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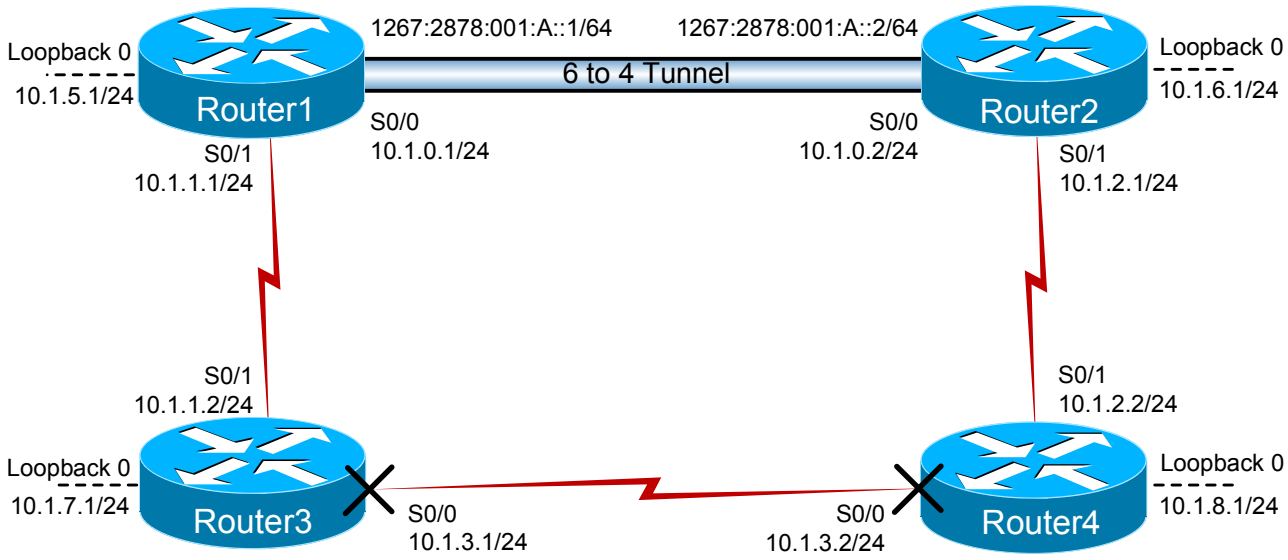
ROUTE Lab: Configuring IPv6 Tunnels

Objective

Configure a manual Internet Protocol version 6 (IPv6)-over-IPv4 tunnel on the routers that make up the simulated network. Verify the correct configuration and operation of the IPv6 tunnels.

Lab Topology

The Topology diagram below represents the NetMap in the Simulator.



Command Summary

Command	Description
clear counters	clears the interface counters
clock rate *clock-rate*	sets the clock rate for a Data Communications Equipment (DCE) interface
interface *type number*	changes from global configuration mode to interface configuration mode
interface tunnel *interface-number*	specifies a tunnel interface number to enable a configured tunnel
ipv6 address *address/prefix-length*	statically assigns an IPv6 address and a prefix length to the tunnel interface
ipv6 ospf *process-id* **area** *area-id*	identifies the IPv6 prefix assigned to this interface as part of the Open Shortest Path First version 3 (OSPFv3) network
ipv6 router ospf *process-id*	configures global options for OSPFv3
ipv6 unicast routing	enables IPv6 routing
ping ipv6 *ip-address*	sends an Internet Control Message Protocol (ICMP) echo request to the specified IPv6 address
router id *ip-address*	defines which IP address OSPFv3 should use as its router ID
show interfaces tunnel *interface-number*	displays information about the tunnel 0 interface

Command	Description
show ipv6 interface brief	displays a brief summary of each IPv6 interface's configuration and status
show ipv6 route	displays the IPv6 routing table
show running-config	displays the active configuration file
shutdown; **no shutdown**	disables an interface; enables an interface
tunnel destination *ipv4-address*	defines the tunnel endpoint destination IPv4 address (the remote end of the tunnel)
tunnel mode ipv6ip	configures a static IPv6 tunnel interface
tunnel source {*ipv4-address* | *interface-type interface-number*}	defines the local IPv4 address used as the source address for the tunnel interface

The IP addresses and subnet masks used in this lab are shown in the table below:

IP Addresses

Device	Interface	IP Address	Subnet Mask
Router1	Serial 0/0 Serial 0/1 Loopback 0	10.1.0.1 10.1.1.1 10.1.5.1	255.255.255.0 255.255.255.0 255.255.255.0
Router2	Serial 0/0 Serial 0/1 Loopback 0	10.1.0.2 10.1.2.1 10.1.6.1	255.255.255.0 255.255.255.0 255.255.255.0
Router3	Serial 0/0 Serial 0/1 Loopback 0	10.1.3.1 10.1.1.2 10.1.7.1	255.255.255.0 255.255.255.0 255.255.255.0
Router4	Serial 0/0 Serial 0/1 Loopback 0	10.1.3.2 10.1.2.2 10.1.8.1	255.255.255.0 255.255.255.0 255.255.255.0

Lab Tasks

Task 1

A. Assign IPv6 Addresses

1. The table below lists the IPv6 addresses that you should assign to each router interface:

Device	Interface	IPv6 Address
Router1	Serial 0/0 Serial 0/1	1267:2878:001:3::1/64 1267:2878:001:1::1/64
Router2	Serial 0/0 Serial 0/1	1267:2878:001:3::2/64 1267:2878:001:2::1/64
Router3	Serial 0/0 Serial 0/1	1267:2878:001:4::1/64 1267:2878:001:1::2/64
Router4	Serial 0/0 Serial 0/1	1267:2878:001:4::2/64 1267:2878:001:2::2/64

2. Access Router1, Router2, Router3, and Router4, and assign the appropriate IPv6 addresses to each interface.

3. Use the **show ipv6 interface brief** command to determine the status of each interface. Are all interfaces up and operational? _____

Task 2

A. Configure the OSPFv3 Dynamic Routing Protocol

1. Enable IPv6 routing on all four devices. What comamnds did you issue?

2. Using OSPF process ID **1**, configure the router ID on each router; use the IPv4 address from each router's Loopback 0 interface. What commands and IP addresses should you use to configure the router ID for each router? _____

3. Which interfaces should Router1, Router2, Router3, and Router4 advertise? _____

4. Configure OSPFv3 on each interface; use process ID **1** and Area 0. What commands did you use to accomplish this? _____

B. Verify IPv6 and OSPFv3 Configuration

1. On Router1, ping the Serial 0/1 interface on Router4 (1267:2878:001:2::2). If the ping is successful, you will know that connectivity exists throughout the network.

2. Display the IPv6 routing table on Router1. What command did you use? _____

Task 3

A. Prepare for the Tunnel Interface

1. A tunnel interface is used to carry traffic when the networks along the route between two distant networks are using different protocols. In this lab, IPv6 information must traverse an IPv4 network. To enable this to happen, you will create an IPv4-only segment between two devices and configure the IPv6 tunnel between Router1 and Router2. However, before you can do so, you must remove the IPv6 addresses from Router1 Serial 0/0 and Router2 Serial 0/0 to create a valid IPv4-only segment. Write down the commands you use to remove the IPv6 addresses. _____
_____

2. To ensure that all traffic traverses the tunnel segment, you should disconnect all other connections between the Router1 and Router3 networks to the Router2 and Router4 networks. You can accomplish this by shutting down the Serial 0/0 interfaces of both Router3 and Router4. Write down the commands you use. _____

B. Configure the Tunnel Interface

1. On which Router1 interface and Router2 interface should the tunnel interface configuration take place?

   _____

2. Create a tunnel between Router1 and Router2, and put both ends of the tunnel in the same IPv6 subnet. Set the tunnel source and destination commands at both ends of the tunnel. For example, Router1 points to the Serial 0/0 interface of Router2 for the tunnel destination and its own Serial 0/0 interface for the tunnel source. You must also configure OSPFv3 routing on the tunnel interface. What commands did you use?

   _____

C. Verify Tunnel Configuration

1. Confirm the tunnel configuration by displaying information about the tunnel interface on Router1 and Router2. What command did you use to do this? _____

2. Display the running configuration on Router1 to see the tunnel configuration. What command did you use to do this? _____

3. Display the IPv6 routing table on Router1. What command did you use to do this? _____

4. To verify that the ping packets are traversing the tunnel interface, clear the counters on the tunnel interface on Router1. What command did you use to do this? _____

5. Issue the **show interface tunnel 0** command on Router1 to confirm that the packet counts have been cleared.

6. Ping across the tunnel. From Router1, ping the IPv6 address of Router2 Serial 0/1 (1267:2878:001:2::1) on the other side of the tunnel.

7. Was the ping successful? _____

8. On Router1 and Router2, display the tunnel interface information again and verify that the number of input and output packets has gone up.

Lab Solutions

Task 1

A. Assign IPv6 Addresses

1. No action is required.

2. You should issue the following commands to assign the appropriate IPv6 addresses to the interfaces on Router1, Router2, Router3, and Router4:

```
Router1(config)#interface serial 0/0
Router1(config-if)#ipv6 address 1267:2878:001:3::1/64
Router1(config-if)#interface serial 0/1
Router1(config-if)#ipv6 address 1267:2878:001:1::1/64

Router2(config)#interface serial 0/0
Router2(config-if)#ipv6 address 1267:2878:001:3::2/64
Router2(config-if)#interface serial 0/1
Router2(config-if)#ipv6 address 1267:2878:001:2::1/64

Router3(config)#interface serial 0/0
Router3(config-if)#ipv6 address 1267:2878:001:4::1/64
Router3(config-if)#interface serial 0/1
Router3(config-if)#ipv6 address 1267:2878:001:1::2/64

Router4(config)#interface serial 0/0
Router4(config-if)#ipv6 address 1267:2878:001:4::2/64
Router4(config-if)#interface serial 0/1
Router4(config-if)#ipv6 address 1267:2878:001:2::2/64
```

3. Yes, all interfaces are up. Sample output from Router1 is shown below:

```
Router1#show ipv6 interface brief
Serial0/0                  [up/up]
    FE80::020C:77FF:FE54:4156
    1267:2878:1:3::1
Serial0/1                  [up/up]
    FE80::020C:77FF:FE54:4156
    1267:2878:1:1::1
FastEthernet0/0            [down/down]
    unassigned
Loopback0                  [up/up]
    unassigned
```

Task 2

A. Configure the OSPFv3 Dynamic Routing Protocol

1. You should issue the following commands to enable IPv6 routing on all four devices:

```
Router1(config)#ipv6 unicast-routing

Router2(config)#ipv6 unicast-routing

Router3(config)#ipv6 unicast-routing

Router4(config)#ipv6 unicast-routing
```

2. You should issue the following commands to configure a router ID using the IPv4 address of each router's Loopback interface:

```
Router1(config)#ipv6 router ospf 1
Router1(config-rtr)#router-id 10.1.5.1

Router2(config)#ipv6 router ospf 1
Router2(config-rtr)#router-id 10.1.6.1

Router3(config)#ipv6 router ospf 1
Router3(config-rtr)#router-id 10.1.7.1

Router4(config)#ipv6 router ospf 1
Router4(config-rtr)#router-id 10.1.8.1
```

3. Each router should advertise both its Serial 0/0 and Serial 0/1 interfaces. When enabling OSPF for IPv6, or OSPFv3, commands are issued on each interface in interface configuration mode. Conversely, OSPFv2 for IPv4 is enabled for interfaces indirectly by using the router configuration mode.

4. You should issue the following commands to enable OSPFv3 on the Serial 0/0 and Serial 0/1 interfaces of Router1, Router2, Router3, and Router4:

```
Router1(config)#interface serial 0/0
Router1(config-if)#ipv6 ospf 1 area 0
Router1(config-if)#interface serial 0/1
Router1(config-if)#ipv6 ospf 1 area 0

Router2(config)#interface serial 0/0
Router2(config-if)#ipv6 ospf 1 area 0
Router2(config-if)#interface serial 0/1
Router2(config-if)#ipv6 ospf 1 area 0

Router3(config)#interface serial 0/0
Router3(config-if)#ipv6 ospf 1 area 0
Router3(config-if)#interface serial 0/1
Router3(config-if)#ipv6 ospf 1 area 0
```

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```
Router4(config)#interface serial 0/0
Router4(config-if)#ipv6 ospf 1 area 0
Router4(config-if)#interface serial 0/1
Router4(config-if)#ipv6 ospf 1 area 0
```

B. Verify IPv6 and OSPFv3 Configuration

1. The IPv6 ping from Router1 to Router4's Serial 0/1 interface should succeed.

```
Router1#ping ipv6 1267:2878:001:2::2
```

2. You should issue the **show ipv6 route** command on Router1 to view the IPv6 routing table. Sample output is shown below:

```
Router1#show ipv6 route
IPv6 Routing Table - 8 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   1267:2878:1:1::/64 [0/0]
     via ::, Serial0/1
L   1267:2878:1:1::1/128 [0/0]
     via ::, Serial0/1
C   1267:2878:1:3::/64 [0/0]
     via ::, Serial0/0
L   1267:2878:1:3::1/128 [0/0]
     via ::, Serial0/0
O   1267:2878:1:2::/64 [110/128]
     via 1267:2878:1:3::2, Serial0/0
O   1267:2878:1:4::/64 [110/128]
     via 1267:2878:1:1::2, Serial0/1
L   FE80::/10 [0/0]
     via ::, Null0
L   FF00::/8 [0/0]
     via ::, Null0
```

Task 3

A. Prepare for the Tunnel Interface

1. To create an IPv4-only segment between two devices and to configure the IPv6 tunnel between Router1 and Router2, you must issue the following commands to remove the IPv6 addresses from Router1 Serial 0/0 and Router2 Serial 0/0:

```
Router1(config)#interface serial 0/0
Router1(config-if)#no ipv6 address

Router2(config)#interface serial 0/0
Router2(config-if)#no ipv6 address
```

2. You should issue the following commands to shut down the Serial 0/0 interfaces of both Router3 and Router4:

```
Router3(config)#interface serial 0/0
Router3(config-if)#shutdown

Router4(config)#interface serial 0/0
Router4(config-if)#shutdown
```

B. Configure the Tunnel Interface

1. The tunnel interface configuration should take place on Router1 Serial 0/0 and Router2 Serial 0/0.

2. To create a tunnel between Router1 and Router2 and put both ends of the tunnel in the same IPv6 subnet, you should set the tunnel source and destination commands at both ends of the tunnel. In this lab, Router1 (10.1.0.1) points to the Serial 0/0 interface of Router2 (10.1.0.2) for the tunnel destination and its own Serial 0/0 interface for the tunnel source. You must issue the following commands to create the tunnel between Router1 and Router2 and to configure OSPFv3 routing on the tunnel interface:

```
Router1(config)#interface tunnel 0
Router1(config-if)#ipv6 address 1267:2878:001:a::1/64
Router1(config-if)#tunnel source 10.1.0.1
Router1(config-if)#tunnel destination 10.1.0.2
Router1(config-if)#tunnel mode ipv6ip
Router1(config-if)#ipv6 ospf 1 area 0

Router2(config)#interface tunnel 0
Router2(config-if)#ipv6 address 1267:2878:001:a::2/64
Router2(config-if)#tunnel source 10.1.0.2
Router2(config-if)#tunnel destination 10.1.0.1
Router2(config-if)#tunnel mode ipv6ip
Router2(config-if)#ipv6 ospf 1 area 0
```

C. Verify Tunnel Configuration

1. You should issue the **show interfaces tunnel 0** command on Router1 and Router2 to confirm the tunnel configuration. The following is sample output from Router1:

```
Router1#show interfaces tunnel 0
Tunnel0 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 10.1.0.1, destination 10.1.0.2
  Tunnel protocol/transport IPv6/IP
    Key disabled, sequencing  disabled
    Checksumming of packets disabled
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of show interface counters never
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 1000 bits/sec, 2 packets/sec
  5 minute output rate 1000 bits/sec, 2 packets/sec
     193 packets input, 19,686 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     189 packets output, 19,292 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

2. A portion of the output from the **show running-config** command issued on Router1 is shown below:

```
Router1#show running-config
<output omitted>
!
interface Tunnel0
 no ip address
 ipv6 address 1267:2878:1:a::1/64
 ipv6 ospf 1 area 0
 tunnel source 10.1.0.1
 tunnel destination 10.1.0.2
 tunnel mode ipv6ip
<output omitted>
```

3. You should issue the **show ipv6 route** command on Router1 to display the IPv6 routing table. Sample output is shown below:

```
Router1#show ipv6 route
IPv6 Routing Table - 8 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B – BGP
       U - Per-user Static route
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   1267:2878:1:1::/64 [0/0]
     via ::, Serial0/1
L   1267:2878:1:1::1/128 [0/0]
     via ::, Serial0/1
O   1267:2878:1:2::/64 [100/11175]
     via 1267:2878:1:A::2, Tunnel0
C   1267:2878:1:A::/64 [0/0]
     via ::, Tunnel0
L   1267:2878:1:A::1/128 [0/0]
     via ::, Tunnel0
L   FE80::/10 [0/0]
     via ::, Null0
L   FF00::/8 [0/0]
     via ::, Null0
```

4. You should issue the **clear counters tunnel 0** command on Router1 to clear the interface counters.

5. The **show interfaces tunnel 0** command should show that the number of packets for both input and output is close to zero. Make a note of these values so that you can refer to them later in this lab. Sample output is shown below:

```
Router1#show interfaces tunnel 0
Tunnel0 is up, line protocol is up
<output omitted>
  5 minute input rate 1000 bits/sec, 2 packets/sec
  5 minute output rate 1000 bits/sec, 2 packets/sec
     10 packets input, 1,020 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 input packets with dribble condition detected
     10 packets output, 1,000 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
<output omitted>
```

6. From Router1, you should ping the IPv6 address of Router2 Serial 0/1 on the other side of the tunnel.

```
Router1#ping ipv6 1267:2878:001:2::1
```

7. This ping across the tunnel from Router1 to the IPv6 address of Router2 should succeed.

8. You should issue the **show interfaces tunnel 0** command on Router1 and Router2 to verify that the number of input and output packets has gone up when you compare them to your previously noted values. The following is sample output from Router1:

```
Router1#show interfaces tunnel 0
Tunnel0 is up, line protocol is up
  Hardware is Tunnel
  MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 10.1.0.1, destination 10.1.0.2
  Tunnel protocol/transport IPv6/IP
     Key disabled, sequencing disabled
     Checksumming of packets disabled
  Tunnel TTL 255
  Fast tunneling enabled
  Tunnel transmit bandwidth 8000 (kbps)
  Tunnel receive bandwidth 8000 (kbps)
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of show interface counters 00:04:50
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 1000 bits/sec, 2 packets/sec
  5 minute output rate 1000 bits/sec, 2 packets/sec
     90 packets input, 9,180 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 input packets with dribble condition detected
     88 packets output, 8,996 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

Sample Configuration Scripts

Router1

```
Router1#show running-config
Building configuration...
!
Version 12.3
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router1
ip cef
!
ip subnet-zero
!
interface Tunnel0
 no ip address
 ipv6 address 1267:2878:1:A::1/64
 ipv6 ospf 1 area 0
 tunnel source 10.1.0.1
 tunnel destination 10.1.0.2
 tunnel mode ipv6ip
!
interface Loopback0
 ip address 10.1.5.1 255.255.255.0
 no ip directed broadcast
!
interface Serial0/0
 ip address 10.1.0.1 255.255.255.0
 no ip directed-broadcast
 clock rate 64000
 ipv6 ospf 1 area 0
!
interface Serial0/1
 ip address 10.1.1.1 255.255.255.0
 no ip directed-broadcast
 ip ospf cost 1
 ipv6 ospf 1 area 0
 ipv6 address 1267:2878:1:1::1/64
!
router eigrp 100
 network 10.0.0.0
!
router ospf 1
!
ipv6 router ospf 1
 router-id 10.1.5.1
!
ip classless
no ip http server
!
line con 0
line aux 0
line vty 0 4
!
no scheduler allocate
end
```

Router2

```
Router2#show running-config
Building configuration...
!
Version 12.3
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router2
ip cef
!
ip subnet-zero
!
interface Tunnel0
 no ip address
 ipv6 address 1267:2878:1:A::2/64
 ipv6 ospf 1 area 0
 tunnel source 10.1.0.2
 tunnel destination 10.1.0.1
 tunnel mode ipv6ip
!
interface Loopback0
 ip address 10.1.6.1 255.255.255.0
 no ip directed broadcast
!
interface Serial0/0
 ip address 10.1.0.2 255.255.255.0
 no ip directed-broadcast
 ipv6 ospf 1 area 0
!
interface Serial0/1
 ip address 10.1.2.1 255.255.255.0
 no ip directed-broadcast
 ip ospf cost 1
 ipv6 ospf 1 area 0
 ipv6 address 1267:2878:1:2::1/64
!
router eigrp 100
 network 10.0.0.0
!
router ospf 1
!
ipv6 router ospf 1
 router-id 10.1.6.1
!
ip classless
no ip http server
!
line con 0
line aux 0
line vty 0 4
!
no scheduler allocate
end
```