



Implementing Static Routes

Static routes are user-defined routes that cause packets moving between a source and a destination to take a specified path. Static routes can be important if the software cannot build a route to a particular destination. They are useful for specifying a gateway of last resort to which all unroutable packets are sent.

This module describes how to implement static routes.

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Prerequisites for Implementing Static Routes

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Restrictions for Implementing Static Routes

These restrictions apply while implementing Static Routes:

- Static routing to an indirect next hop, (any prefix learnt through the RIB and may be more specific over the AIB), that is part of a local subnet requires configuring static routes in the global table indicating the egress interfaces as next hop. To avoid forward drop, configure static routes in the global table indicating the next-hop IP address to be the next hop.
- Generally, a route is learnt from the AIB in the global table and is installed in the FIB. However, this behavior will not be replicated to leaked prefixes. This could lead to inconsistencies in forwarding behavior.

Information About Implementing Static Routes

To implement static routes you need to understand the following concepts:

Static Route Functional Overview

Table 1: Feature History Table

Feature Name	Release Information	Feature Description
Conditional Static Anycast Route Advertisement	Release 25.4.1	Introduced in this release on: Fixed Systems (8700 [ASIC: K100])(select variants only*) *This feature is supported on Cisco 8711-48Z-M routers.
Conditional Static Anycast Route Advertisement	Release 25.1.1	Introduced in this release on: Fixed Systems (8010 [ASIC: A100])(select variants only*) *This feature is supported on Cisco 8011-4G24Y4H-I routers.
Conditional Static Anycast Route Advertisement	Release 24.4.1	Introduced in this release on: Fixed Systems (8200 [ASIC: P100], 8700 [ASIC: P100, K100])(select variants only); Modular Systems (8800 [LC ASIC: P100])(select variants only*) *This feature is supported on: <ul style="list-style-type: none"> • 8212-48FH-M • 8711-32FH-M • 8712-MOD-M • 88-LC1-36EH • 88-LC1-12TH24FH-E • 88-LC1-52Y8H-EM

Conditional Static Anycast Route Advertisement	Release 7.3.15	<p>This feature enables you to detect core isolation and improve network convergence. The conditional installation of static route in routing table (RIB) based on object state functionality has been enhanced to use event driven notification, instead of the polling mechanism used earlier. This event driven approach allows faster detection and notification of object state changes. This feature along with BGP Neighbor address-family tracking, allows users to detect network faults quicker and take corrective action faster.</p> <p>This feature improves network convergence and reduces, and in some cases, eliminates traffic outages in the event of certain network faults, such as either link or node failures or both. Without this new feature, it will take longer to detect network faults and increase the duration of network outage.</p>
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Networking devices forward packets using route information that is either manually configured or dynamically learned using a routing protocol. Static routes are manually configured and define an explicit path between two networking devices. Unlike a dynamic routing protocol, static routes are not automatically updated and must be manually reconfigured if the network topology changes. The benefits of using static routes include security and resource efficiency. Static routes use less bandwidth than dynamic routing protocols, and no CPU cycles are used to calculate and communicate routes. The main disadvantage to using static routes is the lack of automatic reconfiguration if the network topology changes.

Static routes can be redistributed into dynamic routing protocols, but routes generated by dynamic routing protocols cannot be redistributed into the static routing table. No algorithm exists to prevent the configuration of routing loops that use static routes.

Static routes are useful for smaller networks with only one path to an outside network and to provide security for a larger network for certain types of traffic or links to other networks that need more control. In general, most networks use dynamic routing protocols to communicate between networking devices but may have one or two static routes configured for special cases.

Default Administrative Distance

Static routes have a default administrative distance of 1. A low number indicates a preferred route. By default, static routes are preferred to routes learned by routing protocols. Therefore, you can configure an administrative distance with a static route if you want the static route to be overridden by dynamic routes. For example, you could have routes installed by the Open Shortest Path First (OSPF) protocol with an administrative distance of 120. To have a static route that would be overridden by an OSPF dynamic route, specify an administrative distance greater than 120.

Directly Connected Routes

The routing table considers the static routes that point to an interface as “directly connected.” Directly connected networks are advertised by IGP routing protocols if a corresponding **interface** command is contained under the router configuration stanza of that protocol.

In directly attached static routes, only the output interface is specified. The destination is assumed to be directly attached to this interface, so the packet destination is used as the next hop address. The following example

shows how to specify that all destinations with address prefix 2001:0DB8::/32 are directly reachable through interface FourHundredGigE 0/0/0/0:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 FourHundredGigE 0/0/0/0
```

Directly attached static routes are candidates for insertion in the routing table only if they refer to a valid interface; that is, an interface that is both up and has IPv4 or IPv6 enabled on it.

Recursive Static Routes

In a recursive static route, only the next hop is specified. The output interface is derived from the next hop. The following example shows how to specify that all destinations with address prefix 2001:0DB8::/32 are reachable through the host with address 2001:0DB8:3000::1:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 2001:0DB8:3000::1
```

A recursive static route is valid (that is, it is a candidate for insertion in the routing table) only when the specified next hop resolves, either directly or indirectly, to a valid output interface, provided the route does not self-recuse, and the recursion depth does not exceed the maximum IPv6 forwarding recursion depth.

A route self-recurses if it is itself used to resolve its own next hop. If a static route becomes self-recursive, RIB sends a notification to static routes to withdraw the recursive route.

Assuming a BGP route 2001:0DB8:3000::0/16 with next hop of 2001:0DB8::0104, the following static route would not be inserted into the IPv6 RIB because the BGP route next hop resolves through the static route and the static route resolves through the BGP route making it self-recursive:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 001:0DB8::/32 2001:0DB8:3000::1
```

This static route is not inserted into the IPv6 routing table because it is self-recursive. The next hop of the static route, 2001:0DB8:3000:1, resolves through the BGP route 2001:0DB8:3000:0/16, which is itself a recursive route (that is, it only specifies a next hop). The next hop of the BGP route, 2001:0DB8::0104, resolves through the static route. Therefore, the static route would be used to resolve its own next hop.

It is not normally useful to manually configure a self-recursive static route, although it is not prohibited. However, a recursive static route that has been inserted in the routing table may become self-recursive as a result of some transient change in the network learned through a dynamic routing protocol. If this occurs, the fact that the static route has become self-recursive will be detected and it will be removed from the routing table, although not from the configuration. A subsequent network change may cause the static route to no longer be self-recursive, in which case it is re-inserted in the routing table.

Fully Specified Static Routes

In a fully specified static route, both the output interface and next hop are specified. This form of static route is used when the output interface is multiaccess and it is necessary to explicitly identify the next hop. The next hop must be directly attached to the specified output interface. The following example shows a definition of a fully specified static route:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 FourHundredGigE 0/0/0/0
2001:0DB8:3000::1
```

A fully specified route is valid (that is, a candidate for insertion into the routing table) when the specified interface, IPv4 or IPv6, is enabled and up.

Floating Static Routes

Floating static routes are static routes that are used to back up dynamic routes learned through configured routing protocols. A floating static route is configured with a higher administrative distance than the dynamic routing protocol it is backing up. As a result, the dynamic route learned through the routing protocol is always preferred to the floating static route. If the dynamic route learned through the routing protocol is lost, the floating static route is used in its place.



Note By default, static routes have smaller administrative distances than dynamic routes, so static routes are preferred to dynamic routes.

Default VRF

A static route is always associated with a VPN routing and forwarding (VRF) instance. The VRF can be the default VRF or a specified VRF. Specifying a VRF, using the `vrf vrf-name` command, allows you to enter VRF configuration mode for a specific VRF where you can configure a static route. If a VRF is not specified, a default VRF static route is configured.



Note An IPv4 or IPv6 static VRF route is the same as a static route configured for the default VRF. The IPv4 and IPv6 address families are supported in each VRF.

IPv4 and IPv6 Static VRF Routes

An IPv4 or IPv6 static VRF route is the same as a static route configured for the default VRF. The IPv4 and IPv6 address families are supported in each VRF.

Dynamic ECMP

The dynamic ECMP (equal-cost multi-path) for IGP (Interior Gateway Protocol) prefixes feature supports dynamic selection of ECMP paths ranging from 1 to 64 IGP paths. ECMP for non-recursive prefixes is dynamic. This feature enables loadbalancing support in hardware among egress links.

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How to Implement Static Routes

This section contains the following procedures:

Configure Static Route

Static routes are entirely user configurable and can point to a next-hop interface, next-hop IP address, or both. In the software, if an interface was specified, then the static route is installed in the Routing Information Base (RIB) if the interface is reachable. If an interface was not specified, the route is installed if the next-hop address is reachable. The only exception to this configuration is when a static route is configured with the permanent attribute, in which case it is installed in RIB regardless of reachability.



Tip You can programmatically configure and view the operational state of the static route using `openconfig-local-routing.yang` OR `openconfig-network-instance.yang` OpenConfig data models. To get started with using data models, see the .

This task explains how to configure a static route.

Procedure

Step 1 **configure**

Example:

```
RP/0/# configure
Enters mode.
```

Step 2 **router static**

Example:

```
RP/0/RP0/CPU0:router(config)# router static
Enters static route configuration mode.
```

Step 3 **vrf vrf-name**

Example:

```
RP/0/RP0/CPU0:router(config-static)# vrf vrf_A
(Optional) Enters VRF configuration mode.
If a VRF is not specified, the static route is configured under the default VRF.
```

Step 4 **address-family { ipv4 | ipv6 } { unicast | multicast }**

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf)# address family ipv4 unicast
```

Enters address family mode.

Step 5 `prefix mask [vrf vrf-name] { ip-address | interface-type interface-instance } [distance] [description text] [tag tag] [permanent]`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 10.0.0.0/8 172.20.16.6 110
```

Configures an administrative distance of 110.

- This example shows how to route packets for network 10.0.0.0 through to a next hop at 172.20.16.6 if dynamic information with administrative distance less than 110 is not available.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

A default static route is often used in simple router topologies. In the following example, a route is configured with an administrative distance of 110.

```
configure
router static
address-family ipv4 unicast
0.0.0.0/0 2.6.0.1 110
end
```

Configure Floating Static Route

This task explains how to configure a floating static route.

Procedure

Step 1 **configure**

Example:

```
RP/0/# configure
```

Enters mode.

Step 2 **router static**

Example:

```
RP/0/RP0/CPU0:router(config)# router static
```

Enters static route configuration mode.

Step 3 `vrf vrf-name`**Example:**

```
RP/0/RP0/CPU0:router(config-static)# vrf vrf_A
```

(Optional) Enters VRF configuration mode.

If a VRF is not specified, the static route is configured under the default VRF.

Step 4 `address-family { ipv4 | ipv6 } { unicast | multicast }`**Example:**

```
RP/0/RP0/CPU0:router(config-static-vrf)# address family ipv6 unicast
```

Enters address family mode.

Step 5 `prefix mask [vrf vrf-name] { ip-address | interface-type interface-instance } [distance] [description text] [tag tag] [permanent]`**Example:**

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 2001:0DB8::/32 2001:0DB8:3000::1 201
```

Configures an administrative distance of 201.

Step 6 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

A floating static route is often used to provide a backup path if connectivity fails. In the following example, a route is configured with an administrative distance of 201.

```
configure
router static
address-family ipv6 unicast
2001:0DB8::/32 2001:0DB8:3000::1 201
end
```

Configure Static Routes Between PE-CE Routers

This task explains how to configure static routing between PE-CE routers.



Note VRF fallback is not supported with IPv6 VPN Provider Edge (6VPE).

Procedure

Step 1 **configure**

Example:

```
RP/0/# configure
Enters mode.
```

Step 2 **vrf vrf-name**

Example:

```
RP/0/RP0/CPU0:router(config)# router vrf_A
Enters VRF configuration mode.
```

Step 3 **address-family { ipv4 | ipv6 } { unicast | multicast }**

Example:

```
RP/0/RP0/CPU0:router(config-vrf)# address family ipv6 unicast
Enters address family mode.
```

Step 4 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-vrf)# exit
Exits VRF configuration mode.
```

Step 5 **router static**

Example:

```
RP/0/RP0/CPU0:router(config)# router static
Enters static route configuration mode.
```

Step 6 **vrf vrf-name**

Example:

```
RP/0/RP0/CPU0:router(config-static)# vrf vrf_A
```

(Optional) Enters VRF configuration mode.

If a VRF is not specified, the static route is configured under the default VRF.

Step 7 `address-family { ipv4 | ipv6 } { unicast | multicast }`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf)# address family ipv6 unicast
```

Enters address family mode.

Step 8 `prefix mask [vrf vrf-name] { ip-address | interface-type interface- path-id } [distance] [description text] [tag tag] [permanent]`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 2001:0DB8::/32 2001:0DB8:3000::1 201
```

Configures an administrative distance of 201.

Step 9 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

In the following example, a static route between PE and CE routers is configured, and a VRF is associated with the static route:

```
configure
router static
vrf vrf_A
address-family ipv4 unicast
0.0.0.0/0 2.6.0.2 120
end
```

Change Maximum Number of Allowable Static Routes

This task explains how to change the maximum number of allowable static routes.

Before you begin



Note The number of static routes that can be configured on a router for a given address family is limited by default to 4000. The limit can be raised or lowered using the **maximum path** command. Note that if you use the **maximum path** command to reduce the configured maximum allowed number of static routes for a given address family below the number of static routes currently configured, the change is rejected. In addition, understand the following behavior: If you commit a batch of routes that would, when grouped, push the number of static routes configured above the maximum allowed, the first *n* routes in the batch are accepted. The number previously configured is accepted, and the remainder are rejected. The *n* argument is the difference between the maximum number allowed and number previously configured.

Procedure

Step 1 **configure**

Example:

```
RP/0/# configure
```

Enters mode.

Step 2 **router static**

Example:

```
RP/0/(config)# router static
```

Enters static route configuration mode.

Step 3 **maximum path { ipv4 | ipv6 } value**

Example:

```
RP/0/(config-static)# maximum path ipv4 10000
```

Changes the maximum number of allowable static routes.

- Specify IPv4 or IPv6 address prefixes.
- Specify the maximum number of static routes for the given address family. The range is from 1 to 140000.
- This example sets the maximum number of static IPv4 routes to 10000.

Step 4 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.

- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuring a static route to point at interface null 0 may be used for discarding traffic to a particular prefix. For example, if it is required to discard all traffic to prefix 2001:0DB8:42:1/64, the following static route would be defined:

```
configure
router static
address-family ipv6 unicast
2001:0DB8:42:1::/64 null 0
end
```

Associate VRF with a Static Route

This task explains how to associate a VRF with a static route.

Procedure

Step 1 **configure**

Example:

```
RP/0/# configure
Enters mode.
```

Step 2 **router static**

Example:

```
RP/0/
/CPU0:router(config)# router static
Enters static route configuration mode.
```

Step 3 **vrf vrf-name**

Example:

```
RP/0/RP0/CPU0:router(config-static)# vrf vrf_A
Enters VRF configuration mode.
```

Step 4 **address-family { ipv4 | ipv6 } { unicast | multicast }**

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf)# address family ipv6 unicast
Enters address family mode.
```

Step 5 `prefix mask [vrf vrf-name] {next-hop ip-address | interface-name} {path-id} [distance] [description text] [tag tag] [permanent]`

Example:

```
RP/0/RP0/CPU0:router(config-static-vrf-afi)# 2001:0DB8::/32 2001:0DB8:3000::1 201
```

Configures an administrative distance of 201.

Step 6 `interface interface-name`

Example:

```
RP/0/  
/CPU0:router(config)# interface FourHundredGigE 0/5/0/0
```

Enters interface configuration mode.

Note

Ensure that the name of the interface you configured in this step is the same as the VRF name configured in step 5.

Step 7 Use the **commit** or **end** command.

commit —Saves the configuration changes and remains within the configuration session.

end —Prompts user to take one of these actions:

- **Yes** — Saves configuration changes and exits the configuration session.
- **No** —Exits the configuration session without committing the configuration changes.
- **Cancel** —Remains in the configuration session, without committing the configuration changes.

Configuration Examples

This section provides the following configuration examples:

Configure Native UCMP for Static Routing

In a network where traffic is load balanced on two or more links, configuring equal metrics on the links would create Equal Cost Multipath (ECMP) next hops. Because the bandwidth of the links is not taken into consideration while load balancing, the higher bandwidth links are underutilized. To avoid this problem, you can configure Unequal Cost Multipath (UCMP), either locally (local UCMP), or natively (native UCMP) so that the higher bandwidth links carry traffic in proportion to the capacity of the links. UCMP supports IPv4 and IPv6 static VRF routes.

Local UCMP: All static routes are configured with the same link metrics. The static IGP calculates the load metric based on the bandwidth of the links and load balances the traffic across the links. However, local UCMP does not consider bandwidth while load balancing across links that are closer to the destination (multiple hops away).

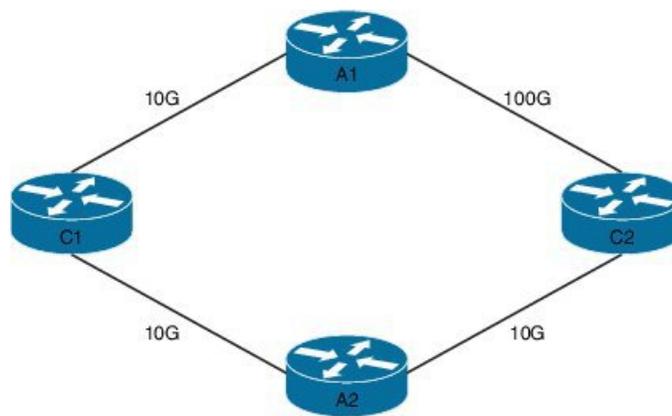
Native UCMP: Static routes over higher bandwidth links are configured with lower link metrics so that they are preferred to routes over lower bandwidth links. The static IGP calculates the load metric based on the

bandwidth of the links and determines the percentage of traffic going out of the higher and lower bandwidth links. By matching the configured link metrics with end-to-end available bandwidth, native UCMP is able to effectively load balance traffic across links that are closer to the destination (multiple hops away).

Configuration Example

Consider the topology in the following figure. For load balancing traffic out of Router A1, if local UCMP is used, then both 10G and 100G links will have equal link metrics. The static IGP decides to send more traffic out of the 100G link because of the higher load metric. However, for load balancing traffic out of Router A2, local UCMP works only on links to Routers C1 and C2. For load balancing traffic from Router C1 to Router A1 and Router C2 to Router A1, native UCMP is preferred. As a result, local UCMP is used only on single hop destinations, and native UCMP is used for multi-hop destinations.

Figure 1: Unequal Cost Multipath for Static Routing



To configure UCMP for static routing, use the following steps:

1. Enter the global configuration mode.

```
RP/0/0/CPU0:Router# configure
```

2. Enter the static routing mode.

```
RP/0/0/CPU0:Router(config)# router static
```

3. Configure UCMP with load metric for IPv4 or IPv6 address family.

```
RP/0/0/CPU0:Router(config-static)# address-family ipv4 unicast
RP/0/0/CPU0:Router(config-static-afi)# 10.10.10.1/32 FourHundredGigE 0/5/0/0 metric 10
```

In this example, we have configured UCMP for IPv4 address family. To configure UCMP for IPv6 address family, use the following sample configuration.

```
RP/0/0/CPU0:Router(config-static)# address-family ipv6 unicast
RP/0/0/CPU0:Router(config-static-afi)# 10:10::1/64 FourHundredGigE0/5/0/0 metric 10
```

4. Exit the static configuration mode and commit your configuration.

```
RP/0/0/CPU0:Router(config-static-afi)# exit
RP/0/0/CPU0:Router(config-static)# exit
RP/0/0/CPU0:Router(config)# commit
Fri Feb 19 06:16:33.164 IST
RP/0/0/CPU0:Feb 19 06:16:34.273 : ipv4_static[1044]:
%ROUTING-IP_STATIC-4-CONFIG_NEXTHOP_ETHER_INTERFACE :
Route for 10.10.10.1 is configured via ethernet interface
```

Repeat this procedure on all routers that need to be configured with UCMR.

Any static route does not have a default route installed. This example provides the static route configuration without the default metric specified.

```
router static
address-family ipv4 unicast
5.0.0.0/8 5.18.0.1
203.0.113.0/24 192.0.2.2
203.0.113.0/24 192.0.2.6 metric 100
```

To achieve the UCMR load balancing, you need to specify the metric value explicitly. This static route configuration example includes the default metric value.

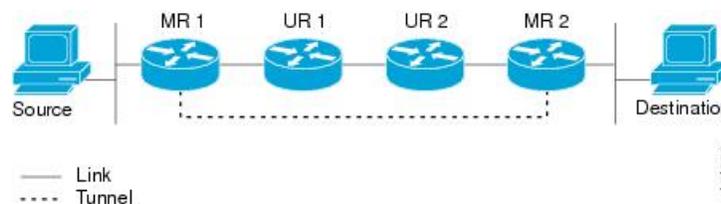
```
router static
address-family ipv4 unicast
5.0.0.0/8 5.18.0.1
203.0.113.0/24 192.0.2.2 metric 1
203.0.113.0/24 192.0.2.6 metric 100
```

IPv4 Multicast Static Routes

IP multicast static routes (mroutes) allow you to have multicast paths diverge from the unicast paths. When using Protocol Independent Multicast (PIM), the router expects to receive packets on the same interface where it sends unicast packets back to the source. This expectation is beneficial if your multicast and unicast topologies are congruent. However, you might want unicast packets to take one path and multicast packets to take another.

The most common reason for using separate unicast and multicast paths is tunneling. When a path between a source and a destination does not support multicast routing, configuring two routers with a GRE tunnel between them is the solution. In the figure below, each unicast router (UR) supports unicast packets only; each multicast router (MR) supports multicast packets.

Figure 2: Tunnel for Multicast Packets



In the figure, the source delivers multicast packets to destination by using MR 1 and MR 2. MR 2 accepts the multicast packet only if it predicts it can reach source over the tunnel. If this situation is true, when the destination sends unicast packets to the source, MR 2 sends them over the tunnel. The check that MR2 can reach the source over the tunnel is a Reverse Path Forwarding (RPF) check, and the static mroute allows the check to be successful when the interface, on which the multicast packet arrives, is not the unicast path back to the source. Sending the packet over the tunnel could be slower than natively sending it through UR 2, UR 1, and MR 1.

A multicast static route allows you to use the configuration in the above figure by configuring a static multicast source. The system uses the configuration information instead of the unicast routing table to route the traffic. Therefore, multicast packets can use the tunnel without having the unicast packets use the tunnel. Static mroutes are local to the router they are configured on and not advertised or redistributed in any way to any other router.

Configure Multicast Static Routes

The following example shows how to configure multiple static routes in IPv4 and IPv6 address family configuration modes:

```

/* Enables a static routing process */
Router(config)# router static

/* Configures the IPv4 address-family for the unicast topology with a destination prefix.
*/
Router(config-static)# address-family ipv4 unicast
Router(config-static-afi)# 10.1.1.0/24 198.51.100.1
Router(config-static-afi)# 223.255.254.254/32 203.0.113.1
Router(config-static-afi)# exit

/* Configures the IPv4 address-family for the multicast topology with a destination prefix.
*/
Router(config-static)# address-family ipv4 multicast
Router(config-static-afi)# 198.51.100.20/32 209.165.201.0
Router(config-static-afi)# 192.0.2.10/32 209.165.201.0
Router(config-static-afi)# exit

/* Enable the address family IPv4 and IPv6 multicast on the next hop interface. */
Router(config)# interface FourHundredGigE 0/0/0/12
Router(config-if)# address-family ipv4 multicast
Router(config-if)# address-family ipv6 multicast

```

Running Configuration

```

router static
  address-family ipv4 unicast
    10.1.1.0/24 198.51.100.1
    223.255.254.254/32 203.0.113.1
  !
  address-family ipv4 multicast
    198.51.100.20/32 209.165.201.0
    192.0.2.10/32 209.165.201.0
  !
  interface FourHundredGigE 0/0/0/12
    address-family ipv4 multicast
    address-family ipv6 multicast

```

Verification

Verify the IPv4 multicast routes.

```
show route ipv4 multicast
```

```

Codes: C - connected, S - static, R - RIP, B - BGP, (>) - Diversion path
O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
i - ISIS, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, su - IS-IS summary null, * - candidate default
U - per-user static route, o - ODR, L - local, G - DAGR, l - LISP
A - access/subscriber, a - Application route
M - mobile route, r - RPL, t - Traffic Engineering, (!) - FRR Backup path

```

Gateway of last resort is 10.1.1.20 to network 0.0.0.0

```

i*L1 0.0.0.0/0 [115/10] via 10.1.1.20, 00:41:12, FourHundredGigE0/0/0/6
C    10.1.1.0/24 is directly connected, 00:41:12, FourHundredGigE0/0/0/0
L    10.1.1.10/32 is directly connected, 00:41:12, FourHundredGigE0/0/0/0
S    172.16.2.10/32 [1/0] via 198.51.100.20, 00:41:12
i L1 172.16.3.1/32 [115/20] via 198.51.100.20, 00:41:12, FourHundredGigE0/0/0/12
i L1 192.0.2.1/24 [115/20] via 198.51.100.20, 00:41:12, FourHundredGigE0/0/0/1

```

Cross-Address Family static routing

Cross-Address Family static routing is a routing feature that

- supports IPv4 static routes with IPv6 next hops, and
- allows IPv4 traffic to travel over an IPv6 network.

Table 2: Feature History Table

Feature Name	Release Information	Feature Description
Cross-Address Family Static Routing	Release 26.1.1	<p>With the introduction of this feature, you can now configure IPv4 prefixes with IPv6 next-hops. The router programs these routes into the routing table once the Routing Information Base (RIB) confirms the next-hop is reachable. This feature allows IPv4 traffic to traverse IPv6-capable infrastructure, providing a scalable solution for network management.</p> <p>This feature introduces these changes:</p> <p>CLI:</p> <ul style="list-style-type: none"> • router static address-family • show static vrf • show static interfaces <p>YANG Data Model:</p> <p>Cisco-IOS-XR-um-router-static-cfg (see GitHub, YANG Data Models Navigator)</p>

Configuration guidelines for Cross-Address Family static routes

These configuration guidelines apply to Cross-Address Family static routes:

- The router can configure the routes within a VRF. If the destination resides in a different routing table, the **show route** command will explicitly list the associated VRF.
- Supports recursive next-hop routes or paths that include both an interface and a next-hop.

Restrictions for Cross-Address Family static routes

These restrictions apply when you configure Cross-Address Family static route:

- IPv6 over IPv4 is not supported: The feature only supports IPv4 static routes over IPv6 next-hop. Attempting to configure an IPv4 next-hop for an IPv6 route results in an "Invalid Address Family" error.
- No BFD: Bidirectional Forwarding Detection (BFD) is not supported for Cross-Address Family next-hops.
- No interface-Only paths: You cannot configure a **v4-over-v6** route using only an interface; an IPv6 next-hop must be specified.

Configure Cross-Address Family static routes

Use this procedure to configure Cross-Address Family static routes. This procedure demonstrates how to configure an IPv4 prefix with an IPv6 next-hop.

Procedure

Step 1 Enter global configuration mode.

Example:

```
Router# configure
```

Step 2 Enter the static router configuration mode.

Example:

```
Router(config)# router static
```

Step 3 Specify the IPv4 Address Family.

Example:

```
Router(config-static)# address-family ipv4 unicast
```

Step 4 Configure the Cross-AFI Route. You can configure this using either a **recursive next-hop** or a **next-hop** via a specific interface.

- Option A: Recursive IPv6 next-hop

Use this option when the IPv6 next-hop is reachable via another route in the routing table.

Example:

```
Router(config-static-afi)# 1.1.0.0/16 1::1::1
```

- Option B: IPv6 next-hop via an interface

Use this option to specify exactly which interface must be used to reach the IPv6 next-hop.

Example:

```
Router(config-static-afi)# 1.1.0.0/16 GigabitEthernet0/0/0/0 1:1:1::1
```

Step 5 Save the configuration.

Example:

```
Router(config-static-afi)# commit
Router(config-static-afi)# exit
Router(config-static)# exit
Router(config)# exit
```

What to do next

Verify the configuration.

Verify the configuration

Use this procedure to ensure the route is correctly programmed and the next-hop is resolved.

Procedure

Step 1 Check the Routing Table (RIB) and verify that the IPv4 prefix is present and shows the IPv6 next-hop.

Example:

```
Router# show route ipv4 unicast 1.1.0.0/16
```

Expected output:

```
S 1.1.0.0/16 [1/0] via 1:1:1::1 ...
```

Step 2 Verify if the static routing process has successfully resolved the IPv6 next-hop. Look for the status **Resolved** next to the IPv6 address.

Example:

```
Router# show static vrf default ipv4 next-hops
```

Step 3 Check interface tracking (if Option B is used). Ensure the interface state is **Up** and tracked for cross-afi traffic.

Example:

```
Router# show static interfaces
```

References for Static Routes

The following topics provide additional conceptual information on static routes:

- [Static Route Functional Overview, on page 2](#)
- [Default Administrative Distance, on page 3](#)

- [Directly Connected Routes](#), on page 3
- [Floating Static Routes](#), on page 5
- [Fully Specified Static Routes](#), on page 4
- [Recursive Static Routes](#), on page 4

Static Route Functional Overview

Table 3: Feature History Table

Feature Name	Release Information	Feature Description
Conditional Static Anycast Route Advertisement	Release 25.4.1	Introduced in this release on: Fixed Systems (8700 [ASIC: K100])(select variants only*) *This feature is supported on Cisco 8711-48Z-M routers.
Conditional Static Anycast Route Advertisement	Release 25.1.1	Introduced in this release on: Fixed Systems (8010 [ASIC: A100])(select variants only*) *This feature is supported on Cisco 8011-4G24Y4H-I routers.
Conditional Static Anycast Route Advertisement	Release 24.4.1	Introduced in this release on: Fixed Systems (8200 [ASIC: P100], 8700 [ASIC: P100, K100])(select variants only); Modular Systems (8800 [LC ASIC: P100])(select variants only*) *This feature is supported on: <ul style="list-style-type: none"> • 8212-48FH-M • 8711-32FH-M • 8712-MOD-M • 88-LC1-36EH • 88-LC1-12TH24FH-E • 88-LC1-52Y8H-EM

Conditional Static Anycast Route Advertisement	Release 7.3.15	<p>This feature enables you to detect core isolation and improve network convergence. The conditional installation of static route in routing table (RIB) based on object state functionality has been enhanced to use event driven notification, instead of the polling mechanism used earlier. This event driven approach allows faster detection and notification of object state changes. This feature along with BGP Neighbor address-family tracking, allows users to detect network faults quicker and take corrective action faster.</p> <p>This feature improves network convergence and reduces, and in some cases, eliminates traffic outages in the event of certain network faults, such as either link or node failures or both. Without this new feature, it will take longer to detect network faults and increase the duration of network outage.</p>
--	----------------	--

Networking devices forward packets using route information that is either manually configured or dynamically learned using a routing protocol. Static routes are manually configured and define an explicit path between two networking devices. Unlike a dynamic routing protocol, static routes are not automatically updated and must be manually reconfigured if the network topology changes. The benefits of using static routes include security and resource efficiency. Static routes use less bandwidth than dynamic routing protocols, and no CPU cycles are used to calculate and communicate routes. The main disadvantage to using static routes is the lack of automatic reconfiguration if the network topology changes.

Static routes can be redistributed into dynamic routing protocols, but routes generated by dynamic routing protocols cannot be redistributed into the static routing table. No algorithm exists to prevent the configuration of routing loops that use static routes.

Static routes are useful for smaller networks with only one path to an outside network and to provide security for a larger network for certain types of traffic or links to other networks that need more control. In general, most networks use dynamic routing protocols to communicate between networking devices but may have one or two static routes configured for special cases.

Default Administrative Distance

Static routes have a default administrative distance of 1. A low number indicates a preferred route. By default, static routes are preferred to routes learned by routing protocols. Therefore, you can configure an administrative distance with a static route if you want the static route to be overridden by dynamic routes. For example, you could have routes installed by the Open Shortest Path First (OSPF) protocol with an administrative distance of 120. To have a static route that would be overridden by an OSPF dynamic route, specify an administrative distance greater than 120.

Directly Connected Routes

The routing table considers the static routes that point to an interface as “directly connected.” Directly connected networks are advertised by IGP routing protocols if a corresponding **interface** command is contained under the router configuration stanza of that protocol.

In directly attached static routes, only the output interface is specified. The destination is assumed to be directly attached to this interface, so the packet destination is used as the next hop address. The following example

shows how to specify that all destinations with address prefix 2001:0DB8::/32 are directly reachable through interface FourHundredGigE 0/0/0/0:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 FourHundredGigE 0/0/0/0
```

Directly attached static routes are candidates for insertion in the routing table only if they refer to a valid interface; that is, an interface that is both up and has IPv4 or IPv6 enabled on it.

Floating Static Routes

Floating static routes are static routes that are used to back up dynamic routes learned through configured routing protocols. A floating static route is configured with a higher administrative distance than the dynamic routing protocol it is backing up. As a result, the dynamic route learned through the routing protocol is always preferred to the floating static route. If the dynamic route learned through the routing protocol is lost, the floating static route is used in its place.



Note By default, static routes have smaller administrative distances than dynamic routes, so static routes are preferred to dynamic routes.

Fully Specified Static Routes

In a fully specified static route, both the output interface and next hop are specified. This form of static route is used when the output interface is multiaccess and it is necessary to explicitly identify the next hop. The next hop must be directly attached to the specified output interface. The following example shows a definition of a fully specified static route:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 FourHundredGigE 0/0/0/0
2001:0DB8:3000::1
```

A fully specified route is valid (that is, a candidate for insertion into the routing table) when the specified interface, IPv4 or IPv6, is enabled and up.

Recursive Static Routes

In a recursive static route, only the next hop is specified. The output interface is derived from the next hop. The following example shows how to specify that all destinations with address prefix 2001:0DB8::/32 are reachable through the host with address 2001:0DB8:3000::1:

```
RP/0/RP0/CPU0:router(config)# router static
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast
RP/0/RP0/CPU0:router(config-static-afi)# 2001:0DB8::/32 2001:0DB8:3000::1
```

A recursive static route is valid (that is, it is a candidate for insertion in the routing table) only when the specified next hop resolves, either directly or indirectly, to a valid output interface, provided the route does not self-recurse, and the recursion depth does not exceed the maximum IPv6 forwarding recursion depth.

A route self-recurses if it is itself used to resolve its own next hop. If a static route becomes self-recursive, RIB sends a notification to static routes to withdraw the recursive route.

Assuming a BGP route 2001:0DB8:3000::0/16 with next hop of 2001:0DB8::0104, the following static route would not be inserted into the IPv6 RIB because the BGP route next hop resolves through the static route and the static route resolves through the BGP route making it self-recursive:

```
RP/0/RP0/CPU0:router(config)# router static  
RP/0/RP0/CPU0:router(config-static)# address-family ipv6 unicast  
RP/0/RP0/CPU0:router(config-static-afi)# 001:0DB8::/32 2001:0DB8:3000::1
```

This static route is not inserted into the IPv6 routing table because it is self-recursive. The next hop of the static route, 2001:0DB8:3000:1, resolves through the BGP route 2001:0DB8:3000:0/16, which is itself a recursive route (that is, it only specifies a next hop). The next hop of the BGP route, 2001:0DB8::0104, resolves through the static route. Therefore, the static route would be used to resolve its own next hop.

It is not normally useful to manually configure a self-recursive static route, although it is not prohibited. However, a recursive static route that has been inserted in the routing table may become self-recursive as a result of some transient change in the network learned through a dynamic routing protocol. If this occurs, the fact that the static route has become self-recursive will be detected and it will be removed from the routing table, although not from the configuration. A subsequent network change may cause the static route to no longer be self-recursive, in which case it is re-inserted in the routing table.

