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OmniSwitch 6600 Family Advanced Routing Configuration Guide

www.alcatel.com

This user guide documents release 5.4 of the OmniSwitch 6600 Family.
The functionality described in this guide is subject to change without notice.

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Contents

About This Guide

This *OmniSwitch 6600 Family Advanced Routing Configuration Guide* describes how to set up and monitor advanced routing protocols for operation in a live network environment. The routing protocols described in this manual are purchased as an add-on package to the base switch software.

Note. The *OmniSwitch 6600 Family Advanced Routing Configuration Guide* was originally known as the "*OmniSwitch 6624/6648 Advanced Routing Configuration Guide*."

Supported Platforms

This information in this guide applies to the following products:

- OmniSwitch 6624
- OmniSwitch 6648
- OmniSwitch 6600-U24
- OmniSwitch 6600-P24
- OmniSwitch 6602-24
- OmniSwitch 6602-48

OmniSwitch 6600 Family switches are next generation enterprise edge/workgroup switches. The OmniSwitch 6624 and 6602-24 offer 24 copper 10/100 ports, the 6600-P24 offers 24 copper 10/100 Power over Ethernet (PoE) ports, the 6648 and 6602-48 offer 48 copper 10/100 ports, and the 6600-U24 offers 24 fiber 100 ports.

In addition, OmniSwitch 6624/6600-U24/6648/6600-P24 switches have one expansion port that can be used for a Gigabit Ethernet uplink module and another expansion port that can be used for a Gigabit Ethernet uplink or a stacking module while the 6602-24/6602-48 switches offer fixed Gigabit Ethernet uplinks and fixed stacking ports. The stacking ports on all OmniSwitch 6600 Family switches allow two to eight OmniSwitch 6600 Family switches to be configured as one virtual chassis known as a *stack*.

Note. All references to OmniSwitch 6624 and 6648 switches also apply to the OmniSwitch 6600-U24, 6600-P24, 6602-24, and 6602-48 unless specified otherwise.

Unsupported Platforms

The information in this guide does not apply to the following products:

- OmniSwitch (original version with no numeric model name)
- OmniSwitch 6800-24
- OmniSwitch 6800-48
- OmniSwitch 6800-U24
- OmniSwitch 6800-24L
- OmniSwitch 6800-48L
- OmniSwitch 7700
- OmniSwitch 7800
- OmniSwitch 8800
- OmniSwitch 6850
- OmniSwitch 9700
- Omni Switch/Router
- OmniStack
- OmniAccess

Who Should Read this Manual?

The audience for this user guide is network administrators and IT support personnel who need to configure, maintain, and monitor switches and routers in a live network. However, anyone wishing to gain knowledge on how advanced routing software features are implemented in the OmniSwitch 6600 Family will benefit from the material in this configuration guide.

When Should I Read this Manual?

Read this guide as soon as you are ready to integrate your OmniSwitch into your network and you are ready to set advanced routing protocols. You should already be familiar with the basics of managing a single OmniSwitch as described in the *OmniSwitch 6600 Family Switch Management Guide*.

Note. The *OmniSwitch 6600 Family Switch Management Guide* was originally known as the "*OmniSwitch 6624/6648 Switch Management Guide*."

The topics and procedures in this manual assume an understanding of the OmniSwitch directory structure and basic switch administration commands and procedures. This manual will help you set up your switches to route on the network using protocols.

What is in this Manual?

This configuration guide includes information about configuring Open Shortest Path First (OSPF) for routing.

What is Not in this Manual?

The configuration procedures in this manual use Command Line Interface (CLI) commands in all examples. CLI commands are text-based commands used to manage the switch through serial (console port) connections or via Telnet sessions. Procedures for other switch management methods, such as web-based (WebView or OmniVista) or SNMP, are outside the scope of this guide.

For information on WebView and SNMP switch management methods consult the *OmniSwitch 6600 Family Switch Management Guide.* Information on using WebView and OmniVista can be found in the context-sensitive on-line help available with those network management applications.

This guide provides overview material on software features, how-to procedures, and application examples that will enable you to begin configuring your OmniSwitch. It is not intended as a comprehensive reference to all CLI commands available in the OmniSwitch. For such a reference to all OmniSwitch 6600 Family CLI commands, consult the *OmniSwitch CLI Reference Guide*.

How is the Information Organized?

Quick Information. The chapter includes a *specifications table* that lists RFCs and IEEE specifications supported by the software feature. In addition, this table includes other pertinent information such as minimum and maximum values and sub-feature support. The chapter also includes a *defaults table* that lists the default values for important parameters along with the CLI command used to configure the parameter. It also includes a *Quick Steps* section, which is a procedure covering the basic steps required to get a software feature up and running.

In-Depth Information. The chapter includes an *overview section* on the software feature as well as on selected topics of that software feature. *Topical sections* may often lead into *procedure sections* that describe how to configure the feature just described. Serious readers and advanced users will also find the many *application examples*, located near the end of chapters, helpful. Application examples include diagrams of real networks and then provide solutions using the CLI to configure a particular feature, or more than one feature, within the illustrated network.

Documentation Roadmap

The OmniSwitch user documentation suite was designed to supply you with information at several critical junctures of the configuration process. The following section outlines a roadmap of the manuals that will help you at each stage of the configuration process. Under each stage, we point you to the manual or manuals that will be most helpful to you.

Stage 1: Using the Switch for the First Time

Pertinent Documentation: *OmniSwitch 6600 Family Getting Started Guide*
Release Notes

A hard-copy *OmniSwitch 6600 Family Getting Started Guide* is included with OmniSwitch 6600 Family switches; these guides provide all the information you need to get your switch up and running the first time. These guides provide information on unpacking the switch, rack mounting the switch, installing uplink and stacking modules, unlocking access control, setting the switch's IP address, setting up a password, and setting up stacks. They also include succinct overview information on fundamental aspects of the switch, such as hardware LEDs, the software directory structure, CLI conventions, and web-based management.

At this time you should also familiarize yourself with the Release Notes that accompanied your switch. This document includes important information on feature limitations that are not included in other user guides.

Note. The *OmniSwitch 6600 Family Getting Started Guide* was originally known as the "*OmniSwitch 6624/6648 Getting Started Guide*."

Stage 2: Gaining Familiarity with Basic Switch Functions

Pertinent Documentation: *OmniSwitch 6600 Family Hardware Users Guide*
OmniSwitch 6600 Family Switch Management Guide

Once you have your switch up and running, you will want to begin investigating basic aspects of its hard ware and software. Information about OmniSwitch 6600 Family hardware is provided in the *OmniSwitch 6600 Family Hardware Users Guide*. This guide provides specifications, illustrations, and descriptions of all hardware components—chassis, power supplies, uplink and stacking modules, and cooling fans. They also include steps for common procedures, such as removing and installing switch components.

The *OmniSwitch 6600 Family Switch Management Guide* is the primary user guide for the basic software features on a single switch. This guide contains information on the switch directory structure, basic file and directory utilities, switch access security, SNMP, and web-based management. It is recommended that you read this guide before connecting your switch to the network.

Note. The *OmniSwitch 6600 Family Switch Management Guide* and the *OmniSwitch 6600 Family Hardware Users Guide* were originally known as the "*OmniSwitch 6624/6648 Switch Management Guide*" and "*OmniSwitch 6624/6648 Hardware Users Guide*", respectively.

Stage 3: Integrating the Switch Into a Network

Pertinent Documentation: *OmniSwitch 6600 Family Network Configuration Guide*
OmniSwitch 6600 Family Advanced Routing Configuration Guide

When you are ready to connect your switch to the network, you will need to learn how the OmniSwitch implements fundamental software features, such as 802.1Q, VLANs, Spanning Tree, and network routing protocols. The *OmniSwitch 6600 Family Network Configuration Guide* contains overview information, procedures and examples on how standard networking technologies are configured in the OmniSwitch 6600 Family.

Note. The *OmniSwitch 6600 Family Network Configuration Guide* and the *OmniSwitch 6600 Family Advanced Routing Configuration Guide* were originally known as the "*OmniSwitch 6624/6648 Network Configuration Guide*" and the "*OmniSwitch 6624/6648 Advanced Routing Configuration Guide*", respectively.

The *OmniSwitch 6600 Family Advanced Routing Configuration Guide* includes configuration information for networks using Open Shortest Path First (OSPF).

Anytime

The *OmniSwitch CLI Reference Guide* contains comprehensive information on all CLI commands supported by the switch. This guide includes syntax, default, usage, example, related CLI command, and CLI-to-MIB variable mapping information for all CLI commands supported by the switch. This guide can be consulted anytime during the configuration process to find detailed and specific information on each CLI command.

Related Documentation

The following are the titles and descriptions of all the OmniSwitch 6600 Family user manuals:

- *OmniSwitch 6600 Family Getting Started Guide*

  Describes the hardware and software procedures for getting an OmniSwitch 6600 Family switch up and running. Also provides information on fundamental aspects of OmniSwitch software and stacking architecture.

Note. The *OmniSwitch 6600 Family Getting Started Guide* was originally known as the "*OmniSwitch 6624/6648 Getting Started Guide*."

- *OmniSwitch 6600 Family Hardware Users Guide*

  Complete technical specifications and procedures for all OmniSwitch 6600 Family chassis, power supplies, fans, and uplink and stacking modules.

Note. The *OmniSwitch 6600 Family Hardware Users Guide* was originally known as the "*OmniSwitch 6624/6648 Hardware Users Guide*."

- *OmniSwitch CLI Reference Guide*

  Complete reference to all CLI commands supported on the OmniSwitch 6600, 7700, 7800, and 8800. Includes syntax definitions, default values, examples, usage guidelines, and CLI-to-MIB variable mappings.

- *OmniSwitch 6600 Family Switch Management Guide*

  Includes procedures for readying an individual switch for integration into a network. Topics include the software directory architecture, image rollback protections, authenticated switch access, managing switch files, system configuration, using SNMP, and using web management software (WebView).

Note. The *OmniSwitch 6600 Family Switch Management Guide* was originally known as the "*OmniSwitch 6624/6648 Switch Management Guide*."

- *OmniSwitch 6600 Family Network Configuration Guide*

  Includes network configuration procedures and descriptive information on all the major software features and protocols included in the base software package. Chapters cover Layer 2 information (Ethernet and VLAN configuration), Layer 3 information, security options (authenticated VLANs), Quality of Service (QoS), and link aggregation.

Note. The *OmniSwitch 6600 Family Network Configuration Guide* was originally known as the "*OmniSwitch 6624/6648 Network Configuration Guide*."

- *OmniSwitch 6600 Family Advanced Routing Configuration Guide*

  Includes network configuration procedures and descriptive information on all the software features and protocols included in the advanced routing software package OSPF.

Note. The *OmniSwitch 6600 Family Advanced Routing Configuration Guide* was originally known as the "*OmniSwitch 66/24/6648 Advanced Routing Configuration Guide.*"

- Technical Tips, Field Notices

  Includes information published by Alcatel's Customer Support group.

- *Release Note*

  Includes critical Open Problem Reports, feature exceptions, and other important information on the features supported in the current release and any limitations to their support.

User Manuals Web Site

All related user guides for the OmniSwitch 6600 Family can be found on our web site at http://www.alcatel.com/enterprise/en/resource_library/user_manuals.html

All documentation on the User Manual web site is in PDF format and requires the Adobe Acrobat Reader program for viewing. Acrobat Reader freeware is available at www.adobe.com.

Note. When printing pages from the documentation PDFs, de-select Fit to Page if it is selected in your print dialog. Otherwise pages may print with slightly smaller margins.

Technical Support

An Alcatel service agreement brings your company the assurance of 7x24 no-excuses technical support. You'll also receive regular software updates to maintain and maximize your Alcatel product's features and functionality and on-site hardware replacement through our global network of highly qualified service delivery partners. Additionally, with 24-hour-a-day access to Alcatel's Service and Support web page, you'll be able to view and update any case (open or closed) that you have reported to Alcatel's technical support, open a new case or access helpful release notes, technical bulletins, and manuals. For more information on Alcatel's Service Programs, see our web page at eservice.ind.alcatel.com, call us at 1-800-995-2696, or email us at support@ind.alcatel.com.

1 Configuring OSPF

Open Shortest Path First routing (OSPF) is the shortest path first (SPF), or *link state*, protocol. OSPF is an interior gateway protocol (IGP) that distributes routing information between routers in a single Autonomous System (AS), and chooses the least-cost path as the best path. OSPF is suitable for complex networks with large numbers of routers as it provides faster convergence where multiple flows to a single destination can be forwarded on one or more interfaces simultaneously.

In This Chapter

This chapter describes the basic components of OSPF and how to configure them through the Command Line Interface (CLI). CLI commands are used in the configuration examples; for more details about the syntax of commands, see the *OmniSwitch CLI Reference Guide*.

Configuration procedures described in this chapter include:

- Loading and enabling OSPF. See "Activating OSPF" on page 1-17.
- Creating OSPF areas. See "Creating an Area" on page 1-18.
- Creating OSPF interfaces. See "Creating OSPF Interfaces" on page 1-22.
- Creating virtual links. See "Creating Virtual Links" on page 1-25
- Using redistribution policies and filters. See "Enabling Redistribution" on page 1-26

For information on creating and managing VLANs, see "Configuring VLANs" in the *OmniSwitch 6600 Family Network Configuration Guide*.

OSPF Specifications

RFCs Supported	1370—Applicability Statement for OSPF 1587—The OSPF NSSA Option 1850—OSPF Version 2 Management Information Base 2328—OSPF Version 2 3101—The OSPF Not-So-Stubby Area (NSSA) Option 3623 — Graceful OSPF Restart
Maximum number of Areas (per router)	3
Maximum number of Interfaces (per router)	5
Maximum number of Link State Database entries (per router)	5000
Maximum number of adjacencies (per router)	16
Maximum number of ECMP gateways (per destination)	4
Maximum number of neighbors (per router)	16
Maximum number of routes (per router)	4000 (Depending on the number of interfaces/ neighbors, this value may vary.)

OSPF Defaults Table

The following table shows the default settings of the configurable OSPF parameters.

Parameter Description	Command	Default Value/Comments
Enables OSPF.	**ip ospf status**	disabled
Enables an area.	**ip ospf area status**	disabled
Enables an interface.	**ip ospf interface status**	disabled
Enables OSPF redistribution.	**ip ospf redist status**	disabled
Sets the overflow interval value.	**ip ospf exit-overflow-interval**	0
Assigns a limit to the number of External Link-State Database (LSDB) entries.	**ip ospf extlsdb-limit**	-1
Configures timers for Shortest Path First (SPF) calculation.	**ip ospf spf-timer**	delay: 5 hold: 10
Creates or deletes an area default metric.	**ip ospf area default-metric**	ToS: 0 Type: OSPF Cost: 1
Configures OSPF interface dead interval.	**ip ospf interface dead-interval**	40 seconds (broadcast and point-to-point) 120 seconds (NBMA and point-to-multipoint)
Configures OSPF interface hello interval.	**ip ospf interface hello-interval**	10 seconds (broadcast and point-to-point) 30 seconds (NBMA and point-to-multipoint)
Configures the OSPF interface cost.	**ip ospf interface cost**	1
Configures the OSPF poll interval.	**ip ospf interface poll-interval**	120 seconds
Configures the OSPF interface priority.	**ip ospf interface priority**	1
Configures OSPF interface retransmit interval.	**ip ospf interface retrans-interval**	5 seconds
Configures the OSPF interface transit delay.	**ip ospf interface transit-delay**	1 second
Configures the OSPF interface type.	**ip ospf interface type**	broadcast
Configures graceful restart on redundant switches in a stack	**ip ospf restart-support**	Disabled

OSPF Quick Steps

The followings steps are designed to show the user the necessary set of commands for setting up a router to use OSPF:

1 Create a VLAN using the **vlan** command. For example:

```
-> vlan 5

-> vlan 5 enable
```

2 Assign a router IP address and subnet mask to the VLAN using the **ip interface** command. For example:

```
-> ip interface vlan-5 vlan 5 address 120.1.4.1 mask 255.0.0.0
```

3 Assign a port to the created VLANs using the **vlan** command. For example:

```
-> vlan 5 port default 2/1
```

Note. The port will be statically assigned to the VLAN, as a VLAN must have a physical port assigned to it in order for the router port to function. However, the router could be set up in such a way that mobile ports are dynamically assigned to VLANs using VLAN rules. See the chapter titled "Defining VLAN Rules" in the *OmniSwitch 6600 Family Network Configuration Guide*.

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4 Assign a router ID to the router using the **ip router router-id** command. For example:

```
-> ip router router-id 1.1.1.1
```

5 Load and enable OSPF using the **ip load ospf** and the **ip ospf status** commands. For example:

```
-> ip load ospf

-> ip ospf status enable
```

6 Create a backbone to connect this router to others and an area for the router's traffic using the **ip ospf area** command. (Backbones are always labeled area 0.0.0.0.) For example:

```
-> ip ospf area 0.0.0.0

-> ip ospf area 0.0.0.1
```

7 Enable the backbone and area using the **ip ospf area status** command. For example:

```
-> ip ospf area 0.0.0.0 status enable

-> ip ospf area 0.0.0.1 status enable
```

8 Create an OSPF interface for each VLAN created in Step 1 using the **ip ospf interface** command. The OSPF interface should use the same IP address or interface name used for the VLAN router IP created in Step 2. For example:

```
-> ip ospf interface 120.1.4.1
```

or

```
-> ip ospf interface vlan-5
```

9 Assign the OSPF interface to the area and the backbone using the **ip ospf interface area** command. For example:

```
-> ip ospf interface 120.1.4.1 area 0.0.0.0
```

or

```
-> ip ospf interface vlan-5 area 0.0.0.0
```

10 Enable the OSPF interfaces using the **ip ospf interface status** command. For example:

```
-> ip ospf interface 120.1.4.1 status enable
```

or

```
-> ip ospf interface vlan-5 status enable
```

11 You can now display the router OSPF settings by using the **show ip ospf** command. The output generated is similar to the following:

```
-> show ip ospf

Router Id                        = 1.1.1.1,
OSPF Version Number              = 2,
Admin Status                     = Enabled,
Area Border Router?              = Yes,
AS Border Router Status          = Disabled,
Route Redistribution Status      = Disabled,
Route Tag                        = 0,
SPF Hold  Time (in seconds)      = 10,
SPF Delay  Time (in seconds)     = 5,
MTU Checking                     = Disabled,
# of Routes                      = 0,
# of AS-External LSAs            = 0,
# of self-originated LSAs        = 0,
# of LSAs received               = 0,
External LSDB Limit              = -1,
Exit Overflow Interval           = 0,
# of SPF calculations done       = 1,
# of Incr SPF calculations done  = 0,
# of Init State Nbrs             = 0,
# of 2-Way State Nbrs            = 0,
# of Exchange State Nbrs         = 0,
# of Full State Nbrs             = 0,
# of attached areas              = 2,
# of Active areas                = 2,
# of Transit areas               = 0,
# of attached NSSAs              = 0
```

Router ID
As set in Step 5

12 You can display OSPF area settings using the **show ip ospf area** command. For example:

```
-> show ip ospf area 0.0.0.0

Area Identifier                          = 0.0.0.0,
Admin Status                             = Enabled,
Operational Status                       = Up,
Area Type                                = normal,
Area Summary                             = Enabled,
Time since last SPF Run                  = 00h:08m:37s,
# of Area Border Routers known           = 1,
# of AS Border Routers known             = 0,
# of LSAs in area                        = 1,
# of SPF Calculations done               = 1,
# of Incremental SPF Calculations done   = 0,
# of Neighbors in Init State             = 0,
# of Neighbors in 2-Way State            = 0,
# of Neighbors in Exchange State         = 0,
# of Neighbors in Full State             = 0
# of Interfaces attached                 = 1
```

Area ID
As set in Step 7

Area Status
As set in Step 8

13 You can display OSPF interface settings using the **show ip ospf interface** command. For example:

```
-> show ip ospf interface 120.1.4.1

Interface IP Name                    = vlan-5
VLAN Id                              = 5,
Interface IP Address                 = 120.1.4.1,
Interface IP Mask                    = 255.0.0.0,
Admin Status                         = Enabled,
Operational Status                   = Down,
OSPF Interface State                 = Down,
Interface Type                       = Broadcast,
Area Id                              = 0.0.0.0,
Designated Router IP Address         = 0.0.0.0,
Designated Router RouterId           = 0.0.0.0,
Backup Designated Router IP Address  = 0.0.0.0,
Backup Designated Router RouterId    = 0.0.0.0,
MTU  (bytes)                         = 1500,
Metric Cost                          = 1,
Priority                             = 1,
Hello Interval (seconds)             = 10,
Transit Delay (seconds)              = 1,
Retrans Interval (seconds)           = 5,
Dead Interval (seconds)              = 40,
Poll Interval (seconds)              = 120,
Link Type                            = Broadcast,
Authentication Type                  = none,
# of Events                          = 0,
# of Init State Neighbors            = 0,
# of 2-Way State Neighbors           = 0,
# of Exchange State Neighbors        = 0,
# of Full State Neighbors            = 0
```

VLAN ID
As set in Step 1

Interface ID
As set in Step 9

Interface Status
As set in Step 11

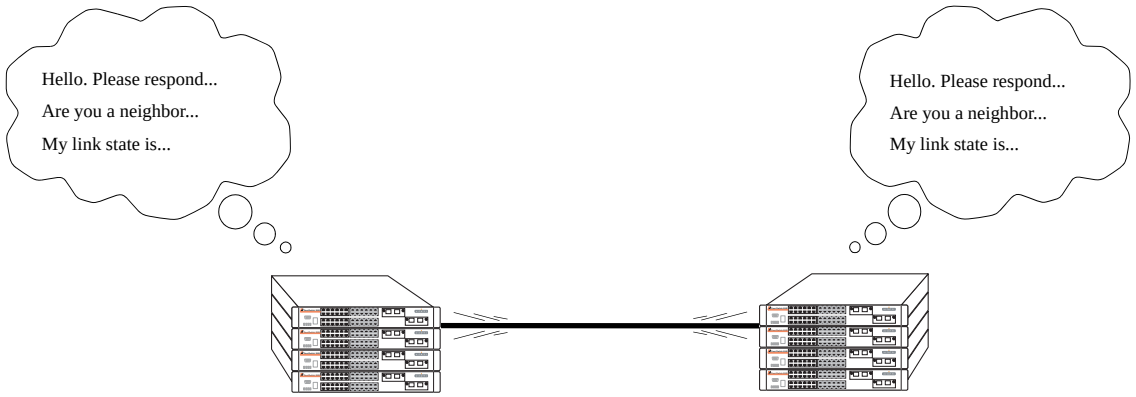
Area ID
As set in Step 7

OSPF Overview

Open Shortest Path First routing (OSPF) is a shortest path first (SPF), or link-state, protocol. OSPF is an interior gateway protocol (IGP) that distributes routing information between routers in a Single Autonomous System (AS). OSPF chooses the least-cost path as the best path.

Each participating router distributes its local state (i.e., the router's usable interfaces, local networks, and reachable neighbors) throughout the AS by flooding. In a link-state protocol, each router maintains a database describing the entire topology. This database is built from the collected link state advertisements of all routers. Each multi-access network that has at least two attached routers has a designated router and a backup designated router. The designated router floods a link state advertisement for the multi-access network.

When a router starts, it uses the OSPF Hello Protocol to discover neighbors. The router sends Hello packets to its neighbors, and in turn receives their Hello packets. On broadcast and point-to-point networks, the router dynamically detects its neighboring routers by sending Hello packets to a multicast address. On nonbroadcast and point-to-multipoint networks, some configuration information is necessary in order to configure neighbors. On all networks (broadcast or nonbroadcast), the Hello Protocol also elects a designated router for the network.



OSPF Hello Protocol

The router will attempt to form full adjacencies with all of its newly acquired neighbors. Only some pairs, however, will be successful in forming full adjacencies. Topological databases are synchronized between pairs of fully adjacent routers.

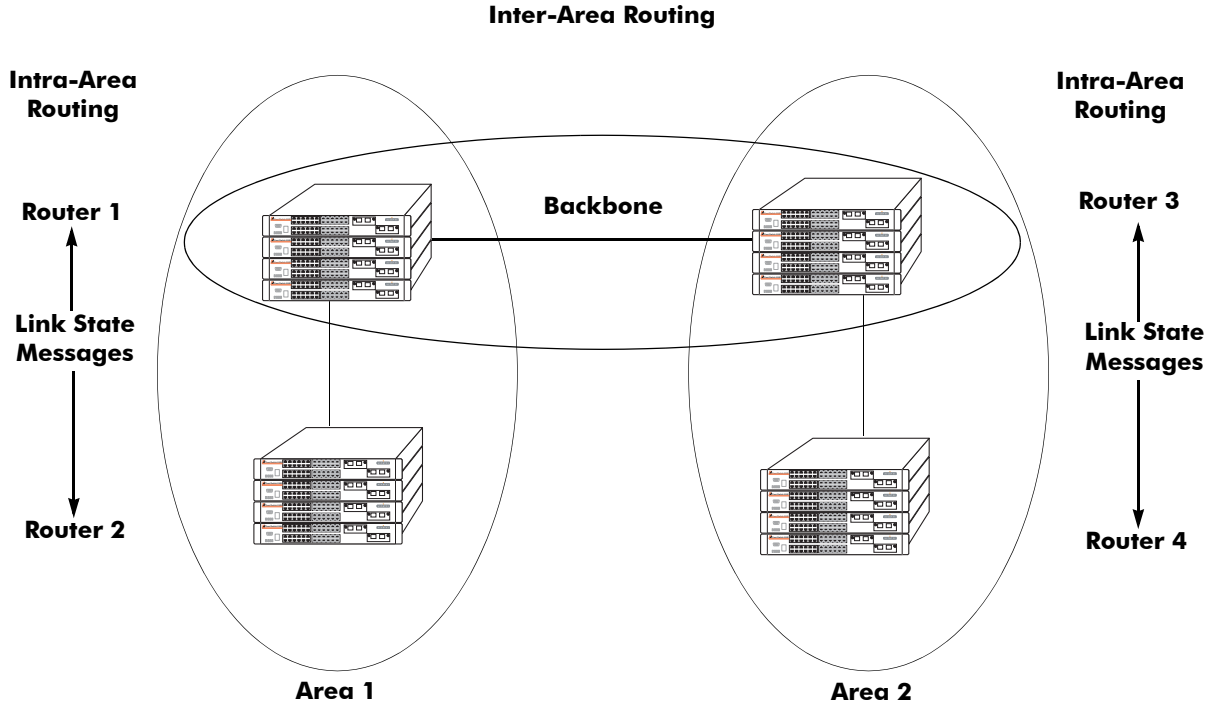
Adjacencies control the distribution of routing protocol packets. Routing protocol packets are sent and received only on adjacencies. In particular, distribution of topological database updates proceeds along adjacencies.

Link state is also advertised when a router's state changes. A router's adjacencies are reflected in the contents of its link state advertisements. This relationship between adjacencies and link state allows the protocol to detect downed routers in a timely fashion.

Link state advertisements are flooded throughout the AS. The flooding algorithm ensures that all routers have exactly the same topological database. This database consists of the collection of link state advertisements received from each router belonging to the area. From this database each router calculates a shortest-path tree, with itself as root. This shortest-path tree in turn yields a routing table for the protocol.

OSPF Areas

OSPF allows collections of contiguous networks and hosts to be grouped together as an *area*. Each area runs a separate copy of the basic link-state routing algorithm (usually called SPF). This means that each area has its own topological database, as explained in the previous section.



OSPF Intra-Area and Inter-Area Routing

An area's topology is visible only to the members of the area. Conversely, routers internal to a given area know nothing of the detailed topology external to the area. This isolation of knowledge enables the protocol to reduce routing traffic by concentrating on small areas of an AS, as compared to treating the entire AS as a single link-state domain.

Areas cause routers to maintain a separate topological database for each area to which they are connected. (Routers connected to multiple areas are called *area border routers*). Two routers belonging to the same area have identical area topological databases.

Different areas communicate with each other through a *backbone*. The backbone consists of routers with contacts between multiple areas. A backbone must be contiguous (i.e., it must be linked to all areas).

The backbone is responsible for distributing routing information between areas. The backbone itself has all the properties of an area. The topology of the backbone is invisible to each of the areas, while the backbone itself knows nothing of the topology of the areas.

All routers in an area must agree on that area's parameters. Since a separate copy of the link-state algorithm is run in each area, most configuration parameters are defined on a per-router basis. All routers belonging to an area must agree on that area's configuration. Misconfiguration will keep neighbors from forming adjacencies between themselves, and OSPF will not function.

Classification of Routers

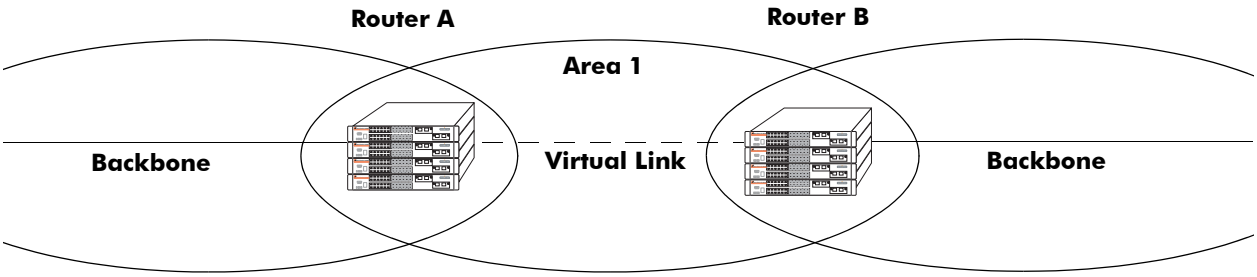
When an AS is split into OSPF areas, the routers are further divided according to function into the following four overlapping categories:

- **Internal routers**. A router with all directly connected networks belonging to the same area. These routers run a single copy of the SPF algorithm.
- **Area border routers**. A router that attaches to multiple areas. Area border routers run multiple copies of the SPF algorithm, one copy for each attached area. Area border routers condense the topological information of their attached areas for flooding to other areas.
- **Backbone routers**. A router that has an interface to the backbone. This includes all routers that interface to more than one area (i.e., area border routers). However, backbone routers do not have to be area border routers. Routers with all interfaces connected to the backbone are considered to be internal routers.
- **AS boundary routers**. A router that exchanges routing information with routers belonging to other Autonomous Systems. Such a router has AS external routes that are advertised throughout the Autonomous System. The path to each AS boundary router is known by every router in the AS. This classification is completely independent of the previous classifications (i.e., internal, area border, and backbone routers). AS boundary routers may be internal or area border routers, and may or may not participate in the backbone.

Virtual Links

It is possible to define areas in such a way that the backbone is no longer contiguous. (This is not an ideal OSPF configuration, and maximum effort should be made to avoid this situation.) In this case the system administrator must restore backbone connectivity by configuring *virtual links*.

Virtual links can be configured between any two backbone routers that have a connection to a common non-backbone area. The protocol treats two routers joined by a virtual link as if they were connected by an unnumbered point-to-point network. The routing protocol traffic that flows along the virtual link uses intra-area routing only, and the physical connection between the two routers is not managed by the network administrator (i.e., there is no dedicated connection between the routers as there is with the OSPF backbone).



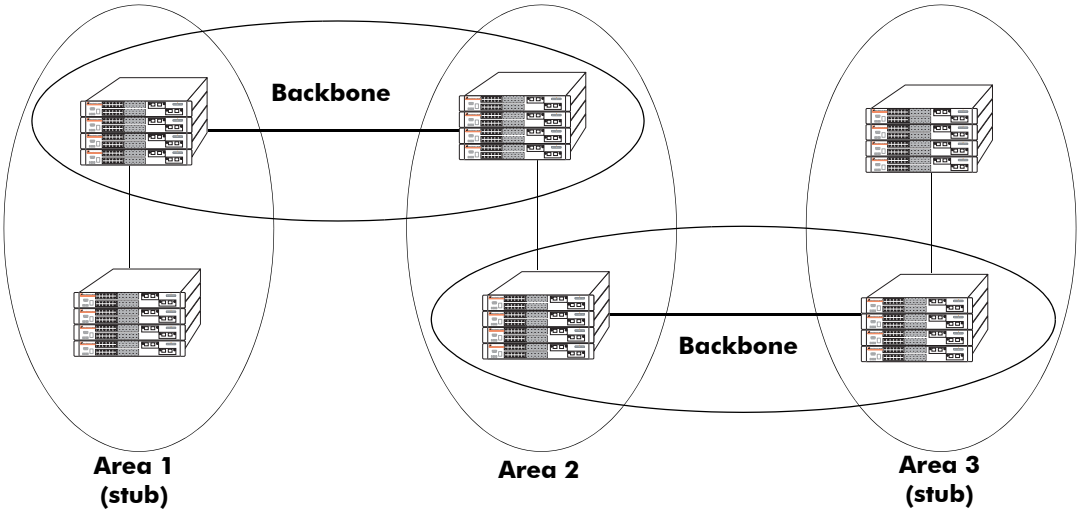
OSPF Routers Connected with a Virtual Link

In the above diagram, Router A and Router B are connected via a virtual link in Area 1, which is known as a transit area. See "Creating Virtual Links" on page 1-25 for more information.

Stub Areas

OSPF allows certain areas to be configured as *stub areas*. A stub area is an area with routers that have no AS external Link State Advertisements (LSAs).

In order to take advantage of the OSPF stub area support, default routing must be used in the stub area. This is accomplished by configuring only one of the stub area's border routers to advertise a default route into the stub area. The default routes will match any destination that is not explicitly reachable by an intra-area or inter-area path (i.e., AS external destinations).



OSPF Stub Area

Area 1 and Area 3 could be configured as stub areas. Stub areas are configured using the OSPF **ip ospf area** command, described in "Creating an Area" on page 1-18. For more overview information on areas, see "OSPF Areas" on page 1-8.

The OSPF protocol ensures that all routers belonging to an area agree on whether the area has been configured as a stub. This guarantees that no confusion will arise in the flooding of AS external advertisements.

Two restrictions on the use of stub areas are:

- Virtual links cannot be configured through stub areas.
- AS boundary routers cannot be placed internal to stub areas.

Not-So-Stubby-Areas

NSSA, or not-so-stubby area, is an extension to the base OSPF specification and is defined in RFC 1587. An NSSA is similar to a stub area in many ways: AS-external LSAs are not flooded into an NSSA and virtual links are not allowed in an NSSA. The primary difference is that selected external routing information can be imported into an NSSA and then redistributed into the rest of the OSPF routing domain. These routes are imported into the NSSA using a new LSA type: Type-7 LSA. Type-7 LSAs are flooded within the NSSA and are translated at the NSSA boundary into AS-external LSAs so as to convey the external routing information to other areas.

NSSAs enable routers with limited resources to participate in OSPF routing while also allowing the import of a selected number of external routes into the area. For example, an area which connects to a small external routing domain running RIP may be configured as an NSSA. This will allow the import of RIP routes into this area and the rest of the OSPF routing domain and at the same time, prevent the flooding of other external routing information (learned, for example, through IP) into this area.

All routers in an NSSA must have their OSPF area defined as an NSSA. To configure otherwise will ensure that the router will be unsuccessful in establishing an adjacent in the OSPF domain.

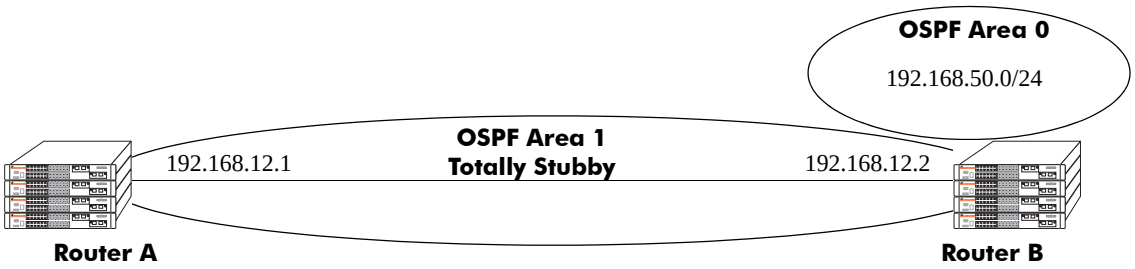
Totally Stubby Areas

In Totally Stubby Areas the ABR advertises a default route to the routers in the totally stubby area but does not advertise any inter-area or external LSAs. As a result, routers in a totally stubby area know only the routes for destination networks in the stub area and have a default route for any other destination outside the stub.

Note. Virtual links cannot be configured through totally stubby areas.

The router memory is saved when using stub area networks by filtering Type 4 and 5 LSAs. This concept has been extended with Totally Stubby Areas by filtering Type 3 LSAs (Network Summary LSA) in addition to Type 4 and 5 with the exception of one single Type 3 LSA used to advertise a default route within the area.

The following is an example of a simple totally stubby configuration with Router B being an ABR between the backbone area 0 and the stub area 1. Router A is in area 1.1.1.1, totally stubby area:



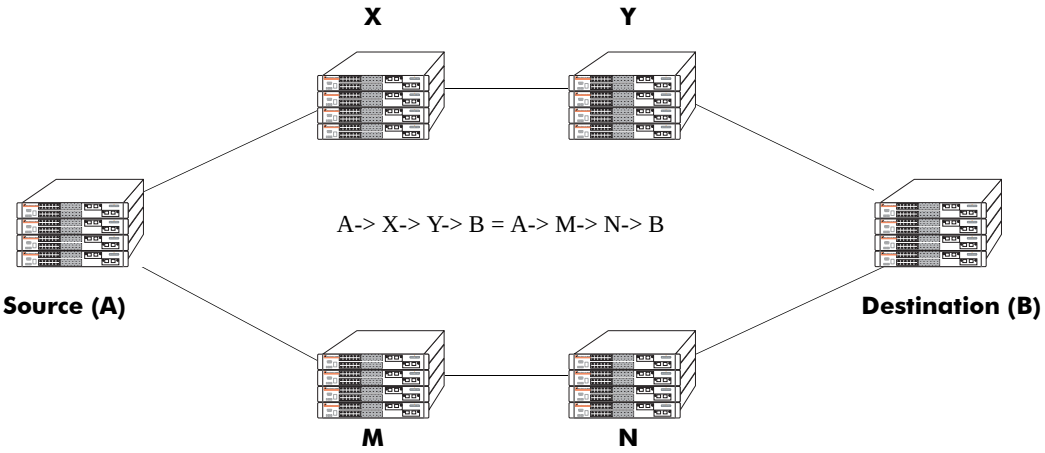
Totally Stubby Area Example

Note. See “Configuring a Totally Stubby Area” on page 1-20 for information on configuring Totally Stubby Areas.

Equal Cost Multi-Path (ECMP) Routing

Using information from its continuously updated databases, OSPF calculates the shortest path to a given destination. The shortest path is determined from metric values at each hop along a path. At times, two or more paths to the same destination will have the same metric cost.

In the network illustration below, there are two paths from Source router A to Destination router B. One path traverses two hops at routers X and Y and the second path traverses two hops at M and N. If the total cost through X and Y to B is the same as the cost via M and N to B, then these two paths have equal cost. In this version of OSPF both paths will be stored and used to transmit data.



Multiple Equal Cost Paths

Delivery of packets along equal paths is based on flows rather than a round-robin scheme. Equal cost is determined based on standard routing metrics. However, other variables, such as line speed, are not considered. So it is possible for OSPF to decide two paths have an equal cost even though one may contain faster links than another.

Non-Broadcast OSPF Routing

OSPF can operate in two modes on non-broadcast networks: NBMA and point-to-multipoint. The interface type for the corresponding network segment should be set to non-broadcast or point-to-point, respectively.

For non-broadcast networks, neighbors should be statically configured. For NBMA neighbors, the eligibility option must be enabled for the neighboring router to participate in Designated Router (DR) election.

For the correct working of an OSPF NBMA network, a fully meshed network is mandatory. Also, the neighbor eligibility configuration for a router on every other router should match the routers interface priority configuration.

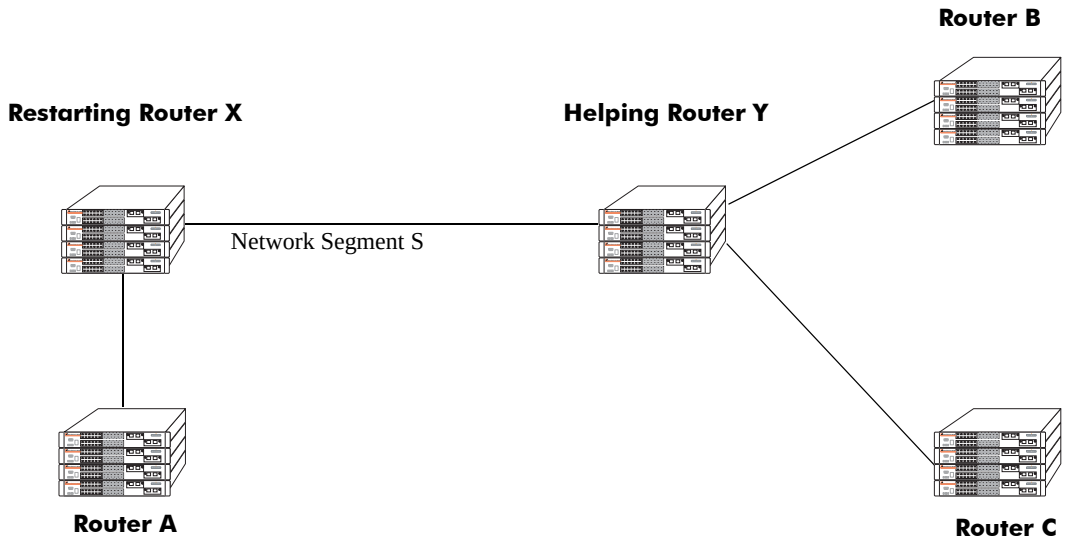
See "Configuring Static Neighbors" on page 1-30 for more information and setting up static neighbors.

Graceful Restart on Stacks with Redundant Switches

OmniSwitch 6600 Family stacks with two or more switches can support redundancy where if the primary switch fails or goes offline for any reason, the secondary switch is instantly notified. The secondary switch automatically assumes the primary role. This switch between the primary and secondary switches is known as *takeover*.

When a takeover occurs, which can be planned (e.g., the users performs the takeover) or unplanned (e.g., the primary switch unexpectedly fails), an OSPF router must re-establish full adjacencies with all its previously fully adjacent neighbors. This time period between the restart and the re-establishment of adjacencies is termed *graceful restart*.

In the network illustration below, a helper router, Router Y, monitors the network for topology changes. As long as there are none, it continues to advertise its LSAs as if the restarting router, Router X, had remained in continuous OSPF operation (i.e., Router Y's LSAs continue to list an adjacency to Router X over network segment S, regardless of the adjacency's current synchronization state.)



OSPF Graceful Restart Helping and Restarting Router Example

If the restarting router, Router X, was the Designated Router (DR) on network segment S when the helping relationship began, the helper neighbor, Router Y, maintains Router X as the DR until the helping relationship is terminated. If there are multiple adjacencies with the restarting Router X, Router Y will act as a helper on all other adjacencies.

Continuous forwarding during a graceful restart depends on several factors. If the secondary module has a different router MAC than the primary module, or if one or more ports of a VLAN belonged to the primary module, spanning tree re-convergence might disrupt forwarding state, even though OSPF performs a graceful restart.

Note. See "Configuring Redundant Switches in a Stack for Graceful Restart" on page 1-31 for more information on configuring graceful restart.

Configuring OSPF

Configuring OSPF on a router requires several steps. Depending on your requirements, you may not need to perform all of the steps listed below.

By default, OSPF is disabled on the router. Configuring OSPF consists of these tasks:

- Set up the basics of the OSPF network by configuring the required VLANs, assigning ports to the VLANs, and assigning router identification numbers to the routers involved. This is described in "Preparing the Network for OSPF" on page 1-16.
- Enable OSPF. When the image file for advanced routing (**Hadvrout.img**) is installed, you must load the code and enable OSPF. The commands for enabling OSPF are described in "Activating OSPF" on page 1-17.
- Create an OSPF area and the backbone. The commands to create areas and backbones are described in "Creating an OSPF Area" on page 1-18.
- Set area parameters (optional). OSPF will run with the default area parameters, but different networks may benefit from modifying the parameters. Modifying area parameters is described in "Configuring Stub Area Default Metrics" on page 1-20.
- Create OSPF interfaces. OSPF interfaces are created and assigned to areas. Creating areas is described in "Creating an Interface" on page 1-22, and assigning areas is described in "Assigning an Interface to an Area" on page 1-22.
- Set interface parameters (optional). OSPF will run with the default interface parameters, but different networks may benefit from modifying the parameters. Also, it is possible to set authentication on an interface. Setting interface authentication is described in "Interface Authentication" on page 1-23, and modifying interface parameters is described in "Modifying Interface Parameters" on page 1-24.
- Configure virtual links (optional). A virtual link is used to establish backbone connectivity when two backbone routers are not physically contiguous. To create a virtual link, see "Creating Virtual Links" on page 1-25.
- Create a redistribution policy (optional). A redistribution policy allows for the control of how routes are advertised into OSPF from outside the Autonomous System. Once a policy is created, redistribution must be enabled. Creating a redistribution policy is described in "Creating A Redistribution Policy" on page 1-27, and enabling redistribution is described in "Enabling Redistribution" on page 1-26.
- Create redistribution filters (optional). A redistribution filter controls whether routes are advertised in the OSPF network. Creating a redistribution filter is described in "Creating a Redistribution Filter" on page 1-27.
- Configuring router capabilities (optional). There are several commands that influence router operation. These are covered briefly in a table in "Configuring Router Capabilities" on page 1-29.
- Creating static neighbors (optional). These commands allow you to statically configure neighbors. See "Configuring Static Neighbors" on page 1-30.
- Configuring redundant switches in a stack for graceful OSPF restart (optional). Configuring stacks with redundant switches for graceful restart is described in "Configuring Redundant Switches in a Stack for Graceful Restart" on page 1-31.

At the end of the chapter is a simple OSPF network diagram with instructions on how it was created on a router-by-router basis. See "OSPF Application Example" on page 1-32 for more information.

Preparing the Network for OSPF

OSPF operates on top of normal switch functions, using existing ports, virtual ports, VLANs, etc. The following network components should already be configured:

- **Configure VLANs that are to be used in the OSPF network**. VLANS should be created for both the backbone interfaces and all other connected devices that will participate in the OSPF network. A VLAN should exist for each instance in which the backbone connects two routers. VLAN configuration is described in "Configuring VLANs," in the *OmniSwitch 6600 Family Network Configuration Guide*.
- **Assign IP interfaces to the VLANs.** IP interfaces, or router ports, must be assigned to the VLAN. Assigning IP interfaces is described in "Configuring VLANs," in the *OmniSwitch 6600 Family Network Configuration Guide*.
- **Assign ports to the VLANs**. The physical ports participating in the OSPF network must be assigned to the created VLANs. Assigning ports to a VLAN is described in "Assigning Ports to VLANs," in the *OmniSwitch 6600 Family Network Configuration Guide*.
- **Set the router identification number**. (optional) The routers participating in the OSPF network must be assigned a router identification number. This number can be any number, as long as it is in standard dotted decimal format (e.g., 1.1.1.1). Router identification number assignment is discussed in "Configuring IP," in the *OmniSwitch 6600 Family Network Configuration Guide*. If this is not done, the router identification number is automatically the primary interface address.

Activating OSPF

For OSPF to run on the router, the advanced routing image (**Hadvrout.img**) must be installed. (For information on how to install image files, see "Managing System Files" in the *OmniSwitch 6600 Family Switch Management Guide*.)

After the image file has been installed onto the router, you will need to load the OSPF software into memory and enable it as described below.

Loading the Software

To load the OSPF software into the router's running configuration, enter the **ip load ospf** command at the system prompt:

```
-> ip load ospf
```

The OPSF software is now loaded into memory and can be enabled.

Enabling OSPF

Once the OSPF software has been loaded into the router's running configuration (either through the CLI or on startup), it must be enabled. To enable OSPF on a router, enter the **ip ospf status** command at the CLI prompt, as shown:

```
-> ip ospf status enable
```

Once OSPF is enabled, you can begin to set up OSPF parameters. To disable OSPF, enter the following:

```
-> ip ospf status disable
```

Removing OSPF from Memory

To remove OSPF from the router memory, it is necessary to manually edit the **boot.cfg** file. The **boot.cfg** file is an ASCII text-based file that controls many of the switch parameters. Open the file and delete all references to OSPF.

For the operation to take effect the switch needs to be rebooted.

Creating an OSPF Area

OSPF allows a set of network devices in an AS system to be grouped together in *areas*.

There can be more than one router in an area. Likewise, there can be more than one area on a single router (in effect, making the router the Area Border Router (ABR) for the areas involved), but standard networking design does not recommended that more than three areas be handled on a single router.

Areas are named using 32-bit dotted decimal format (e.g., 1.1.1.1). Area 0.0.0.0 is reserved for the backbone.

Creating an Area

To create an area and associate it with a router, enter the **ip ospf area** command with the area identification number at the CLI prompt, as shown:

```
-> ip ospf area 1.1.1.1
```

Area 1.1.1.1 will now be created on the router with the default parameters.

The backbone is always area 0.0.0.0. To create this area on a router, you would use the above command, but specify the backbone, as shown:

```
-> ip ospf area 0.0.0.0
```

The backbone would now be attached to the router, making it an Area Border Router (ABR).

Enabling an Area

Once an area is created, it must be enabled using the **ip ospf area status** command, as shown:

```
-> ip ospf area 0.0.0.0 status enable
```

Specifying an Area Type

When creating areas, an area type can be specified (normal, stub, or NSSA). Area types are described above in "OSPF Areas" on page 1-8. To specify an area type, use the **ip ospf area** command as shown:

```
-> ip ospf area 1.1.1.1 type stub
```

Note. By default, an area is a **normal** area. The **type** keyword would be used to change a stub or NSSA area into a normal area.

Enabling and Disabling Summarization

Summarization can also be enabled or disabled when creating an area. Enabling summarization allows for ranges to be used by Area Border Routers (ABRs) for advertising routes as a single route rather than multiple routes, while disabling summarization prevents set ranges from functioning in stub and NSSA areas. (Configuring ranges is described in "Setting Area Ranges" on page 1-20.)

For example, to enable summarization for area 1.1.1.1, enter the following:

```
-> ip ospf area 1.1.1.1 summary enable
```

To disable summarization for the same area, enter the following:

```
-> ip ospf area 1.1.1.1 summary disable
```

Note. By default, an area has summarization enabled. Disabling summarization for an area is useful when ranges need to be deactivated, but not deleted.

Displaying Area Status

You can check the status of the newly created area by using the **show** command, as demonstrated:

```
-> show ip ospf area 1.1.1.1
```

or

```
-> show ip ospf area
```

The first example gives specifics about area 1.1.1.1, and the second example shows all areas configured on the router.

To display a stub area's parameters, use the **show ip ospf area stub** command as follows:

```
-> show ip ospf area 1.1.1.1 stub
```

Deleting an Area

To delete an area, enter the **ip ospf area** command as shown:

```
-> no ip ospf area 1.1.1.1
```

Configuring Stub Area Default Metrics

The default metric configures the type of cost metric that a default area border router (ABR) will advertise in the default summary Link State Advertisement (LSA). Use the **ip ospf area default-metric** command to create or delete a default metric for stub or Not So Stubby Area (NSSA) area. Specify the stub area and select a cost value or a route type, as shown:

```
-> ip ospf area 1.1.1.1 default-metric 0 cost 50
```

or

```
-> ip ospf area 1.1.1.1 default-metric 0 type type1
```

A route has a preset metric associated to it depending on its type. The first example, the stub area is given a default metric of 0 (this is Type of Service 0) and a cost of 50 added to routes from the area. The second example specifies that the cost associated with Type 1 routes should be applied to routes from the area.

Note. At this time, only the default metric of ToS 0 is supported.

To remove the area default-metric setting, enter the **ip ospf area default-metric** command using the **no** command, as shown:

```
-> no ip ospf area 1.1.1.1 default-metric 0
```

Setting Area Ranges

Area ranges are used to summarize many area routes into a single advertisement at an area boundary. Ranges are advertised as summaries or NSSAs. Ranges also act as filters that either allow the summary to be advertised or not. Ranges are created using the **ip ospf area range** command. An area and the summary IP address and IP mask must be specified. For example, to create a summary range with IP address 192.5.40.1 and an IP mask of 255.255.255.0 for area 1.1.1.1, the following commands would be entered at the CLI prompt:

```
-> ip ospf area 1.1.1.1 range summary 192.5.40.1 255.255.255.0

-> ip ospf area 1.1.1.1 range summary 192.5.40.1 255.255.255.0 effect noMatching
```

To view the configured ranges for an area, use the **show ip ospf area range** command as demonstrated:

```
-> show ip ospf area 1.1.1.1 range
```

Configuring a Totally Stubby Area

In order to configure a totally stubby area you need to configure the area as stub on the ABR and disable summarization. By doing so the ABR will generate a default route in the totally stubby area. In addition, the other routers within the totally stubby area must only have their area configured as stub.

For example, to configure the simple totally stubby configuration shown in the figure in “Configuring a Totally Stubby Area” on page 1-20 where Router B is an ABR between the backbone area 0 and the stub area 1 and Router A is in Totally Stubby Area 1.1.1.1 follow the steps below:

1 Enter the following commands on Router B:

```
-> ip load ospf
-> ip ospf area 0.0.0.0
-> ip ospf area 0.0.0.0 status enable
-> ip ospf area 1.1.1.1
-> ip ospf area 1.1.1.1 type stub
-> ip ospf area 1.1.1.1 summary disable
-> ip ospf area 1.1.1.1 status enable
-> ip ospf area 1.1.1.1 default-metric 0
-> ip ospf interface 192.168.12.2
-> ip ospf interface 192.168.12.2 area 1.1.1.1
-> ip ospf interface 192.168.12.2 status enable
-> ip ospf interface 192.168.50.2
-> ip ospf interface 192.168.50.2 area 0.0.0.0
-> ip ospf interface 192.168.50.2 status enable
-> ip ospf status enable
```

2 Enter the following on Router A:

```
-> ip load ospf
-> ip ospf area 1.1.1.1
-> ip ospf area 1.1.1.1 type stub
-> ip ospf area 1.1.1.1 status enable
-> ip ospf interface 192.168.12.1
-> ip ospf interface 192.168.12.1 area 1.1.1.1
-> ip ospf interface 192.168.12.1 status enable
-> ip ospf status enable
```

Creating OSPF Interfaces

Once areas have been established, interfaces need to be created and assigned to the areas.

Creating an Interface

To create an interface, enter the **ip ospf interface** command with an IP address or interface name, as shown:

```
-> ip ospf interface 120.5.80.1

-> ip ospf interface vlan-213
```

Note. The interface name *cannot* have spaces.

The interface can be deleted the by using the **no** keyword, as shown:

```
-> no ip ospf interface 120.5.80.1
```

Assigning an Interface to an Area

Once an interface is created, it must be assigned to an area. (Creating areas is described in "Creating an Area" on page 1-18 above.)

To assign an interface to an area, enter the **ip ospf interface area** command with the interface IP address or interface name and area identification number at the CLI prompt. For example to add interface 120.5.80.1 to area 1.1.1.1, enter the following:

```
-> ip ospf interface 120.5.80.1 area 1.1.1.1
```

An interface can be removed from an area by re-assigning it to a new area.

Once an interface has been created and enabled, you can check its status and configuration by using the **show ip ospf interface** command, as demonstrated:

```
-> show ip ospf interface 120.5.80.1
```

Instructions for configuring authentication are given in "Interface Authentication" on page 1-23, and interface parameter options are described in "Modifying Interface Parameters" on page 1-24.

Activating an Interface

Once the interface is created and assigned to an area, it must be activated using the **ip ospf interface status** command with the interface IP address or interface name, as shown:

```
-> ip ospf interface 120.5.80.1 status enable
```

The interface can be disabled using the **disable** keyword in place of the **enable** keyword.

Interface Authentication

OSPF allows for the use of authentication on configured interfaces. When authentication is enabled, only neighbors using the same type of authentication and the matching passwords or keys can communicate.

There are two types of authentication: simple and MD5. Simple authentication requires only a text string as a password, while MD5 is a form of encrypted authentication that requires a key and a password. Both types of authentication require the use of more than one command.

Simple Authentication

To enable simple authentication on an interface, enter the **ip ospf interface auth-type** command with the interface IP address or interface name, as shown:

```
-> ip ospf interface 120.5.80.1 auth-type simple
```

Once simple authentication is enabled, the password must be set with the **ip ospf interface auth-key** command, as shown:

```
-> ip ospf interface 120.5.80.1 auth-key test
```

In the above instance, only other interfaces with simple authentication and a password of “test” will be able to use the configured interface.

MD5 Encryption

To configure the same interface for MD5 encryption, enter the **ip ospf interface auth-type** as shown:

```
-> ip ospf interface 120.5.80.1 auth-type md5
```

Once MD5 authentication is set, a key identification and key string must be set with the **ip ospf interface md5 key** command. For example to set interface 120.5.80.1 to use MD5 authentication with a key identification of 7 and key string of “test”, enter:

```
-> ip ospf interface 120.5.80.1 md5 7
```

and

```
-> ip ospf interface 120.5.80.1 md5 7 key "test"
```

Note that setting the key ID and key string must be done in two separate commands. Once the key ID and key string have been set, MD5 authentication is enabled. To disable it, use the **ip ospf interface md5** command, as shown:

```
-> ip ospf interface 120.5.80.1 md5 7 disable
```

To remove all authentication, enter the **ip ospf interface auth-type** as follows:

```
-> ip ospf interface 120.5.80.1 auth-type none
```

Modifying Interface Parameters

There are several interface parameters that can be modified on a specified interface. Most of these deal with timer settings.

The cost parameter and the priority parameter help to determine the cost of the route using this interface, and the chance that this interface's router will become the designated router, respectively.

The following table shows the various interface parameters that can be set:

ip ospf interface dead-interval	Configures OSPF interface dead interval. If no hello packets are received in this interval from a neighboring router the neighbor is considered dead.
ip ospf interface hello-interval	Configures the OSPF interface interval for NBMA segments.
ip ospf interface cost	Configures the OSPF interface cost. A cost metric refers to the network path preference assigned to certain types of traffic.
ip ospf interface poll-interval	Configures the OSPF poll interval.
ip ospf interface priority	Configures the OSPF interface priority. The priority number helps determine if this router will become the designated router.
ip ospf interface retrans-interval	Configures OSPF interface retransmit interval. The number of seconds between link state advertisement retransmissions for adjacencies belonging to this interface.
ip ospf interface transit-delay	Configures the OSPF interface transit delay. The estimated number of seconds required to transmit a link state update over this interface.

These parameters can be added any time. (See "Creating OSPF Interfaces" on page 1-22 for more information.) For example, to set an the dead interval to 50 and the cost to 100 on interface 120.5.80.1, enter the following:

```
-> ip ospf interface 120.5.80.1 dead-interval 50 cost 100
```

To set an the poll interval to 25, the priority to 100, and the retransmit interval to 10 on interface 120.5.80.1, enter the following:

```
-> ip ospf interface 120.5.80.1 poll-interval 25 priority 100 retrans-interval
10
```

To set the hello interval to 5000 on interface 120.5.80.1, enter the following:

```
-> ip ospf interface 120.5.80.1 hello-interval 5000
```

To reset any parameter to its default value, enter the keyword with no parameter value, as shown:

```
-> ip ospf interface 120.5.80.1 dead-interval
```

Note. Although you can configure several parameters at once, you can only reset them to the default one at a time.

Creating Virtual Links

A virtual link is a link between two backbones through a transit area. Use the **ip ospf virtual-link** command to create or delete a virtual link.

Accepted network design theory states that virtual links are the option of last resort. For more information on virtual links, see "Virtual Links" on page 1-10 and refer to the figure on page 1-10.

Creating a Virtual Link

To create a virtual link, commands must be submitted to the routers at both ends of the link. The router being configured should point to the other end of the link, and both routers must have a common area.

When entering the **ip ospf virtual-link** command, it is necessary to enter the Router ID of the far end of the link, and the area ID that both ends of the link share.

For example, a virtual link needs to be created between Router A (router ID 1.1.1.1) and Router B (router ID 2.2.2.2). We must:

1 Establish a transit area between the two routers using the commands discussed in "Creating an OSPF Area" on page 1-18 (in this example, we will use Area 0.0.0.1).

2 Then use the **ip ospf virtual-link** command on Router A as shown:

```
-> ip ospf virtual-link 0.0.0.1 2.2.2.2
```

3 Next, enter the following command on Router B:

```
-> ip ospf virtual-link 0.0.0.1 1.1.1.1
```

Now there is a virtual link across Area 0.0.0.1 linking Router A and Router B.

4 To display virtual links configured on a router, enter the following **show** command:

```
-> show ip ospf virtual-link
```

5 To delete a virtual link, enter the **ip ospf virtual-link** command with the area and far end router information, as shown:

```
-> no ip ospf virtual-link 0.0.0.1 2.2.2.2
```

Modifying Virtual Link Parameters

There are several parameters for a virtual link (such as authentication type and cost) that can be modified at the time of the link creation. They are described in the **ip ospf virtual-link** command description.These parameters are identical in function to their counterparts in the section "Modifying Interface Parameters" on page 1-24.

Creating Redistribution Policies and Filters

Redistribution in OSPF controls the way routes are learned and distributed in the OSPF network. Non-OSPF routers can be advertised into the OSPF network as AS-external or NSSA-external routes. NSSA-external routes are advertised only in OSPF-NSSA areas. Redistribution policies are set on Autonomous System Boundary Routers (ASBRs) and control how routes from outside the Autonomous System (AS) are learned and distributed. Redistribution Filters are set on any OSPF router and control how routes on the router are distributed to other routers in the OSPF network.

To set up redistribution on a router:

1 Specify the router as an ASBR, as described in "Specifying an Autonomous System Boundary Router" on page 1-26. (For redistribution policies only.)

2 Enable redistribution, as described in "Enabling Redistribution" on page 1-26.

3 Create a redistribution policy or filter, as described in "Creating A Redistribution Policy" on page 1-27 and "Creating a Redistribution Filter" on page 1-27.

Specifying an Autonomous System Boundary Router

Redistribution policies can only be created on ASBRs. ASBRs are routers that are directly connected to a network outside of the AS (e.g., the internet). To configure a router to be an ASBR, enter the **ip ospf asbr** command at the CLI prompt, as shown:

```
-> ip ospf asbr
```

You can check to see if a router is an ASBR router by using the **show ip ospf** command.

Enabling Redistribution

Before using any type of redistribution policy or filter, you must enable redistribution on the router, using the **ip ospf redist status** command. To enable redistribution, enter the command at the CLI prompt as shown:

```
-> ip ospf redist status enable
```

To disable redistribution, enter the command as shown:

```
-> ip ospf redist status disable
```

Creating A Redistribution Policy

Once a router is set as an ASBR and redistribution is enabled, a redistribution policy can be created. This is done using the **ip ospf redist** command. When setting up a redistribution policy, choose the type of route or protocol that will be redistributed as an OSPF route in the OSPF network. For example, to redistribute RIP routes, enter the following:

```
-> ip ospf redist rip
```

To redistribute static routes, enter the following:

```
-> ip ospf redist static
```

A cost metric can be added to the redistributed route, either as a set number or by specifying a route type (route types have pre-assigned metrics and other rule that control how they are redistributed). For example, to add a cost metric of 50 to RIP routes, enter the following:

```
-> ip ospf redist rip metric 50
```

To set RIP route redistribution as type 1 routes, enter the following:

```
-> ip ospf redist rip metric-type type1
```

For more information on route types, see the **ip ospf redist** command in the *OmniSwitch CLI Reference Guide*.

To display the redistribution policies on a router, enter the **show ip ospf redist** command at the CLI prompt.

To delete a redistribution policy, enter the **ip ospf redist** command with the route or protocol type, and the **no** keyword, as shown:

```
-> no ip ospf redist rip
```

Creating a Redistribution Filter

Redistribution filters are used by routers to control which routes are advertised to the rest of the network. Filters can be created on any OSPF router that has redistribution enabled.

Filters are created using the **ip ospf redist-filter** command.When using a filter, a route or protocol type must be specified, along with the IP address and mask. Only routes matching the specified criteria will be advertised. For example, to create a filter for RIP routes 1.1.0.0 with a mask of 255.255.0.0, enter the following:

```
-> ip ospf redist-filter rip 1.1.0.0 255.255.0.0
```

Filters can also be used to prevent routes from being advertised by using the **effect** keyword. Using the above example, to prevent RIP routes learned from 1.1.0.0 being advertised, enter the following:

```
-> ip ospf redist-filter rip 1.1.0.0 255.255.0.0 effect deny
```

This filter would stop the advertisement of RIP routes learned within the range 1.1.0.0 with a mask of 255.255.0.0. All other routes would be advertised normally.

Note. By default, filters are set to **permit**. If **permit** is the filter action desired, it is not necessary to use the **effect** keyword.

In certain cases, redistribution can either be an adjacent route or a subnet. In these cases, the redistributed route can correspond to several routes. It is possible to advertise these routes separately or not with the **redist-control** keyword.

If it is desired to advertise only an aggregated route instead of all the routes to comprise the aggregate, use the **ip ospf redist-filter** command with the **redist-control aggregate** keyword, as shown (you will also need to enter the route information as above):

```
-> ip ospf redist-filter rip 1.1.0.0 255.255.0.0 redist-control aggregate
```

If it is desired that the subnet routes that fall within the aggregate range should not be advertised, use the **ip ospf redist-filter** command with the **redist-control** keyword as shown (you will also need to enter the route information as above):

```
-> ip ospf redist-filter rip 1.1.0.0 255.255.0.0 redist-control no-subnets
```

Note. By default, filters are set to allow subnet routes to be advertised. If this is the filter action desired, it is not necessary to use the **redist-control** keyword.

A cost metric and route tag can be assigned to the routes that are allowed to pass through the filter, by using the **metric** and **route-tag** keywords, as shown (these options are described in the **ip ospf redist-filter** command):

```
-> ip ospf redist-filter rip 1.1.0.0 255.255.0.0 metric 100 route-tag 5
```

To display all of the configured filters on a router, enter the **show ip ospf redist-filter** command as shown:

```
-> show ip ospf redist-filter
```

To display the configured filters for a specific route or protocol type, enter the **show** command and the route or protocol type:

```
-> show ip ospf redist-filter rip
```

To display a specific filter, enter the **show** command with the route or protocol type and the ip address and mask, as demonstrated:

```
-> show ip ospf redist-filter rip 1.1.0.0 255.255.0.0
```

To delete a redistribution filter, enter the **ip ospf redist-filter** command with the route or protocol type and its associated IP address and mask, as shown:

```
-> no ip ospf redist-filter rip 1.1.0.0 255.255.0.0
```

Configuring Router Capabilities

The following list shows various commands that can be useful in tailoring a router's performance capabilities. All of the listed parameters have defaults that are acceptable for running an OSPF network.

ip ospf exit-overflow-interval	Sets the overflow interval value. The overflow interval is the time whereby the router will wait before attempting to leave the database overflow state.
ip ospf extlsdb-limit	Sets a limit to the number of external Link State Databases entries learned by the router. An external LSDB entry is created when the router learns a link address that exists outside of its Autonomous System (AS).
ip ospf host	Creates and deletes an OSPF entry for directly attached hosts.
ip ospf mtu-checking	Enables or disables the use of Maximum Transfer Unit (MTU) checking on received OSPF database description packets.
ip ospf route-tag	Configures a tag value for Autonomous System External (ASE) routes created.
ip ospf spf-timer	Configures timers for Shortest Path First (SPF) calculation.

To configure a router parameter, enter the parameter at the CLI prompt with the new value or required variables. For example to set the exit overflow interval to 40, enter:

```
-> ip ospf exit-overflow-interval 40
```

To enable MTU checking, enter:

```
-> ip ospf mtu-checking
```

To set the route tag to 5, enter:

```
-> ip ospf route-tag 5
```

To set the SPF timer delay to 3 and the hold time to 6, enter:

```
-> ip ospf spf-timer delay 3 hold 6
```

To return a parameter to its default setting, enter the command with no parameter value, as shown:

```
-> ip ospf spf-timer
```

Configuring Static Neighbors

It is possible to configure neighbors statically on Non Broadcast Multi Access (NBMA), point-to-point, and point-to-multipoint networks.

NBMA requires all routers attached to the network to communicate directly (unicast), and every attached router in this network becomes aware of all of its neighbors through configuration. It also requires a Designated Router (DR) “eligibility” flag to be set for every neighbor.

To set up a router to use NBMA routing, follow the following steps:

1 Create an OSPF interface using the CLI command **ip ospf interface** and perform all the normal configuration for the interface as with broadcast networks (attaching it to an area, enabling the status, etc.).

2 The OSPF interface type for this interface should be set to non-broadcast using the CLI **ip ospf interface type** command. For example, to set interface 1.1.1.1 to be an NBMA interface, enter the following:

```
-> ip ospf interface 1.1.1.1 type non-broadcast
```

3 Configure static neighbors for every OSPF router in the network using the **ip ospf neighbor** command. For example, to set an OSPF neighbor with an IP address of 1.1.1.8 to be a static neighbor, enter the following:

```
-> ip ospf neighbor 1.1.1.8 eligible
```

The neighbor attaches itself to the right interface by matching the network address of the neighbor and the interface. If the interface has not yet been created, the neighbor gets attached to the interface as and when the interface comes up.

If this neighbor is not required to participate in DR election, configure it as non-eligible. The eligibility can be changed at any time as long as the interface it is attached to is in the disabled state.

Configuring Redundant Switches in a Stack for Graceful Restart

By default, OSPF graceful restart is disabled. To configure OSPF graceful restart support use the **ip ospf restart-support** command by entering ip **ospf restart-support** followed by either **planned-unplanned** (the default) or **planned-only**.

For example, to modify OSPF graceful restart so that it only supports planned restarts enter:

```
-> ip ospf restart-support planned-only
```

To disable support for graceful restart use the **no** form of the **ip ospf restart-support** command by entering:

```
-> no ip ospf restart-support
```

Continuous forwarding during a graceful restart depends on several factors. If the secondary module has a different router MAC than the primary module, or if one or more ports of a VLAN belonged to the primary module, spanning tree reconvergence might disrupt forwarding state, even though OSPF performs a graceful restart.

Note. Graceful restart is only supported on active ports (i.e., interfaces), which are on the secondary or idle switches in a stack during a takeover. It is not supported on ports on a primary switch in a stack.

Optionally, you can configure graceful restart parameters with the following CLI commands:

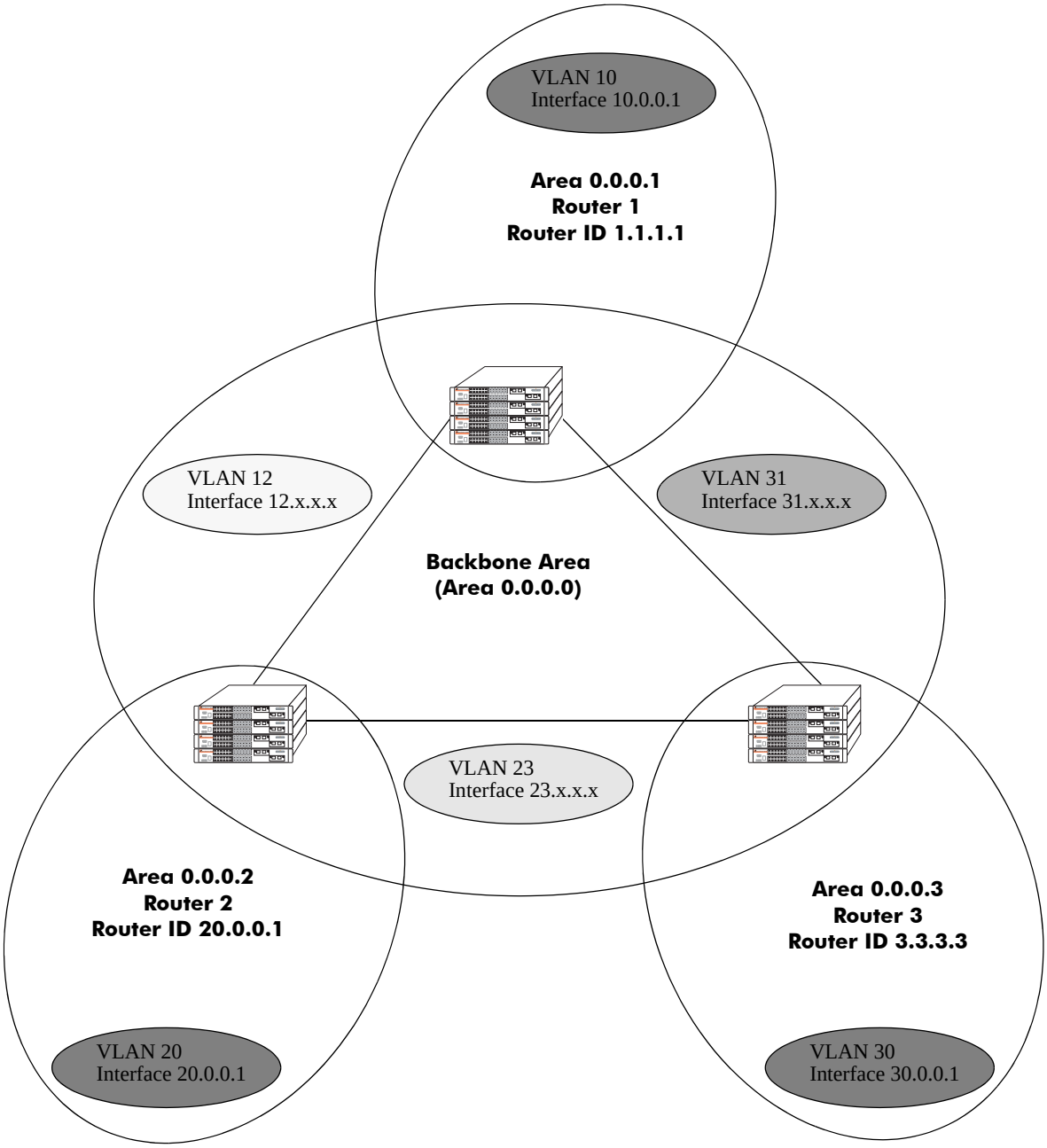
ip ospf restart-interval	Configures the grace period for achieving a graceful OSPF restart.
ip ospf restart-helper status	Administratively enables and disables the capability of an OSPF router to operate in helper mode in response to a router performing a graceful restart.
ip ospf restart-helper strict-lsa-checking-status	Administratively enables and disables whether or not a changed Link State Advertisement (LSA) will result in termination of graceful restart by a helping router.
ip ospf restart initiate	Initiates a planned graceful restart.

For more information about graceful restart commands, see the “OSPF Commands” chapter in the *OmniSwitch CLI Reference Guide*.

OSPF Application Example

This section will demonstrate how to set up a simple OSPF network. It uses three routers, each with an area. Each router uses three VLANs. A backbone connects all the routers. This section will demonstrate how to set it up by explaining the necessary commands for each router.

The following diagram is a simple OSPF network. It will be created by the steps listed on the following pages.



Three Area OSPF Network

Step 1: Prepare the Routers

The first step is to create the VLANs on each router, add an IP interface to the VLAN, assign a port to the VLAN, and assign a router identification number to the routers. For the backbone, the network design in this case uses slot 2, port 1 as the egress port and slot 2, port 2 as ingress port on each router. Router 1 connects to Router 2, Router 2 connects to Router 3, and Router 3 connects to Router 1 using 10/100 Ethernet cables.

Note. The ports will be statically assigned to the router, as a VLAN must have a physical port assigned to it in order for the router port to function. However, the router could be set up in such a way that mobile ports are dynamically assigned to VLANs using VLAN rules. See the chapter titled "Defining VLAN Rules" in the *OmniSwitch 6600 Family Network Configuration Guide.*

The commands setting up VLANs are shown below:

Router 1 (using ports 2/1 and 2/2 for the backbone, and ports 2/3-5 for end devices):

```
-> vlan 31
-> ip interface vlan-31 vlan 31 address 31.0.0.1 mask 255.0.0.0
-> vlan 31 port default 2/1

-> vlan 12
-> ip interface vlan-12 vlan 12 address 12.0.0.1 mask 255.0.0.0
-> vlan 12 port default 2/2

-> vlan 10
-> ip interface vlan-10 vlan 10 address 10.0.0.1 mask 255.0.0.0
-> vlan 10 port default 2/3-5

-> ip router router-id 1.1.1.1
```

These commands created VLANs 31, 12, and 10.

- VLAN 31 handles the backbone connection from Router 1 to Router 3, using the IP router port 31.0.0.1 and physical port 2/1.
- VLAN 12 handles the backbone connection from Router 1 to Router 2, using the IP router port 12.0.0.1 and physical port 2/2.
- VLAN 10 handles the device connections to Router 1, using the IP router port 10.0.0.1 and physical ports 2/3-5. More ports could be added at a later time if necessary.

The router was assigned the Router ID of 1.1.1.1.

Router 2 (using ports 2/1 and 2/2 for the backbone, and ports 2/3-5 for end devices):

```
-> vlan 12
-> ip interface vlan-12 vlan 12 address 12.0.0.2 mask 255.0.0.0
-> vlan 12 port default 2/1

-> vlan 23
-> ip interface vlan-23 vlan 23 address 23.0.0.2 mask 255.0.0.0
-> vlan 23 port default 2/2

-> vlan 20
-> ip interface vlan-20 vlan 20 address 20.0.0.2 mask 255.0.0.0
-> vlan 20 port default 2/3-5

-> ip router router-id 2.2.2.2
```

These commands created VLANs 12, 23, and 20.

- VLAN 12 handles the backbone connection from Router 1 to Router 2, using the IP router port 12.0.0.2 and physical port 2/1.
- VLAN 23 handles the backbone connection from Router 2 to Router 3, using the IP router port 23.0.0.2 and physical port 2/2.
- VLAN 20 handles the device connections to Router 2, using the IP router port 20.0.0.2 and physical ports 2/3-5. More ports could be added at a later time if necessary.

The router was assigned the Router ID of 2.2.2.2.

Router 3 (using ports 2/1 and 2/2 for the backbone, and ports 2/3-5 for end devices)

```
-> vlan 23
-> ip interface vlan-23 vlan 23 address 23.0.0.3 mask 255.0.0.0
-> vlan 23 port default 2/1

-> vlan 31
-> ip interface vlan-31 vlan 31 address 31.0.0.3 mask 255.0.0.0
-> vlan 31 port default 2/2

-> vlan 30
-> ip interface vlan-30 vlan 30 address 30.0.0.3 mask 255.0.0.0
-> vlan 30 port default 2/3-5

-> ip router router-id 3.3.3.3
```

These commands created VLANs 23, 31, and 30.

- VLAN 23 handles the backbone connection from Router 2 to Router 3, using the IP router port 23.0.0.3 and physical port 2/1.
- VLAN 31 handles the backbone connection from Router 3 to Router 1, using the IP router port 31.0.0.3 and physical port 2/2.
- VLAN 30 handles the device connections to Router 3, using the IP router port 30.0.0.3 and physical ports 2/3-5. More ports could be added at a later time if necessary.

The router was assigned the Router ID of 3.3.3.3.

Step 2: Enable OSPF

The next step is to load and enable OSPF on each router. The commands for this step are below (the commands are the same on each router):

```
-> ip load ospf
-> ip ospf status enable
```

Step 3: Create and Enable the Areas and Backbone

Now the areas should be created and enabled. In this case, we will create an area for each router, and a backbone (area 0.0.0.0) that connects the areas.

The commands for this step are below:

Router 1

```
-> ip ospf area 0.0.0.0
-> ip ospf area 0.0.0.0 status enable

-> ip ospf area 0.0.0.1
-> ip ospf area 0.0.0.1 status enable
```

These commands created area 0.0.0.0 (the backbone) and area 0.0.0.1 (the area for Router 1). Both of these areas are also enabled.

Router 2

```
-> ip ospf area 0.0.0.0
-> ip ospf area 0.0.0.0 status enable

-> ip ospf area 0.0.0.2
-> ip ospf area 0.0.0.2 status enable
```

These commands created Area 0.0.0.0 (the backbone) and Area 0.0.0.2 (the area for Router 2). Both of these areas are also enabled.

Router 3

```
-> ip ospf area 0.0.0.0
-> ip ospf area 0.0.0.0 status enable

-> ip ospf area 0.0.0.3
-> ip ospf area 0.0.0.3 status enable
```

These commands created Area 0.0.0.0 (the backbone) and Area 0.0.0.3 (the area for Router 3). Both of these areas are also enabled.

Step 4: Create, Enable, and Assign Interfaces

Next, OSPF interfaces must be created, enabled, and assigned to the areas. The OSPF interfaces should have the same IP address as the IP router ports created above in "Step 1: Prepare the Routers" on page 1-33.

Router 1

```
-> ip ospf interface 31.0.0.1
-> ip ospf interface 31.0.0.1 area 0.0.0.0
-> ip ospf interface 31.0.0.1 status enable

-> ip ospf interface 12.0.0.1
-> ip ospf interface 12.0.0.1 area 0.0.0.0
-> ip ospf interface 12.0.0.1 status enable

-> ip ospf interface 10.0.0.1
-> ip ospf interface 10.0.0.1 area 0.0.0.1
-> ip ospf interface 10.0.0.1 status enable
```

IP router port 31.0.0.1 was associated to OSPF interface 31.0.0.1, enabled, and assigned to the backbone. IP router port 12.0.0.1 was associated to OSPF interface 12.0.0.1, enabled, and assigned to the backbone. IP router port 10.0.0.1 which connects to end stations and attached network devices, was associated to OSPF interface 10.0.0.1, enabled, and assigned to Area 0.0.0.1.

Alternatively, you can also configure Router 1 with the interface name instead of the IP address as shown below:

```
-> ip ospf interface vlan-12
-> ip ospf interface vlan-12 area 0.0.0.0
-> ip ospf interface vlan-12 status enable

-> ip ospf interface vlan-12
-> ip ospf interface vlan-12 area 0.0.0.0
-> ip ospf interface vlan-12 status enable

-> ip ospf interface vlan-10
-> ip ospf interface vlan-10 area 0.0.0.1
-> ip ospf interface vlan-10 status enable
```

Router 2

```
-> ip ospf interface 12.0.0.2
-> ip ospf interface 12.0.0.2 area 0.0.0.0
-> ip ospf interface 12.0.0.2 status enable

-> ip ospf interface 23.0.0.2
-> ip ospf interface 23.0.0.2 area 0.0.0.0
-> ip ospf interface 23.0.0.2 status enable

-> ip ospf interface 20.0.0.2
-> ip ospf interface 20.0.0.2 area 0.0.0.2
-> ip ospf interface 20.0.0.2 status enable
```

IP router port 12.0.0.2 was associated to OSPF interface 12.0.0.2, enabled, and assigned to the backbone. IP router port 23.0.0.2 was associated to OSPF interface 23.0.0.2, enabled, and assigned to the backbone. IP router port 20.0.0.2, which connects to end stations and attached network devices, was associated to OSPF interface 20.0.0.2, enabled, and assigned to Area 0.0.0.2.

Alternatively, you can also configure Router 2 with the interface name instead of the IP address as shown below:

```
-> ip ospf interface vlan-12
-> ip ospf interface vlan-12 area 0.0.0.0
-> ip ospf interface vlan-12 status enable

-> ip ospf interface vlan-23
-> ip ospf interface vlan-23 area 0.0.0.0
-> ip ospf interface vlan-23 status enable

-> ip ospf interface vlan-20
-> ip ospf interface vlan-20 area 0.0.0.2
-> ip ospf interface vlan-20 status enable
```

Router 3

```
-> ip ospf interface 23.0.0.3
-> ip ospf interface 23.0.0.3 area 0.0.0.0
-> ip ospf interface 23.0.0.3 status enable

-> ip ospf interface 31.0.0.3
-> ip ospf interface 31.0.0.3 area 0.0.0.0
-> ip ospf interface 31.0.0.3 status enable

-> ip ospf interface 30.0.0.3
-> ip ospf interface 30.0.0.3 area 0.0.0.3
-> ip ospf interface 30.0.0.3 status enable
```

IP router port 23.0.0.3 was associated to OSPF interface 23.0.0.3, enabled, and assigned to the backbone. IP router port 31.0.0.3 was associated to OSPF interface 31.0.0.3, enabled, and assigned to the backbone. IP router port 30.0.0.3, which connects to end stations and attached network devices, was associated to OSPF interface 30.0.0.3, enabled, and assigned to Area 0.0.0.3.

Alternatively, you can also configure Router 3 with the interface name instead of the IP address as shown below:

```
-> ip ospf interface vlan-23
-> ip ospf interface vlan-23 area 0.0.0.0
-> ip ospf interface vlan-23 status enable

-> ip ospf interface vlan-31
-> ip ospf interface vlan-31 area 0.0.0.0
-> ip ospf interface vlan-31 status enable

-> ip ospf interface vlan-30
-> ip ospf interface vlan-30 area 0.0.0.3
-> ip ospf interface vlan-30 status enable
```

Step 5: Examine the Network

After the network has been created, you can check various aspects of it using show commands:

- For OSPF in general, use the **show ip ospf** command.
- For areas, use the **show ip ospf area** command.
- For interfaces, use the **show ip ospf interface** command.
- To check for adjacencies formed with neighbors, use the **show ip ospf neighbor** command.
- For routes, use the **show ip ospf routes** command.

Verifying OSPF Configuration

To display information about areas, interfaces, virtual links, redistribution, or OPSF in general, use the **show** commands listed in the following table:

show ip ospf	Displays OSPF status and general configuration parameters.
show ip ospf border-routers	Displays information regarding all or specified border routers.
show ip ospf ext-lsdb	Displays external Link State Advertisements from the areas to which the router is attached.
show ip ospf host	Displays information on directly attached hosts.
show ip ospf lsdb	Displays LSAs in the Link State Database associated with each area.
show ip ospf neighbor	Displays information on OSPF non-virtual neighbor routers
show ip ospf redist-filter	Displays OSPF redistribution filter attributes.
show ip ospf redist	Displays the specified redistribution instance that allows routes to be redistributed into OSPF.
show ip ospf routes	Displays OSPF routes known to the router.
show ip ospf virtual-link	Displays virtual link information.
show ip ospf virtual-neighbor	Displays OSPF virtual neighbors.
show ip ospf area	Displays either all OSPF areas, or a specified OSPF area.
show ip ospf area range	Displays all or specified configured area address range summaries for the given area.
show ip ospf area stub	Displays stub area status.
show ip ospf interface	Displays OSPF interface information.
show ip ospf restart	Displays the OSPF graceful restart related configuration and status.

For more information about the resulting displays form these commands, see the “OSPF Commands” chapter in the *OmniSwitch CLI Reference Guide*.

Examples of the **show ip ospf**, **show ip ospf area**, and **show ip ospf interface** command outputs are given in the section “OSPF Quick Steps” on page 1-4.

2 Configuring DVMRP

This chapter includes descriptions of Distance Vector Multicast Routing Protocol (DVMRP). DVMRP is a dense-mode multicast routing protocol. DVMRP, which is essentially a “broadcast and prune” routing protocol, is designed to assist routers in propagating IP multicast traffic through a network.

In This Chapter

This chapter describes the basic components of DVMRP and how to configure them through the Command Line Interface (CLI). CLI commands are used in the configuration examples. For more details about the syntax of commands, see the *OmniSwitch CLI Reference Guide*.

Configuration procedures described in this chapter include:

- Loading DVMRP into memory—see page 2-14.
- Enabling DVMRP—see page 2-16.
- Neighbor communications—see page 2-18.
- Routes—see page 2-19.
- Pruning—see page 2-20.
- Grafting—see page 2-22.
- Tunnels—see page 2-22.
- Verifying the DVMRP configuration—see page 2-24.

DVMRP Specifications

RFCs Supported	2667—IP Tunnel MIB
IETF Internet-Drafts Supported	Distance-Vector Multicast Routing Protocol MIB draft-ietf-idmr-dvmrp-v3-11.txt
DVMRP Version Supported	DVMRPv3.255
DVMRP Attributes Supported	Reverse Path Multicasting, Neighbor Discovery, Multicast Source Location, Route Report Messages, Distance metrics, Dependent Downstream Routers, Poison Reverse, Pruning, Grafting, DVMRP Tunnels
DVMRP Timers Supported	Flash update interval, Graft retransmissions, Neighbor probe interval, Neighbor timeout, Prune lifetime, Prune retransmission, Route report interval, Route holddown, Route expiration timeout
Maximum Number of Interfaces Supported	128
Range for Interface Distance Metrics	1 to 31
Range for Tunnel TTL Value	0 to 255
Multicast Protocols per Interface	1 (e.g., you cannot enable both PIM-SM and DVMRP on the same IP interface)

DVMRP Defaults

The following table lists the defaults for DVMRP configuration:

Parameter Description	Command	Default Value/Comments
DVMRP load status	**ip load dvmrp**	Unloaded
DVMRP status	**ip dvmrp status**	Disabled
DVMRP interface status	**ip dvmrp interface**	Disabled
Flash update interval	**ip dvmrp flash-interval**	5 seconds
Graft retransmission timeout	**ip dvmrp graft-timeout**	5 seconds
Neighbor probe interval time	**ip dvmrp neighbor-interval**	10 seconds
Neighbor timeout	**ip dvmrp neighbor-timeout**	35 seconds
Prune lifetime	**ip dvmrp prune-lifetime**	7200 seconds
Prune retransmission timeout	**ip dvmrp prune-timeout**	30 seconds
Route report interval	**ip dvmrp report-interval**	60 seconds
Route holddown time	**ip dvmrp route-holddown**	120 seconds
Route expiration timeout	**ip dvmrp route-timeout**	140 seconds
Interface distance metric	**ip dvmrp interface metric**	1
DVMRP tunnel status	**ip dvmrp tunnel**	Disabled
DVMRP tunnel TTL value	**ip dvmrp tunnel ttl**	255
Subordinate neighbor status	**ip dvmrp subord-default**	true

Quick Steps for Configuring DVMRP

Note. DVMRP requires that IP Multicast Switching (IPMS) is enabled. IPMS is automatically enabled when a multicast routing protocol (either PIM-SM or DVMRP) is enabled globally and on an interface *and* when the operational status of the interface is *up*. However, if you wish to manually enable IPMS on the switch, use the **ip multicast switching** command.

1 Manually load DVMRP into memory by entering the following command:

```
-> ip load dvmrp
```

2 Create a router port (i.e., *interface*) on an existing VLAN by specifying a valid IP address. To do this, use the **ip interface** command. For example:

```
-> ip interface vlan-5 address 178.14.1.43 vlan 5
```

3 Enable the DVMRP protocol on the interface via the **ip dvmrp interface** command. For example:

```
-> ip dvmrp interface 178.14.1.43
```

4 Globally enable either one of the DVMRP protocol modes by entering the following commands:

```
-> ip dvmrp status safe-enable
```

```
-> ip dvmrp status unrestricted-enable
```

5 Save your changes to the Working directory's **boot.cfg** file by entering the following command:

```
-> write memory
```

Once loaded and enabled, DVMRP is typically ready to use because its default values are appropriate for the majority of installations.

Note. *Optional*. To verify DVMRP interface status, enter the **show ip dvmrp interface** command. The display is similar to the one shown here:

```
 Interface Name    Vlan   Metric  Admin-Status  Oper-Status
-----------------+------+--------+-------------+-------------
vlan-5            5         1       Enabled     Enabled
```

To verify the global DVMRP status, enter the **show ip dvmrp** command:

```
-> show ip dvmrp

DVMRP Admin Status = enabled (safe mode),
Flash Interval     = 5,
Graft Timeout      = 5,
Neighbor Interval  = 10,
Neighbor Timeout   = 35,
Prune Lifetime     = 7200,
Prune Timeout      = 30,
Report Interval    = 60,
Route Holddown     = 120,
Route Timeout      = 140,
Subord Default     = true,
Number of Routes         = 2,
Number of Reachable Routes = 2
```

For more information about these displays, see the “DVMRP Commands” chapter in the *OmniSwitch CLI Reference Guide*.

DVMRP Overview

Distance Vector Multicast Routing Protocol (DVMRP) Version 3 is a multicast routing protocol that enables routers to efficiently propagate IP multicast traffic through a network. Multicast traffic consists of a data stream that originates from a single source and is sent to hosts that have subscribed to that stream. Live video broadcasts, video conferencing, corporate communications, distance learning, and distribution of software, stock quotes, and news services are examples of multicast traffic. Multicast traffic is distinguished from unicast traffic and broadcast traffic as follows:

- Unicast traffic is addressed to a single host.
- Broadcast traffic is transmitted to all hosts.
- Multicast traffic is transmitted to a subset of hosts (the hosts that have subscribed to the multicast data stream).

DVMRP is a distributed multicast routing protocol that dynamically generates per-source delivery trees based upon routing exchanges, using a technique called *Reverse Path Multicasting*. When a multicast source begins to transmit, the multicast data is flooded down the delivery tree to all points in the network. DVMRP then *prunes* (i.e., removes branches from) the delivery tree where the traffic is unwanted.

Pruning continues to occur as group membership changes or routers determine that no group members are present. This restricts the delivery trees to the minimum branches necessary to reach all group members, thus optimizing router performance. New branches can also be added to the delivery trees dynamically as new members join the multicast group. The addition of new branches is referred to as *grafting*.

Reverse Path Multicasting

DVMRP uses Internet Group Management Protocol (IGMP) messages to exchange the routing information needed to build per-source multicast delivery trees. Once built, packets follow a multicast delivery tree from the source to all members of the multicast group. Packets are replicated only at necessary branches in the delivery tree. The trees are calculated and updated dynamically to track the membership of individual groups.

When a packet arrives on an interface, the reverse path back to the source of the packet is determined by examining a DVMRP routing table of known source networks. If the packet arrived on an upstream interface that would be used to transmit packets back to the source, it is forwarded to the appropriate list of downstream interfaces. Otherwise, it is not on the optimal delivery tree and is discarded. In this way duplicate packets can be filtered when loops exist in the network topology.

Neighbor Discovery

DVMRP routers must maintain a database of DVMRP adjacencies with other DVMRP routers. A DVMRP router must be aware of its DVMRP neighbors on each interface. To gather this information, DVMRP routers use a neighbor discovery mechanism and periodically multicast DVMRP *Probe messages* to the All-DVMRP-Routers group address (224.0.0.4). Each Probe message includes a Neighbor List of DVMRP routers known to the transmitting router.

When a DVMRP router (let's call it "router B") receives a Probe (let's say from "router A"), it adds the IP address of router A to its own internal list of DVMRP neighbors on that interface. It then sends a Probe of its own with the IP address of router A included in the Probe's Neighbor List. When a DVMRP router receives a Probe with its own IP address included in the Neighbor List, the router knows that a two-way adjacency has been successfully formed between itself and the neighbor that sent the Probe.

Probes effectively serve three main purposes:

- Probes provide a mechanism for DVMRP routers to locate each other as described above.
- Probes provide a way for DVMRP routers to determine each others' capabilities. This is deduced from the major and minor version numbers in the Probe packet and directly from the capability flags in the Probe packet.
- Probes provide a keep-alive function in order to quickly detect neighbor loss.

A DVMRP router sends periodic *Route Report* messages to its DVMRP neighbors (by default, every 60 seconds). A Route Report message contains the sender's current routing table, which contains entries that advertise a source network (with a mask) and a hop-count that is used as the routing metric. This routing information is used to build source distribution trees and to perform multicast forwarding. The DVMRP neighbor that advertises the route with the lowest metric will be used for forwarding. (In case of a tie, the DVMRP neighbor with the lowest IP address will be used.)

In DVMRPv3, a router will not accept a Route Report from another DVMRP router until it has established adjacency with that neighboring router.

Note. Older versions of DVMRP use Route Report messages to perform neighbor discovery rather than the Probe messages used in DVMRP Version 3.

Multicast Source Location, Route Report Messages, and Metrics

When an IP multicast packet is received by a router running DVMRP, it first looks up the source network in the DVMRP routing table. The interface that provides the best route back to the source of the packet is called the upstream interface. If the packet arrived on that upstream interface, then it is a candidate for forwarding to one or more downstream interfaces. If the packet did not arrive on that anticipated upstream interface, then it is discarded. This check is known as a *reverse path forwarding check* and is performed by all DVMRP routers.

Note. Under normal, stable DVMRP operation, packets would not arrive on the wrong interface because the upstream router would not forward the packet unless the downstream router poison-reversed the route in the first place (as explained below). However, there are cases—such as immediately after a network topology change—when DVMRP routing has not yet converged across all routers where this can occur. It can also occur when loops exist in the network topology.

In order to ensure that all DVMRP routers have a consistent view of the path back to a source, routing tables are propagated by all DVMRP routers in *Route Report messages*. Each router transmits a Route Report message at specified intervals. The Route Report message advertises the network numbers and masks of those interfaces to which the router is directly connected. It also relays the routes received from neighboring routers.

DVMRP requires an interface metric (i.e., a hop-count) to be configured on all physical and tunnel interfaces. When a route is received from a neighboring router via a Route Report message, the metric of the interface over which the packet was received is added to the metric of the route being advertised. This adjusted metric is used when comparing metrics to determine the most efficient upstream interface.

Dependent Downstream Routers and Poison Reverse

In addition to providing a consistent view of source networks, the exchange of routes in DVMRP Route Report messages provides one other important feature. DVMRP uses the route exchange as a mechanism for upstream routers to determine if any downstream routers depend on them for forwarding packets from particular source networks.

DVMRP accomplishes this by using a technique called *poison reverse*. If a downstream router selects an upstream router as the best next hop to a particular source network, it indicates this by echoing back the route on the upstream interface with a metric equal to the original metric plus infinity. (DVMRP uses a metric of 32 as infinity.) When the upstream router receives the report and sees a metric that lies between infinity and twice infinity (that is, between 32 and 64), it adds the downstream router from which it received the report to a list of dependent routers for this source network.

The list of dependent routers per source network built by the poison reverse technique provides the foundation necessary to determine when it is appropriate to prune back the IP source-specific multicast trees.

Note. Poison reverse is used differently in DVMRP than in most unicast distance vector routing protocols (such as RIP), which use poison reverse to advertise that a particular route is unreachable.

Pruning Multicast Traffic Delivery

Initially, all interfaces with downstream-dependent neighbors are included in the downstream interface list and multicast traffic is flooded down the truncated broadcast tree to all possible receivers. This allows the downstream routers to be aware of traffic destined for a particular Source, Group (S, G) pair. The downstream routers then have the option to send prunes (and subsequent grafts) for this (S, G) pair as requirements change.

A DVMRP router will remove an interface from its forwarding list that has no group members associated with an IP multicast packet. If a router removes all of its downstream interfaces, it notifies the upstream router that it no longer wants traffic destined for that particular (S, G) pair. This is accomplished by sending a DVMRP Prune message upstream to the router expected to forward packets from that particular source.

A downstream router will inform an upstream router that it depends on the upstream router to receive packets from particular source networks by using the poison reverse technique during the exchange of Route Report messages. This method allows the upstream router to build a list of downstream routers on each interface that are dependent upon it for packets from a particular source. If the upstream router receives Prune messages from each one of the dependent downstream routers on an interface, then the upstream router can in turn remove this interface from its downstream interface list. If the upstream router is able to remove all of its downstream interfaces in this manner, it can then send a DVMRP Prune message to its upstream router. This continues until all unneeded branches are removed. Refer to "Pruning" on page 2-20 for more specific information on pruning.

Grafting Branches Back onto the Multicast Delivery Tree

A pruned branch will be automatically reattached to the multicast delivery tree when the prune times out. However, the graft mechanism provides a quicker method to reattach a pruned branch than waiting for the prune to time out. Without the graft mechanism, the join latency for new hosts in the group might be unacceptably great, because the prunes in the upstream routers would have to time out before multicast traffic could again begin to flow to the pruned branches. Depending on the number of routers along the pruned branch and the timeout values in use, several minutes might elapse before the host could begin to receive multicast traffic. By using a graft mechanism, DVMRP reduces the join latency to a few milliseconds.

The graft mechanism is made reliable through the use of Graft-Ack (Graft Acknowledgment) messages. A Graft-Ack message is returned by the upstream router in response to a Graft message. If the Graft-Ack message is not received, the downstream router will resend the Graft message. This prevents the loss of a Graft message due to congestion.

The **ip dvmrp graft-timeout** command enables you to set the Graft message retransmission value. This value defines the duration of time that the router will wait before retransmitting a Graft message if it has not received a Graft-Ack message. Refer to "Grafting" on page 2-22 for more information.

DVMRP Tunnels

Since not all IP routers support native multicast routing, DVMRP includes direct support for tunneling IP multicast packets through routers. Tunnel interfaces are used when routers incapable of supporting multicast traffic exist between DVMRP neighbors. In tunnel interfaces, IP multicast packets are encapsulated in unicast IP packets and addressed directly to the routers that do not support native multicast routing. DVMRP protocol messages (such as Route Reports, Probes for neighbor discovery, etc.) and multicast traffic are sent between tunnel endpoints using unicast, rather than multicast, packets.

Multicast data is encapsulated using a standard IP-IP encapsulation method. The unicast IP addresses of the tunnel endpoints are used as the source and destination IP addresses in the outer IP header. The inner IP header remains unchanged from the original multicast packet.

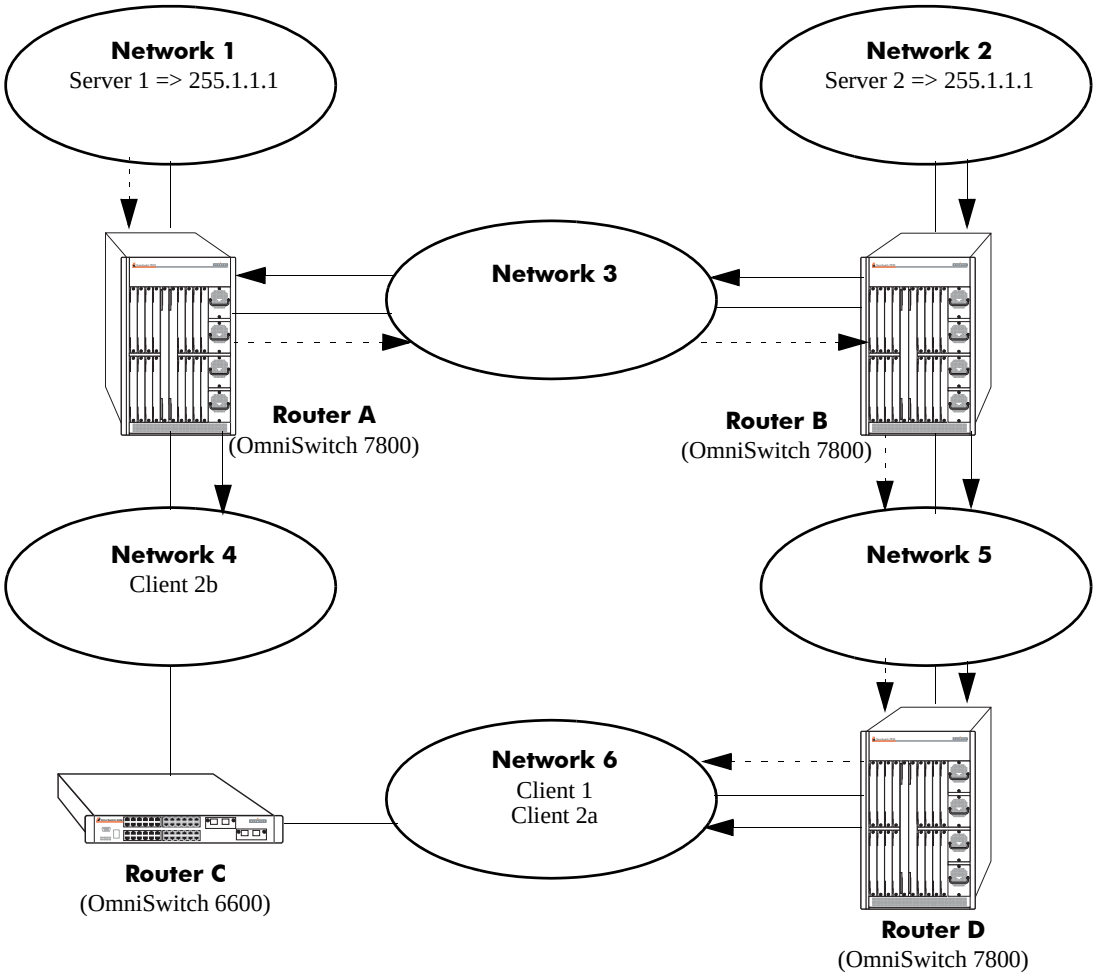
Operational Modes

On OmniSwitch 6600 Family switches, DVMRP can operate in two operational modes: *safe-enable* and *unrestricted-enable*. In safe-enable mode the switch will never route traffic between two branch networks. (A branch network is defined as having at least one DVMRP neighbor present on the interface/VLAN.) In unrestricted-enable mode DVMRP operates in the same way it does on OmniSwitch 7700, 7800, and 8800 switches. See the following subsections for more information on these two modes.

Note. The operational mode is a global (switch-wide) parameter. You cannot mix and match safe-enable and unrestricted-enable modes on the same switch.

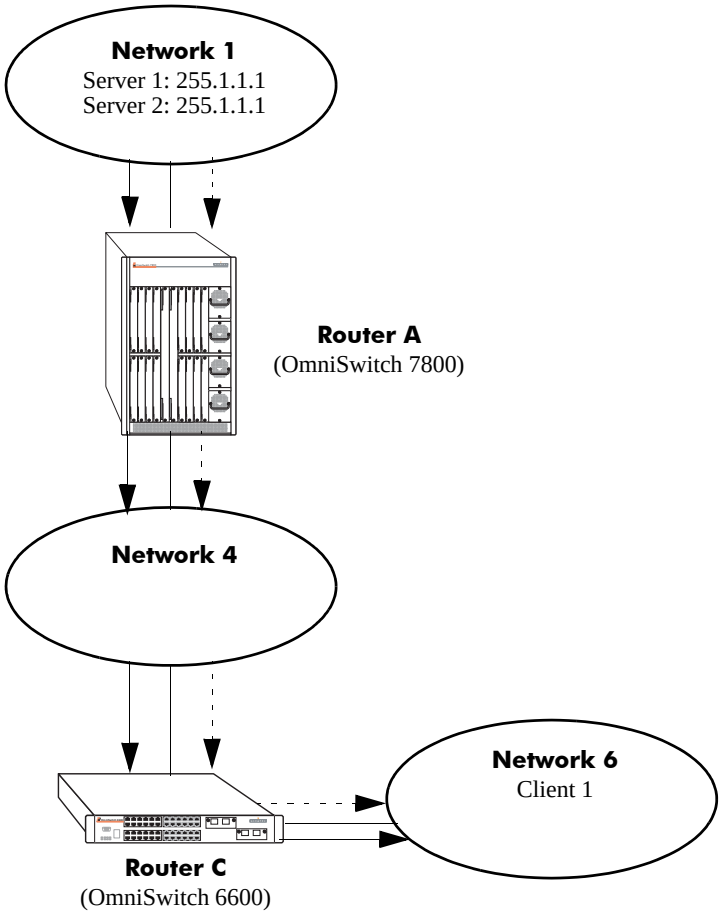
Safe-Enable Mode

Safe-enable mode allows you to place 6600 switches anywhere in your network without creating disastrous side effects by introducing routing loops with duplicate packets. Due to the 6600 hardware limitations, it is still possible to see a 6600 forwarding unwanted traffic from a branch to a leaf network. Unfortunately, this cannot be prevented by the DVMRP software. Fortunately though, the unwanted traffic will go no further than that leaf network. It will not be propagated to any other branch networks. The DVMRP software is designed to minimize problems inherent with the 6600 hardware, but it can't fix all of them.



Below is an example illustrating the basic problem. This figure shows an example of unwanted network traffic appearing in Network 6. Both Server1 and Server2 are transmitting traffic to the multicast group address 255.1.1.1. Network 6 is considered a Leaf network since only one DVMRP router is attached to it (i.e. Router C 6600). Client1 is running IGMPv3 and only wishes to receive traffic from Server1. The traffic is routed successfully from Server1 to Client1, branch to leaf network routing. Since Router C is a 6600, it cannot distinguish between the two traffic flows destined to 255.1.1.1. And because it has already established a forwarding entry in its hardware for the traffic from Server1, it will automatically, incorrectly, route traffic from Server2 into Network 6.

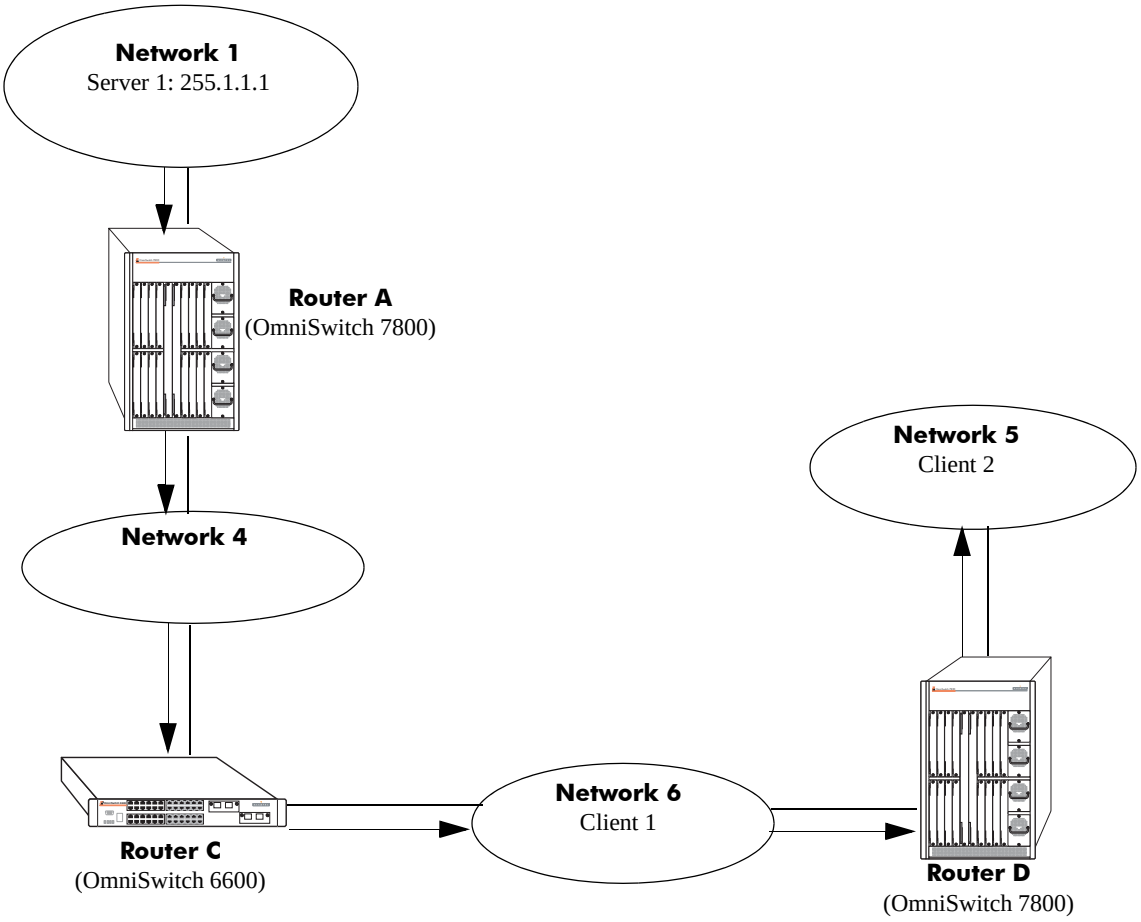
It is not clear how the client may react to unwanted traffic. If the IGMPv3 client/system is implemented correctly, the unwanted traffic should be ignored. However, it is possible that the clients' hardware may not operate properly if it is blasted with a large amount of unwanted traffic.



(**Note**: A Branch network is defined as having at least one DVMRP neighbor present on the interface/vlan. Any other networks are considered to be Leaf networks. Multicast servers and clients may reside on either Branch or Leaf networks.)

Unrestricted-Enable Mode

It is necessary to configure 6600 switch's DVMRP to run in unrestricted-mode. The below example clearly states the importance for 6600 Router C to be enabled for unrestricted mode in order for Client1 and Client2 to receive traffic from Server1. Both Networks 4 and 6 are considered Branch networks due to the presence of Router A and Router D. Only unrestricted-enable mode will allow the 6600 to route between branch networks. If the 6600 had been configured for the safe-enable mode, there would be no multicast communication between Server1 and the two clients.



Configuring DVMRP

Before configuring DVMRP, consider the following:

- The **Hadvrout.img** file must be present in the switch's current running directory (i.e., Working or Certified) before DVMRP can be enabled or configured.
- DVMRP requires that IP Multicast Switching (IPMS) is enabled. IPMS is automatically enabled when a multicast routing protocol (either PIM-SM or DVMRP) is enabled globally and on an interface *and* when the operational status of the interface is up. However, if you wish to manually enable IPMS on the switch, use the **ip multicast switching** command.
- You can configure DVMRP parameters when the protocol is not running *as long as DVMRP is loaded into memory* (see "Loading DVMRP into Memory" below).
- The DVMRP parameters will *not* take effect until the protocol is enabled globally *and* on specific IP interfaces.

Enabling DVMRP on the Switch

By default, the DVMRP protocol is disabled on the switch. Before running DVMRP, you must enable the protocol by completing the following steps:

- Loading DVMRP into memory
- Enabling DVMRP on desired IP interfaces
- Enabling DVMRP globally on the switch

Note. Once loaded and enabled, DVMRP is typically ready to use because its factory default values are appropriate for the majority of installations. Note, however, if neighbors in the DVMRP domain have difficulty handling large initial bursts of traffic, it is recommended that the subordinate neighbor status is changed to false. For more information on the subordinate neighbor status, refer to the **ip dvmrp subord-default** command in the *OmniSwitch CLI Reference Guide*.

For information on completing these steps, refer to the sections below.

Loading DVMRP into Memory

You must load DVMRP into memory before you can begin configuring the protocol on the switch. If DVMRP is not loaded and you enter a configuration command, the following message displays:

```
ERROR: The specified application is not loaded
```

To dynamically load DVMRP into memory, enter the following command:

```
-> ip load dvmrp
```

Enabling DVMRP on a Specific Interface

Note. It does not matter whether DVMRP is first enabled globally or on specific interfaces. However, DVMRP will not run on an interface until it is enabled both globally and on the interface.

DVMRP must be enabled on an interface before any other interface-specific DVMRP command can be executed (e.g., the **ip dvmrp interface metric** command). An interface can be any IP router port that has been assigned to an existing VLAN. For information on assigning a router port to a VLAN, refer to the "Configuring VLANs" chapter in the *OmniSwitch 6600 Family Network Configuration Guide*.

To enable DVMRP on a specific interface, use the **ip dvmrp interface** command. The interface identifier used in the command syntax is the valid IP address of an existing VLAN router port or the name of the interface defined with the **ip interface** command. For example:

```
-> ip dvmrp interface 172.22.2.115
```

or

```
-> ip dvmrp interface vlan-2
```

Note. Only one multicast routing protocol is supported per interface. This means that you cannot enable both PIM-SM and DVMRP on the same interface.

Disabling DVMRP on a Specific Interface

To disable DVMRP on a specific IP interface, use the **no ip dvmrp interface** command. Be sure to include the interface IP address or interface name. For example:

```
-> no ip dvmrp interface 172.22.2.115
```

or

```
-> no ip dvmrp interface vlan-2
```

Specifying a Distance Metric on a Specific Interface

The **ip dvmrp interface metric** command enables you to specify the distance metric for an interface. The default interface distance metric value is 1. DVMRP uses the metric value to determine the most cost-effective way of passing data. The higher an interface's metric value, the higher the cost of passing data over that interface. DVMRP will transmit data over the interface with the lowest available metric. Note that, just as in RIP, the metric of an incoming route advertisement is automatically incremented by the metric of the incoming interface (typically one hop). You can assign an interface any distance metric from 1 to 31.

To assign a distance metric to a specific interface, use the **ip dvmrp interface metric** command. The command syntax must include either the IP address for the VLAN router port (i.e., interface) or the name of the interface defined with the **ip interface** command, as well as a distance metric value. For example:

```
-> ip dvmrp interface 172.22.2.115 metric 3
```

or

```
-> ip dvmrp interface vlan-2 metric 3
```

Viewing DVMRP Status and Parameters for a Specific Interface

To view current DVMRP interfaces, including their operational status and assigned metrics, use the **show ip dvmrp interface** command. For example:

```
-> show ip dvmrp interface
 Interface Name       Vlan   Metric  Admin-Status  Oper-Status
--------------------+-----+--------+-------------+-------------
 vlan-2                2        3         Enabled      Disabled
```

Current assigned metric is shown as 3.

The corresponding interface is configured for DVMRP (i.e., it is DVMRP-enabled).

The interface is operationally down because there are no ports operationally up in VLAN 2.

Note. The **show ip dvmrp interface** command displays information for *all multicast-capable interfaces* (i.e., DVMRP).

Globally Enabling DVMRP on a Switch

Before you enable DVMRP you must first decide whether to use safe-enable or unrestricted-enable mode. (See "Operational Modes" on page 2-11 for more information.) Once you have made that decision use the **ip dvmrp status** command with the **safe-enable** parameter to globally enable safe-enable mode on a switch or use the **ip dvmrp status** command with the **unrestricted-enable** parameter to globally enable unrestricted-enable mode on a switch.

For example, to globally enable safe-enable mode on a switch enter:

```
-> ip dvmrp status safe-enable
```

To globally enable unrestricted-enable mode on a switch enter:

```
-> ip dvmrp status unrestricted-enable
```

Globally Disabling DVMRP

The following command will globally disable DVMRP on the switch:

```
-> ip dvmrp status disable
```

Checking the Current Global DVMRP Status

To view current global DVMRP enable/disable status, as well as additional global DVMRP settings, use the **show ip dvmrp** command. For example:

```
-> show ip dvmrp
DVMRP Admin Status = (safe mode),
Flash Interval     = 5,
Graft Timeout      = 5,
Neighbor Interval  = 10,
Neighbor Timeout   = 35,
Prune Lifetime     = 7200,
Prune Timeout      = 30,
Report Interval    = 60,
Route Holddown     = 120,
Route Timeout      = 140,
Subord Default     = true,

Number of Routes           = 20,
Number of Reachable Routes = 18
```

Current global DVMRP status is shown as safe-enable mode.

Automatic Loading and Enabling of DVMRP Following a System Boot

If *any* DVMRP command is saved to the **boot.cfg** file in the post-boot running directory, DVMRP will be loaded into memory automatically. The post-boot running directory refers to the directory the switch will use as its running directory following the next system boot (i.e., Working or Certified). If the command syntax **ip dvmrp status safe-enable** or **ip dvmrp status unrestricted-enable** is saved to the **boot.cfg** file in the post-boot running directory, DVMRP will be automatically loaded into memory *and* globally enabled following the next system boot. For detailed information on the Working and Certified directories and on how they are used during system boot, see the “CMM Directory Management” chapter in the *OmniSwitch 6600 Family Switch Management Guide*.

Neighbor Communications

Probe messages are sent out periodically on all the DVMRP interfaces. However, only on the non-tunnel interfaces are they sent out to the multicast group address 224.0.0.4.

Note. Older versions of DVMRP use Route Report messages to perform neighbor discovery rather than the Probe messages used in DVMRP Version 3.

The **ip dvmrp neighbor-interval** command enables you to configure the interval, in seconds, at which Probe messages are transmitted. For example, to configure the Probe interval to ten seconds, enter the following command:

```
-> ip dvmrp neighbor-interval 10
```

The **ip dvmrp neighbor-timeout** command enables you to configure the number of seconds that the DVMRP router will wait for activity from a neighboring DVMRP router before assuming the neighbor is down. For example, to configure the neighbor timeout period to 35 seconds, enter the following command:

```
-> ip dvmrp neighbor-timeout 35
```

When the neighbor timeout expires and it is assumed that the neighbor is down, the following occurs:

- All routes learned from the neighbor are immediately placed in hold down.
- If the neighbor is considered to be the designated forwarder for any of the routes it is advertising, a new designated forwarder for each source network is selected.
- If the neighbor is upstream, any cache entries based upon this upstream neighbor are flushed.
- Any outstanding grafts awaiting acknowledgments from this neighbor are flushed.
- All downstream dependencies received from this neighbor are removed.

The **ip dvmrp neighbor-interval** should be set to 10 seconds and the **ip dvmrp neighbor-timeout** should be set to 35 seconds. This allows fairly early detection of a lost neighbor yet provides tolerance for busy multicast routers. Both of these values must be coordinated between all DVMRP routers on a physical network segment.

Note. Current global DVMRP parameter values, including the **ip dvmrp neighbor-interval** value and the **ip dvmrp neighbor-timeout** value, can be viewed via the **show ip dvmrp** command. The DVMRP neighbor table can be viewed via the **show ip dvmrp neighbor** command.

Routes

In DVMRP, source network routing information is exchanged in the same basic manner as it is in RIP. That is to say, periodic Route Report messages are sent between DVMRP neighbors (by default, every 60 seconds). A Route Report contains the sender's current routing table. The routing table contains entries that advertise a source network (with a mask) and a hop-count that is used as the routing metric. (The key difference between the way routing information is exchanged in DVMRP and in RIP is that DVMRP routes are advertised with a subnet mask, which makes DVMRP effectively a classless protocol.)

The routing information stored in a DVMRP routing table is separate from the unicast routing table and is used to build source distribution trees and to perform multicast forwarding (that is, Reverse Path Forwarding checks).

The **ip dvmrp report-interval** command enables you to specify the number of seconds between transmission of Route Report messages. For example, the following command specifies that a Route Report message be sent every 60 seconds:

```
-> ip dvmrp report-interval 60
```

The **ip dvmrp flash-interval** command enables you to specify the number of seconds between transmission of Routing Table Change messages. Routing Table Change messages are sent between transmissions of the complete routing tables contained in Route Report messages. For this reason, the Flash Interval value must be lower than the Route Report interval. For example:

```
-> ip dvmrp flash-interval 5
```

The **ip dvmrp route-timeout** command enables you to specify the route expiration timeout value. The route expiration timeout value determines the number of seconds before a route to an inactive network is aged out. For example, the following command specifies that the route to an inactive network age out in 140 seconds:

```
-> ip dvmrp route-timeout 140
```

The **ip dvmrp route-holddown** command enables you to specify the number of seconds that DVMRP routes are kept in a holddown state. A holddown state refers to the period of time that a route to an inactive network continues to be advertised as unreachable. When a route is deleted (because it expires, the neighbor it was learned from goes down, etc.) a router may be able to reach the source network described by the route through an alternate gateway. However, in the presence of complex topologies, often the alternate gateway may only be echoing back the same route learned via a different path. If this occurs, the route will continue to be propagated long after it is no longer valid.

In order to prevent this, it is common in distance vector protocols to continue to advertise a route that has been deleted with a metric of infinity for one or more report intervals. This is a holddown. While it is in holddown, a route must o00nly be advertised with an infinity metric. The hold down period is usually two report intervals.

For example, the following command specifies that the route to an inactive network continue to be advertised for 120 seconds:

```
-> ip dvmrp route-holddown 120
```

Note. Current global DVMRP parameter values, including the **ip dvmrp report-interval**, **ip dvmrp flash-interval**, **ip dvmrp route-timeout**, and **ip dvmrp route-holddown** values, can be viewed via the **show ip dvmrp** command. The DVMRP routes that are being advertised to other routers can be viewed via the **show ip dvmrp route** command.

Pruning

DVMRP uses a flood-and-prune mechanism that starts by delivering multicast traffic to all routers in the network. This means that, initially, traffic is flooded down a multicast delivery tree. DVMRP routers then prune this flow where the traffic is unwanted. Routers that have no use for the traffic send DVMRP Prune messages up the delivery tree to stop the flow of unwanted multicast traffic, thus pruning the unwanted branches of the tree. After pruning, a source distribution tree for that specific source exists.

However, the source distribution tree that results from DVMRP pruning reverts back to the original delivery tree when the prunes time out. When a prune times out, traffic is again flooded down the branch.

The **ip dvmrp prune-lifetime** command sets the period of time that a prune will be in effect — essentially, the prune's lifetime. When the prune-lifetime period expires, the interface is joined back onto the multicast delivery tree. (If unwanted multicast traffic continues to arrive at the interface, the prune mechanism is reinitiated and the cycle continues.) For example, the following command sets a prune's lifetime to 7200 seconds:

```
-> ip dvmrp prune-lifetime 7200
```

Refer to "More About Prunes" below for further information on the **ip dvmrp prune-lifetime** command and how it affects the lifetime of prunes sent and, in some cases, received.

The **ip dvmrp prune-timeout** command sets the Prune packet retransmission interval. This is the duration of time that the router will wait before retransmitting a Prune message if it continues to receive unwanted multicast traffic. For example, the following command sets the Prune packet retransmission interval to forty seconds:

```
-> ip dvmrp prune-timeout 40
```

Note. Current global DVMRP parameter values, including the **ip dvmrp prune-lifetime** value and the **ip dvmrp prune-timeout** value, can be viewed via the **show ip dvmrp** command. Current DVMRP prunes can be viewed via the **show ip dvmrp prune** command.

More About Prunes

Prune-Lifetime Values in Sent Prune Packets

The value of **ip dvmrp prune-lifetime** is set to 7200 seconds (two hours) by default. On leaf routers (that is, routers that have no further downstream dependent routers), the value of **ip dvmrp prune-lifetime** is inserted into prune packets sent upstream as their lifetime value.

However, when a branch router (that is, a router that does have further downstream dependent routers) sends a prune upstream, the prune-lifetime value inserted into the prune packet is the smallest of the following values:

- the value of **ip dvmrp prune-lifetime** on the sending device
- the amount of lifetime that remains for each individual prune on the router's timer queue that was received for the pruned group. (When a prune is queued on the router's timer queue, its lifetime value decrements until the prune expires.)

As an example, let's say that the following situation exists on a branch router: **ip dvmrp prune-lifetime** is set to 7200 seconds and three prunes for the pruned group exist on the router's timer queue. These three prunes have remaining lifetimes of 7000 seconds, 5000 seconds, and 4500 seconds. When the branch

router sends a prune upstream for this group, a prune-lifetime value of 4500 seconds will be inserted into the prune packet.

Prune-Lifetime Expiration Value

You can view the prunes that have been sent via the **show ip dvmrp prune** command. (However, note that this command does not display received prunes.) The expiration time displayed by the **show ip dvmrp prune** command is the earliest time that the router expects multicast traffic for the pruned group to start arriving. If the expiration time displays as **expired**, the prune has expired but no further multicast traffic has been received. The expiration value may be reset if multicast traffic is received and another prune was sent because no stations downstream want the traffic.

Received Prunes

When prune packets are received, a timer is set up on the receiving device that halts traffic sent to the pruned group on the neighbor that originated the prune. The timer value used is the prune-lifetime value found in the received prune packet. The setting of **ip dvmrp prune-lifetime** on the device that received the prune is not normally taken into consideration in this situation.

However, there are times when the setting of **ip dvmrp prune-lifetime** can affect the timeout value used for received prunes. This occurs if the setting of **ip dvmrp prune-lifetime** is modified after prunes have been received. If the new prune-lifetime value is less than the period of time a received prune has been on the router's timer queue, the router will treat the prune as if it just expired. This means that multicast traffic may flow to the neighbor even though the neighbor does not expect the prune to have expired.

Even in cases where modification of the **ip dvmrp prune-lifetime** setting does not cause the received prunes to expire earlier than specified by their internal prune-lifetime value, such modification will still cause the prune-lifetime value of received prunes to be adjusted to the new value. This means that received prunes may expire sooner or later than the neighbor expects.

Once the lifetime value of received prunes on the router’s timer queue have been modified per the new setting of **ip dvmrp prune-lifetime**, all future incoming prunes will experience normal timer operation and the prune-lifetime value in the received prune packet will be used without modification. Outgoing prunes will use the new value of **ip dvmrp prune-lifetime**.

For the reasons explained, the value of **ip dvmrp prune-lifetime** should only be modified with caution.

Grafting

A pruned branch will be automatically reattached to the multicast delivery tree when the prune times out. However, the graft mechanism provides a quicker method to reattach a pruned branch than waiting for the prune to time out. As traffic is forwarded, routers that do not want multicast traffic send Prune messages to signal the upstream router to stop sending the traffic. If new IGMP membership requests are later received by the downstream router, the router can send Graft messages to the upstream router and wait for acknowledgment (a Graft Ack).

The **ip dvmrp route-timeout** command enables you to set the Graft message retransmission value. This value defines the duration of time that the router will wait before retransmitting a Graft message if it has not received a Graft-Ack message acknowledging that a previously transmitted Graft message was received. For example, enter the following to set the Graft message retransmission value to 5 seconds:

```
-> ip dvmrp graft-timeout 5
```

Note. Current global DVMRP parameter values, including the **ip dvmrp graft-timeout** value, can be viewed via the **show ip dvmrp** command.

Tunnels

DVMRP networks may use DVMRP tunnels to interconnect two multicast-enabled networks across non-multicast networks. In a DVMRP tunnel, IP multicast packets are encapsulated in unicast IP packets so that the multicast traffic can traverse through a non-multicast network.

The **ip dvmrp tunnel** command enables you to add or delete a DVMRP tunnel between a specified local and remote address. Any packet sent through the tunnel will be encapsulated in an outer IP header. For example, the following command would create a tunnel between local address 172.22.2.115 and remote address 172.22.2.120:

```
-> ip dvmrp tunnel 172.22.2.115 172.22.2.120
```

The local tunnel address must match an existing IP interface on a router that has been configured for DVMRP. The tunnel's remote IP address must be the IP address of the remote DVMRP router to which the tunnel is connected.

You can also use interface names of the local and remote routers instead of their IP addressees. For example:

```
-> ip dvmrp tunnel vlan-2 vlan-10
```

The interface name for the local tunnel must match an existing interface name on a router that has been configured for DVMRP. The tunnel's remote interface name must be the name of the remote DVMRP router to which the tunnel is connected.

Important. The tunnel will be operational only when the DVMRP interface is also operational. To enable DVMRP on an interface, use the **ip dvmrp interface** command. For more information, refer to "Enabling DVMRP on a Specific Interface" on page 2-15.

The **ip dvmrp tunnel ttl** command sets the tunnel's Time-To-Live (TTL) value. For example:

```
-> ip dvmrp tunnel 172.22.2.115 172.22.2.120 ttl 255
```

You can also use interface names of the local and remote routers instead of their IP addressees. For example:

```
-> ip dvmrp tunnel vlan-2 vlan-10 ttl 255
```

Note. Current DVMRP tunnels, including the tunnels' operational (OPER) status and TTL values, can be viewed via the **show ip dvmrp tunnel** command. The status of the DVMRP interface can be viewed via the **show ip dvmrp interface** command.

Verifying the DVMRP Configuration

A summary of the show commands used for verifying the DVMRP configuration is given here:

show ip dvmrp	Displays global DVMRP parameters such as admin status, flash interval value, graft timeout value, neighbor interval value, subordinate neighbor status, number of routes, number of routes reachable, etc.
show ip dvmrp interface	Displays the DVMRP interface table, which lists all multicast-capable interfaces.
show ip dvmrp neighbor	Displays the DVMRP neighbor table, which lists adjacent DVMRP routers.
show ip dvmrp nexthop	Displays the DVMRP next hop entries table. The next hop entries table lists which VLANs will receive traffic forwarded from a designated multicast source. The table also lists whether a VLAN is considered a DVMRP branch or leaf for the multicast traffic (i.e., its *hop type*).
show ip dvmrp prune	Displays the prune table. Each entry in the prune table lists a pruned branch of the multicast delivery tree and includes the time interval remaining before the current prune state expires.
show ip dvmrp route	Displays the DVMRP routes that are being advertised to other routers in Route Report messages.
show ip dvmrp tunnel	Displays DVMRP tunnels. This command lists DVMRP tunnel interfaces, including both active and inactive tunnels.

For more information about the displays that result from these commands, see the *OmniSwitch CLI Reference Guide*.

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G. Random.c

PR 30872 B Kesner created May 5 2000
PR 30872 B Kesner June 16 2000 moved batch_entropy_process to own task iWhirlpool to make code more efficient

random.c -- A strong random number generator

Version 1.89, last modified 19-Sep-99

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