



Introduction to IPv6 protocol

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Some [IPv4] history first ...

- 1969 : Arpanet Research network for at most 64 networks ~ 100 computers
- 1974-1981 Experiments on first Internet
 - At most 16 M networks (2B Computers)
 - If all were to be globally reachable
- 1983 Experimental Network moved to Research Service
- 1992 : Commercial activity
 - Exponential growth
- 1993 : Exhaustion of the class B address space forecast for few years hence!
 - Work on IPNG (New Generation) started

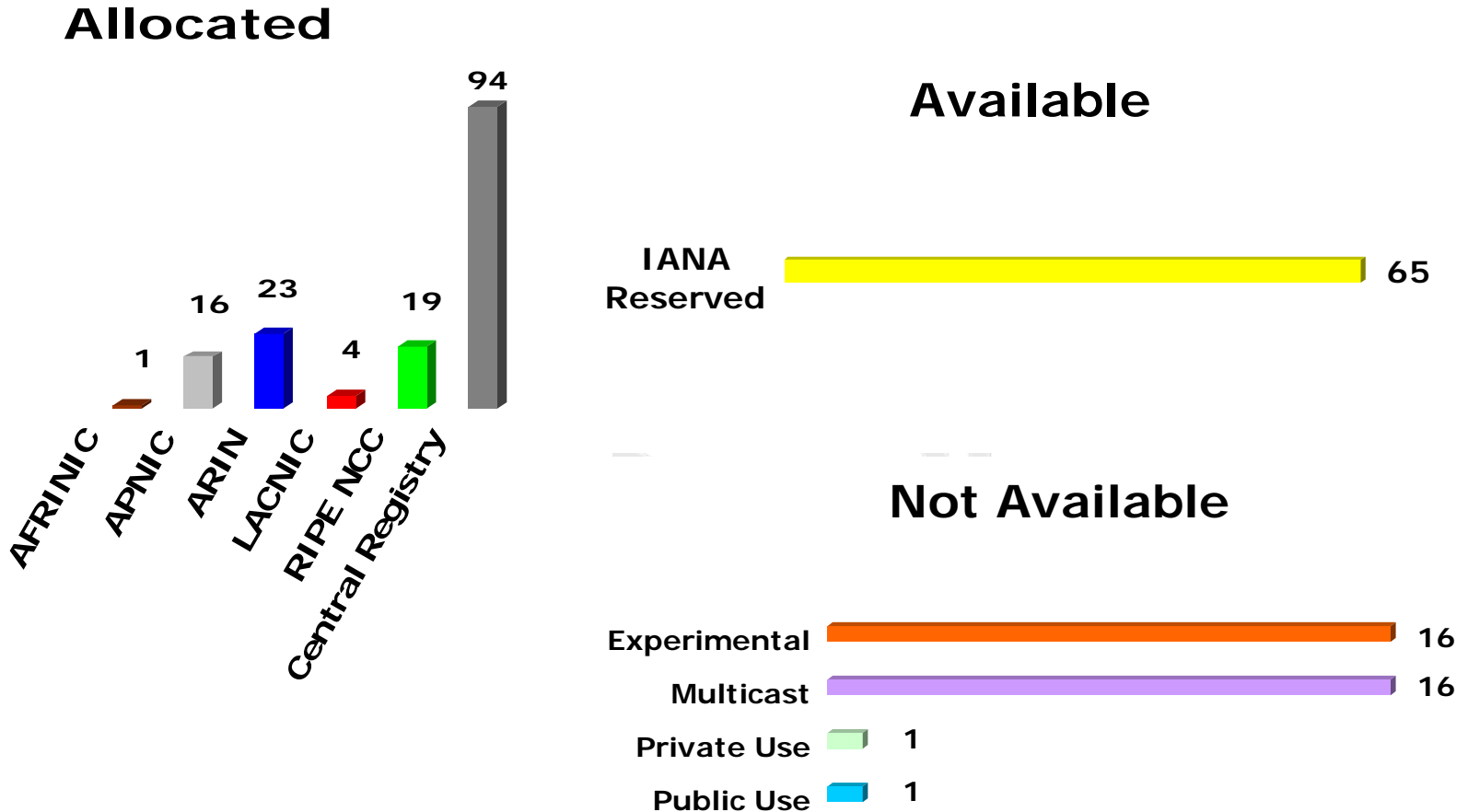


IPv4 Depletion

- Urgency of address space depletion reduced by various mechanisms
 - Reclaiming addresses
 - UCL had class A, 16M computers
 - Using addresses more efficiently (CIDR)
 - Using Net Address Translation (NAT)
 - Being somewhat unfair in global distribution of addresses
- Developed system of IANA/RIR, LIR



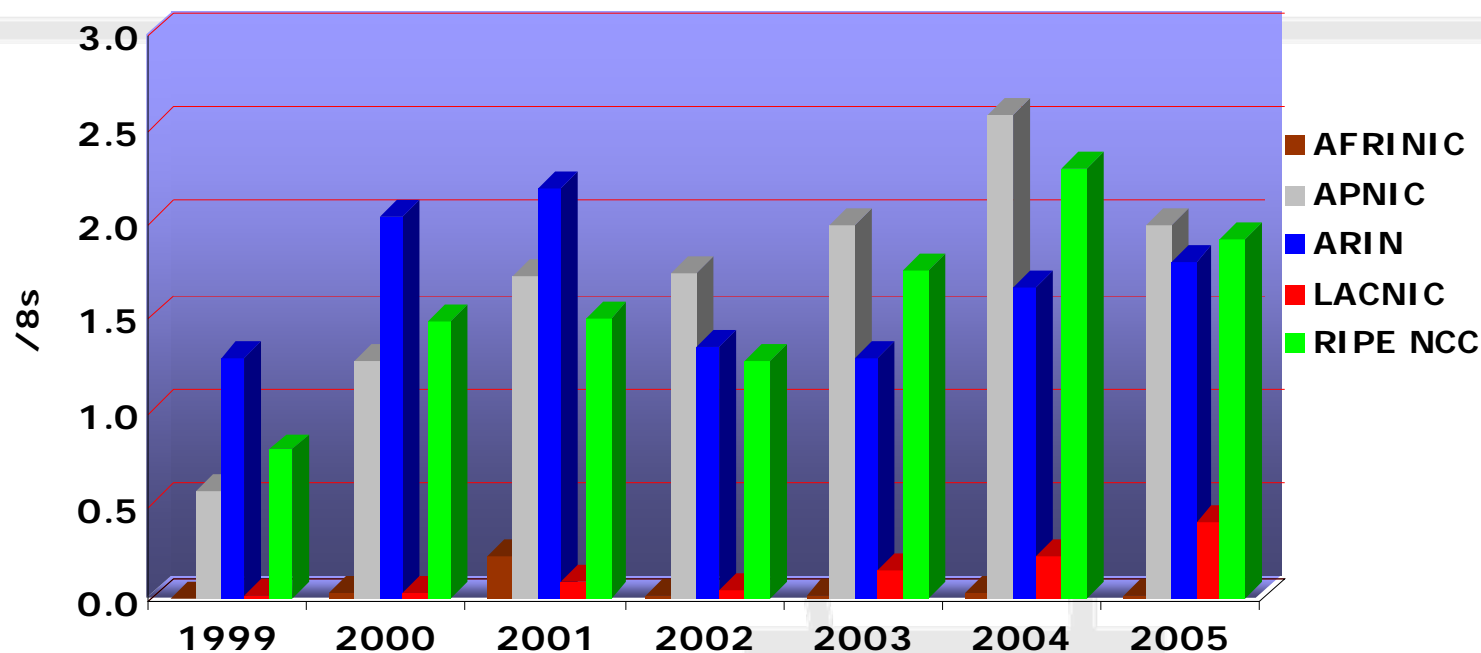
IPv4 /8 Address Space Status



(Statistics updated in September 2005)



IPv4 Allocations from RIRs to LIRs/ISPs

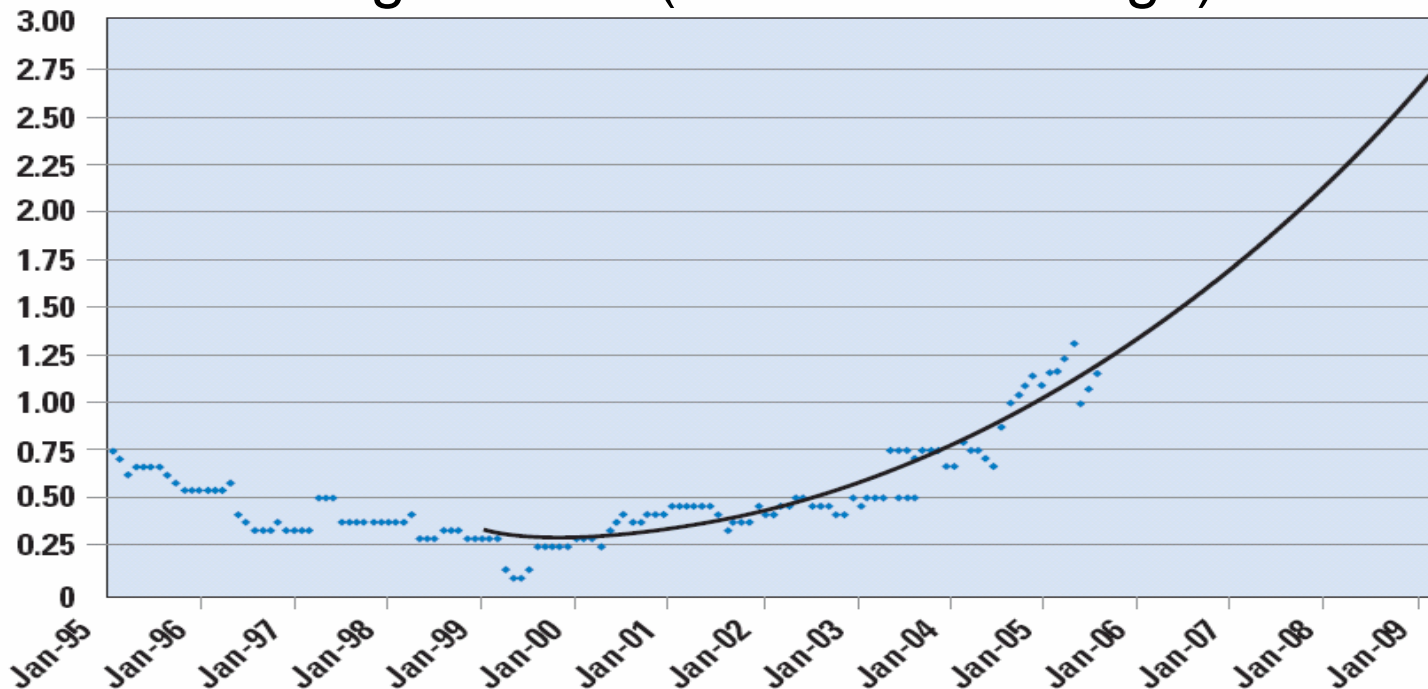


- More info : <http://www.nro.net/statistics/>



Some future IPv4 projections

IANA allocations to RIRs
Sliding window (24-month average)



source: Tony Hain, "The Internet protocol Journal", Vol8, No3, Sept2005



Emergency Measures

- Allocate exceptionally class B addresses
- Re-use class C address space
- *Classless Internet Domain Routing (CIDR)*
 - RFC 1519
 - network address = [prefix/prefix length]
 - less address waste
 - allows aggregation



Emergency Measures (2)

- Private Addresses
 - RFC 1918 (BCP)
 - 10.0.0.0/8, 172.16.0.0/12, 192.168.0.0/16
 - Allow private addressing plans
- Network Address Translation
 - RFC 1631, 2663 and 2993
 - ...but NAT does not scale and breaks end-to-end connectivity



IPv6 Standards

- Main standards ratified by 1998
 - Many had a counterpart in IPv4
- Some, like Mobility, were first designed for IPv4
 - IPv6 versions often designed better
 - Sometimes new features could have gone into IPv4 versions, but did not bother.



So ...

- Emergency measures gave time to develop a **new version** of IP, named **IPv6**
- IPv6 keeps principles that have made the success of IP
- Corrects (?) what is wrong with the current version, aka IPv4
- However, the IPv4 emergency measures gave a necessary time – which is nearly used up.



IPv6 Aims

- IPv6 first motivation was to deal with address depletion
 - Started in 1992/3
- Decided to address other weaknesses in IPv4 implementations
 - Inefficiency of Header Processing
 - Lack of standardisation on mobility, flow control, security, M/c and re-configuration



Advantages of IPv6 Choices

- Many of the improvements in IPv6 could, and often have, been done in IPv4
 - One cannot rely on them existing in IPv4 implementations
- With IPv6 a mandatory set of characteristics were defined
 - Most IPv6 implementations meet the mandatory functions
 - This is required for a “fit for IPv6” approval



Mandatory vs Optional Features

- The early attempts were to have a very rich set of mandatory features
 - Some large players did not want this
- Examples are Mobility Support
 - Mobile phones do it quite differently
- IPSEC security was mandatory
 - Too heavyweight for sensors
 - Not liked by mobile operators
 - Has export control issues



Research Project Phase

- For 1998-2004 many research projects in the US, Europe and Japan
 - DARPA (US) on Multicast and security
 - KAME (FreeBSD implementation) – and later LINUX
 - 6BONE international Overlay
 - 6WINIT IPv6 over wireless etc



Preliminary Implementations

- 2001 – 2005 Most big vendors started to have products – but usually not enabled as a default
 - Some did not really want to take the trouble, but had to when large procurements made this feature a requirement
 - The Japanese government and the US DoD followed this path by 2004;
- Some delayed a little to develop Silicon for speed (e.g. Cisco with VPNs)



2004-2007 True Products

- By 2004, there were serious trial deployments
 - 6NET for the NRENs, followed by GEANT
 - In Euro6IX Telecoms ran Internet Exchanges
 - The vendors and DoD had large MOONv6 testbed in US
 - WIDE had large NREN deployment in Japan
 - CERNET for China



Attitude of Suppliers

- Commercial Computer and Router vendors first slow to take IPv6 seriously
- By 2001 many had a version – but not a production version.
- By 2004, there were versions which could have IPv6 enabled
- By 2007, many have IPv6 enabled as of course



IANA Moves

- IANA feels that address depletion is at most five years out
- Needs some addresses to allow transition
- A recent ARIN proposal suggests (still under discussion):
 - A-date: Date of Announcement of a T-Date - when only 30/8s IPv4 addresses are available
 - T-Date: Date of Termination (of IPv4 address allocation) - when only 10/8s IPv4 addresses are available
- Feels that black market in addresses is already starting to exist
- Feels that commercial pressure will force move

soon

Big Users

- Mobile have agreed to adopt IPv6 (some of it) for UMTS R6 IMS
- Emergency services looking at need for IPv6 for addressing large-scale deployments
 - See RUNES and U2010, but this is not agreed yet
- US GSA has made major study on cost of transition
 - Mandates that government departments must have a policy for its adoption



Current Situation

- It is clear that eventual IPv6 capability is a requirement for many large projects
- DoD has some large projects with IPv6 in production
- There will be a lengthy transition period
 - Transition technology is of vital importance
- Some countries going more rapidly than others
 - Particularly Japan, China



Conclusions

- IPv6 has real advantages, and will be coming very soon now
- IPv4 will be around for a long time, but the growth must be with IPv6
- This is a good time for this course

