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# Configuring basic IP routing

This chapter focuses on unicast routing protocols. For more information about multicast routing protocols, see *IP Multicast Configuration Guide*.

## About IP routing

IP routing directs IP packet forwarding on routers. Based on the destination IP address in the packet, a router looks up a route for the packet in a routing table and forwards the packet to the next hop. Routes are path information used to direct IP packets.

## Routing table

A RIB contains the global routing information and related information, including route recursion, route redistribution, and route extension information. The router selects optimal routes from the routing table and puts them into the FIB table. It uses the FIB table to forward packets. For more information about the FIB table, see *Layer 3—IP Services Configuration Guide*.

## Route categories

[Table 1](#) categorizes routes by different criteria.

**Table 1 Route categories**

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

## Dynamic routing protocols

Static routes work well in small, stable networks. They are easy to configure and require fewer system resources. However, in networks where topology changes occur frequently, a typical practice is to configure a dynamic routing protocol. Compared with static routing, a dynamic routing protocol is complicated to configure, requires more router resources, and consumes more network resources.

Dynamic routing protocols dynamically collect and report reachability information to adapt to topology changes. They are suitable for large networks.

Dynamic routing protocols can be classified by different criteria, as shown in [Table 2](#).

**Table 2 Categories of dynamic routing protocols**

Criterion	Categories
Operation scope	<ul style="list-style-type: none"><li>• <b>IGPs</b>—Work within an AS. Examples include RIP, OSPF, and IS-IS.</li><li>• <b>EGPs</b>—Work between ASs. The most popular EGP is BGP.</li></ul>
Routing algorithm	<ul style="list-style-type: none"><li>• <b>Distance-vector protocols</b>—Examples include RIP and BGP. BGP is also considered a path-vector protocol.</li><li>• <b>Link-state protocols</b>—Examples include OSPF and IS-IS.</li></ul>
Destination address type	<ul style="list-style-type: none"><li>• <b>Unicast routing protocols</b>—Examples include RIP, OSPF, BGP, and IS-IS.</li><li>• <b>Multicast routing protocols</b>—Examples include PIM-SM and PIM-DM.</li></ul>
IP version	<ul style="list-style-type: none"><li>• <b>IPv4 routing protocols</b>—Examples include RIP, OSPF, BGP, and IS-IS.</li><li>• <b>IPv6 routing protocols</b>—Examples include RIPng, OSPFv3, IPv6 BGP, and IPv6 IS-IS.</li></ul>

An AS refers to a group of routers that use the same routing policy and work under the same administration.

## Route preference

Routing protocols, including static and direct routing, each by default have a preference. If they find multiple routes to the same destination, the router selects the route with the highest preference as the optimal route.

The preference of a direct route is always 0 and cannot be changed. You can configure a preference for each static route and each dynamic routing protocol. The following table lists the route types and default preferences. The smaller the value, the higher the preference.

**Table 3 Route types and default route preferences**

Route type	Preference
Direct route	0
Multicast static route	1
OSPF	10
IS-IS	15
Unicast static route	60
RIP	100
OSPF ASE	150
OSPF NSSA	150
IBGP	255
EBGP	255
Unknown (route from an untrusted source)	256

## Load sharing

A routing protocol might find multiple optimal equal-cost routes to the same destination. You can use these routes to implement equal-cost multi-path (ECMP) load sharing.

Static routing, IPv6 static routing, RIP, RIPng, OSPF, OSPFv3, BGP, IPv6 BGP, IS-IS, and IPv6 IS-IS support ECMP load sharing.

## Route backup

Route backup can improve network availability. Among multiple routes to the same destination, the route with the highest priority is the primary route and others are secondary routes.

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

## Route recursion

To use a BGP, static, or RIP route that has an indirectly connected next hop, a router must perform route recursion to find the output interface to reach the next hop.

Link-state routing protocols, such as OSPF and IS-IS, do not need route recursion, because they obtain directly connected next hops through route calculation.

The RIB records and saves route recursion information, including brief information about related routes, recursive paths, and recursion depth.

## Route redistribution

Route redistribution enables routing protocols to learn routing information from each other. A dynamic routing protocol can redistribute routes from other routing protocols, including direct and static routing. For more information, see the respective chapters on those routing protocols in this configuration guide.

The RIB records redistribution relationships of routing protocols.

## Extension attribute redistribution

Extension attribute redistribution enables routing protocols to learn route extension attributes from each other, including BGP extended community attributes, OSPF area IDs, route types, and router IDs.

The RIB records extended attributes of each routing protocol and redistribution relationships of different routing protocol extended attributes.

# Setting the maximum lifetime for routes and labels in the RIB

### About setting the maximum lifetime for routes and labels in the RIB

Perform this task to prevent routes of a certain protocol from being aged out due to slow protocol convergence resulting from a large number of route entries or long GR period.

### Restrictions and guidelines

The configuration takes effect at the next protocol or RIB process switchover.

### Procedure (IPv4)

1. Enter system view.  
`system-view`

2. Enter RIB view.  
`rib`
3. Create the RIB IPv4 address family and enter its view.  
`address-family ipv4`
4. Set the maximum lifetime for IPv4 routes and labels in the RIB.  
`protocol protocol [ instance instance-name ] lifetime seconds`  
By default, the maximum lifetime for routes and labels in the RIB is 480 seconds.

#### Procedure (IPv6)

1. Enter system view.  
`system-view`
2. Enter RIB view.  
`rib`
3. Create the RIB IPv6 address family and enter its view.  
`address-family ipv6`
4. Set the maximum lifetime for IPv6 routes and labels in the RIB.  
`protocol protocol [ instance instance-name ] lifetime seconds`  
By default, the maximum lifetime for routes and labels in the RIB is 480 seconds.

## Setting the maximum lifetime for routes in the FIB

#### About setting the maximum lifetime for routes in the FIB

When GR or NSR is disabled, FIB entries must be retained for some time after a protocol process switchover or RIB process switchover. When GR or NSR is enabled, FIB entries must be removed immediately after a protocol or RIB process switchover to avoid routing issues. Perform this task to meet such requirements.

#### Procedure (IPv4)

1. Enter system view.  
`system-view`
2. Enter RIB view.  
`rib`
3. Create the RIB IPv4 address family and enter its view.  
`address-family ipv4`
4. Set the maximum lifetime for IPv4 routes in the FIB.  
`fib lifetime seconds`  
By default, the maximum lifetime for routes in the FIB is 600 seconds.

#### Procedure (IPv6)

1. Enter system view.  
`system-view`
2. Enter RIB view.  
`rib`
3. Create the RIB IPv6 address family and enter its view.  
`address-family ipv6`
4. Set the maximum lifetime for IPv6 routes in the FIB.

**fib lifetime** *seconds*

By default, the maximum lifetime for routes in the FIB is 600 seconds.

## Enabling the RIB to flush route attribute information to the FIB

1. Enter system view.  
**system-view**
2. Enter RIB view.  
**rib**
3. Create the RIB IPv4 address family and enter its view.  
**address-family ipv4**
4. Enable the RIB to flush route attribute information to the FIB.  
**flush route-attribute** *protocol*

By default, the RIB does not flush route attribute information to the FIB.

## Setting the maximum number of ECMP routes

### Restrictions and guidelines

This configuration takes effect at reboot. Make sure the reboot does not impact your network.

### Procedure

1. Enter system view.  
**system-view**
2. Set the maximum number of ECMP routes.  
**max-ecmp-num** *number*

By default, the maximum number of ECMP routes is 8 on the S6800 switch series and 32 on the S6820, S6860, and S6861 switch series.

## Configuring the ECMP mode

### Restrictions and guidelines for configuring the ECMP mode

This configuration takes effect at reboot. Make sure the reboot does not impact your network.

The task applies to both IPv4 and IPv6 ECMP routes.

## Enabling the enhanced ECMP mode

### About the enhanced ECMP mode

When one or multiple ECMP routes fail, the default ECMP mode enables the device to reallocate all traffic to the remaining routes.

The enhanced ECMP mode enables the device to reallocate only the traffic of the failed routes to the remaining routes, which ensures forwarding continuity.

## Procedure

1. Enter system view.  
`system-view`
2. Enable the enhanced ECMP mode.  
`ecmp mode enhanced`  
By default, the enhanced ECMP mode is disabled.

# Enabling the compressed ECMP mode

## About the compressed ECMP mode

An ECMP route group contains ECMP routes to the same destination. When the hardware resources used by all ECMP route groups on the device reach the upper limit, no more ECMP route groups can be created.

This feature enables the device to compress the hardware resources of all ECMP route groups to save storage space for more ECMP route groups.

## Procedure

1. Enter system view.  
`system-view`
2. Enable the compressed ECMP mode.  
`ecmp mode compressed`  
By default, the compressed ECMP mode is disabled.

# Configuring RIB NSR

## About RIB NSR

When an active/standby switchover occurs, nonstop routing (NSR) backs up routing information from the active process to the standby process to avoid routing flapping and ensure forwarding continuity.

RIB NSR provides faster route convergence than protocol NSR during an active/standby switchover.

## Restrictions and guidelines

Use this feature with protocol GR or NSR to avoid route timeouts and traffic interruption.

## Procedure (IPv4)

1. Enter system view.  
`system-view`
2. Enter RIB view.  
`rib`
3. Create the RIB IPv4 address family and enter its view.  
`address-family ipv4`
4. Enable IPv4 RIB NSR.  
`non-stop-routing`  
By default, RIB NSR is disabled.

## Procedure (IPv6)

1. Enter system view.

- `system-view`
  - 2. Enter RIB view.  
`rib`
  - 3. Create the RIB IPv6 address family and enter its view.  
`address-family ipv6`
  - 4. Enable IPv6 RIB NSR.  
`non-stop-routing`
- By default, RIB NSR is disabled.

# Configuring inter-protocol FRR

## About inter-protocol FRR

Inter-protocol fast reroute (FRR) enables fast rerouting between routes of different protocols. A backup next hop is automatically selected to reduce the service interruption time caused by unreachable next hops. When the next hop of the primary link fails, the traffic is redirected to the backup next hop.

Among the routes to the same destination in the RIB, a router adds the route with the highest preference to the FIB table. For example, if a static route and an OSPF route in the RIB have the same destination, the router adds the OSPF route to the FIB table by default. The next hop of the static route is selected as the backup next hop for the OSPF route. When the next hop of the OSPF route is unreachable, the backup next hop is used.

## Restrictions and guidelines

This feature uses the next hop of a route from a different protocol as the backup next hop, which might cause loops.

### Procedure (IPv4)

- 1. Enter system view.  
`system-view`
  - 2. Enter RIB view.  
`rib`
  - 3. Create the RIB IPv4 address family and enter its view.  
`address-family ipv4`
  - 4. Enable IPv4 RIB inter-protocol FRR.  
`inter-protocol fast-reroute [ vpn-instance vpn-instance-name ]`
- By default, inter-protocol FRR is disabled.  
If you do not specify a VPN instance, inter-protocol FRR is enabled for the public network.

### Procedure (IPv6)

- 1. Enter system view.  
`system-view`
- 2. Enter RIB view.  
`rib`
- 3. Create the RIB IPv6 address family and enter its view.  
`address-family ipv6`
- 4. Enable IPv6 RIB inter-protocol FRR.  
`inter-protocol fast-reroute [ vpn-instance vpn-instance-name ]`

By default, inter-protocol FRR is disabled.

If you do not specify a VPN instance, inter-protocol FRR is enabled for the public network.

# Enabling route fast switchover

## About enabling route fast switchover

This feature applies to a device that provides the same physical output interface for large numbers of routes, including ECMP routes and primary/secondary routes. When a link failure occurs on the interface, the device must perform the following tasks before switching the traffic to another route:

1. Deletes all ARP or ND entries for the link.
2. Instructs the FIB to delete the associated FIB entries.

This procedure is time consuming and interrupts traffic for a long time. To resolve this problem, you can enable route fast switchover. This feature allows the device to instruct the FIB to delete the invalid FIB entries for route switchover first.

### Procedure (IPv4)

1. Enter system view.  
`system-view`
2. Enable IPv4 route fast switchover.  
`ip route fast-switchover enable`  
By default, IPv4 route fast switchover is disabled.

### Procedure (IPv6)

1. Enter system view.  
`system-view`
2. Enable IPv6 route fast switchover.  
`ipv6 route fast-switchover enable`  
By default, IPv6 route fast switchover is disabled.

# Enabling support for IPv6 routes with prefixes longer than 64 bits

## Restrictions and guidelines

This feature takes effect after a device reboot. Make sure the reboot does not impact your network.

### Procedure

1. Enter system view.  
`system-view`
2. Enable or disable support for IPv6 routes with prefixes longer than 64 bits.  
`hardware-resource routing-mode { ipv6-64 | ipv6-128 }`  
By default, the device does not support IPv6 routes with prefixes longer than 64 bits.

# Configuring routing policy-based recursive lookup

## About routing policy-based recursive lookup

Configure routing policy-based recursive lookup to control route recursion results. For example, when a route changes, the routing protocol has to perform a route recursion if the next hop is indirectly connected. The routing protocol might select an incorrect path, which can cause traffic loss. To prevent this problem, you can use a routing policy to filter out incorrect routes. The routes that pass the filtering of the routing policy will be used for route recursion.

## Restrictions and guidelines

The **apply** clauses in the specified routing policy cannot take effect.

Make sure a minimum of one related route can match the routing policy for correct traffic forwarding.

## Procedure (IPv4)

1. Enter system view.  
**system-view**
2. Enter RIB view.  
**rib**
3. Create the RIB IPv4 address family and enter its view.  
**address-family ipv4**
4. Configure routing policy-based recursive lookup.  
**protocol protocol nexthop recursive-lookup route-policy route-policy-name**  
By default, routing policy-based recursive lookup is not configured.

## Procedure (IPv6)

1. Enter system view.  
**system-view**
2. Enter RIB view.  
**rib**
3. Create the RIB IPv6 address family and enter its view.  
**address-family ipv6**
4. Configure routing policy-based recursive lookup.  
**protocol protocol nexthop recursive-lookup route-policy route-policy-name**  
By default, routing policy-based recursive lookup is not configured.

# Setting the maximum number of active routes supported by the device

## About setting the maximum number of active routes supported by the device

The feature allows you to set the maximum number of active IPv4/IPv6 routes supported by the device. When the maximum number of active IPv4/IPv6 routes is exceeded, the device still accepts new active routes but generates a system log message. You can take relevant actions based on the message to save system resources.

## Procedure (IPv4)

1. Enter system view.  
**system-view**
2. Enter RIB view.  
**rib**
3. Create the RIB IPv4 address family and enter its view.  
**address-family ipv4**
4. Set the maximum number of active IPv4 routes supported by the device.  
**routing-table limit *number* simply-alert**

By default, the maximum number of active IPv4 routes is not set for the device.

Configuration in RIB IPv4 address family view limits the number of active IPv4 routes for the public network and all VPN instances.

## Procedure (IPv6)

1. Enter system view.  
**system-view**
2. Enter RIB view.  
**rib**
3. Create the RIB IPv6 address family and enter its view.  
**address-family ipv6**
4. Set the maximum number of active IPv6 routes supported by the device.  
**routing-table limit *number* simply-alert**

By default, the maximum number of active IPv6 routes is not set for the device.

Configuration in RIB IPv6 address family view limits the number of active IPv6 routes for the public network and all VPN instances.

# Display and maintenance commands for basic IP routing

Execute **display** commands in any view and **reset** commands in user view.

Task	Command
Display the ECMP mode.	<b>display ecmp mode</b>
Display support for IPv6 routes with prefixes longer than 64 bits.	<b>display hardware-resource routing-mode</b>
Display routing table information.	<b>display ip routing-table [ all-vpn-instance   vpn-instance <i>vpn-instance-name</i> ] [ verbose ]</b> <b>display ip routing-table [ all-routes ]</b>
Display information about routes permitted by an IPv4 basic ACL.	<b>display ip routing-table [ vpn-instance <i>vpn-instance-name</i> ] acl <i>ipv4-acl-number</i> [ verbose ]</b>

Task	Command
Display information about routes to a specific destination address.	<b>display ip routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <i>ip-address</i> [ <i>mask-length</i>   <i>mask</i> ] [ <b>longer-match</b> ] [ <b>verbose</b> ]
Display information about routes to a range of destination addresses.	<b>display ip routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <i>ip-address1</i> to <i>ip-address2</i> [ <b>verbose</b> ]
Display information about routes permitted by an IP prefix list.	<b>display ip routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <b>prefix-list</b> <i>prefix-list-name</i> [ <b>verbose</b> ]
Display information about routes installed by a protocol.	<b>display ip routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <b>protocol</b> <i>protocol</i> [ <b>inactive</b>   <b>verbose</b> ]
Display IPv4 route statistics.	<b>display ip routing-table</b> [ <b>all-routes</b>   <b>all-vpn-instance</b>   vpn-instance <i>vpn-instance-name</i> ] <b>statistics</b>
Display brief IPv4 routing table information.	<b>display ip routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <b>summary</b>
Display route attribute information in the IPv6 RIB.	<b>display ipv6 rib attribute</b> [ <i>attribute-id</i> ]
Display IPv6 RIB GR state information.	<b>display ipv6 rib graceful-restart</b>
Display next hop information in the IPv6 RIB.	<b>display ipv6 rib nib</b> [ <b>self-originated</b> ] [ <i>nib-id</i> ] [ <b>verbose</b> ] <b>display ipv6 rib nib protocol</b> <i>protocol</i> [ <b>verbose</b> ]
Display next hop information for IPv6 direct routes.	<b>display ipv6 route-direct nib</b> [ <i>nib-id</i> ] [ <b>verbose</b> ]
Display IPv6 routing table information.	<b>display ipv6 routing-table</b> [ <b>all-vpn-instance</b>   vpn-instance <i>vpn-instance-name</i> ] [ <b>verbose</b> ] <b>display ipv6 routing-table</b> [ <b>all-routes</b> ]
Display information about routes permitted by an IPv6 basic ACL.	<b>display ipv6 routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <b>acl</b> <i>ipv6-acl-number</i> [ <b>verbose</b> ]
Display information about routes to an IPv6 destination address.	<b>display ipv6 routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <i>ipv6-address</i> [ <i>prefix-length</i> ] [ <b>longer-match</b> ] [ <b>verbose</b> ]
Display information about routes to a range of IPv6 destination addresses.	<b>display ipv6 routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <i>ipv6-address1</i> to <i>ipv6-address2</i> [ <b>verbose</b> ]
Display information about routes permitted by an IPv6 prefix list.	<b>display ipv6 routing-table</b> [ vpn-instance <i>vpn-instance-name</i> ] <b>prefix-list</b> <i>prefix-list-name</i> [ <b>verbose</b> ]

Task	Command
Display information about routes installed by an IPv6 protocol.	<b>display ipv6 routing-table</b> [ <b>vpn-instance</b> <i>vpn-instance-name</i> ] <b>protocol</b> <i>protocol</i> [ <b>inactive</b>   <b>verbose</b> ]
Display IPv6 route statistics.	<b>display ipv6 routing-table</b> [ <b>all-routes</b>   <b>all-vpn-instance</b>   <b>vpn-instance</b> <i>vpn-instance-name</i> ] <b>statistics</b>
Display brief IPv6 routing table information.	<b>display ipv6 routing-table</b> [ <b>vpn-instance</b> <i>vpn-instance-name</i> ] <b>summary</b>
Display the maximum number of IPv4 ECMP routes.	<b>display max-ecmp-num</b>
Display route attribute information in the RIB.	<b>display rib attribute</b> [ <i>attribute-id</i> ]
Display RIB GR state information.	<b>display rib graceful-restart</b>
Display next hop information in the RIB.	<b>display rib nib</b> [ <b>self-originated</b> ] [ <i>nib-id</i> ] [ <b>verbose</b> ] <b>display rib nib protocol</b> <i>protocol</i> [ <b>verbose</b> ]
Display next hop information for direct routes.	<b>display route-direct nib</b> [ <i>nib-id</i> ] [ <b>verbose</b> ]
Clear IPv4 route statistics.	<b>reset ip routing-table statistics protocol</b> [ <b>vpn-instance</b> <i>vpn-instance-name</i> ] { <i>protocol</i>   <b>all</b> } <b>reset ip routing-table</b> [ <b>all-routes</b>   <b>all-vpn-instance</b> ] <b>statistics protocol</b> { <i>protocol</i>   <b>all</b> }
Clear IPv6 route statistics.	<b>reset ipv6 routing-table statistics protocol</b> [ <b>vpn-instance</b> <i>vpn-instance-name</i> ] { <i>protocol</i>   <b>all</b> } <b>reset ipv6 routing-table</b> [ <b>all-routes</b>   <b>all-vpn-instance</b> ] <b>statistics protocol</b> { <i>protocol</i>   <b>all</b> }