

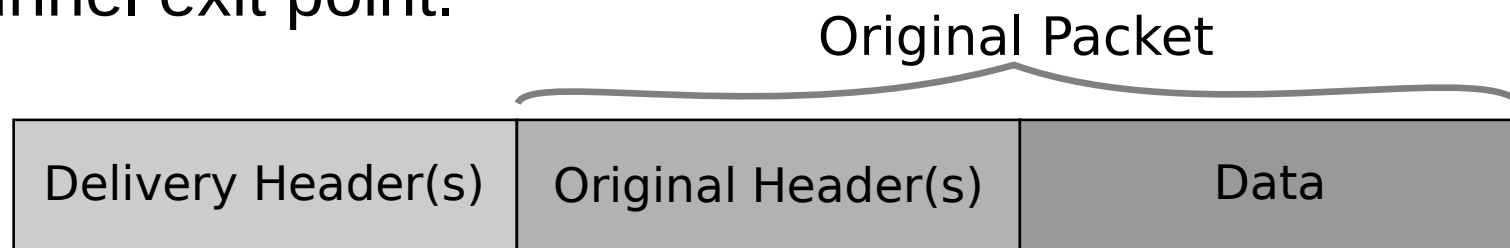
Traffic Tunneling & Overlay Networks

Redes de Comunicações II

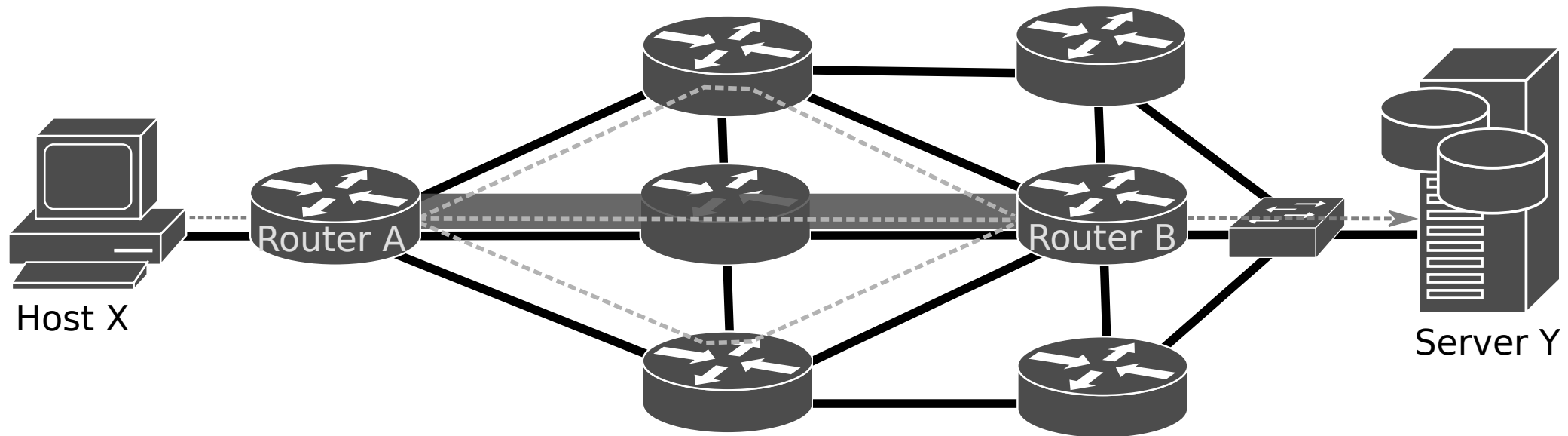
**Licenciatura em
Engenharia de Computadores e Informática
DETI-UA**

Traffic Tunnel Concept

- Main purposes
 - Guarantee that a packet that reaches a network node will reach a specific secondary network node independently of the intermediary nodes routing processes,
 - Guarantee the delivery of a packet to a remote node when the intermediary nodes do not support the original packet network protocol, and,
 - Define a virtual channel that adds additional data transport features in order to provide differentiated QoS, security requirements and/or optimized routing.
- Achieved by adding, at the tunnel entry point, one or more protocol headers to the original packets to handle their delivery to the tunnel exit point.



Tunnel End-Points



Delivery protocol(s)	Original protocol(s)	Data
Source: A address Destination: B address	Source: X address Destination: Y address	

Virtual Tunnel Interface (VTI)

- Logical construction that creates a virtual network interface that can be handled as any other network interface within a network equipment.
- A tunnel does not require to have any network addresses other the ones already bound to the end-point router.
- However, most implementations impose that a network address must be bound to a tunnel interface in order to enable IP processing on the interface.
 - ◆ The tunnel interface may have a explicitly bound network address or reuse an address of another interface already configured on the router.

```
1 #interface Tunnel 1
2 #ip address 10.1.1.1 255.255.255.252
3 #ipv6 address 2001:A:A::1/64
4 #ip unnumbered FastEthernet0/0
5 #ipv6 unnumbered FastEthernet0/0
6 #ip ospf cost 10
7 #ipv6 ospf 1 area 0
8 #tunnel mode ipip
9 #tunnel source FastEthernet0/0
10 #tunnel destination 200.2.2.2
```

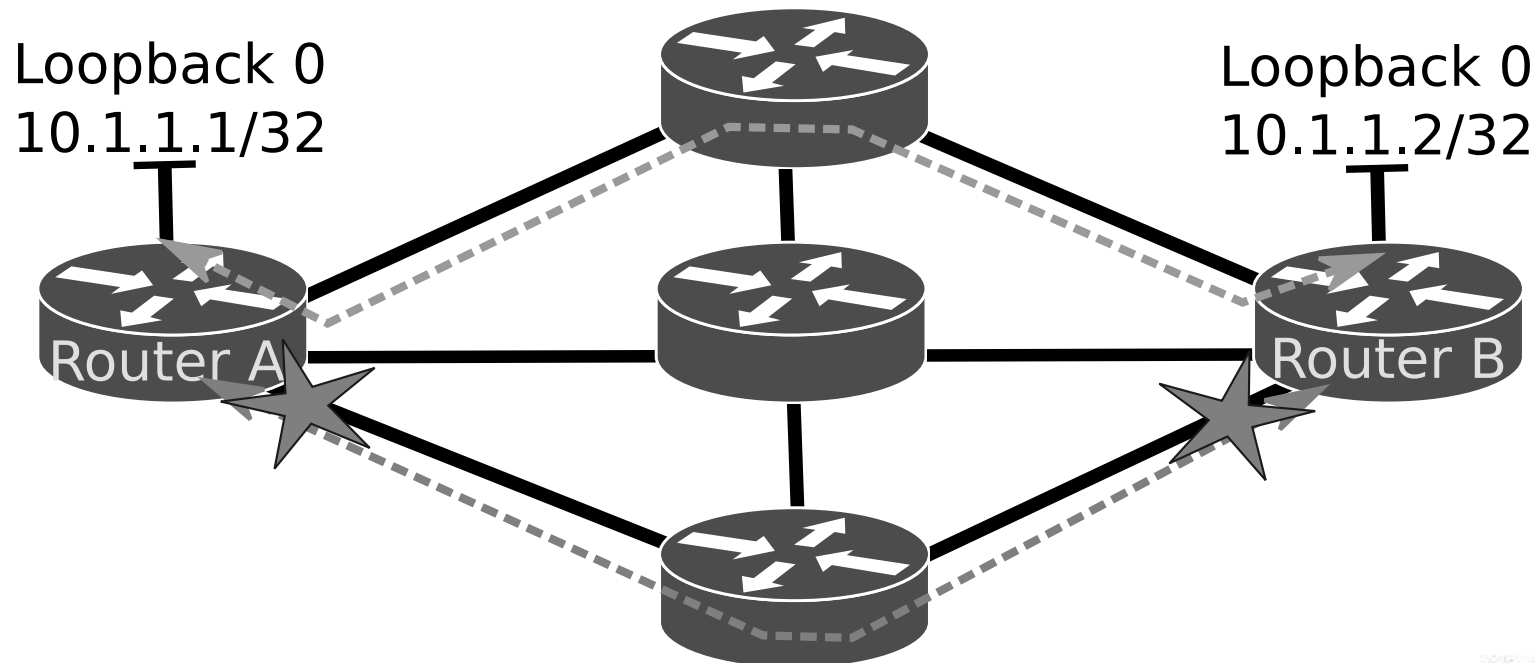
VTI Requirements

- A numeric identifier,
- A bounded IP address, this will enable IP processing,
 - ◆ Add the tunnel interface to the routing table and allow routing via the interface,
- A defined mode or type of tunnel,
 - ◆ Availability of tunnel models depends on the Router model, operating software and licenses.
- Tunnel source,
 - ◆ Defined as the name of the local interface or IPv4/IPv6 address depending on the type of the tunnel.
- Tunnel destination,
 - ◆ Defined as a domain name or IPv4/IPv6 address depending on the type of the tunnel.
 - ◆ This definition is not mandatory for all types of tunnels because in some cases the tunnel end-point is determined dynamically.
- May optionally have additional configurations for routing, security and QoS purposes.

```
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2 #ip address 10.1.1.1 255.255.255.252
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10 #tunnel destination 200.2.2.2
```

Loopback Interfaces as End-Points

- Loopback interface is another logical construction that creates a virtual network interface completely independent from the remaining physical and logical router network interfaces.
- The main propose of a loopback interface is to provide a network address to serve as router identifier in remote network configurations and distribute algorithms.
- The main advantage of using loopback interfaces as tunnel end-points, is the creation of a tunnel not bounded to any individual network card/link that may fail.



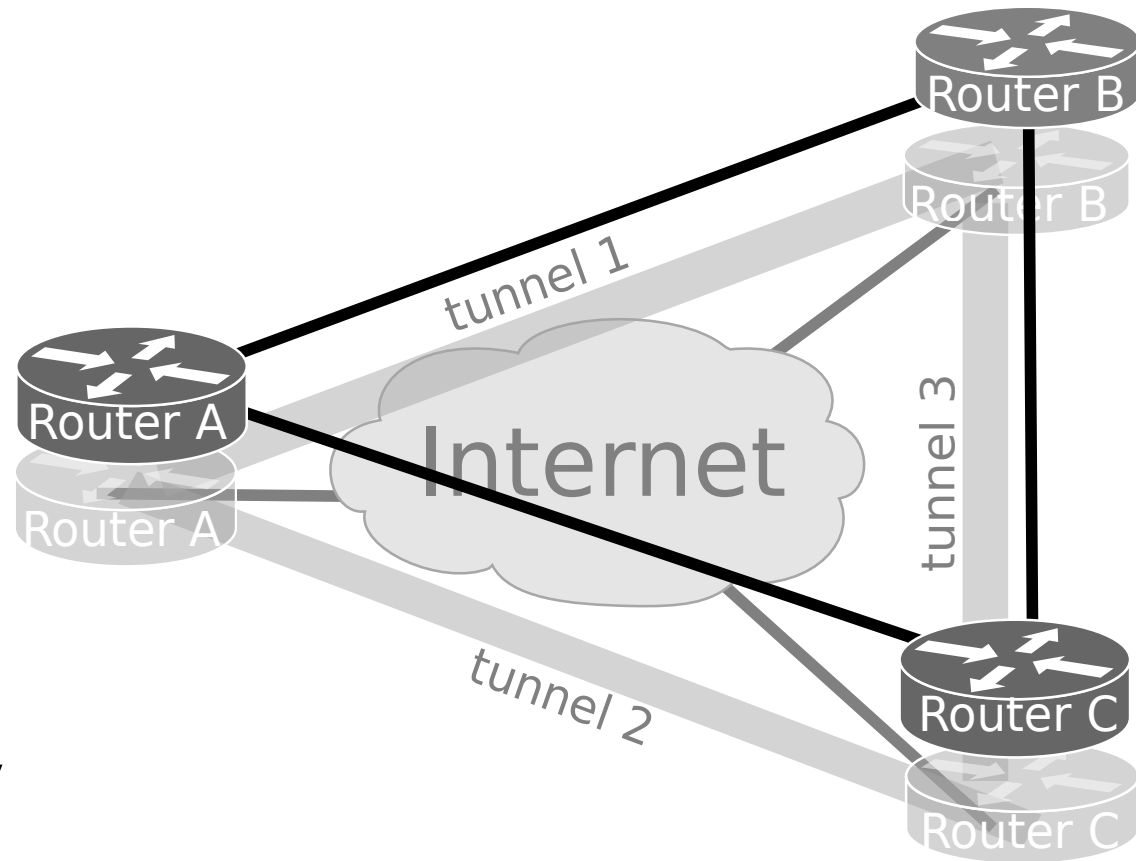
IP Tunnel Types

- IPv4-IPv4
 - ♦ Original IPv4 packets are delivered using IPv4 as network protocol.
- GRE IPv4
 - ♦ Original packets protocol (any network protocol) is defined by GRE header and delivered using IPv4 as network protocol.
- IPv6-IPv6
 - ♦ Original IPv6 packets are delivered using IPv6 as network protocol.
- GRE IPv6
 - ♦ Original packets protocol (any network protocol) is defined by a GRE header and delivered using IPv6 as network protocol.
- IPv6-IPv4
 - ♦ Original IPv6 packets are delivered using IPv4 as network protocol.
- IPv4-IPv6
 - ♦ Original IPv4 packets are delivered using IPv6 as network protocol.



Overlay Network

- An overlay network can be defined as a virtual network defined over another network.
 - For a specific purpose like private transport/routing policies, QoS, security.
- The underlying network can be physical or also virtual.
 - May result in multiple layers of overlay networks.
- When any level of privacy protocol is present on an overlay network is designated by Virtual Private Network (VPN).



Routing Through/Between Tunnels

- Static Routes

```
1 #ip route 192.168.2.0 255.255.255.0 Tunnel1
2 #ip route 192.168.2.0 255.255.255.0 10.1.1.2
3 #ipv6 route 2001:A:1::/64 Tunnel1
4 #ipv6 route 2001:A:1::/64 2001:0:0::2
5 #ip route 192.168.2.100 255.255.255.255 10.1.1.2
6 #ipv6 route 2001:A:1::100/128 2001:0:0::2
```

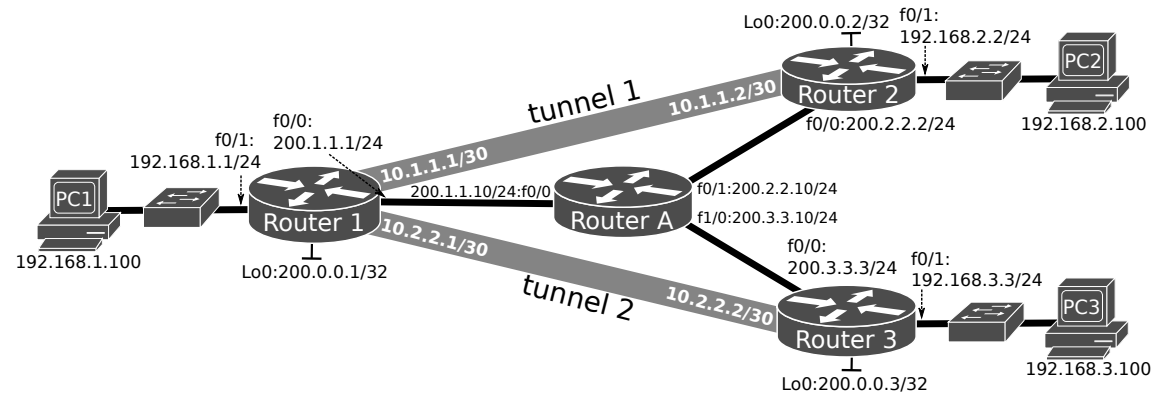
- Route-maps

```
1 #access-list 100 permit ip host 192.168.1.100 192.168.2.0 255.255.255.0
2 #route-map routeT1
3 #match ip address 100
4 #set ip next-hop 10.1.1.2
5 #interface FastEthernet0/1
6 #ip policy route-map routeT1
```

- Dynamic Routing

- Multiple (distinct) routing processes.
 - ➔ One per overlay network, and
 - ➔ One for the underlying network.

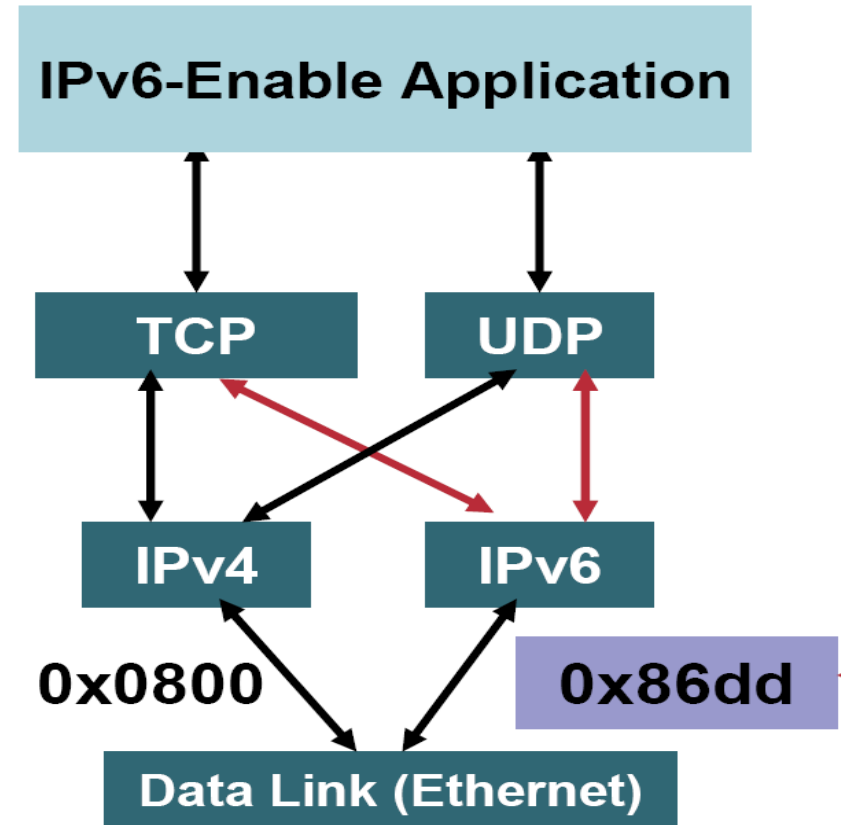
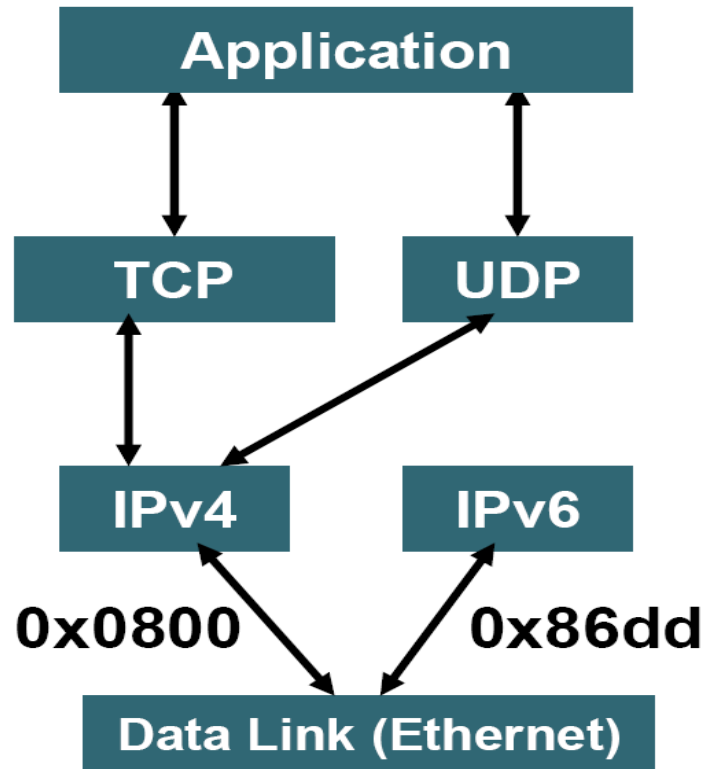
```
1 #router ospf 1
2 #network 200.1.1.0 0.0.0.255 area 0
3 #network 200.0.0.1 0.0.0.0 area 0
4 !
5 #router ospf 2
6 #network 10.0.0.0 0.255.255.255 area 0
7 #network 192.168.0.0 0.0.255.255 area 1
```



IPv6 Deployment Techniques

- Deploying IPv6 using dual-stack backbones
 - ♦ IPv4 and IPv6 applications coexist in a dual IP layer routing backbone
 - ♦ All routers in the network need to be upgraded to be dual-stack
- IPv6 over IPv4 tunnels
 - ♦ Manually configured
 - With and without Generic Routing Encapsulation (GRE)
 - ♦ Semiautomatic tunnel mechanisms
 - ♦ Fully automatic tunnel mechanisms (IPv4-compatible and 6to4)

Dual Stack



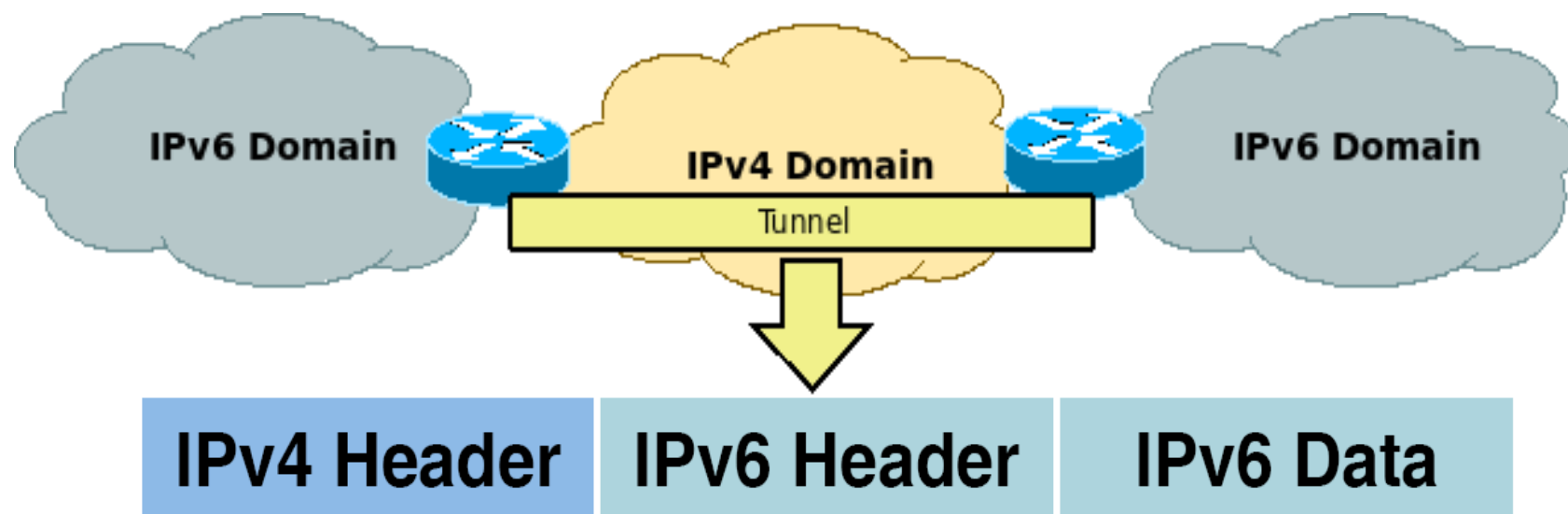
- Applications may talk to both
- Choice of the IP version is based on DNS responses and application preferences

IPv6 Overlay Tunneling

- Manual
 - ♦ IPv6 Manually Configured IPv6 over IPv4
 - ♦ IPv6 over IPv4 GRE Tunnel
- Semi-automatic mechanisms
 - ♦ Tunnel Broker
 - ♦ Teredo
 - ♦ Dual Stack Transition Mechanism (DSTM)
- Automatic mechanisms
 - ♦ Automatic IPv4 Compatible Tunnel (deprecated)
 - ♦ 6to4 Tunnel
 - ♦ ISATAP Tunnels

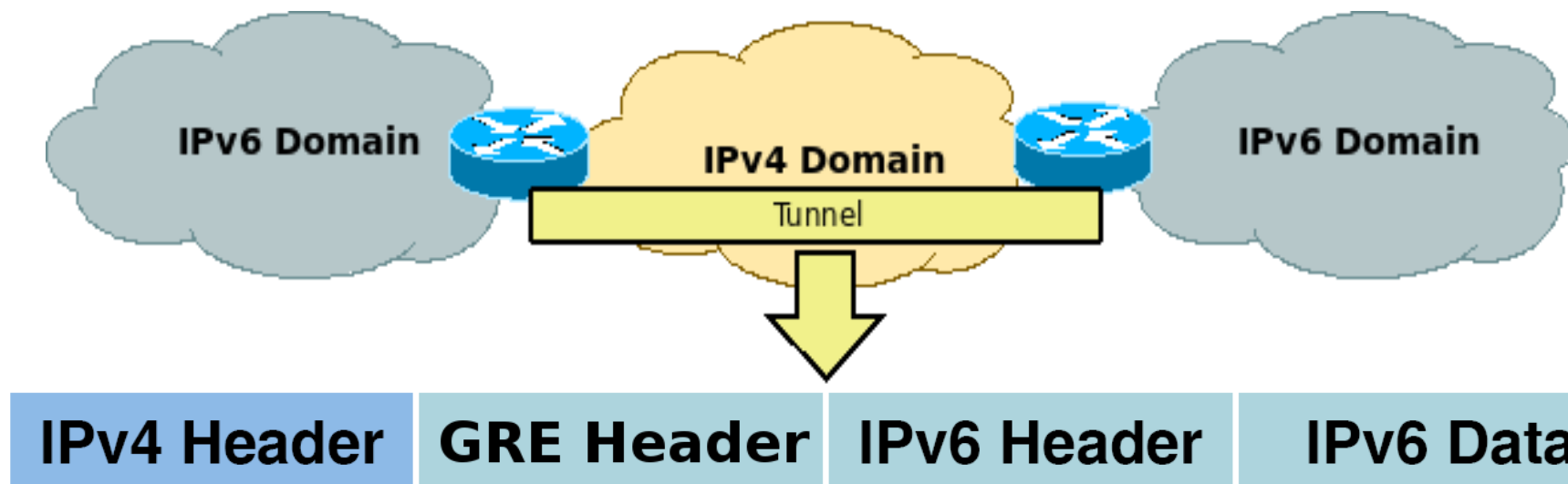
IPv6 Manually Configured

- Permanent link between two IPv6 domains over an IPv4 backbone
- Primary use is for stable connections that require regular secure communication between
 - ◆ Two edge routers, end system and an edge router, or for connection to remote IPv6 networks
- Tunnel between two points
- Complex management



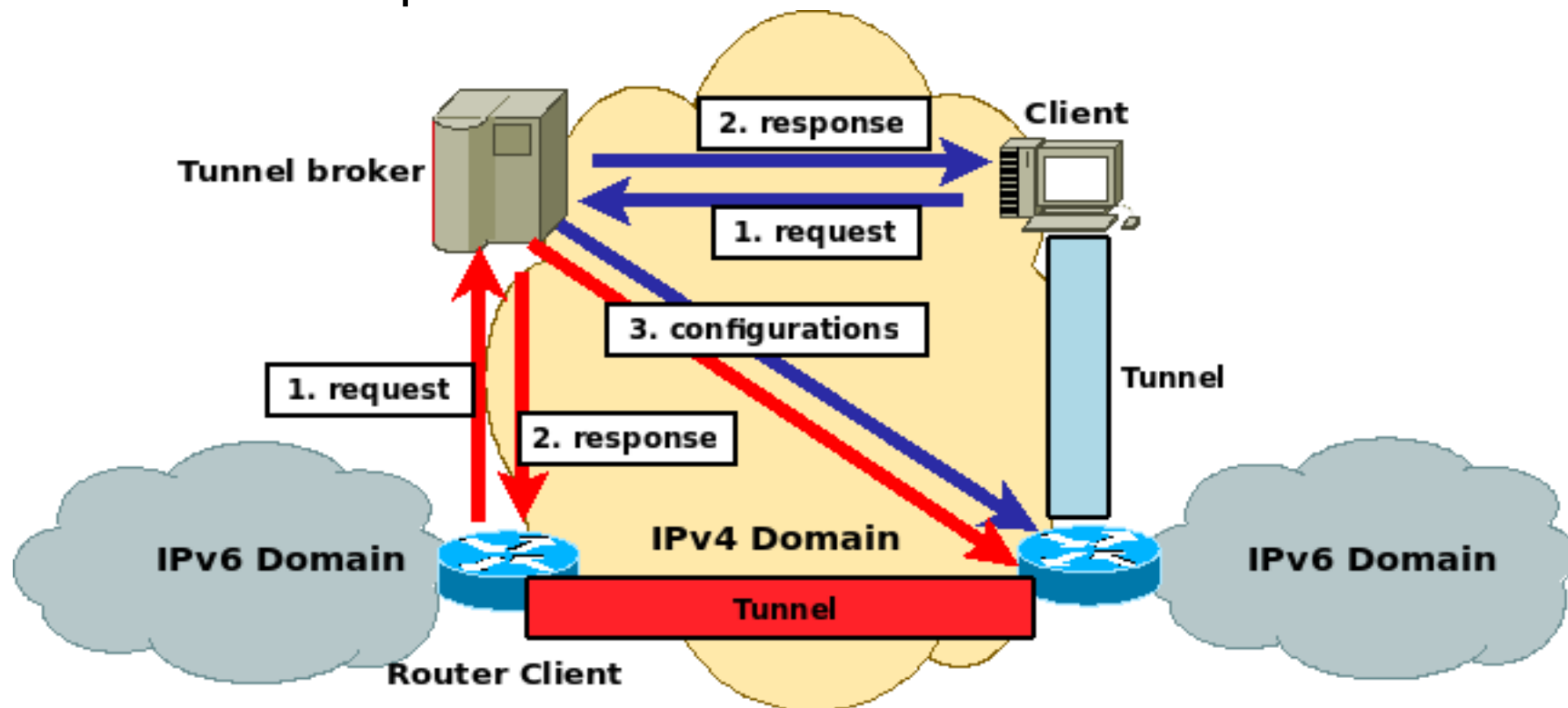
IPv6 over IPv4 GRE Tunnel

- Uses the standard GRE tunneling technique
 - ◆ GRE – Generic Route Encapsulation
- Also must be manually configured
- Primary use is for stable connections that require regular stable communications
- IPv4 over IPv6 also possible



Tunnel Broker

- A tunnel broker service allows IPv6 applications on dual-stack systems access to an IPv6 backbone
- Automatically manages tunnel requests and configuration
- Potential security implications
 - ♦ Broker is a single point of failure
- Most common implementation: Teredo.



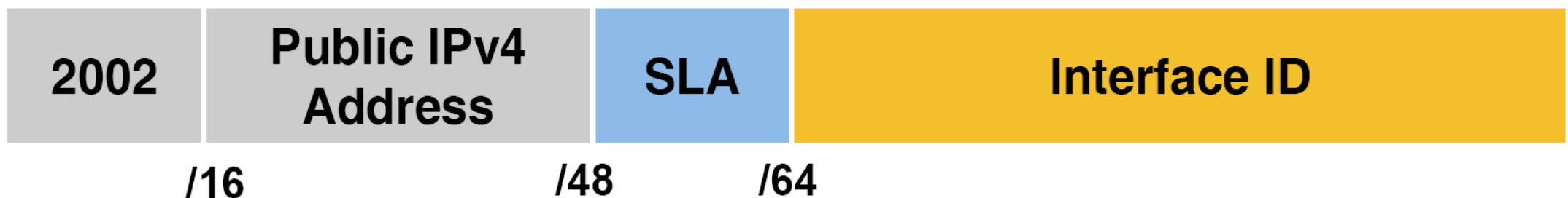
Automatic IPv4 Compatible Tunnel

- IPv4 tunnel end-point address is embedded within the destination IPv6 address
- An automatic IPv4-compatible tunnel can be configured between edge routers or between an edge router and an end system.
- Systems must be dual-stack
- Communication only with other IPv4-compatible sites
- This tunneling technique is currently deprecated



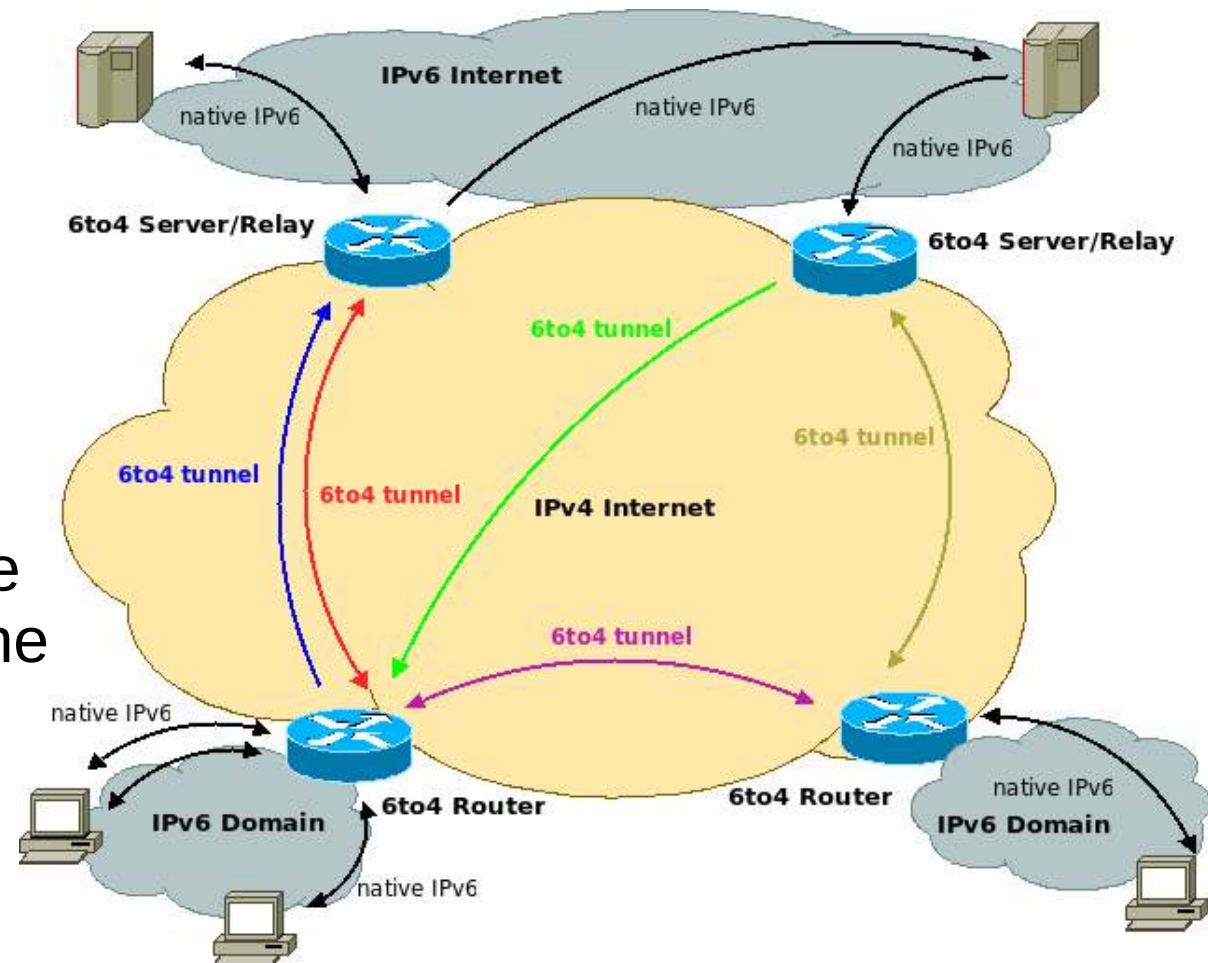
Automatic 6to4 Tunnels

- IPv4 tunnel end-point address is embedded within the destination IPv6 address
 - Automatic 6to4 tunnel allows isolated IPv6 domains to connect over an IPv4 network
 - Unlike the manually configured tunnels are not point-to-point, they are multipoint tunnels
 - 6to4 host/router needs to have a globally addressable IPv4 address
 - Cannot be located behind a NAT box
 - Unless the NAT box supports protocol 41 packets forwarding
 - Address format is:



6to4 Relay Routers

- 6to4 router
 - Connects 6to4 hosts from a IPv6 domain and
 - Other 6to4 routers
 - The IPv6 Internet through a 6to4 relay router
- 6to4 relay router
 - Connects 6to4 routers on the IPv4 Internet and hosts on the IPv6 Internet.



ISATAP Tunnels

- Intra-site Automatic Tunnel Address Protocol
- Point-to-multipoint tunnels that can be used to connect systems within a site
- Used to tunnel IPv4 within an administrative domain to create a virtual IPv6 network over a IPv4 network
- Scalable approach for incremental deployment
- Encode IPv4 Address in IPv6 Address within the interface ID

64-bit Unicast Prefix

Interface ID

0000:5EFE: IPv4 Address

/64