Configure Policy-based Routing with Next-Hop Commands

Contents

Introduction

This document describes how to use the **set ip default next-hop** and **set ip next-hop** commands to configure policy-based routing (PBR).

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

The information in this document is based on software that supports policy-based routing.

You can use the Cisco Feature Navigator to determine which hardware and software is supported for this configuration.

Note: Only registered Cisco users can access internal tools and information.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to Cisco Technical Tips Conventions.

Background Information

This document provides a sample configuration for policy-based routing (PBR) with the **set ip default next-hop** and **set ip next-hop** commands.

The **set ip default next-hop** command verifies the existence of the destination IP address in the routing table, and:

- if the destination IP address exists, the command does not policy route the packet, but forwards the packet based on the routing table.
- if the destination IP address does not exist, the command policy routes the packet and sends it to the specified next hop.

The **set ip next-hop** command verifies the existence of the next hop specified, and:

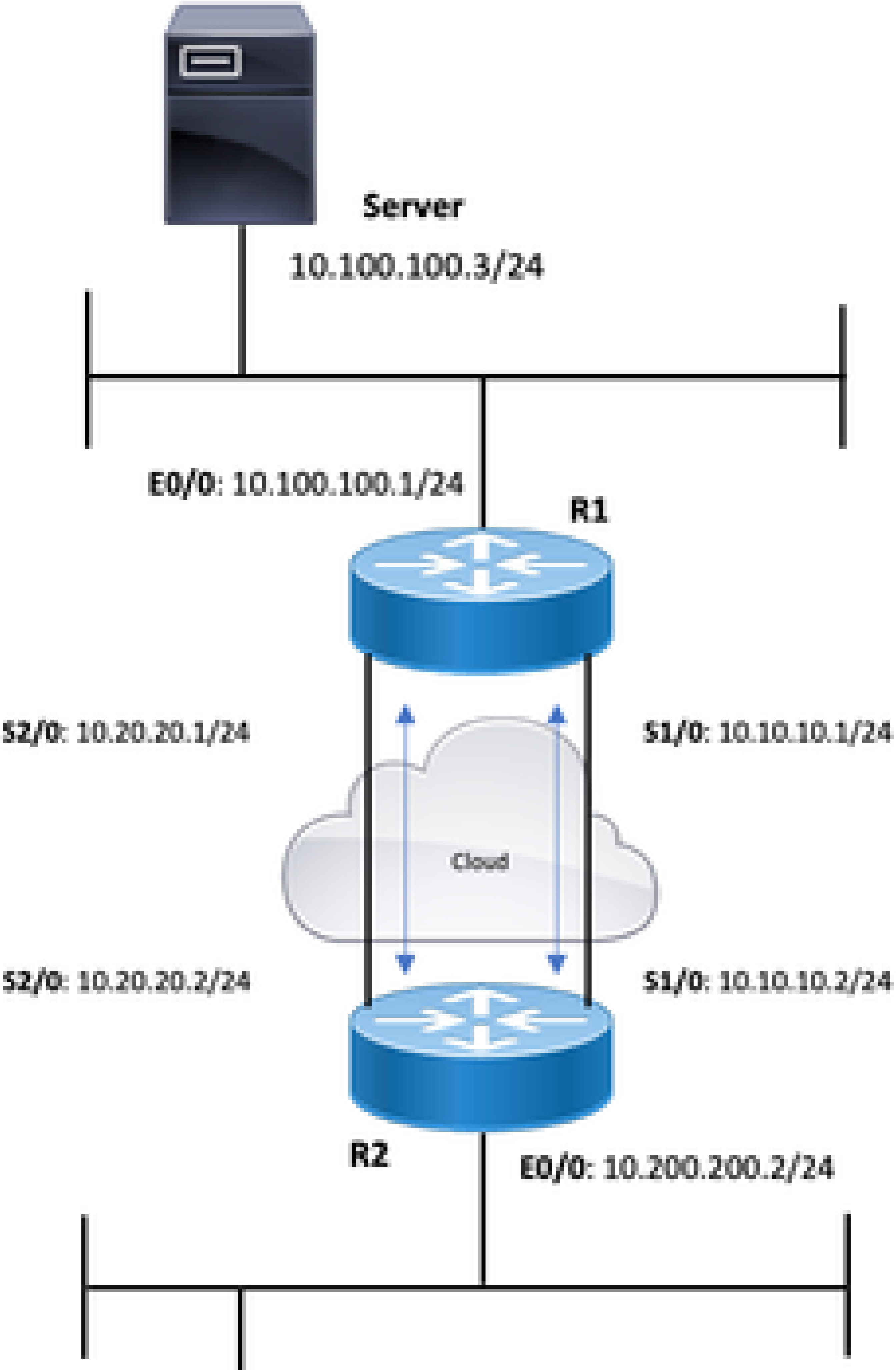
- if the next hop exists in the routing table, then the command policy routes the packet to the next hop.
- if the next hop does not exist in the routing table, the command uses the normal routing table to forward the packet.

Configure

This section provides the information to configure the features described in this document.

Network Diagram

This document uses this network setup:


Server
10.100.100.3/24
E0/0: 10.100.100.1/24
R1
S2/0: 10.20.20.1/24
S1/0: 10.10.10.1/24
Cloud
S2/0: 10.20.20.2/24
S1/0: 10.10.10.2/24
R2
E0/0: 10.200.200.2/24

```
R1#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.100.100.1 255.255.255.0
 ip policy route-map blah
!
interface Serial1/0
 ip address 10.10.10.1 255.255.255.0
!
interface Serial2/0
 ip address 10.20.20.1 255.255.255.0
!
router ospf 1

!--- OSPF is not configured on Serial1/0.

 log-adjacency-changes
 network 10.20.20.0 0.0.0.255 area 0
 network 10.100.100.0 0.0.0.255 area 0
!
ip classless
no ip http server
!
access-list 100 permit ip host 10.100.100.3 host 10.200.200.4
!
route-map blah permit 10
 match ip address 100
 set ip default next-hop 10.10.10.2
!
end
```

R2

```
R2#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.200.200.2 255.255.255.0
 ip policy route-map blah
!
interface Serial1/0
 ip address 10.10.10.2 255.255.255.0
 fair-queue
!
interface Serial2/0
 ip address 10.20.20.2 255.255.255.0
!
router ospf 1

!--- OSPF is not configured on Serial1/0.

 log-adjacency-changes
 network 10.20.20.0 0.0.0.255 area 0
 network 10.200.200.0 0.0.0.255 area 0
!
ip classless
```

```
no ip http server
!
access-list 100 permit ip host 10.200.200.4 host 10.100.100.3
!
route-map blah permit 10
 match ip address 100
 set ip default next-hop 10.10.10.1
!
end
```

Verify Case Study 1

With the use of command **set ip default next-hop**, when the destination route exists in the routing table, normal forwarding is used — do not policy route the packet.

<#root>

```
R1#show ip route 10.200.200.4
   Routing entry for 10.200.200.0/24
   Known via "ospf 1", distance 110, metric 74, type intra area
   Last update from 10.20.20.2 on Serial2/0, 00:11:48 ago
   Routing Descriptor Blocks:
   * 10.20.20.2, from 10.30.30.3, 00:11:48 ago, via Serial2/0
   Route metric is 74, traffic share count is 1

R1#debug ip policy
  Policy routing debugging is on
*Dec 4 12:50:57.363: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 4 12:50:57.363: IP: route map blah, item 10, permit
*Dec 4 12:50:57.363: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 4 12:50:57.431: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 4 12:50:57.431: IP: route map blah, item 10, permit
*Dec 4 12:50:57.431: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 4 12:50:57.491: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 4 12:50:57.491: IP: route map blah, item 10, permit
```

```
*Dec 4 12:50:57.491: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding

R2#

show ip route 10.100.100.3

  Routing entry for 10.100.100.0/24
  Known via "ospf 1", distance 110, metric 74, type intra area
  Last update from 10.20.20.1 on Serial2/0, 00:11:42 ago
  Routing Descriptor Blocks:
  * 10.20.20.1, from 10.100.100.1, 00:11:42 ago, via Serial2/0
      Route metric is 74, traffic share count is 1

R2#

debug ip policy


  Policy routing debugging is on
*Dec 4 12:50:57.779: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec 4 12:50:57.779: IP: route map blah, item 10, permit
*Dec 4 12:50:57.779: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 4 12:50:57.839: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec 4 12:50:57.839: IP: route map blah, item 10, permit
*Dec 4 12:50:57.839: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 4 12:50:57.911: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec 4 12:50:57.911: IP: route map blah, item 10, permit
*Dec 4 12:50:57.911: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3 (Serial2/0), len 100, policy rejected -- normal forwarding
```

When Serial 2/0 goes down and the destination address disappears from the routing table, the packet is policy routed.

```
<#root>

R1#

show ip route 10.200.200.0

% Network not in table
R1#
*Dec 5 13:26:27.567: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:26:27.567: IP: route map blah, item 10, permit
*Dec 5 13:26:27.567: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:26:27.567: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:26:27.655: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:26:27.655: IP: route map blah, item 10, permit
*Dec 5 13:26:27.655: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:26:27.655: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:26:27.727: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:26:27.727: IP: route map blah, item 10, permit
*Dec 5 13:26:27.727: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:26:27.727: IP: Ethernet0/0 to Serial1/0 10.10.10.2
```

Case Study 2: Policy Routing with the set ip next-hop Command with Dynamic Routing Protocol

This section uses these configurations:

R1

```
R1#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.100.100.1 255.255.255.0
 ip policy route-map blah
!
interface Serial1/0
 ip address 10.10.10.1 255.255.255.0
!
interface Serial2/0
 ip address 10.20.20.1 255.255.255.0
!
router ospf 1

!--- OSPF is not configured on Serial1/0.

 log-adjacency-changes
 network 10.20.20.0 0.0.0.255 area 0
 network 10.100.100.0 0.0.0.255 area 0
!
ip classless
no ip http server
!
access-list 100 permit ip host 10.100.100.3 host 10.200.200.4
!
route-map blah permit 10
 match ip address 100
 set ip next-hop 10.10.10.2
!
end
```

R2

```
R2#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.200.200.2 255.255.255.0
 ip policy route-map blah
```

```
!
interface Serial1/0
 ip address 10.10.10.2 255.255.255.0
 fair-queue
!
interface Serial2/0
 ip address 10.20.20.2 255.255.255.0
!
router ospf 1

!--- OSPF is not configured on Serial1/0.

 log-adjacency-changes
 network 10.20.20.0 0.0.0.255 area 0
 network 10.200.200.0 0.0.0.255 area 0
!
ip classless
no ip http server
!
!
!
access-list 100 permit ip host 10.200.200.4 host 10.100.100.3
!
route-map blah permit 10
 match ip address 100
 set ip next-hop 10.10.10.1
!
end
```

Verify Case Study 2

With the use of command **set ip next-hop**, router verifies the existence of the next hop 10.10.10.2, in the routing table. If the destination route exists in the routing table, the packet is policy routed if the next hop is reachable.

```
R1#show ip route 10.10.10.2
Routing entry for 10.10.10.0/24
  Known via "connected", distance 0, metric 0 (connected, via interface)
  Routing Descriptor Blocks:
  * directly connected, via Serial1/0
      Route metric is 0, traffic share count is 1

R1#show ip route 10.200.200.4
Routing entry for 10.200.200.0/24
Known via "ospf 1", distance 110, metric 74,
type intra area Last update from 10.20.20.2 on Serial2/0, 00:11:48 ago
Routing Descriptor Blocks: * 10.20.20.2, from 10.30.30.3, 00:11:48 ago,
via Serial2/0 Route metric is 74, traffic share count is 1
R1#debug ip policy Policy routing debugging is on
*Dec 4 12:53:38.271: IP: s=10.100.100.3 (Ethernet0/0), d=10.200.200.4, len 100, policy match
*Dec 4 12:53:38.271: IP: route map blah, item 10, permit
*Dec 4 12:53:38.271: IP: s=10.100.100.3 (Ethernet0/0),
d=10.200.200.4 (Serial1/0), len 100, policy routed *Dec 4 12:53:38.271:
IP: Ethernet0/0 to Serial1/0 10.10.10.2 *Dec 4 12:53:38.355:
IP: s=10.100.100.3 (Ethernet0/0), d=10.200.200.4, len 100, policy match *Dec 4 12:53:38.355:
IP: route map blah, item 10, permit *Dec 4 12:53:38.355:
IP: s=10.100.100.3 (Ethernet0/0), d=10.200.200.4 (Serial1/0), len 100, policy routed
```

```
*Dec 4 12:53:38.355: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 4 12:53:38.483: IP: s=10.100.100.3 (Ethernet0/0), d=10.200.200.4, len 100, policy match
*Dec 4 12:53:38.483: IP: route map blah, item 10, permit
R2#show ip route 10.100.100.3 Routing entry for 10.100.100.0/24 Known via "ospf 1",
distance 110, metric 74, type intra area Last update from 10.20.20.1 on Serial2/0,
00:11:42 ago Routing Descriptor Blocks: * 10.20.20.1, from 10.100.100.1, 00:11:42 ago,
via Serial2/0 Route metric is 74, traffic share count is 1 R2#debug ip policy
Policy routing debugging is on *Dec 4 12:53:38.691:
IP: s=10.200.200.4 (Ethernet0/0), d=10.100.100.3, len 100, policy match *Dec 4 12:53:38.691:
IP: route map blah, item 10, permit *Dec 4 12:53:38.691: IP: s=10.200.200.4 (Ethernet0/0),
d=10.100.100.3 (Serial1/0), len 100, policy routed
*Dec 4 12:53:38.691: IP: Ethernet0/0 to Serial1/0 10.10.10.1 *Dec 4 12:53:38.799:
IP: s=10.200.200.4 (Ethernet0/0), d=10.100.100.3, len 100, policy match
*Dec 4 12:53:38.799: IP: route map blah, item 10, permit
*Dec 4 12:53:38.799: IP: s=10.200.200.4 (Ethernet0/0), d=10.100.100.3 (Serial1/0), len 100, policy
*Dec 4 12:53:38.799: IP: Ethernet0/0 to Serial1/0 10.10.10.1 *Dec 4 12:53:38.899:
IP: s=10.200.200.4 (Ethernet0/0),
d=10.100.100.3, len 100, policy match
*Dec 4 12:53:38.899: IP: route map blah, item 10, permit
```

When the destination IP address disappears from the routing, the packet is policy routed.

```
*Dec 5 13:33:23.607: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:33:23.607: IP: route map blah, item 10, permit
*Dec 5 13:33:23.607: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:33:23.607: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:33:23.707: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:33:23.707: IP: route map blah, item 10, permit
*Dec 5 13:33:23.707: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:33:23.707: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:33:23.847: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:33:23.847: IP: route map blah, item 10, permit
```

When Serial 1/0 interface goes down, you lose the next hop 10.10.10.2 from the routing table and the packet traces the normal routing table.

```
*Dec 5 13:40:38.887: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:40:38.887: IP: route map blah, item 10, permit
*Dec 5 13:40:38.887: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 5 13:40:39.047: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:40:39.047: IP: route map blah, item 10, permit
*Dec 5 13:40:39.047: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding
*Dec 5 13:40:39.115: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:40:39.115: IP: route map blah, item 10, permit
```

```
*Dec 5 13:40:39.115: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0), len 100, policy rejected -- normal forwarding
```

Case Study 3: Policy Routing with the set ip default next-hop with a Default Route

This section uses these configurations:

R1

```
R1#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.100.100.1 255.255.255.0
 ip policy route-map blah
!
interface Serial1/0
 ip address 10.10.10.1 255.255.255.0
!
interface Serial2/0
 ip address 10.20.20.1 255.255.255.0
!
ip route 0.0.0.0 0.0.0.0 10.20.20.2
!
ip classless
no ip http server
!
access-list 100 permit ip host 10.100.100.3 host 10.200.200.4
!
route-map blah permit 10
 match ip address 100
 set ip default next-hop 10.10.10.2
!
end
```

R2

```
R2#show running-config
Building configuration...
!
!
interface Ethernet0/0
 ip address 10.200.200.2 255.255.255.0
 ip policy route-map blah
!
interface Serial1/0
 ip address 10.10.10.2 255.255.255.0
 fair-queue
!
interface Serial2/0
 ip address 10.20.20.2 255.255.255.0
!
ip route 0.0.0.0 0.0.0.0 10.20.20.1
!
```

```
ip classless
no ip http server
!
!
!
access-list 100 permit ip host 10.200.200.4 host 10.100.100.3
!
route-map blah permit 10
 match ip address 100
 set ip default next-hop 10.10.10.1
!
end
```

Verify Case Study 3

With the use of command **set ip default next-hop**, when the only route to the destination is the default route — there is no specific route for that destination in the routing tale — the packet is policy routed.

```
R1#show ip route 10.200.200.4
% Network not in table
R1#

R1#show ip route 0.0.0.0
Routing entry for 0.0.0.0/0, supernet
Known via "static", distance 1, metric 0, candidate default path
Routing Descriptor Blocks:
* 10.20.20.2
Route metric is 0, traffic share count is 1

R1#
*Dec  4 12:58:55.191: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec  4 12:58:55.191: IP: route map blah, item 10, permit
*Dec  4 12:58:55.191: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.191: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec  4 12:58:55.291: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec  4 12:58:55.291: IP: route map blah, item 10, permit
*Dec  4 12:58:55.291: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.291: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec  4 12:58:55.391: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec  4 12:58:55.391: IP: route map blah, item 10, permit
*Dec  4 12:58:55.391: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.391: IP: Ethernet0/0 to Serial1/0 10.10.10.2

R2#show ip route 10.100.100.3
% Network not in table

R2#show ip route 0.0.0.0
Routing entry for 0.0.0.0/0, supernet
Known via "static", distance 1, metric 0, candidate default path
Routing Descriptor Blocks:
* 10.20.20.1
```

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

R2#
*Dec  4 12:58:20.819: %SYS-5-CONFIG_I: Configured from console by console
*Dec  4 12:58:55.611: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec  4 12:58:55.611: IP: route map blah, item 10, permit
*Dec  4 12:58:55.611: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.611: IP: Ethernet0/0 to Serial1/0 10.10.10.1
*Dec  4 12:58:55.739: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec  4 12:58:55.739: IP: route map blah, item 10, permit
*Dec  4 12:58:55.739: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.739: IP: Ethernet0/0 to Serial1/0 10.10.10.1
*Dec  4 12:58:55.799: IP: s=10.200.200.4 (Ethernet0/0),
  d=10.100.100.3, len 100, policy match
*Dec  4 12:58:55.799: IP: route map blah, item 10, permit
*Dec  4 12:58:55.799: IP: s=10.200.200.4 (Ethernet0/0),
   d=10.100.100.3 (Serial1/0), len 100, policy routed
*Dec  4 12:58:55.799: IP: Ethernet0/0 to Serial1/0 10.10.10.1
```

When the default route does not exist because Serial 2/0 went down, the packet is policy routed.

<#root>

```
R1#

show ip route 0.0.0.0

% Network not in table
R1#
*Dec 5 13:02:31.283: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:02:31.283: IP: route map blah, item 10, permit
*Dec 5 13:02:31.283: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:02:31.283: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:02:31.375: IP: s=10.100.100.3 (Ethernet0/0),
   d=10.200.200.4, len 100, policy match
*Dec 5 13:02:31.375: IP: route map blah, item 10, permit
*Dec 5 13:02:31.375: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:02:31.375: IP: Ethernet0/0 to Serial1/0 10.10.10.2
*Dec 5 13:02:31.435: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 13:02:31.435: IP: route map blah, item 10, permit
*Dec 5 13:02:31.435: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial1/0),len 100, policy routed
*Dec 5 13:02:31.435: IP: Ethernet0/0 to Serial1/0 10.10.10.2
```

In the situation where Serial2/0 is up and Serial 1/0 goes down, you loose the next hop and the packet traces the normal forwarding (routing table) - policy rejected.

<#root>

```
R1#
```

```
debug ip policy
```

```
Policy routing debugging is on
R1#
*Dec 5 12:46:49.543: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 12:46:49.543: IP: route map blah, item 10, permit
*Dec 5 12:46:49.543: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0),len 100, policy rejected -- normal forwarding
*Dec 5 12:46:49.623: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 12:46:49.623: IP: route map blah, item 10, permit
*Dec 5 12:46:49.623: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0),len 100, policy rejected -- normal forwarding
*Dec 5 12:46:49.691: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4, len 100, policy match
*Dec 5 12:46:49.691: IP: route map blah, item 10, permit
*Dec 5 12:46:49.691: IP: s=10.100.100.3 (Ethernet0/0),
  d=10.200.200.4 (Serial2/0),len 100, policy rejected -- normal forwarding
```

Related Information

- IP Routed Protocols
- Cisco Technical Support & Downloads