

HP 5120 EI Switch Series

Layer 3 - IP Routing

Configuration Guide

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IP routing basics

Overview

IP routing directs the forwarding of IP packets on routers based on a routing table. This book focuses on unicast routing protocols. For more information about multicast routing protocols, see *IP Multicast Configuration Guide*.

The term "router" in this chapter refers to both routers and Layer 3 switches.

The types of interfaces that appear in any figures other than the network diagrams for configuration examples are for illustration only. Some of them might be unavailable on your switch.

Routing table

A router maintains at least two routing tables: one global routing table and one forwarding information base (FIB). The FIB table contains only the optimal routes, and the global routing table contains all routes. The router uses the FIB table to forward packets. For more information about the FIB table, see *Layer 3—IP Services Configuration Guide*.

Routes can be classified by different criteria, as shown in [Table 1](#).

Table 1 Categories of routes

Criterion	Categories
Destination	<ul style="list-style-type: none">• Network route—Destination is a network. The subnet mask is less than 32 bits.• Host route—Destination is a host. The subnet mask is 32 bits.
Whether the destination is directly connected	<ul style="list-style-type: none">• Direct route—Destination is directly connected.• Indirect route—Destination is indirectly connected.
Origin	<ul style="list-style-type: none">• Direct route—A direct route is discovered by the data link protocol on an interface, and is also called an "interface route."• Static route—A static route is manually configured by an administrator.• Dynamic route—A dynamic route is dynamically discovered by a routing protocol.

Static routes are easy to configure and require less system resources. They work well in small and stable networks. In networks where topology changes may occur frequently, using a dynamic routing protocol is better.

To display brief information about a routing table, use the **display ip routing-table** command:

```
<Sysname> display ip routing-table
```

```
Routing Tables: Public
```

```
Destinations : 7          Routes : 7
```

Destination/Mask	Proto	Pre	Cost	NextHop	Interface
1.1.1.0/24	Direct	0	0	1.1.1.1	Vlan11
2.2.2.0/24	Static	60	0	12.2.2.2	Vlan12

...

A route entry includes the following key items:

- **Destination**—IP address of the destination host or network.
- **Mask**—Mask length of the IP address.
- **Pre**—Preference of the route. Among routes to the same destination, the one with the highest preference is optimal.
- **Cost**—If multiple routes to a destination have the same preference, the one with the smallest cost is the optimal route.
- **NextHop**—Next hop.
- **Interface**—Output interface.

Routing preference

Different routing protocols can find different routes to the same destination. However, not all of those routes are optimal. For route selection, direct routes, and static routes are assigned different preferences. The route with the highest preference is preferred.

The preference of a direct route is always 0 and cannot be changed. You can manually configure preferences for any other route type. Each static route can be configured with a different preference. The following table lists the types of routes and the default preferences. The smaller the preference value, the higher the preference.

Table 2 Route types and their default route preferences

Routing approach	Preference
Direct route	0
Static route	60

Route backup

Route backup can improve network availability. Among multiple routes to the same destination, the route with the highest preference is the main route and all others are backup routes.

The router forwards matching packets through the main route. When the main route fails, the route with the highest preference among the backup routes is selected to forward packets. When the main route recovers, the router uses it to forward packets.

Displaying and maintaining a routing table

Task	Command	Remarks
Display information about the routing table.	<code>display ip routing-table [verbose] [{ begin exclude include } regular-expression]</code>	Available in any view

Task	Command	Remarks
Display information about routes to the specified destination.	display ip routing-table <i>ip-address</i> [<i>mask</i> <i>mask-length</i>] [longer-match] [verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display information about routes with destination addresses in the specified range.	display ip routing-table <i>ip-address1</i> { <i>mask</i> <i>mask-length</i> } <i>ip-address2</i> { <i>mask</i> <i>mask-length</i> } [verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display routes of a routing protocol.	display ip routing-table protocol <i>protocol</i> [inactive verbose] [{ begin exclude include } <i>regular-expression</i>] [{ begin exclude include } <i>regular-expression</i>] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display statistics about the routing table.	display ip routing-table statistics [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Clear statistics for the routing table.	reset ip routing-table statistics protocol { <i>protocol</i> all }	Available in user view
Display IPv6 routing table information.	display ipv6 routing-table [verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display routing information for a specified destination IPv6 address.	display ipv6 routing-table <i>ipv6-address</i> <i>prefix-length</i> [longer-match] [verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display IPv6 routing information for an IPv6 address range.	display ipv6 routing-table <i>ipv6-address1</i> <i>prefix-length1</i> <i>ipv6-address2</i> <i>prefix-length2</i> [verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display IPv6 routing information of a routing protocol.	display ipv6 routing-table protocol <i>protocol</i> [inactive verbose] [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Display IPv6 routing statistics.	display ipv6 routing-table statistics [{ begin exclude include } <i>regular-expression</i>]	Available in any view
Clear specified IPv6 routing statistics.	reset ipv6 routing-table statistics protocol { <i>protocol</i> all }	Available in user view

Configuring static routing

Introduction

Static route

Static routes are manually configured. If a network's topology is simple, you only need to configure static routes for the network to work properly. The proper configuration and usage of static routes can improve network performance and ensure bandwidth for important network applications.

Static routes cannot adapt to network topology changes. If a fault or a topological change occurs in the network, the relevant routes will be unreachable and the network breaks. When this happens, the network administrator must modify the static routes manually.

The term "router" in this chapter refers to both routers and Layer 3 switches.

Default route

Without a default route, a packet that does not match any routing entries is discarded.

A default route is used to forward packets that do not match any routing entry.

The network administrator can configure a default route with both the destination and mask being 0.0.0.0. The router forwards any packet whose destination address fails to match any entry in the routing table to the next hop of the default static route.

Static route configuration items

Before you configure a static route, you must know the following concepts:

- Destination address and mask

In the **ip route-static** command, an IPv4 address is in dotted decimal notation. A mask can be either in dotted decimal format or in the form of mask length—the number of consecutive 1s in the mask.

- Output interface and next hop address

When you configure a static route, specify either the output interface, next hop address, or both depending on the specific occasion. The next hop address cannot be a local interface IP address; otherwise, the route configuration will not take effect.

Each route lookup operation has to find the next hop to resolve the destination link layer address.

Follow these guidelines when you specify the output interface:

- If the output interface is a Null 0 interface, no next hop address is required.
 - If you specify a broadcast interface (such as a VLAN interface) as the output interface, you must specify the corresponding next hop for the output interface.
- Other attributes

You can configure different priorities for different static routes so that route management policies can be more flexible. For example, specifying different priorities for these routes enables route backup.

Configuring a static route

Before you configure a static route, complete the following tasks:

- Configure the physical parameters for related interfaces.
- Configure the link-layer attributes for related interfaces.
- Configure the IP addresses for related interfaces.

Follow these guidelines when you configure a static route:

- The next hop address cannot be the IP address of a local interface (such as VLAN interface). Otherwise, the static route does not take effect.
- If you do not specify the preference when you configure a static route, the default preference applies. Reconfiguring the default preference applies only to newly created static routes.
- If the destination IP address and mask are both configured as 0.0.0.0 with the **ip route-static** command, then the route is the default route.
- For more information about track, see *High Availability Configuration Guide*.

To configure a static route:

Step	Command	Remarks
1. Enter system view.	system-view	N/A
2. Configure a static route.	ip route-static dest-address { mask mask-length } { next-hop-address [track track-entry-number] interface-type interface-number [next-hop-address] } [preference preference-value] [permanent] [description description-text]	Required. By default, preference for static routes is 60, and no description information is configured. Do not specify the permanent and track keywords simultaneously. If the output interface is down, the permanent static route is still active.
3. Configure the default preference for static routes.	ip route-static default-preference <i>default-preference-value</i>	Optional. 60 by default.

Displaying and maintaining static routes

Task	Command	Remarks
Display information of static routes.	display ip routing-table protocol static [inactive verbose] [[{ begin exclude include } <i>regular-expression</i>]	Available in any view

Task	Command	Remarks
Delete all the static routes.	delete static-routes all	Available in system view

For more information about the **display ip routing-table protocol static [inactive | verbose] [| { begin | exclude | include } regular-expression]** command, see *Layer 3—IP Routing Command Reference*.

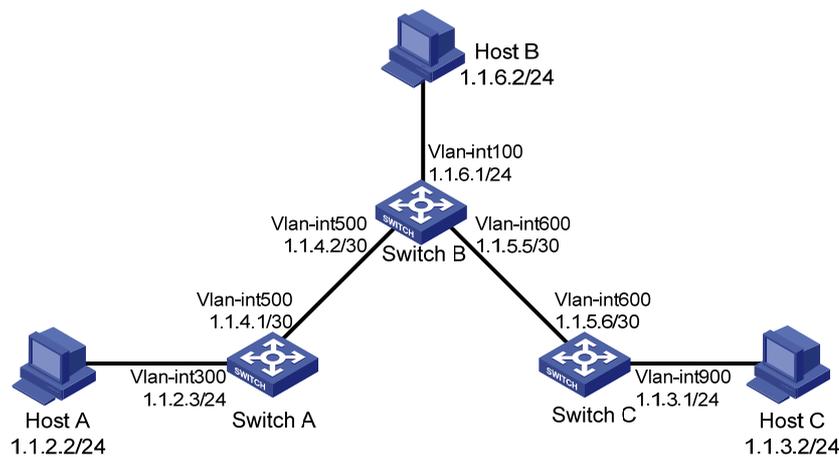
Static route configuration examples

Basic static route configuration example

Network requirements

Configure static routes in [Figure 1](#) for interconnection between any two hosts.

Figure 1 Network diagram



Configuration procedure

1. Configure IP addresses for interfaces. (Details not shown.)
2. Configure static routes:
 - # Configure a default route on Switch A.

```
<SwitchA> system-view
[SwitchA] ip route-static 0.0.0.0 0.0.0.0 1.1.4.2
```

 - # Configure two static routes on Switch B.

```
<SwitchB> system-view
[SwitchB] ip route-static 1.1.2.0 255.255.255.0 1.1.4.1
[SwitchB] ip route-static 1.1.3.0 255.255.255.0 1.1.5.6
```

 - # Configure a default route on Switch C.

```
<SwitchC> system-view
[SwitchC] ip route-static 0.0.0.0 0.0.0.0 1.1.5.5
```
3. Configure the default gateways of hosts A, B, and C as 1.1.2.3, 1.1.6.1, and 1.1.3.1. (Details not shown.)
4. Verify the configuration:

Display the IP routing table on Switch A.

```
[SwitchA] display ip routing-table
Routing Tables: Public
          Destinations : 7          Routes : 7
```

Destination/Mask	Proto	Pre	Cost	NextHop	Interface
0.0.0.0/0	Static	60	0	1.1.4.2	Vlan500
1.1.2.0/24	Direct	0	0	1.1.2.3	Vlan300
1.1.2.3/32	Direct	0	0	127.0.0.1	InLoop0
1.1.4.0/30	Direct	0	0	1.1.4.1	Vlan500
1.1.4.1/32	Direct	0	0	127.0.0.1	InLoop0
127.0.0.0/8	Direct	0	0	127.0.0.1	InLoop0
127.0.0.1/32	Direct	0	0	127.0.0.1	InLoop0

Display the IP routing table on Switch B.

```
[SwitchB] display ip routing-table
Routing Tables: Public
          Destinations : 10         Routes : 10
```

Destination/Mask	Proto	Pre	Cost	NextHop	Interface
1.1.2.0/24	Static	60	0	1.1.4.1	Vlan500
1.1.3.0/24	Static	60	0	1.1.5.6	Vlan600
1.1.4.0/30	Direct	0	0	1.1.4.2	Vlan500
1.1.4.2/32	Direct	0	0	127.0.0.1	InLoop0
1.1.5.0/30	Direct	0	0	1.1.5.5	Vlan600
1.1.5.5/32	Direct	0	0	127.0.0.1	InLoop0
127.0.0.0/8	Direct	0	0	127.0.0.1	InLoop0
127.0.0.1/32	Direct	0	0	127.0.0.1	InLoop0
1.1.6.0/24	Direct	0	0	1.1.6.1	Vlan100
1.1.6.1/32	Direct	0	0	127.0.0.1	InLoop0

Use the **ping** command on Host B to test the reachability of Host A (assuming Windows XP runs on the two hosts).

```
C:\Documents and Settings\Administrator>ping 1.1.2.2
```

```
Pinging 1.1.2.2 with 32 bytes of data:
```

```
Reply from 1.1.2.2: bytes=32 time=1ms TTL=255
```

```
Ping statistics for 1.1.2.2:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 1ms, Average = 1ms
```

Use the **tracert** command on Host B to test the reachability of Host A.

```
C:\Documents and Settings\Administrator>tracert 1.1.2.2
```

Tracing route to 1.1.2.2 over a maximum of 30 hops

1	<1 ms	<1 ms	<1 ms	1.1.6.1
2	<1 ms	<1 ms	<1 ms	1.1.4.1
3	1 ms	<1 ms	<1 ms	1.1.2.2

Trace complete.

Configuring IPv6 static routing

Overview

Static routes are manually configured. They work well in simple networks. Proper configuration and use can improve network performance and ensure enough bandwidth for important applications.

Static routes cannot adapt to network topology changes. If a fault or a topological change occurs in the network, the network administrator has to modify the static routes manually.

The term "router" in this chapter refers to both routers and Layer 3 switches.

IPv6 static routes features

Similar to IPv4 static routes, IPv6 static routes work well in simple IPv6 network environments.

Their major difference lies in the destination and next hop addresses. IPv6 static routes use IPv6 addresses, whereas IPv4 static routes use IPv4 addresses.

Default IPv6 route

An IPv6 static route with a destination prefix of `::/0` is a default IPv6 route. The default route is used to forward packets that match no specific routes in the routing table.

Configuring an IPv6 static route

In small IPv6 networks, IPv6 static routes can be used to forward packets. In comparison to dynamic routes, it helps to save network bandwidth.

Before you configure an IPv6 static route, complete the following tasks:

- Configure parameters for the related interfaces.
- Configure link layer attributes for the related interfaces.
- Enable IPv6 packet forwarding.
- Make sure that the neighboring nodes can reach each other.

To configure an IPv6 static route:

Step	Command	Remarks
1. Enter system view.	system-view	N/A
2. Configure an IPv6 static route.	ipv6 route-static ipv6-address prefix-length { interface-type interface-number [next-hop-address] next-hop-address } [preference preference-value]	Required. The default preference of IPv6 static routes is 60.

NOTE:

If you specify a broadcast interface, such as a VLAN interface, as the output interface for a static route, you must specify the next hop address.

Displaying and maintaining IPv6 static routes

Task	Command	Remarks
Display IPv6 static route information.	<code>display ipv6 routing-table protocol static [inactive verbose] [[{ begin exclude include } regular-expression]</code>	Available in any view
Remove all IPv6 static routes.	<code>delete ipv6 static-routes all</code>	Available in system view

To delete a single IPv6 static route, use the `undo ipv6 route-static` command. To delete all IPv6 static routes, including the default route, use the `delete ipv6 static-routes all` command.

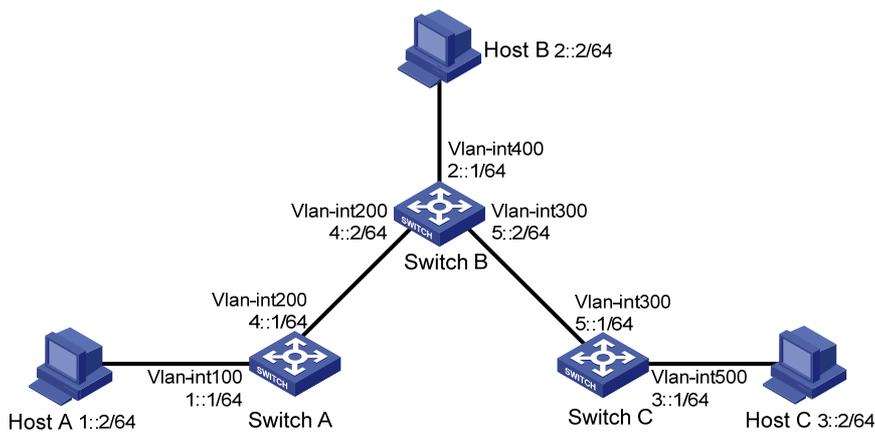
For more information about the `display ipv6 routing-table protocol static [inactive | verbose] [[{ begin | exclude | include } regular-expression]` command, see *Layer 3—IP Routing Command Reference*.

IPv6 static routing configuration example

Network requirements

As shown in [Figure 2](#), configure IPv6 static routes so that hosts can reach one another.

Figure 2 Network diagram



Configuration procedure

1. Configure the IPv6 addresses for all VLAN interfaces. (Details not shown.)
2. Configure IPv6 static routes:

```
# Enable IPv6 and configure a default IPv6 static route on Switch A.
```

```
<SwitchA> system-view  
[SwitchA] ipv6
```

```
[SwitchA] ipv6 route-static :: 0 4::2
```

Enable IPv6 and configure two IPv6 static routes on Switch B.

```
<SwitchB> system-view
```

```
[SwitchB] ipv6
```

```
[SwitchB] ipv6 route-static 1:: 64 4::1
```

```
[SwitchB] ipv6 route-static 3:: 64 5::1
```

Enable IPv6 and configure a default IPv6 static route on Switch C.

```
<SwitchC> system-view
```

```
[SwitchC] ipv6
```

```
[SwitchC] ipv6 route-static :: 0 5::2
```

3. Configure the IPv6 addresses for all the hosts based on the network diagram, configure the default gateway of Host A, Host B, and Host C as 1::1, 2::1, and 3::1.

4. Verify the configuration:

Display the IPv6 routing table on Switch A.

```
[SwitchA] display ipv6 routing-table
```

```
Routing Table :
```

```
Destinations : 5          Routes : 5
```

```
Destination : ::
NextHop     : 4::2
Interface   : Vlan200          Cost      : 0
Protocol    : Static
Preference  : 60
```

```
Destination : ::1/128
NextHop     : ::1
Interface   : InLoop0        Cost      : 0
Protocol    : Direct
Preference  : 0
```

```
Destination : 1::/64
NextHop     : 1::1
Interface   : Vlan100        Cost      : 0
Protocol    : Direct
Preference  : 0
```

```
Destination : 1::1/128
NextHop     : ::1
Interface   : InLoop0        Cost      : 0
Protocol    : Direct
Preference  : 0
```

```
Destination : FE80::/10
NextHop     : ::
Interface   : NULL0          Cost      : 0
Protocol    : Direct
Preference  : 0
```

Verify the connectivity with the **ping** command.

```
[SwitchA] ping ipv6 3::1
```

```
  PING 3::1 : 56 data bytes, press CTRL_C to break
```

```
    Reply from 3::1
```

```
      bytes=56 Sequence=1 hop limit=254  time = 63 ms
```

```
    Reply from 3::1
```

```
      bytes=56 Sequence=2 hop limit=254  time = 62 ms
```

```
    Reply from 3::1
```

```
      bytes=56 Sequence=3 hop limit=254  time = 62 ms
```

```
    Reply from 3::1
```

```
bytes=56 Sequence=4 hop limit=254 time = 63 ms
Reply from 3::1
bytes=56 Sequence=5 hop limit=254 time = 63 ms
```

```
--- 3::1 ping statistics ---
 5 packet(s) transmitted
 5 packet(s) received
 0.00% packet loss
round-trip min/avg/max = 62/62/63 ms
```

Support and other resources

Contacting HP

For worldwide technical support information, see the HP support website:

<http://www.hp.com/support>

Before contacting HP, collect the following information:

- Product model names and numbers
- Technical support registration number (if applicable)
- Product serial numbers
- Error messages
- Operating system type and revision level
- Detailed questions

Subscription service

HP recommends that you register your product at the Subscriber's Choice for Business website:

<http://www.hp.com/go/wwalerts>

After registering, you will receive email notification of product enhancements, new driver versions, firmware updates, and other product resources.

Related information

Documents

To find related documents, browse to the Manuals page of the HP Business Support Center website:

<http://www.hp.com/support/manuals>

- For related documentation, navigate to the Networking section, and select a networking category.
- For a complete list of acronyms and their definitions, see *HP FlexNetwork Technology Acronyms*.

Websites

- HP.com <http://www.hp.com>
- HP Networking <http://www.hp.com/go/networking>
- HP manuals <http://www.hp.com/support/manuals>
- HP download drivers and software <http://www.hp.com/support/downloads>
- HP software depot <http://www.software.hp.com>
- HP Education <http://www.hp.com/learn>

Conventions

This section describes the conventions used in this documentation set.

Command conventions

Convention	Description
Boldface	Bold text represents commands and keywords that you enter literally as shown.
<i>Italic</i>	<i>Italic</i> text represents arguments that you replace with actual values.
[]	Square brackets enclose syntax choices (keywords or arguments) that are optional.
{ x y ... }	Braces enclose a set of required syntax choices separated by vertical bars, from which you select one.
[x y ...]	Square brackets enclose a set of optional syntax choices separated by vertical bars, from which you select one or none.
{ x y ... } *	Asterisk-marked braces enclose a set of required syntax choices separated by vertical bars, from which you select at least one.
[x y ...] *	Asterisk-marked square brackets enclose optional syntax choices separated by vertical bars, from which you select one choice, multiple choices, or none.
&<1-n>	The argument or keyword and argument combination before the ampersand (&) sign can be entered 1 to n times.
#	A line that starts with a pound (#) sign is comments.

GUI conventions

Convention	Description
Boldface	Window names, button names, field names, and menu items are in bold text. For example, the New User window appears; click OK .
>	Multi-level menus are separated by angle brackets. For example, File > Create > Folder .

Symbols

Convention	Description
 WARNING	An alert that calls attention to important information that if not understood or followed can result in personal injury.
 CAUTION	An alert that calls attention to important information that if not understood or followed can result in data loss, data corruption, or damage to hardware or software.
 IMPORTANT	An alert that calls attention to essential information.
NOTE	An alert that contains additional or supplementary information.
 TIP	An alert that provides helpful information.

Network topology icons

	Represents a generic network device, such as a router, switch, or firewall.
	Represents a routing-capable device, such as a router or Layer 3 switch.
	Represents a generic switch, such as a Layer 2 or Layer 3 switch, or a router that supports Layer 2 forwarding and other Layer 2 features.
	Represents an access controller, a unified wired-WLAN module, or the switching engine on a unified wired-WLAN switch.
	Represents an access point.
	Represents a security product, such as a firewall, a UTM, or a load-balancing or security card that is installed in a device.
	Represents a security card, such as a firewall card, a load-balancing card, or a NetStream card.

Port numbering in examples

The port numbers in this document are for illustration only and might be unavailable on your device.

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