

Specify a Next Hop IP Address for Static Routes

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Introduction

This document describes the basic concept of static routes. A problem scenario is used in order to demonstrate the circumstances in which it becomes desirable to specify the interface through which the next hop IP address can be reached when you configure a static route. Failure to do so can lead to unwanted behavior and a broken network state.

Background Information

Static routes are used for a variety of reasons and are often used when there is no dynamic route to the destination IP address, or when you want to override the dynamically learned route.

By default, static routes have an [administrative distance](#) of one, which gives them precedence over routes from any dynamic routing protocol. When you increase the administrative distance to a value greater than that of a dynamic routing protocol, the static route can be a safety net in the event that dynamic routing fails. For example, Enhanced Interior Gateway Routing Protocol (EIGRP)-derived routes have a default administrative distance of 90 for internal routes and 170 for external routes. In order to configure a static route that is overridden by an EIGRP route, specify an administrative distance that is greater than 170 for the static route.

This kind of static route with a high administrative distance is called a *floating* static route. It is installed in the routing table only when the dynamically learned route disappears. An example of a floating static route is [ip route 172.31.10.0 255.255.255.0 10.10.10.2 101](#).

Note: An administrative distance of 255 is considered unreachable, and static routes with an administrative distance of 255 are never entered into the routing table.

Static Route to Interface without Next Hop IP Address

If you point a static route to an interface and do not specify the next hop IP address, the route is inserted into the routing table only when the interface is active. This configuration is not recommended because when the static route points to an interface and has no next hop

information, the router considers each of the hosts within the range of the route to be directly connected through that interface. An example of such a static route is [ip route 0.0.0.0 0.0.0.0 Ethernet0](#).

With this type of configuration, a router performs Address Resolution Protocol (ARP) on the Ethernet for every destination that the router finds through the default route because the router considers all of these destinations as directly connected to Ethernet 0. This kind of static route, especially if it is used by many packets to many different destination subnets, can cause high processor utilization and a very large ARP cache (along with memory allocation failures). Therefore, this kind of static route is not recommended.

When you specify the next hop address on a directly connected interface, the router does not perform ARP for each destination address. An example is `ip route 0.0.0.0 0.0.0.0 Ethernet0 192.168.1.1`. You can specify the directly connected next hop address only, but this is not recommended for reasons that are described in this document. You do not need to specify the directly connected next hop address. You can specify the remote next hop address and the interface to which the remote next hop recurses.

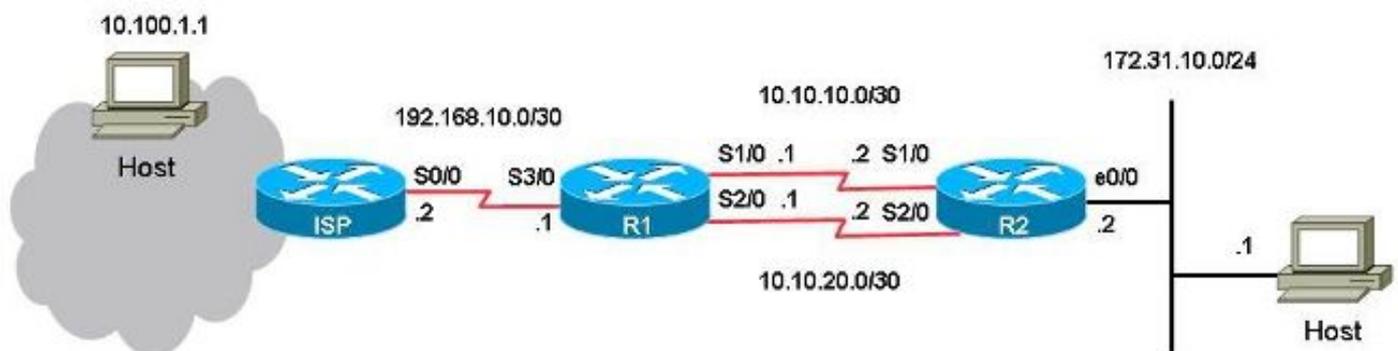
If there is the possibility that the interface with the next hop goes down and the next hop would become reachable through a recursive route, then you should specify both the next hop IP address and the alternate interface through which the next hop should be found. For example, `ip route 10.0.0.1 255.255.255.255 Serial 3/3 192.168.20.1`. The addition of the alternate interface enables the static route installation to become more deterministic.

Floating Static Route Example

This example describes the use of floating static routes and illustrates the need to both specify the outbound interface and the next hop address with the static route command.

Problem

With the network configuration that is illustrated in the next image, one host 172.31.10.1 has connectivity to the Internet. In this example, the host makes a connection to the remote Internet host 10.100.1.1:



With this configuration, the primary link is the link between serial port 1/0 on R1 to serial port 1/0 on R2 for traffic to and from the host 172.31.10.1 to the Internet. The host 10.100.1.1 is used here as an example of an Internet host. The link between serial port 2/0 on R1 to serial port 2/0 on R2 is the backup link. The backup link should only be used if the primary link fails. This is deployed with the use of static routes that point to the primary link and the use of floating static routes that point to the backup link.

There are two static routes to the same destination (172.31.10.0/24) on R1. One route is the regular static route and another route is a floating static route, which is the *backup*, or *redundant* path to the destination network on the LAN. The problem in this scenario is that the floating static route is never installed in the routing table when the primary link is down.

This is the configuration on R1:

```
hostname R1
!
interface Serial1/0
ip address 10.10.10.1 255.255.255.252
!
interface Serial2/0
ip address 10.10.20.1 255.255.255.252
!
ip route 10.0.0.0 255.0.0.0 192.168.10.2

! This is the primary route to get to hosts on the Internet.

ip route 172.31.10.0 255.255.255.0 10.10.10.2

! This is the preferred route to the LAN.

ip route 172.31.10.0 255.255.255.0 10.10.20.2 250

! This is the floating static route to the LAN.
```

This is the configuration on R2:

```
hostname R1
!
interface Serial1/0
ip address 10.10.10.1 255.255.255.252
!
interface Serial2/0
ip address 10.10.20.1 255.255.255.252
!
ip route 10.0.0.0 255.0.0.0 192.168.10.2

! This is the primary route to get to hosts on the Internet.

ip route 172.31.10.0 255.255.255.0 10.10.10.2

! This is the preferred route to the LAN.

ip route 172.31.10.0 255.255.255.0 10.10.20.2 250

! This is the floating static route to the LAN.
```

This is the routing table for R1:

```
R1#show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
```

+ - replicated route, % - next hop override

Gateway of last resort is not set

```
10.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
S    10.0.0.0/8 [1/0] via 192.168.10.2
C    10.10.10.0/30 is directly connected, Serial1/0
L    10.10.10.1/32 is directly connected, Serial1/0
C    10.10.20.0/30 is directly connected, Serial2/0
L    10.10.20.1/32 is directly connected, Serial2/0
172.31.0.0/24 is subnetted, 1 subnets
S    172.31.10.0 [1/0] via 10.10.10.2
192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.10.0/30 is directly connected, Serial3/0
L    192.168.10.1/32 is directly connected, Serial3/0
```

When a ping is performed from the host to the Internet host 10.100.1.1, it functions as expected:

```
host#ping 10.100.1.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.100.1.1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 73/78/80 ms
```

A traceroute from the host to the Internet host 10.100.1.1 shows this:

```
host#traceroute 10.100.1.1
Type escape sequence to abort.
Tracing the route to 10.100.1.1
VRF info: (vrf in name/id, vrf out name/id)
 0 172.31.10.2 1 msec 1 msec 1 msec
 1 10.10.10.1 31 msec 39 msec 39 msec
 2 192.168.10.2 80 msec * 80 msec
```

The primarily link 10.10.10.0/30 is used.

If you shut down serial port 1/0 on R1 in order to test the failover, you should expect R1 to install the floating static route to the local LAN 172.31.10.0, and for R2 to install the floating static route to 0.0.0.0 through 10.10.20.1. You should expect traffic to flow over the backup link.

```
R1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R1(config)#interface serial1/0
R1(config-if)#shutdown
R1(config-if)#end
R1#
```

However, the static route for the LAN 172.31.10.0/24 remains in the routing table for R1:

```
R1#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, 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
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override
```

Gateway of last resort is not set

```
10.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
S    10.0.0.0/8 [1/0] via 192.168.10.2
C    10.10.20.0/30 is directly connected, Serial2/0
L    10.10.20.1/32 is directly connected, Serial2/0
    172.31.0.0/24 is subnetted, 1 subnets
S    172.31.10.0 [1/0] via 10.10.10.2
    192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.10.0/30 is directly connected, Serial3/0
L    192.168.10.1/32 is directly connected, Serial3/0
```

R1#show ip route 172.31.10.0

```
Routing entry for 172.31.10.0/24
Known via "static", distance 1, metric 0
Routing Descriptor Blocks:
* 10.10.10.2
  Route metric is 0, traffic share count is 1
```

R1#show ip route 10.10.10.2

```
Routing entry for 10.0.0.0/8
Known via "static", distance 1, metric 0
Routing Descriptor Blocks:
* 192.168.10.2
  Route metric is 0, traffic share count is 1
```

The ping and traceroute from the host no longer work:

host#ping 10.100.1.1

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.100.1.1, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)
```

host#traceroute 10.100.1.1

```
Type escape sequence to abort.
Tracing the route to 10.100.1.1
VRF info: (vrf in name/id, vrf out name/id)
 0 172.31.10.2 1 msec 1 msec 1 msec
 1 * * *
 2 * * *
 3 * * *
 4 * * *
 5 * * *
 6 * * *
 7 * * *
 8 * * *
 9 * * *
10 * * *
11 * * *
```

...

The floating static route is not installed on R1 and the primary static route is still in the routing table for R1, even though the serial port 1/0 link is shut down. This occurs because static routes are recursive in nature. You always keep the static route in the routing table as long as you have a route to the next hop.

In this problem scenario, you might expect that since the primary link is down, you should have the floating static route with administrative distance 250 installed in the routing table on R1. However, the floating static route is not installed in the routing table since the regular static route remains in the routing table. The next hop address 10.10.10.2 is successfully recursed to (to 192.168.10.2) through the static route 10.0.0.0/8, which is present in the routing table.

Solution

Configure a static route on R1 where the next hop cannot be recursive to another static route. Cisco recommends that you configure both the outbound interface and the next hop address for a static route. In the case of a serial interface, the specification of the outbound interface is sufficient because a serial interface is a point-to-point interface. If the outbound interface is an Ethernet interface, then you must configure both the outbound interface and the next hop address.

Here, a static route for the LAN is configured with the specification of the outbound interface:

```
R1#conf t
```

```
Enter configuration commands, one per line. End with CNTL/Z.
```

```
R1(config)#no ip route 172.31.10.0 255.255.255.0 10.10.10.2
```

```
R1(config)#ip route 172.31.10.0 255.255.255.0 Serial1/0
```

```
R1(config)#end
```

```
R1#show ip route
```

```
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
```

```
D - EIGRP, EX - EIGRP external, 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
```

```
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
```

```
ia - IS-IS inter area, * - candidate default, U - per-user static route
```

```
o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
```

```
a - application route
```

```
+ - replicated route, % - next hop override
```

```
Gateway of last resort is not set
```

```
10.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
```

```
S 10.0.0.0/8 [1/0] via 192.168.10.2
```

```
C 10.10.20.0/30 is directly connected, Serial2/0
```

```
L 10.10.20.1/32 is directly connected, Serial2/0
```

```
172.31.0.0/24 is subnetted, 1 subnets
```

```
S 172.31.10.0 [250/0] via 10.10.20.2
```

```
192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
```

```
C 192.168.10.0/30 is directly connected, Serial3/0
```

```
L 192.168.10.1/32 is directly connected, Serial3/0
```

The ping and traceroute from the host to the Internet host now work and the backup link is used:

```
R1#show ip route 172.31.10.0
```

```
Routing entry for 172.31.10.0/24
```

```
Known via "static", distance 250, metric 0 (connected)
```

```
Routing Descriptor Blocks:
```

```
* 10.10.20.2
```

```
Route metric is 0, traffic share count is 1
```

```
host#ping 10.100.1.1
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.100.1.1, timeout is 2 seconds:
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 76/79/80 ms
```

```
host#traceroute 10.100.1.1
```

```
Type escape sequence to abort.
```

```
Tracing the route to 10.100.1.1
```

```
VRF info: (vrf in name/id, vrf out name/id)
```

```
1 172.31.10.2 1 msec 1 msec 1 msec
```

```
2 10.10.20.1 38 msec 39 msec 40 msec
3 192.168.10.2 80 msec * 80 msec
```

Conclusion

Cisco highly recommends that you specify the outbound interface and the next hop IP address when you configure static routes. When the outbound interface is a point-to-point type of link (for example, a serial link), the specification of the next hop address is not needed.