Configuring IP-in-IP Tunnels

This chapter provides conceptual and configuration information for IP-in-IP tunnels.

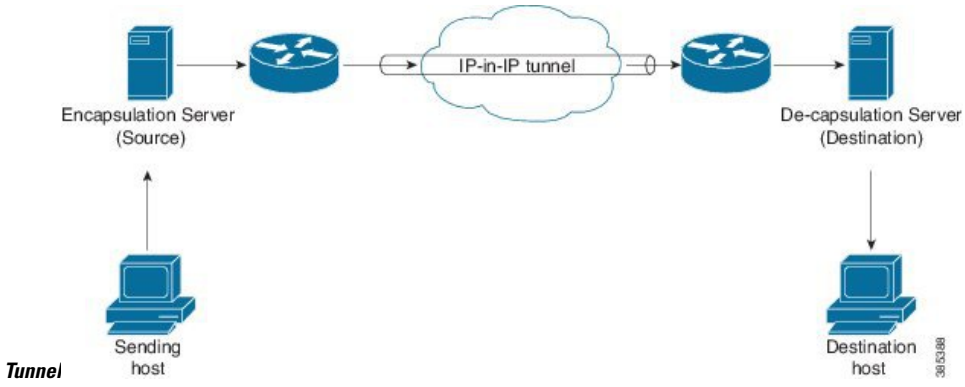
IP-in-IP Decapsulation

Encapsulation of datagrams in a network is done for multiple reasons, such as when a source server wants to influence the route that a packet takes to reach the destination host. The source server is also known as the encapsulation server.

IP-in-IP encapsulation involves the insertion of an outer IP header over the existing IP header. The source and destination address in the outer IP header point to the endpoints of the IP-in-IP tunnel. The stack of IP headers is used to direct the packet over a predetermined path to the destination, provided the network administrator knows the loopback addresses of the routers transporting the packet. This tunneling mechanism can be used for determining availability and latency for most network architectures. It is to be noted that the entire path from source to the destination does not have to be included in the headers, but a segment of the network can be chosen for directing the packets.

The following illustration describes the basic IP-in-IP encapsulation and decapsulation model.

Figure 1: Basic Encapsulation and Decapsulation with an IP-in-IP

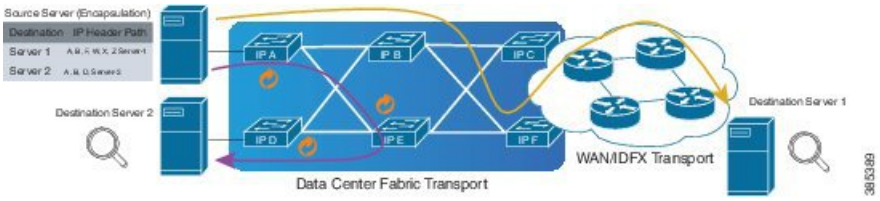


Tunnel

Use Case: Configure IP-in-IP Decapsulation

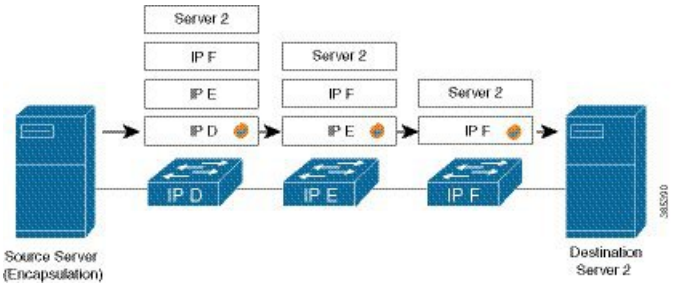
The following topology describes a use case where IP-in-IP encapsulation and decapsulation are used for different segments of the network from source to destination. The IP-in-IP tunnel consists of multiple routers that are used to decapsulate and direct the packet through the data center fabric network.

Figure 2: IP-in-IP Decapsulation Through a Data Center Network



The following illustration shows how the stacked IPv4 headers are de-capsulated as they traverse through the de-capsulating routers.

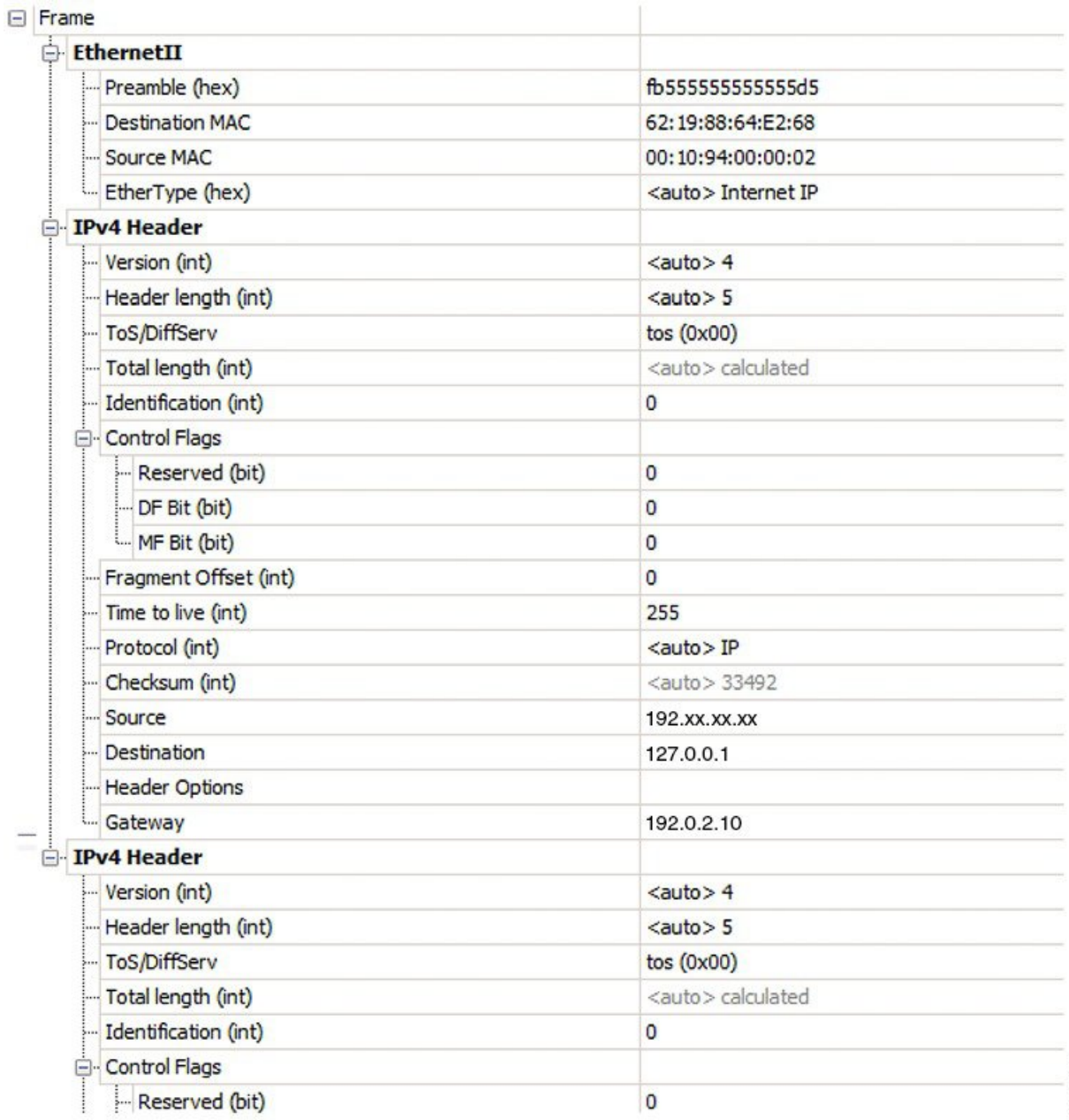
Figure 3: IP Header Decapsulation



Stacked IP Header in an Encapsulated Packet

The encapsulated packet has an outer IPv4 header that is stacked over the original IPv4 header, as shown in the following illustration.

Encapsulated Packet



Configuration

You can use the following sample configuration on the routers to decapsulate the packet as it traverses the IP-in-IP tunnel:

```
RP/0/RP0/CPU0:router(config)# interface tunnel-ip 10
RP/0/RP0/CPU0:router(config-if)# tunnel mode ipv4 decap
RP/0/RP0/CPU0:router(config-if)# tunnel source loopback 0
RP/0/RP0/CPU0:router(config-if)# tunnel destination 10.10.1.2/32
```

- **tunnel-ip**: configures an IP-in-IP tunnel interface.

- **ipv4 unnumbered loopback address**: enables ipv4 packet processing without an explicit address, except for loopback address.
- **tunnel mode ipv4 decap**: enables IP-in-IP decapsulation.
- **tunnel source**: indicates the source address for the IP-in-IP decap tunnel w.r.t the router interface.
- **tunnel destination**: indicates the destination address for the IP-in-IP decap tunnel w.r.t the router interface.

Running Configuration

```
RP/0/RP0/CPU0:router# show running-config interface tunnel-ip 10
...
interface tunnel-ip 10
tunnel mode ipv4 decap
tunnel source Loopback 0
tunnel destination 10.10.1.2/32
```

This completes the configuration of IP-in-IP decapsulation.

Decapsulation Using Tunnel Source Direct

Table 1: Feature History Table

Feature Name	Release Information	Feature Description
Decapsulating Using Tunnel Source Direct		Tunnel source direct allows you to decapsulate the tunnels on any L3 interface on the router. You can use the **tunnel source direct** configuration command to choose the specific IP Equal-Cost Multipath (ECMP) links for troubleshooting, when there are multiple IP links between two devices.

To debug faults in various large networks, you may have to capture and analyze the network traffic at a packet level. In datacenter networks, administrators face problems with the volume of traffic and diversity of faults. To troubleshoot faults in a timely manner, DCN administrators must identify affected packets inside large volumes of traffic. They must track them across multiple network components, analyze traffic traces for fault patterns, and test or confirm potential causes.

In some networks, IP-in-IP decapsulation is currently used in network management, to verify ECMP availability and to measure the latency of each path within a datacenter.

The Network Management System (NMS) sends IP-in-IP (IPv4 or IPv6) packets with a stack (multiple) of predefined IPv4 or IPv6 headers (device IP addresses). The destination device at each hop removes the outside header, performs a lookup on the next header, and forwards the packets if a route exists.

Using the **tunnel source direct** command, you can choose the specific IP Equal-Cost Multipath (ECMP) links for troubleshooting, when there are multiple IP links between two devices.

Tip You can programmatically configure and manage the Ethernet interfaces using `openconfig-ethernet-if.yang` and `openconfig-interfaces.yang` OpenConfig data models. To get started with using data models, see the *Programmability Configuration Guide for Cisco NCS 5500 Series Routers*.

Guidelines and Limitations

The following guidelines are applicable to this feature.

- The **tunnel source direct** command is supported only with the tunnel mode as **decap** (when an administrator uses the IP-in-IP decapsulation).
- The source-direct tunnel is always operationally `up` unless it is administratively shut down. The directly connected interfaces are identified using the **show ip route direct** command.
- The **tunnel source direct** command is supported only in IP-in-IP tunneling `decap` mode.
- All Layer 3 interfaces that are configured on the device are supported.
- Any inline modification of the **tunnel source direct** command like **tunnel source** *interface | IP address* is not supported. You must delete the tunnel and recreate it.
- Only one source-direct tunnel per address-family is supported for configuration.
- Regular decapsulation tunnels which have specific source address, are supported. However, the tunnel's specific source address must not be part of any interface.

The following functionalities are not supported for the **tunnel source direct** option.

- GRE tunneling mode.
- VRF (only default VRF is supported).
- ACL and QoS on the tunnels.
- Tunnel encapsulation.
- Tunnel NetIO DLL: Decapsulation is not supported if the packet is punted to slow path.

Configuration

The **tunnel source direct** configures IP-in-IP tunnel decapsulation on any directly connected IP addresses. This option is now supported only when the IP-in-IP decapsulation is used to source route the packets through the network.

This example shows how to configure IP-in-IP tunnel decapsulation on directly connected IP addresses:

```
Router# configure terminal
Router(config)#interface Tunnel4
  Router(config)#tunnel mode ipv4 decap
  Router(config)#tunnel source direct
  Router(config)#no shutdown
```

This example shows how to configure IP-in-IP tunnel decapsulation on IPv6 enabled networks:

```
Router# configure terminal
Router(config)#interface Tunnel6
  Router(config)#tunnel mode ipv6 decap
```

```
  Router(config)#tunnel source direct
  Router(config)#no shutdown
```

Verifying the Configuration

The following example shows how to verify IP-in-IP tunnel decapsulation with **tunnel source direct** option:

```
Router#show running-config interface tunnel 1
interface Tunnel1
  tunnel mode ipv6ipv6 decapsulate-any
  tunnel source direct
  no shutdown

Router#show interface tunnel 1
Tunnel1 is up    Admin State: up
MTU 1460 bytes, BW 9 Kbit
Tunnel protocol/transport IPv6/DECAPANY/IPv6
Tunnel source - direct
Tx    0 packets output, 0 bytes    Rx    0 packets input, 0 bytes
```