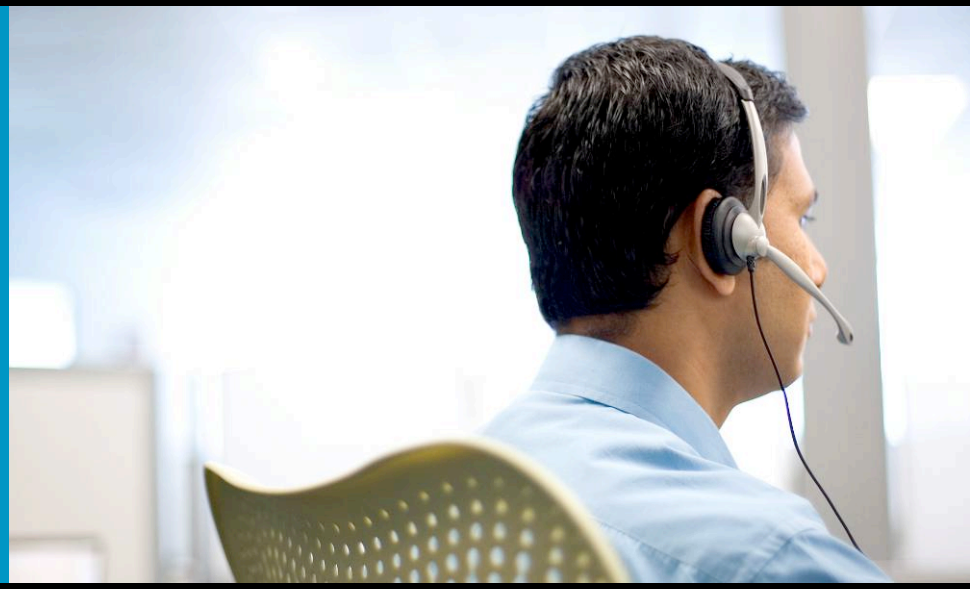
IPv6 – A Global Perspective



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AfriNIC 5

Mauritius

27th Nov – 1st Dec

Early Internet History

- Late 1980s
  - Growth of the early Internet
- 1991-1992
  - Running out of “class-B” network addresses
  - Rapid growth of the “default-free” routing table
  - Imminent exhaustion of 32-bit address space
- Two efforts – short-term versus long-term
  - More at “The Long and Winding ROAD” http://rms46.vlsm.org/1/42.html

Early Internet History

- CIDR and Supernetting proposed in 1992-3
  - Deployment started in 1994
- IETF “ipng” solicitation – RFC1550, Dec 1993
- Direction and technical criteria for ipng choice – RFC1719 and RFC1726, Dec 1994
- Proliferation of proposals:
  - TUBA – RFC1347, June 1992
  - PIP – RFC1621, RFC1622, May 1994
  - CATNIP – RFC1707, October 1994
  - SIP – RFC1710, October 1994
  - NIMROD – RFC1753, December 1994
  - ENCAPS – RFC1955, June 1996

Early Internet History

- Other activities included:
  - Development of NAT, PPP, DHCP,…
  - Some IPv4 address reclamation
  - The RIR system was introduced
  - → Brakes were put on IPv4 address consumption
- IPv4 32 bit address = 4 billion hosts
  - 29.5% address space still unallocated (11/2006)
  - HD Ratio (RFC3194) realistically limits IPv4 to 250 million hosts

Recent Internet History
The “boom” years → 2001

- IPv6 Development in full swing
  - Rapid IPv4 consumption
  - IPv6 specifications sorted out
  - Transition mechanisms developed
- 6bone
  - Experimental IPv6 backbone sitting on top of Internet
  - Participants from over 100 countries
- Early adopters
  - Japan, Germany, France, UK,…

Recent Internet History
The “bust” years: 2001 → 2003

- The DotCom “crash”
  - i.e. Internet became mainstream
- IPv4:
  - Consumption slowed
  - Address space pressure “reduced”
- Indifference
  - Early adopters surging onwards
  - Sceptics more sceptical
  - Yet more transition mechanisms developed

2004 → Today

- Resurgence in demand for IPv4 address space
  - Exhaustion predictions range from wild to conservative
  - …but 2011-ish seems realistic at current rates
  - …but what about the market for address space?
- Market for IPv4 addresses:
  - Creates barrier to entry
  - Condemns the less affluent to tyranny of NATs
- IPv6 offers vast address space
  - The only compelling reason for IPv6

Is there a need for a larger address space?

- Internet population
  - ~600 million users in Q4 CY2002
  - ~945M by end CY 2004 – only 10-15%
  - Future Worldwide population? (~9B in 2050)
- US uses 81 /8s - this is 3.9 IPv4 addresses per person
  - Repeat this the world over…
  - 6 billion population could require 23.4 billion IPv4 addresses
  - (6 times larger than the IPv4 address pool)

Is there a need for a larger address space?

- Other Internet Economies:
  - Japan 7 IPv4 /8s
  - UK 4 IPv4 /8s
  - Korea 3 IPv4 /8s,…
- Emerging Internet economies need address space:
  - China uses more than 94 million IPv4 addresses today (5.5 /8s)
  - Latin America uses only 3 IPv4 /8s
  - India lives behind NATs (using less than half /8)
  - Africa lives behind NATs (using three-quarters of a /8)

Is there a need for a larger address space?

- Mobile Computing introduces new generation of Internet devices
  - PDA (~20M in 2004), Mobile Phones (~1.5B in 2003)
  - Enabled through several technologies, eg: 3G, 802.11,…
- Transportation – Mobile Networks
  - 1B automobiles forecast for 2008
  - Internet access on planes, e.g. Connexion by Boeing
  - Internet access on trains, e.g. Narita express
- Consumer, Home and Industrial Appliances

Is there a need for a larger address space?

- RFC 1918 is not sufficient for large environments
  - Cable Operators (e.g. Comcast - NANOG37 presentation)
  - Mobile providers (fixed/mobile convergence)
  - Large enterprises
- Request to increase RFC 1918 private address space was rejected
  - RIR membership guideline is to use global addresses instead
  - This could lead to more pressure on the global IPv4 address space

Service Provider Status

- Many transit ISPs have “quietly” made their backbones IPv6 capable
  - Native is common (dual stack)
  - Tunnels are also still used
  - MPLS has facilitated this transition
  - Deployed as part of infrastructure upgrades
- Examples:
  - Verio/NTT long time IPv6 capable
  - OpenTransit/FT, Teleglobe/VSNL, Telecom Italia, GlobalCrossing, Telefonica, C&W (EU),…
- OCCAID
  - IPv6-only transit ISP effort (linking Asia, N-America, EU)

Services & Applications

- Operating Systems
  - MacOS X, Linux, BSD Family, many SYS V
  - Windows: XP SP2 (hidden away), Vista
  - All use IPv6 first if available
- Applications
  - Browsers, E-mail clients, IM, P2P,…
- Services
  - DNS, Apache WebServer, E-mail gateways,…

Why are we still waiting…?

- That killer application?
  - Internet Gaming or Peer to Peer applications?
  - Windows Vista (?)
- Our competitors?
  - Any network deployed in last 3 years will be IPv6 capable
  - Even if not enabled!
- The end-user should not have to choose protocols
  - Remember “Turbo” button on early IBM PC clones?
- The “Chattering Classes”
  - People looking for problems, not solutions

The On-going Debate (1)

- IPv6 Multihoming
  - Same toolset as IPv4 — long term non-scalable
  - Ultimate Multihoming Solution no nearer discovery
- Early rigid IPv6 address allocation model
  - “One size fits all” barrier to deployment:
    - Only ISPs “should” get IPv6 space from RIRs
    - Enterprises “should” get IPv6 space from ISPs only
  - Routing table entries matter, not the nature of business
    - What is an ISP?

The On-going Debate (2)

- Not every IPv4 device is IPv6 capable
  - Do we really need to replicate all IPv4 capability in IPv6 prior to considering deployment?
- “We have enough IPv4”
  - Those with plenty denying those with little/nothing
- Migration versus Co-existence
  - Realistically IPv6 and IPv4 will co-exist for many years
  - Dual-stack operating systems and in network equipment makes this trivial

IPv6 Geo-Politics

- Long term global IPv6 “marketing” by IPv6 Promotion Councils and IPv6 Forum
- Per country/region IPv6 Taskforces
  - And more being set up
  - Forming national/regional strategies for IPv6
- Market segments:
  - US Federal mandate: All Federal Agencies must use IPv6 by June 2008
  - Mobile phone industry: 3GPP/3GPP2/MWIF

Conclusion

- “Long and Winding Road”
- More adopters
  - Now is time to plan inclusion of IPv6 in network roll outs
- Remaining IPv4 address space will face market forces soon
- Co-existence, *not* migration!

Further Reading

- Stay up to date:
  - www.ipv6-to-standard.org
  - www.ipv6tf.org