An Overview of IPv6 Transition/Co-existence Technologies

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IPv6 transition/co-existence technologies

- IPv6 is not backwards-compatible with IPv4
- Original transition plan: deploy IPv6 before we ran out of IPv4 addresses, and eventually turn off IPv4 when no longer needed – *it didn't happen*
- Current transition/co-existence plan: based on a toolbox:
  - dual-stack
  - tunnels
  - translation

Dual stack

Dual-stack

- Each node supports both IPv4 and IPv6
- Domain names include both A and AAAA (Quad A) records
- IPv4 or IPv6 are used as needed
- Dual-stack was the original transitionco-existence plan, and still is the recommended strategy for servers

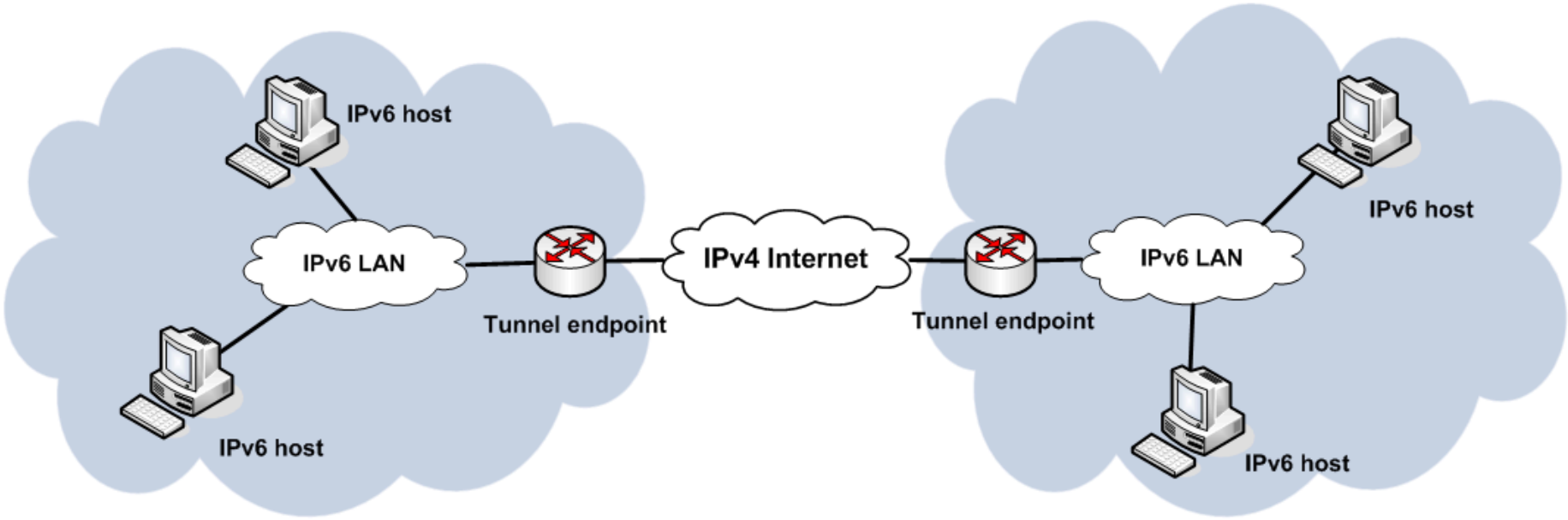
Tunnels

Tunnels

- Use the existing IPv4 Internet to transport IPv6 packets from/to IPv6 islands
- Tunnels can be:
  - configured: some sort of manual configuration is needed
  - automatic: the tunnel end-points are derived from the IPv6 addresses
- Configured tunnels:
  - 6in4
  - Tunnel broker
- Automatic tunnels:
  - ISATAP
  - 6to4
  - 6rd
  - Teredo

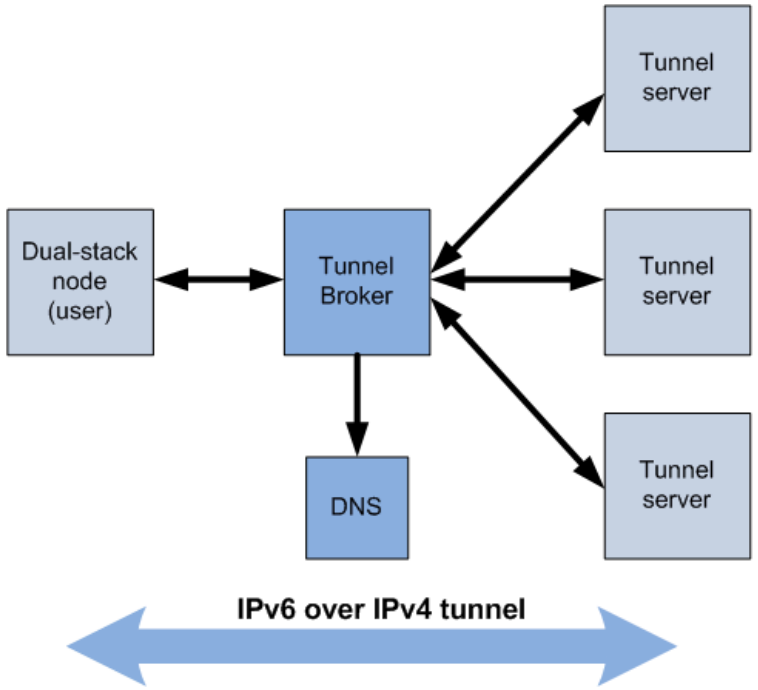
6in4

- The tunnel endpoints must be manually configured
- Management can be tedious
- Security may be used as needed (e.g., IPsec)
- May operate across NATs (e.g. IPsec UDP encapsulation, or if the DMZ function is employed)



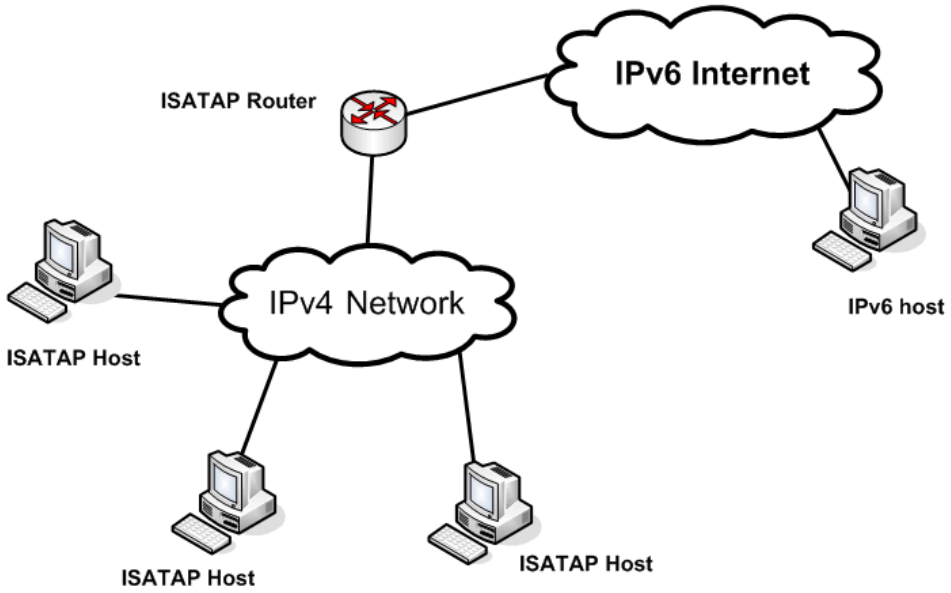
Tunnel broker

- The Tunnel Broker is model to aid the dynamic establishment of tunnels (i.e., relieve the administrator from manual configuration)
- The TB is used to manage the creation, modification or deletion of a tunnel
- Example: “Tunnel Broker with the Tunnel Setup Protocol (TSP)



ISATAP

- Intra-Site Automatic Tunnel and Addressing Protocol
- Aims at enabling IPv6 deployment withing a site with no IPv6 infrastructure
- Does not work across NATs

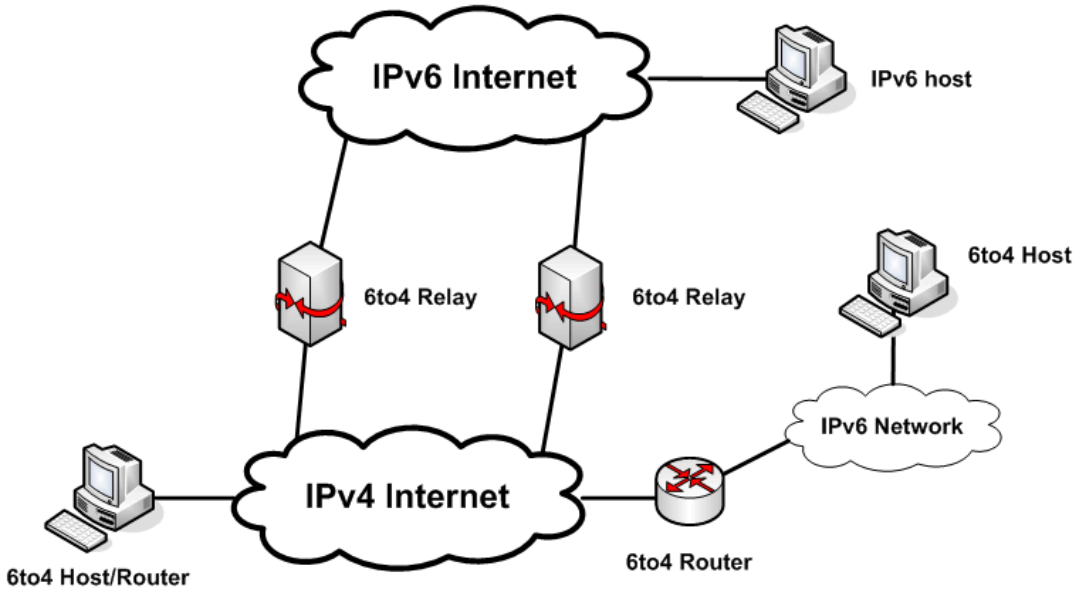


Address format

```
|0                   1|1                   3|3                                 6|
|0                   5|6                   1|2                                 3|
+--------------------+--------------------+-----------------------------------+
|000000ug00000000|0101111011111110|          IPv4 address                      |
+----------------+----------------+-----------------------------------+
```

6to4

- Aims at enabling IPv6 deployment within a site with no global IPv6 connectivity
- Does not work across NATs (unless the DMZ function is used)



Address format

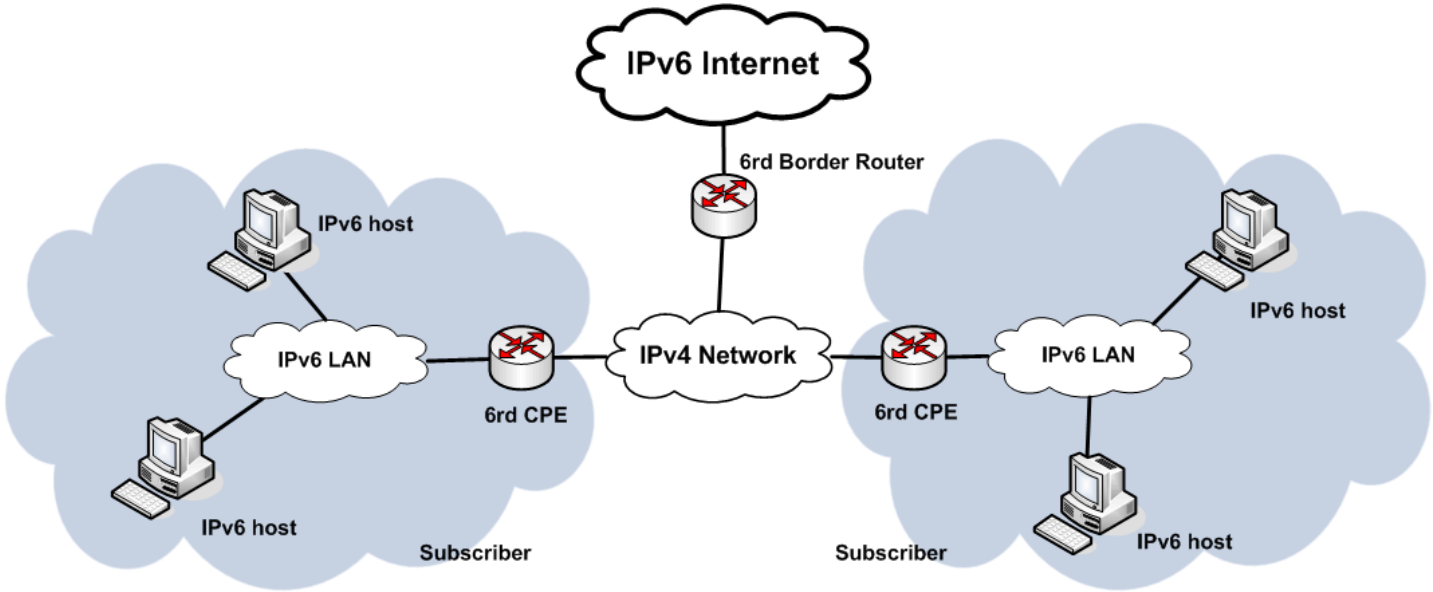
16	32	16	64 bits
2002	V4ADDR	Subnet	Interface ID

Problems with 6to4

- Lots of poorly-managed 6to4 relays have been deployed
- In most cases they introduce PMTUD black-holes (e.g. as a result of ICMPv6 rate-limiting)
- Lack of control of which 6to4 relays are used make troubleshooting difficult
  - Use of the 6to4 anycast address makes it difficult to identify a poorly-managed relay in the 6to4 -> native IPv6 direction
  - It is always difficult to troubleshoot problems in the native IPv6 -> 6to4 direction (the user has no control over which relay is used)

6rd (IPv6 rapid deployment)

- Aims at enabling IPv6 deployment in a site with no IPv6 infrastructure
- Builds upon 6to4 – but the whole system is implemented within a site
- No special prefix – uses global unicast range

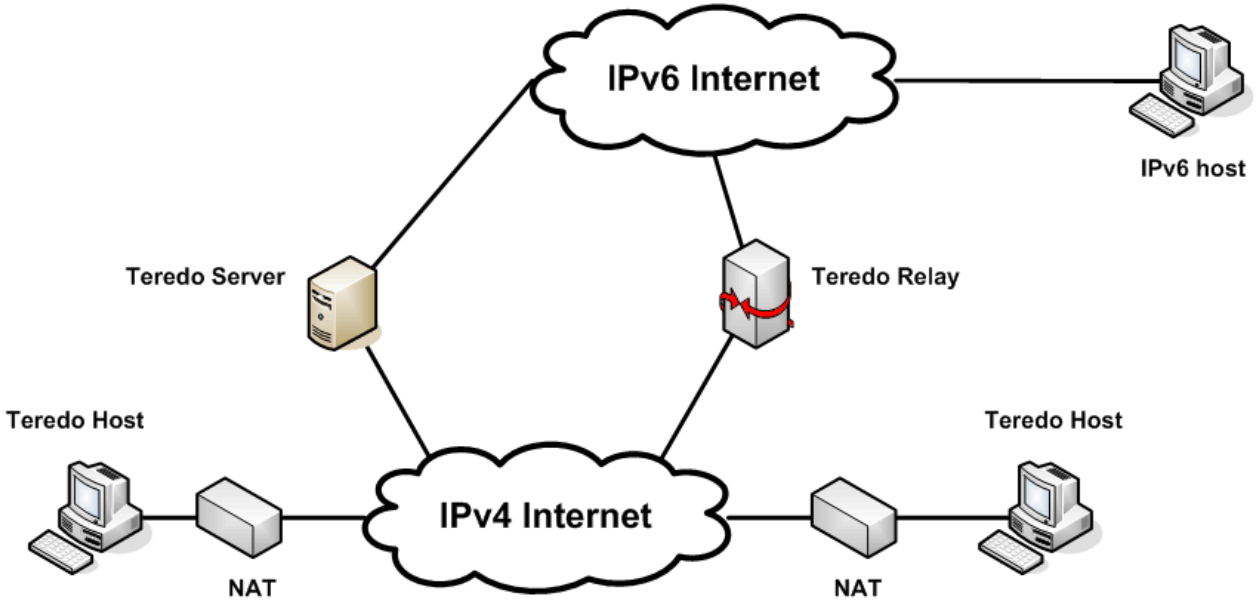


Address format

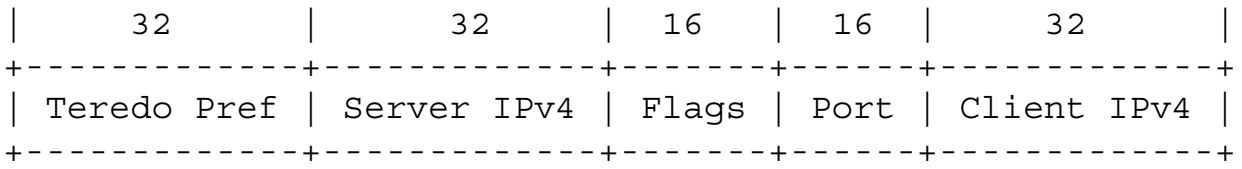
```
|     n bits     |     o bits     |   m bits   |     128-n-o-m bits      |
+----------------+----------------+------------+-------------------------+
|  6rd prefix    | IPv4 address | subnet ID |      interface ID        |
+----------------+----------------+------------+-------------------------+
|<--- 6rd delegated prefix --->|
```

Teredo

- Aims at providing IPv6 connectivity to individual hosts behind one or more NATs -- “last resort” mechanism for IPv6 connectivity
- Suffers some of the same problems as 6to4



Address format



Translation

Translation

- All of the previous transition/co-existence technologies require assignment of both IPv4 and IPv6 addresses – **what if there are no IPv4 addresses left?**
- A number of technologies are curerntly being developed in the IETF such that:
  - IPv4 addresses can be dynamically shared by a large number of hosts, or,
  - IPv6-only nodes can still access IPv4-only nodes
- Among these technlogies are:
  - CGN (Carrier-Grade NAT)
  - NAT 64
  - A+P

The future doesn't look like very NAT-free…..

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