GTRI
GLOBAL TECHNOLOGY RESOURCES INC.

Rocky Mountain IPv6 Summit

Rocky Mountain IPv6 Task Force
RMv6TF

IPv6 Introduction and Drivers

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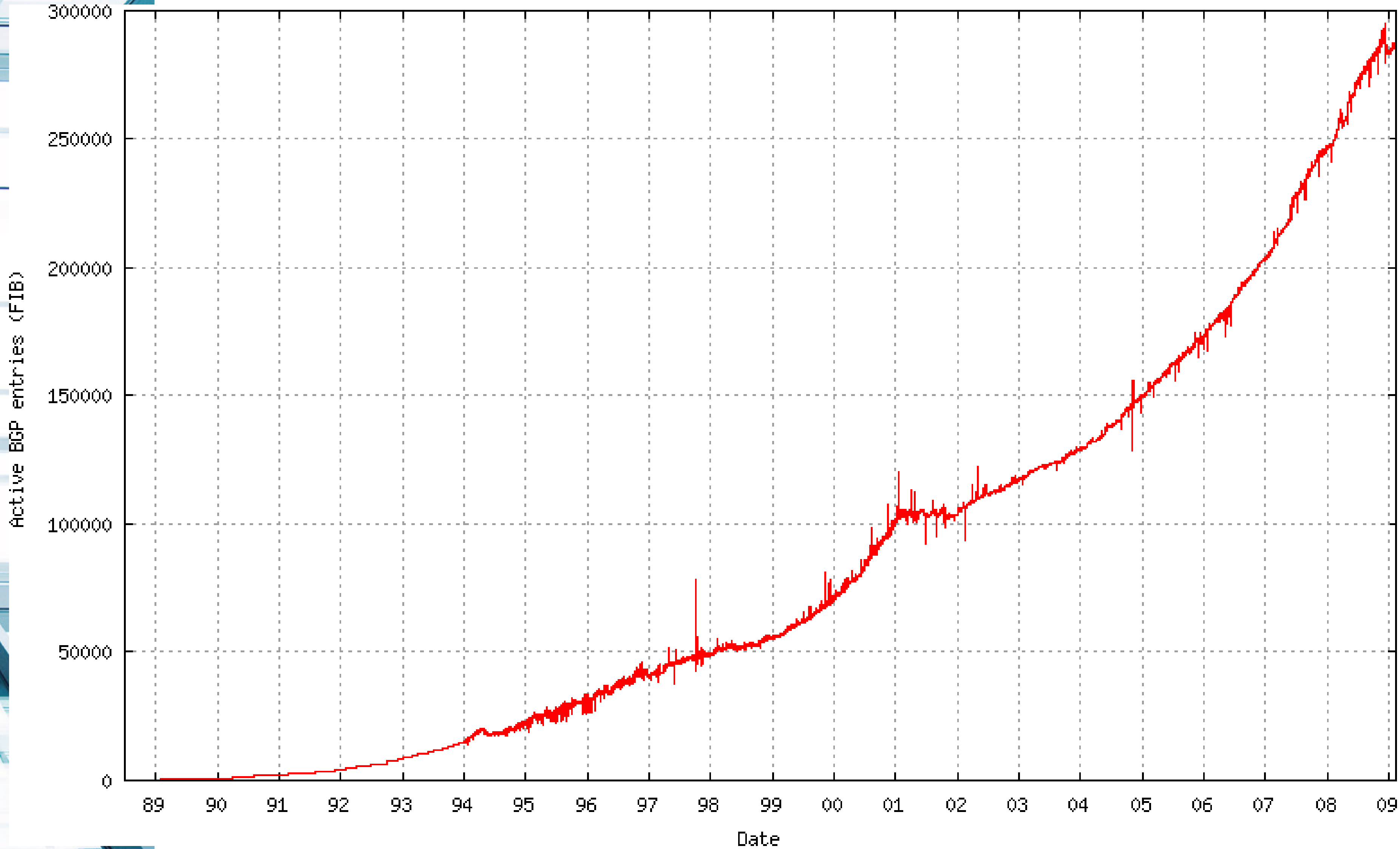
IPv4 Deficiencies

- 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

Current IPv4 BGP Database

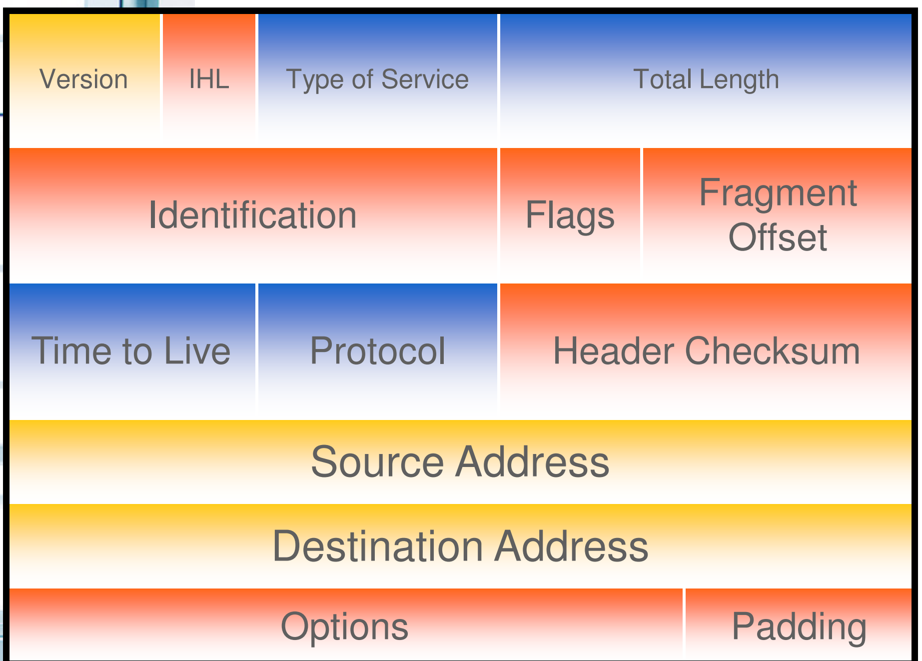


Why NAT is BAD?

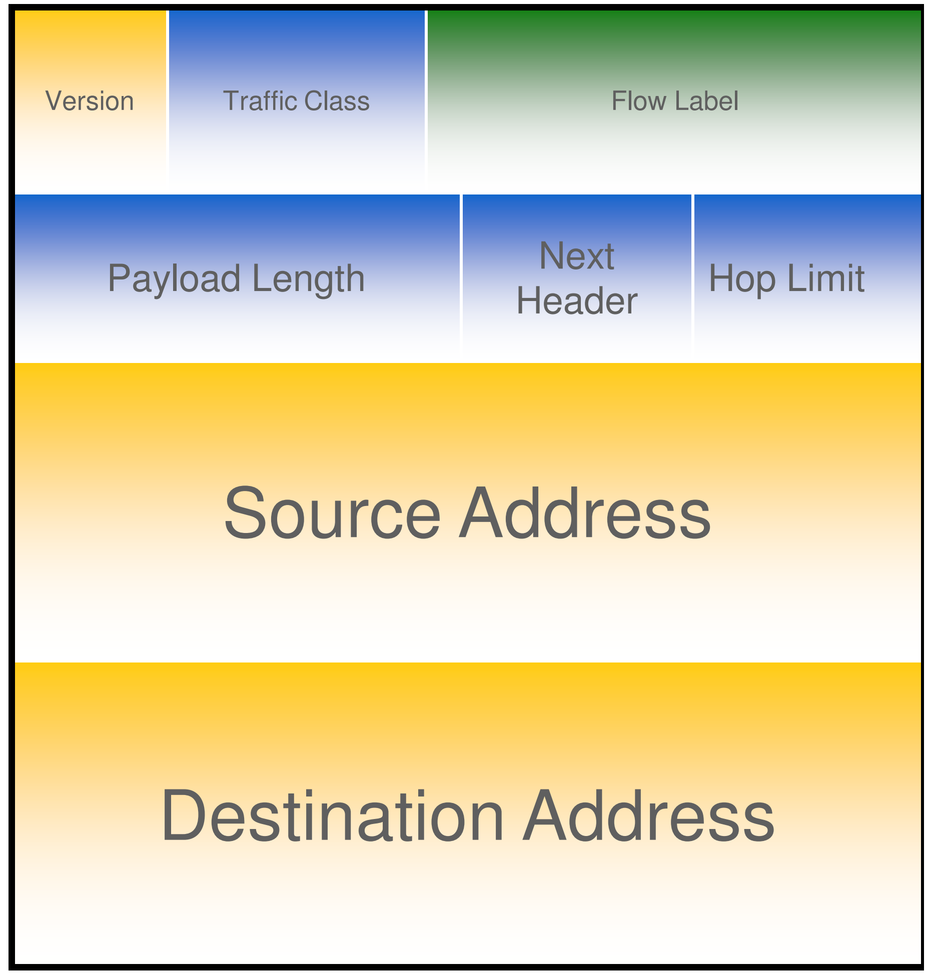
- NAT has to be used with IPv4 because there isn't enough address space for all IP nodes
- NAT is not an optimal solution for Internet communications
- NAT breaks the end-to-end model
  - Lack of peer-to-peer model
  - Growth of NAT has slowed down growth of transparent applications
- No easy way to 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 = 34X1037 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 1023) 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, …

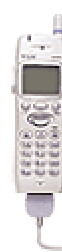
Vendor IPv6 Products

- Routers and Switches
  - Juniper, Cisco, Brocade, Extreme, Huawei, …
- Server Load Balancers
  - F5, Brocade, Citrix
- IP-based cameras
- Printers
- Mobile phones

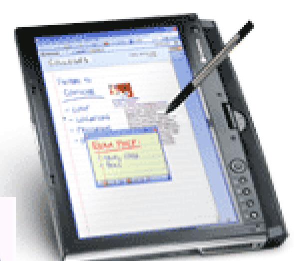













IPv6 Internet Exchange Points

- 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)
- 6iix: 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
    - ipv6.beijing2008.cn   ipv6.beijing2008.cn/en
  - 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 presentation at the Global IPv6 Summit
- Started Moonv6 and UNH IOL testing
- 2003 Started IPv6 procurement guidelines
- 2004 DOD Transition Office formed (DITO)
- 2005 GAO Report d05471
- 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
- 2005 OMB Mandate – Memo M-05-22
- 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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