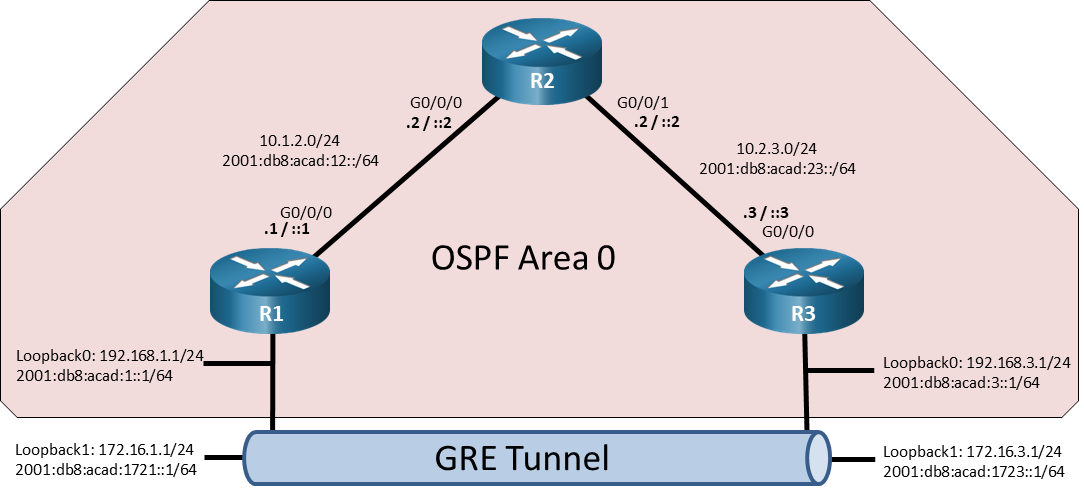
Lab - Implement a GRE Tunnel (Instructor Version)

**Instructor Note**: Red font color or gray highlights indicate text that appears in the instructor copy only.

# Topology



# Addressing Table

| Device | Interface | IPv4 Address | IPv6 Address | IPv6 Link-Local |
| --- | --- | --- | --- | --- |
| R1 | G0/0/0 | 10.1.2.1/24 | 2001:db8:acad:12::1/64 | fe80::1:1 |
| R1 | Loopback 0 | 192.168.1.1/24 | 2001:db8:acad:1::1/64 | fe80::1:2 |
| R1 | Loopback 1 | 172.16.1.1/24 | 2001:db8:acad:1721::1/64 | fe80::1:3 |
| R2 | G0/0/0 | 10.1.2.2/24 | 2001:db8:acad:12::2/64 | fe80::2:1 |
| R2 | G0/0/1 | 10.2.3.2/24 | 2001:db8:acad:23::2/64 | fe80::2:1 |
| R3 | G0/0/0 | 10.2.3.3/24 | 2001:db8:acad:23::3/64 | fe80::3:1 |
| R3 | Loopback 0 | 192.168.3.1/24 | 2001:db8:acad:3::1/64 | fe80::3:2 |
| R3 | Loopback 1 | 172.16.3.1/24 | 2001:db8:acad:1723::1/64 | fe80::3:3 |

# Objectives

Part 1: Build the Network and Configure Basic Device Settings

Part 2: Configure and Verify GRE Tunnels with Static Routing

Part 3: Configure and Verify GRE Tunnels by Using a Routing Protocol

Part 4: Examine the Recursive Routing Problem with GRE

# Background / Scenario

Overlay networks allow you to insert flexibility into existing topologies, which are then referred to as underlay networks. Cisco’s Generic Routing Encapsulation (GRE) protocol is a very useful tool that allows you to create overlay networks to support many different purposes. It is very flexible and works with IPv4 or IPv6 as an underlay network. In this lab you will deploy basic GRE tunnels over both IPv4 and IPv6 underlay networks.

**Note:** This lab is an exercise in configuring and verifying various implementations of GRE tunnels and does not reflect networking best practices.

**Note**: The routers used with CCNP hands-on labs are Cisco 4221 with Cisco IOS XE Release 16.9.4 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

**Note**: Ensure that the routers have been erased and have no startup configurations. If you are unsure contact your instructor.

**Instructor Note**: Refer to the Instructor Lab Manual for the procedures to initialize and reload devices.

# Required Resources

* 3 Routers (Cisco 4221 with Cisco IOS XE Release 16.9.4 universal image or comparable)
* 1 PC (Choice of operating system with a terminal emulation program installed)
* Console cables to configure the Cisco IOS devices via the console ports
* Ethernet cables as shown in the topology

# Instructions

## Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and configure basic settings.

### Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

### Configure basic settings for each switch.

* + - 1. Console into each router, enter global configuration mode, and apply the basic settings. A command list for each device is listed below for initial configurations.

Open configuration window

Router R1

hostname R1

no ip domain lookup

ipv6 unicast-routing

banner motd # R1, Implement a GRE Tunnel #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

router ospf 4

router-id 1.1.1.4

exit

ipv6 router ospf 6

router-id 1.1.1.6

exit

interface g0/0/0

ip address 10.1.2.1 255.255.255.0

ipv6 address fe80::1:1 link-local

ipv6 address 2001:db8:acad:12::1/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

interface loopback 0

ip address 192.168.1.1 255.255.255.0

ipv6 address fe80::1:2 link-local

ipv6 address 2001:db8:acad:1::1/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

interface loopback 1

ip address 172.16.1.1 255.255.255.0

ipv6 address fe80::1:3 link-local

ipv6 address 2001:db8:acad:1721::1/64

no shutdown

exit

Router R2

hostname R2

no ip domain lookup

ipv6 unicast-routing

banner motd # R2, Implement a GRE Tunnel #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

router ospf 4

router-id 2.2.2.4

exit

ipv6 router ospf 6

router-id 2.2.2.6

exit

interface g0/0/0

ip address 10.1.2.2 255.255.255.0

ipv6 address fe80::2:1 link-local

ipv6 address 2001:db8:acad:12::2/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

interface g0/0/1

ip address 10.2.3.2 255.255.255.0

ipv6 address fe80::2:2 link-local

ipv6 address 2001:db8:acad:23::2/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

Router R3

hostname R3

no ip domain lookup

ipv6 unicast-routing

banner motd # R3, Implement a GRE Tunnel #

line con 0

exec-timeout 0 0

logging synchronous

exit

line vty 0 4

privilege level 15

password cisco123

exec-timeout 0 0

logging synchronous

login

exit

router ospf 4

router-id 3.3.3.4

exit

ipv6 router ospf 6

router-id 3.3.3.6

exit

interface g0/0/0

ip address 10.2.3.3 255.255.255.0

ipv6 address fe80::3:1 link-local

ipv6 address 2001:db8:acad:23::3/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

interface loopback 0

ip address 192.168.3.1 255.255.255.0

ipv6 address fe80::3:2 link-local

ipv6 address 2001:db8:acad:3::1/64

no shutdown

ip ospf 4 area 0

ipv6 ospf 6 area 0

exit

interface loopback 1

ip address 172.16.3.1 255.255.255.0

ipv6 address fe80::3:3 link-local

ipv6 address 2001:db8:acad:1723::1/64

no shutdown

exit

* + - 1. Set the clock on each device to UTC time.
      2. Save the running configuration to startup-config.

Close configuration window

## Configure and Verify GRE Tunnels with Static Routing

In Part 2, you will configure and verify GRE Tunnels between R1 and R3, and you will use static routes for overlay reachability and dynamic routing for underlay reachability. You will configure two tunnels, one for IPv4 traffic and one of IPv6 traffic. GRE tunnels are extremely flexible, and there are many options for implementation beyond what is being done in this lab.

### Verify reachability between R1 and R3.

* + - 1. From R1, ping R3 interface Loopback 0 using IPv4. All pings should be successful.

Open configuration window

R1# **ping 192.168.3.1**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

* + - 1. From R1, ping R3 interface Loopback 0 using IPv6. All pings should be successful.

R1# **ping 2001:db8:acad:3::1**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:3::1, timeout is 2 seconds:

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/7 ms

### Create an IPv4-based GRE tunnel between R1 and R3.

* + - 1. On R1, create interface Tunnel 0, specifying the IP address 100.100.100.1/30, a tunnel source of Loopback0, and a tunnel destination of 192.168.3.1.

R1(config)# **interface tunnel 0**

R1(config-if)# **ip address 100.100.100.1 255.255.255.252**

R1(config-if)# **tunnel source loopback 0**

R1(config-if)# **tunnel destination 192.168.3.1**

R1(config-if)# **exit**

* + - 1. On R1, create a static route to 172.16.3.0/24 via interface Tunnel 0.

R1(config)# **ip route 172.16.3.0 255.255.255.0 tunnel 0**

* + - 1. On R3, create interface Tunnel 0, specifying the IP address 100.100.100.2/30, a tunnel source of Loopback0, and a tunnel destination of 192.168.1.1.

R3(config)# **interface tunnel 0**

R3(config-if)# **ip address 100.100.100.2 255.255.255.252**

R3(config-if)# **tunnel source loopback 0**

R3(config-if)# **tunnel destination 192.168.1.1**

R3(config-if)# **exit**

* + - 1. On R3, create a static route to 172.16.1.0/24 via interface Tunnel 0.

R3(config)# **ip route 172.16.1.0 255.255.255.0 tunnel 0**

* + - 1. On R1, issue the command **show interface tunnel 0** and examine the output.

R1# **show interface tunnel 0**

Tunnel0 is up, line protocol is up

Hardware is Tunnel

Internet address is 100.100.100.1/30

MTU 9976 bytes, BW 100 Kbit/sec, DLY 50000 usec,

reliability 255/255, txload 1/255, rxload 1/255

Encapsulation TUNNEL, loopback not set

Keepalive not set

Tunnel linestate evaluation up

Tunnel source 192.168.1.1 (Loopback0), destination 192.168.3.1

Tunnel Subblocks:

src-track:

Tunnel0 source tracking subblock associated with Loopback0

Set of tunnels with source Loopback0, 1 member (includes iterators), on interface <OK>

Tunnel protocol/transport GRE/IP

Key disabled, sequencing disabled

Checksumming of packets disabled

Tunnel TTL 255, Fast tunneling enabled

Tunnel transport MTU 1476 bytes

Tunnel transmit bandwidth 8000 (kbps)

Tunnel receive bandwidth 8000 (kbps)

Last input never, output never, output hang never

Last clearing of "show interface" counters 00:02:45

Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0

Queueing strategy: fifo

Output queue: 0/0 (size/max)

5 minute input rate 0 bits/sec, 0 packets/sec

5 minute output rate 0 bits/sec, 0 packets/sec

0 packets input, 0 bytes, 0 no buffer

Received 0 broadcasts (0 IP multicasts)

0 runts, 0 giants, 0 throttles

0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort

0 packets output, 0 bytes, 0 underruns

0 output errors, 0 collisions, 0 interface resets

0 unknown protocol drops

0 output buffer failures, 0 output buffers swapped out

* + - 1. From R1, **ping 172.16.3.1**. The pings should be successful.

### Create an IPv6-based GRE tunnel between R1 and R3.

* + - 1. On R1, create interface Tunnel 1, specifying the IPv6 address 2001:db8:ffff::1/64, a tunnel source of Loopback0, a tunnel destination of 2001:db8:acad:3::1, and the tunnel mode GRE IPv6.

R1(config)# **interface tunnel 1**

R1(config-if)# **ipv6 address 2001:db8:ffff::1/64**

R1(config-if)# **tunnel source loopback 0**

R1(config-if)# **tunnel destination 2001:db8:acad:3::1**

R1(config-if)# **tunnel mode gre ipv6**

R1(config-if)# **exit**

* + - 1. On R1, create a static route to 2001:db8:acad:1723::/64 via interface Tunnel 1.

R1(config)# **ipv6 route 2001:db8:acad:1723::/64 tunnel 1**

* + - 1. On R3, create interface Tunnel 1, specifying the IPv6 address 1002:db8:ffff::2/64, a tunnel source of Loopback0, and a tunnel destination of 2001:db8:acad:1::1.

R3(config)# **interface tunnel 1**

R3(config-if)# **ipv6 address 2001:db8:ffff::2/64**

R3(config-if)# **tunnel source loopback 0**

R3(config-if)# **tunnel destination 2001:db8:acad:1::1**

R3(config-if)# **tunnel mode gre ipv6**

R3(config-if)# **exit**

* + - 1. On R3, create a static route to 2001:db8:acad:1721::/64 via interface Tunnel 1.

R3(config)# **ipv6 route 2001:db8:acad:1721::/64 tunnel 1**

* + - 1. On R1, issue the command **show interface tunnel 1** and examine the output.

R1# **show interface tunnel 1**

Tunnel1 is up, line protocol is up

Hardware is Tunnel

MTU 1456 bytes, BW 100 Kbit/sec, DLY 50000 usec,

reliability 255/255, txload 255/255, rxload 255/255

Encapsulation TUNNEL, loopback not set

Keepalive not set

Tunnel linestate evaluation up

Tunnel source 2001:DB8:ACAD:1::1 (Loopback0), destination 2001:DB8:ACAD:3::1

Tunnel Subblocks:

src-track:

Tunnel1 source tracking subblock associated with Loopback0

Set of tunnels with source Loopback0, 2 members (includes iterators),on interface <OK>

Tunnel protocol/transport GRE/IPv6

Key disabled, sequencing disabled

Checksumming of packets disabled

Tunnel TTL 255

Path MTU Discovery, ager 10 mins, min MTU 1280

Tunnel transport MTU 1456 bytes

Tunnel transmit bandwidth 8000 (kbps)

Tunnel receive bandwidth 8000 (kbps)

Last input 00:00:31, output 00:01:01, output hang never

Last clearing of "show interface" counters 00:06:58

Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0

Queueing strategy: fifo

Output queue: 0/0 (size/max)

5 minute input rate 367000 bits/sec, 395 packets/sec

5 minute output rate 367000 bits/sec, 395 packets/sec

246335 packets input, 28574884 bytes, 0 no buffer

Received 0 broadcasts (0 IP multicasts)

0 runts, 0 giants, 0 throttles

0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort

246336 packets output, 28575000 bytes, 0 underruns

0 output errors, 0 collisions, 0 interface resets

0 unknown protocol drops

0 output buffer failures, 0 output buffers swapped out

* + - 1. From R1, **ping 2001:db8:acad:1723::1**. The pings should be successful.

Close configuration window

## Configure and verify GRE Tunnels with Dynamic Routing

In Part 3, you will configure and verify GRE tunnels between R1 and R3, and you will use dynamic routing for overlay reachability and static routing for underlay reachability. You will configure two tunnels, one for IPv4 traffic and one of IPv6 traffic.

### Remove the Tunnel 0 and Tunnel 1 interfaces on R1 and R3.

Issue the command **no interface tunnel 0** and **no interface tunnel 1** on R1 and R3.

Open configuration window

### Replace the OSPF configuration on R1, R2, and R3 with static routing.

* + - 1. On R1, R2, and R3, remove OSPF with the **no router ospf 4** and **no ipv6 router ospf 6** commands.
      2. On R1 and R3, create IPv4 and IPv6 static default routes that point to R2.
      3. On R2, create IPv4 and IPv6 static routes that point to R1 and R3 loopback 0 networks.

R2(config)# **ip route 192.168.1.0 255.255.255.0 10.1.2.1**

R2(config)# **ip route 192.168.3.0 255.255.255.0 10.2.3.3**

R2(config)# **ipv6 route 2001:db8:acad:1::/64 2001:db8:acad:12::1**

R2(config)# **ipv6 route 2001:db8:acad:3::/64 2001:db8:acad:23::3**

* + - 1. Verify that R1 can reach Loopback 0 on R3 with pings using a source address of the R1 Loopback 0 address.

R1# **ping 192.168.3.1 source loopback 0**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 192.168.3.1, timeout is 2 seconds:

Packet sent with a source address of 192.168.1.1

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/2 ms

R1# **ping 2001:db8:acad:3::1 source loopback 0**

Type escape sequence to abort.

Sending 5, 100-byte ICMP Echos to 2001:DB8:ACAD:3::1, timeout is 2 seconds:

Packet sent with a source address of 2001:DB8:ACAD:1::1

!!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

### Create an IPv4-based GRE tunnel between R1 and R3.

* + - 1. On R1, create interface Tunnel 0, specifying the IP address 100.100.100.1/30, bandwidth of 4000 kbps, a tunnel source of Loopback0, and a tunnel destination of 192.168.3.1.

R1(config)# **interface tunnel 0**

R1(config-if)# **ip address 100.100.100.1 255.255.255.252**

R1(config-if)# **bandwidth 4000**

R1(config-if)# **ip mtu 1400**

R1(config-if)# **tunnel source loopback 0**

R1(config-if)# **tunnel destination 192.168.3.1**

R1(config-if)# **exit**

* + - 1. On R1, configure OSPFv2 process-id 4 with router-id 1.1.1.4, and use network statements or interface configuration commands to include interface Tunnel 0 in Area 0 and interface Loopback 1 in Area 1.

R1(config)# **router ospf 4**

R1(config-router)# **router-id 1.1.1.4**

R1(config-router)# **network 100.100.100.0 0.0.0.3 area 0**

R1(config-router)# **network 172.16.1.0 0.0.0.255 area 1**

R1(config-router)# **exit**

* + - 1. On R3, create interface Tunnel 0, specifying the IP address 100.100.100.2/30, bandwidth of 4000 kbps, a tunnel source of Loopback0, and a tunnel destination of 192.168.1.1.

R3(config)# **interface tunnel 0**

R3(config-if)# **ip address 100.100.100.2 255.255.255.252**

R3(config-if)# **bandwidth 4000**

R3(config-if)# **ip mtu 1400**

R3(config-if)# **tunnel source loopback 0**

R3(config-if)# **tunnel destination 192.168.1.1**

R3(config-if)# **exit**

* + - 1. On R3, configure OSPFv2 process-id 4 with router-id 3.3.3.4, and use network statements or interface configuration commands to include interface Tunnel 0 in Area 0 and interface Loopback 1 in Area 1.

R3(config)# **router ospf 4**

R3(config-router)# **router-id 3.3.3.4**

R3(config-router)# **network 100.100.100.0 0.0.0.3 area 0**

R3(config-router)# **network 172.16.3.0 0.0.0.255 area 1**

R3(config-router)# **exit**

* + - 1. On R1, issue the command **show interface tunnel 0** and examine the output.

R1# **show interface tunnel 0**

Tunnel0 is up, line protocol is up

Hardware is Tunnel

Internet address is 100.100.100.1/30

MTU 9976 bytes, BW 4000 Kbit/sec, DLY 50000 usec,

reliability 255/255, txload 1/255, rxload 1/255

Encapsulation TUNNEL, loopback not set

Keepalive not set

Tunnel linestate evaluation up

Tunnel source 192.168.1.1 (Loopback0), destination 192.168.3.1

Tunnel Subblocks:

src-track:

Tunnel0 source tracking subblock associated with Loopback0

Set of tunnels with source Loopback0, 1 member (includes iterators), on interface <OK>

Tunnel protocol/transport GRE/IP

Key disabled, sequencing disabled

Checksumming of packets disabled

Tunnel TTL 255, Fast tunneling enabled

Tunnel transport MTU 1476 bytes

Tunnel transmit bandwidth 8000 (kbps)

Tunnel receive bandwidth 8000 (kbps)

Last input 00:00:01, output 00:00:04, output hang never

Last clearing of "show interface" counters 00:06:11

Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0

Queueing strategy: fifo

Output queue: 0/0 (size/max)

5 minute input rate 0 bits/sec, 0 packets/sec

5 minute output rate 0 bits/sec, 0 packets/sec

23 packets input, 2064 bytes, 0 no buffer

Received 0 broadcasts (0 IP multicasts)

0 runts, 0 giants, 0 throttles

0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort

58 packets output, 6784 bytes, 0 underruns

0 output errors, 0 collisions, 0 interface resets

0 unknown protocol drops

0 output buffer failures, 0 output buffers swapped out

* + - 1. On R1, issue the command **show ip route** **ospf** and verify that 172.16.3.0/24 appears in the routing table as an OSPF route.

R1# **show ip route ospf | begin Gateway**

Gateway of last resort is 10.1.2.2 to network 0.0.0.0

172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks

O IA 172.16.3.1/32 [110/26] via 100.100.100.2, 00:02:53, Tunnel0

* + - 1. From R1, ping 172.16.3.1. The pings should be successful.

### Create an IPv6-based GRE tunnel between R1 and R3.

* + - 1. On R1, create interface Tunnel 1, specifying the IPv6 address 2001:db8:ffff::1/64, bandwidth of 4000kbps, a tunnel source of Loopback0, and a tunnel destination of 2001:db8:acad:3::1.

R1(config)# **interface tunnel 1**

R1(config-if)# **ipv6 address 2001:db8:ffff::1/64**

R1(config-if)# **bandwidth 4000**

R1(config-if)# **tunnel source loopback 0**

R1(config-if)# **tunnel destination 2001:db8:acad:3::1**

R1(config-if)# **tunnel mode gre ipv6**

R1(config-if)# **exit**

* + - 1. On R1, configure OSPFv3 process-id 6 with router-id 1.1.1.6, and interface configuration commands to include interface Tunnel 0 in Area 0 and interface Loopback 1 in Area 1.

R1(config)# **ipv6 router ospf 6**

R1(config-rtr)# **router-id 1.1.1.6**

R1(config-rtr)# **exit**

R1(config)# **interface tunnel 1**

R1(config-if)# **ipv6 ospf 6 area 0**

R1(config-if)# **exit**

R1(config)# **interface loopback 1**

R1(config-if)# **ipv6 ospf 6 area 1**

R1(config-if)# **exit**

* + - 1. On R3, create interface Tunnel 1, specifying the IPv6 address 1002:db8:ffff::2/64, bandwidth of 4000kbps, a tunnel source of Loopback0, and a tunnel destination of 2001:db8:acad:1::1.

R3(config)# **interface tunnel 1**

R3(config-if)# **ipv6 address 2001:db8:ffff::2/64**

R3(config-if)# **bandwidth 4000**

R3(config-if)# **tunnel source loopback 0**

R3(config-if)# **tunnel destination 2001:db8:acad:1::1**

R3(config-if)# **tunnel mode gre ipv6**

R3(config-if)# **exit**

* + - 1. On R3, configure OSPFv3 process-id 6 with router-id 3.3.3.6, and use network statements or interface configuration commands to include interface Tunnel 0 in Area 0 and interface Loopback 1 in Area 1.

R3(config)# **ipv6 router ospf 6**

R3(config-rtr)# **router-id 3.3.3.6**

R3(config-rtr)# **exit**

R3(config)# **interface tunnel 1**

R3(config-if)# **ipv6 ospf 6 area 0**

R3(config-if)# **exit**

R3(config)# **interface loopback 1**

R3(config-if)# **ipv6 ospf 6 area 1**

R3(config-if)# **exit**

* + - 1. On R1, issue the command **show interface tunnel 1** and examine the output.

R1# **show interface tunnel 1**

Tunnel1 is up, line protocol is up

Hardware is Tunnel

MTU 1456 bytes, BW 4000 Kbit/sec, DLY 50000 usec,

reliability 255/255, txload 1/255, rxload 1/255

Encapsulation TUNNEL, loopback not set

Keepalive not set

Tunnel linestate evaluation up

Tunnel source 2001:DB8:ACAD:1::1 (Loopback0), destination 2001:DB8:ACAD:3::1

Tunnel Subblocks:

src-track:

Tunnel1 source tracking subblock associated with Loopback0

Set of tunnels with source Loopback0, 2 members (includes iterators),on interface <OK>

Tunnel protocol/transport GRE/IPv6

Key disabled, sequencing disabled

Checksumming of packets disabled

Tunnel TTL 255

Path MTU Discovery, ager 10 mins, min MTU 1280

Tunnel transport MTU 1456 bytes

Tunnel transmit bandwidth 8000 (kbps)

Tunnel receive bandwidth 8000 (kbps)

Last input 00:00:09, output 00:00:04, output hang never

Last clearing of "show interface" counters 00:04:20

Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0

Queueing strategy: fifo

Output queue: 0/0 (size/max)

5 minute input rate 0 bits/sec, 0 packets/sec

5 minute output rate 0 bits/sec, 0 packets/sec

31 packets input, 4048 bytes, 0 no buffer

Received 0 broadcasts (0 IP multicasts)

0 runts, 0 giants, 0 throttles

0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort

46 packets output, 5864 bytes, 0 underruns

0 output errors, 0 collisions, 0 interface resets

0 unknown protocol drops

0 output buffer failures, 0 output buffers swapped out

* + - 1. On R1, issue the command **show ipv6 route ospf** and verify that 2001:db8:acad:1723::/64 appears in the routing table as an OSPF route.

R1# s**how ipv6 route ospf**

IPv6 Routing Table - default - 11 entries

Codes: C - Connected, L - Local, S - Static, U - Per-user Static route

B - BGP, R - RIP, H - NHRP, I1 - ISIS L1

I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP

EX - EIGRP external, ND - ND Default, NDp - ND Prefix, DCE - Destination

NDr - Redirect, RL - RPL, O - OSPF Intra, OI - OSPF Inter

OE1 - OSPF ext 1, OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1

ON2 - OSPF NSSA ext 2, a - Application

OI 2001:DB8:ACAD:1723::1/128 [110/25]

via FE80::12B3:D6FF:FE04:ED10, Tunnel1

* + - 1. From R1, ping 2001:db8:acad:1723::1. The pings should be successful.

Close configuration window

## Examine the Recursive Routing Problem with GRE

Recursive routing in overlay networks occurs when the router decides that the best interface to use to cross the underlay network is an interface that is a part of the overlay network. For example, if R1 decided, based on the routing table, that the best way to get to the tunnel destination is via the tunnel itself. Care must be taken during configuration of routing protocols to prevent this from occurring, as it will cause the overlay network to fail.

* + - 1. To demonstrate how easily this could occur, add network 192.168.1.0 to the OSPF configuration of R1.

Open configuration window

R1(config)# **router ospf 4**

R1(config-router)# **network 192.168.1.0 0.0.0.255 area 0**

R1(config-router)# **end**

R1#

\*Jan 24 18:48:41.437: %SYS-5-CONFIG\_I: Configured from console by console

R1#

\*Jan 24 18:49:17.345: %OSPF-5-ADJCHG: Process 4, Nbr 3.3.3.4 on Tunnel0 from FULL to DOWN, Neighbor Down: Dead timer expired

R1#

\*Jan 24 18:49:45.422: %OSPF-5-ADJCHG: Process 4, Nbr 3.3.3.4 on Tunnel0 from LOADING to FULL, Loading Done

R1#

\*Jan 24 18:50:25.620: %OSPF-5-ADJCHG: Process 4, Nbr 3.3.3.4 on Tunnel0 from FULL to DOWN, Neighbor Down: Dead timer expired

R1#

* + - 1. R1 shows that the dead timer expires and then the adjacency tries to reset. Now look at what is being logged at R3.

Jan 27 00:02:56.654: %ADJ-5-PARENT: Midchain parent maintenance for IP midchain out of Tunnel0 - looped chain attempting to stack

R3(config)#

\*Jan 27 00:03:00.485: %TUN-5-RECURDOWN: Tunnel0 temporarily disabled due to recursive routing

\*Jan 27 00:03:01.485: %LINEPROTO-5-UPDOWN: Line protocol on Interface Tunnel0, changed state to down

\*Jan 27 00:03:01.486: %OSPF-5-ADJCHG: Process 4, Nbr 1.1.1.4 on Tunnel0 from FULL to DOWN, Neighbor Down: Interface down or detached

* + - 1. As you can see, R3 recognizes the issue and even tells you there is a recursive routing problem. Fix this by removing the network statement on R1 and the tunnel will come back up.

R1(config)# **router ospf 4**

R1(config-router)# **no network 192.168.1.0 0.0.0.255 area 0**

R1(config-router)# **end**

R1#

\*Jan 24 18:54:22.496: %SYS-5-CONFIG\_I: Configured from console by console

R1#

\*Jan 24 18:54:29.439: %OSPF-5-ADJCHG: Process 4, Nbr 3.3.3.4 on Tunnel0 from LOADING to FULL, Loading Done

Close configuration window

End of document

# Router Interface Summary Table

| Router Model | Ethernet Interface #1 | Ethernet Interface #2 | Serial Interface #1 | Serial Interface #2 |
| --- | --- | --- | --- | --- |
| 1800 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 1900 | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2801 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |
| 2811 | Fast Ethernet 0/0 (F0/0) | Fast Ethernet 0/1 (F0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 2900 | Gigabit Ethernet 0/0 (G0/0) | Gigabit Ethernet 0/1 (G0/1) | Serial 0/0/0 (S0/0/0) | Serial 0/0/1 (S0/0/1) |
| 4221 | Gigabit Ethernet 0/0/0 (G0/0/0) | Gigabit Ethernet 0/0/1 (G0/0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |
| 4300 | Gigabit Ethernet 0/0/0 (G0/0/0) | Gigabit Ethernet 0/0/1 (G0/0/1) | Serial 0/1/0 (S0/1/0) | Serial 0/1/1 (S0/1/1) |

**Note**: To find out how the router is configured, look at the interfaces to identify the type of router and how many interfaces the router has. There is no way to effectively list all the combinations of configurations for each router class. This table includes identifiers for the possible combinations of Ethernet and Serial interfaces in the device. The table does not include any other type of interface, even though a specific router may contain one. An example of this might be an ISDN BRI interface. The string in parenthesis is the legal abbreviation that can be used in Cisco IOS commands to represent the interface.

End of document

# Device Configs - Final

# Router R1

R1# **show run**

Building configuration...

Current configuration : 4447 bytes

!

version 16.9

service timestamps debug datetime msec

service timestamps log datetime msec

platform qfp utilization monitor load 80

no platform punt-keepalive disable-kernel-core

!

hostname R1

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

no ip domain lookup

!

login on-success log

!

subscriber templating

!

ipv6 unicast-routing

multilink bundle-name authenticated

!

spanning-tree extend system-id

!

redundancy

mode none

!

interface Loopback0

ip address 192.168.1.1 255.255.255.0

ipv6 address FE80::1:2 link-local

ipv6 address 2001:DB8:ACAD:1::1/64

!

interface Loopback1

ip address 172.16.1.1 255.255.255.0

ipv6 address FE80::1:3 link-local

ipv6 address 2001:DB8:ACAD:1721::1/64

ipv6 ospf 6 area 1

!

interface Tunnel0

bandwidth 4000

ip address 100.100.100.1 255.255.255.252

ip mtu 1400

tunnel source Loopback0

tunnel destination 192.168.3.1

!

interface Tunnel1

bandwidth 4000

no ip address

ipv6 address 2001:DB8:FFFF::1/64

ipv6 ospf 6 area 0

tunnel source Loopback0

tunnel mode gre ipv6

tunnel destination 2001:DB8:ACAD:3::1

tunnel path-mtu-discovery

!

interface GigabitEthernet0/0/0

ip address 10.1.2.1 255.255.255.0

negotiation auto

ipv6 address FE80::1:1 link-local

ipv6 address 2001:DB8:ACAD:12::1/64

!

interface GigabitEthernet0/0/1

no ip address

negotiation auto

!

interface Serial0/1/0

no ip address

shutdown

!

interface Serial0/1/1

no ip address

shutdown

!

router ospf 4

router-id 1.1.1.4

network 100.100.100.0 0.0.0.3 area 0

network 172.16.1.0 0.0.0.255 area 1

!

ip forward-protocol nd

no ip http server

ip http authentication local

ip http secure-server

ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 10.1.2.2

!

ipv6 route ::/0 2001:DB8:ACAD:12::2

ipv6 router ospf 6

router-id 1.1.1.6

!

control-plane

!

banner motd ^C R1, Implement a GRE Tunnel ^C

!

line con 0

exec-timeout 0 0

logging synchronous

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

exec-timeout 0 0

privilege level 15

password cisco123

logging synchronous

login

!

end

# Router R2

R2# **show run**

Building configuration...

Current configuration : 3795 bytes

!

version 16.9

service timestamps debug datetime msec

service timestamps log datetime msec

platform qfp utilization monitor load 80

no platform punt-keepalive disable-kernel-core

!

hostname R2

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

no ip domain lookup

!

login on-success log

!

subscriber templating

!

ipv6 unicast-routing

multilink bundle-name authenticated

!

spanning-tree extend system-id

!

redundancy

mode none

!

interface GigabitEthernet0/0/0

ip address 10.1.2.2 255.255.255.0

negotiation auto

ipv6 address FE80::2:1 link-local

ipv6 address 2001:DB8:ACAD:12::2/64

!

interface GigabitEthernet0/0/1

ip address 10.2.3.2 255.255.255.0

negotiation auto

ipv6 address FE80::2:2 link-local

ipv6 address 2001:DB8:ACAD:23::2/64

!

ip forward-protocol nd

no ip http server

ip http secure-server

ip route 192.168.1.0 255.255.255.0 10.1.2.1

ip route 192.168.3.0 255.255.255.0 10.2.3.3

!

ipv6 route 2001:DB8:ACAD:1::/64 2001:DB8:ACAD:12::1

ipv6 route 2001:DB8:ACAD:3::/64 2001:DB8:ACAD:23::3

ipv6 router ospf 5

router-id 2.2.2.6

!

control-plane

!

banner motd ^C R2, Implement a GRE Tunnel ^C

!

line con 0

exec-timeout 0 0

logging synchronous

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

exec-timeout 0 0

privilege level 15

password cisco123

logging synchronous

login

!

end

# Router R3

R3# **show run**

Building configuration...

Current configuration : 4447 bytes

!

version 16.9

service timestamps debug datetime msec

service timestamps log datetime msec

platform qfp utilization monitor load 80

no platform punt-keepalive disable-kernel-core

!

hostname R3

!

boot-start-marker

boot-end-marker

!

no aaa new-model

!

no ip domain lookup

!

login on-success log

!

subscriber templating

!

ipv6 unicast-routing

multilink bundle-name authenticated

!

spanning-tree extend system-id

!

redundancy

mode none

!

interface Loopback0

ip address 192.168.3.1 255.255.255.0

ipv6 address FE80::3:2 link-local

ipv6 address 2001:DB8:ACAD:3::1/64

!

interface Loopback1

ip address 172.16.3.1 255.255.255.0

ipv6 address FE80::3:3 link-local

ipv6 address 2001:DB8:ACAD:1723::1/64

ipv6 ospf 6 area 1

!

interface Tunnel0

bandwidth 4000

ip address 100.100.100.2 255.255.255.252

ip mtu 1400

tunnel source Loopback0

tunnel destination 192.168.1.1

!

interface Tunnel1

bandwidth 4000

no ip address

ipv6 address 2001:DB8:FFFF::2/64

ipv6 ospf 6 area 0

tunnel source Loopback0

tunnel mode gre ipv6

tunnel destination 2001:DB8:ACAD:1::1

tunnel path-mtu-discovery

!

interface GigabitEthernet0/0/0

ip address 10.2.3.3 255.255.255.0

negotiation auto

ipv6 address FE80::3:1 link-local

ipv6 address 2001:DB8:ACAD:23::3/64

!

interface GigabitEthernet0/0/1

no ip address

negotiation auto

!

interface Serial0/1/0

no ip address

shutdown

!

interface Serial0/1/1

no ip address

shutdown

!

router ospf 4

router-id 3.3.3.4

network 100.100.100.0 0.0.0.3 area 0

network 172.16.3.0 0.0.0.255 area 1

!

ip forward-protocol nd

no ip http server

ip http secure-server

ip route 0.0.0.0 0.0.0.0 GigabitEthernet0/0/0 10.2.3.2

!

ipv6 route ::/0 2001:DB8:ACAD:23::2

ipv6 router ospf 6

router-id 3.3.3.6

!

control-plane

!

banner motd ^C R3, Implement a GRE Tunnel ^C

!

line con 0

exec-timeout 0 0

logging synchronous

transport input none

stopbits 1

line aux 0

stopbits 1

line vty 0 4

exec-timeout 0 0

privilege level 15

password cisco123

logging synchronous

login

!

end