

IPv6 – A Global Perspective

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PacNOG 3

16th-23rd June 2007

Rarotonga

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
 - 24.5% address space still unallocated (06/2007)
 - 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
 - ARIN Board: Resolution in May 2007 which encourages migration to IPv6

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* replacement!

Further Reading

- Stay up to date:

www.ipv6-to-standard.org

www.ipv6tf.org