IPv6 Introduction and Drivers

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IPv4 Deficiencies

• It’s hard to argue with success
• However, IPv4 has its fair share of problems
  – Address space limitations
  – Inadequate address aggregation mechanisms
  – Ballooning BGP databases (especially with multi-homing)
  – Router memory exhaustion
  – Increased forwarding table look up time
  – No inherent security
  – Inadequate support for mobility
• IPv4 address space will be fully allocated in the 2011 timeframe
  – IPv4 Address depletion driving IPv6 adoption
  – <15% of IPv4 address space remains
Why NAT is BAD?

• NAT has to be used with IPv4 because there isn’t enough address space for all IP nodes
• NAT is not an optimal solution for Internet communications
• NAT breaks the end-to-end model
  – Lack of peer-to-peer model
  – Growth of NAT has slowed down growth of transparent applications
• No easy way to maintain states of NAT in case of node failures – firewall failover of NAT state
• Troubleshooting with NATs adds complexity
• NAT break security (IPSec)
  – NAT allows for anonymity on the Internet and thus creates an environment for hackers hiding behind NATs
• NAT complicates mergers/acquisitions, double NATing is often needed for devices to communicate with each other
IPv6 Header

IPv4 Header 20 bytes

IPv6 Header, 40 bytes fixed

Legend
- field’s name kept from IPv4 to IPv6
- fields not kept in IPv6
- Name & position changed in IPv6
- New field in IPv6
Increased IPv6 Addresses

• IPv6 Increased Src/Dst Address to 128 bits
• $2^{128} = 34 \times 10^{37}$
  340,282,366,920,938,463,463,374,607,431,768,211,456 addresses (~340 undecillion)
• If each IP address equaled one gram
  – IPv4 would be 1/76th the weight of the Empire State Building
  – IPv6 would be 56.7 billion X the Earth’s weight
• 67 billion billion (6.65 X 10^{23}) addresses per cm² of the Earth’s surface
• 1246 IPv6 addresses per square meter of the area of the Milky Way galaxy
• That ought to be enough!
Future IPv6 Applications

- Car manufacturers – 1 billion cars by 2010 (even just 15% of them means 150 million addresses)
  - GPS and Yellow Page Services
- Home appliances (toaster, dishwasher, video, …)
  - Autoconfiguration is needed for these embedded devices
- IPv6 address in every mobile phone, PDA, MP3 player
- Demand for peer-to-peer & multimedia applications
  - Presence applications tying together IP, VoIP, mobile phone, e-mail
  - VoIP – IPv6 address for every phone
- Always-on broadband Internet access
- Coordination of battlefield operations without NAT requires IPv6
  - DOD pushing for IPv6 systems to support their global operations
- Large sensor networks – many tiny sensors with IPv6 capability
- Internet in every School – unique IPv6 address for every student
- Power industry and agricultural applications of IP
- China, India, Japan, Russia, Asia, South America, Africa
  - Lots of people and registries weren’t granted large IPv4 blocks
Vendor IPv6 Products

• Operating Systems
  – Windows 2k, XP, 2k3, Vista, Server 2k8, Windows 7
  – Linux, FreeBSD, Solaris 8-11, HP-UX, Tru64
  – IBM AIX, i5/OS, OS/390, z/OS, AS400s
  – MacOS X 10.2 (Jaguar) through 10.5 (Leopard)

• Current IPv6 Applications
  – ping, traceroute, DNS, DHCPv6, E-mail, SIP, NFS, FTP, Telnet, SSH, IIS, Apache, SMTP, NetFlow, SNMP, NNTP, IRC, Syslog, Printing, IPAM, IPSec, NTP, VLC, protocol analyzers, …
Vendor IPv6 Products

• Routers and Switches
  – Juniper, Cisco, Brocade, Extreme, Huawei, ...
• Server Load Balancers
  – F5, Brocade, Citrix
• IP-based cameras
• Printers
• Mobile phones
IPv6 Internet Exchange Points

- PAIX(Switch and Data): 6 locations nationwide
- MCI MAE: WashDC, San Jose, Chicago, Dallas, Frankfurt, Paris
- CRG West: Los Angeles
- NY6IX: New York
- S-IX: NTT San Jose
- Telx Phoenix
- 6TAP: Chicago (Canarie, Viagenie, ESNet)
- 6ix: Telehouse - NY, LA, Santa Clara
- 6TAP: Chicago
- XchangePoint: London
- AMS-IX: Amsterdam NL
- INXS: Munich/Hamburg DE
- ECIX: Hamburg DE
- DE-CIX: Frankfurt DE
- FICIX: Helsinki
- TREX: Tampere
- UppRIX: Uppsala SE
- NaMeX: Rome
- FNIX6: Paris
- 6NGIX: Seoul, South Korea
- NSPIXP-6: Japan
- JPIX: Japan
- SIX: Singapore
- KIXP: Kenya

IPv6-Enabled Service Providers

- Service providers are slowly to creating IPv6 capabilities
  - NTT America/Verio, TWTC, Sprint, Verizon, SAVVIS, Hurricane Electric (US)
  - Bouygues Telecom, Free (France)
  - BT, AAISP (UK)
  - Tata (worldwide, India)
  - BahnHof AB, Fredan (Sweeden)
  - XS4All, BIT BV, Danske Telecom (Dutch)
  - M-Net (Germany)
  - Internode (Australia)
  - IIJ, NTT, KDDI, JENS, Japan Telecom
IPv6 Research and Organizations
**IPv6 Adoption in Organizations**

- Government-Sponsored adoption in Asia
  - 2008 Summer Olympic Games in Beijing
  - China's Next Generation Internet project (CNGI)
  - Japan IPv6 Promotion Council
- Content providers are beginning to migrate (IPv6.google.com, few others)
- Enterprises migrating (Bechtel, Cisco)
IPv6 Adoption in U.S. Federal Organizations

- 2003 DOD Mandate: John Stenbit, John Osterholz (DOD CIO) delivered a presentation at the Global IPv6 Summit.
- Started Moonv6 and UNH IOL testing.
- 2003 Started IPv6 procurement guidelines.
- 2004 DOD Transition Office formed (DITO).
- 2005 ASD-NII mandates JITC test and create the DoD's Unified Capabilities Approved Products List (UC APL) for IPv6 – creation of DoD’s IPv6 Profile.
- 2006-2007 Quarterly reports from Government agencies to OMB – most organizations set up simple testbeds.
- June 2008 – IPv6 Capable ≠ IPv6 Enabled
  – Test networks turned down for fear of IPv6 security issues.
IPv6 Advantages

- Added addresses
- Stateless Autoconfiguration
- Simplifies routing – fewer header fields
- Supports IPSec natively
- Improved Mobile IP support
- QOS support – flow label potential
- Native Multicast
- Includes Anycast
- Many transition mechanisms
- Extensible
**IPv6 Challenges**

- New equipment upgrades
- “Touch” all network devices
- Dual-stacking will increase CPU and memory utilization
- Performance issues with equipment that is optimized for IPv4 but not IPv6
- Possible new software upgrades
- Additional capital expenditures
- Overhead caused by maintaining IPv4 and IPv6 routing tables, firewalls, DNS servers, etc.
- Requires a migration plan
Summary

- An IPv6 transition is already underway in the Federal Government and other parts of the world.
- IPv6 infrastructure and Host OSs are ready now!
- Cisco is a leader in IPv6 and has a full-set of IPv6 products
- Much of the infrastructure you have already purchased is IPv6 capable, it’s just a matter of enabling (software upgrade)
- GTRI can assist with transition planning
  - Perform your assessment
  - Create a migration strategy
  - Create a test lab or leverage other test labs and start experimenting.
  - Dual Stack some of your systems
  - Test DNS and focus on your other applications
- The sooner we begin the transition, the sooner we will be done.
Questions and Answers

Q:

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A:

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