Implementing IP in IP Tunnel

This chapter module provides conceptual and configuration information for IP in IP tunnels on Cisco ASR 9000 Series Router.

Note
For a complete description of the IP in IP tunnel commands listed in this chapter, see the VPN and Ethernet Services Command Reference for Cisco ASR 9000 Series Routers. To locate documentation of other commands that appear in this chapter, use the command reference master index, or search online.

Table 1: Feature History for IP in IP tunnel

<table>
<thead>
<tr>
<th>Release</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 5.3.1</td>
<td>This feature was introduced on Cisco ASR 9000 Series Router.</td>
</tr>
</tbody>
</table>

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- IP in IP Tunneling: Examples, on page 3

IP in IP Tunneling

IP in IP tunneling refers to the encapsulation of an IP packet as a payload in another IP packet. ASR9K routers support IP in IP tunnels with all possible combinations of IPv4 and IPv6; that is, IPv4 over IPv4, IPv6 over IPv4, IPv4 over IPv6, and IPv6 over IPv6. For example, an IPv4 over IPv6 refers to an IPv4 packet as a payload encapsulated within an IPv6 packet and routed across an IPv6 network to reach the destination IPv4 network, where it is decapsulated.

IP in IP tunneling does not require any additional header such as a GRE header used in the GRE tunnels. So, IP in IP tunneling is preferred over GRE tunnels if both the networks are IP networks.

Restrictions

The following are not supported in IP in IP tunnels:

- MPLS
- Multicast packets
- Keep-Alive packets
- Path MTU (Maximum Transmission Unit) discovery
- DF (Do not Fragment) bit configuration in IPv6 tunnel mode.

**Note**

If DF bit is configured for the tunnel interface, you cannot enable IPv6 tunnel mode.

### Configuring IP in IP Tunnel

Perform the following steps to configure an IP in IP tunnel.

**SUMMARY STEPS**

1. `configure`
2. `interface tunnel-ip tunnel-id`
3. `{ipv4 | ipv6} address ip-address`
4. `tunnel mode {ipv4 | ipv6}`
5. `tunnel source {interface-id | ipv4/v6-address}`
6. `tunnel destination ipv4/v6-address`
7. *(Optional)* `tunnel df-bit {copy | disable}`
8. *(Optional)* `tunnel tos tos-value`
9. `commit`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>configure</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router# configure</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>interface tunnel-ip tunnel-id</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config)# interface tunnel-ip 1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>`{ipv4</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>RP/0/RSP0/CPU0:router(config-if)# ipv6 address 10::1/64</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Purpose

Command or Action | Purpose
--- | ---
Step 4 tunnel mode \{ipv4 | ipv6\} | Sets the tunnel mode as IPv4 or IPv6. This states the tunnel is in an IPv4 or IPv6 transport network.

Example:
RP/0/RSP0/CPU0:router(config-if)# tunnel mode ipv6

Step 5 tunnel source \{interface-id | ipv4/v6-address\} | Specifies an IP address or an interface that serves as the tunnel source. The encapsulated packet uses this IP address as the source address. If the tunnel mode is set to IPv4 or IPv6, an IPv4 or IPv6 address is selected as a tunnel source address from the specified source interface respectively.

Example:
RP/0/RSP0/CPU0:router(config-if)# tunnel source GigabitEthernet0/0/0/0

Step 6 tunnel destination ipv4/v6-address | Specifies the destination IP address for the tunnel. The encapsulated packet uses this IP address as the destination address.

Example:
RP/0/RSP0/CPU0:router(config-if)# tunnel destination 100::2

Step 7 (Optional) tunnel df-bit \{copy | disable\} | Note: This is valid only for a tunnel that uses an IPv4 transport network.

Example:
RP/0/RSP0/CPU0:router(config-if)# tunnel df-bit disable

Step 8 (Optional) tunnel tos tos-value | Sets the TOS value for the outer IP packet in the tunnel.

Example:
RP/0/RSP0/CPU0:router(config-if)# tunnel tos 1

Step 9 commit

IP in IP Tunneling: Examples

The following examples provide configurations for an IPv4 or IPv6 tunnel, with the transport VRF as the default VRF for the following simplified network topology.

Figure 1: IP in IP tunnel network topology

![Figure 1: IP in IP tunnel network topology](image)

Configuration example for an IPv4 tunnel
### PE1 Router Configuration

interface GigabitEthernet0/0/0/0  
!! Link between PE1-PE2  
ipv4 address 100.1.1.1/64  

interface GigabitEthernet0/0/0/1  
!! Link between CE1-PE1  
ipv4 address 20.1.1.1/24  
ipv6 address 20::1/64  

interface tunnel-ip 1  
ipv4 address 10.1.1.1/24  
ipv6 address 10::1/64  
tunnel mode ipv4  
tunnel source GigabitEthernet0/0/0/0  
tunnel destination 100.1.1.2  

router static  
address-family ipv4 unicast  
30.1.1.0/24 tunnel-ip1  
address-family ipv6 unicast  
30::0/64 tunnel-ip1  


### PE2 Router Configuration

interface GigabitEthernet0/0/0/0  
!! Link between PE1-PE2  
ipv4 address 100.1.1.2/64  

interface GigabitEthernet0/0/0/1  
!! Link between PE2-CE2  
ipv4 address 30.1.1.1/24  
ipv6 address 30::1/64  

tunnel mode ipv4  
tunnel source GigabitEthernet0/0/0/0  
tunnel destination 100.1.1.1  

router static  
address-family ipv4 unicast  
20.1.1.0/24 tunnel-ip1  
address-family ipv6 unicast  
20::0/64 tunnel-ip1  


### CE1 Router Configuration

interface GigabitEthernet0/0/0/1  
!! Link between CE1-PE1  
ipv4 address 20.1.1.2 255.255.255.0  
ipv6 address 20::2/64  

router static  
address-family ipv4 unicast  
30.1.1.0/24 20.1.1.1  
address-family ipv6 unicast  
30::0/64 20::1  


### CE2 Router Configuration

interface GigabitEthernet0/0/0/1  
!! Link between CE2-PE2  
ipv4 address 30.1.1.2 255.255.255.0  
ipv6 address 30::2/64  

router static  
address-family ipv4 unicast  
20.1.1.0/24 30.1.1.1  
address-family ipv6 unicast  
20::0/64 30::1  

---

**Configuration example for an IPv6 tunnel**

<table>
<thead>
<tr>
<th>PE1 Router Configuration</th>
<th>PE2 Router Configuration</th>
</tr>
</thead>
</table>
| interface GigabitEthernet0/0/0/0  
!! Link between PE1-PE2  
ipv4 address 100.1.1.1/64  

interface GigabitEthernet0/0/0/1  
!! Link between CE1-PE1  
ipv4 address 20.1.1.1/24  
ipv6 address 20::1/64  

interface tunnel-ip 1  
ipv4 address 10.1.1.1/24  
ipv6 address 10::1/64  
tunnel mode ipv4  
tunnel source GigabitEthernet0/0/0/0  
tunnel destination 100.1.1.2  

router static  
address-family ipv4 unicast  
30.1.1.0/24 tunnel-ip1  
address-family ipv6 unicast  
30::0/64 tunnel-ip1  

<table>
<thead>
<tr>
<th>PE2 Router Configuration</th>
<th>PE1 Router Configuration</th>
</tr>
</thead>
</table>
| interface GigabitEthernet0/0/0/0  
!! Link between PE1-PE2  
ipv4 address 100.1.1.2/64  

interface GigabitEthernet0/0/0/1  
!! Link between PE2-CE2  
ipv4 address 30.1.1.1/24  
ipv6 address 30::1/64  

tunnel mode ipv4  
tunnel source GigabitEthernet0/0/0/0  
tunnel destination 100.1.1.1  

router static  
address-family ipv4 unicast  
20.1.1.0/24 tunnel-ip1  
address-family ipv6 unicast  
20::0/64 tunnel-ip1  

<table>
<thead>
<tr>
<th>CE1 Router Configuration</th>
<th>CE2 Router Configuration</th>
</tr>
</thead>
</table>
| interface GigabitEthernet0/0/0/1  
!! Link between CE1-PE1  
ipv4 address 20.1.1.2 255.255.255.0  
ipv6 address 20::2/64  

router static  
address-family ipv4 unicast  
30.1.1.0/24 20.1.1.1  
address-family ipv6 unicast  
30::0/64 20::1  

<table>
<thead>
<tr>
<th>CE2 Router Configuration</th>
<th>CE1 Router Configuration</th>
</tr>
</thead>
</table>
| interface GigabitEthernet0/0/0/1  
!! Link between CE2-PE2  
ipv4 address 30.1.1.2 255.255.255.0  
ipv6 address 30::2/64  

router static  
address-family ipv4 unicast  
20.1.1.0/24 30.1.1.1  
address-family ipv6 unicast  
20::0/64 30::1  

---

### Implementing IP in IP Tunnel

**IP in IP Tunneling**: Examples
interface GigabitEthernet0/0/0/0
  !! Link between PE1-PE2
  ipv6 address 100::1/64
!
interface GigabitEthernet0/0/0/1
  !! Link between CE1-PE1
  vrf RED
  ipv4 address 20.1.1.1/24
  ipv6 address 20::1/64
!
interface tunnel-ip 1
  vrf RED
  ipv4 address 10.1.1.1/24
  ipv6 address 10::1/64
  tunnel mode ipv6
  tunnel source GigabitEthernet0/0/0/0
  tunnel destination 100::2
!
  vrf RED
  address-family ipv6 unicast
  import route-target
  2:1
  !
  export route-target
  2:1
  !
  address-family ipv4 unicast
  import route-target
  2:1
  !
  export route-target
  2:1
  !
  router static
  vrf RED
  address-family ipv4 unicast
  30.1.1.0/24 tunnel-ip1
  address-family ipv6 unicast
  30::0/64 tunnel-ip1
  !
  !

CE1 Router Configuration

interface GigabitEthernet0/0/0/1
  !! Link between CE1-PE1
  ipv4 address 20.1.1.2 255.255.255.0
  ipv6 address 20::2/64
!
  router static
  address-family ipv4 unicast
  30.1.1.0/24 20.1.1.1
  address-family ipv6 unicast
  30::0/64 20::1
  !
  !

CE2 Router Configuration

interface GigabitEthernet0/0/0/0
  !! Link between PE1-PE2
  ipv4 address 100::2/64
!
interface GigabitEthernet0/0/0/1
  !! Link between PE2-CE2
  vrf RED
  ipv4 address 30.1.1.1/24
  ipv6 address 30::1/64
!
interface tunnel-ip 1
  vrf RED
  ipv4 address 10.1.1.2/24
  ipv6 address 10::2/64
  tunnel mode ipv6
  tunnel source GigabitEthernet0/0/0/0
  tunnel destination 100::1
!
  vrf RED
  address-family ipv6 unicast
  import route-target
  2:1
  !
  export route-target
  2:1
  !
  address-family ipv4 unicast
  import route-target
  2:1
  !
  export route-target
  2:1
  !
  router static
  vrf RED
  address-family ipv4 unicast
  20.1.1.0/24 tunnel-ip1
  address-family ipv6 unicast
  20::0/64 tunnel-ip1
  !
  !