

Chapter 24

IPv4-to-IPv6 Transition

Implementing IPv6 requires a transition mechanism to allow interoperability between IPv6 nodes (both routers and hosts) and IPv4 nodes. The transition mechanism is the key factor in the successful deployment of IPv6. Because millions of IPv4 nodes already exist, upgrading every node to IPv6 at the same time is not feasible.

As a result, transition from IPv4 to IPv6 happens gradually, allowing nodes to be upgraded independently and without disruption to other nodes. While a gradual upgrade occurs, compatibility between IPv6 and IPv4 nodes becomes a requirement. Otherwise, an IPv6 node would not be able to communicate with an IPv4 node.

Transition mechanisms allow IPv6 and IPv4 nodes to coexist together in the same network, and make gradual upgrading possible. Two transition mechanisms are supported by the JUNOS Internet software:

Dual IP layer operation—Allows a node to support both IPv6 and IPv4 Internet protocols. This mechanism is also known as dual stack.

Configured tunnels—Allows IPv6 packets to be encapsulated into IPv4 headers and sent across an IPv4 infrastructure.

Dual IP Layer

Dual IP layer is a transition mechanism in which a node (router or host) supports both IPv6 and IPv4 simultaneously. Dual IP layer support indicates a node's ability to send and receive both IPv6 and IPv4 packets. This transition mechanism involves no data encapsulation (such as tunneling). A node that has dual IP layer capabilities can interoperate with IPv6 nodes and IPv4 nodes directly.

The JUNOS Internet software supports dual IP layer.

A node that supports dual IP layer can disable one of the IP layers. If a dual IP layer node disables the IPv6 layer, the node acts as an IPv4 node only. If that node disables the IPv4 layer, that node acts as an IPv6 node only.

This section discusses the following topics that provide background information about dual IP layer:

Address Configuration on page 286

DNS on page 286

Address Configuration

You can configure a dual IP layer node with either an IPv6 address or an IPv4 address. A dual IP layer node can acquire its IPv6 address through an IPv6 mechanism (such as stateless address autoconfiguration) and its IPv4 address through an IPv4 mechanism (such as the Dynamic Host Control Protocol [DHCP]).

DNS

The Domain Name System (DNS) uses resource records and resolver libraries to map between IP addresses and hostnames. IPv4 uses record type A, while IPv6 uses record type AAAA. Dual IP layer nodes provide resolver libraries that can handle the new record types.

When a query locates an AAAA record holding an IPv6 address, and an A record holding an IPv4 address, the resolver library sends back one of the following types of addresses to the application making the query:

IPv4 address

IPv6 address

Both an IPv4 address and an IPv4 address

If the library sends back an IPv4 address, the application making the query uses IPv4 to communicate with the node. If the library sends back an IPv6 address, the application making the query uses IPv6 to communicate with the node. If the library sends back both IPv6 and IPv4 addresses, the application must choose based on the ordering of the addresses sent by the resolver library. If an IPv6 address is the first in the order, the application chooses IPv6. If an IPv4 address is first in the order, the application chooses IPv4.

Configured Tunnels

If you have a Tunnel Physical Interface Card (PIC) installed in your router, you can configure IPv6 over IPv4 tunnels. The JUNOS Internet software supports the IP over IP (IP-IP) and generic routing encapsulation (GRE) tunnel encapsulations.

A configured tunnel is a point-to-point connection across an existing IPv4 network infrastructure. IPv6 packets are encapsulated in IPv4 headers and sent across the IPv4 infrastructure through the configured tunnel. You manually configure configured tunnels on each end point.

A configured tunnel cannot go through Network Address Translation (NAT) at any point along the way to the destination.

This section discusses the following topics:

Configured Tunnel Standards on page 287

Establish a Configured Tunnel on page 287

Summary of Configured Tunnel Configuration Statements on page 289

Configured Tunnel Standards

The JUNOS software supports configured IPv6-over-IPv4 tunnels, which are defined in the following document:

RFC 2893, *Transition Mechanisms for IPv6 Hosts and Routers*

To access Internet Requests for Comments (RFCs), see <http://www.ietf.org>.

Establish a Configured Tunnel

To configure a tunnel, use an ip interface (to use IP-IP encapsulation) or a gr interface (to use GRE encapsulation), and then include the tunnel statement.

To configure a tunnel using IP-IP encapsulation, include the following statements at the [edit interfaces] hierarchy level:

```
[edit interfaces]
ip-fpc/pic/port {
  unit logical-unit-number {
    tunnel {
      source address;
      destination address;
    }
    family inet6 {
      address address;
    }
  }
}
```

To configure a configured tunnel using GRE encapsulation, include the following statements at the [edit interfaces] hierarchy level:

```
[edit interfaces]
gr-fpc/pic/port {
  unit logical-unit-number {
    tunnel {
      source address;
      destination address;
    }
    family inet6 {
      address address;
    }
  }
}
```

You can configure multiple logical units for each interface. You can configure only one tunnel per unit.

Each tunnel interface must be a point-to-point interface. Point-to-point is the default interface connection type, so you do not need to include the point-to-point statement at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level.

You must specify the configured tunnel's destination and source addresses. The remaining statements are optional.

You must configure the inet6 address family on the logical interface to create a configured tunnel.

Configured tunnels are bidirectional.

Examples: Configure a Tunnel

Configure a tunnel on both sides of the connection:

Router 1:

```
[edit]
interfaces {
  gr-1/0/0 {
    unit 0 {
      tunnel {
        source 10.19.2.1;
        destination 10.19.3.1;
      }
      family inet6 {
        address 7019::1/126;
      }
    }
  }
}
```

Router 2:

```
[edit]
interfaces {
  gr-1/0/0 {
    unit 0 {
      tunnel {
        source 10.19.3.1;
        destination 10.19.2.1;
      }
      family inet6 {
        address 7019::2/126;
      }
    }
  }
}
```

Summary of Configured Tunnel Configuration Statements

The following sections explain each of the interface configuration statements for configured tunnels. The statements are organized alphabetically.

address

Syntax	address <i>address</i> { destination <i>address</i> ; primary; preferred; }
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> family <i>family</i>]
Description	Configure the interface address.
Options	<i>address</i> —Address of the interface.
Usage Guidelines	See “Configure the IPv6 Address on an Interface” on page 42 and “Establish a Configured Tunnel” on page 287.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

destination

Syntax	destination <i>destination-address</i> ;
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> family <i>family</i> address <i>address</i>] [edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> tunnel]
Description	For point-to-point interfaces only, specify the address of the interface at the remote end of the connection. For tunnel interfaces, specify the remote address of the tunnel.
Options	<i>destination-address</i> —Address of the remote side of the connection. This is an IPv4 address.
Usage Guidelines	See “Establish a Configured Tunnel” on page 287 and “Configure the IPv6 Family on the Interface” on page 42.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

family

```
Syntax family family {
    mtu bytes;
    address address {
        destination destination-address;
        primary;
        preferred;
    }
}
```

Hierarchy Level [edit interfaces *interface-name* unit *logical-unit-number*]

Description Configure protocol family information for the logical interface.

Options *family*—Protocol family:

inet6—Internet Protocol version 6 suite

inet—Internet Protocol version 4 suite

iso—Open Systems Interconnection (OSI) International Organization for Standardization (ISO) protocol suite

mlfr—Multilink Frame Relay

mpls—Multiprotocol Label Switching

multilink-ppp—Multilink Point-to-Point Protocol

tnp—Trivial Network Protocol

Usage Guidelines See “Configure the IPv6 Family on the Interface” on page 42.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

interfaces

```
Syntax interfaces { ... }
```

Hierarchy Level [edit]

Description Configure interfaces on the router.

Default The management and internal Ethernet interfaces are automatically configured. You must configure all other interfaces.

Usage Guidelines See “IPv6 Interface Configuration Guidelines” on page 35.

Required Privilege Level interface—To view this statement in the configuration.
interface-control—To add this statement to the configuration.

mtu

Syntax	mtu <i>bytes</i> ;
Hierarchy Level	[edit interfaces <i>interface-name</i>], [edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> family <i>family</i>]
Description	Maximum transmission unit (MTU) size for the media or protocol. The default MTU size depends on the device type. Not all devices allow you to set an MTU value, and some devices have restrictions on the range of allowable MTU values.
Options	<i>bytes</i> —MTU size. Range: 0 through 5012 bytes
Usage Guidelines	See “Configure the IPv6 Family on the Interface” on page 42.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

preferred

Syntax	preferred;
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> family <i>family</i> address <i>address</i>]
Description	Configure this address to be the preferred address on the interface. If you configure more than one address on the same subnet, the preferred source address is chosen by default as the source address when you originate packets to destinations on the subnet.
Default	The lowest numbered address on the subnet is the preferred address.
Usage Guidelines	See “Configure the Preferred Address for an Interface” on page 44.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

primary

Syntax	primary;
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> family <i>family</i> address <i>address</i>]
Description	Configure this address to be the primary address of the protocol on the interface. If the logical unit has more than one address, the primary address is used by default as the source address when packets originate from the interface and the destination does not indicate the subnet.
Default	For unicast traffic, the primary address is the lowest non-127 preferred address on the unit.
Usage Guidelines	See “Configure the Primary Address for an Interface” on page 43.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

source

Syntax	<code>source source-address;</code>
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i> tunnel <i>destination-address</i>]
Description	Specify the source address of the tunnel.
Default	If you do not specify a source address, the tunnel uses the unit's primary address as the source address of the tunnel.
Options	<i>source-address</i> —Address of the local side of the tunnel. This is the address that is placed in the outer IP header's source field. This is an IPv4 address.
Usage Guidelines	See "Establish a Configured Tunnel" on page 287 and "IPv6 Interface Configuration Guidelines" on page 35.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

tunnel

Syntax	tunnel { destination <i>destination-address</i> ; source <i>source-address</i> ; }
Hierarchy Level	[edit interfaces <i>interface-name</i> unit <i>logical-unit-number</i>]
Description	Configure a tunnel. You can use the tunnel for unicast and multicast traffic or just for multicast traffic.
Options	The statements are explained separately.
Usage Guidelines	See "Establish a Configured Tunnel" on page 287.
Required Privilege Level	interface—To view this statement in the configuration. interface-control—To add this statement to the configuration.

unit

```

Syntax  unit logical-unit-number {
            tunnel {
                source source-address;
                destination destination-address;
            }
            family family {
                mtu bytes;
                address address {
                    destination destination-address;
                    primary;
                    preferred;
                }
            }
        }

```

Hierarchy Level [edit interfaces *interface-name*]

Description Configure a logical interface on the physical device. You must configure a logical interface to be able to use the physical device.

Options *number*—Number of the logical unit.
Range: 0 through 65,535

The remaining statements are explained separately.

Usage Guidelines See “Specify the Logical Interface Number” on page 41.

Required Privilege Level interface—To view this statement in the configuration.
 interface-control—To add this statement to the configuration.

