IPv6

The Next Internet Protocol

IPv4

- It has served the Internet community well with virtually no change for over 20 years

- The connectionless service model upon which it is based has proven to be simple, robust and adaptable to a wide variety of application layer services

- Its primary shortcoming is its address space which is proving to be inadequate in a world that now wants to base everything on IP

- The address space must be enlarged to avoid a future Y2K style panic

IPv6, The Next Generation
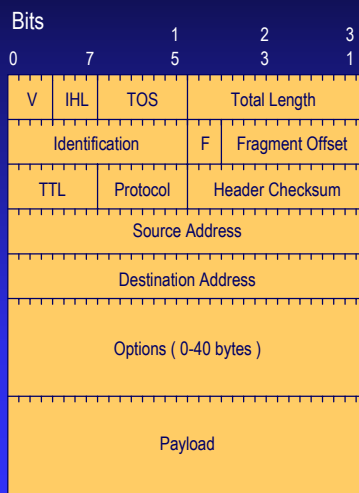
"If it isn't broken don't fix it"

- IPv6 increases the address space dramatically without changing the basic nature of IPv4's operation

- IPv6 does fine tuning rather than wholesale change of IPv4 features

- IPv6 adds some new features which reflect the current reality of Internet usage

- IPv6 aims to ease the process of transition which is expected to take several years

Same Look and Feel

IPv4 Packet
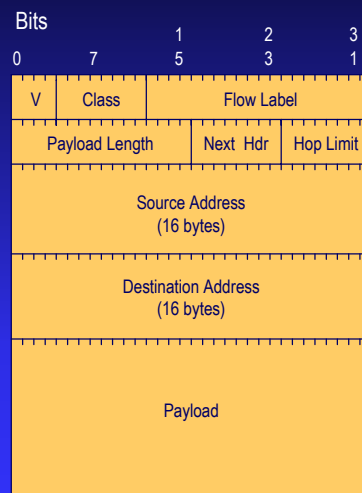
Bits				
0	7	1 5	2 3	3 1

V	IHL	TOS	Total Length	
Identification			F	Fragment Offset
TTL		Protocol	Header Checksum	
Source Address				
Destination Address				
Options (0-40 bytes)				
Payload				

IPv6 Packet

Bits				
0	7	1 5	2 3	3 1

V	Class	Flow Label	
Payload Length		Next Hdr	Hop Limit
Source Address (16 bytes)			
Destination Address (16 bytes)			
Payload			

New Address Space

- 128-bit address space
  - 2^{128} possible addresses
  - 340,282,366,920,
    938,463,463,374,
    607,431,768,211,
    456 addresses (3.4×10^{38})
  - This is more than 10^{20} addresses for each square inch of the earth's surface

Address Changes

- IPv6 uses multicast addresses in place of less bandwidth efficient broadcast addresses

- IPv6 introduces site local and link local addresses to replace IPv4 private addresses

- IPv6 adds a new form of address called "anycast", to find network resources efficiently

- IPv6 uses address prefixes to replace address classes and reduce router table size

Protocol Fine Tuning

Protocol enhancements include:

- The ability to support options of any length (IPv4 has a 40 byte option limit)

- The elimination of the IP header checksum which is redundant due to layer 2 hardware checksums

- The elimination of fragmentation by routers to improve router throughput

- The introduction of a jumbo packet option for high speed, low bit error rate networks

New Features

IPv6 adds some new features:

- IPv6 adds security options to protect against some of the more common Internet attacks
  - Address spoofing
  - Wire Tapping (active and passive)
  - Replay
  - Traffic analysis

- Ipv6 adds mobility support to reflect the popularity of wireless communications

New Features cont.

IPv6 adds some new features:

- IPv6 adds a flow label to support connection oriented features
  - MPLS has shown the value of connection oriented service for quality of service and traffic management

- IPv6 adds stateless address configuration to simplify address management
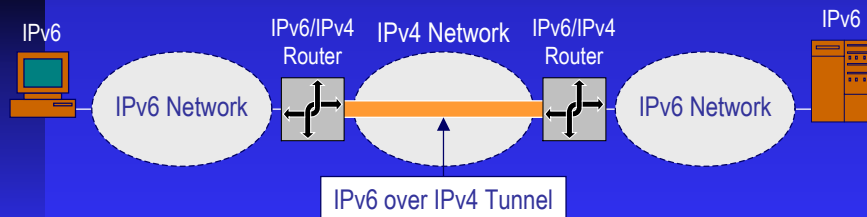
Transition Options

- The transition from IPv4 to IPv6 is expected to take many years

- During the transition period IPv4-IPv6 coexistence and interoperability will be extremely important

- IPv6 coexistence and interoperability options include:
  - Tunneling
  - Dual stack hosts and routers
  - DNS support
  - Transport and application layer proxies

Router to Router Tunneling

- Router to router tunneling allows IPv6 subnets to be connected across an IPv4 network
- Hosts do not need to support tunneling with this method
- Router manufacturers (e.g. Cisco) support several types of router to router tunnels

IPv6   IPv6/IPv4 Router   IPv4 Network   IPv6/IPv4 Router   IPv6

IPv6 Network   IPv6 Network

IPv6 over IPv4 Tunnel

Host to Router Tunnels

- Host to router tunnels can be used to connect a remote host on an IPv4 network to hosts on an IPv6 network

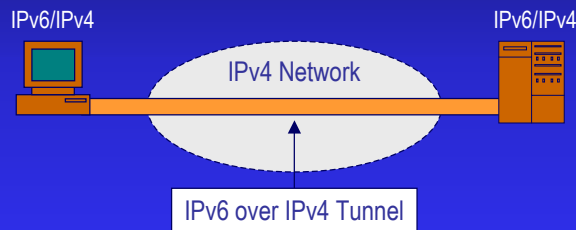- 6 over 4 (RFC 2529) and 6 to 4 (RFC 3056) are two tunneling techniques that can accomplish this

IPv6/IPv4   IPv4 Network   IPv6/IPv4 Router   IPv6

IPv6 Network

IPv6 over IPv4 Tunnel
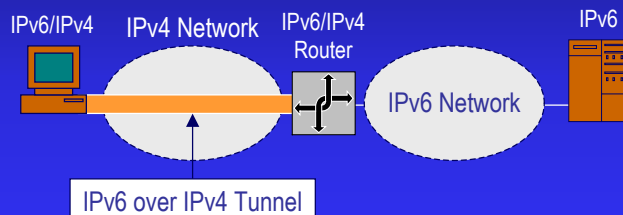
Host to Host Tunnels

- IPv6 hosts can be connected over an IPv4 network using host to host tunnels

- 6 over 4 tunneling is one such mechanism

IPv6/IPv4

IPv6/IPv4

IPv4 Network

IPv6 over IPv4 Tunnel

6over4 Tunneled Packet

V	IHL	TOS	Total Length
Identification		F	Fragment Offset
TTL	41		Header Checksum
131.107.210.52			
131.107.210.49			
V	Class		Flow Label
Payload Length		Next Hdr	Hop Limit
FE80::836B:D234			
FE80::836B:D231			
Payload			

Field	Value
IPv6 Source Address	FE80::836B:D234
IPv6 Destination Address	FE80::836B:D231
IPv4 Source Address	131.107.210.52
IPv4 Destination Address	131.107.210.49

- IPv4 Protocol field is set to 41 indicating an IPv6 packet

- Note that the last 4 bytes of the IPv6 addresses are hexadecimal representations of the IPv4 addresses
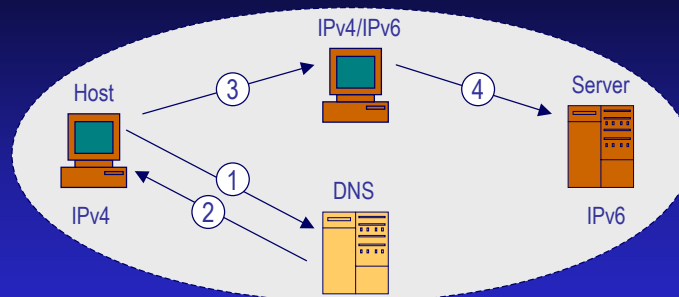
Windows® Portproxy

- TCP relay service on Win XP and Server 2003 for:
  - IPv4 to IPv6
    - IPv4-only host can communicate with IPv6-only server or application
  - IPv6 to IPv4
    - IPv4-only host can communicate with IPv6-only server or application
    - Use to "IPv6-enable" IPv4-only applications running on a Windows.NET Server computer

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Portproxy Example

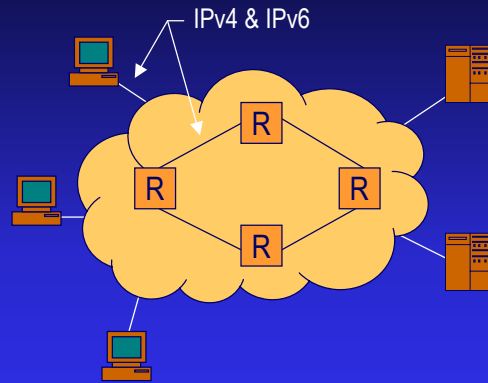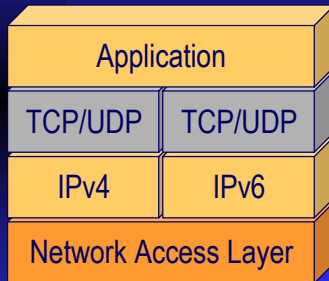| Step 1	Host performs DNS lookup on Server URL
Step 2	DNS server returns IPv4 address of IPv4/IPv6 host
Step 3	Host sets up TCP connection to IPv4/IPv6 host (port 80)
Step 4	IPv4/IPv6 host sets up TCP connection to server using IPv6 address (port 80)

Dual Stack

End System or Router
Protocol Stack

IPv4 & IPv6

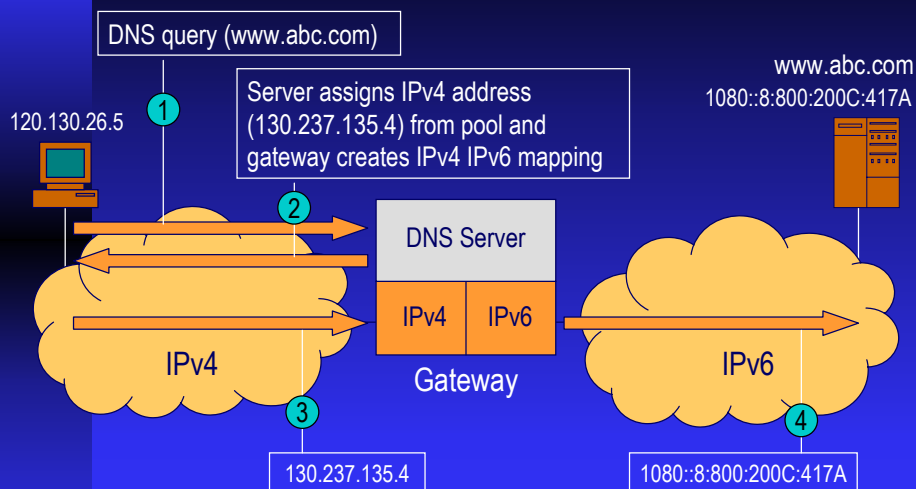| Application	
TCP/UDP	TCP/UDP
IPv4	IPv6
Network Access Layer	

R
R   R
R

Dual stack host or router can operate with IPv4 only or IPv6 only hosts

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Application Layer Gateway

DNS query (www.abc.com)

www.abc.com
1080::8:800:200C:417A

120.130.26.5

1

Server assigns IPv4 address
(130.237.135.4) from pool and
gateway creates IPv4 IPv6 mapping

2

DNS Server

IPv4	IPv6

Gateway

IPv4

IPv6

3

4

130.237.135.4

1080::8:800:200C:417A

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DNS Support

IPv4 and IPv6 address

DNS Server

TCP Connection
and HTTP Get
Request

http://www.infotel-systems.com

Welcome to
Infotel

DNS
Query ①

DNS
Reply ②

Web Server

③

④

208.237.135.4
1080::8:800:200C:417A

HTML file downloaded along
with embedded graphics
files
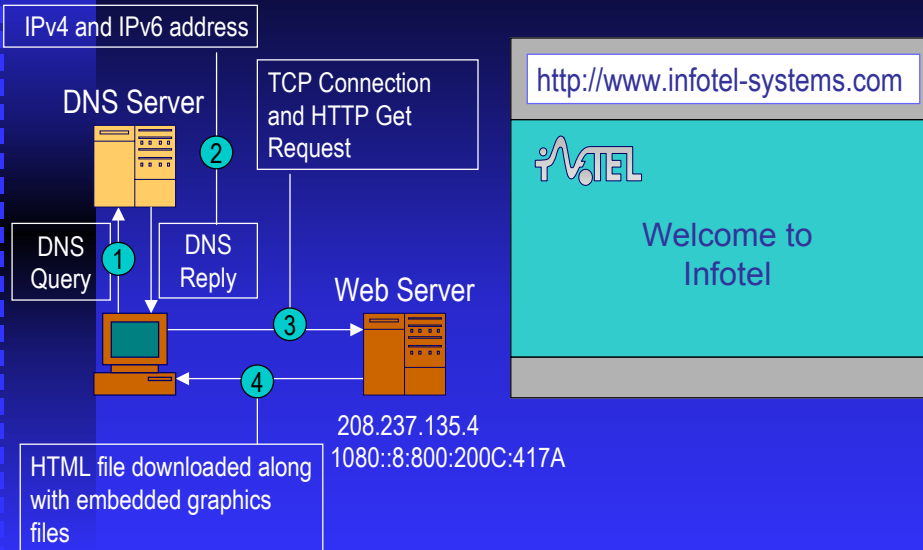
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Summary

- The transition to IPv6 is not a question of if but of when

- All major vendors now support IPv6 in some way

- Planning ahead will avoid a Y2K style panic as the IPv4 address space exhausts

- Enterprises should consider implementing some form of IPv6 pilot project to gain experience with the new address formats and operational features

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Thank You for Listening

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to learn about on-site IPv6 training