**bintec elmeg®**

# IPv6 over IPv4 Tunnel

## bintec Dm810-I

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# Chapter 1  Introduction

## 1.1  Necessity

IPv4 over IPv6 tunneling emerged due to the need to maintain compatibility between new IPv6 infrastructures and the large number of IPv4 hosts and routers currently deployed. This is a transition mechanism needed to ensure interoperability between new IPv6 networks with the available IPv4 infrastructures. Said transition mechanism is described in RFC 4213.

Figure 1 shows this need set out: in order to send a packet from an IPv6 network to a destination located in another IPv6 network, the packet needs to pass through an IPv4 infrastructure.
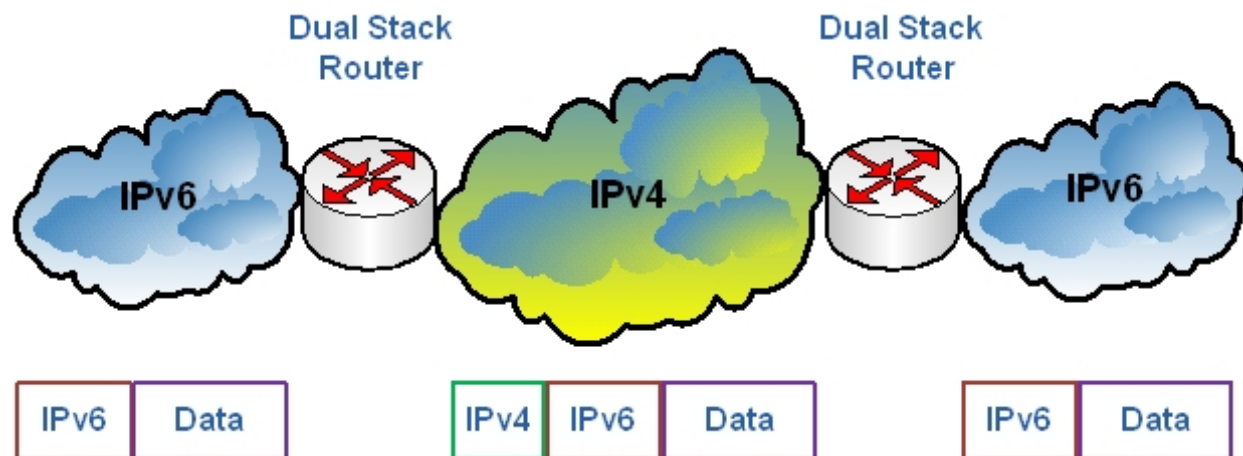


*Fig. 1: IPv6 over IPv4 tunnel*

## 1.2  Frame format

In IPv6 over IPv4 tunneling, IPv6 packets are encapsulated in IPv4 packets, so the IPv6 packet is contained in the data of the IPv4. This kind of encapsulation is executed by a *Dual Stack* (DS) device located on the border between the IPv6 network and the IPv4 infrastructure. A DS device can support both protocols: IPv4 and IPv6.

Figure 2 shows the format of the IPv6 packet encapsulated in an IPv4 packet. This is made up of the IPv4 header, followed by the IPv6 header and the data (both in the IPv4 packet data field). The value of the type of IPv4 header protocol (assigned in RFC 4213) for this type of encapsulation is 41. The source and destination IPv4 addresses are those from the *Dual Stack* routers where the tunnel is established.

*Fig. 2: IPv6 packet encapsulated in an IPv4 packet*

You need to bear in mind that by using IPv6 over IPv4 tunnels, you are reducing the MTU ( *Maximum Transmission Unit*) for an interface by 20 octets, assuming the length of the IPv4 header is 20 octets, i.e., there are no optional fields.

## 1.3 Types of IPv6 over IPv4 tunnels

There are various types of IPv6 over IPv4 tunnels, but this document will only describe those supported by the bintec router. Each of these is described below.

### 1.3.1 Manually configured IPv6 over IPv4 tunnels

An IPv6 over IPv4 manual tunnel is equivalent to a permanent link between two IPv6 domains connected over an IPv4 infrastructure. The main use is, for stable connections that need secure communications between two end routers, between a host and an end router or, for connections between isolated IPv6 networks.

In said tunnels, the administrator needs to configure source and destination IPv4 addresses for the tunnel i.e., the IPv4 address for the DS ends (at either end of the tunnel).

RFC 4213 provides a more in-depth explanation of these types of tunnels.

### 1.3.2 Automatic 6to4 tunnels

An automatic 6to4 tunnel permits isolated IPv6 domains to be connected over an IPv4 network to remote IPv6 networks.

The key difference between automatic 6to4 tunnels and manual tunnels is that the tunnel is not point-to-point, but point-to-multipoint.

In automatic 6to4 tunnels, the ends are not configured in pairs because they treat the IPv4 infrastructure as a virtual NBMA (*nonbroadcast multiaccess*) link.

Tunnel destination is determined by the IPv4 address, extracted from the IPv6 address, beginning with prefix *2002::/16* where the format is *2002:border-router-IPv4-address::/48* . After the embedded IPv4 address, there are 16 bits, which can be used to address different subnets within the domain. IPv6 addresses with this format are known as 6to4 addresses.

For a 6to4 host (one that only has 6to4 domain addresses) to be able to communicate with a native IPv6 network

(any address that isn't 6to4), its default route must have a *6to4 relay router* 6to4 IPv6 address as the next hop: a *6to4 relay router* is a router capable of supporting transactions between 6to4 addresses and native IPv6 addresses. To avoid configuring this manually, address 192.88.99.1 has deliberately been reserved as the *6to4 relay router anycast* address (specified in RFC 3066). Consequently, the IPv6 address for said *6to4 relay router* is 2002:c058:6301::.

RFC 3056 provides a more in-depth description of these types of tunnels.

### 1.3.3  Automatic 6rd tunnels (Rapid Deployment)

Automatic 6rd (*Rapid Deployment*) tunnels are an extension of the 6to4 tunnels we have already seen. These allow an ISP (*Internet Service Provider*) to provide IPv6 connectivity, to customers, over their IPv4 networking, using IPv6 encapsulation over IPv4. Similarly to 6to4 tunnels, the tunnel destination IPv4 address is taken from the IPv6 address of the 6rd domain; it is made up of the 6rd prefix followed by an IPv4 address.

The main differences between the 6to4 tunnels and the 6rd tunnels are as follows:

• 6rd tunnels don't need IPv6 addresses to begin with prefix 2002::/16; the prefix can be any of those an operator has available. This allows the entire 6rd domain to be within an SP network.

• You don't need to include the 32-bit IPv4 address in these tunnels to make up the IPv6 6rd address. The tunnel destination IPv4 address is obtained by combining the bits that come after the 6rd prefix in the IPv6 address with the information configured in the router. The embedded IPv4 address isn't in a fixed location in the IPv6 6rd address (as it was in 6to4 addresses).

You need to configure the *Border Relay* (BR) IPv4 address for the 6rd domain to reach native IPv6 destinations (outside the 6rd domain). Said BR is a router administrated by the ISP located at the border of the 6rd domain. You need to have at least one interface with IPv4 enabled, a 6rd virtual interface (which acts as the 6rd tunnel end) and an interface with IPv6 enabled and connected to a native IPv6 network.

For any given 6rd domain, the BR and the customer must have the following elements identically configured:

• *IPv4MaskLen*: number of bits in the part of the network that are identical in all the CE (*Customer Edge*) IPv4 addresses within the 6rd domain. This number of bits is not included when creating the 6rd delegated prefix.

• *6rdPrefix*: common 6rd prefix for a given 6rd domain.

• *6rdPrefixLen*: length of the 6rd prefix.

• *6rdBRIPv4Address*: 6rd BR IPv4 address for a given 6rd domain.

As previously indicated, the 6rd delegated prefix is created by linking the 6rd prefix for the domain with a set of bits from the device IPv4 address. The 6rd delegated prefix length is the same as the length of the prefix ( **n**) plus the number of bits in the IPv4 address being used (**o**). Figure 3 shows the format for an IPv6 address, with a 6rd prefix and an embedded IPv4 address:
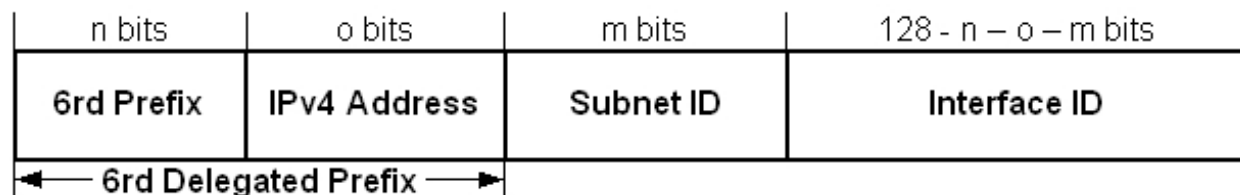


*Fig. 3: 6rd IPv6 address*

RFC 5969 provides a more in-depth description of these types of tunnels.

# Chapter 2  Configuration

## 2.1  Configuring an IPv6 over IPv4 manual tunnel

To configure an IPv6 over IPv4 manual tunnel, first create an IP tunnel interface and subsequently enter **ADD DEVICE tnip <tunnel_id>** in the global configuration menu.

```
Config>ADD DEVICE tnip 1
Added TNIP interface tnip1
Config>
```

To subsequently access the configuration, enter **NETWORK tnipX**, where **X** represents the tunnel identifier:

```
Config>NETWORK tnip1

-- IP Tunnel Net Configuration --
tnip1 config>
```

In this manual we are only going to detail the commands available for tnip interfaces, which are implied in the configuration of the above-described tunnels. The rest of the commands for a tnip interface can be found in manual bintec Dm719-I IP Tunnel.

The basic commands used to configure IPv6 over IPv4 manual tunnels are as follows:

### 2.1.1  MODE

Allows you to select the encapsulation mode. For an IPv6 over IPv4 manual tunnel, the mode must be **ipv6ip**.

*Syntax*:

```
tnip1 config>mode ?
  gre       Generic Routing Encapsulation Protocol
  ipv6      IPv4 or IPv6 over IPv6 tunnel
  ipv6ip    IPv6 over IPv4 tunnel
tnip1 config>mode ipv6ip ?
  6rd     Automatic 6rd Tunnel
  6to4    Automatic 6to4 Tunnel
  <cr>    Manual 6to4 Tunnel
tnip1 config>
```

*Example:*

```
tnip1 config>mode ipv6ip
tnip1 config>
```

### 2.1.2  SOURCE

Configures the IPv4 source address for a manual tunnel. This must match the IP address of one of the interfaces configured in the router (Ethernet, PPP, Loopback, etc.).

The IPv4 address configured as destination in the device at the other end of the tunnel, must also match.

If the IPv4 address configured as source does not match that configured as destination (at the other end of the router), then a link can never exist.

The tunnel source address can be:

• A numerated IPv4 address.

• An interface. Where the address configured in this interface is taken as source address. For PPP interfaces, which receive dynamically assigned IPv4 addresses and whose address is *unnumbered* (please see manual bintec Dm710-I PPP Interface), the source address is taken when it is assigned through IPCP.

*Syntax:*

```
tnip1 config>source ?
  <a.b.c.d>      Tunnel source address
  <a::b>         Ipv6 address
  <interface>    Tunnel source interface
```

```
tnip1 config>
```

*Example1:*

```
tnip1 config>source 10.10.10.10
tnip1 config>
```

*Example2:*

```
tnip1 config>source ppp1
tnip1 config>
```

### 2.1.3  DESTINATION

Configures an IPv4 destination address for a manual tunnel. This must match the IPv4 address configured as source for the tunnel in the router at the other end. If the IPv4 destination address for the tunnel does not match that configured as source at the other end, the packets sent to said router are dropped (not pertaining to tunnel).

A route towards the IPv4 destination address must exist, otherwise tunnel packets cannot be routed.

*Syntax:*

```
tnip1 config>destination ?
  <a.b.c.d>    Ipv4 format
  <a::b>       Ipv6 address
tnip1 config>
```

*Example:*

```
tnip1 config>destination 10.10.10.11
tnip1 config>
```

### 2.1.4  ENABLE

Enables the tunnel interface. Default is tunnel inactive.

*Syntax:*

```
tnip1 config>enable ?
  <cr>
tnip1 config>
```

*Example:*

```
tnip1 config>enable
tnip1 config>
```

### 2.1.5  IPV6 ENABLE

Enables IPv6 protocol in the interface. By default this protocol is disabled in the interface. This command is explained in manual bintec Dm805-I IPv6 Addressing.

*Syntax:*

```
tnip1 config>ipv6 enable
```

*Examle:*

```
tnip1 config>ipv6 enable
tnip1 config>
```

Another way of enabling IPv6 protocol in the interface, is by configuring an IPv6 address (in the interface) using the **ipv6 address** command.

### 2.1.6  IPV6 ADDRESS

Configures an IPv6 address in the interface.

This command is explained in manual bintec Dm805-I IPv6 Addressing.

*Syntax:*

```
tnip1 config>ipv6 address ?
  <a::b>           IPv6 link-local address
  <a::b/l>         Ipv6 prefix
  autoconfig       Obtain address using autoconfiguration
  general-prefix   Configure address using general IPv6 prefix
tnip1 config>
```

*Example:*

```
tnip1 config>ipv6 address 2001:db8::1/64
tnip1 config>
```

## 2.1.7  LIST

Displays the configuration for IPv6 over IPv4 manual tunnel.

*Example:*

```
tnip1 config>list
Tunnel mode: ipv6ipv4 manual (enabled)
Tunnel source 10.10.10.10, destination 10.10.10.11
QoS preclassify: disabled
Keepalive disabled
NHRP type of service: 0
tnip1 config>
```

*Tunnel mode:* indicates the type of encapsulation and the state (enabled/disabled).

*Tunnel source / destination:* IPv4 source addresses / tunnel destination.

*QoS preclassify:* indicates if BRS pre-classification is enabled.

*Keepalive:* displays the *keepalive* maintenance configuration.

*NHRP type of service:* displays the type of service selected for NHRP packets.

## 2.2  Configuring an automatic 6to4 tunnel

The basic steps to follow to configure an automatic 6to4 tunnel are similar to those described when configuring an IPv4 over IPv4 manual tunnel. You will find the details below for the configuration commands relative to automatic 6to4 tunnels; these are slightly different with respect to the previous tunnels.

### 2.2.1  MODE

Allows you to select the encapsulation mode. For an automatic 6to4 tunnel, the mode must be **ipv6ip 6to4**.

*Syntax:*

```
tnip1 config>mode ?
  gre      Generic Routing Encapsulation Protocol
  ipv6     IPv4 or IPv6 over IPv6 tunnel
  ipv6ip   IPv6 over IPv4 tunnel
tnip1 config>mode ipv6ip ?
  6rd    Automatic 6rd Tunnel
  6to4   Automatic 6to4 Tunnel
  <cr>   Manual 6to4 Tunnel
tnip1 config>
```

*Example:*

```
tnip1 config>mode ipv6ip 6to4
tnip1 config>
```

### 2.2.2  DESTINATION

As automatic 6to4 tunnels are point-to-multipoint tunnels, the destination IPv4 tunnel address isn't configured.

As already explained in the introduction, the IPv4 address at the other end of the tunnel is obtained from the IPv6 address we want to reach:

- If the IPv6 address belongs to the 6to4 domain, i.e., has prefix 2002::/16, the IPv4 address is located in the IPv6 address after the 6to4 prefix.
- If, contrariwise, we are dealing with a native IPv6 address, the tunnel destination IPv4 address used is a *6to4 relay router* (192.88.99.1).

If you try and enter a tunnel destination address when mode is ipv6ip 6to4, the device displays an error message.

*Example:*

```
tnip1 config>destination 10.10.10.10
CLI Error: The tunnel destination can not be configured under the existing mode
CLI Error: Command error
tnip1 config>
```

### 2.2.3  IPV6 ADDRESS

As in manual tunnels, by using this command you configure an IPv6 address in the tunnel (even though, in this case, it's useful to use an option from this command relative to the 6to4 tunnels). This option is to configure an address from a *general prefix* where a 6to4 domain prefix has been configured.

*Syntax:*

```
tnip1 config>ipv6 address ?
  <a::b>            IPv6 link-local address
  <a::b/l>          Ipv6 prefix
  autoconfig        Obtain address using autoconfiguration
  general-prefix    Configure address using general IPv6 prefix
tnip1 config>ipv6 address general-prefix ?
  <1..32 chars>    General prefix name
tnip1 config>ipv6 address general-prefix myprefix6to4 ?
  <a::b/l>    Ipv6 prefix
tnip1 config>
```

*Example:*

```
tnip1 config> ipv6 address general-prefix myprefix6to4 ::1/64
tnip1 config>
```

The *general prefix* is configured in the IPv6 protocol configuration menu, as explained in manual bintec Dm805-I IPv6 Addressing:

*Syntax:*

```
Config>protocol ipv6

-- IPv6 user configuration --
IPv6 config>general-prefix ?
  <1..32 chars>    Prefix name
IPv6 config>general-prefix myprefix6to4 ?
  6to4       Create 6to4 prefix based on a 6to4 interface
  6rd        Create 6rd prefix based on a 6rd interface
  <a::b/l>    IPv6 prefix
IPv6 config>general-prefix myprefix6to4 6to4 ?
  <interface>    Interface name
IPv6 config>
```

*Example:*

```
IPv6 config>general-prefix myprefix6to4 6to4 tnip1
IPv6 config>
```

## 2.3  Configuring an automatic 6rd tunnel

Here we are going to detail the configuration commands relative to automatic 6rd tunnels. These are slightly different with respect to automatic 6to4 tunnels.

### 2.3.1  MODE

Allows you to select the encapsulation mode. For a tunnel to be an automatic 6rd, the mode must be **ipv6ip 6rd**.

*Syntax:*

```
tnip1 config>mode ?
  gre      Generic Routing Encapsulation Protocol
  ipv6     IPv4 or IPv6 over IPv6 tunnel
  ipv6ip   IPv6 over IPv4 tunnel
tnip1 config>mode ipv6ip ?
  6rd     Automatic 6rd Tunnel
  6to4    Automatic 6to4 Tunnel
  <cr>    Manual 6to4 Tunnel
tnip1 config>
```

*Example:*

```
tnip1 config>mode ipv6ip 6rd
tnip1 config>
```

## 2.3.2  6RD

Configures the configuration parameters for the 6rd domain. These can only be configured when the tunnel mode is set to **ipv6ip 6rd.** They must be deconfigured when switching to an encapsulation mode other than 6rd.

*Syntax:*

```
tnip1 config>6rd ?
  br       Border Relay parameters
  ipv4     Common IPv4 transport source parameters
  prefix   Provider selected common IPv6 prefix
tnip1 config>6rd
```

### 2.3.2.1  6RD BR

Configures the *Border Relay* (BR) IPv4 address from the 6rd domain. When you want to send a packet with a native IPv6 address through the automatic 6rd tunnel, said packet is routed to BR i.e., a tunnel is established with the configured IPv4 address as destination.

*Syntax:*

```
tnip1 config>6rd br ?
  <a.b.c.d>   BR IPv4 address
tnip1 config>
```

*Example:*

```
tnip1 config>6rd br 10.1.5.1
tnip1 config>
```

### 2.3.2.2  6RD IPV4

Specifies the length of the IPv4 address prefix and/or suffix, which is common to all devices in the 6rd domain. Default is 0. The sum of both values cannot surpass 31. This command is optional in 6rd tunnel configuration.

*Syntax:*

```
tnip1 config>6rd ipv4 ?
  prefix-len    Common IPv4 transport source prefix length
  suffix-len    Common IPv4 transport source suffix length
tnip1 config>
```

*Example:*

```
tnip1 config>6rd ipv4 prefix-len 8 suffix-len 8
tnip1 config>
```

As explained in the introduction, to form the delegated 6rd prefix, link the 6rd prefix (from the domain) with the set of IPv4 address bits, which are not common in devices in the 6rd domain, i.e., IPv4 address stripping the first configured *prefix-len* and the last configured *suffix-len* .

### 2.3.2.3  6RD PREFIX

Specifies the common IPv6 prefix in the 6rd domain. This command is mandatory for tunnel operation. Prefix length determines the position of the IPv4 address in the delegated 6rd prefix.

*Syntax:*

```
tnip1 config>6rd prefix ?
  <a::b/l>    Ipv6 prefix
tnip1 config>
```

*Example:*

```
tnip1 config>6rd prefix 2001:A000::/32
tnip1 config>
```

## 2.3.3  DESTINATION

Automatic 6rd tunnels, like automatic 6to4 tunnels (tunnels are point-to-multipoint tunnels), the destination IPv4 tunnel address isn't configured.

As explained in the introduction, the IPv4 address at the other end of the tunnel is obtained from the IPv6 address we want to reach:

- If the IPv6 address belongs to the 6rd domain, i.e., has a 6rd prefix configured using the **6rd prefix** command, the IPv4 address (or part of it, depending if there are common bits, which are configured using **6rd ipv4 prefix-len** and **6rd ipv4 suffix-len** ), is located in the IPv6 address after the 6rd prefix.
- If however, we are dealing with a native IPv6 address, the tunnel IPv4 address destination address used is that from the BA, which is configured using the **6rd br** command.

Like automatic 6to4 tunnels, if you try and enter a tunnel destination address when mode is **ipv6ip 6to4**, the device displays an error message.

*Example:*

```
tnip1 config>destination 10.10.10.10
CLI Error: The tunnel destination can not be configured under the existing mode
CLI Error: Command error
tnip1 config>
```

## 2.3.4  IPV6 ADDRESS

As in automatic 6to4 tunnels, it's useful to use an option from this command relative to 6rd tunnels. Said option is to configure an address from a *general prefix,* where a 6rd domain prefix has been configured.

*Syntax:*

```
tnip1 config>ipv6 address ?
  <a::b>             IPv6 link-local address
  <a::b/l>           Ipv6 prefix
  autoconfig         Obtain address using autoconfiguration
  general-prefix     Configure address using general IPv6 prefix
tnip1 config>ipv6 address general-prefix ?
  <1..32 chars>    General prefix name
tnip1 config>ipv6 address general-prefix myprefix6rd ?
  <a::b/l>    Ipv6 prefix
tnip1 config>
```

*Example:*

```
tnip1 config> ipv6 address general-prefix myprefix6rd ::1/64
tnip1 config>
```

The *general prefix* is configured with the **6rd** option instead of **6to4** (as seen in automatic 6to4 tunnels):

*Syntax:*

```
Config>protocol ipv6

-- IPv6 user configuration --
IPv6 config>general-prefix ?
```

```
   <1..32 chars>    Prefix name
IPv6 config>general-prefix myprefix6rd ?
  6to4        Create 6to4 prefix based on a 6to4 interface
  6rd         Create 6rd prefix based on a 6rd interface
  <a::b/l>    IPv6 prefix
IPv6 config>general-prefix myprefix6rd 6rd ?
  <interface>    Interface name
IPv6 config>
```

*Example:*

```
IPv6 config>general-prefix myprefix6rd 6rd tnip1
IPv6 config>
```

# Chapter 3  Monitoring

## 3.1  Monitoring IPv6 over IPv4 tunnels

In addition to the TNIP interface monitoring commands described in manual bintec Dm719-I IP Tunnel, there are oth-
er commands to monitor IPv6 over IPv4 tunnels. To access these, access the IPv6 protocol monitoring menu through
**protocol ipv6** from the general monitoring menu.

```
+protocol ipv6
-- IPv6 protocol monitor --
IPv6+
```

Options to display information on IPv6 over IPv4 tunnels are as follows:

### 3.1.1  LIST INTERFACE

Displays IPv6 interface information i.e., state, address and other parameters configured in said interface. If the inter-
face name is not specified, information on all interfaces present in the device is displayed. This command is common
to all interfaces.

*Example:*

```
IPv6+list interface ?
  <interface>    Interface name
  <cr>
IPv6+list interface tnip1

Interface tnip1:
---------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0b [PERM]

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
Post_Encap features: Tunnel 6TO4
ND DAD is not supported
ND reachable time is 30000 milliseconds

Router Advertisement is not supported on this interface
IPv6+
```

### 3.1.2  LIST TUNNEL

This is a specific command for IPv6 over IPv4 tunnels. It has the following options:

```
IPv6+list tunnel ?
  6rd        Display 6RD parameters
  6to4       Display 6to4 parameters
  interface  List the parameters on this tunnel interface
  manual     Display manual parameters
  <cr>
IPv6+
```

| Option | Function |
|---|---|
| *6RD* | Displays parameters for automatic 6rd tunnels configured in the device. |
| *6TO4* | Displays parameters for automatic 6to4 tunnels configured in the device. |
| *INTERFACE* | Displays parameters for the configured tunnel, indicated below. |
| *MANUAL* | Displays parameters for IPv6 over IPv4 manual tunnels configured in the device. |
| *<CR>* | If you don't enter an option, parameters for all IPv6 over IPv4 tunnels configured in the device are displayed. |

We will now show the monitoring for each of the IPv6 over IPv4 tunnels described above.

Events relative to IPv6 over IPv4 tunnels can be found in the TNIP subsystem.

## 3.2  Monitoring IPv6 over IPv4 manual tunnels

The specific command for displaying information on IPv6 over IPv4 manual tunnels is **list tunnel manual**, as shown below:

```
IPv6+list tunnel manual ?
  interface    List the parameters on this tunnel interface
  <cr>
IPv6+
```

After this command, you can enter the **interface** option to display information on a specific interface. If you don't enter the interface, information on all IPv6 over IPv4 manual tunnels configured in the device is displayed. The information displayed is source and destination IPv4 addresses configured in the tunnel:

```
IPv6+list tunnel manual interface ?
  <interface>    Interface name
Device1 IPv6+list tunnel manual interface tnip1

Interface tnip1
  Tunnel Source: 10.10.10.10
  Tunnel Destination: 10.10.10.11
Device1 IPv6+
```

## 3.3  Monitoring automatic 6to4 tunnels

The specific command for displaying configuration information on the automatic 6to4 tunnel, configured in the device, is **list tunnel 6to4**, which has the following options:

```
IPv6+list tunnel 6to4 ?
  destination    Destination endpoint for a 6to4 delegated prefix
  interface      List the parameters on this tunnel interface
  prefix         6to4 delegated prefix for a destination endpoint
  <cr>
IPv6+
```

| Option | Function |
|--------|----------|
| DESTINATION | Displays the IPv4 address embedded in the 6to4 domain prefix that is subsequently entered. |
| INTERFACE | Displays parameters for the configured automatic 6to4 tunnel, indicated below. |
| PREFIX | Displays the 6to4 domain prefix obtained for an IPv4 address. |
| <CR> | If you don't enter any option, parameters for all automatic 6to4 tunnels configured in the device are displayed. |

In addition to this command with its options, there is another monitoring command that provides information relative to automatic 6to4 tunnels; **list general-prefix**. This is explained in detail in the bintec Dm805-I IPv6 Addressing manual.

### 3.3.1  LIST TUNNEL 6to4 DESTINATION

Displays the IPv4 address embedded in the 6to4 domain prefix entered below:

*Syntax:*

```
IPv6+list tunnel 6to4 destination ?
  <a::b>    6to4 delegated prefix
IPv6+
```

*Example:*

```
IPv6+list tunnel 6to4 destination 2002:a0a:a0b::
  6to4 Prefix: 2002:a0a:a0b::
  Destination: 10.10.10.11
```

```
IPv6+
```

### 3.3.2  LIST TUNNEL 6to4 INTERFACE

Displays the configured automatic 6to4 tunnel parameters, such as the tunnel source IPv4 address, and the device 6to4 domain prefix (obtained from said source IPv4 address), as shown below:

*Syntax:*

```
IPv6+list tunnel 6to4 interface ?
  <interface>    Interface name
IPv6+
```

*Example:*

```
IPv6+list tunnel 6to4 interface tnip1

Interface tnip1
  Tunnel Source: 10.10.10.10
  General Prefix: 2002:a0a:a0a::/48
IPv6+
```

### 3.3.3  LIST TUNNEL 6to4 PREFIX

Displays the 6to4 domain prefix obtained for an IPv4 address:

*Syntax:*

```
IPv6+list tunnel 6to4 prefix ?
  <a.b.c.d>    IPv4 destination endpoint address
IPv6+
```

*Example:*

```
IPv6+list tunnel 6to4 prefix 10.10.10.12
  Destination: 10.10.10.12
  6to4 Prefix: 2002:a0a:a0c::
IPv6+
```

### 3.3.4  LIST GENERAL-PREFIX

Displays the *general prefixes* configured in the device. This command is relative to the automatic 6to4 tunnels we have already seen in previous sections. For further information, please see manual bintec- **Dm805-I IPv6 Addressing**.

*Example:*

```
IPv6+list general-prefix name myprefix6to4

General-prefix name: myprefix6to4
  General-prefix                2002:a0a:a0a::/48 (6to4)
  Address on loopback1          ::1/64
IPv6+
```

## 3.4  Monitoring automatic 6rd tunnels

The command to display configuration information on an automatic 6rd tunnel, configured in the device, is  **list tunnel 6rd**, which has the following options:

```
IPv6+list tunnel 6rd ?
  destination    Destination endpoint for a 6RD delegated prefix
  interface      List the parameters on this tunnel interface
  prefix         6RD delegated prefix for a destination endpoint
  <cr>
IPv6+
```

| Option                      | Function |
|-----------------------------|----------|

| DESTINATION | Displays the IPv4 address embedded in the 6rd domain prefix, which is subsequently entered, depending on 6RD parameters configured in the tunnel. |
|---|---|
| INTERFACE | Displays the parameters for the configured automatic 6rd tunnel, indicated below. |
| PREFIX | Displays the 6rd domain prefix obtained for an IPv4 address, depending on the 6RD parameters configured in the tunnel. |
| <CR> | If you don't enter an option, parameters for all automatic 6rd tunnels configured in the device are displayed. |

Like automatic 6to4 tunnels, in addition to this command with its options, there is another monitoring command that provides information relative to automatic 6rd tunnels, **list general-prefix**. This is explained in detail in manual bintec Dm805-I IPv6 Addressing.

### 3.4.1  LIST TUNNEL 6RD INTERFACE

Lists the configured automatic 6rd tunnel parameters indicated below, such as source IPv4 address for the tunnel, 6RD domain parameters (6rd prefix, bits for the IPv4 addresses for the common domain devices and the BR IPv4 address), as well as the device 6rd domain prefix, obtained through said source IPv4 address and 6RD parameters:

*Syntax:*

```
IPv6+list tunnel 6rd interface ?
  <interface>    Interface name
IPv6+
```

*Example:*

```
IPv6+list tunnel 6rd interface tnip1

Interface tnip1
  Tunnel Source: 10.10.10.10
  6RD: Operational, V6 Prefix: 2001:a000::/32
       V4 Prefix, Length: 24, Value: 10.10.10.0
       V4 Suffix, Length: 0, Value: 0.0.0.0
       Border Relay address: 10.10.10.1
  General Prefix: 2001:a000:a00::/40
IPv6+
```

### 3.4.2  LIST TUNNEL 6RD DESTINATION

Displays the IPv4 address embedded in the 6rd domain delegated prefix entered below, using parameters configured in the indicated tunnel:

*Syntax:*

```
IPv6+list tunnel 6rd destination ?
  <a::b>    6RD delegated prefix
IPv6+list tunnel 6rd destination  2001:a000:b00:: ?
  <interface>    Interface name
IPv6+
```

*Example:*

```
IPv6+list tunnel 6rd destination  2001:a000:b00:: tnip1

Interface: tnip1
  6RD Prefix: 2001:a000:b00::
  Destination: 10.10.10.11
IPv6+
```

### 3.4.3  LIST TUNNEL 6RD PREFIX

Displays the 6rd domain delegated prefix obtained for a given IPv4 address using the parameters configured in the indicated tunnel:

*Syntax:*

```
IPv6+list tunnel 6rd prefix ?
  <a.b.c.d>    IPv4 destination endpoint address
Router1 IPv6+list tunnel 6rd prefix 10.10.10.12 ?
```

```
   <interface>    Interface name
IPv6+
```

*Example:*

```
IPv6+list tunnel 6rd prefix 10.10.10.12 tnip1

Interface: tnip1
  Destination: 10.10.10.12
  6RD Prefix: 2001:a000:c00::
IPv6+
```

## 3.4.4  LIST GENERAL-PREFIX

As with automatic 6to4 tunnels, this command is relative to automatic 6rd tunnels (seen in the previous section) where you can configure *general prefixes* to generate IPv6 addresses for the automatic 6rd tunnel 6rd domain. For further information, please see manual bintec-**Dm805-I IPv6 Addressing**.

*Example:*

```
IPv6+list general-prefix name myprefix6rd

General-prefix name: myprefix6rd
  General-prefix                2001:a000:a00::/40 (6rd)
  Address on loopback1          ::1/64
IPv6+
```

# Chapter 4  Configuring IPv6 over IPv4 tunnels: Examples

## 4.1  IPv6 over IPv4 manual tunnel

### 4.1.1  Steps to carry out at each end of the tunnel

- Create a tnip interface using **add device tnip <tunnel-id>** configuration command. (This command is global.)
- Configure the IP address in the interface where packets are going to exit the tunnel.
- Configure the tunnel encapsulation mode as manual IPv6 over IPv4 using **mode ipv6ip**.
- Configure the tunnel source using the **source** command, which may be an IPv4 address or an interface, whose main IP will be used.
- Configure the tunnel destination using the **destination** command and the tunnel destination IPv4 address. Add the necessary IP route to reach said destination.
- Enable IPv6 protocol in the interface using **ipv6 enable**.
- Enable the tunnel through **enable**.
- Add the IPv6 routes for those networks, which need to be accessible through the tunnel, by entering the tunnel interface as next hop.
- Save and restart.

### 4.1.2  Example

Configuration for an IPv6 over IPv4 manual tunnel with Router1 as source and Router2 as destination. Networks IPv6 2001:db8:0:1::/64 and 2001:db8:0:2::/64, to which the loopback interfaces of each router belong respectively, can communicate, as shown in Figure 4.
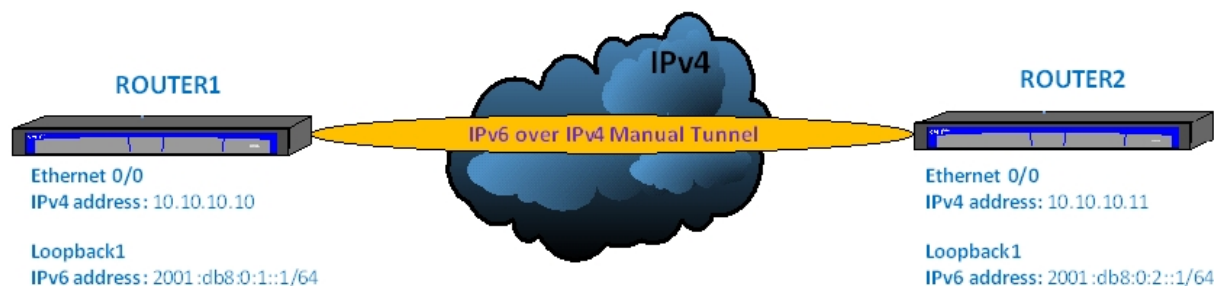


*Fig. 4: IPv6 over IPv4 manual tunnel.*

#### 4.1.2.1  Configuring Router1

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router1
Router1 Config>add device tnip 1
Router1 Config>add device loopback 1
Router1 Config>
```

Configure the addresses for the interfaces:

```
Router1 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router1 ethernet0/0 config>ip address 10.10.10.10 255.255.255.0
Router1 IP config>exit
Router1 Config>
Router1 Config>network loopback1

-- Loopback interface configuration --
Router1 loopback1 config>ipv6 address 2001:db8:0:1::1/64
Router1 loopback1 config>exit
Router1 Config>
```

Subsequently, configure the IPv6 over IPv4 manual tunnel:

```
Router1 Config>network tnip1

-- IP Tunnel Net Configuration --
Router1 tnip1 config>mode ipv6ip
Router1 tnip1 config>source 10.10.10.10
Router1 tnip1 config>destination 10.10.10.11
Router1 tnip1 config>ipv6 enable
Router1 tnip1 config>enable
Router1 tnip1 config>exit
Router1 Config>
```

Add the necessary IPv6 routes:

```
Router1 Config>protocol ipv6

-- IPv6 user configuration --
Router1 IPv6 config>route 2001:db8:0:2::/64 interface tnip1
Router1 IPv6 config>exit
Router1 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router1 Config$show config
;
    set hostname Router1
    add device tnip 1
    add device loopback 1
;
    network ethernet0/0
; -- Ethernet Interface User Configuration --
        ip address 10.10.10.10 255.255.255.0
;
    exit
;
;
    network tnip1
; -- IP Tunnel Net Configuration --
        ipv6 enable
        enable
        mode ipv6ip
        source 10.10.10.10
        destination 10.10.10.11
    exit
;
    network loopback1
; -- Loopback interface configuration --
        ipv6 address 2001:db8:0:1::1/64
    exit
;
    protocol ipv6
; -- IPv6 user configuration --
        route 2001:db8:0:2::/64 interface tnip1
    exit
;
Router1 Config$
```

### 4.1.2.2 Configuring Router2

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router2
Router2 Config>add device tnip 1
Router2 Config>add device loopback 1
Router2 Config>
```

Configure the addresses for the interfaces:

```
Router2 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router2 ethernet0/0 config>ip address 10.10.10.11 255.255.255.0
Router2 ethernet0/0 config>exit
Router2 Config>
Router2 Config>network loopback1

-- Loopback interface configuration --
Router2 loopback1 config>ipv6 address 2001:db8:0:2::1/64
Router2 loopback1 config>exit
Router2 Config>
```

Subsequently, configure the IPv6 over IPv4 manual tunnel:

```
Router2 Config>network tnip1

-- IP Tunnel Net Configuration --
Router2 tnip1 config>mode ipv6ip
Router2 tnip1 config>source 10.10.10.11
Router2 tnip1 config>destination 10.10.10.10
Router2 tnip1 config>ipv6 enable
Router2 tnip1 config>enable
Router2 tnip1 config>exit
Router2 Config>
```

Add the necessary IPv6 routes:

```
Router2 Config>protocol ipv6

-- IPv6 user configuration --
Router2 IPv6 config>route  2001:db8:0:1::/64 interface tnip1
Router2 IPv6 config>exit
Router2 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router2 Config$show config
;
   set hostname Router2
   add device tnip 1
   add device loopback 1
;
   network ethernet0/0
; -- Ethernet Interface User Configuration --
     ip address 10.10.10.11 255.255.255.0
;
   exit
;
;
   network tnip1
; -- IP Tunnel Net Configuration --
     ipv6 enable
     enable
     mode ipv6ip
     source 10.10.10.11
     destination 10.10.10.10
   exit
;
   network loopback1
; -- Loopback interface configuration --
     ipv6 address 2001:db8:0:2::1/64
   exit
;
   protocol ipv6
; -- IPv6 user configuration --
```

```
      route 2001:db8:0:1::/64 interface tnip1
   exit
;
Router2 Config$
```

With the above configurations, the devices present the following states in their interfaces

State of the interfaces for Router1:

```
Router1 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0a [PERM]

Joined group address(es):
  ff02::1:ff0a:a0a
  ff02::1

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds
There is no default router
Router1 IPv6+
Router1 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe28:3918 [PERM]

Global unicast address(es):
  2001:db8:0:1::1/64 cfg [PERM/UP]

Joined group address(es):
  ff02::1

MTU is 1592 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds

Router Advertisement is not supported on this interface
Router1 IPv6+
```

State of the interfaces for Router2:

```
Router2 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0b [PERM]

Joined group address(es):
  ff02::1:ff0a:a0b
  ff02::1

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is enabled, number of DAD attempts: 1
```

```
ND reachable time is 30000 milliseconds
There is no default router
Router2 IPv6+
Router2 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe32:28c8 [PERM]

Global unicast address(es):
  2001:db8:0:2::1/64 cfg [PERM/UP]

Joined group address(es):
  ff02::1

MTU is 2140 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds

Router Advertisement is not supported on this interface
Router2 IPv6+
```

## 4.2  Automatic 6to4 tunnel

### 4.2.1  Steps to carry out at each end of the tunnel

- Create a **tnip** interface using the **add device tnip <tunnel-id>** configuration command. (This command is global.)
- Configure the IP address in the interface where packets are going to exit the tunnel.
- Configure tunnel encapsulation mode as automatic 6to4 IPv6 over IPv4 through **mode ipv6ip 6to4**.
- Configure tunnel source using the **source** command, which may be an IPv4 address or an interface whose main IP is used.
- Add a static route to the 6to4 domain network (2002::/16) with tnip interface as next hop. Use the **route 2002::/16 interface tnip<tunnel-id>** command (found in the ipv6 protocol global menu).
- Enable the IPv6 protocol in the interface through the **ipv6 enable** command.
- Enable the tunnel using **enable**, save and restart.

### 4.2.2  Example

Configuration for an automatic 6to4 tunnel with Router1 as source and Router2 as destination. 6to4 domain networks can communicate and their addresses are configured in the loopback interfaces, as shown in Figure 5:



*Fig. 5: Automatic 6to4 tunnel.*

#### 4.2.2.1  Configuring Router1

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router1
Router1 Config>add device tnip 1
```

```
Router1 Config>add device loopback 1
Router1 Config>
```

Configure the IP address for the tunnel output interface:

```
Router1 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router1 ethernet0/0 config>ip address 10.10.10.10 255.255.255.0
Router1 IP config>exit
Router1 Config>
```

Subsequently, configure the automatic 6to4 tunnel:

```
Router1 Config>network tnip1

-- IP Tunnel Net Configuration --
Router1 tnip1 config>mode ipv6ip 6to4
Router1 tnip1 config>source 10.10.10.10
Router1 tnip1 config>ipv6 enable
Router1 tnip1 config>enable
Router1 tnip1 config>exit
Router1 Config>
```

Configure the 6to4 domain *general prefix* to be used when configuring the loopback interface address:

```
Router1 Config>protocol ipv6

-- IPv6 user configuration --
Router1 IPv6 config>general-prefix myprefix6to4 6to4 tnip1
Router1 IPv6 config>
```

Add the necessary 6to4 domain route:

```
Router1 IPv6 config>route 2002::/16 interface tnip1
Router1 IPv6 config>exit
Router1 Config>
```

Configure the loopback interface address:

```
Router1 Config>network loopback1

-- Loopback interface configuration --
Router1 loopback1 config>ipv6 address general-prefix myprefix6to4 ::1/64
Router1 loopback1 config>exit
Router1 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router1 Config$show config
;
   set hostname Router1
   add device tnip 1
   add device loopback 1
;
   network ethernet0/0
; -- Ethernet Interface User Configuration --
     ip address 10.10.10.10 255.255.255.0
;
   exit
;
;
   network tnip1
; -- IP Tunnel Net Configuration --
     enable
     ipv6 enable
     mode ipv6ip 6to4
     source 10.10.10.10
   exit
```

```
;
   network loopback1
; -- Loopback interface configuration --
     ipv6 address general-prefix myprefix6to4 ::1/64
   exit
;
   protocol ipv6
; -- IPv6 user configuration --
     general-prefix myprefix6to4 6to4 tnip1
     route 2002::/16 interface tnip1
   exit
;
Router1 Config$
```

### 4.2.2.2  Configuring Router2

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router1
Router2 Config>add device tnip 1
Router2 Config>add device loopback 1
Router2 Config>
```

Configure the IP address for the tunnel output interface:

```
Router2 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router2 ethernet0/0 config>ip address 10.10.10.11 255.255.255.0
Router2 IP config>exit
Router2 Config>
```

Subsequently, configure the automatic 6to4 tunnel:

```
Router2 Config>network tnip1

-- IP Tunnel Net Configuration --
Router2 tnip1 config>mode ipv6ip 6to4
Router2 tnip1 config>source 10.10.10.11
Router2 tnip1 config>ipv6 enable
Router2 tnip1 config>enable
Router2 tnip1 config>exit
Router2 Config>
```

Configure the 6to4 domain *general prefix* to be used when configuring the loopback interface address:

```
Router2 Config>protocol ipv6

-- IPv6 user configuration --
Router2 IPv6 config>general-prefix myprefix6to4 6to4 tnip1
Router2 IPv6 config>
```

Add the necessary 6to4 domain route:

```
Router2 IPv6 config>route 2002::/16 interface tnip1
Router2 IPv6 config>exit
Router2 Config>
```

Configure the loopback interface address:

```
Router2 Config>network loopback1

-- Loopback interface configuration --
Router2 loopback1 config>ipv6 address general-prefix myprefix6to4 ::1/64
Router2 loopback1 config>exit
Router2 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router2 Config$show config
;
   set hostname Router2
   add device tnip 1
   add device loopback 1
;
   network ethernet0/0
; -- Ethernet Interface User Configuration --
       ip address 10.10.10.11 255.255.255.0
;
   exit
;
;
   network tnip1
; -- IP Tunnel Net Configuration --
       enable
       ipv6 enable
       mode ipv6ip 6to4
       source 10.10.10.11
   exit
;
   network loopback1
; -- Loopback interface configuration --
       ipv6 address general-prefix myprefix6to4 ::1/64
   exit
;
   protocol ipv6
; -- IPv6 user configuration --
       general-prefix myprefix6to4 6to4 tnip1
       route 2002::/16 interface tnip1
   exit
;
Router2 Config$
```

With the above configurations, the devices present the following states in their interfaces

State of the interfaces for Router1:

```
Router1 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0a [PERM]

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
Post_Encap features: Tunnel 6TO4
ND DAD is not supported
ND reachable time is 30000 milliseconds

Router Advertisement is not supported on this interface
Router1 IPv6+
Router1 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe28:3918 [PERM]

Global unicast address(es):
  2002:a0a:a0a::1/64 gen-pref [PERM/UP]

MTU is 1592 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
```

```
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router1 IPv6+
```

State of the interfaces for Router2:

```
Router2 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0b [PERM]

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
Post_Encap features: Tunnel 6TO4
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router2 IPv6+
Router2 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe32:28c8 [PERM]

Global unicast address(es):
  2002:a0a:a0b::1/64 gen-pref [PERM/UP]

MTU is 2140 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router2 IPv6+
```

The *general prefixes* configured in both devices are:

For Router1:

```
Router1 IPv6+list general-prefix

General-prefix name: myprefix6to4
  General-prefix               2002:0a0a:0a0a::/48 (6to4)
  Address on loopback1         ::1/64
Router1 IPv6+
```

For Router2:

```
Router2 IPv6+list general-prefix

General-prefix name: myprefix6rd
  General-prefix               2002:0a0a:0a0b::/48 (6to4)
  Address on loopback1         ::1/64
Router2 IPv6+
```

## 4.3  Automatic 6rd tunnel

### 4.3.1  Steps to carry out at each end of the tunnel

- Create a **tnip** interface through **add device tnip <tunnel-id>**. (This configuration command is global.)
- Configure the IP address in the interface where the packets are going to exit the tunnel.
- Configure the tunnel encapsulation mode as automatic 6rd IPv6 over IPv4 through **mode ipv6ip 66rd**.
- Configure the tunnel source using a **source** command, which may be an IPv4 address or an interface, whose main IP is used.
- Configure the 6rd domain 6rd prefix through **6rd prefix <IPv6-prefix>**.
- Configure the number of common IPv4 address high-order bits in the 6rd domain using **6rd ipv4 prefix-len <pref-len>**.
- Configure the number of common IPv4 address low-order bits in the 6rd domain using **6rd ipv4 suffix-len <suff-len>**.
- Configure the *Border Relay* router (BR) IPv4 address, used to send traffic that goes through the 6rd tunnel (does not belong to the 6rd domain),through **6rd br <IPv4-addr>**.
- Add a static route to the 6rd domain network, with tnip interface as next hop, through **route <6rd-prefix> interface tnip<tunnel-id>** (from the ipv6 protocol global menu).
- Enable IPv6 protocol in the interface through **ipv6 enable**.
- Enable the tunnel through **enable**. Save and restart.

### 4.3.2  Example

Configuration for an automatic 6rd tunnel with Router1 as source and Router2 as destination, where the networks in the same 6rd domain can communicate and whose addresses are configured in the loopback interfaces: as shown in Figure 6.
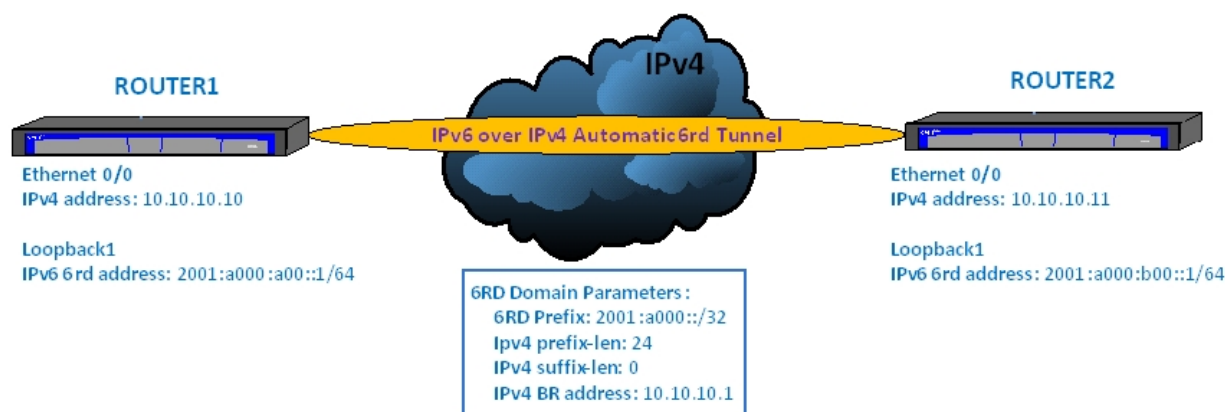


*Fig. 6: Automatic 6rd tunnel.*

#### 4.3.2.1  Configuring Router1

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router1
Router1 Config>add device tnip 1
Router1 Config>add device loopback 1
Router1 Config>
```

Configure the IP address for the tunnel output interface:

```
Router1 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router1 ethernet0/0 config>ip address 10.10.10.10 255.255.255.0
Router1 IP config>exit
Router1 Config>
```

Subsequently, configure the automatic 6rd tunnel where the 6rd domain prefix is 2001:A000::/32; the first 24 bits of the IPv4 addresses for domain devices are common and the *Border Relay* Router IPv4 address for the 6rd domain is 10.10.10.1:

```
Router1 Config>network tnip1
```

```
-- IP Tunnel Net Configuration --
Router1 tnip1 config>mode ipv6ip 6rd
Router1 tnip1 config>source 10.10.10.10
Router1 tnip1 config>6rd prefix 2001:A000::/32
Router1 tnip1 config>6rd ipv4 prefix-len 24
Router1 tnip1 config>6rd br 10.10.10.1
Router1 tnip1 config>ipv6 enable
Router1 tnip1 config>enable
Router1 tnip1 config>exit
Router1 Config>
```

Configure the 6rd domain *general prefix* going to be used when configuring the loopback interface address:

```
Router1 Config>protocol ipv6

-- IPv6 user configuration --
Router1 IPv6 config>general-prefix myprefix6rd 6rd tnip1
Router1 IPv6 config>
```

Add the necessary 6rd domain route:

```
Router1 IPv6 config>route 2001:A000::/32 interface tnip1
Router1 IPv6 config>exit
Router1 Config>
```

Configure the loopback interface address:

```
Router1 Config>network loopback1

-- Loopback interface configuration --
Router1 loopback1 config>ipv6 address general-prefix myprefix6rd ::1/64
Router1 loopback1 config>exit
Router1 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router1 Config$show config
;
   set hostname Router1
   add device tnip 1
   add device loopback 1
;
   network ethernet0/0
; -- Ethernet Interface User Configuration --
      ip address 10.10.10.10 255.255.255.0
;
   exit
;
;
   network tnip1
; -- IP Tunnel Net Configuration --
      enable
      ipv6 enable
      mode ipv6ip 6rd
      source 10.10.10.10
      6rd ipv4 prefix-len 24
      6rd prefix 2001:a000::/32
      6rd br 10.10.10.1
   exit
;
   network loopback1
; -- Loopback interface configuration --
      ipv6 address general-prefix myprefix6rd ::1/64
   exit
;
   protocol ipv6
; -- IPv6 user configuration --
```

```
      general-prefix myprefix6rd 6rd tnip1
      route 2001:a000::/32 interface tnip1
   exit
;
Router1 Config$
```

### 4.3.2.2  Configuring Router2

Add the IP tunnel interface and the loopback interface:

```
*P 4
Config>set hostname Router1
Router2 Config>add device tnip 1
Router2 Config>add device loopback 1
Router2 Config>
```

Configure the IP address for the tunnel output interface:

```
Router2 Config>network ethernet0/0

-- Ethernet Interface User Configuration --
Router2 ethernet0/0 config>ip address 10.10.10.11 255.255.255.0
Router2 IP config>exit
Router2 Config>
```

Subsequently configure the automatic 6rd tunnel where, as with Router1, the 6rd domain prefix is 2001:A000::/32;
the first 24 bits of the IPv4 addresses for domain devices are common and the *Border Relay* Router IPv4 address for
the 6rd domain is 10.10.10.1:

```
Router2 Config>network tnip1

-- IP Tunnel Net Configuration --
Router2 tnip1 config>mode ipv6ip 6rd
Router2 tnip1 config>source 10.10.10.11
Router2 tnip1 config>6rd prefix 2001:A000::/32
Router2 tnip1 config>6rd ipv4 prefix-len 24
Router2 tnip1 config>6rd br 10.10.10.1
Router2 tnip1 config>ipv6 enable
Router2 tnip1 config>enable
Router2 tnip1 config>exit
Router2 Config>
```

Configure the 6rd domain *general prefix* going to be used when configuring the loopback interface address:

```
Router2 Config>protocol ipv6

-- IPv6 user configuration --
Router2 IPv6 config>general-prefix myprefix6rd 6rd tnip1
Router2 IPv6 config>
```

Add the necessary 6rd domain route:

```
Router2 IPv6 config>route 2001:a000::/32 interface tnip1
Router2 IPv6 config>exit
Router2 Config>
```

Configure the loopback interface address:

```
Router2 Config>network loopback1

-- Loopback interface configuration --
Router2 loopback1 config>ipv6 address general-prefix myprefix6rd ::1/64
Router2 loopback1 config>exit
Router2 Config>
```

Once you have carried out all these configuration steps, simply save the configuration and restart the device.

The final configuration looks like this:

```
Router2 Config$show config
;
   set hostname Router2
```

```
   add device tnip 1
   add device loopback 1
;
   network ethernet0/0
; -- Ethernet Interface User Configuration --
     ip address 10.10.10.11 255.255.255.0
;
   exit
;
;
   network tnip1
; -- IP Tunnel Net Configuration --
     enable
     ipv6 enable
     mode ipv6ip 6rd
     source 10.10.10.11
     6rd ipv4 prefix-len 24
     6rd prefix 2001:a000::/32
     6rd br 10.10.10.1
   exit
;
   network loopback1
; -- Loopback interface configuration --
     ipv6 address general-prefix myprefix6rd ::1/64
   exit
;
   protocol ipv6
; -- IPv6 user configuration --
     general-prefix myprefix6rd 6rd tnip1
     route 2001:a000::/32 interface tnip1
   exit
;
Router2 Config$
```

With these configurations, the devices present the following states in their interfaces

State of the interfaces for Router1:

```
Router1 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0a [PERM]

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
Post_Encap features: Tunnel 6RD
ND DAD is not supported
ND reachable time is 30000 milliseconds

Router Advertisement is not supported on this interface
Router1 IPv6+
Router1 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe28:3918 [PERM]

Global unicast address(es):
  2001:a000:a00::1/64 gen-pref [PERM/UP]

MTU is 1592 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
```

```
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router1 IPv6+
```

State of the interfaces for Router2:

```
Router2 IPv6+list interface tnip1

Interface tnip1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::a0a:a0b [PERM]

MTU is 1480 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
Post_Encap features: Tunnel 6RD
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router2 IPv6+list interface loopback1

Interface loopback1:
----------------------------
IPv6 is Enabled
Link-local address is:  fe80::2a0:26ff:fe32:28c8 [PERM]

Global unicast address(es):
  2001:a000:b00::1/64 gen-pref [PERM/UP]

MTU is 2140 bytes
ICMP error messages limited to one every 1000 milliseconds
ICMP redirects are enabled
ICMP unreachables are sent
ND DAD is not supported
ND reachable time is 30000 milliseconds


Router Advertisement is not supported on this interface
Router2 IPv6+
```

The general prefixes configured in both devices are:

For Router1:

```
Router1 IPv6+list general-prefix

General-prefix name: myprefix6rd
  General-prefix               2001:a000:a00::/40 (6rd)
  Address on loopback1         ::1/64
Router1 IPv6+
```

For Router2:

```
Router2 IPv6+list general-prefix

General-prefix name: myprefix6rd
  General-prefix               2001:a000:b00::/40 (6rd)
  Address on loopback1         ::1/64
Router2 IPv6+
```