

# IPv6 Basics

## Share Anaheim Session 14497



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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**

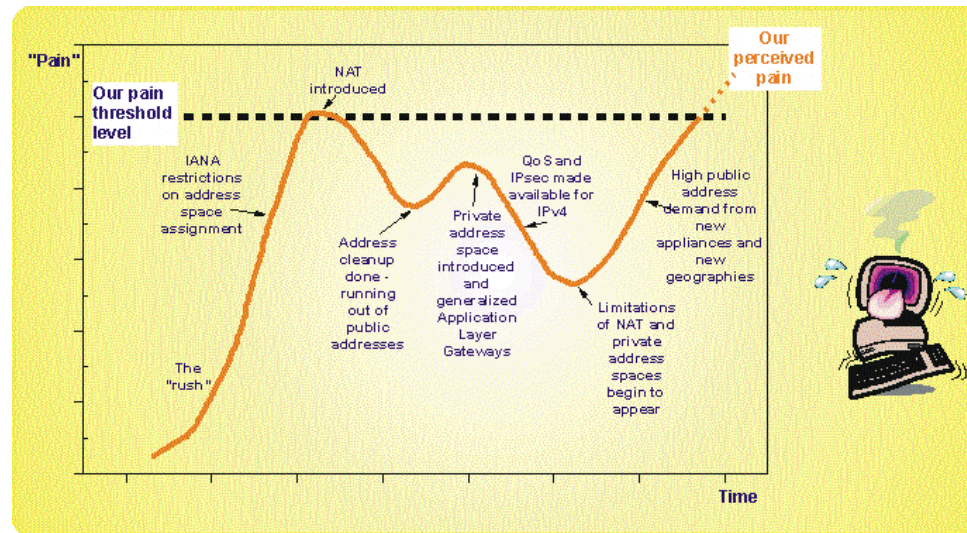
- Automatic configuration/reconfiguration**

- Support for non-IP protocols**



**Coexist with IPv4**

## Why Do We Need More Address Spaces?

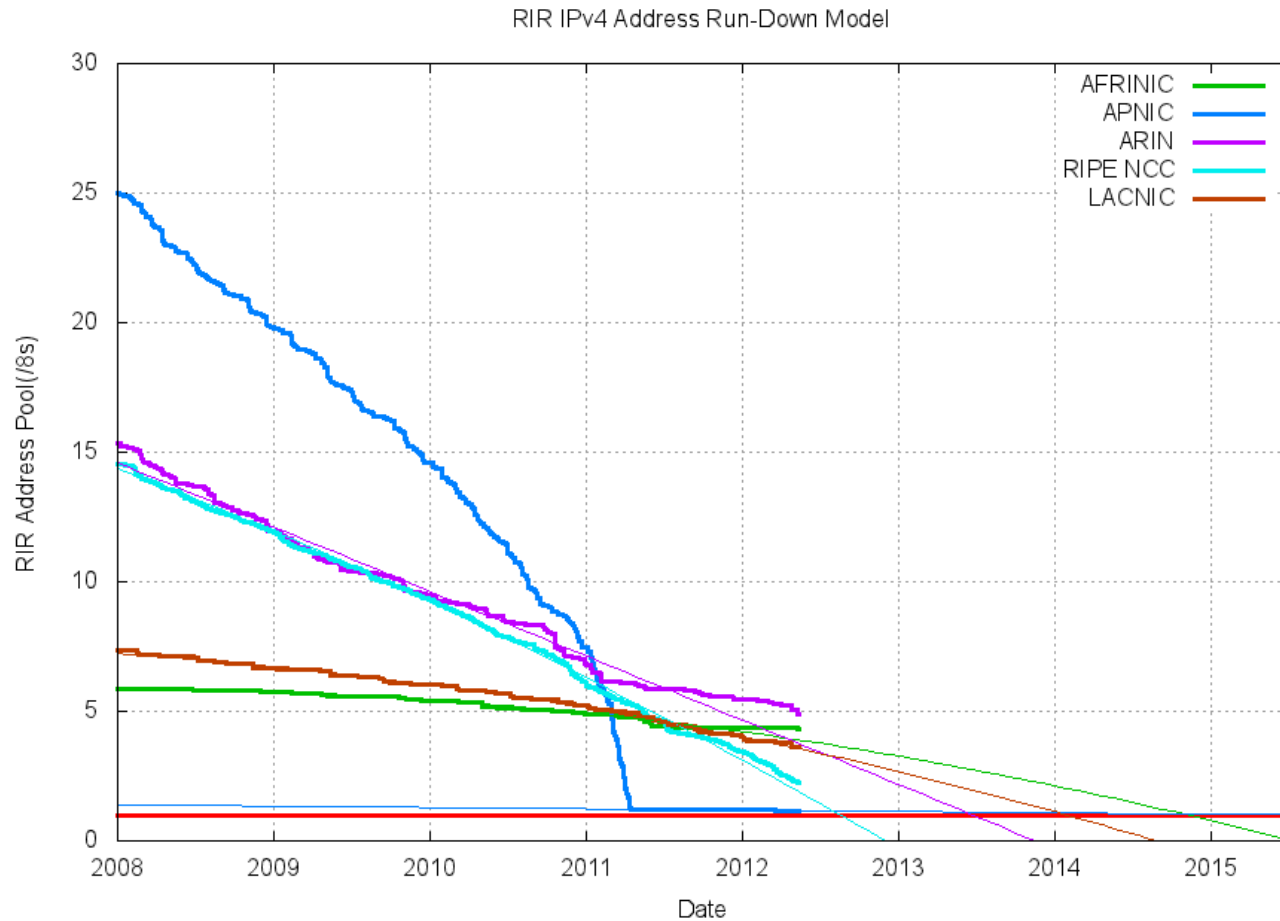


February 2011 – NRO (Number Resource Organization of the IANA) allocated the last IPv4 addresses to RIR

Microsoft paid \$7.5M for Nortels 666,624 IPv4 addresses

Trading sites like Tradipv4.com have emerged

## IPv4 address allocation by /8





[illegible]

# IPv6 Technology Scope

<i>IP Service</i>	<i>IPv4 Solution</i>	<i>IPv6 Solution</i>
Addressing Range	32-bit, Network Address Translation	128-bit, Multiple Scopes
Autoconfiguration	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 Address Size

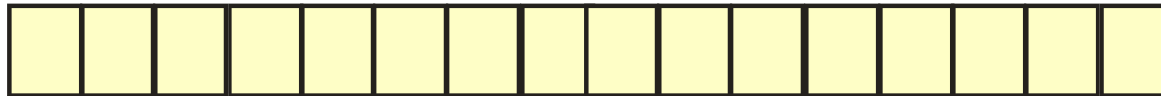
207.217.125.50/24



IPv4  
(4 bytes - 32 bits)

2001:0DB8::15:219:D1FF:FE10:74EE/64

**C** **L**



IPv6  
(16 bytes - 128 bits)

Asia feeling address squeeze fastest due to receiving addresses last

Mobil digital telephony pressuring existing IPv4 network

ICANN continues to handle overall addressing issues

Shortcuts like dropping **L** leading zeros or **C** ontiguous zeros permitted

# IPv6 Header

## IPv4 Header

Vers: HD	TOS	Payload length
Fragment ID		Fragment Information
TTL	Protocol	Header Checksum
Source Address		
Destination Address		

## IPv6 Header

Vers:Class	Flow Label	
Payload length	Next hdr	Hop limit
Source Address		
Destination Address		

IPv4 header is 20 bytes : IPv6 header is 40 bytes  
 Address increased from 32 to 128 bits  
 Fragmentation fields moved out of base header  
 Header checksum  
 Time to Live replaced with 'Hop Limit'  
 Protocol replaced with 'Next Header'  
 TOS replaced with 'Flow Label'  
 Alignment changed from 32 to 64 bits



## IPv6 Flow Label

### IPv6 Header

Vers: TC	Flow Label		
Payload length	Next hdr	Hop limit	
Source Address			
Destination Address			

Identifies datagrams that require special quality of service

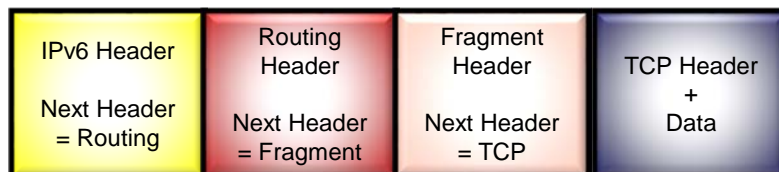
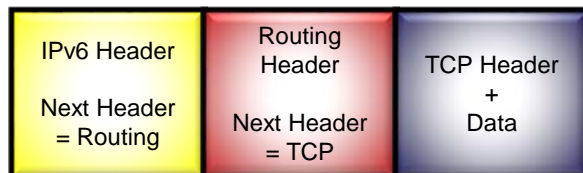
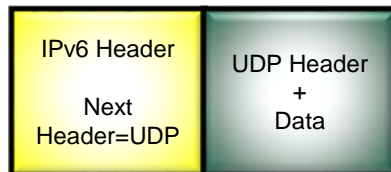
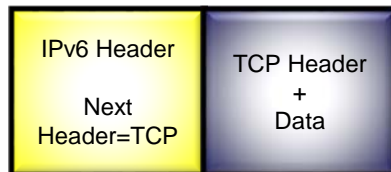
May be used to tie particular traffic to pre-allocated network resources

Zero value indicates no flow label

Other protocols like RSVP may provide information for the Flow Label

TC class identifies delivery of priority packets  
Values 0-7 : TCP flow controlled packets  
Values 8-15 : real time packets

## IPv6 Extension Headers



**Hop by hop options = 0**  
Information for all devices in the path

**Destination options = 60**  
Destination information for all devices

**Routing = 43**  
Specify route for a datagram

**Fragment = 44**  
Breaks datagram if MTU exceeded

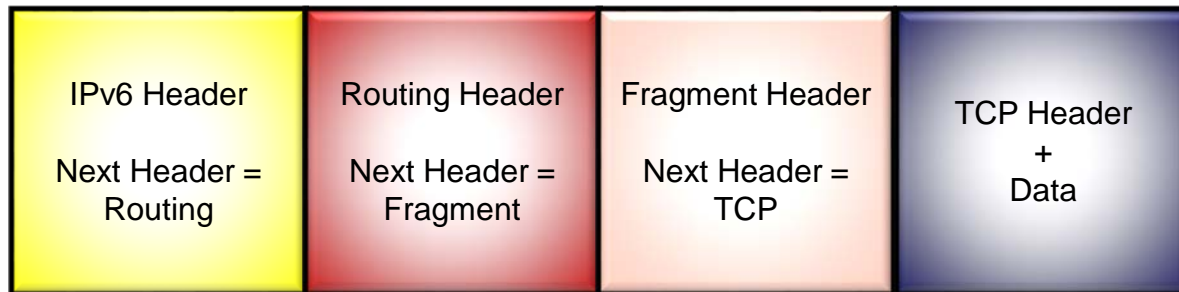
**Encapsulating Security Payload = 50**  
Encryption type and parameters

**Authentication = 51**  
Hash type and parameters

**Destination options = 60**  
Information only for destination host

**Protocols**  
TCP = 6, UDP = 17, RSVP = 46, ICMP = 58

## IPv6 Fragmentation Header

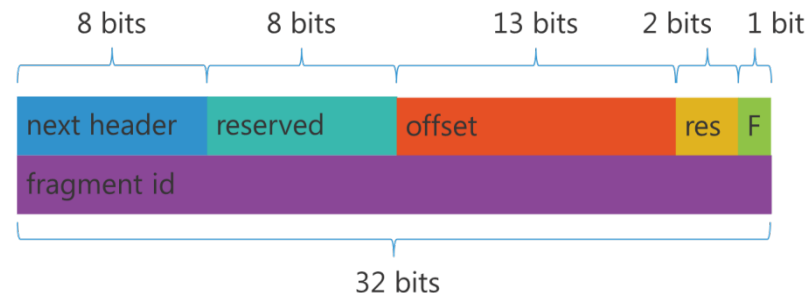


In IPv4 Routers handled fragmenting frames

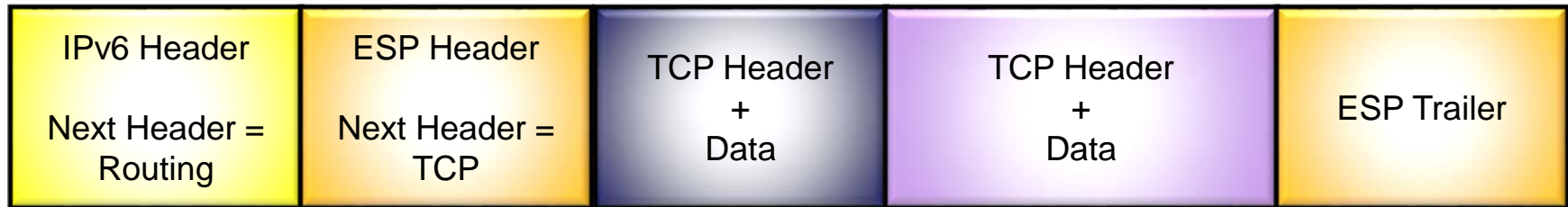
If needed, IPv6 hosts fragment frames:

Increased guaranteed minimum MTU of 1280

Pat MTU discovery to find maximum fragment size for a path



## IPv6 Security



### Authentication Header (AH)

- Packet authentication and integrity without confidentiality
- Algorithm independent (MD5) (SHA1)

### Data Privacy Header (ESP)

- Message including next headers encrypted
- Mandatory support of DES-CBC
- May also include AH with no separate header

## IPv6 Address Types

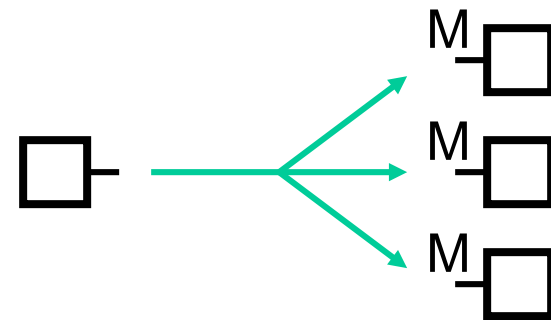
unicast:

for one-to-one  
communication



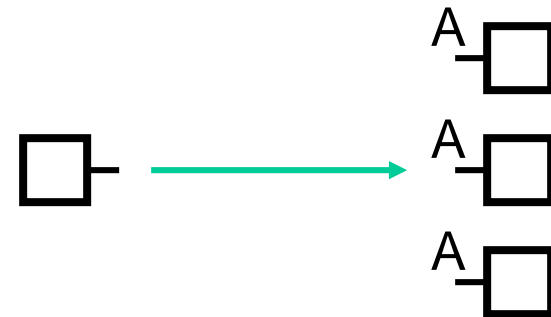
multicast:

for one-to-many  
communication



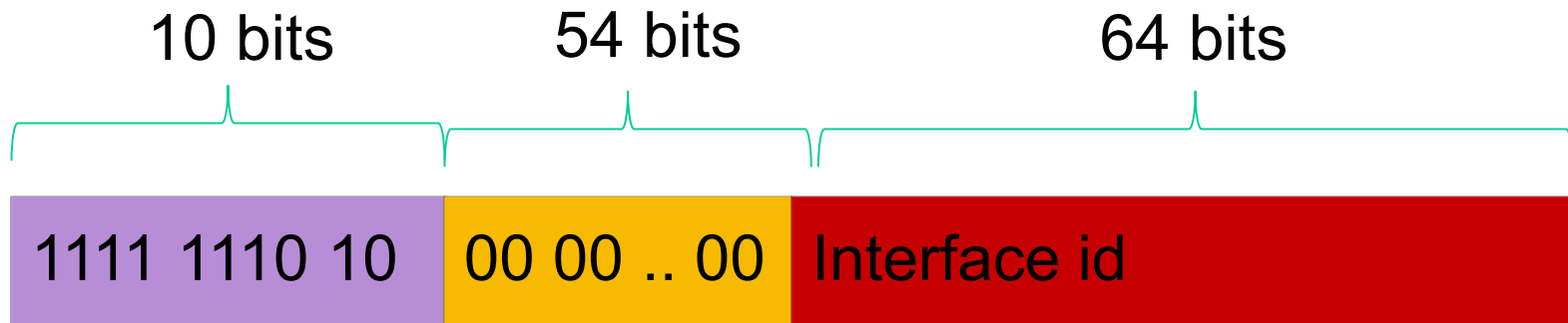
anycast:

for one-to-nearest  
communication



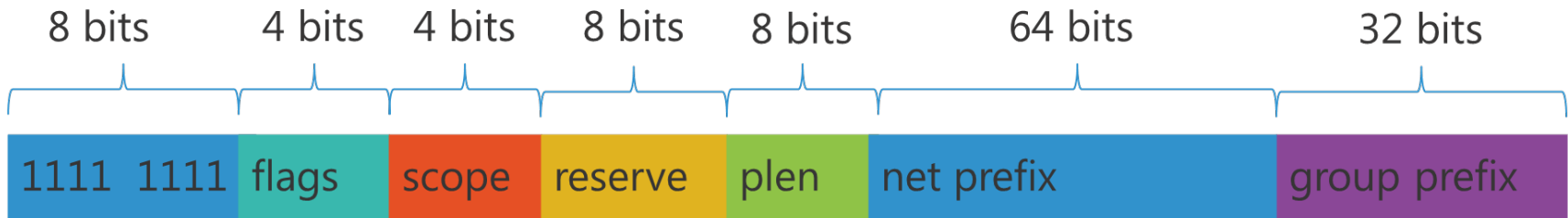


## Link Local Address



- FE80 prefix
- Similar to IPv4 APIPA (169.254.0.0/16)
- Only for on-link communication, not routable
- Used for
  - Auto configured addresses
  - Neighbor discovery process

## Multicast Address



### Flags

0: well known address, 1: transient address

### Scope

1: Node Local (FF01::1), 2: Link Local (FF02::1)

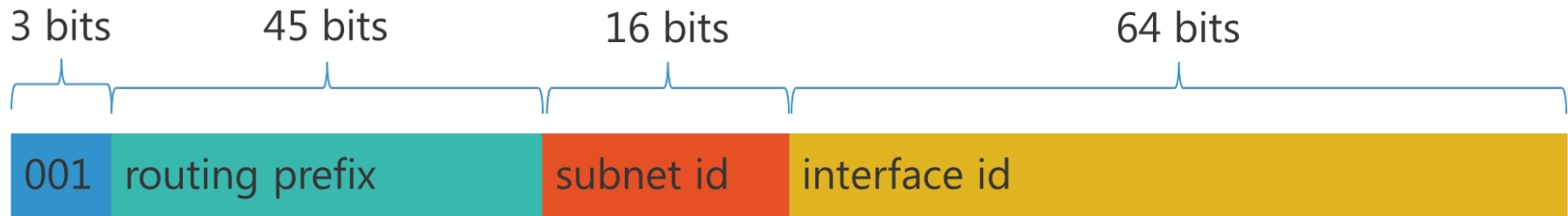
All routers group: FF02::2)

### Group ID

1: All nodes, 2: All routers, 101: all NTP servers

- Multicast replaces Broadcast
- All IPv6 nodes must support multicast
- You must enable IGMP snooping

## Global Unicast Address



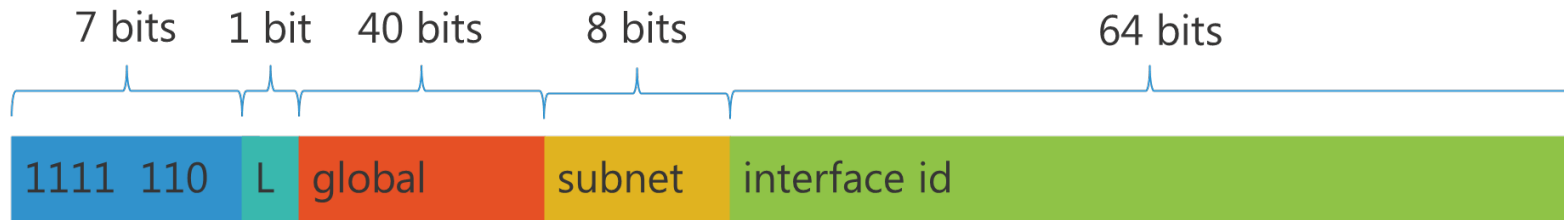
Address Type	Binary Prefix	Prefix
Unspecified	000...0	::/128
Loopback	0000...01	::1/128
ULA	1111 110	FC00::/7
Assigned to RIRs	001	2003:/3
Global Unicast	Everything else!!	

Korea: 2001:0200 – 099F

ATT: 2001:0408/32

Verizon: 2001:0506:0000/48

## Unique Local Address (ULA)



- L=1
- FC00::/7 prefix
- Local or site local communications
- Most likely will be unique and not expected to be routable
- Well known, somewhat like the RFC1918

## Windows and IPv6

IPv6 is preferred

Nameserver query

Try to reach IPv6

Try to reach IPv4

Timeout

```
Wireless LAN adapter Wireless Network Connection 2:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . :

Wireless LAN adapter Wireless Network Connection:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . :

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix  . : hawaii.rr.com
    Link-local IPv6 Address . . . . . : fe80::6947:83b1:88e2:73d4%13
    IPv4 Address. . . . . : 192.168.1.146
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.1.1

Ethernet adapter Bluetooth Network Connection:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . :

Tunnel adapter Teredo Tunneling Pseudo-Interface:

    Connection-specific DNS Suffix  . :
    IPv6 Address. . . . . : 2001:0:4137:9e76:10f7:1e4b:9d69:43f8
    Link-local IPv6 Address . . . . . : fe80::10f7:1e4b:9d69:43f8%15
    Default Gateway . . . . . : ::

Tunnel adapter isatap.hawaii.rr.com:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : hawaii.rr.com
```



## Interface ID from MAC

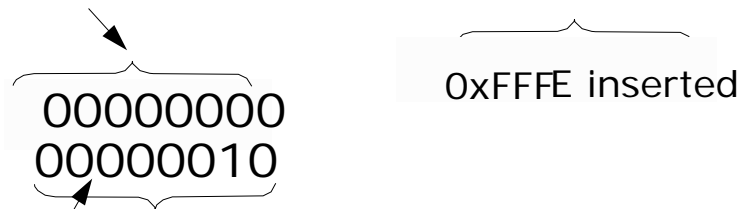
Company ID    Manufacturer Data



IEEE 48-Bit MAC Address



Expand to EUI-64

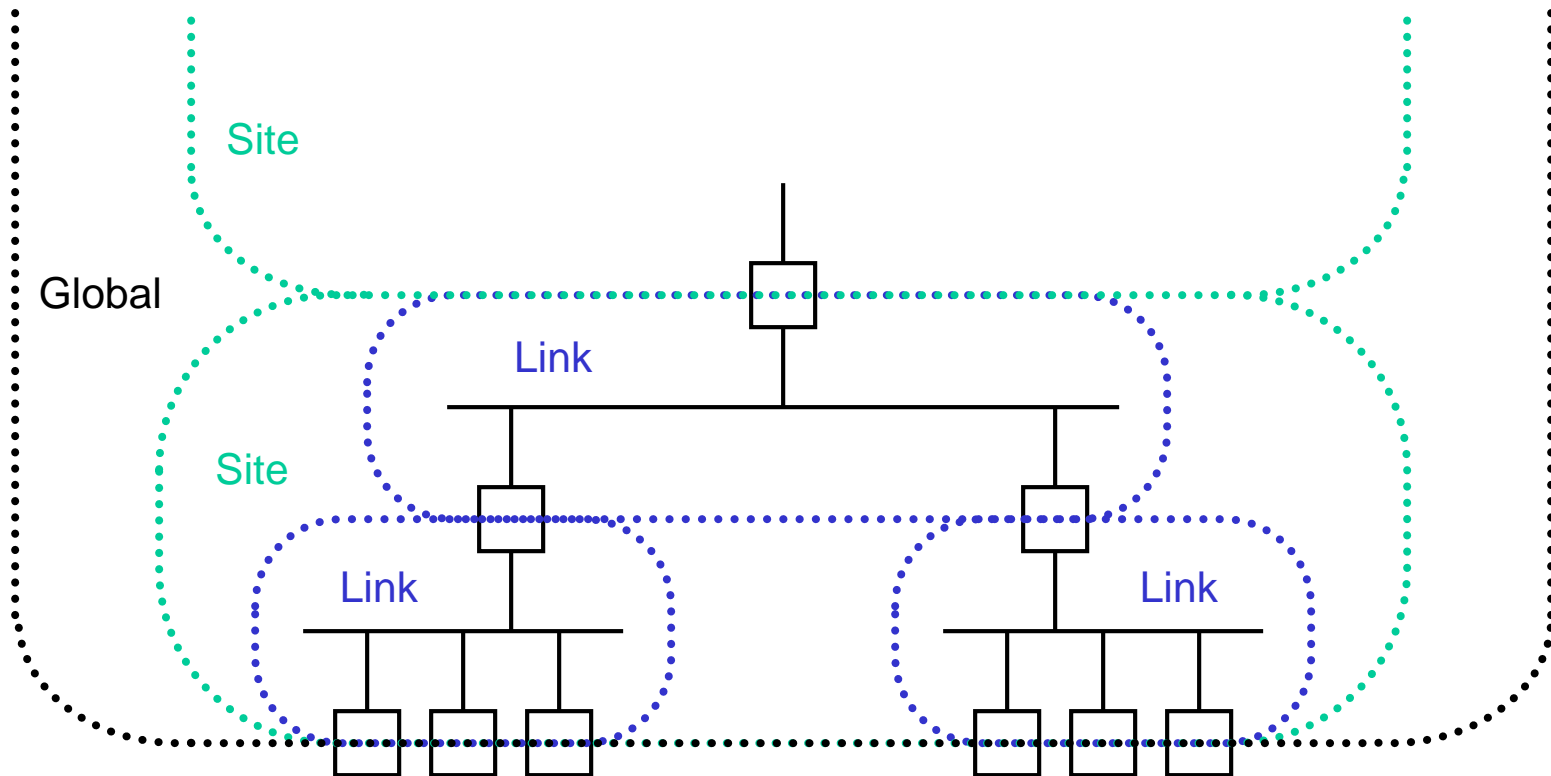


Invert the Global Bit

0219:71FF:FE64:3F00

Interface ID

## Boundaries



## IPv6: Autoconfiguration

### Combination

ARP : ICMP router discovery : ICMP redirect

### Neighbor discovery

Multicast and unicast datagrams

Establishes MAC address on same network

ICMPv6 router solicitation

ICMPv6 router advertisement

ICMPv6 neighbor solicitation

ICMPv6 redirect

ICMPv6 includes IGMP protocol for Multicast IP

Reduces impact of finding hosts

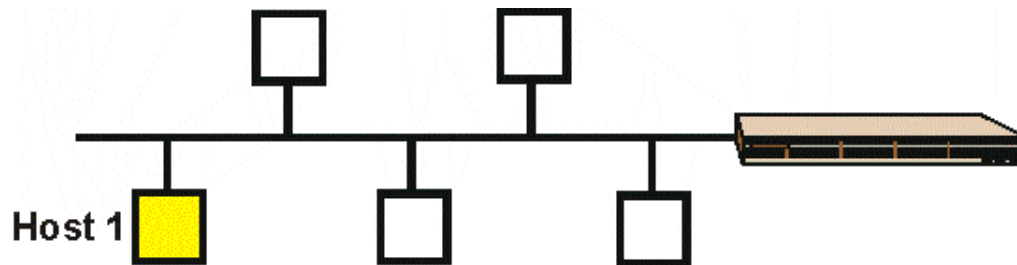
Stateless: router configures a host with IPv6 address

Stateful: DHCP for IPv6

Link Local Address: IPv6 connectivity on isolated LANs



## IPv6 Auto-configuration



**Host 1 comes on line and generates a link local address**

**Host 1 sends out a query called neighbor discovery to the same address to verify uniqueness. If there is a positive response a random number generator is used to generate a new address**

**Host 1 multicasts a router solicitation message to all routers**

**Routers respond with a router advertisement that contains an aggregatable global address (AGA) prefix and other information**

**Host 1 automatically configures its global address by appending its interface ID to the AGA**

**Host 1 can now communicate**

# Changes Needed to Implement IPv6

## Hosts

- Implement IPv6 code in operating system

- TCP/UDP aware of IPv6

- Sockets/Winsock library updates for IPv6

- Domain Name Server updates for IPv6

## Domain Name Server (DNS)

- Many products already support 128 bit addresses

- Uses 'AAAA' records for IPv6

- IP6.INT (in\_addr\_arpa in IPv4)

## Routers

- IPv6 forwarding protocols

- Routing protocols updated to support IPv6

- Management needs to support ICMPv6

- Implement transition mechanisms

## IPv6 Protocol Status

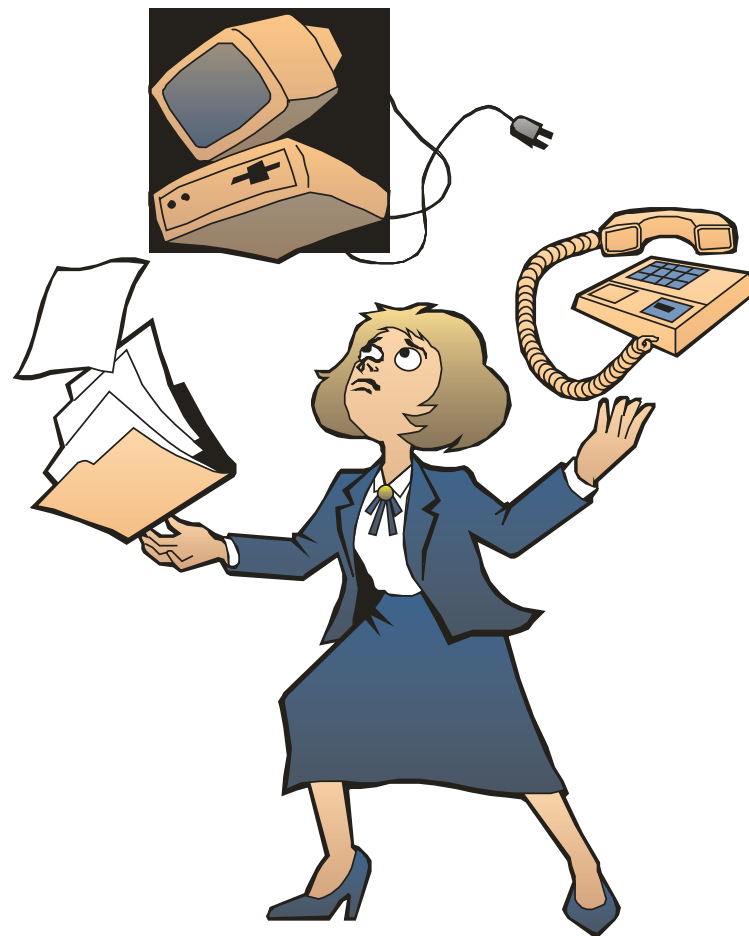
- RIPv6 - Same as RIPv2

- OSPFv6 - Updated for IPv6

- EIGRP - Extensions implemented

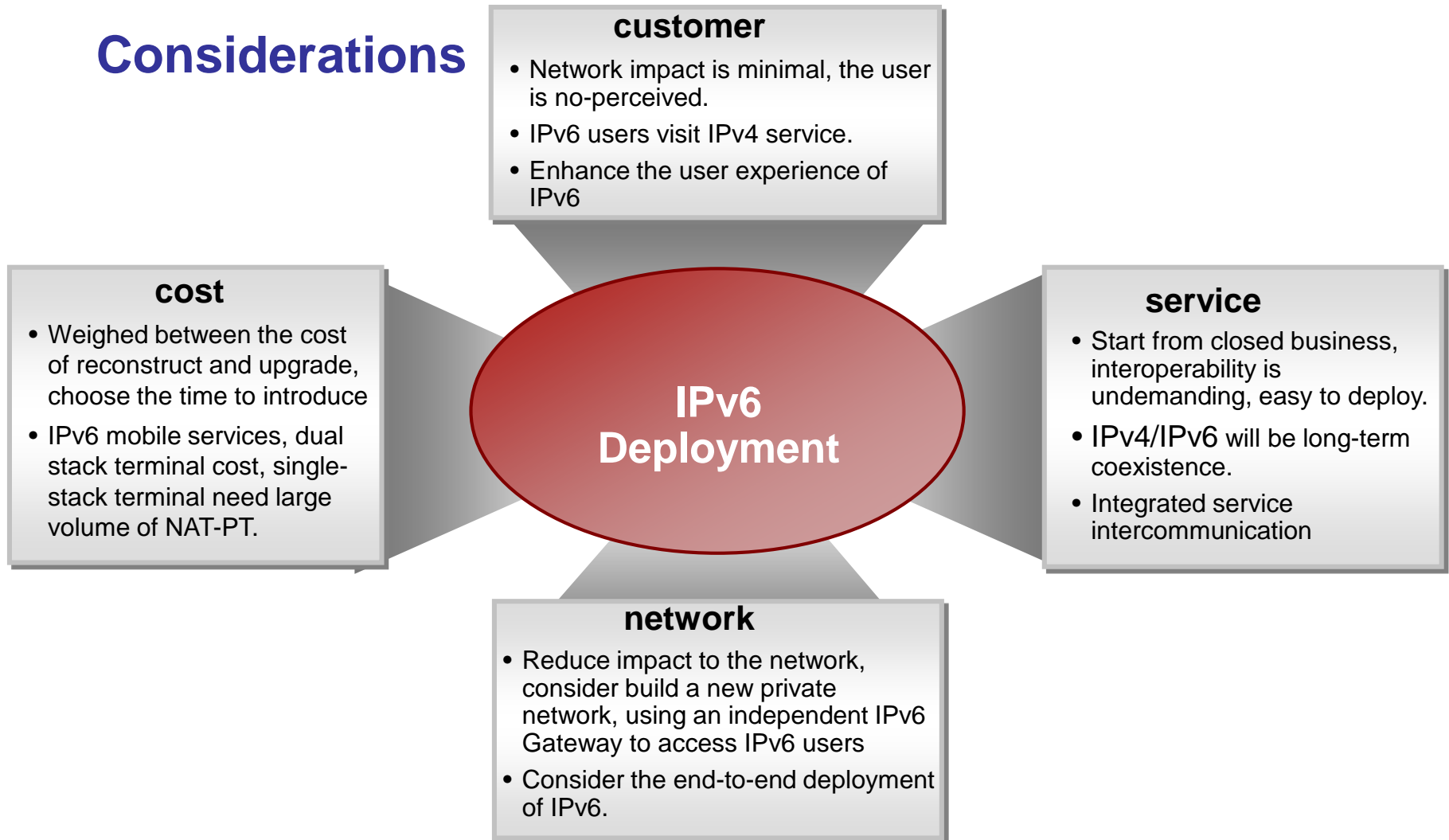
- IDRP - Recommended for exterior protocol over BGP4

- BGP4+ - Preferred implementation in IPv6 today





## Considerations








## Applications



NTT Technical Review

- NTT 'Earthquake Alert Service'
  - On detecting P-wave an S-wave alert is delivered
  - IPv6 Multicast is adopted
    - Low delay delivery is achieved
    - IPv4 is not suitable for a push-type service due to NAT
- Sensor Arrays
  - 6LoWPAN (RFC 4919 and 4944) based networks
  - Routing over low power and Lossy Networks
    - Sensors on aging infrastructure
    - Fire sensors
- Chinese Academy of Sciences
  - Integrated wireless, control and precision agriculture technologies linked
    - Accurate watering of farmland
    - Water/soil pollution monitoring

## IPv6 Deployment

China Telecom 	2009 deploy Experimental IPv6 network, in 2010 commercialized. The Telecommunications Research Institute draft guidance of large-scale IPv6 introduction, Hunan Telecom starts IPv6 test point. In 2010 Shanghai World Expo and Guangzhou Asian Games displayed IPv6.
China mobile 	3G mobile broadband deploy IPV6, to resolve the limitation of private network address space. The original IPv4 reserve is very limited, the mobile broadband has more requirements. 2010, China mobile deployed 3G IPv6 commercial services.
China Unicom 	2010 commercial-scale test users reached 20,000, China Unicom built a new type IPv6 access network
France Telecom 	2009 Q2-Q3 FT deployed Enterprise IPV6, in 2010 deployed the family IPv6 Livebox, the Core network maintains IPv4 temporarily. Poland subnet has strong interest, actively discusses the deployment of IPv6 solution, requests the current network equipment support dual-stack.
Japan 	IPv6 large-scale commercial from 2005, package the new concept of next-generation network, provide high-speed network services based on IPv6, leveraging next-generation network evolution, and promote various IPV6 new technologies and new services.
America	The U.S. government required government and Defense departments migrate telecommunication network into IPv6 platform before the summer of 2008. It led that the United States new applied IPv6 addresses reached 14,729 pieces, the world's ranking jumped from No. 11 to No. 1.



# NTT and IPv6



1.Latency Statistics(ms)

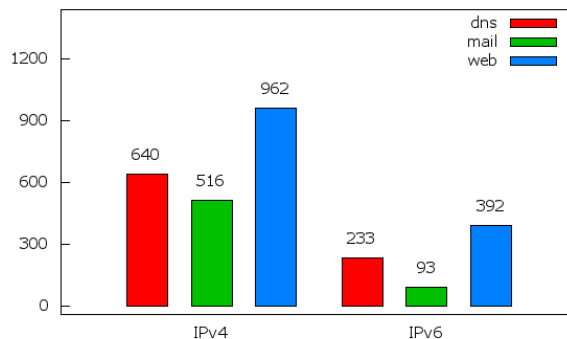
Month	Intra-Japan (25ms)	Intra-Asia (95ms)	Intra-US (60ms)	Intra-Europe (35ms)	Trans-Atlantic (90ms)	US-Japan (130ms)	Japan-Europe (300ms)
Oct 2012	10.39	51.17	44.30	23.26	72.31	105.49	262.25
Nov 2012	9.68	52.53	44.17	23.36	72.01	103.24	262.07
Dec 2012	10.18	57.55	43.88	23.39	71.99	93.63	224.09

2.Packet Loss Statistics(%)

Month	Intra-Japan	Intra-US	Trans-Atlantic	Japan-US	Intra-Asia	Intra-Europe	Japan-Europe
Oct 2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov 2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec 2012	0.00	0.00	0.00	0.00	0.00	0.00	0.00

# IPv6 and the US Government

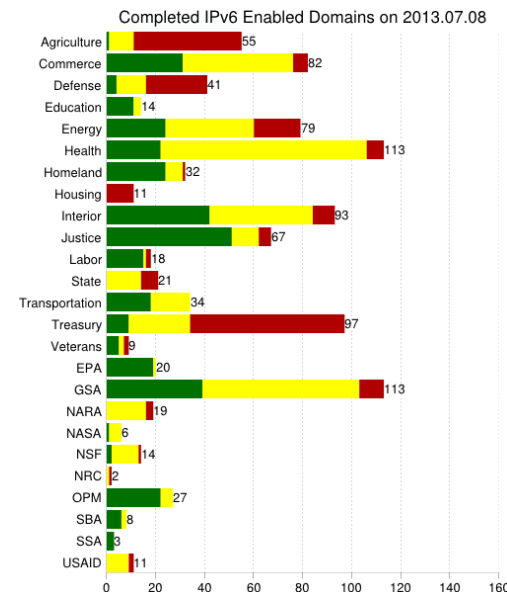
USG Unique Configured Service Interfaces for 2013.07.08  
 - 1350 Domains Measured -



- Detailed IPv6 & DNSSEC Service Interface Statistics for 2013.07.08 -

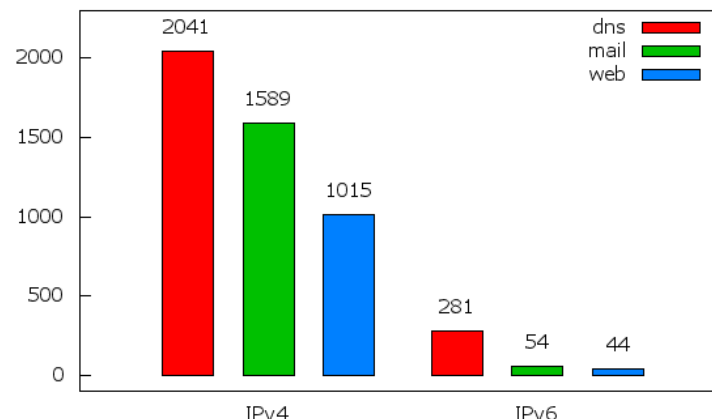
Domain	Organization	DNS	Mail	Web	DNSSEC
<a href="#">gov.404.</a>	Securities and Exchange Commission	[8] 3/2/2 [0]	[0] 0/0/0 [-]	[3] 0/0/0 [I]	S/V/C
<a href="#">gov.9-11commission.</a>	National Archives and Records Administration	[2] 2/2/2 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.911.</a>	Department of Transportation	[3] 3/0/3 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.911commission.</a>	National Archives and Records Administration	[2] 2/2/2 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.aapi.</a>	Department of Education	[4] 4/0/4 [0]	[0] 0/0/0 [-]	[1] 1/0/1 [I]	S/V/C
<a href="#">gov.abandonedmines.</a>	Department of the Interior	[6] 4/4/4 [0]	[1] 0/0/0 [0]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.abilityone.</a>	Comm for People Who Are Blind/Severly Disabled	[2] 2/2/2 [0]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
<a href="#">gov.abmc.</a>	American Battle Monuments Commission	[2] 0/0/0 [0]	[2] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
<a href="#">gov.access-board-members.</a>	U. S. Access Board	[4] 4/4/4 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [I]	U/-/-
<a href="#">gov.access-board.</a>	U. S. Access Board	[2] 0/0/0 [0]	[2] 0/0/0 [0]	[1] 1/0/0 [I]	U/-/-
<a href="#">gov.acf.</a>	Department of Health And Human Services	[4] 4/4/4 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [0]	S/V/C
<a href="#">gov.achp.</a>	Advisory Council on Historic Preservation	[4] 2/0/2 [0]	[2] 0/0/0 [I]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.acquisition.</a>	General Services Administration	[6] 2/0/2 [0]	[0] 0/0/0 [-]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.acus.</a>	Administrative Conference of the United States	[6] 2/0/2 [0]	[2] 0/0/0 [0]	[1] 0/0/0 [I]	S/V/C
<a href="#">gov.acwi.</a>	Department of the Interior	[6] 6/0/6 [0]	[2] 0/0/0 [0]	[6] 6/4/4 [0]	S/V/C

<http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-gov>



# IPv6 and Industry

Industry Unique Configured Service Interfaces for 2013.07.08  
 - 1070 Domains Measured -

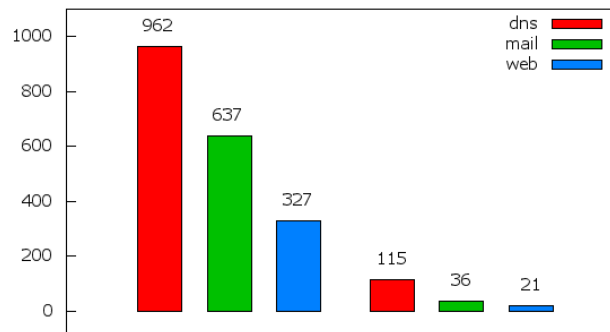


IPv4		IPv6				
com.yahoo.	<a href="#">Yahoo!</a>	[7] 0/0/0 [I]	[3] 0/0/0 [O]	[2] 4/4/4 [I]		U/-/-
com.youtube.	<a href="#">YouTube</a>	[4] 0/0/0 [O]	[5] 5/5/5 [O]	[11] 1/1/1 [O]		U/-/-
com.yrcw.	<a href="#">YRC Worldwide</a>	[2] 2/2/2 [O]	[4] 0/0/0 [I]	[1] 0/0/0 [I]		U/-/-
com.yum.	<a href="#">Yum Brands</a>	[2] 0/0/0 [O]	[2] 0/0/0 [O]	[2] 0/0/0 [O]		U/-/-
com.zalecorp.	<a href="#">Zale</a>	[4] 0/0/0 [O]	[2] 0/0/0 [I]	[1] 0/0/0 [I]		U/-/-
com.zedo.	<a href="#">ZEDO</a>	[5] 5/3/5 [O]	[7] 6/6/6 [O]	[1] 0/0/0 [I]		U/-/-
com.zimmer.	<a href="#">Zimmer Holdings</a>	[3] 0/0/0 [I]	[1] 0/0/0 [I]	[2] 0/0/0 [O]		U/-/-
com.zionsbancorporation.	<a href="#">Zions Bancorp.</a>	[6] 6/0/6 [O]	[0] 0/0/0 [-]	[1] 0/0/0 [I]		U/-/-
edu.apollogrp.	<a href="#">Apollo Group</a>	[4] 0/0/0 [I]	[1] 0/0/0 [O]	[2] 0/0/0 [O]		U/-/-
net.arin.	<a href="#">ARIN</a>	[4] 4/4/4 [I]	[2] 2/2/2 [I]	[2] 2/2/2 [I]		U/-/-
net.att.	<a href="#">AT&amp;T</a>	[4] 4/4/4 [I]	[3] 0/0/0 [I]	[1] 1/1/1 [I]		U/-/-
net.att.ipv6.	<a href="#">AT&amp;T</a>	[3] 3/3/3 [P]	[0] 0/0/0 [-]	[0] 0/0/0 [-]		U/-/-
net.chs.	<a href="#">Community Health Systems</a>	[4] 2/0/2 [O]	[4] 0/0/0 [I]	[1] 0/0/0 [I]		U/-/-
net.comcast.	<a href="#">Comcast</a>	[5] 5/3/5 [I]	[2] 2/2/2 [I]	[2] 2/2/2 [O]		S/V/C
net.cox	<a href="#">Cox</a>	[3] 0/0/0 [I]	[2] 0/0/0 [I]	[1] 0/0/0 [I]		U/-/-

<http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-gov>

# IPv6 and University

University Unique Configured Service Interfaces for 2013.07.07  
 - 346 Domains Measured -

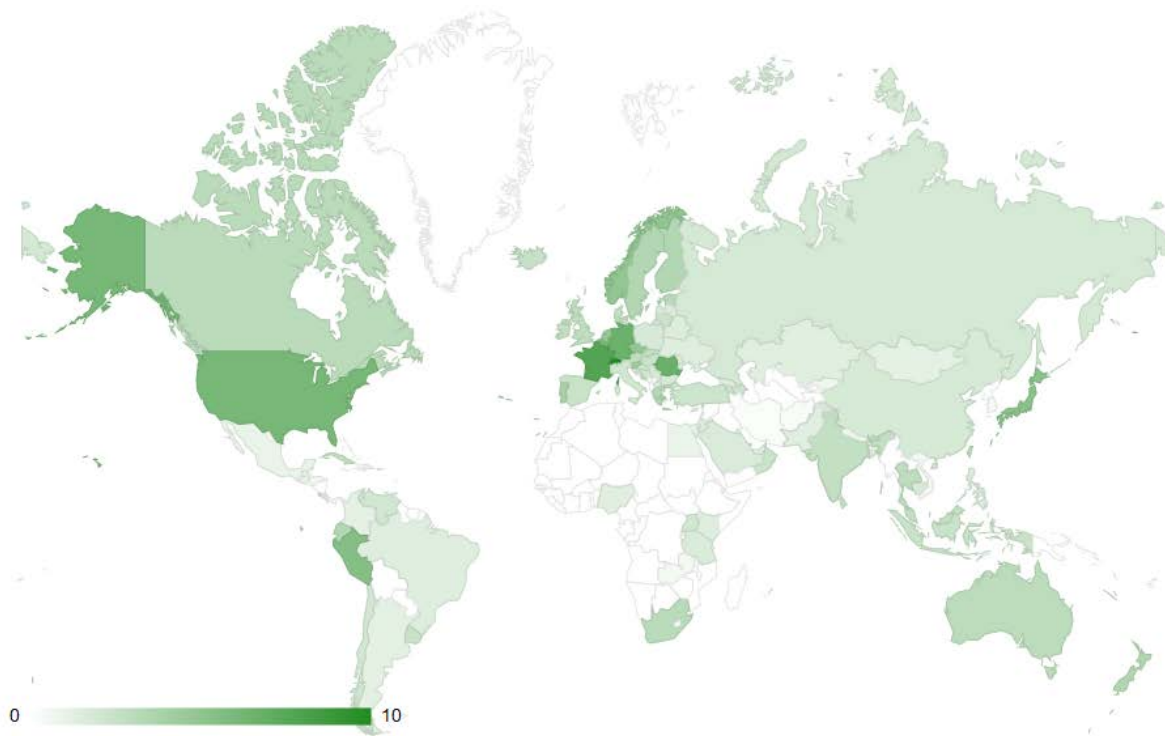


- Detailed IPv6 & DNSSEC Service Interface Statistics for 2013.07.07 -

Domain	Organization	DNS	Mail	Web	DNSSEC
edu.uakron.	<a href="#">University of Akron</a>	[2] 0/0/0 [I]	[2] 0/0/0 [O]	[1] 0/0/0 [I]	U/-/-
edu.aamu.	<a href="#">Alabama A&amp;M University</a>	[4] 0/0/0 [M]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.alasu.	<a href="#">Alabama State University</a>	[5] 0/0/0 [O]	[5] 0/0/0 [M]	[1] 0/0/0 [I]	U/-/-
edu.uab.	<a href="#">University of Alabama at Birmingham</a>	[5] 2/2/2 [M]	[2] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.ua.	<a href="#">University of Alabama Tuscaloosa</a>	[3] 0/0/0 [M]	[2] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.albany.	<a href="#">University at Albany</a>	[5] 2/2/2 [M]	[1] 0/0/0 [O]	[1] 1/1/1 [I]	U/-/-
edu.alcorn.	<a href="#">Alcorn State University</a>	[2] 0/0/0 [I]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.american.	<a href="#">American University</a>	[4] 0/0/0 [I]	[3] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.appstate.	<a href="#">Appalachian State University</a>	[2] 0/0/0 [I]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.arizona.	<a href="#">University of Arizona</a>	[5] 0/0/0 [M]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.asu.	<a href="#">Arizona State University</a>	[4] 0/0/0 [I]	[4] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.astate.	<a href="#">Arkansas State University</a>	[4] 1/0/0 [M]	[1] 0/0/0 [I]	[1] 0/0/0 [I]	U/-/-
edu.uark.	<a href="#">University of Arkansas Fayetteville</a>	[2] 0/0/0 [I]	[3] 2/0/0 [I]	[1] 0/0/0 [I]	U/-/-

<http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-gov>

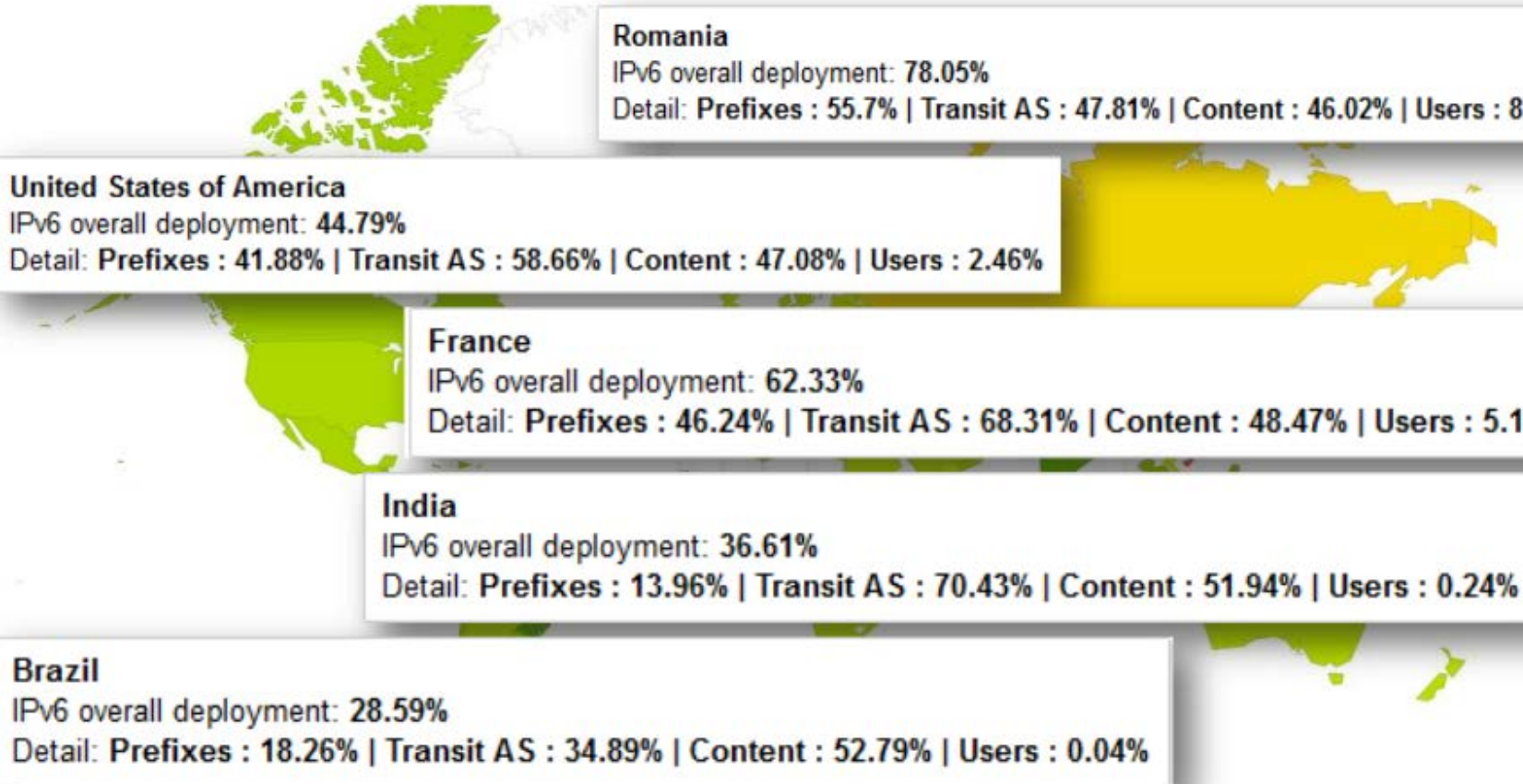
**6lab.cisco.com**





## IPv6 Statistics

[6lab.cisco.com/stat](http://6lab.cisco.com/stat)



### Romania

IPv6 overall deployment: 78.05%

Detail: **Prefixes** : 55.7% | **Transit AS** : 47.81% | **Content** : 46.02% | **Users** : 8.74%

### United States of America

IPv6 overall deployment: 44.79%

Detail: **Prefixes** : 41.88% | **Transit AS** : 58.66% | **Content** : 47.08% | **Users** : 2.46%

### France

IPv6 overall deployment: 62.33%

Detail: **Prefixes** : 46.24% | **Transit AS** : 68.31% | **Content** : 48.47% | **Users** : 5.11%

### India

IPv6 overall deployment: 36.61%

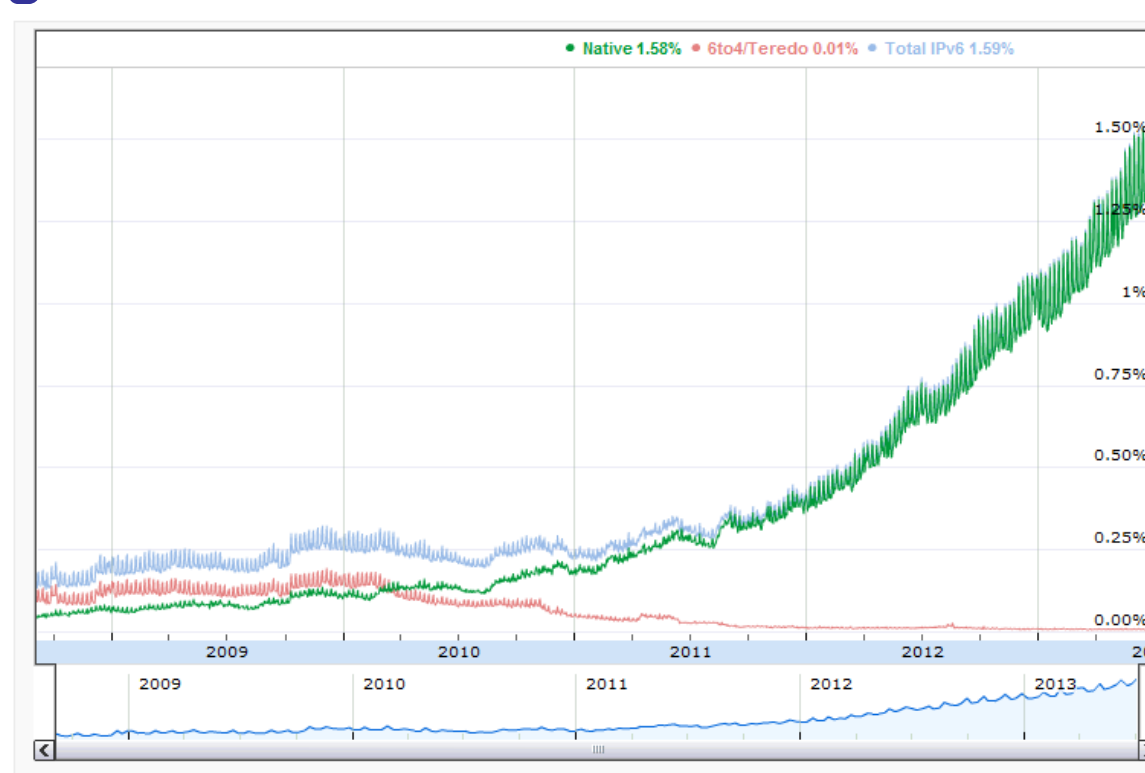
Detail: **Prefixes** : 13.96% | **Transit AS** : 70.43% | **Content** : 51.94% | **Users** : 0.24%

### Brazil

IPv6 overall deployment: 28.59%

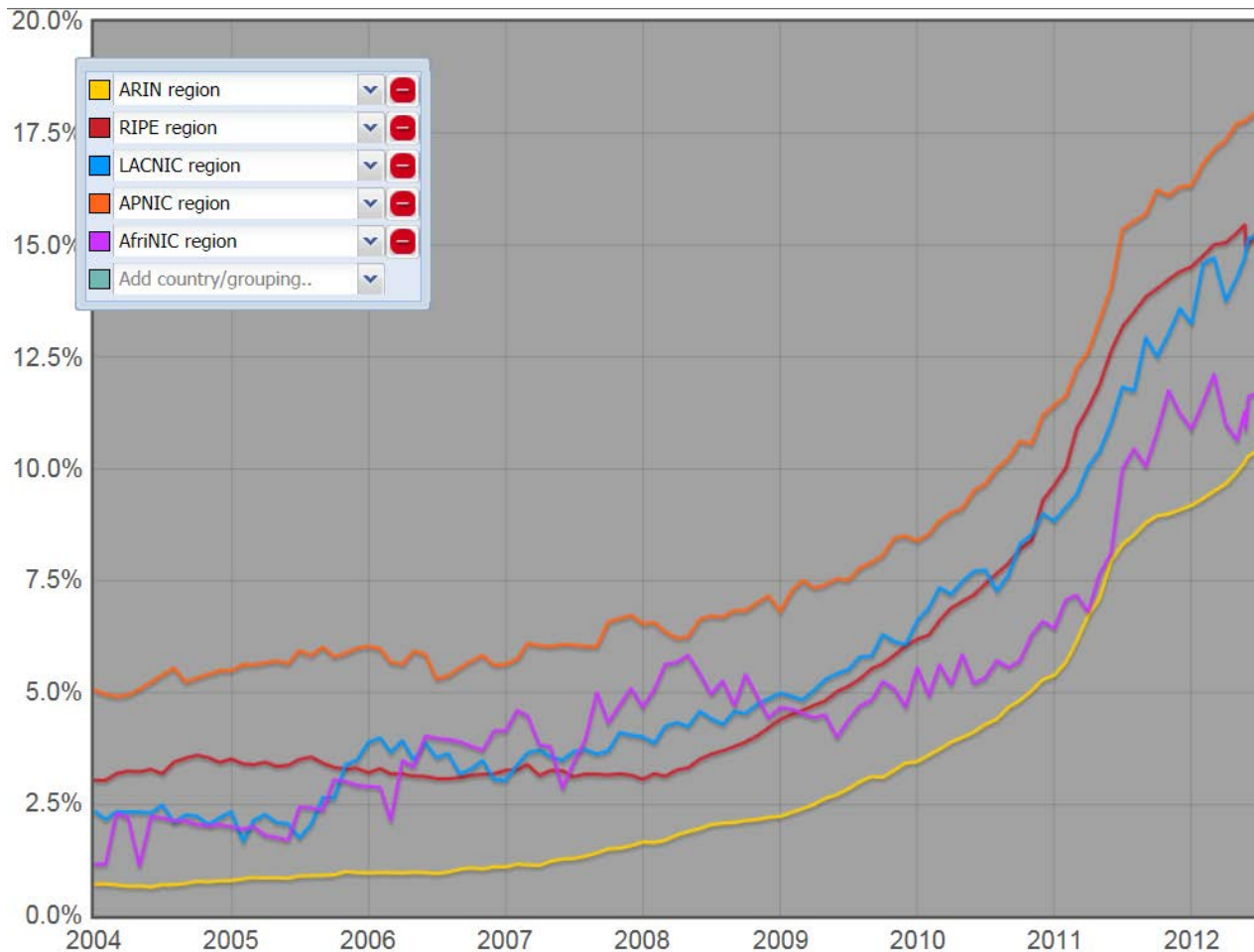
Detail: **Prefixes** : 18.26% | **Transit AS** : 34.89% | **Content** : 52.79% | **Users** : 0.04%

## Google IPv6 Statistics



**Google Statistics on IPv6 continuous usage**  
<http://www.google.com/ipv6/statistics.html#>

## IPv6 Networks Advertised



## IPv6 Transition Methods

### Tunneling

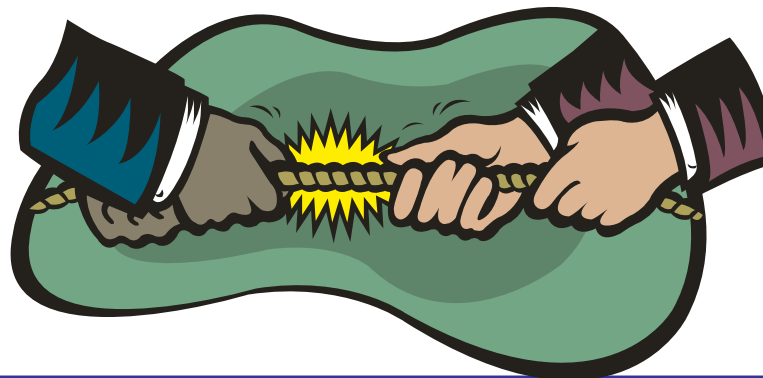
IPv6 only systems communicate across an IPv4 network

### Header translation

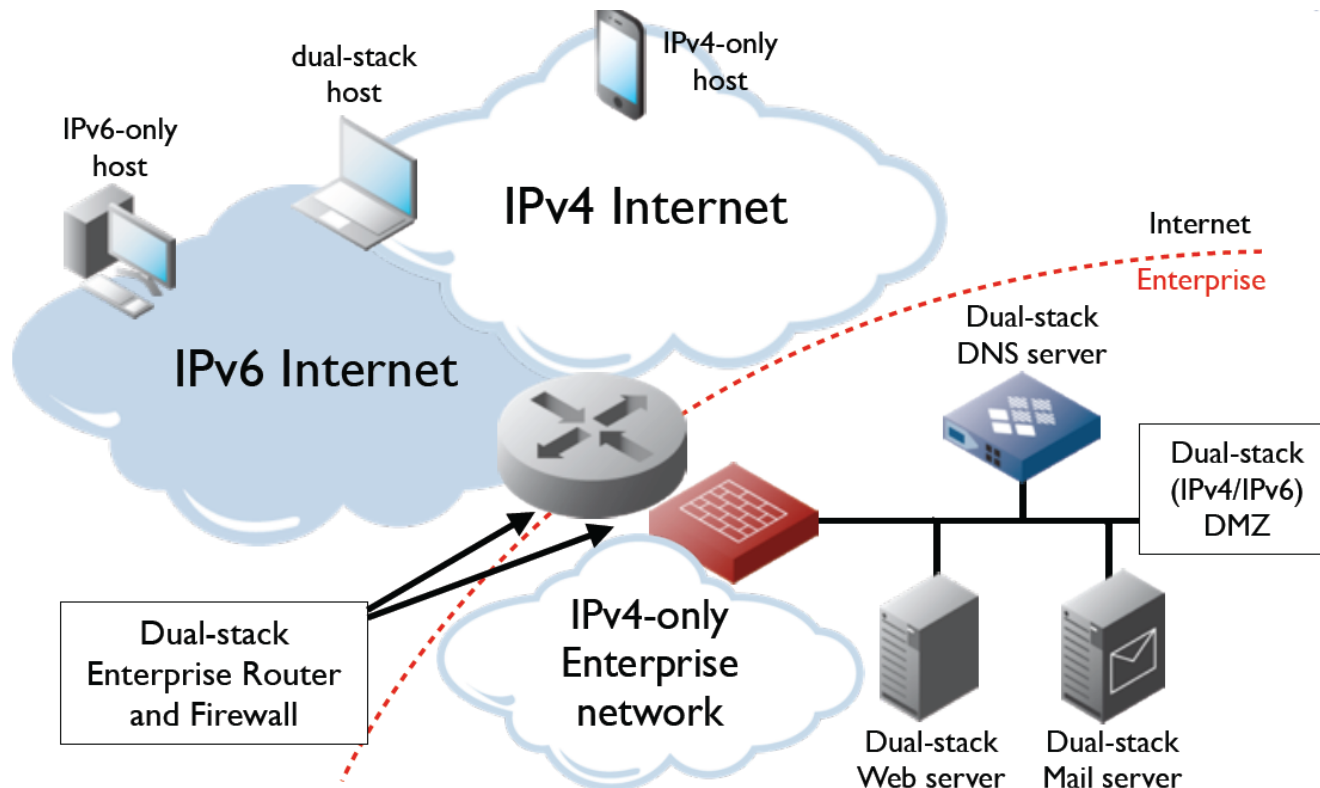
IPv6 system communicates with an IPv4 system

(header conversion, transport relay, application proxy)

### Dual Stack

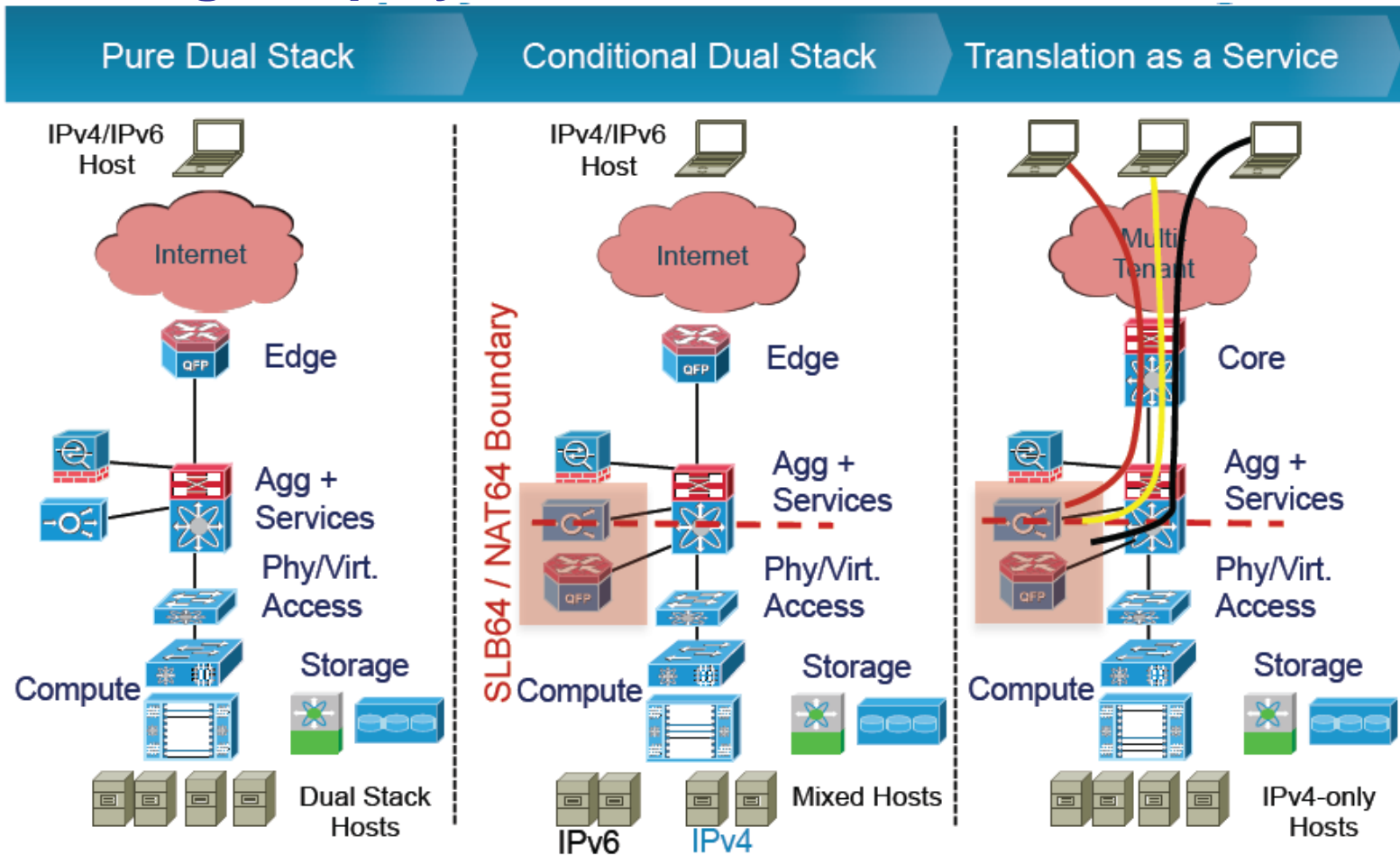


## Enterprise Content



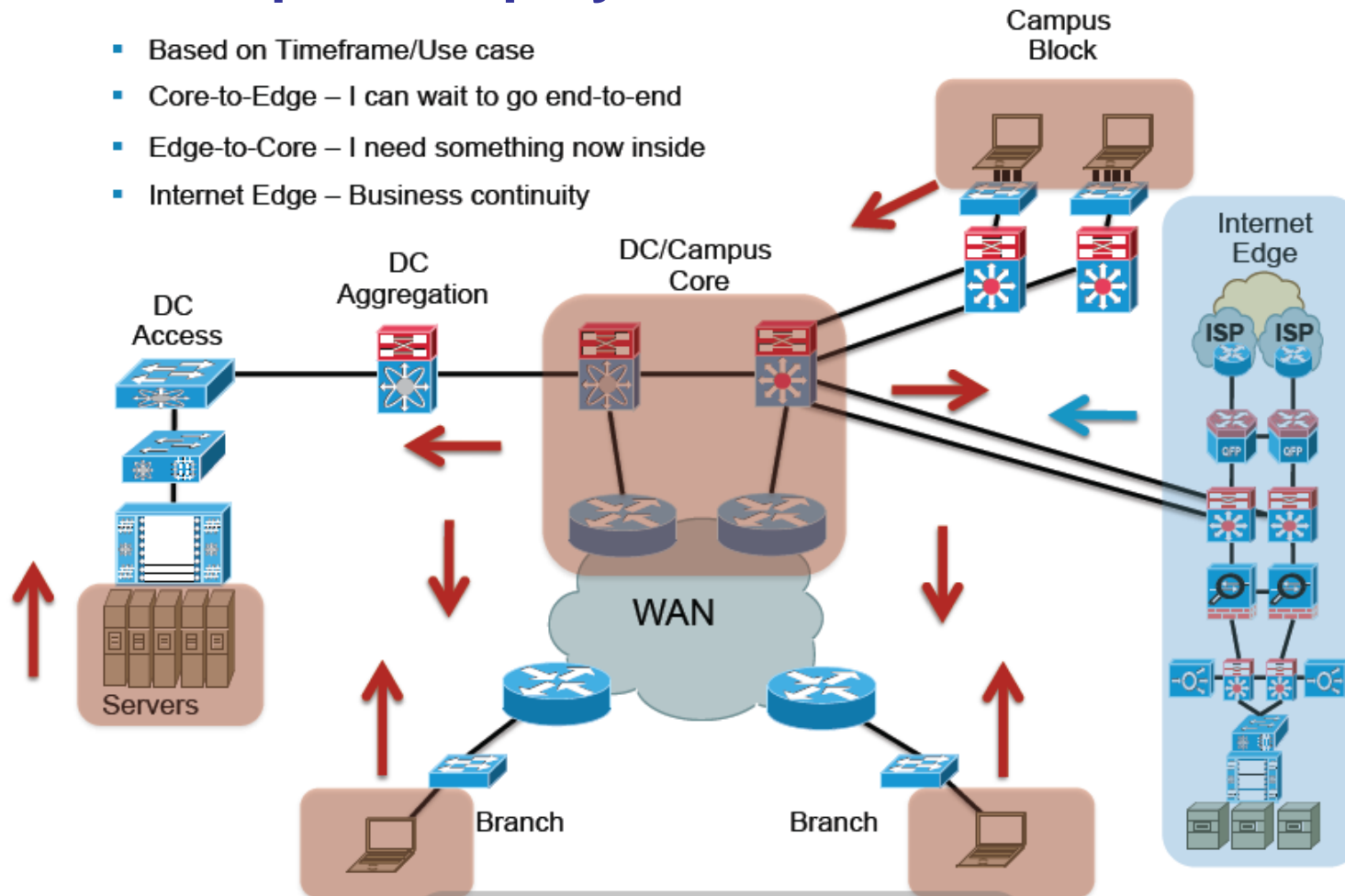
**Availability of enterprise content over IPv6**

# IPv6 Edge Deployment



## IPv6 Enterprise Deployment

- Based on Timeframe/Use case
- Core-to-Edge – I can wait to go end-to-end
- Edge-to-Core – I need something now inside
- Internet Edge – Business continuity



# Why IPv6 in Korea?

## Prepare IPv4 Address Depletion

- Usage ratio of assigned IP addresses : 96.2% (Mar. 2006)
- More IP addresses to be needed for the future IT839 Strategy

## Promoting New Services

- IPv6 based Home Network Service
- IPv6 Service over 2.3 GHz based WiBro
- IPv6 based VoIP Service
- IPv6 based Telematics Service, and many others

## IT839 New Growth Engine

- A master plan for the IT industry
- Effort to gain more growth momentum from the IT sectors



## 6to4 Tunneling

IPv6 traffic tunneled to go through an IPv4 network  
www.sixxs.net – Worldwide tunnel broker

Address - 2002:wwxx:yyzz::/48

wwxx:yyzz is both the NLA and the colon-hexadecimal representation of an IPv4 address assigned to the site or host

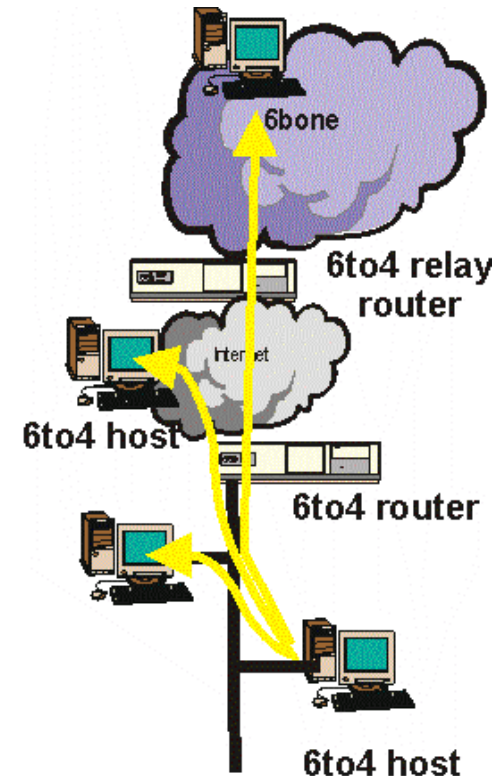
2002:wwxx:yyzz:[Subnet]:{Interface ID}

6to4 host - an IPv6 host that is configured with at least one 6to4 address

6to4 router - an IPv4/IPv6 router that forwards 6to4 traffic between 6to4 hosts within a site or 6to4 relay routers on the IPv4 Internet

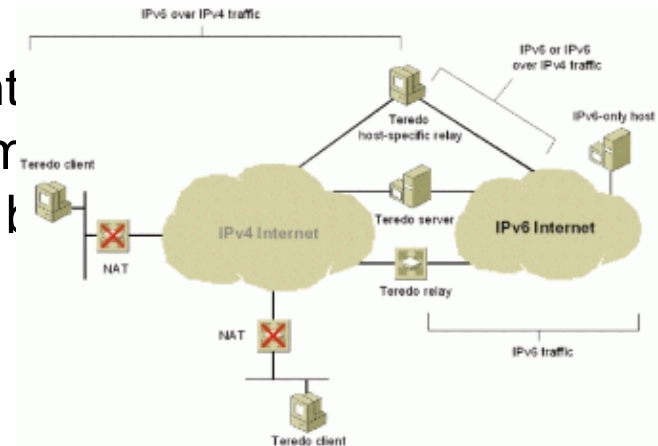
6to4 relay router - an IPv4/IPv6 router that forwards 6to4 addressed traffic between 6to4 routers on the IPv4 Internet and hosts on IPv6 networks

**Anycast**  
**2002:C058:6301::**



## Teredo

- 6to4 tunnels requires the tunnel end point public IPv4 address.....so for many that run behind NAT device...Many NAT devices cannot be upgraded
- Teredo encapsulates IPv6 in UDP/IPv4 datagrams.
  - Diagnoses UDP 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.



## 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

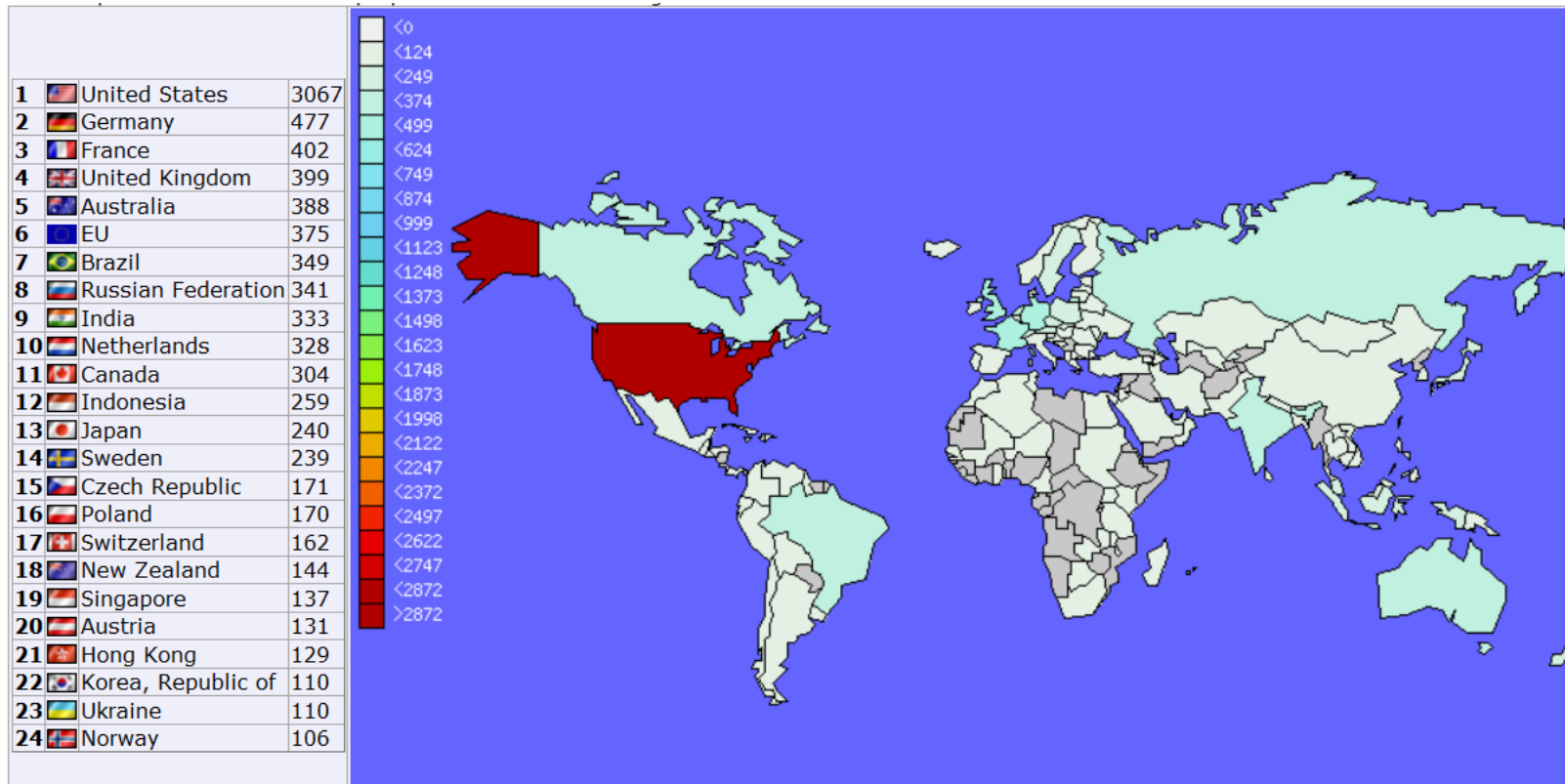
### **SIIT (Stateless IP/ICMP Translation)**

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

## IPv6 BGP Weathermap – Prefixes per Country



## IPv6 Migration Plans

**Define topology and functions on hosts, routers, and service machines**

**Upgrade DNS, DHCP, ARP servers to handle IPv6 addresses**

**Introduce dual stack systems that support IPv4 and IPv6**

**Configure to Internet using IPv6**

**Rely on tunnels to connect IPv6 islands separated by IPv4 networks**

**Gradually remove IPv4 from systems**

**Work closely with ISP for connections to the Internet**



## IPv6 References

<http://www.ietf.org/>

<http://playground.sun.com/pub/ipng/html/ipng-main.html>

[http://www.getipv6.info/index.php/IPv6\\_Presentations\\_and\\_Documents](http://www.getipv6.info/index.php/IPv6_Presentations_and_Documents)<http://www.6ren.net>

<http://www.ipv6forum.com>

<http://arin.net>

<http://www.internet2.edu>

<http://www.ipv6.org>

<http://ipv6.or.kr/english/natpt.overview>

<http://www.research.microsoft.com/msripv6>

<http://www.ipv6.org.uk>

New Internet Protocol - Prentice Hall - ISBN 0-13-241936-x

IPNG and the TCP/IP Protocols - John Wiley and Sons - ISBN-0-471-13088-5

IPv6 The New Internet Protocol - ISBN-0-13-24-241936

IPNG Internet Protocol Next Generation - ISBN-0-201-63395-7

Internetworking IPv6 with Cisco Routers - ISBN 0-07-022831-1



## AES Sessions

Session	Title	Day	Time	Room
12152	IPv6 Basics	Tuesday February 5	1:30 PM	Golden Gate 4
12777	Network Problem Diagnosis with Packet Traces	Wednesday February 6	9:30 AM	Golden Gate 3
12778	Performance Factors in Cloud Computing	Wednesday February 6	11:00 AM	Golden Gate 4
12150	I'm Running IPv6 How Do I Access?	Wednesday February 6	3:00 PM	Golden Gate 4
12158	Managing an IPv6 Network	Thursday February 7	11:00 AM	Golden Gate 4
12149	Kick Start your IPv6 Skills using your home network	Friday February 8	8:00 AM	Golden Gate 4
12153	IPv6 Deep Dive	Friday February 8	9:30 AM	Golden Gate 4

*Vielen*  
**Dank**

ありがとうございました

*Köszönettel*

*Obi* Спасибо

ขอบคุณ

شكراً

**Bedankt**

**Gracias**

شكراً

धन्यवाद

Ευχαριστώ

Grazie

**THANK YOU**

Danke

*Merci*

*Díky*

*Hvala*

Merci

ขอบคุณ

Teşekkürler

감사합니다

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Obrigado

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Tamil