Transitioning to IPv6
Share Anaheim Session 14499

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Applications are Changing

What is IPv6

Updated version of the Internet Protocol (IPv4)

Defined in RFC 1752

New features

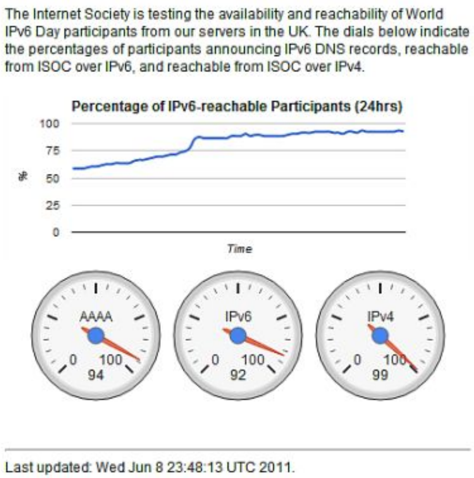
- Larger address space
- Encapsulation
- Class of service for audio, video, etc.
- Multicast support
- Authentication
- Encryption
- Automatic configuration/reconfiguration
- Support for non-IP protocols

Coexist with IPv4

IPv6 Technology Scope

IP Service	*IPv4 Solution*	*IPv6 Solution*
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 Day



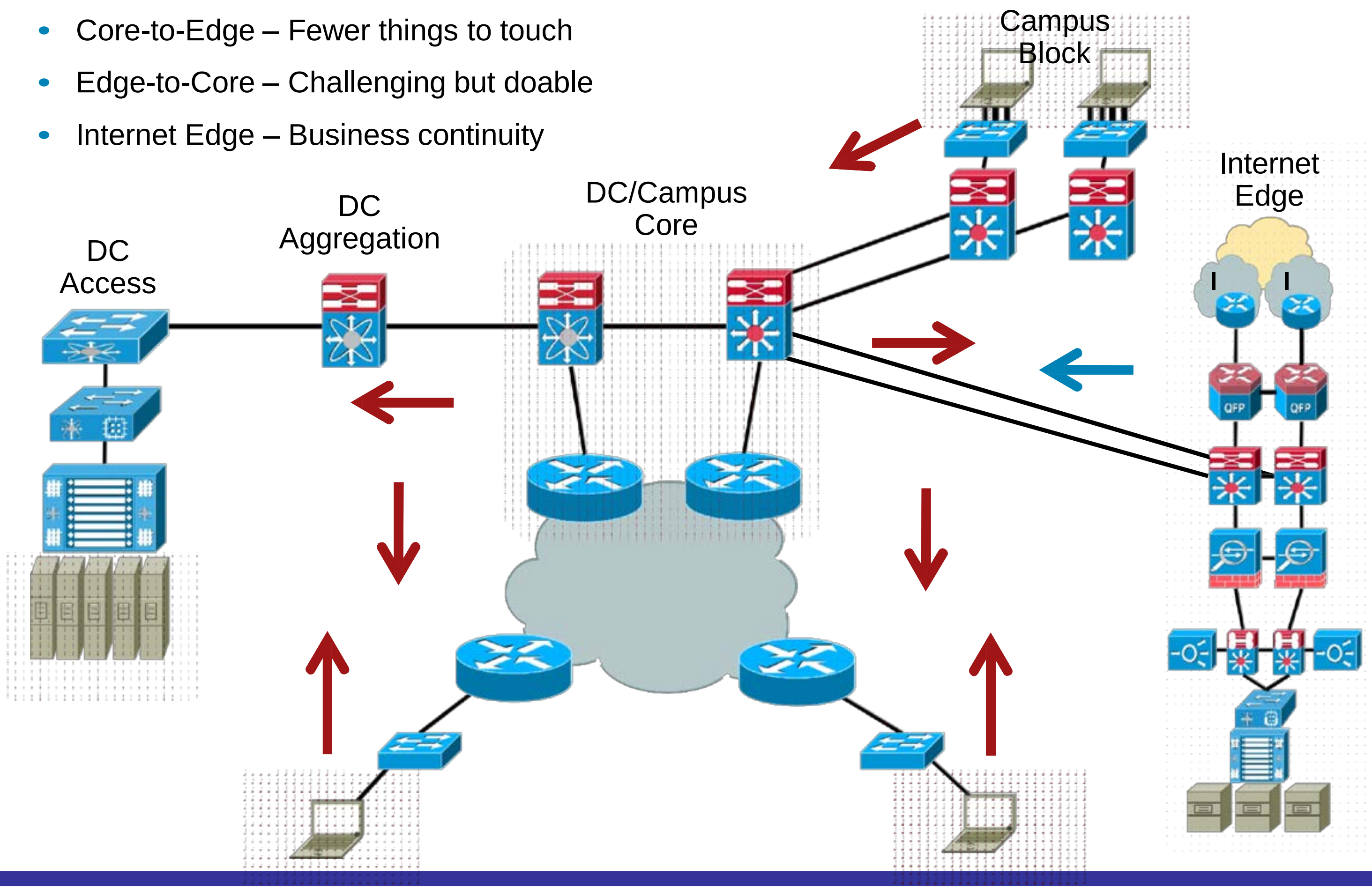
Comcast, Time-Warner, Bing, Yahoo, Facebook to name a few all will have native IPv6 after June 6 2012

January 18th, 2012, 11:10 GMT

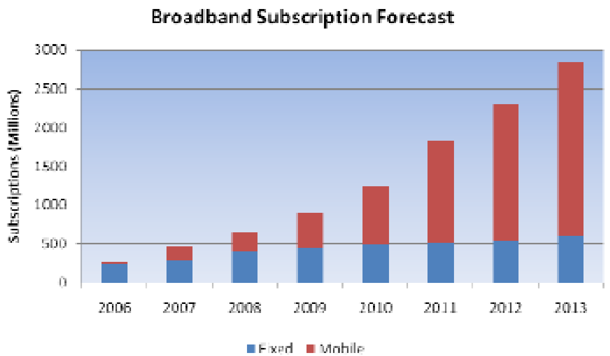
Google Will Permanently Switch on IPv6 Connectivity on June 6, 2012

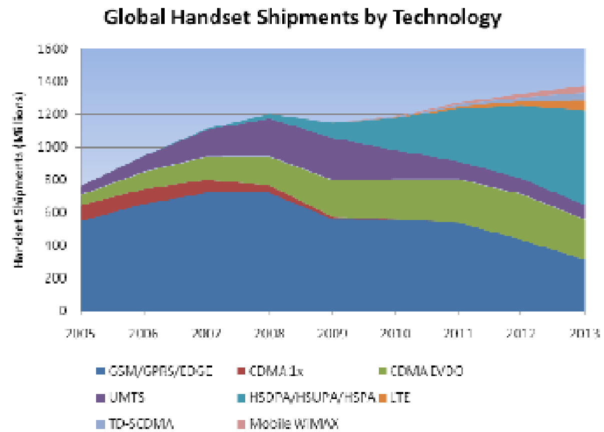
IPv6 Transition Paths

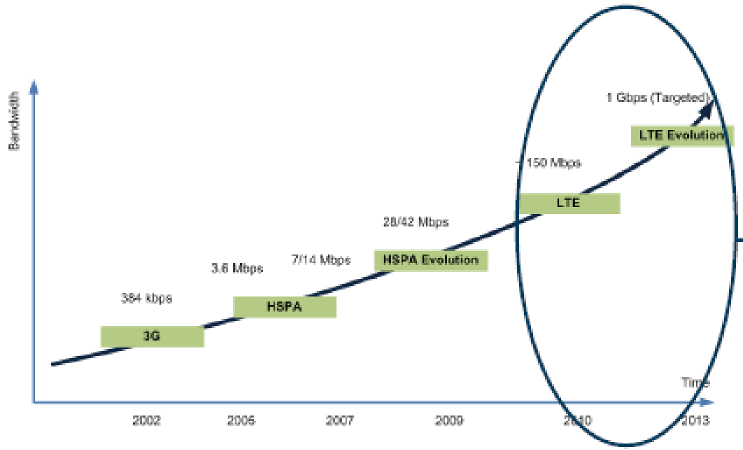
- Based on Timeframe/Use case
- Core-to-Edge – Fewer things to touch
- Edge-to-Core – Challenging but doable
- Internet Edge – Business continuity



Number 1 Application Driver: Mobile IP



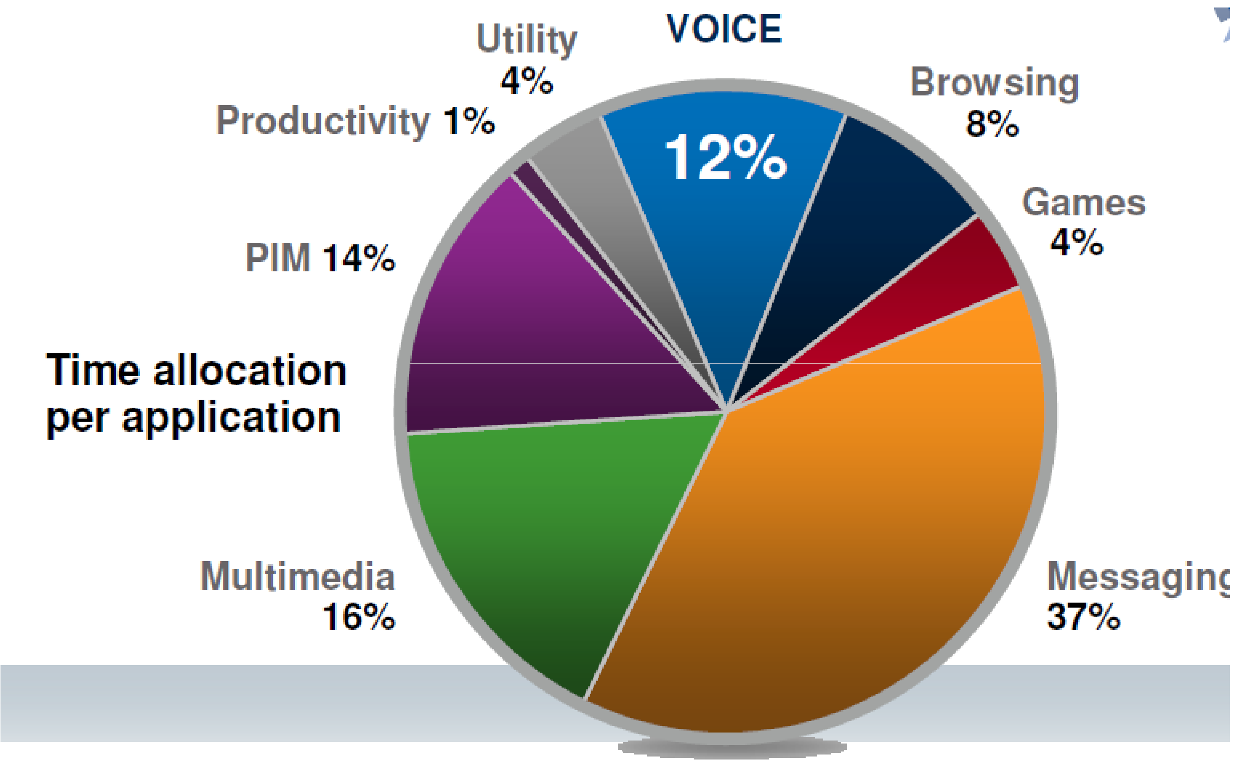




LTE stands for Long Term Evolution – Technology to provide all IP networking; In other words, IP from Mobile terminal to support growing mobile broadband needs

Source: Ericsson, ABI

IPv6 – New Information Types – Critical to LTE



Voice is 12% of usage

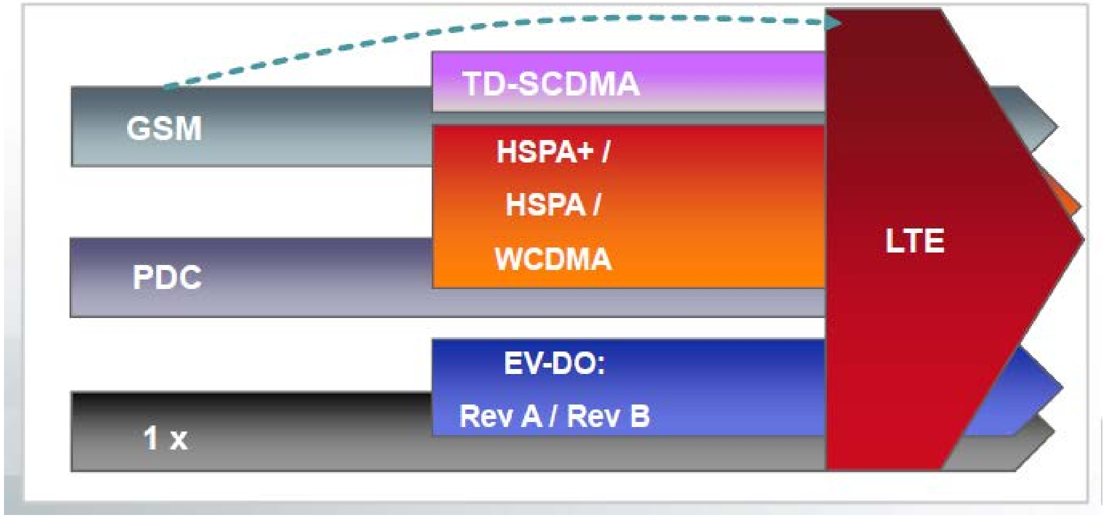
LTE – 4G

Flat IPv6 network

High Through-put

Low Latency

Increased spectrum flexibility



Future of LTE

	HSPA Evolution	LTE	Future releases of LTE
Market impact	2009	2010	~2014
Peak rate	42 Mbps	~150 Mbps	~1000 Mbps
Typical user rate downlink	1-10 Mbps	10-100 Mbps	Operator dependent
Typical user rate uplink	0.5-4.5 Mbps	5-10 Mbps	Operator dependent

Enterprise Driver of IPv6 – CLOUD Computing

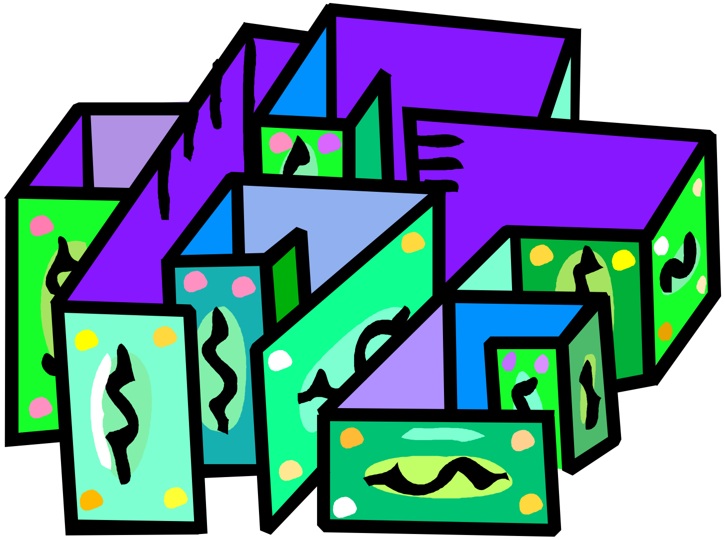
Enterprise Class	Global class
On-premise	Hybrid/off-premise
100s -1000s of nodes	10,000+ nodes
Proprietary	Commodity
HW resiliency	SW resiliency
Max performance	Max efficiency
Silo'ed Resources	Shared Resources
Clusters	Grids/Cloud
Static	Elastic
Shared storage	Replicated storage
Facility costs	Power Usage Efficiency

Cost-Center

Value/
Revenue-Center

Courtesy: John Rhoton
Distinguished Technologist
HP EDS CTO Office

NAT Makes IPv4 Enterprise Successful
NAT Breaks Cloud Computing



Overhead due to Translation

Protocol incompatibilities

Peer-Peer breakage
- Instant messaging
- Interactive games
- VOIP
- Netmeeting
- BitTorrent

Scalability

Business IPv6 Demand Drivers

More network appliances

Mandates for Government Agencies

Control operation expenses for IT

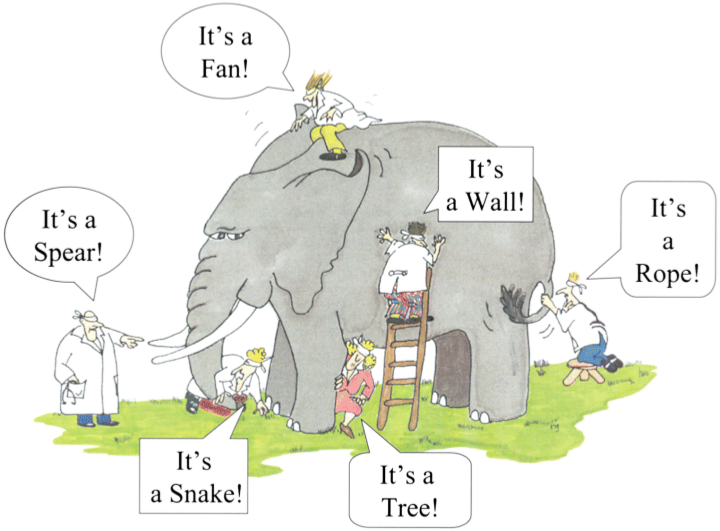
Elimination of complex NAT networks

Strong intrinsic security

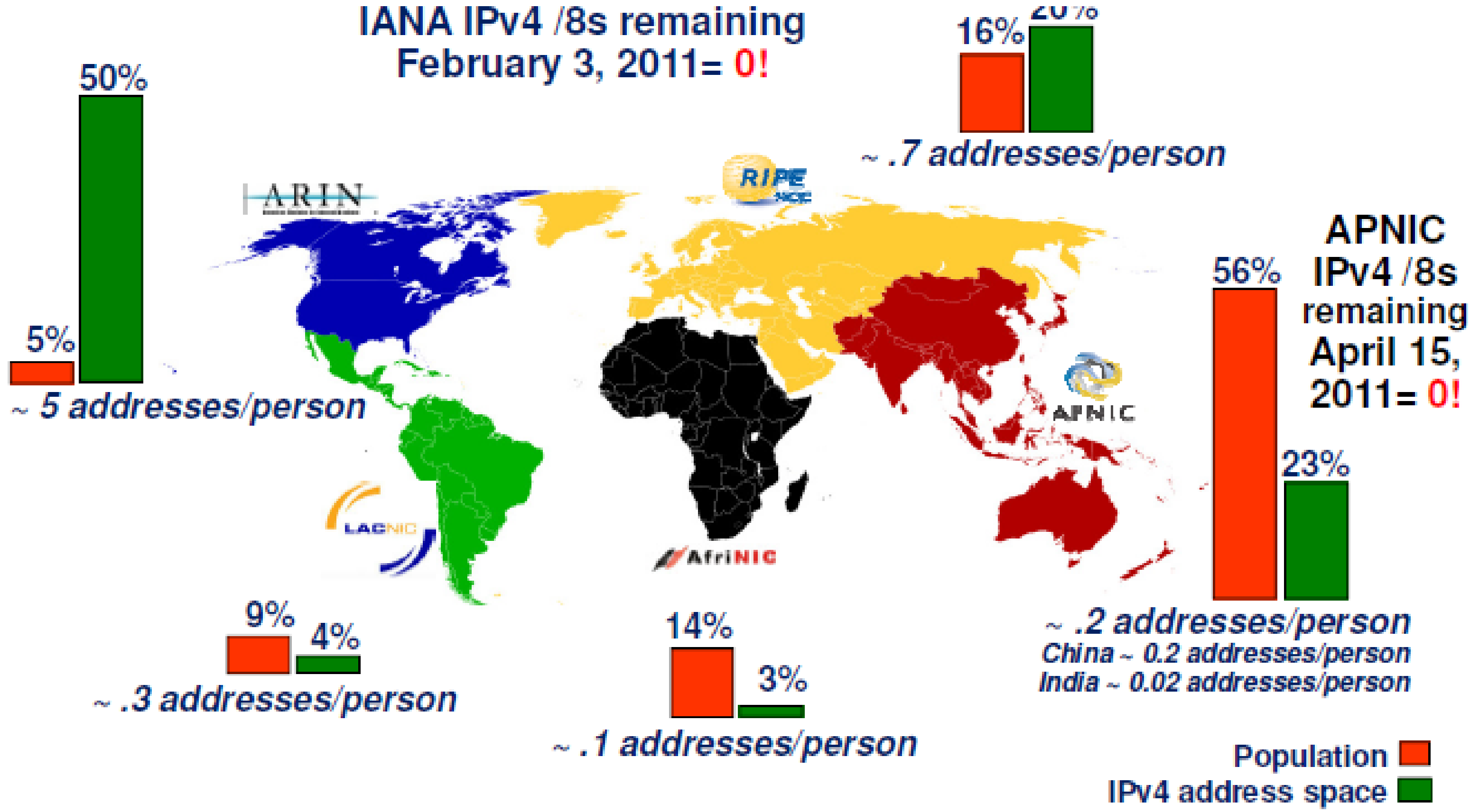
Robust mobility support

Greater flexibility and simplicity

Business process improvements



IPv6 Address Importance



Regional IPv4 depletion will occur unevenly

(see www.ipv4depletion.com for details)

History Repeats !

It will always take longer than planned

The best plans are always changed

It will always be more complicated than planned

Why deploy something if you cannot manage it

Why deploy something if you cannot secure it

Deployment Considerations

Compatibility issues between IPv4 and IPv6

Vendor interoperability issues

Potential security issues

Service management

Existing hardware and software support of IPv6

Cost of potential hardware and software upgrades

Cost of education

Global public routing practices continue to evolve

DNS Issues Behind Many IPv6 Rollout Problems

Poor DNS Planning

Well documented

RFC 3596
(DNS extensions to support IPv6)
RFC 3901 and 4472
(DNS transport operational guidelines)
RFC 4074
(Common misbehavior for IPv6 responses)
RFC 5211
(An Internet Transition Plan)

Be sure to consider

Transport
Dedicated vs dual stack resolvers
Name space fragmentation
Placement related to NAT devices, load balancers, etc
Applications

IPv6 Dependencies

DNS –inserting AAAA records

Operational support and maintenance

FCAPS – Fault, Configuration, Availability, Performance and Security systems for measurement and reporting

IP address tools and automated deployment systems

Education

Infrastructure components – DNS, firewalls, IDSs, routers, switches

IPv6 Risk Mitigation

Security organizations need to be early adapters

Increase level of security controls during initial IPv6 deployment

Monitor for false router advertisement

Authenticate routers and other infrastructure devices

Develop filtering strategies

Enforce multicast scope limits at appropriate boundaries

Deployment Elements

- IPv6 transition is a process
- Time phased iterative endeav
- Safeguard business continuit during the process

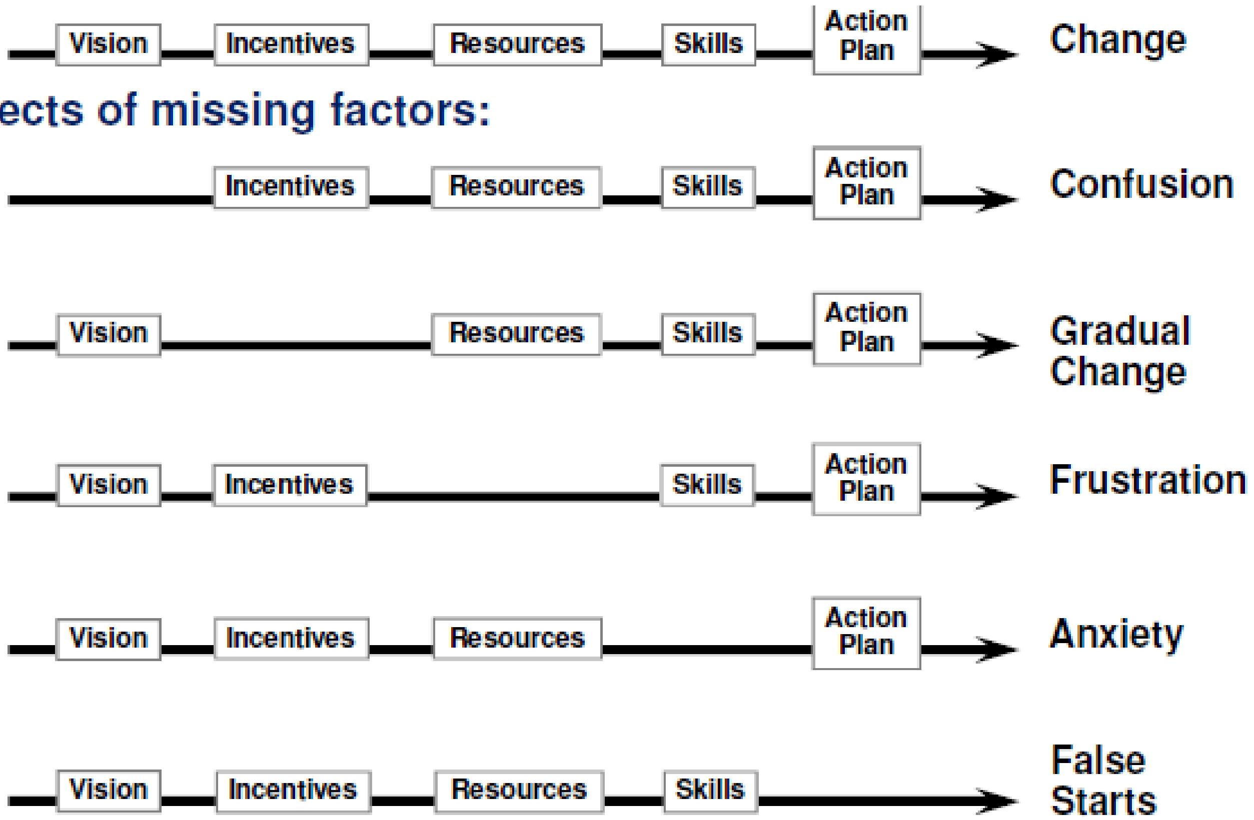
- Requirements analysis
- GAP assessment
- Planning and Design
- Implementation

IPv6

- Infrastructure updates
- Security system updates
- Process and procedure changes
- Competency development

- Infrastructure logic enhancements
- Business logic enhancements
- IT logic enhancements

Critical Success Factors for any Transition



From Enterprise Corporation a consulting firm no longer in existence

AES
aesclever.com

Building the Transition Plan

Build IPv6 business case

Where do we Start? → *Where are we now?* → *Where do we want to go?* → *How do we get there?* → *Taking it live*

Where do we Start?
- Setting the context for IPv6
- IPv6 Maturity Assessment

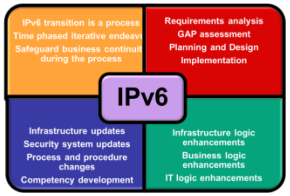
Where are we now?
- Process Assessment
- People & Organization Assessment
- Technology & Tool Assessment

Where do we want to go?
- Business Requirements
- Infrastructure Requirements
- Technology Requirements

How do we get there?
- GAP analysis
- IPv6 Process Prioritization
- IPv6 Conceptual Design

Taking it live
- IPv6 Strategic Plan
- IPv6 Enablement Plan

Conceptualizing IPv6 business case



IPv6 Preliminary Assessment

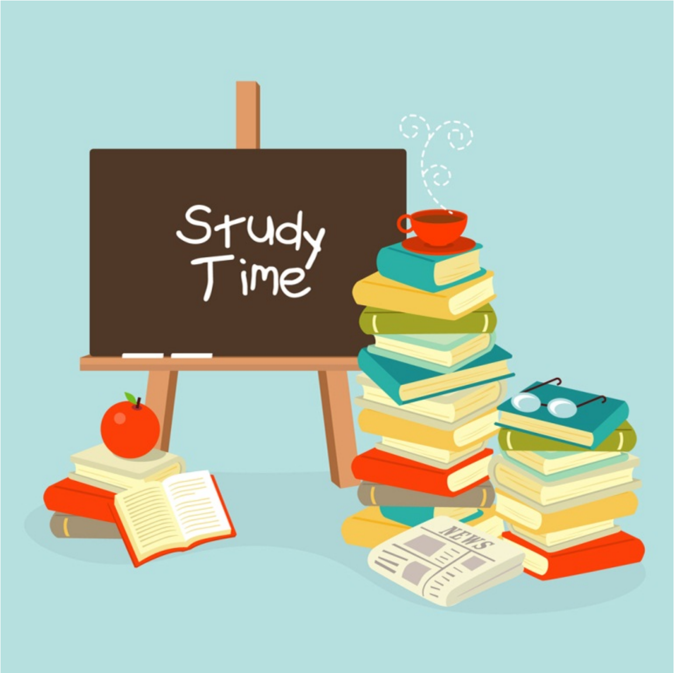
Educational services on IPv6 transition

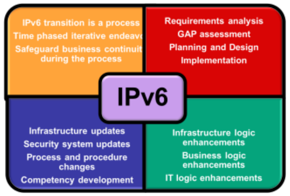
- – Presentations covering industry trends
- – Case studies including lessons learned and caveats

Situational analysis and requirements elicitation

- – Review of overall market-specific business context and drivers for IPv6
- – Preliminary assessment of existing network infrastructure: architecture, deployed components and systems
- – Preliminary assessment of business logic systems, applications, and services
- – Review of IT and network operations management
- – Review of security management

Development of strategic IPv6 roadmaps





IPv6 Assessment

Detailed assessment of network capabilities and systems

- Hardware, software, associated management tools

Identification of business and technical drivers for IPv6 transition

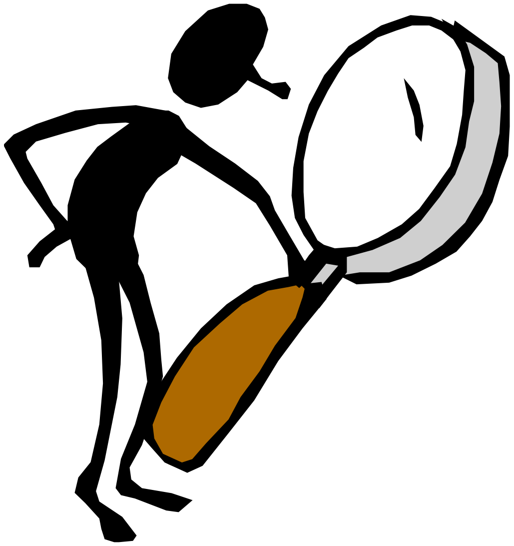
Detailed assessments and compliance analysis

- Site survey, network logic, business logic, security management and compliance, evolution plans

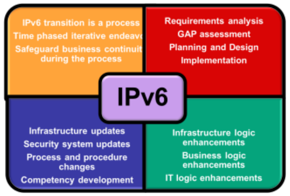
Education and competency development

- Benefits, industry directions, standards, compliance, vendor roadmaps

Training, reports on IPv6 readiness findings, detailed transition roadmaps



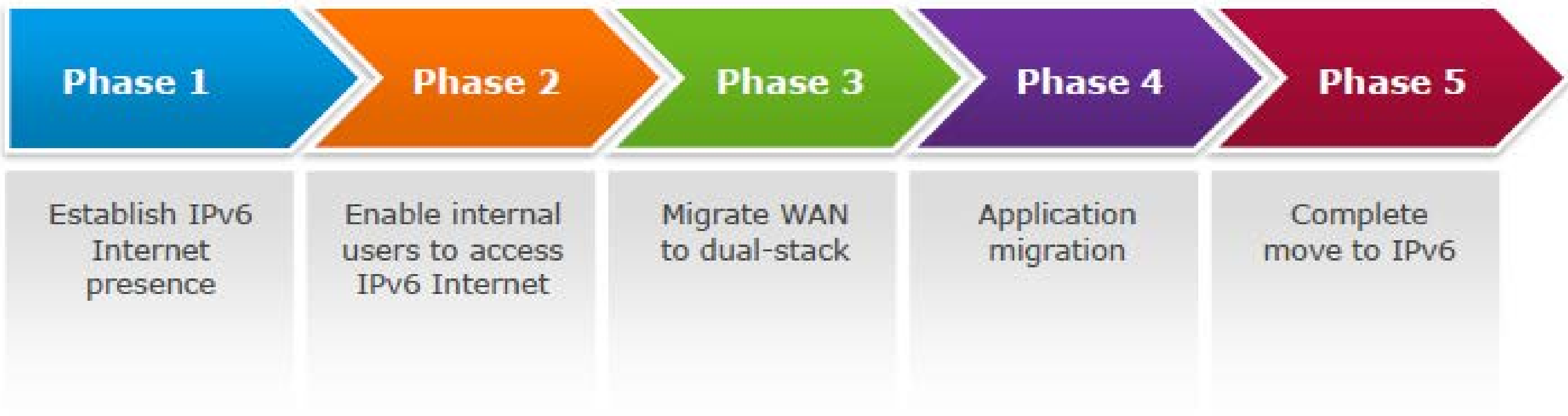
IPv6 Planning



A comprehensive, enterprise-wide migration strategy

- Provide vertical-specific industry analysis and best practices
- Identify technologies and develop a target compliant architecture
- Develop a POC lab simulation environment prior to migration
- Define IP addressing framework, automated tools, management processes
- Develop detailed project management plan
- Develop detailed pre and post-migration test plans and success criteria
- Recommend migration paths for non compliant network devices
- Develop the detailed implementation plan and related documents
- Provide education, coaching, and training

IPv6 Transition Technologies



Have a Report Card

Report Card	PASS/ FAIL/Document
Define IPv6 support levels for infrastructure components	
Baseline existing server, application, and infrastructure (DNS, routers, etc) elements for key KPI’s	
Deploy Infrastructure on IPv6	
Perform IPV6 infrastructure “internal move”	
Perform IPv6 infrastructure “external move”	
Connect and test external IPv6 connections	
Define items that will never support IPv6	
Failover testing of the management modules	
Failover testing of the network switches	

Report Card	PASS/ FAIL/Document
Device activation	
Zero Downtime Upgrades	
Baseline core network elements before and after	
Datacenter upgrades	
Increased infrastructure to administrator ratio	
Reduced deployment times	
Infrastructure cost savings	
Labor cost savings	
Centralized management of IPv6infrastructure	

IPv6 Design Motto

Go Native where you can!

Tunnel where you must!

Reality is Dual Stack

Tunneling Issues

Latency

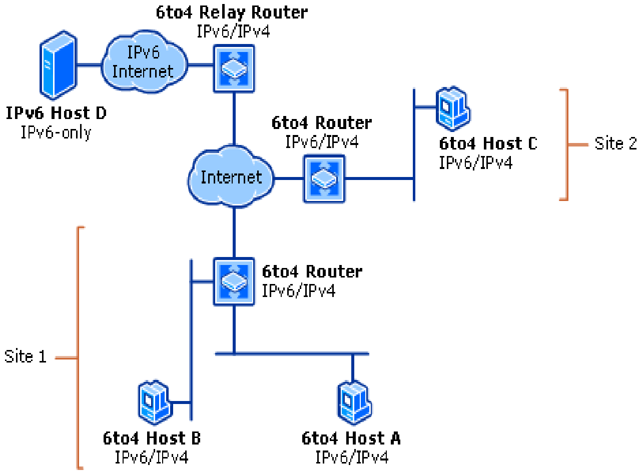
Where are the tunnel endpoints

Distant 6to4 relays

Broken Teredo servers

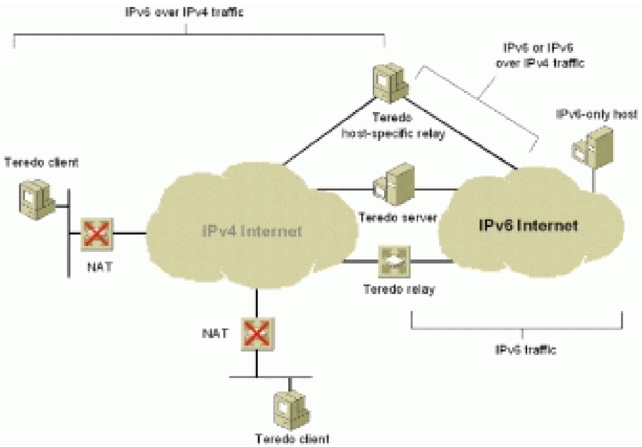
6to4 Tunneling

- 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



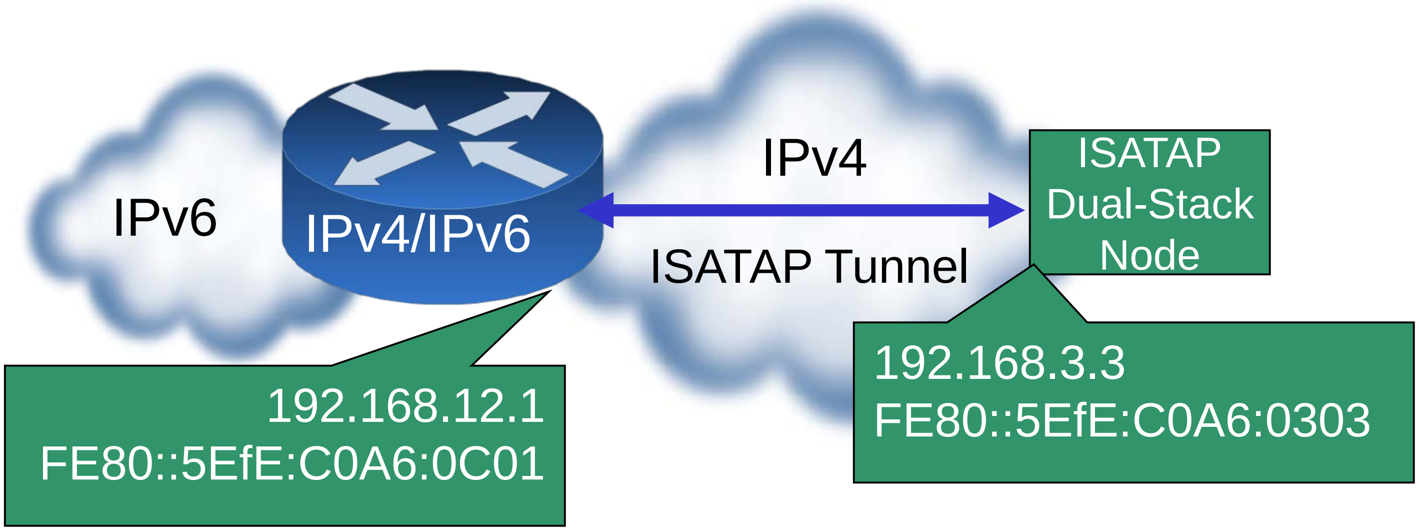
Teredo

- 6to4 tunnels requires the tunnel end point public IPv4 address…..so for many that m NAT device…Many NAT devices cannot b 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 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]



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)

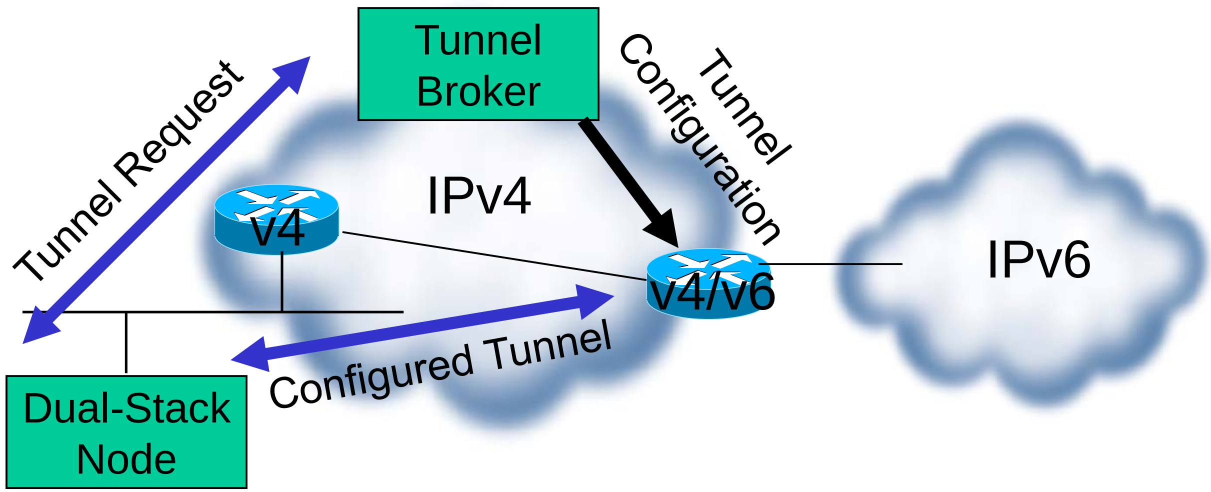
IP packets and ICMP messages are translated between IPv4 and IPv6 with temporary assignments of IPv4 addresses creating a one-one mapping

Upside: Does not require state detail to be maintained

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

IPv6 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



IPv6 Design Mistakes

Assuming you need feature parity – you want functional parity

Assuming you need your entire network running IPv6

Assuming that your existing security, logging and monitoring products support IPv6

Challenges
Managing and monitoring transition services

Inconsistent advice from vendors

IPv6 Transition Plan

Physical and logical implementations of the developed IPv6 transition plan

Detailed project management of every aspect of implementation and Management

- Physical installations
- Device configurations
- Execute pre and post-test plans
- Documentation
- Design and configurations procedures
- Fine-tune network elements

IPv6 Security

Hardware: Routers, servers, switches, firewalls, etc.

Software: Applications, tools, scripts, databases, etc.

Documentation: Policies, procedures, best practices

Access Control: Authentication, Authorization, Accounting

Forensics: preservation of evidence, data privacy protection

Business and Legal (SOX, HIPPA, GLB, etc)

Business Continuity

IPv6 Security Types of Attacks

Layer 1: (primarily physical) wiretapping, tapping, console access, rogue devices, etc.

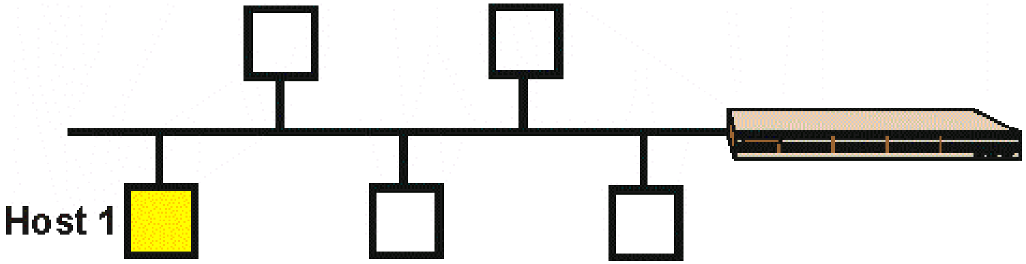
Layer 2 attacks: VLAN "hopping"; MAC, DHCP, ARP, spoofing; …..

Layer 3: IP spoofing, DoD/DDoS, routing, smurf, tunneling, translation, transition

Layer 4-7: viruses, worms, application, rogue software, Man in the Middle

All Layers
reconnaissance, unauthorized access
sniffing

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

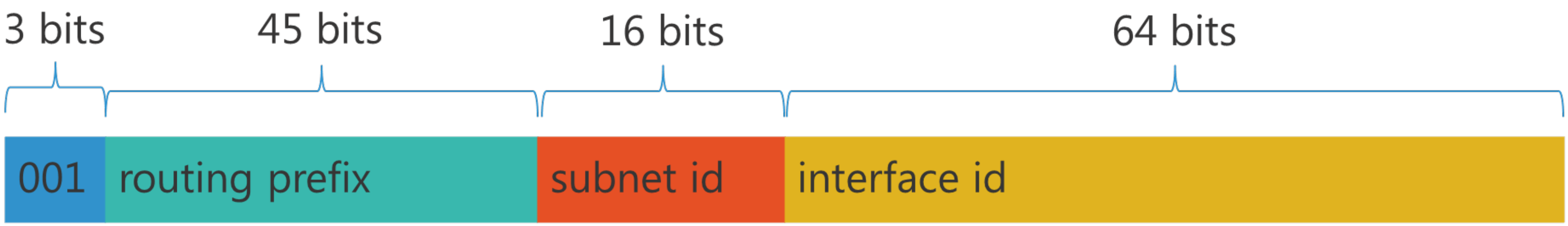
Host 1 multicasts a router solicitation message to all routers

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

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!!	

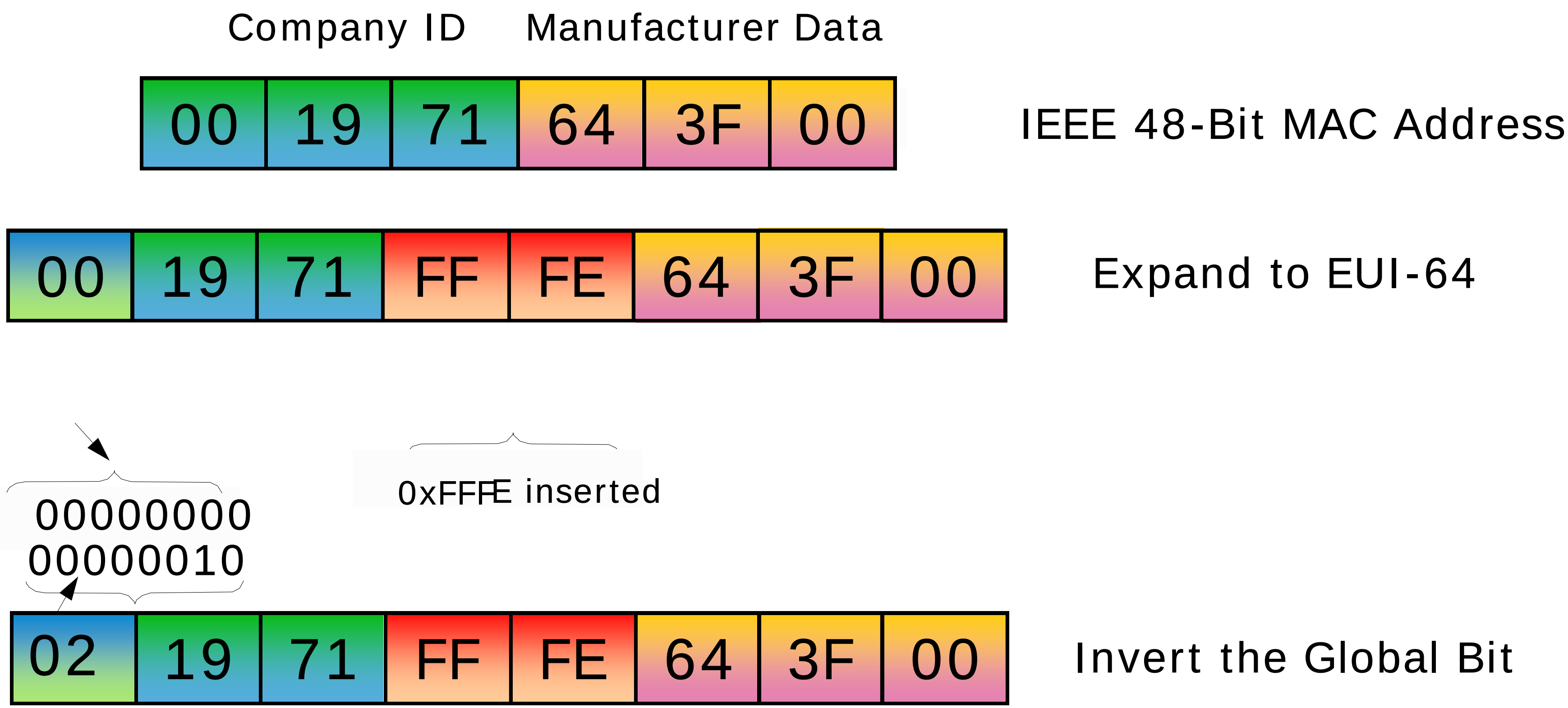
Korea: 2001:0200 – 099F
ATT: 2001:0408/32
Verizon: 2001:0506:0000/48

Getting an IPv6 on a System

In IPv6 world, most user workstations will get IPv6 addresses from state-less address auto configuration, or SLAAC. SLAAC runs on a router (not on a separate DHCP server), and as you might expect from the name, the IPv6 addresses that one gets via SLAAC are not maintained in a table anywhere (no "state" gets created when an IPv6 address is assigned via SLAAC).

So how does the router know that it won't accidentally give you the same address as someone else (e.g., assign a duplicate address) if it doesn't keep track of who it has given an address to? Answer: it derives the address it gives you from something only you have, namely the MAC (hardware ethernet) address of your NIC

Interface ID from MAC



0219:71FF:FE64:3F00 Interface ID

IPv6 Privacy Address

“The whole world will know my unique and unvarying hardware MAC address! Evil marketers will track and correlate my every move wherever I may connect my IPv6 device based on my MAC address! This is worse
than cookies!”

True (especially the evil marketers bit).

This concern spawned another type of IPv6 address, so-called RFC3041 Privacy Addresses. These addresses effectively use a random address for the low order 64 bits of the IPv6 address, instead of a value derived from the host’s MAC address. We may also change those addresses from time to time.

Selecting/Deselecting Privacy Addresses

Windows: privacy addresses are **enabled** by default when IPv6 is enabled on Windows XP. To disable them, see the next slide.

Macs: privacy addresses are **disabled** by default.
To enable them:
sysctl net.inet6.ip6.use_tempaddr=1

Linux: like Macs, privacy addresses are disabled by default. To enable them:
sysctl net.ip6.conf.all.use_tempaddr=2
sysctl net.ip6.conf.default.use_tempaddr=2
Periodically recheck your assigned addresses if this is a big deal for you, and remember, this is NOT life-and-death privacy, it is just “something-to-make-life- hard(er)-for-intrusive-marketers”-grade privacy.

Enabling IPv6 on Systems

Automatic enablement

Usually IPv6 preffered

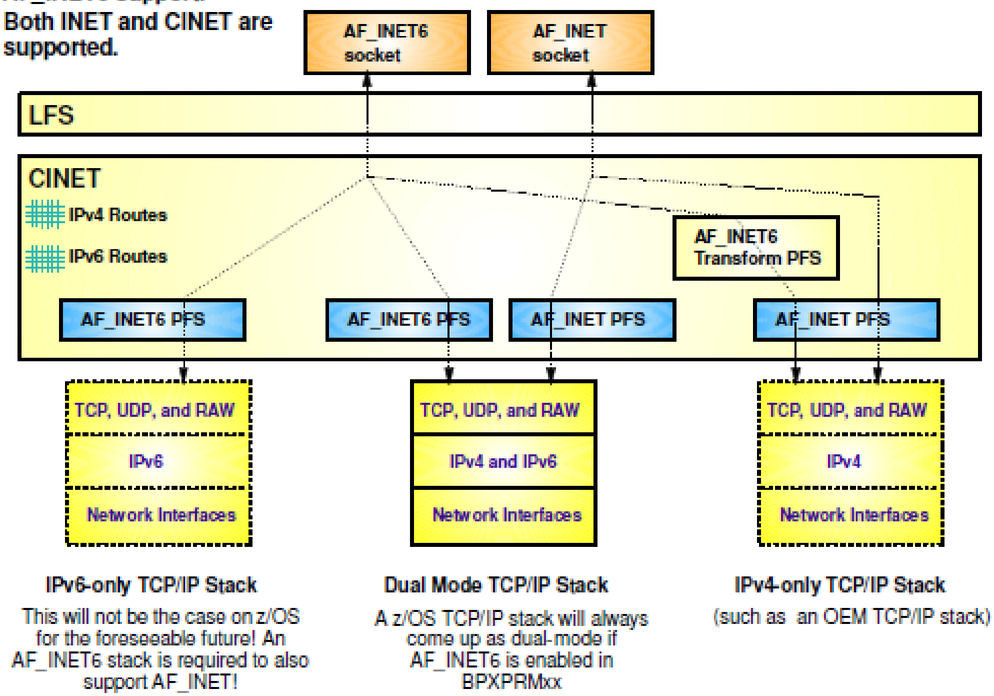
```
Wireless LAN adapter Wireless Network Connection 2:

   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
```

Enabling IPv6 on z/OS

IPv6 is enabled at an LPAR level via an option in BPXPRMxx to enable AF_INET6 support.

Both INET and CINET are supported.

When IPv6 is enabled, a z/OS TCP/IP stack will always have an IPv6 Loopback interface. You can define real IPv6 interfaces in addition to the loopback interface.



- Existing AF_INET sockets programs will continue to work as they always did - no difference in behavior or support.
- AF_INET6 enabled sockets programs will be able to communicate with IPv4 partners (just as before they were changed to support IPv6), but in addition to that they will also be able to communicate with IPv6 partners.

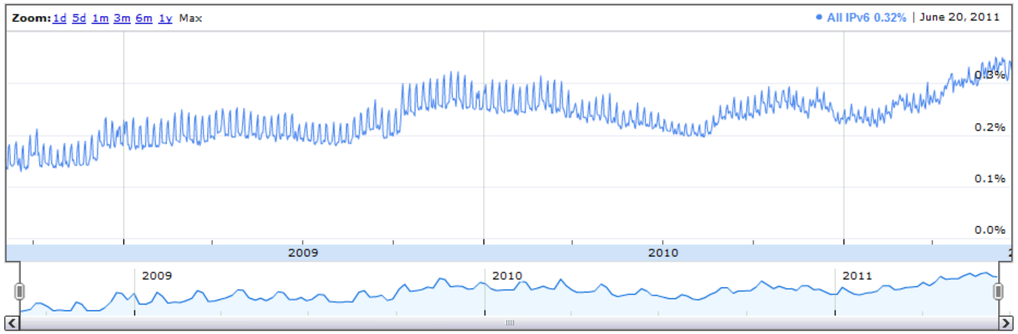
IPv6 Address in Linux

```
% ifconfig -a
eth0      Link encap:Ethernet  HWaddr 00:09:3D:13:FC:F7
          inet addr:128.223.142.32  Bcast:128.223.143.255  Mask:255.255.254.0
          inet6 addr: 2001:468:d01:8e:209:3dff:fe13:fcf7/64 Scope:Global
          inet6 addr: fe80::209:3dff:fe13:fcf7/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:1187468996 errors:0 dropped:1805 overruns:0 frame:0
          TX packets:1338373204 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:232065679216 (216.1 GiB)  TX bytes:915094219311 (852.2 GiB)
          Interrupt:185
[snip]
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:8143461 errors:0 dropped:0 overruns:0 frame:0
          TX packets:8143461 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:4295055907 (4.0 GiB)  TX bytes:4295055907 (4.0 GiB)
```

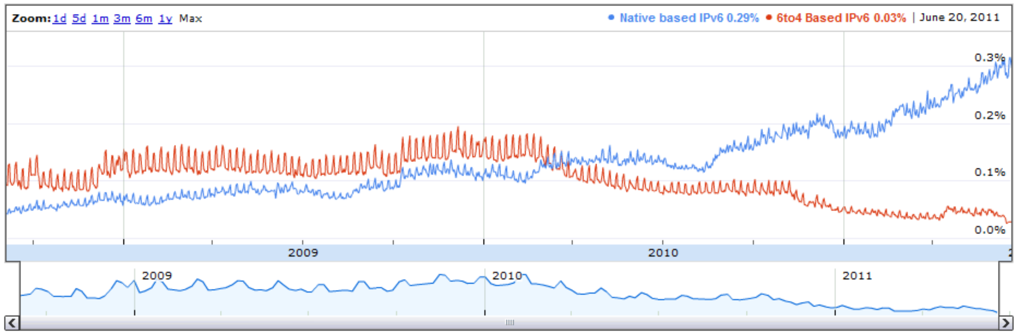
IPv6 Address on MAC OS X

```
% ifconfig -a
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
        inet6 ::1 prefixlen 128
        inet6 fe80::1 prefixlen 64 scopeid 0x1
        inet 127.0.0.1 netmask 0xff000000
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        inet 128.223.214.23 netmask 0xfffffe00 broadcast 128.223.215.255
        inet6 fe80::203:93ff:fecf:b638 prefixlen 64 scopeid 0x4
        inet6 2001:468:d01:d6::80df:d617 prefixlen 64
        ether 00:03:93:cf:b6:38
        media: autoselect (1000baseTX <full-duplex>) status: active
        supported media: none autoselect 10baseT/UTP <half-duplex> 10baseT/UTP
      <full-duplex> 10baseT/UTP <full-duplex,hw-loopback> 100baseTX <half-duplex>
      100baseTX <full-duplex> 100baseTX <full-duplex,hw-loopback> 1000baseTX <full-
      duplex> 1000baseTX <full-duplex,hw-loopback> 1000baseTX <full-duplex,flow-
      control> 1000baseTX <full-duplex,flow-control,hw-loopback>
[etc]
```

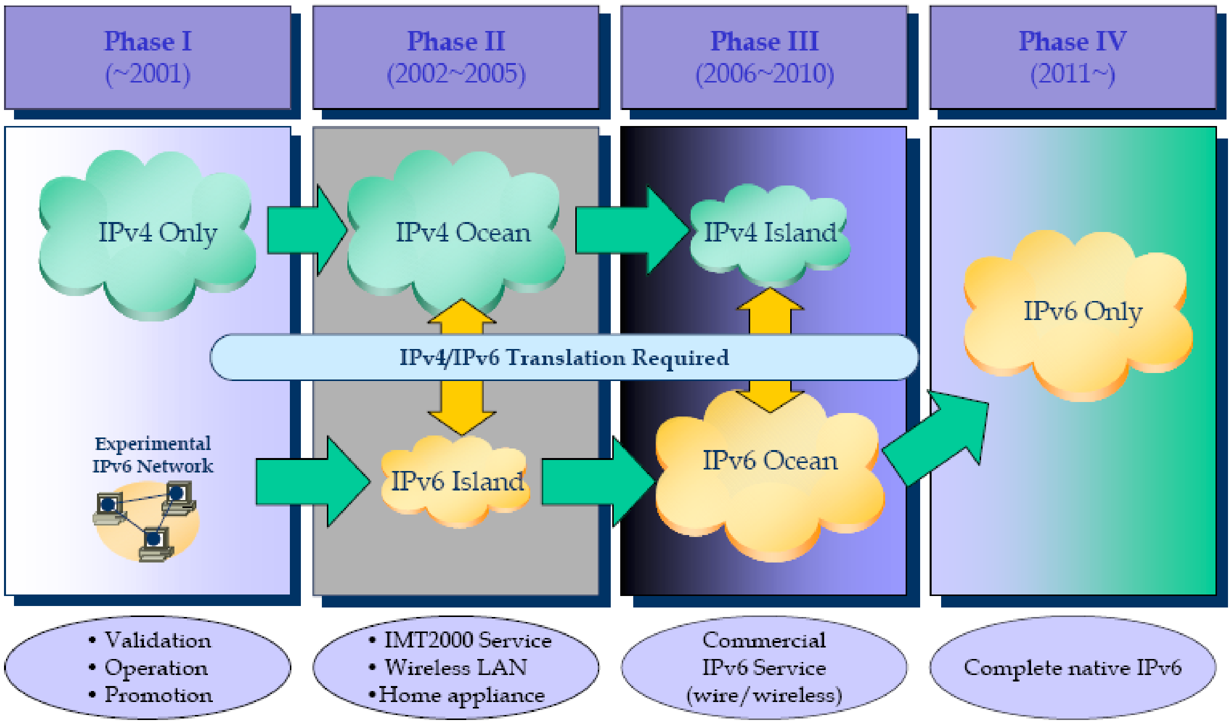
Google IPv6 Statistics



This is the Native IPv6 vs. 6to4/Teredo graph and shows what connectivity method is used by users. More connectivity is now native than before.



IPv6 Transition Roadmap – Leading Korean ISP



Expanded with country wide support services
6NGIX provides exchange among ISPs
Korea dvanced Network providing IPv6 for orgnizations now
By end of 2009 3 new ISPs moving to IPv6 backbones
Public Sector transition planned for 2011

Implementation Snapshot

Acquire Provider Independent IPv6 space

Do native IPv6 peering or use a tunnel service

Get external firewall and external routing working

Trial public IPv6 with external DNS and Mail

Evaluate transition services as needed

Test your applications in a lab

Get internal IPv6 routing, DNS & DHCP working

Dual stack your servers

Provide dual stack to your workstation vlans

Deploy VPN dual stacked

Vielen Dank

Köszönettel

QUESTIONS?

Obi

Спасибо

ขอบคุณ

شكراً

Bedankt

Gracias

Ευχαριστώ

شكرا

धन्यवाद

THANK YOU

Merci

Díky

Grazie

Danke

Hvala

תודה

ありがとうございました

Merci

ขอบคุณ

Teşekkürler

धन्यवाद
Hindi

Gracias

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감사합니다

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Tamil

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Obrigado

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