



Manually Configured IPv6 over IPv4 Tunnels

This feature provides support for manually configured IPv6 over IPv4 tunnels. A manually configured tunnel is equivalent to a permanent link between two IPv6 domains over an IPv4 backbone.

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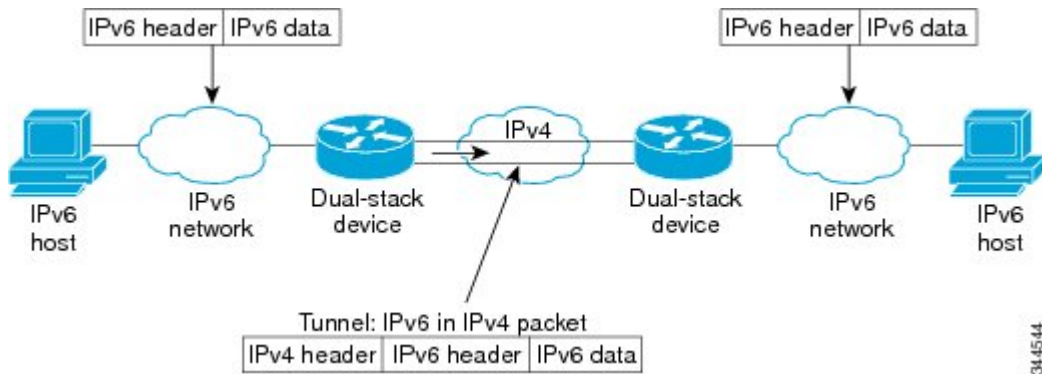
Information About Manually Configured IPv6 over IPv4 Tunnels

Overlay Tunnels for IPv6

Overlay tunneling encapsulates IPv6 packets in IPv4 packets for delivery across an IPv4 infrastructure (a core network or the figure below). By using overlay tunnels, you can communicate with isolated IPv6 networks without upgrading the IPv4 infrastructure between them. Overlay tunnels can be configured between border devices or between a border device and a host; however, both tunnel endpoints must support both the IPv4 and IPv6 protocol stacks. IPv6 supports the following types of overlay tunneling mechanisms:

- Manual
- Generic routing encapsulation (GRE)
- IPv4-compatible
- 6to4
- Intrasite Automatic Tunnel Addressing Protocol (ISATAP)

Figure 1: Overlay Tunnels



Note Overlay tunnels reduce the maximum transmission unit (MTU) of an interface by 20 octets (assuming that the basic IPv4 packet header does not contain optional fields). A network that uses overlay tunnels is difficult to troubleshoot. Therefore, overlay tunnels that connect isolated IPv6 networks should not be considered a final IPv6 network architecture. The use of overlay tunnels should be considered as a transition technique toward a network that supports both the IPv4 and IPv6 protocol stacks or just the IPv6 protocol stack.

Use the table below to help you determine which type of tunnel that you want to configure to carry IPv6 packets over an IPv4 network.

Table 1: Suggested Usage of Tunnel Types to Carry IPv6 Packets over an IPv4 Network

Tunneling Type	Suggested Usage	Usage Notes
Manual	Simple point-to-point tunnels that can be used within a site or between sites.	Can carry IPv6 packets only.
GRE- and IPv4-compatible	Simple point-to-point tunnels that can be used within a site or between sites.	Can carry IPv6, Connectionless Network Service (CLNS), and many other types of packets.
IPv4-compatible	Point-to-multipoint tunnels.	Uses the <code>::/96</code> prefix. We do not recommend using this tunnel type.
6to4	Point-to-multipoint tunnels that can be used to connect isolated IPv6 sites.	Sites use addresses from the <code>2002::/16</code> prefix.
6RD	IPv6 service is provided to customers over an IPv4 network by using encapsulation of IPv6 in IPv4.	Prefixes can be from the SP's own address block.
ISATAP	Point-to-multipoint tunnels that can be used to connect systems within a site.	Sites can use any IPv6 unicast addresses.

Individual tunnel types are discussed in detail in this document. We recommend that you review and understand the information about the specific tunnel type that you want to implement. When you are familiar with the

type of tunnel you need, see the table below for a summary of the tunnel configuration parameters that you may find useful.

Table 2: Tunnel Configuration Parameters by Tunneling Type

Tunneling Type	Tunnel Configuration Parameter			
Tunnel Mode	Tunnel Source	Tunnel Destination	Interface Prefix or Address	
Manual	ipv6ip	An IPv4 address, or a reference to an interface on which IPv4 is configured.	An IPv4 address.	An IPv6 address.
GRE/IPv4	gre ip		An IPv4 address.	An IPv6 address.
IPv4- compatible	ipv6ip auto-tunnel		Not required. These are all point-to-multipoint tunneling types. The IPv4 destination address is calculated, on a per-packet basis, from the IPv6 destination.	Not required. The interface address is generated as <code>::tunnel-source/96</code> .
6to4	ipv6ip 6to4			An IPv6 address. The prefix must embed the tunnel source IPv4 address.
6RD	ipv6ip 6rd			An IPv6 address.
ISATAP	ipv6ip isatap			An IPv6 prefix in modified eui-64 format. The IPv6 address is generated from the prefix and the tunnel source IPv4 address.

IPv6 Manually Configured Tunnels

A manually configured tunnel is equivalent to a permanent link between two IPv6 domains over an IPv4 backbone. The primary use is for stable connections that require regular secure communication between two edge devices or between an end system and an edge device, or for connection to remote IPv6 networks.

An IPv6 address is manually configured on a tunnel interface, and manually configured IPv4 addresses are assigned to the tunnel source and the tunnel destination. The host or device at each end of a configured tunnel must support both the IPv4 and IPv6 protocol stacks. Manually configured tunnels can be configured between border devices or between a border device and a host. Cisco Express Forwarding switching can be used for IPv6 manually configured tunnels, or Cisco Express Forwarding switching can be disabled if process switching is needed.

How to Enable Manually Configured IPv6 over IPv4 Tunnels

Configuring Manual IPv6 Tunnels

Before you begin

With manually configured IPv6 tunnels, an IPv6 address is configured on a tunnel interface, and manually configured IPv4 addresses are assigned to the tunnel source and the tunnel destination. The host or device at each end of a configured tunnel must support both the IPv4 and IPv6 protocol stacks.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface tunnel *tunnel-number***
4. Enter one of the following commands:
 - **ipv6 address** {*ipv6-address/prefix-length* | *prefix-name sub-bits/prefix-length*}
 - **ipv6 address** *ipv6-prefix/prefix-length* [**eui-64**]
5. **tunnel source** {*ip-address* | *interface-type interface-number*}
6. **tunnel destination** *ip-address*
7. **tunnel mode ipv6ip**
8. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	enable Example: <pre>Device> enable</pre>	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	interface tunnel <i>tunnel-number</i> Example: <pre>Device(config)# interface tunnel 0</pre>	Specifies a tunnel interface and number, and enters interface configuration mode.
Step 4	Enter one of the following commands: • ipv6 address {<i>ipv6-address/prefix-length</i> <i>prefix-name sub-bits/prefix-length</i>} • ipv6 address <i>ipv6-prefix/prefix-length</i> [eui-64] Example: <pre>Device(config-if)# ipv6 address 3ffe:b00:c18:1::3/127</pre>	Specifies the IPv6 network assigned to the interface and enables IPv6 processing on the interface. • If you specify the eui-64 keyword, the software configures an IPv6 address for an interface and enables IPv6 processing on the interface using an EUI-64 interface ID in the low-order 64 bits of the address. Note See the “Implementing IPv6 Addressing and Basic Connectivity” module for more information on configuring IPv6 addresses.
Step 5	tunnel source { <i>ip-address</i> <i>interface-type interface-number</i> }	Specifies the source IPv4 address or the source interface type and number for the tunnel interface.

	Command or Action	Purpose
	Example: Device(config-if)# tunnel source gigabitethernet 0/0/0	If an interface is specified, the interface must be configured with an IPv4 address.
Step 6	tunnel destination <i>ip-address</i> Example: Device(config-if)# tunnel destination 192.168.30.1	Specifies the destination IPv4 address or hostname for the tunnel interface.
Step 7	tunnel mode ipv6ip Example: Device(config-if)# tunnel mode ipv6ip	Specifies a manual IPv6 tunnel. Note The tunnel mode ipv6ip command specifies IPv6 as the passenger protocol and IPv4 as both the encapsulation and transport protocol for the manual IPv6 tunnel.
Step 8	end Example: Device(config-if)# end	Returns to privileged EXEC mode.

Configuration Examples for Manually Configured IPv6 over IPv4 Tunnels

Example: Configuring Manual IPv6 Tunnels

The following example configures a manual IPv6 tunnel between router A and router B. In the example, tunnel interface 0 for both router A and router B is manually configured with a global IPv6 address. The tunnel source and destination addresses are also manually configured.

Router A Configuration

```
interface ethernet 0
 ip address 192.168.99.1 255.255.255.0
interface tunnel 0
 ipv6 address 3ffe:b00:c18:1::3/127
 tunnel source ethernet 0
 tunnel destination 192.168.30.1
 tunnel mode ipv6ip
```

Router B Configuration

```
interface ethernet 0
 ip address 192.168.30.1 255.255.255.0
interface tunnel 0
 ipv6 address 3ffe:b00:c18:1::2/127
```

```
tunnel source ethernet 0
tunnel destination 192.168.99.1
tunnel mode ipv6ip
```

Example: IPv6 over GRE IPv4 Tunnel

Example: Configuring CE1

```
!
ipv6 unicast-routing
ipv6 cef
!
interface Ethernet0/0
no ip address
ipv6 address 2001:DB8:2:1::1/64
no shutdown
exit
!
!
ipv6 route 2001:DB8:2:2::/64 2001:DB8:2:1::2
ipv6 route 2001:DB8:2:4::/64 2001:DB8:2:1::2
!
```

Example: Configuring PE1

```
ipv6 unicast-routing
ipv6 cef
!
interface Tunnel0
no ip address
ipv6 address 2001:DB8:2:4::1/64
tunnel source 10.22.22.22
tunnel destination 10.44.44.44
exit
!
interface Ethernet0/0
no ip address
ipv6 address 2001:DB8:2:1::2/64
no shutdown
exit
!
interface Ethernet1/1
no ip address
ip address 10.22.22.22 255.255.255.0
no shutdown
exit
!
ip route 10.44.44.0 255.255.255.0 10.22.22.23
ipv6 route 2001:DB8:2:2::/64 Tunnel0 2001:DB8:2:4::2
```

Example: Configuring PE2

```
!
ipv6 unicast-routing
```

```

ipv6 cef
!
interface Tunnel0
 no ipv6 address
 ipv6 address 2001:DB8:2:4::2/64
 tunnel source 10.44.44.44
 tunnel destination 10.22.22.22
 exit
!
interface Ethernet0/0 no ipv6 address
 ipv6 address 2001:DB8:2:2::1/64
 no shutdown
 exit
!
interface Ethernet1/0
 no ip address
 ip address 10.44.44.44 255.255.255.0
 no shutdown
 exit
!
ip route 10.22.22.0 255.255.255.0 10.44.44.43
!
ipv6 route 2001:DB8:2:1::/64 Tunnel0 2001:DB8:2:4::1
!

```

Example: Configuring CE2

```

!
ipv6 unicast-routing
ipv6 cef
!
!
interface Ethernet0/0
 no ipv6 address
 ipv6 address 2001:DB8:2:2::2/64
 no shutdown
 exit
!
!
ipv6 route 2001:DB8:2:1::/64 2001:DB8:2:2::1
ipv6 route 2001:DB8:2:4::/64 2001:DB8:2:2::1
!

```

Example: Configuring Device X

```

!
interface Ethernet1/0
 no ip address
 ip address 10.44.44.43 255.255.255.0
 no shutdown
 exit
!
interface Ethernet1/1
 no ip address
 ip address 10.22.22.23 255.255.255.0
 no shutdown
 exit

```

!

Example: Verifying the Tunnel Configuration

From CE1

```
Device# ping ipv6 2001:db8:2:2::2
```

Type escape sequence to abort.

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

!!!!

Success rate is 100 percent (5/5), round-trip min/avg/max = 1/9/43 ms

```
Device# ping ipv6 2001:db8:2:2::2 source 2001:db8:2:1::1
```

Type escape sequence to abort.

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

Packet sent with a source address of 2001:DB8:2:1::1

!!!!

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

From PE1

```
Device# show tunnel interface
```

Tunnel0

Mode:GRE/IP, Destination 10.44.44.44, Source 10.22.22.22

IP transport: output interface Ethernet1/1 next hop 10.22.22.23

Application ID 1: unspecified

Linestate - current up

Internal linestate - current up, evaluated up

Tunnel Source Flags: Local

Transport IPv4 Header DF bit cleared

OCE: IP tunnel decap

Provider: interface Tu0, prot 47

Performs protocol check [47]

Protocol Handler: GRE: opt 0x0

ptype: ipv4 [ipv4 dispatcher: punt]

ptype: ipv6 [ipv6 dispatcher: from if Tu0]

ptype: mpls [mpls dispatcher: drop]

ptype: otv [mpls dispatcher: drop]

ptype: generic [mpls dispatcher: drop]

There are 0 tunnels running over the EON IP protocol

There are 0 tunnels running over the IPinIP protocol

There are 0 tunnels running over the NOSIP protocol

There are 0 tunnels running over the IPv6inIP protocol

There are 0 tunnels running over the RBSCP/IP protocol

```
Device# show ip route 10.44.44.44
```

Routing entry for 10.44.44.0/24

Known via "static", distance 1, metric 0

Routing Descriptor Blocks:

* 10.22.22.23

Route metric is 0, traffic share count is 1

```
Device# debug ipv6 icmp
```

ICMP Packet debugging is on

```
*Jan  1 10:57:37.882: ICMPv6: Sent R-Advert, Src=FE80::A8BB:CCFF:FE00:5200, Dst=FF02::1
*Jan  1 11:00:18.634: ICMPv6: Received R-Advert, Src=FE80::A8BB:CCFF:FE00:5200, Dst=FF02::1
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	<i>IPv6 Configuration Guide</i>
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	<i>IPv6 RFCs</i>

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Manually Configured IPv6 over IPv4 Tunnels

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 3: Feature Information for Manually Configured IPv6 over IPv4 Tunnels

Feature Name	Releases	Feature Information
IPv6 Tunneling: Manually Configured IPv6 over IPv4 Tunnels	Cisco IOS XE Release 2.1	A manually configured tunnel is equivalent to a permanent link between two IPv6 domains over an IPv4 backbone. The following commands were introduced or modified: tunnel destination, tunnel ipv6ip, tunnel source.