interface).
- Assign an IP address to the interface.
- Enable RIP globally.
- Change the VRF instance as required to configure RIP on a specific VRF instance. The VRF must have an RP trigger of RIP. Not all parameters are configurable on non0 VRFs.

About this task

On an interface, RIP does not operate until you enable it globally and on the interface.

Although visible, Avaya Virtual Services Platform 4000 does not support the AuthType and AuthKey parameters.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **RIP**.
3. Click the **Interface** tab.
4. Double-click the **Send** value to edit it, and then select the RIP version datagrams the router sends.
5. Double-click the **Receive** value to edit it, and then select the RIP version datagrams for which the router listens.
6. Click **Apply**.

Interface field descriptions

Use the data in the following table to use the **Interface** tab.

Name	Description
Address	Specifies the IP address of the router interface.
AuthType	Specifies the type of authentication to use on this interface.
AuthKey	Specifies the authentication key whenever AuthType is not noAuthentication.
Send	Specifies the update version the router sends on this interface: • DoNotSend—no RIP updates sent on this interface • ripVersion1—RIP updates compliant with RFC1058

Table continues…

Name	Description
	• rip1Compatible—broadcast RIPv2 updates using RFC1058 route subassumption rules • ripVersion2—multicast RIPv2 updates The default is rip1compatible.
Receive	Indicates which versions of RIP updates to accept: • rip1 • rip2 • rip1OrRip2 The default is rip1OrRip2. Rip2 and rip1OrRip2 imply receipt of multicast packets.

Job aid

Choose one of three options for receiving RIP updates:

- rip1OrRip2—accepts RIPv1 or RIPv2 updates
- rip1—accepts RIPv1 updates only
- rip2—accepts RIPv2 updates only

The following table describes the four RIP send modes that Virtual Services Platform 4000 supports. You can configure RIP send modes on all router interfaces.

Table 8: RIP send modes

Send mode	Description	Result
rip1Compatible	Broadcasts RIPv2 updates using RFC1058 route consumption rules. This mode is the default mode on the Virtual Services Platform 4000.	• Destination MAC is a broadcast, ff-ff-ff-ff-ff-ff • Destination IP is a broadcast for the network (for example, 192.1.2.255) • RIP update is formed as a RIP-2 update, including network mask • RIP version = 2
ripVersion1	Broadcasts RIP updates that are compliant with RFC1058	• Destination MAC is a broadcast, ff-ff-ff-ff-ff-ff • Destination IP is a broadcast for the network (for example, 192.1.2.255) • RIP update is formed as a RIP-1 update, no network mask included • RIP version = 1
ripVersion2	Broadcasts multicast RIPv2 updates	• Destination MAC is a multicast, 01-00-5e-00-00-09 • Destination IP is the RIP-2 multicast address, 224.0.0.9

Table continues…

Send mode	Description	Result
		• RIP update is formed as a RIP-2 update including network mask • RIP version = 2
doNotSend	Does not send RIP updates on the interface	None

Configuring RIP on an interface

Configure RIP parameters to control and optimize RIP routing for the interface.

Before you begin

- Change the VRF instance as required to configure RIP on a specific VRF instance. The VRF must have an RP trigger of RIP. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **RIP**.
3. Click the **Interface Advance** tab.
4. Double-click a RIP parameter to edit it, as required.
5. Click **Apply**.

Interface Advance field descriptions

Use the data in the following table to use the RIP **Interface Advance** tab.

Name	Description
Address	Shows the address of the entry in the IP RIP interface table.
Interface	Indicates the index of the RIP interface.
Enable	Shows if the RIP interface is enabled or disabled.
Supply	Enables (true) or disables (false) the ability to send RIP updates on this interface.
Listen	Configures whether the switch learns routes on this interface.
Poison	Configures whether to advertise RIP routes learned from a neighbor back to the neighbor. If disabled, the interface invokes Split Horizon and does not advertise IP routes learned from an immediate neighbor back to the neighbor. If enabled, RIP poisons the RIP updates, sent to the neighbor from which a route is learned, with a metric of 16. Therefore, the receiver neighbor ignores this route because the metric 16 indicates infinite hops in the network.

Table continues…

Name	Description
DefaultSupply	Enables (true) or disables (false) an advertisement of a default route on this interface. This command takes effect only if a default route exists in the routing table.
DefaultListen	Enables (true) or disables (false) the switch to accept the default route learned through RIP on this interface. The default is disabled. Enable DefaultListen to add a default route to the route table if another route advertises it.
TriggeredUpdate	Enables (true) or disables (false) the switch to send RIP updates from this interface.
AutoAggregate	Enables (true) or disables (false) automatic route aggregation on this interface. If enabled, the switch automatically aggregates routes to their natural mask when an interface advertises them. The default is disabled.
InPolicy	Determines if RIP can learn routes on this interface. This variable also specifies the parameters of the route when RIP adds it to the routing table.
OutPolicy	Determines if RIP advertises a route from the routing table on this interface. This policy also specifies the parameters of the advertisement.
Cost	Indicates the RIP cost for this interface. The range is 1–15. The default is 1.

Job aid

The following table indicates the relationship between switch action and the RIP supply and listen settings.

Table 9: RIP supply and listen settings and switch action

RIP supply settings		RIP listen settings		Switch action
Supply	**Default supply**	**Listen**	**Default listen**	
Disabled (false)	Disabled (false)			Sends no RIP updates.
Enabled (true)	Disabled (false)			Sends RIP updates except the default.
Disabled (false)	Disabled (false)			Sends only the default (default route must exist in routing table).
Enabled (true)	Enabled (true)			Sends RIP updates including the default route (if it exists).
		Disabled (false)	Disabled (false)	Does not listen to RIP updates.
		Enabled (true)	Disabled (false)	Listens to all RIP updates except the default.

Table continues…

RIP supply settings		RIP listen settings		Switch action
Supply	**Default supply**	**Listen**	**Default listen**	
		Disabled (false)	Enabled (true)	Listens only to the default.
		Enabled (true)	Enabled (true)	Listens to RIP updates including the default route (if it exists).

Configuring RIP on a port

Configure RIP on a port so that the port can participate in RIP routing.

Before you begin

- Assign an IP address to the port.
- Configure RIP and enable it globally.

  Both brouter ports and VLAN virtual routing interfaces use the same RIP global parameters.
- Enable RIP on the interface.

About this task

On an interface, RIP does not operate until you enable it globally and on the interface.

Procedure

1. In the Device Physical View tab, select a port.
2. In the navigation tree, expand the following folders: **Configuration** > **Edit** > **Port**.
3. Click **IP**.
4. Click the **RIP** tab.
5. Configure the RIP parameters as required.
6. Click **Apply**.

RIP field descriptions

Use the data in the following table to use the **RIP** tab.

Name	Description
Enable	Enables or disables RIP on the port.
Supply	Specifies that the routing switch advertises RIP routes through the interface. The default is enable.
Listen	Specifies that the routing switch learns RIP routes through this interface. The default is enable.
Poison	If disabled, the interface invokes Split Horizon and does not advertise IP routes learned from an immediate neighbor back to the neighbor. If

Table continues…

Name	Description
	enabled, the RIP update sent to a neighbor from which a route is learned is poisoned with a metric of 16. In this manner, the route entry is not passed to the neighbor, because 16 is infinity in terms of hops on a network. The default is disable.
DefaultSupply	Enables or disables DefaultSupply. Enable DefaultSupply if a default route exists in the routing table. The default is false. RIP advertises the default route only if it exists in the routing table.
DefaultListen	Enables or disables DefaultListen. Enable DefaultListen if this interface must learn a default route after another router that connects to the interface advertises it. The default is false (disabled). Enable DefaultListen to add a default route to the route table if another router advertises it.
TriggeredUpdateEnable	Enables or disables triggered RIP updates. The default is false (disabled).
AutoAggregateEnable	Enables or disables RIP automatic aggregation. RIPv2 automatically aggregates routes to their natural mask. You can enable automatic aggregation only in RIPv2 mode or RIPv1 compatibility mode. The default is false.
AdvertiseWhenDown	Enables or disables AdvertiseWhenDown. If true, RIP advertises the network on this interface as up, even if the port is down. The default is false. If you configure a port with no link and enable AdvertiseWhenDown, the port does not advertise the route until the port is active. RIP advertises the route even when the link is down. To disable advertising based on link-states, disable AdvertiseWhenDown.
InPolicy	Determines whether the RIP can learn a route on this interface. This variable also specifies the parameters of the route when RIP adds it to the routing table.
OutPolicy	Determines if this interface advertises a route from the routing table on this interface. This policy also specifies the parameters of the advertisement.
Cost	Indicates the RIP cost for this interface. The default is 1, and the range is 1–15.
HolddownTime	Configures the length of time that RIP continues to advertise a network after determining it is unreachable. The range is 0–360 seconds. The default is 120 seconds
TimeOutInterval	Configures the RIP timeout interval in seconds. The range is 15–259200 seconds. The default is 180 seconds.

Configuring RIP on a VLAN

Configure RIP on a VLAN so that the VLAN acts as a routed VLAN (a virtual router).

Before you begin

- Configure the VLAN.
- Assign an IP address to the VLAN.
- Enable RIP globally.
- Enable RIP on the interface.
- Change the VRF instance as required to configure RIP on a specific VRF instance. The VRF must have an RP trigger of RIP. Not all parameters are configurable on non0 VRFs.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **VLAN**.
2. Click **VLANs**.
3. Click the **Basic** tab.
4. Select a VLAN.
5. Click **IP**.
6. Click the **RIP** tab.
7. Configure the VLAN RIP parameters as required.
8. Click **Apply**.

RIP field descriptions

Use the data in the following table to use the **RIP** tab.

Name	Description
Enable	Enables or disables RIP on the VLAN.
Supply	Specifies that the routing switch advertises RIP routes through the interface. The default is enable.
Listen	Specifies that the routing switch learns RIP routes through this interface. The default is enable.
Poison	If disabled, the interface invokes Split Horizon and does not advertise IP routes learned from an immediate neighbor back to the neighbor. If enabled, the RIP update sent to a neighbor from which a route is learned is poisoned with a metric of 16. In this manner, the route entry is not passed to the neighbor, because 16 is infinity in terms of hops on a network. The default is disable.
DefaultSupply	Enables or disables DefaultSupply. Enable DefaultSupply if a default route exists in the routing table. The default is false. RIP advertises the default route only if it exists in the routing table.
DefaultListen	Enables or disables DefaultListen. Enable DefaultListen if this interface must learn a default route after another router that connects to the interface advertises it. The default is false (disabled).

Table continues…

Name	Description
	Enable DefaultListen to add a default route to the route table if another router advertises it.
TriggeredUpdateEnable	Enables or disables triggered RIP updates. The default is false (disabled).
AutoAggregateEnable	Enables or disables RIP automatic aggregation. RIPv2 automatically aggregates routes to their natural mask. You can enable automatic aggregation only in RIPv2 mode or RIPv1 compatibility mode. The default is false.
AdvertiseWhenDown	Enables or disables AdvertiseWhenDown. If true, RIP advertises the network on this interface as up, even if the interface is down. The default is false. If you configure a VLAN with no link and enable AdvertiseWhenDown, the VLAN does not advertise the route until the VLAN is active. RIP advertises the route even when the link is down. To disable advertising based on link-states, disable AdvertiseWhenDown.
InPolicy	Determines whether the RIP can learn a route on this interface. This variable also specifies the parameters of the route when RIP adds it to the routing table.
OutPolicy	Determines if this interface advertises a route from the routing table. This policy also specifies the parameters of the advertisement.
Cost	Indicates the RIP cost for this interface. The default is 1, and the range is 1–15.
HolddownTime	Configures the length of time that RIP continues to advertise a network after determining it is unreachable. The range is 0–360 seconds. The default is 120 seconds
TimeOutInterval	Configures the RIP timeout interval in seconds. The range is 15–259200 seconds. The default is 180 seconds.

Configuring interVRF route redistribution policies

Configure interVRF route redistribution so that a VRF interface can announce routes that other protocols learn, for example, OSPF or BGP. Use a route policy to control the redistribution of routes.

Before you begin

- VRF instances exist.
- Configure route policies, if required.
- Change the VRF instance as required.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **Policy**.
3. Click the **Route Redistribution** tab.

4. Click **Insert**.
5. Click the ellipsis (**...**) button near the **DstVrfId** box to select the source and destination VRF IDs.
6. Click the ellipsis (**...**) button near the **SrcVrfId** box to select the source and destination VRF IDs.
7. In the **Protocol** option box, select the protocol.
8. In the **RouteSource** option box, select the route source.
9. Select **enable**.
10. Click the ellipsis (**...**) button near the **RoutePolicy** box to choose the route policy to apply to the redistributed routes.
11. Configure other parameters as required.
12. Click **Insert**.
13. Click the **Applying Policy** tab.
14. Select **RedistributeApply**.
15. Click **Apply**.

Route Redistribution field descriptions

Use the data in the following table to use the **Route Redistribution** tab.

Name	Description
DstVrfId	Specifies the destination VRF ID to use in the redistribution.
Protocol	Specifies the protocols for which you want to receive external routing information.
SrcVrfId	Specifies the source VRF ID to use in the redistribution.
RouteSource	Indicates if the protocol receives notification about the routes this source learns. The route source is equivalent to the owner in the routing table.
Enable	Enables or disables route redistribution.
RoutePolicy	Specifies the route policies to apply to the redistributed routes from the source VRF. Use the route policy to determine whether the system advertises a specific route to the specified protocol.
Metric	Specifies the metric announced in advertisements.
MetricType	Specifies the metric type (applies to OSPF and BGP only). Specifies a type 1 or a type 2 metric. For metric type 1, the cost of the external routes is equal to the sum of all internal costs and the external cost. For metric type 2, the cost of the external routes is equal to the external cost alone.
Subnets	Indicates that subnets must be advertised individually (applies to OSPF only).

Configuring route redistribution to RIP

Configure a redistribute entry to announce routes of a certain source protocol type into the RIP domain, for example, static, RIP, or direct. Use a route policy to control the redistribution of routes.

Before you begin

- Enable RIP globally.
- Configure a route policy.
- Change the VRF instance as required to configure RIP on a specific VRF instance. The VRF must have an RP trigger of RIP. Not all parameters are configurable on non0 VRFs.

About this task

Important:

Changing the RIP redistribute context is a process-oriented operation that can affect system performance and network reachability while you perform the procedures. Avaya recommends that if you want to change default preferences for a RIP redistribute context, you must do so before you enable the protocols.

Procedure

1. In the navigation tree, expand the following folders: **Configuration** > **IP**.
2. Click **RIP**.
3. Click the **Redistribute** tab.
4. Click **Insert**.
5. Configure the source of the routes to redistribute.
6. Select **enable**.
7. Select the route policy to apply to redistributed routes.
8. Configure a metric value.
9. Click **Insert**.

Redistribute field descriptions

Use the data in the following table to use the **Redistribute** tab.

Name	Description
DstVrfId	Specifies the destination VRF instance. You cannot configure this variable.
Protocol	Specifies the dynamic routing protocol that receives the external routing information.
SrcVrfId	Specifies the source VRF instance. You cannot configure this variable.
RouteSource	Specifies the route source protocol for the redistribution entry.

Table continues…

Name	Description
Enable	Enables (or disables) a RIP redistribute entry for a specified source type.
RoutePolicy	Configures the route policy (by name) that redistributes external routes from a specified source into an RIP domain. Click the ellipsis (...) button and choose from the list in the Route Policy dialog box.
Metric	Configures the RIP route redistribution metric for basic redistribution. The value can be in the range 0–65535. A value of 0 indicates to use the original cost of the route.

Glossary

area border router (ABR)	A router attached to two or more areas inside an Open Shortest Path First (OSPF) network. Area border routers play an important role in OSPF networks by condensing the amount of disseminated OSPF information.
Autonomous System (AS)	A set of routers under a single technical administration, using a single IGP and common metrics to route packets within the AS, and using an EGP to route packets to other ASs.
autonomous system border router (ASBR)	A router attached at the edge of an OSPF network. An ASBR uses one or more interfaces that run an interdomain routing protocol such as BGP. In addition, a router distributing static routes or Routing Information Protocol (RIP) routes into OSPF is considered an ASBR.
backup designated router (BDR)	A router that assumes the designated router (DR) role for the Open Shortest Path First (OSPF) protocol if the DR fails.
Circuitless IP (CLIP)	A CLIP is often called a loopback and is a virtual interface that does not map to any physical interface.
classless interdomain routing (CIDR)	The protocol defined in RFCs 1517 and 1518 for using subnetwork masks, other than the defaults for IP address classes.
database description (DD) packets	Exchanged when a link is initially established between neighboring routers that synchronizes their link state databases. The Open Shortest Path First (OSPF) protocol uses DD packets.
designated router (DR)	A single router elected as the designated router for the network. In a broadcast or nonbroadcast multiple access (NBMA) network running the Open Shortest Path First (OSPF) protocol, a DR ensures all network routers synchronize with each other and advertises the network to the rest of the Autonomous System (AS). In a multicast network running Protocol Independent Multicast (PIM), the DR acts as a representative router for directly connected hosts. The DR sends control messages to the rendezvous point (RP) router, sends register messages to the RP on behalf of directly connected sources, and maintains RP router status information for the group.

equal cost multipath (ECMP)	Distributes routing traffic among multiple equal-cost routes.
Interior Gateway Protocol (IGP)	Distributes routing information between routers that belong to a single Autonomous System (AS).
internal router (IR)	A router with interfaces only within a single area inside an Open Shortest Path First (OSPF) network.
Internet Protocol Control Packet (IPCP)	Establishes and configures Internet Protocol data transmission over a Point-to-Point Protocol link.
Layer 2	Layer 2 is the Data Link Layer of the OSI model. Examples of Layer 2 protocols are Ethernet and Frame Relay.
Layer 3	Layer 3 is the Network Layer of the OSI model. An example of a Layer 3 protocol is Internet Protocol (IP).
link-state advertisement (LSA)	Packets that contain state information about directly connected links (interfaces) and adjacencies. Each Open Shortest Path First (OSPF) router generates the packets.
link-state database (LSDB)	A database built by each OSPF router to store LSA information. The router uses the LSDB to calculate the shortest path to each destination in the autonomous system (AS), with itself at the root of each path.
management information base (MIB)	The MIB defines system operations and parameters used for the Simple Network Management Protocol (SNMP).
maximum transmission unit (MTU)	The largest number of bytes in a packet—the maximum transmission unit of the port.
Message Digest 5 (MD5)	A one-way hash function that creates a message digest for digital signatures.
next hop	The next hop to which a packet can be sent to advance the packet to the destination.
nonbroadcast multiaccess (NBMA)	Interconnects multiple devices over a broadcast network through point-to-point links. NBMA reduces the number of IP addresses required for point-to-point connections.
not so stubby area (NSSA)	Prevents the flooding of external link-state advertisements (LSA) into the area by providing them with a default route. An NSSA is a configuration of the Open Shortest Path First (OSPF) protocol.

Open Shortest Path First (OSPF)	A link-state routing protocol used as an Interior Gateway Protocol (IGP).
prefix	A group of contiguous bits, from 0 to 32 bits in length, that defines a set of addresses.
remote monitoring (RMON)	A remote monitoring standard for Simple Network Management Protocol (SNMP)-based management information bases (MIB). The Internetwork Engineering Task Force (IETF) proposed the RMON standard to provide guidelines for remote monitoring of individual LAN segments.
route table manager (RTM)	Determines the best route to a destination based on reachability, route preference, and cost.
shortest path first (SPF)	A class of routing protocols that use Djikstra's algorithm to compute the shortest path through a network, according to specified metrics, for efficient transmission of packet data.
spanning tree	A simple, fully-connected active topology formed from the arbitrary physical topology of connected bridged Local Area Network components by relaying frames through selected bridge ports. The protocol parameters and states that are used and exchanged to facilitate the calculation of the active topology and to control the bridge relay function.
type of service (TOS)	A field in the IPv4 header that determines the Class of Service prior to the standardization of Differentiated Services.
User Datagram Protocol (UDP)	In TCP/IP, a packet-level protocol built directly on the Internet Protocol layer. TCP/IP host systems use UDP for application-to-application programs.
variable-length subnet masking (VLSM)	Allocating IP addressing resources to subnets according to their individual need rather than some general network-wide rule.