



IP over IPv6 Tunnels

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IPv6 supports IP over IPv6 tunnels, which includes the following:

- **Overlay tunneling**—Encapsulates IPv6 packets in IPv4 packets for delivery across an IPv4 infrastructure (a core network or the Internet). By using overlay tunnels, you can communicate with isolated IPv6 networks without upgrading the IPv4 infrastructure between them.
 - **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.
 - **Generic routing encapsulation (GRE) IPv4 tunnel support for IPv6 traffic**—IPv6 traffic can be carried over IPv4 GRE tunnels using the standard GRE tunneling technique that is designed to provide the services to implement any standard point-to-point encapsulation scheme. The primary use of GRE tunnels is for stable connections that require regular secure communication between two edge devices or between an edge device and an end system. The edge devices and the end systems must be dual-stack implementations.
 - **GRE support over IPv6 transport**—GRE has a protocol field that identifies the passenger protocol. GRE tunnels allow Intermediate System-to-Intermediate System (IS-IS) or IPv6 to be specified as a passenger protocol, which allows both IS-IS and IPv6 traffic to run over the same tunnel.
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Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.



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Information About IP over IPv6 Tunnels

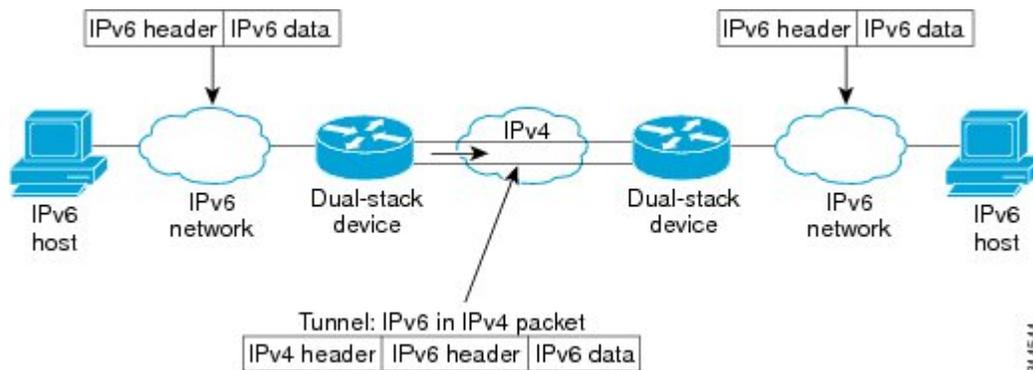
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Overlay Tunnels for IPv6

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-compatible 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 ::/96 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 2002::/16 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.

Tunneling Type	Tunnel Configuration Parameter		
		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.

GRE IPv4 Tunnel Support for IPv6 Traffic

IPv6 traffic can be carried over IPv4 GRE tunnels using the standard GRE tunneling technique that is designed to provide the services to implement any standard point-to-point encapsulation scheme. As in IPv6 manually configured tunnels, GRE tunnels are links between two points, with a separate tunnel for each link. The tunnels are not tied to a specific passenger or transport protocol but, in this case, carry IPv6 as the passenger protocol with the GRE as the carrier protocol and IPv4 or IPv6 as the transport protocol.

The primary use of GRE tunnels is for stable connections that require regular secure communication between two edge devices or between an edge device and an end system. The edge devices and the end systems must be dual-stack implementations.

GRE Support over IPv6 Transport

GRE has a protocol field that identifies the passenger protocol. GRE tunnels allow Intermediate System-to-Intermediate System (IS-IS) or IPv6 to be specified as a passenger protocol, which allows both IS-IS and IPv6 traffic to run over the same tunnel. If GRE did not have a protocol field, it would be impossible to distinguish whether the tunnel was carrying IS-IS or IPv6 packets. The GRE protocol field makes it desirable to tunnel IS-IS and IPv6 inside GRE.

How to Configure IP over IPv6 Tunnels

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Configuring Manual IPv6 Tunnels

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

Command or Action	Purpose
Step 1 enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 interface tunnel <i>tunnel-number</i></p> <p>Example:</p> <pre>Device(config)# interface tunnel 0</pre>	<p>Specifies a tunnel interface and number, and enters interface configuration mode.</p>
<p>Step 4 Enter one of the following commands:</p> <ul style="list-style-type: none"> • 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] <p>Example:</p> <pre>Device(config-if)# ipv6 address 3ffe:b00:c18:1::3/127</pre>	<p>Specifies the IPv6 network assigned to the interface and enables IPv6 processing on the interface.</p> <ul style="list-style-type: none"> • 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. <p>Note See the “Implementing IPv6 Addressing and Basic Connectivity” module for more information on configuring IPv6 addresses.</p>
<p>Step 5 tunnel source { <i>ip-address</i> <i>interface-type interface-number</i> }</p> <p>Example:</p> <pre>Device(config-if)# tunnel source gigabitethernet 0/0/0</pre>	<p>Specifies the source IPv4 address or the source interface type and number for the tunnel interface.</p> <ul style="list-style-type: none"> • If an interface is specified, the interface must be configured with an IPv4 address.
<p>Step 6 tunnel destination <i>ip-address</i></p> <p>Example:</p> <pre>Device(config-if)# tunnel destination 192.168.30.1</pre>	<p>Specifies the destination IPv4 address or hostname for the tunnel interface.</p>
<p>Step 7 tunnel mode ipv6ip</p> <p>Example:</p> <pre>Device(config-if)# tunnel mode ipv6ip</pre>	<p>Specifies a manual IPv6 tunnel.</p> <p>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.</p>

Command or Action	Purpose
Step 8 <code>end</code> Example: Device(config-if)# <code>end</code>	Returns to privileged EXEC mode.

Configuring GRE on IPv6 Tunnels

GRE tunnels can be configured to run over an IPv6 network layer and to transport IPv4 and IPv6 packets in IPv6 tunnels.

When GRE IPv6 tunnels are configured, IPv6 addresses are assigned to the tunnel source and the tunnel destination. The tunnel interface can have either IPv4 addresses or IPv6 addresses assigned (this is not shown in the task). 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 | ipv6-address | interface-type interface-number}`
6. `tunnel destination {hostname | ip-address | ipv6-address}`
7. `tunnel mode {aurp | cayman | dvmrp | eon | gre | gre multipoint | gre ipv6 | ipip [decapsulate-any] | iptalk | ipv6 | mpls | nos}`
8. `end`

DETAILED STEPS

Command or Action	Purpose
Step 1 <code>enable</code> Example: Device> <code>enable</code>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Device# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 <code>interface tunnel <i>tunnel-number</i></code></p> <p>Example:</p> <pre>Device(config)# interface tunnel 0</pre>	<p>Specifies a tunnel interface and number, and enters interface configuration mode.</p>
<p>Step 4 Enter one of the following commands:</p> <ul style="list-style-type: none"> • <code>ipv6 address {<i>ipv6-address/prefix-length</i> <i>prefix-name sub-bits/prefix-length</i>}</code> • <code>ipv6 address <i>ipv6-prefix/prefix-length</i> [eui-64]</code> <p>Example:</p> <pre>Device(config-if)# ipv6 address 3ffe:b00:c18:1::3/127</pre>	<p>Specifies the IPv6 network assigned to the interface and enables IPv6 processing on the interface.</p> <ul style="list-style-type: none"> • 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.
<p>Step 5 <code>tunnel source {<i>ip-address</i> <i>ipv6-address</i> <i>interface-type interface-number</i>}</code></p> <p>Example:</p> <pre>Device(config-if)# tunnel source gigabitethernet 0/0/0</pre>	<p>Specifies the source IPv4 address, IPv6 address, or the source interface type and number for the tunnel interface.</p> <ul style="list-style-type: none"> • If an interface is specified, the interface must be configured with an IPv4 address.
<p>Step 6 <code>tunnel destination {<i>hostname</i> <i>ip-address</i> <i>ipv6-address</i>}</code></p> <p>Example:</p> <pre>Device(config-if)# tunnel destination 2001:DB8:1111:2222::1/64</pre>	<p>Specifies the destination IPv4 address, IPv6 address, or hostname for the tunnel interface.</p>
<p>Step 7 <code>tunnel mode {<i>aurp</i> <i>cayman</i> <i>dvmrp</i> <i>eon</i> <i>gre</i> <i>gre multipoint</i> <i>gre ipv6</i> <i>ipip</i> [<i>decapsulate-any</i>] <i>iptalk</i> <i>ipv6</i> <i>mpls</i> <i>nos</i>}</code></p> <p>Example:</p> <pre>Device(config-if)# tunnel mode gre ipv6</pre>	<p>Specifies a GRE IPv6 tunnel.</p> <p>Note The <code>tunnel mode gre ipv6</code> command specifies GRE as the encapsulation protocol for the tunnel.</p>

Command or Action	Purpose
Step 8 end Example: Device(config-if)# end	Returns to privileged EXEC mode.

Configuration Examples for IP over IPv6 Tunnels

- [Example: Configuring Manual IPv6 Tunnels, page 9](#)
- [Example: Configuring GRE on IPv6 Tunnels, page 9](#)

Example: Configuring Manual IPv6 Tunnels

The following example shows how to manually configure an IPv6 tunnel between Device A and Device B. In the example, tunnel interface 0 for both Device A and Device B is manually configured with a global IPv6 address. The tunnel source and destination addresses are also manually configured.

Device A

```
Device(config)# interface GigabitEthernet 0/0/0
Device(config-if)# ip address 192.168.99.1 255.255.255.0
Device(config-if)# exit
Device(config-if)# interface tunnel 0
Device(config-if)# ipv6 address 2001:0db8:c18:1::3/126
Device(config-if)# tunnel source GigabitEthernet 0/0/0
Device(config-if)# tunnel destination 192.168.30.1
Device(config-if)# tunnel mode ipv6ip
Device(config-if)# end
```

Device B

```
Device(config)# interface GigabitEthernet 0/0/0
Device(config-if)# ip address 192.168.30.1 255.255.255.0
Device(config-if)# exit
Device(config-if)# interface tunnel 0
Device(config-if)# ipv6 address 2001:0db8:c18:1::2/126
Device(config-if)# tunnel source GigabitEthernet 0/0/0
Device(config-if)# tunnel destination 192.168.99.1
Device(config-if)# tunnel mode ipv6ip
Device(config-if)# end
```

Example: Configuring GRE on IPv6 Tunnels

The following example shows how to configure a GRE tunnel over an IPv6 transport. Gigabit Ethernet interface 0/0/0 is configured with an IPv6 address, and this is the source address used by the tunnel interface. The destination IPv6 address of the tunnel is specified directly. In the following example, the tunnel carries both IPv4 and IS-IS traffic:

```
Device(config)# interface tunnel 0
Device(config-if)# ip address 10.1.1.1 255.255.255.0
```

```

Device(config-if)# ip router isis
Device(config-if)# tunnel source GigabitEthernet 0/0/0
Device(config-if)# tunnel destination 2001:DB8:1111:2222::1
Device(config-if)# tunnel mode gre ipv6
Device(config-if)# exit
Device(config)# interface FastEthernet 0/0
Device(config-if)# no ip address
Device(config-if)# ipv6 address 2001:DB8:1111:1111::1/64
Device(config-if)# exit
Device(config)# router isis
Device(config-router)# net 49.0001.0000.0000.000a.00

```

Additional References

Related Documents

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

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	IPv6 RFCs

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 IP over IPv6 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.

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Table 3 Feature Information for IP over IPv6 Tunnels

Feature Name	Releases	Feature Information
IP over IPv6 Tunnels	12.2(30)S 12.2(33)SRA 12.3(7)T 12.4 12.4(2)T 15.0(1)S Cisco IOS XE Release 2.1 15.1(1)SY	IP over IPv6 Tunnels feature is supported. The following commands were introduced or modified: tunnel destination , tunnel mode , tunnel mode ipv6ip , tunnel source .

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