I'm Running IPv6: How Do I Access??? Share Session 11165

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What is IPv6

Updated version of the Internet Protocol (IPv4)

Defined in RFC 1752

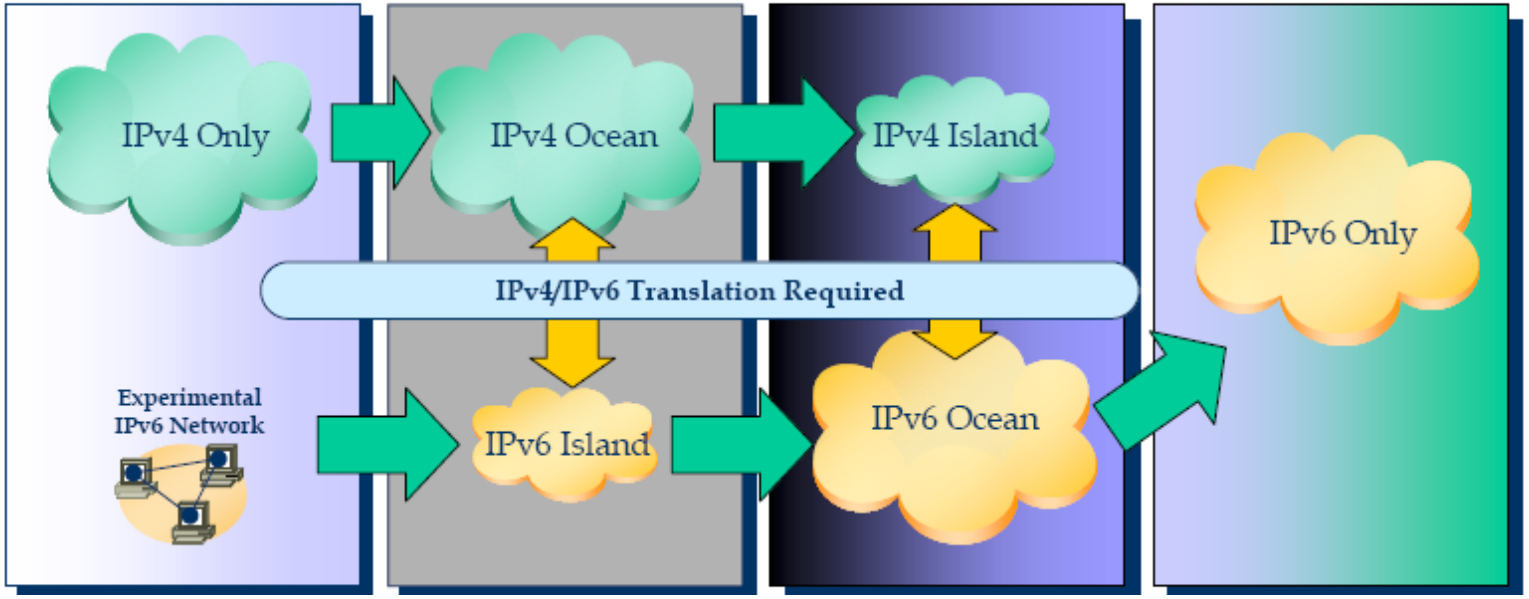
New features

- **Larger address space**
- **Encapsulation**
- **Class of service for audio, video, etc.**
- **Multicast support**
- **Authentication**
- **Encryption**
- **Automatic configuration/reconfiguration**
- **Support for non-IP protocols**

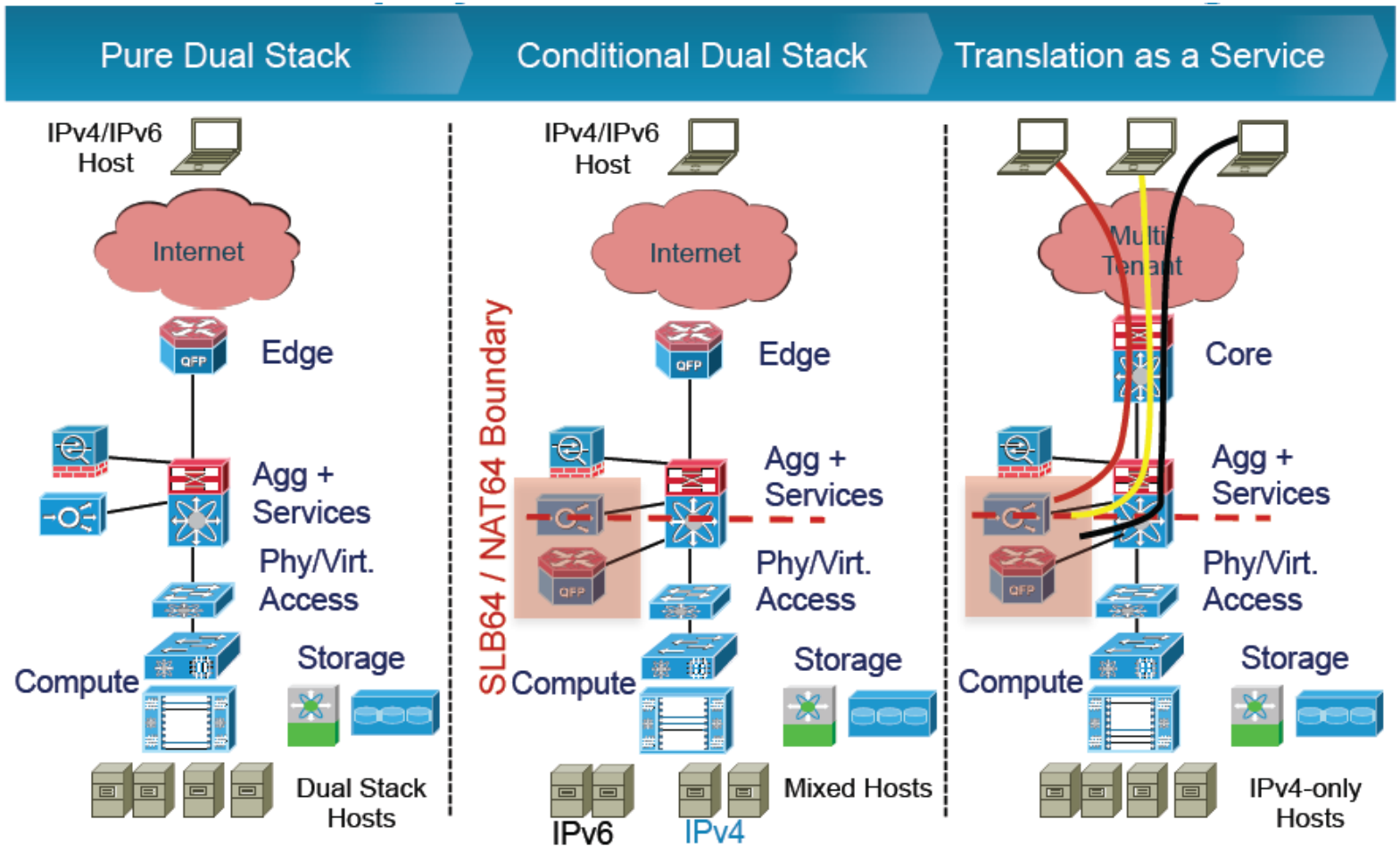
IPv6 Technology Scope

IP Service	IPv4 Solution	IPv6 Solution
Addressing Range	32-bit, Network Address Translation	128-bit, Multiple Scopes
Auto configuration	DHCP	Serverless, Reconfiguration, DHCP
Security	IPSec	IPSec Mandated, works End-to-End
Mobility	Mobile IP	Mobile IP with Direct Routing
Quality-of-Service	Differentiated Service, Integrated Service	Differentiated Service, Integrated Service
IP Multicast	IGMP/PIM/Multicast BGP	MLD/PIM/Multicast BGP,Scope Identifier

IPv6 Transition Paths – ISP Focus



IPv6 in the Enterprise



Types of IPv6 Node Types

IPv4 only node – a node running only IPv4

IPv6/IPv4 node – a node running dual stack

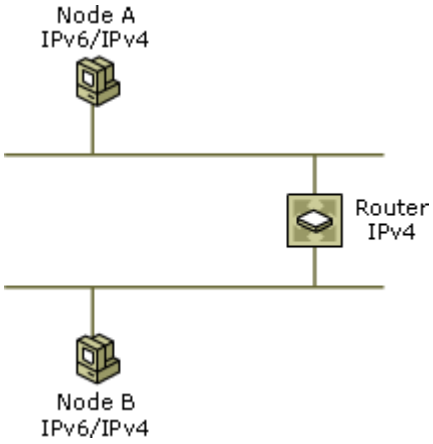
IPv6 only node – a node running only IPv6

IPv6 node – node running IPv6 and it may also run IPv4

IPv4 node – node running IPv4 and it may also run IPv6

IPv6 with IPv4 Compatible Address - Depricated

Dynamic tunneling of IPv6 over an IPv4 infrastructure
Carry a **public** IPv4 address in the lower 32 bits
Bit 16 is 0000
IPv4 address 131.107.41.17 is ::0000:131.107.41.17



Host A (IPv4 address of 131.107.41.17) uses IPv4-compatible addresses to send IPv6 traffic to Host B (IPv4 address of 157.60.15.93), the source and destination addresses for the IPv4 and IPv6 headers are

Field	Value
Source address in IPv6 header	::131.107.41.17
Destination address in IPv6 header	::157.60.15.93
Source address in IPv4 header	131.107.41.17
Destination address in IPv4 header	157.60.15.93

IPv6 Mapped Address

Dynamic tunneling of IPv6 over an IPv4 infrastructure for IPv4 nodes that are not IPv6 compatible

IPv6 address used to represent an IPv4 device – JAVA uses this extensively

The device is not IPv6 capable

Internal representation only – never used as source or destination address of an IPv6 packet

Embeds an IPv4 address in lower 32 bits

Bit 16 is FFFF

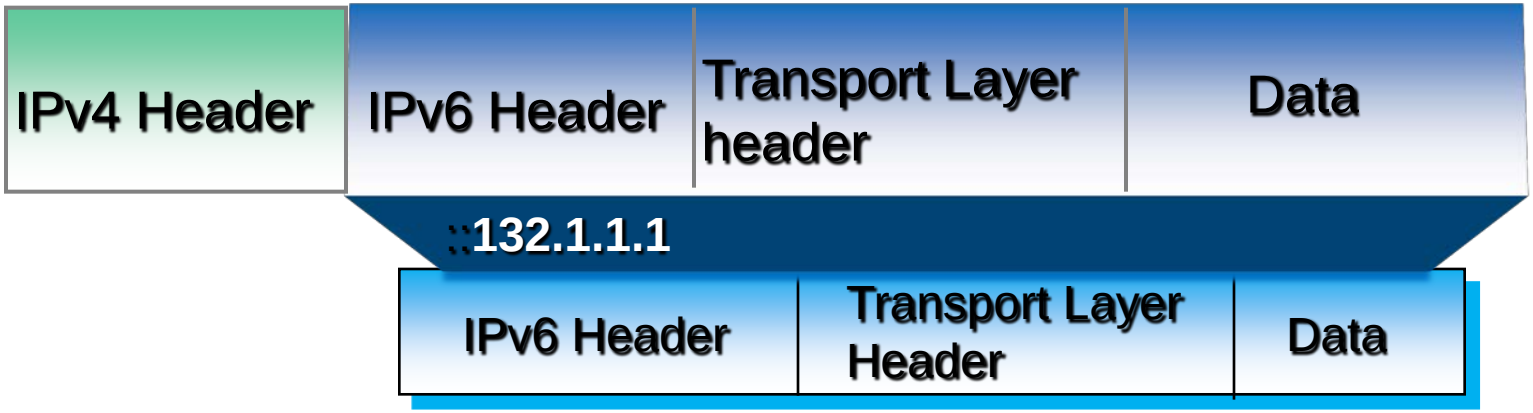
IPv4 address 10.0.1.170 would be ::FFF:10.0.1.170

IPv6 Transition Methods: Tunneling

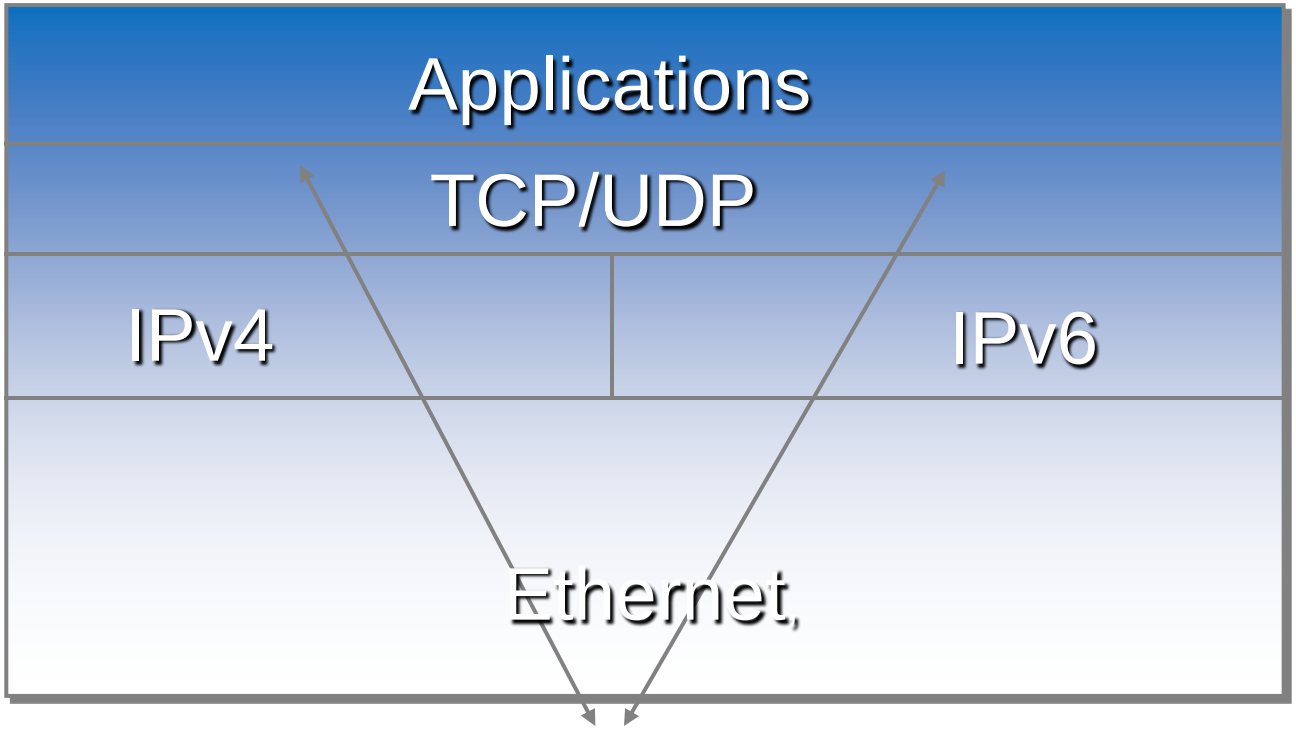
Tunneling (aka encapsulation using protocol 41)

Automatic Tunneling

6to4, TOREDO, ISATAP, Tunnel Broker



Transition Method: Dual Stack

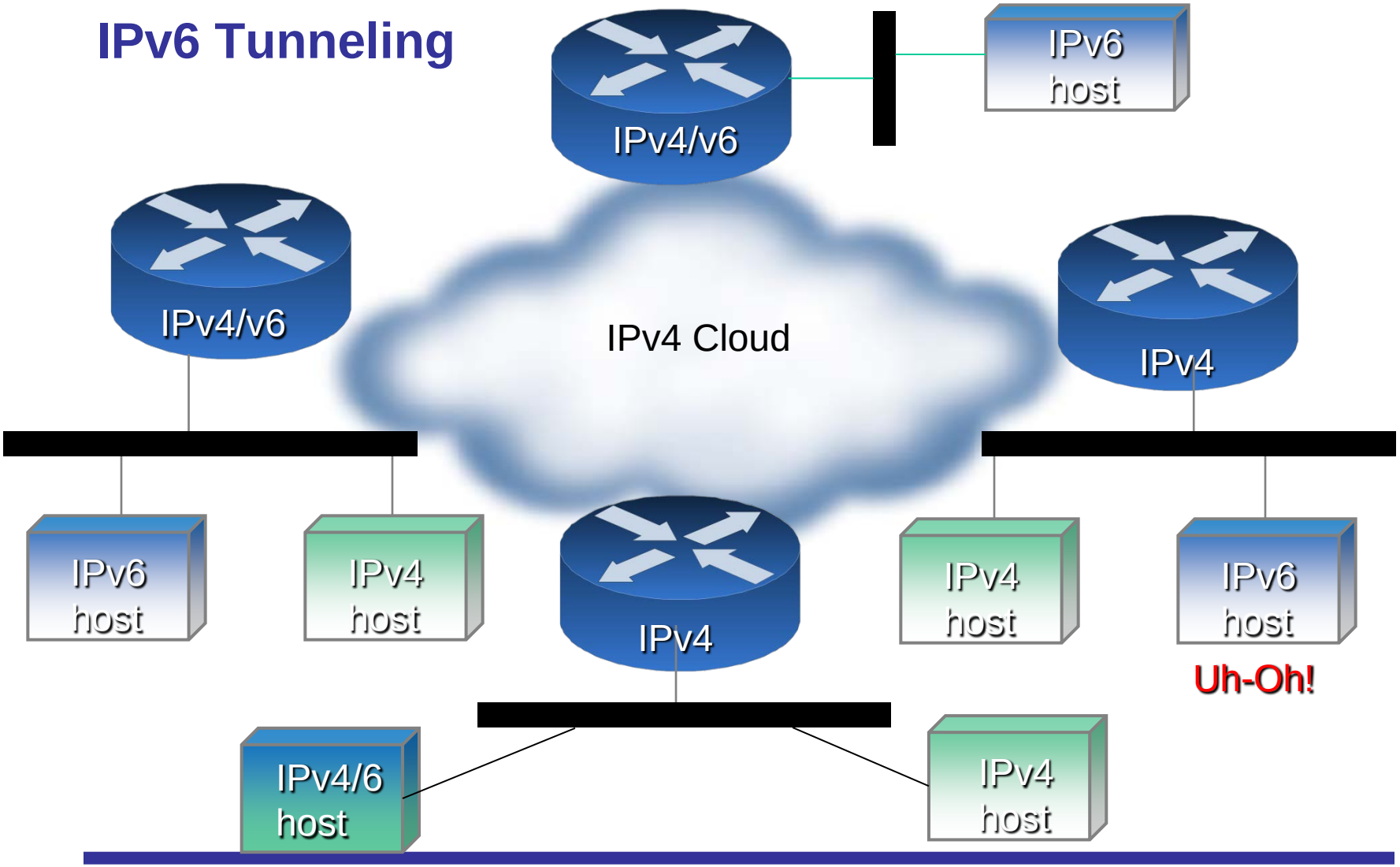


IPv6 Design Motto

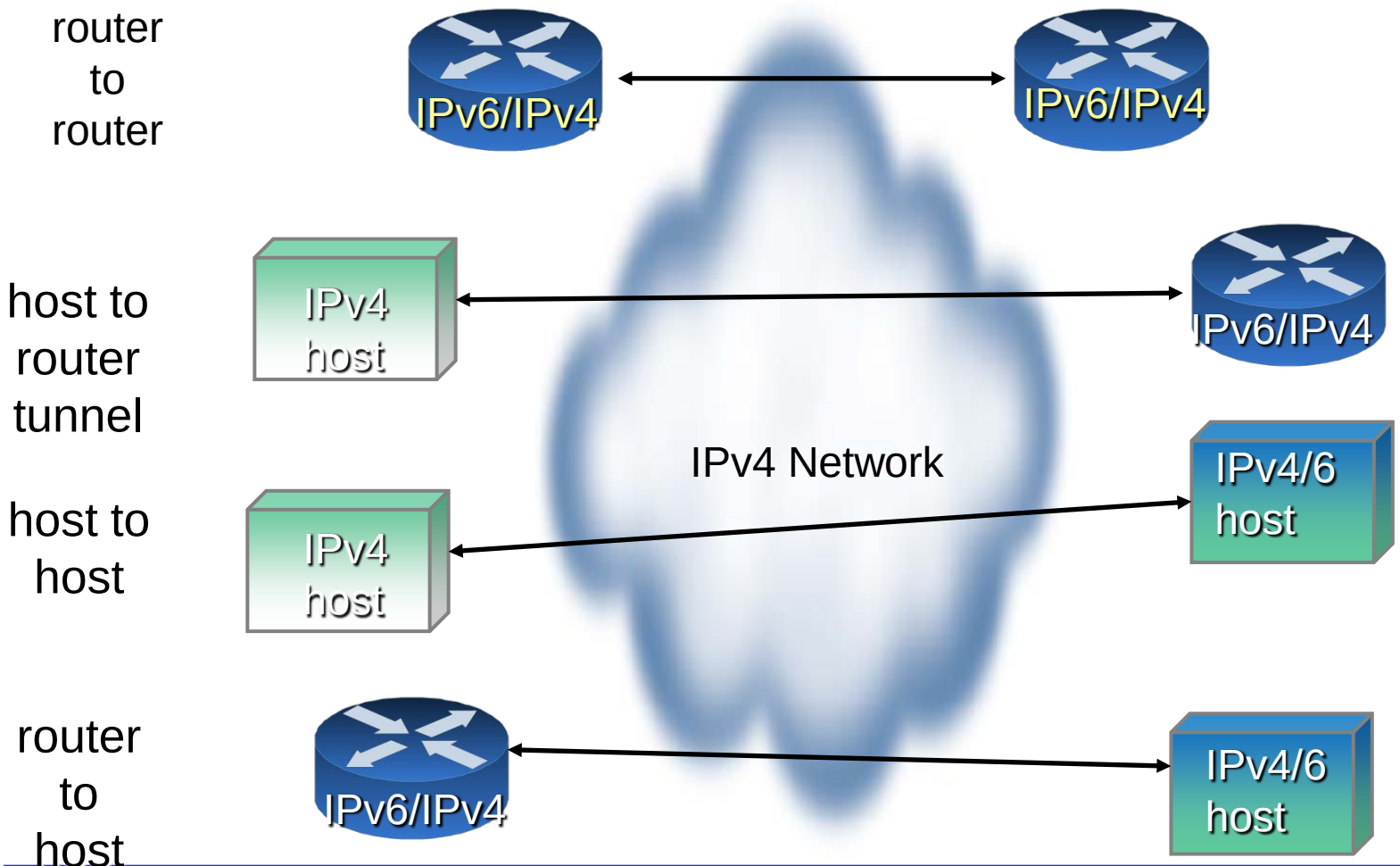
Dual Stack or Tunnel where you must!

Go Native where you can!

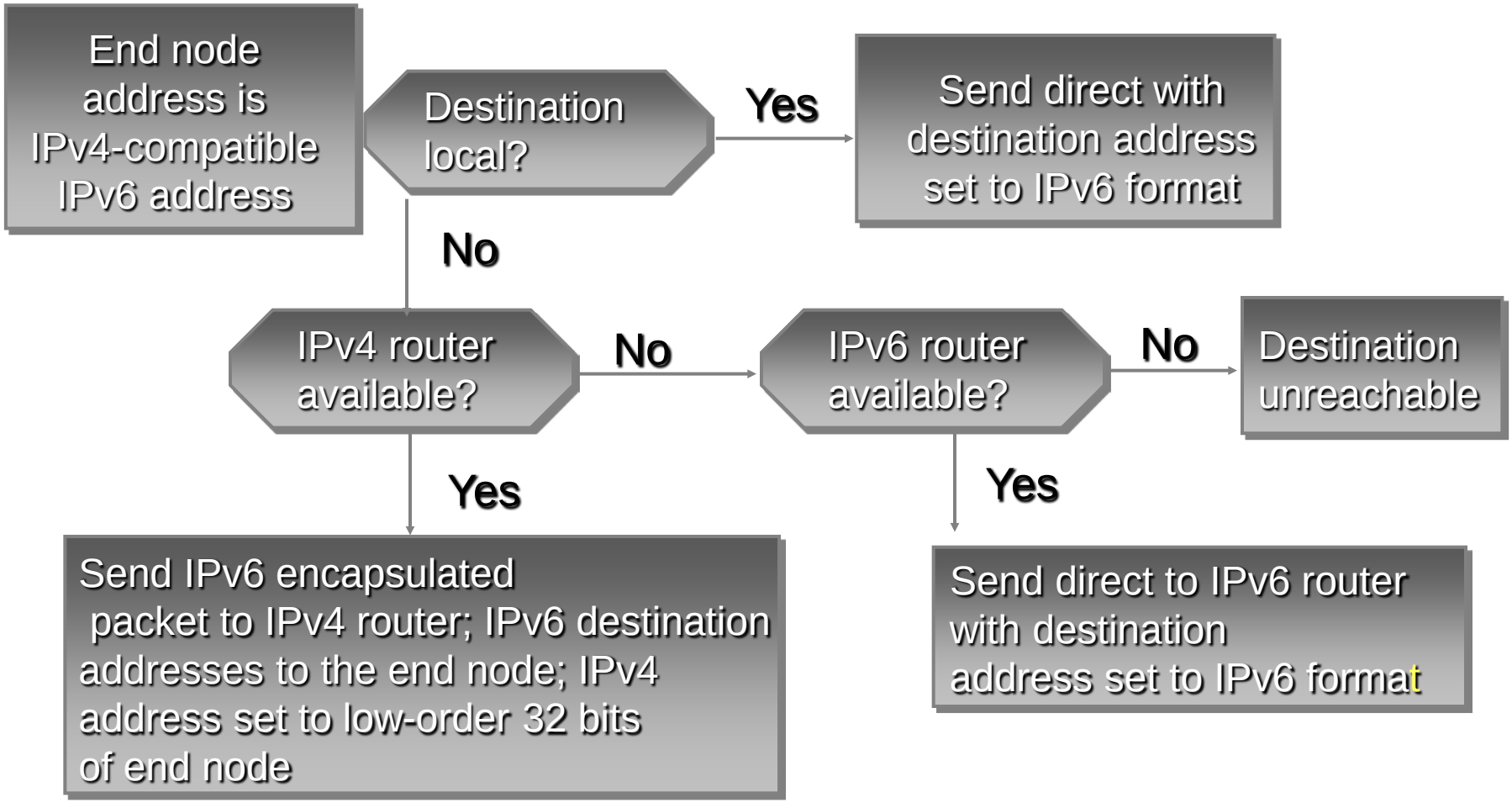
IPv6 Tunneling



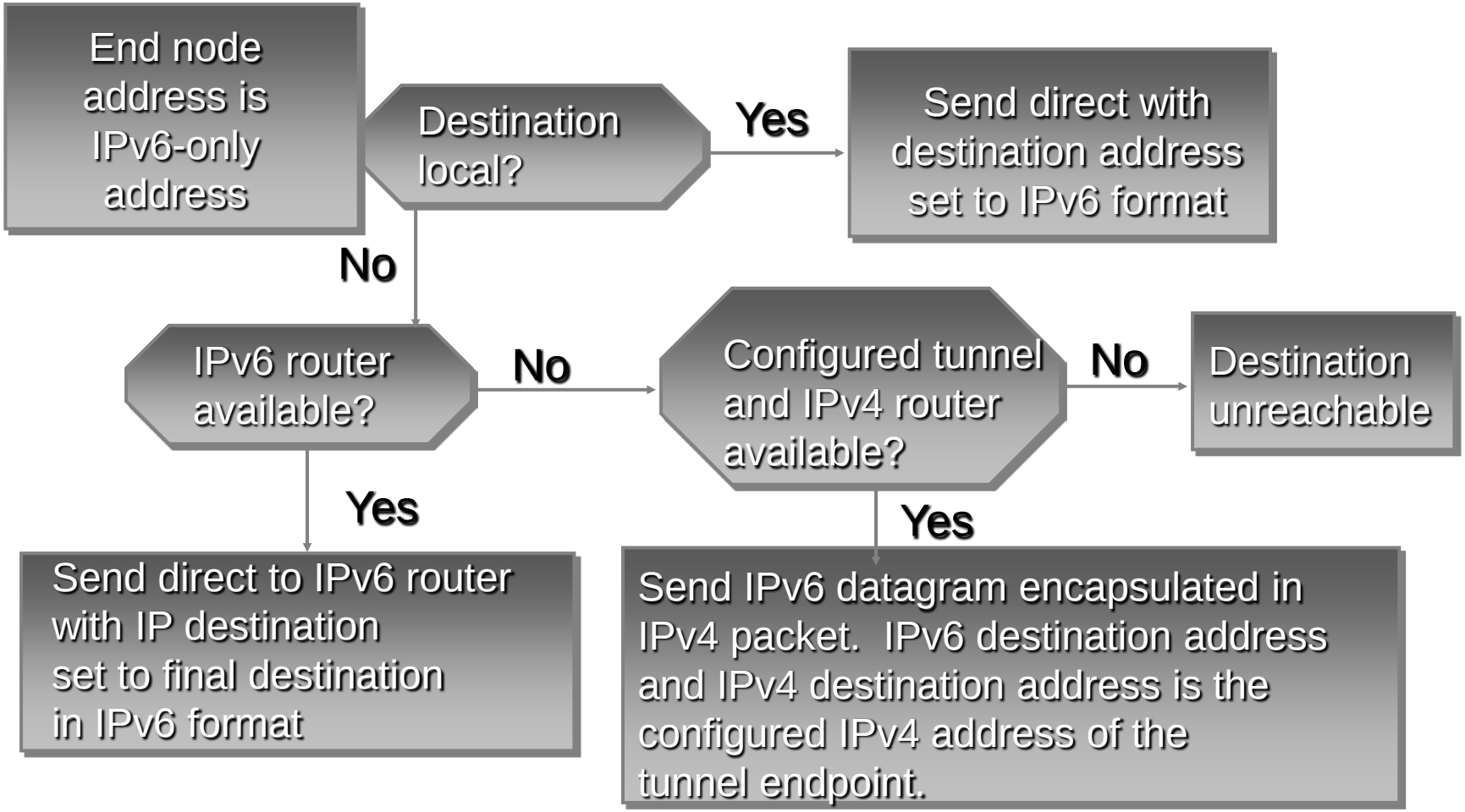
IPv6 Tunneling Options



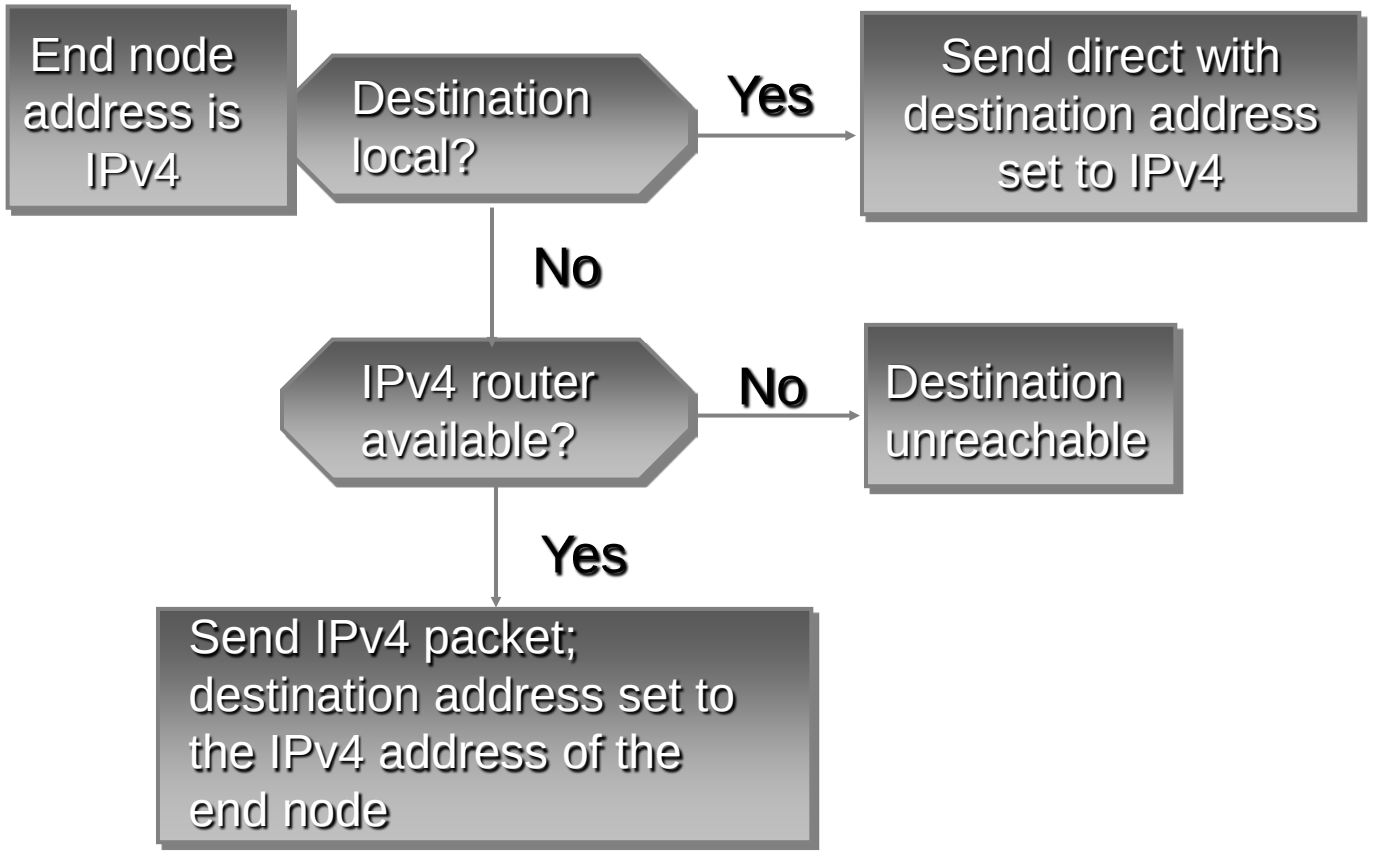
IPv6 Tunneling Flowchart: End Node IPv6 Address is IPv4 Compatible Address



IPv6 Tunneling Flowchart
End Node is IPv6 ONLY Address

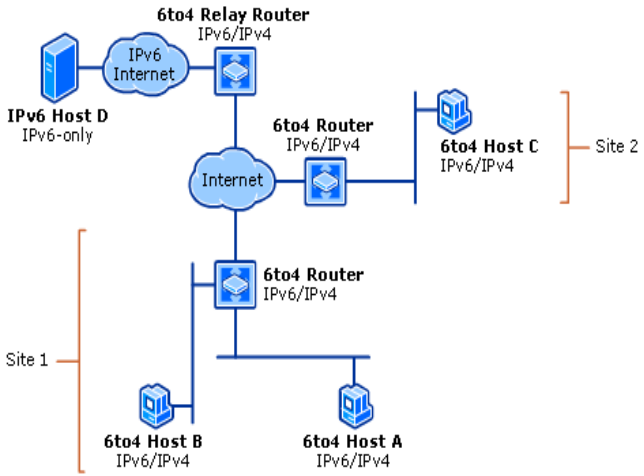


IPv6 Tunnel Flowchart: IPv4 ONLY Address

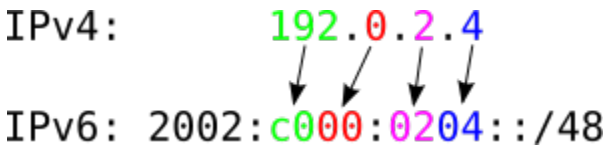


6to4 Tunneling

- Automatic IPv6 packet transit over an IPv4 network
- Interconnects isolated IPv6 nodes and networks
- IPv4 is treated as a unicast point-point link layer
- Public relay servers allow 6to4 networks to communicate with native IPv6 networks
- The 6to4 tunnel endpoint must have a public IPv4 address
- Functions
  - Assigns a block of IPv6 address space to any host or network that has a global IPv4 address.
  - Encapsulates IPv6 packets inside IPv4 packets for transmission over an IPv4 network using 6in4.
  - Routes traffic between 6to4 and "native" IPv6 networks



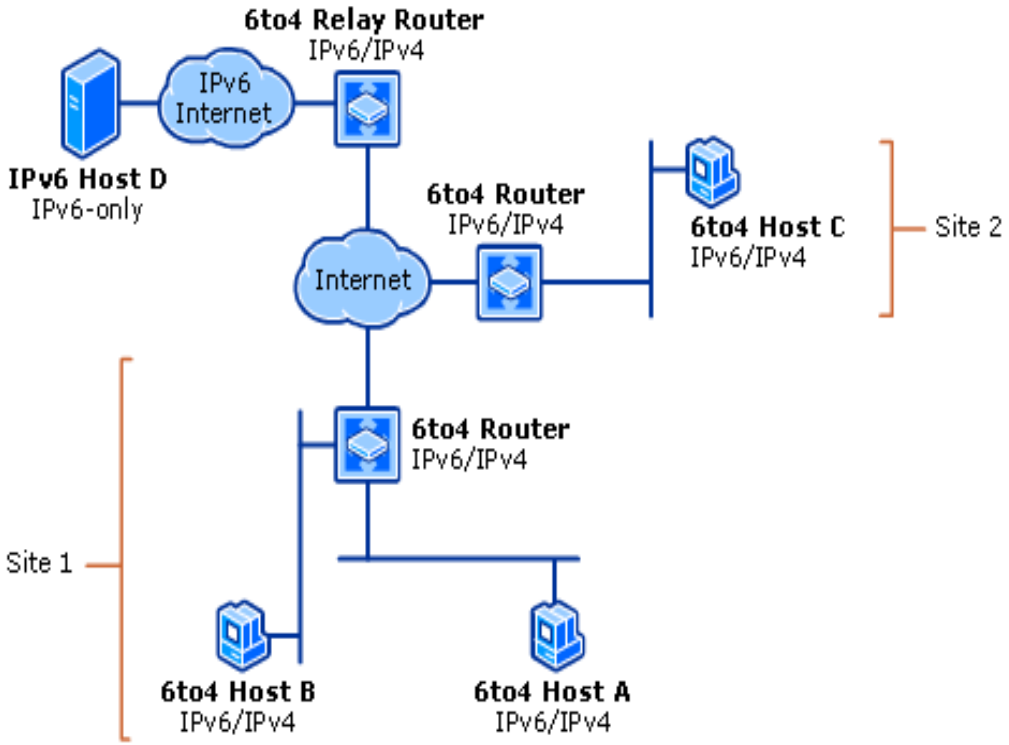
6to4 Details



- Inter-domain tunneling using IPv4 address as IPv6 site prefix IPv6 using IPv4 as a virtual link-layer
  - IPv6 VPN over IPv4 Internet Automatic tunneling approach – 6to4 routers advertise
  - Uses globally unique prefix comprised of the unique 6to4 TLA and the globally unique IPv4 address of the exit router (2002:WWXX:YYZZ::/48)

- 6to4 Relay is the gateway between the IPv6 and IPv4 worlds
  - No NAT can exist in the path
  - 6to4 Relay may be far away from end node
  - Security issues related to an open relay

6to4 Example



Host A and Host B

- native IPv6 packet
- packets sent via 6to4 router in site 1

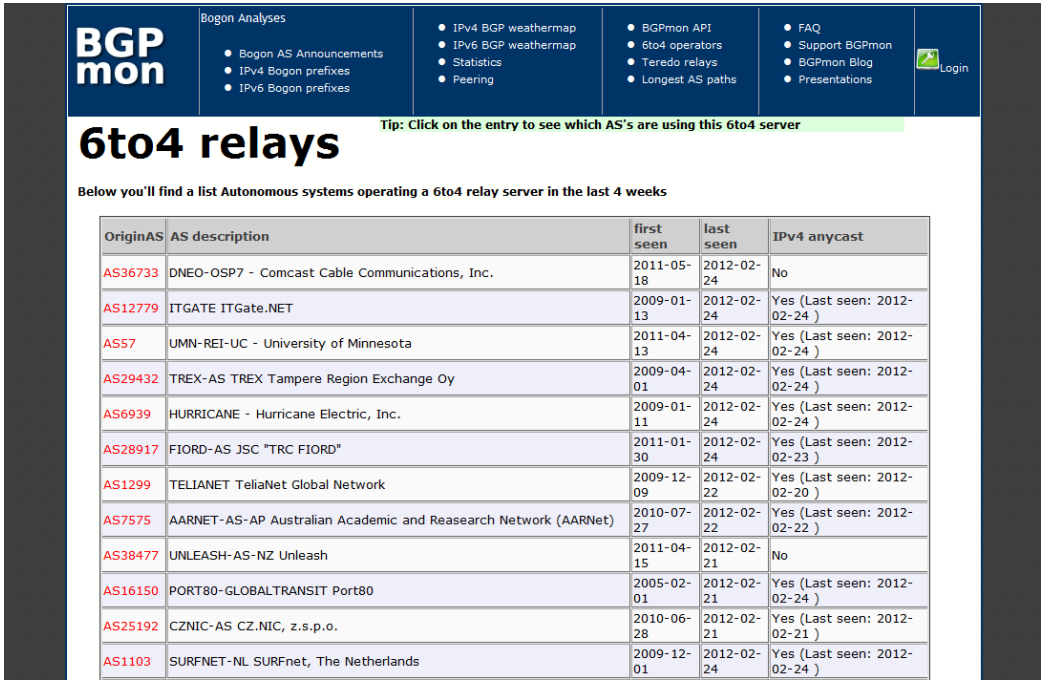
Host A and Host

- Host a sends IPv6 packet to 6to4 Router Site 1
- 6to4 Router Site 1 encapsulates IPv6 packet in IPv4 and sends to 6to4 Router Site 2
- 6to4 Router Site 2 removes the IPv4 header and forwards IPv6 packet to Host C

6to4 Relay Router

With the promulgation of RFC 3068, the list that used to be here is no longer necessary. Everyone using 6to4 should now set their default router to 2002:c058:6301:: which is a special magic anycast address for the nearest (in BGP terms, anyhow) Relay Router

http://bgpmon.net/6to4.php



BGP mon

Bogon Analyses
- Bogon AS Announcements
- IPv4 Bogon prefixes
- IPv6 Bogon prefixes

- IPv4 BGP weathermap
- IPv6 BGP weathermap
- Statistics
- Peering

- BGPmon API
- 6to4 operators
- Teredo relays
- Longest AS paths

- FAQ
- Support BGPmon
- BGPmon Blog
- Presentations

Login

6to4 relays

Tip: Click on the entry to see which AS's are using this 6to4 server

Below you'll find a list Autonomous systems operating a 6to4 relay server in the last 4 weeks

OriginAS	AS description	first seen	last seen	IPv4 anycast
AS36733	DNEO-OSP7 - Comcast Cable Communications, Inc.	2011-05-18	2012-02-24	No
AS12779	ITGATE ITGate.NET	2009-01-13	2012-02-24	Yes (Last seen: 2012-02-24)
AS57	UMN-REI-UC - University of Minnesota	2011-04-13	2012-02-24	Yes (Last seen: 2012-02-24)
AS29432	TREX-AS TREX Tampere Region Exchange Oy	2009-04-01	2012-02-24	Yes (Last seen: 2012-02-24)
AS6939	HURRICANE - Hurricane Electric, Inc.	2009-01-11	2012-02-24	Yes (Last seen: 2012-02-24)
AS28917	FIORD-AS JSC "TRC FIORD"	2011-01-30	2012-02-24	Yes (Last seen: 2012-02-23)
AS1299	TELIANET TeliaNet Global Network	2009-12-09	2012-02-22	Yes (Last seen: 2012-02-20)
AS7575	AARNET-AS-AP Australian Academic and Reasearch Network (AARNet)	2010-07-27	2012-02-22	Yes (Last seen: 2012-02-22)
AS38477	UNLEASH-AS-NZ Unleash	2011-04-15	2012-02-21	No
AS16150	PORT80-GLOBALTRANSIT Port80	2005-02-01	2012-02-21	Yes (Last seen: 2012-02-24)
AS25192	CZNIC-AS CZ.NIC, z.s.p.o.	2010-06-28	2012-02-21	Yes (Last seen: 2012-02-21)
AS1103	SURFNET-NL SURFnet, The Netherlands	2009-12-01	2012-02-24	Yes (Last seen: 2012-02-24)

6to4 Router Tunnel Configuration

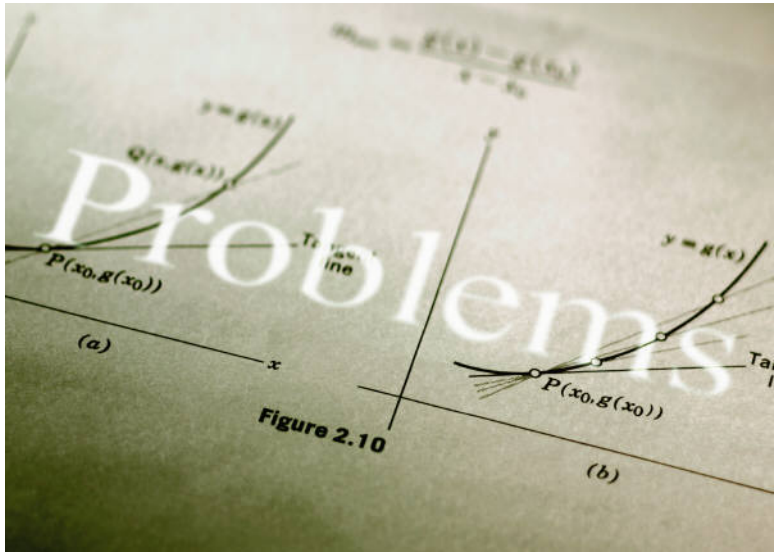
```
hostname IPv6HI
interface Ethernet 0
 ip address 200.168.100.1 255.255.255.0
 ipv6 address 2002:c8a8:6401:1::1/64
interface Tunnel 0
 no ip address
 ipv6 unnumbered Ethernet 0
 tunnel source Ethernet 0
 tunnel mode ipv6ip 6to4
ipv6 route 2002::/16 Tunnel0
```

```
hostname IPv6MP
interface Ethernet 0
 ip address 200.168.200.2 255.255.255.0
 ipv6 address 2002:c8a8:c802:2::2/64
interface Tunnel 0
 no ip address
 ipv6 unnumbered Ethernet 0
 tunnel source Ethernet 0
 tunnel mode ipv6ip 6to4
ipv6 route 2002::/16 Tunnel0
```

6to4 Issues

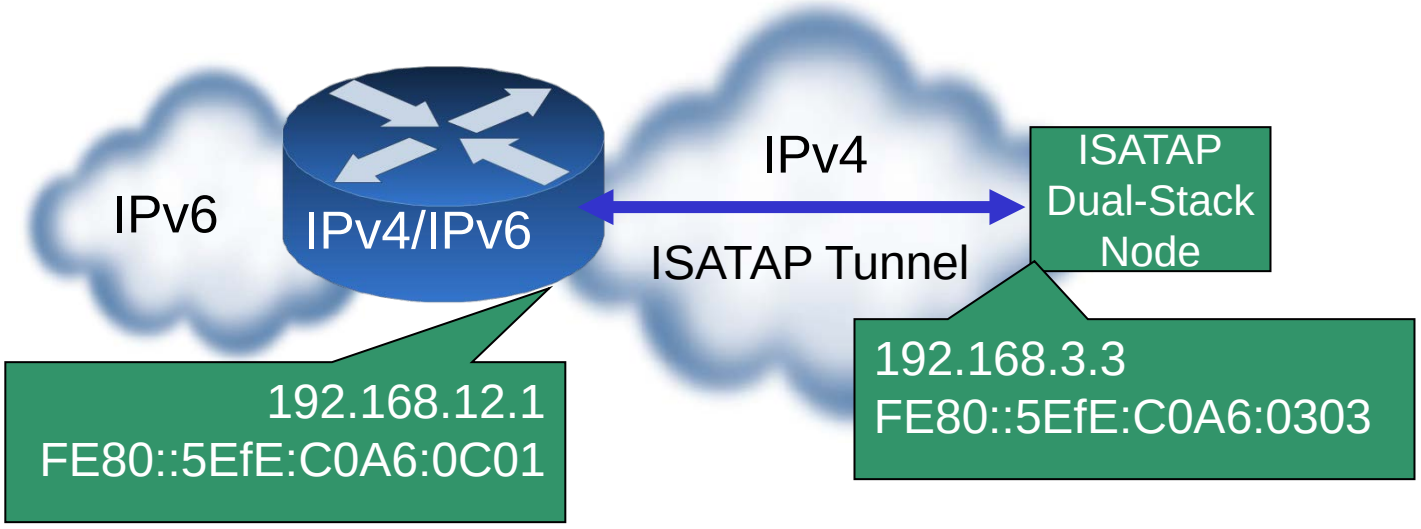
6to4 can fail or perform poorly due to a variety of reasons:

- Inbound/outbound black holes (routers or firewalls filtering protocol 41, ICMP etc.)
- Lack of working return 6to4 relay
- Circuitous/Asymmetric path with large round trip time
- Path MTU failures due to encapsulation overhead
- Privacy concerns with 3rd party relay routers
- See RFC 6343: Advisory Guidelines for 6to4 Deployment



IPv6 Tunnel – ISATAP
Intra-Site Automatic Tunnel Addressing Protocol

Automatic tunneling inside an enterprise
Nodes must be dual stack
Does not require the use of IPv4 Multicast
Creates a virtual IPv6 link over an IPv4 network
RFC [RFC5214]



ISATAP Functions

Generates a link-local IPv6 address from an IPv4 address

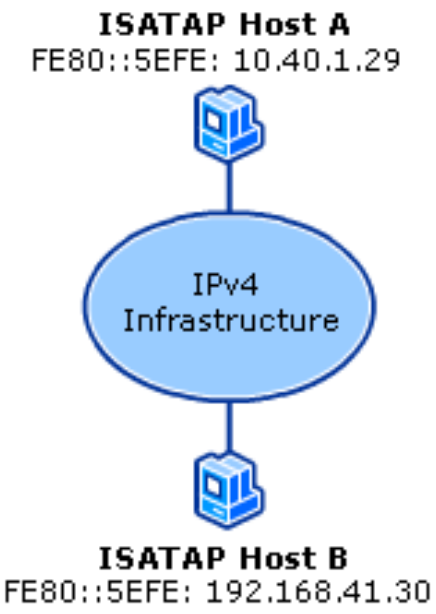
- 192.0.2.143 would use fe80:0000:0000:0000:0200:5efe:192.0.2.143 as its link-local IPv6 address

Performs 'Neighbor Discovery' on top of IPv4

- address auto configuration of nodes, discovery of other nodes on the link, determining the Link Layer addresses of other nodes, duplicate address detection, finding available routers and Domain Name System (DNS) servers, address prefix discovery, and maintaining reachability information about the paths to other active neighbor nodes (RFC 4861).[1]

Implementation

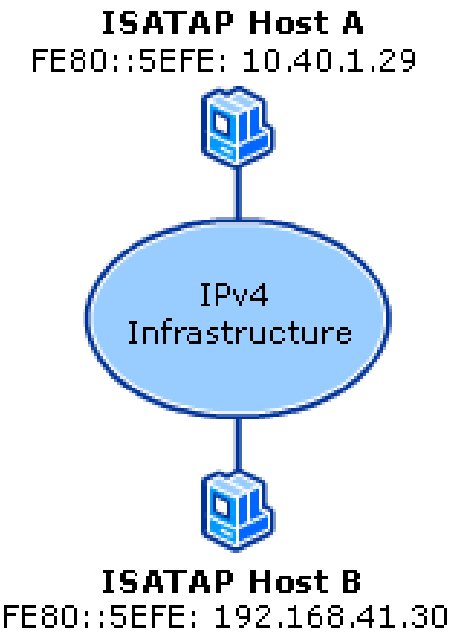
- Windows, Linux and some CISCO devices



ISATAP Example

When Host A and Host B start their IPv6 protocol stack they are automatically configured with the ISATAP address shown

These are on the same IPv4 subnet



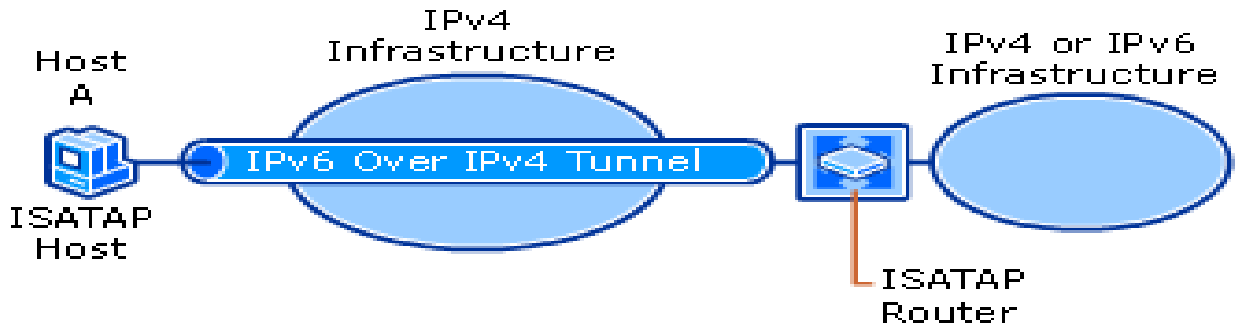
Field	Value
IPv6 Source Address	FE80::5EFE:10.40.1.29
IPv6 Destination Address	FE80::5EFE:192.168.41.30
IPv4 Source Address	10.40.1.29
IPv4 Destination Address	192.168.41.30

ISATAP using a Router

Use of Link-Local ISATAP address allows IPv6/IPv4 hosts to communicate who are on the same logical IPv4 subnet

To communicate outside a logical subnet a ISATAP router must be used

ISATAP router will send router advertisement with prefixes



ISATAP Setup for Linux

First set up a router:

192.0.2.1 as its ISATAP router address with the prefix 3ffe:ffff:1234:5678::/64 assigned to its clients

To set up the interface:

```
# ip tunnel add is0 mode isatap local 192.0.2.1 ttl 64
# ip link set is0 up
# ip addr add 3ffe:ffff:1234:5678::5efe:192.0.2.1/64 dev is0
```

Setup RALVD to advertise to ISATAP clients

Same as Ethernet interface definition except Unicast Only is set ON

Configure a client

```
# ip tunnel add is0 mode isatap local V4ADDR_NODE v4any
 V4ADDR_RTR ttl 64
# ip link set is0 up
```

The clients solicit the router information and auto-configure

```
# ip tunnel add is0 mode isatap local 192.0.40.25 v4any 192.0.2.1 ttl 64
# ip link set is0 up
```

Teredo (aka IPv4 NAT)

- 6to4 tunnels requires the tunnel end point to be public IPv4 address…..so for many that means the NAT device…Many NAT devices cannot be upgraded
- Teredo encapsulates IPv6 in UDP/IPv4 datagrams.
  - Diagnoses UDP (port 3544) over IPv4 (UDPv4) connectivity and discovers the kind of NAT
  - assigns a globally-routable unique IPv6 address to each host using it;
  - encapsulates IPv6 packets inside UDPv4 datagrams for transmission over an IPv4 network (this includes NAT traversal);
  - routes traffic between Teredo hosts and native (or otherwise non-Teredo) IPv6 hosts.

Toredo Details

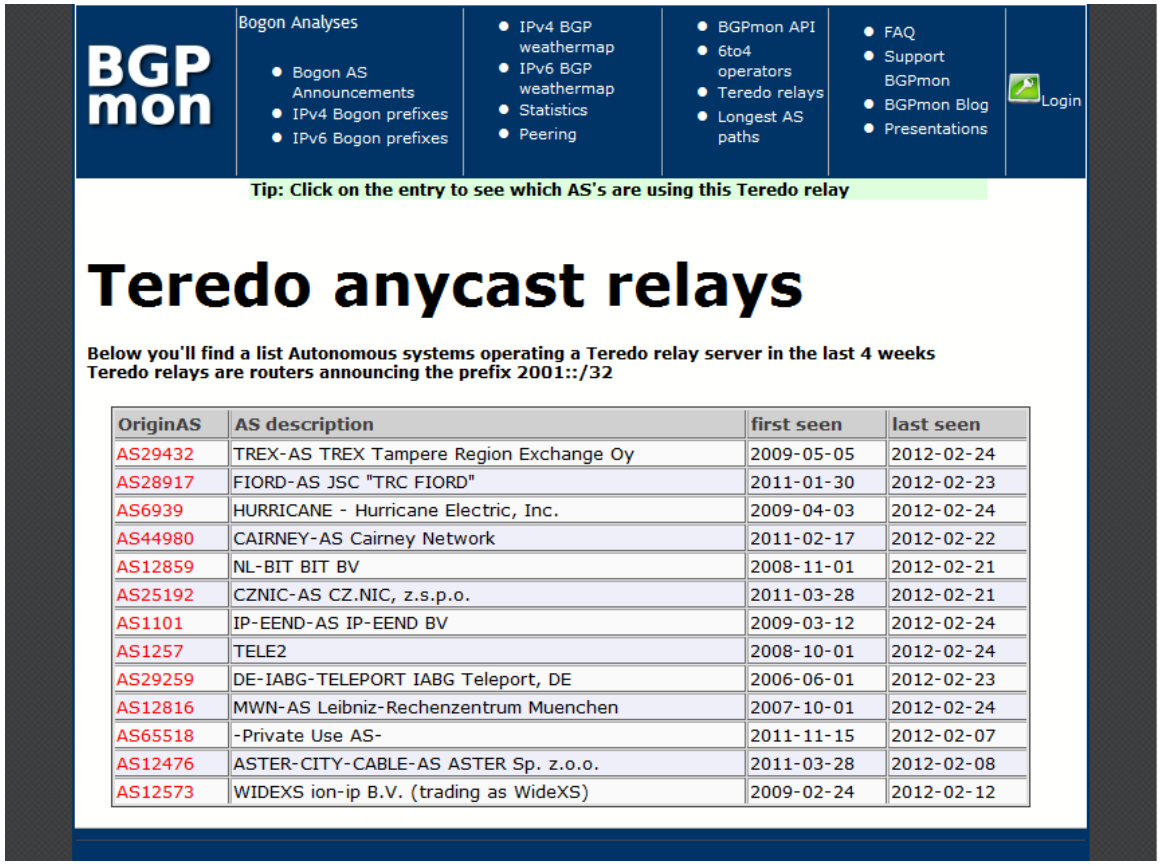
Addressing scheme for Toredo clients

Bits	0 - 31	32 - 63	64 - 79	80 - 95	96 - 127
Length	32 bits	32 bits	16 bits	16 bits	32 bits
Description	Prefix	Teredo server IPv4	Flags	Obfuscated UDP port	Obfuscated Client public IPv4

2001:0000:4136:e378:8000:63bf:3fff:fdd2 refers to a Teredo client:

- using Teredo server at address 65.54.227.120 (4136e378 in hexadecimal),
- located behind a cone NAT (bit 64 is set)
- using UDP mapped port 40000 on its NAT (in hexadecimal 63bf xor ffff equals 9c40, or decimal number 40000)
- whose NAT has public IPv4 address 192.0.2.45 (3ffffdd2 xor ffffffff equals c000022d, which is to say 192.0.2.45)

Toredo Relays



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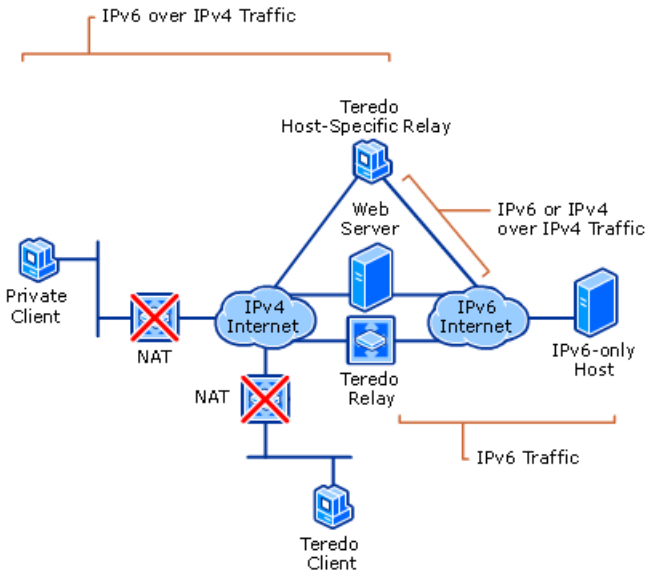
AS6939	HURRICANE - Hurricane Electric, Inc.	2009-04-03	2012-02-24
AS44980	CAIRNEY-AS Cairney Network	2011-02-17	2012-02-22
AS12859	NL-BIT BIT BV	2008-11-01	2012-02-21
AS25192	CZNIC-AS CZ.NIC, z.s.p.o.	2011-03-28	2012-02-21
AS1101	IP-EEND-AS IP-EEND BV	2009-03-12	2012-02-24
AS1257	TELE2	2008-10-01	2012-02-24
AS29259	DE-IABG-TELEPORT IABG Teleport, DE	2006-06-01	2012-02-23
AS12816	MWN-AS Leibniz-Rechenzentrum Muenchen	2007-10-01	2012-02-24
AS65518	-Private Use AS-	2011-11-15	2012-02-07
AS12476	ASTER-CITY-CABLE-AS ASTER Sp. z.o.o.	2011-03-28	2012-02-08
AS12573	WIDEXS ion-ip B.V. (trading as WideXS)	2009-02-24	2012-02-12

Toredo Issues

Cannot work through some types of NAT (e.g.. Symmetric)
• NAT detection and traversal mechanisms employed have a significant
impact on network performance
• Possible issues with inoperable Teredo servers and relays
• Privacy concerns with 3rd party servers and relays
• Security concerns have been expressed:
• http://tools.ietf.org/html/draft-ietf-v6ops-teredo-securityconcerns



IPv6 Translations

NAT-PT (Network Address Translation and Protocol Translation)

Translates by mapping each IPv6 address onto one from a pool of IPv4 addresses

Upside: easy to implement and understand

Downside: Limits simultaneous access to multiple services with a network

Breaks end-end networking

Single point of failure

NAPT-PT (Network Address Translation plus Port Translation)

Protocol gateway translates the IPv4/IPv6 network addresses and also maps port across boundaries

Upside: Easy to implement, adds support for more simultaneous sessions

Downside: Breaks end-end networking, single point of failure

SIIT (Stateless IP/ICMP Translation)

IP packets and ICMP messages are translated between IPv4 and IPv6 with temporary assignments of IPv4 addresses creating a one-one mapping

Upside: Does not require state detail to be maintained

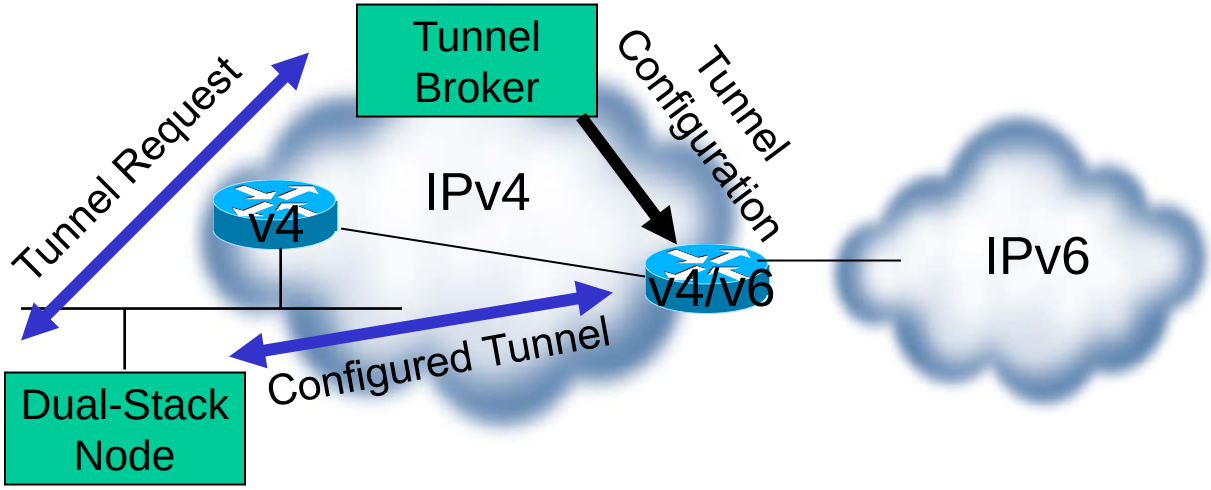
Downside: Does not save on IP addresses, single point of failure

Identifying Tunneled Traffic

6to4 uses well known prefix 2002::/16
- Teredo uses 2001::/32
- Both use value 41 (IPv6 encapsulation) in the IPv4 protocol field
- 6to4 encapsulates IPv6 packets directly in IPv4
- Teredo is encapsulated in UDP inside IPv4
- 6to4 commonly uses well-known anycast relay routers (192.88.99.0/24)
- There are also public Teredo servers and relays
- *Note: blindly blocking tunneled traffic may cause more harm than good*

IPv6 Tunneling: Tunnel broker

- Tunnel Brokers use a web-based service to create a tunnel
- Connects an isolated host to IPv6 net of provider operating the tunnel broker
- Tunnel information is sent via http-ipv4
  - Tunnel managed by ISP
  - Sends scripts/configs to Dual Stack Router

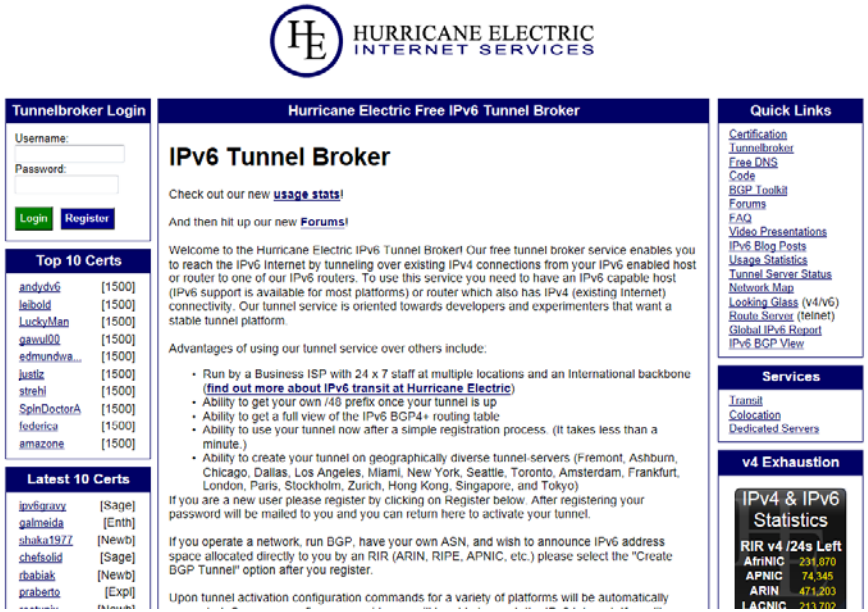


What a Tunnel Broker Provides

- Automation of configured tunnels
- Tunnel Setup Protocol (TSP)
- Client sends request for tunnel
- Broker is based on policies
- Broker sends tunnel information
- Broker configures its tunnel endpoint
- Client then configures its tunnel endpoint
- Client receives stable IPv6 address and prefix
- Well known free services Freenet6, Hurricane Electric, XS26, among others
- 20 different tunnel brokers exist
- Clients for Windows, BSD, Linux, Solaris, etc.

Some IPv6 Tunnel Brokers

- Hurricane Electric: www.tunnelbroker.net
- Freenet6: www.hexago.com
- Consulintel: tb.consulintel.euro6ix.org
- Sixxs: www.sixxs.net
- 6fei: www.6fei.com.cn
- Netnam: tunnelbroker.netnam.vn
- Aarnet: broker.aarnet.net.au
- Internode: www.internode.on.net
- Saudia Arabia: www.ipv6.org.sa/tunnel_broker



Why Use a Tunnel Broker

Bring IPv6 to the public
Advocate the use of IPv6 properly to end users (company and individual)

Gain a user base, and thus:

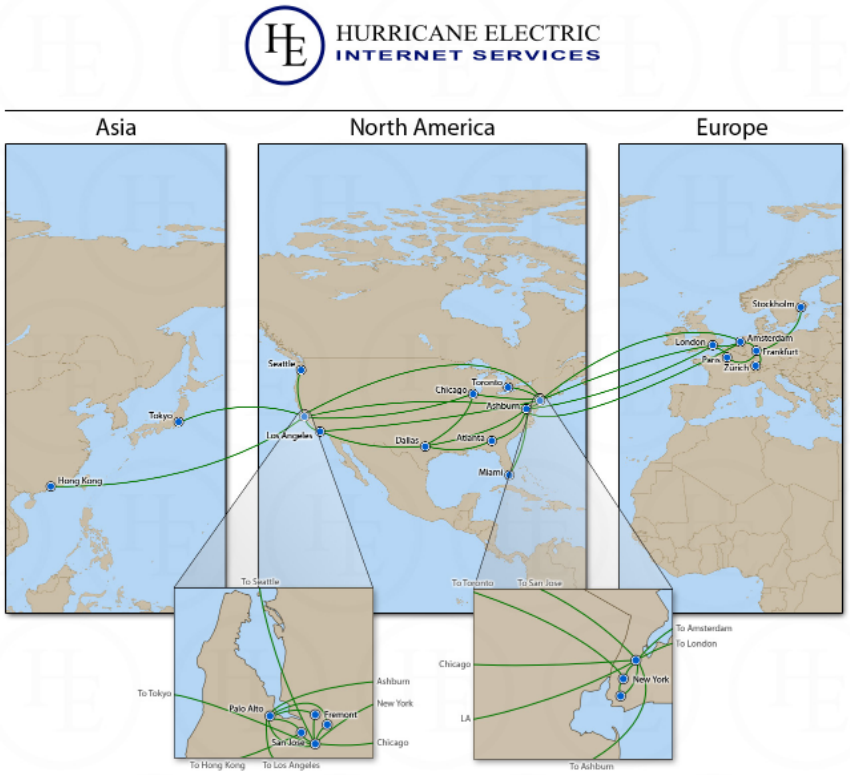
- Gain expertise on the matter with a live network
- Collect invaluable feedback from the field
- Present cases and bug reports to vendors

Companies

- Enabling engineers to take a look at the operational tasks in IPv6
- Stimulating provision: *top-down* from ISP to end user

- Private individuals
  - Gaining a higher educational level of Internet users
  - Creating demand: *bottom-up* from end user to ISP

Hurricane Electric Network



Tunnel Server Status		
Asia		
tserv19.hkg1	Hong Kong, HK	Up
tserv20.hkg1	Hong Kong, HK	Up
tserv25.sin1	Singapore, SG	Up
tserv22.tyo1	Tokyo, JP	Up
Europe		
tserv11.ams1	Amsterdam, NL	Up
tserv26.ber1	Berlin, DE	Up
tserv6.fra1	Frankfurt, DE	Up
tserv18.fra1	Frankfurt, DE	Up
tserv5.lon1	London, UK	Up
tserv17.lon1	London, UK	Up
tserv10.par1	Paris, FR	Up
tserv27.prg1	Prague, CZ	Up
tserv24.sto1	Stockholm, SE	Up
tserv28.waw1	Warsaw, PL	Up
tserv23.zrh1	Zurich, CH	Up
North America		
tserv7.ash1	Ashburn, VA, US	Up
tserv13.ash1	Ashburn, VA, US	Up
tserv9.chi1	Chicago, IL, US	Up
tserv8.dal1	Dallas, TX, US	Up
tserv1.fmt	Fremont, CA, US	Up
tserv2.fmt	Fremont, CA, US	Up
tserv3.fmt2	Fremont, CA, US	Up
tserv29.fmt1	Fremont, CA, US	Up
tserv15.lax1	Los Angeles, CA, US	Up
tserv12.mia1	Miami, FL, US	Up
tserv16.mia1	Miami, FL, US	Up
tserv4.nyc4	New York, NY, US	Up
tserv14.sea1	Seattle, WA, US	Up
tserv21.tor1	Toronto, ON, CA	Up

Tunneling Issues

Latency

Where are the tunnel endpoints

Distant 6to4 relays

Broken Teredo servers

AES Sessions

Session	Title	Day	Time	Room
11918	Performance factors in Cloud Computing	Tuesday August 7	3:00 PM	Grand Ballroom Salon A
11156	IPv6 Basics	Wednesday August 8	8:00 AM	Grand Ballroom Salon A
11895	Network Problem Diagnosis with Packet Traces	Wednesday August 8	9:30 AM	Platinum Ballroom Salon 9
11165	I'm Running IPv6 How Do I Access?	Wednesday August 8	4:30 PM	Grand Ballroom Salon A
11164	IPv6 Deep Dive	Thursday August 9	3:00 PM	Grand Ballroom Salon A
11161	Managing an IPv6 Network	Friday August 10	8:00 AM	Grand Ballroom Salon A
11162	Home Networking with IPv6	Friday August 10	11:00 AM	Grand Ballroom Salon A

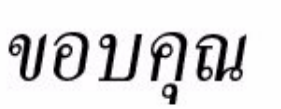
QUESTIONS?

Grazie

Danke

ありがとうございました

Merci



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நன்றி
Tamil

Obrigado

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Microsoft IPv6 page – http://www.microsoft.com/ipv6
IPv6 Source/Dest Address selection process - http://technet.microsoft.com/enus/library/bb877985.aspx
Microsoft Infrastructure Planning and Design Guides - http://technet.microsoft.com/en-us/library/cc196387.aspx
Microsoft Exchange: Understanding IPv6 Support in Exchange 2010 - http://technet.microsoft.com/en-us/library/gg144561.aspx
Cisco links:
Cisco Validated Design - http://www.cisco.com/en/US/netsol/ns817/networking_solutions_program_home.html
IPv6 Addressing Plan from RIPE:
RIPE IPv6 Address Planning Guide - http://www.ripe.net/training/material/IPv6-for-LIRs-Training-Course/IPv6_addr_plan4.pdf

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• ARIN IPv6 Wiki:
http://www.getipv6.info/index.php/Main_Page
• World IPv6 Day (June 8, 2011):
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• IPv6 at IBM
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• IBM IPv6 Compliance
http://www-01.ibm.com/software/info/ipv6/compliance.jsp
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www.**nsa.gov**/ia/_files/routers/I33-002R-06.pdf

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