APNIC

"Addressing the Internet"

The development of the Internet and the RIR System

- e Connect 2004 -12 October 2004, Colombo, Sri Lanka

> Nurani Nimpuno APNIC

## **Overview**

- Introduction to APNIC and IP addresses
- History of the Internet
- The RIR system and APNIC
- IP Addresses Today

## What is **APNIC**?

 Regional Internet Registry (RIR) for the Asia Pacific Region



- Regional authority for Internet Resource distribution
- IP addresses (IPv4 and IPv6), AS numbers, in-addr.arpa delegation

#### Membership-based organisation

- Established 1993
- Non-profit, neutral and impartial

Not operations forum
<u>Not</u> standards development

## What is an IP address?

Example: The email address:

hostmaster@apnic.net

will be translated into Internet destination:

202.12.29.211

## What is an IP address?

- A number used for routing
  - Not dependent on the DNS
- A finite common resource
  - IPv4: 32-bit number
    - 4 billion addresses available
  - IPv6: 128-bit number
    - 340 billion billion billion available
- Not "owned" by address users
- APNIC 📎
- IP does not mean "Intellectual Property"

° APNIC

# "History of the Internet"

The development of the Internet we have today

## **Brief history of the Internet**

• 1961

- 1st paper on packet-switching theory
- "Information Flow in Large Communication Nets" Leonard Kleinrock, MIT

#### • 1969

• ARPANET created – 4 initial nodes

## • 1972

• Ray Tomlinson (BBN) modifies email program for ARPANET - becomes a quick hit. The @ sign is chosen to symbolise "at"



## **Brief history of the Internet (cont'd)**

- 1973
  - First international connections to the ARPANET: University College of London (England) via NORSAR (Norway)
- 1974
  - Vint Cerf & Bob Kahn publishes "A protocol for Packet Network Interconnection" – Transmission Control Program (TCP)
- 1984
  - Domain Name System (DNS) introduced
  - Number of hosts breaks 1,000
  - The Internet converts en masse to use TCP/IP



## Brief history of the Internet (cont'd)

• 1987

- 10,000 hosts connected to the Internet
- 1989
  - 100,000 hosts connected to the Internet
- 1991
  - The World Wide Web is released by CERN
- 1992
  - 1000,000 hosts connect to the Internet



Asia Pacific Network Information Centre

# **APNIC**



RFC 790

**IP** allocation pre-1992

lana

"The assignment of numbers is also handled by Jon. If you are developing a protocol or application that will require the use of a link, socket, port, protocol, or network number please contact Jon to receive a number assignment."

 $\cup$ 

## Address management challenges 1992

- Address space depletion
  - Wasteful, classful allocation (A, B, C)

#### Routing chaos

- Legacy routing structure, router overload
- Lack of routing aggregation

#### Inequitable management

• Unstructured and wasteful address space distribution



# The Internet in 1992

## Internet widely projected to fail

- Growth would stop by mid-'90s
- Urgent measures required
- Action taken by IETF / Internet community



# Important developments 1992-93

• 1992

- RFC 1366: the "growth of the Internet and its increasing" globalization" RFC
  - Additional complexity of address management
  - Basis for a regionally distributed Internet registry system
- The RIPE NCC is established

#### • 1993

- Development of "CIDR"
  - addressed both technical problems
- **Þ** Address depletion
- P Routing table overload
- Asia Pacific Network Information Centre (APNIC) is born





1366

# Brief history of the Internet (cont'd)

- 1996
  - 10M hosts connected to the Internet
  - Hotmail is born
  - Netscape Microsoft war

#### • 1997

- The American Registry for Internet Numbers (ARIN) is born
- 2000
  - ICANN selects 7 new TLDs: .aero, .biz, .coop, .info, .museum, .name, .pro



 $\bigcirc$ 

# Brief history of the Internet (cont'd)

- 2001
  - The Code Red worm hits thousands of webservers and email accounts
- 2002
  - Latin American and Carribbean Network Information Centre (LACNIC) is born

#### • 2003

 The slammer worm causes one of the largest and fastest spreading DDos attacks ever



 $\bigcirc$ 

# The Internet in 2004

- Routing table
  - CIDR & Classless addressing have prolonged the lifetime
  - But routing table is still growing
    - Aggregation is vital

#### • IP addresses

- RIR structure with proper address management
- Not running out of IPv4 addresses today
  - But responsible management is essential
- IPv6 is starting to be deployed

#### Security

- Becoming increasingly important
  - RIRs do not regulate behaviour
    - But assist in maintaining public Whois DB
    - RIRs also provide information and education

# The RIR System

17

APNIC 📎

# Address management today

## • Four RIRs in the world



## What are RIRs?

Industry self-regulatory structures
Non-profit, open membership bodies

• First established in early 1990's

- Voluntarily by consensus of community
- To satisfy emerging technical/admin needs

APNIC STANIC

- In the "Internet Tradition"
  - Consensus-based, open and transparent

# Address management objectives

(Lessons learnt from the past)

#### Conservation

- Efficient use of resources
- Based on demonstrated need

#### Aggregation

- Limit routing table growth
- Support provider-based routing

#### Registration

- Ensure uniqueness
- Facilitate trouble shooting

Uniqueness, fairness and consistency



# **APNIC** region



# 943 members in47 economies\*

\* 31 Aug 2004

# **APNIC** services & activities

#### Resources Services

- IPv4, IPv6, ASN, reverse DNS
- Policy development
  - Approved and implemented by membership
- APNIC whois db



Resource Services

- whois.apnic.net
- Registration of resources
- Routing Registry: irr.apnic.net

#### Information dissemination

- APNIC meetings
- Publications
  - Web and ftp site



- Newsletters, global resource reports
- Mailing lists



- Open for anyone!
- Training Courses
  - Subsidised for members
     Training
- Co-ordination & liaison
  - With membership, other RIRs & other Internet Orgs.





Centre

APNIC 2 23

# **IP Addresses Today**

## Where are all the addresses?





# **IPv4** Lifetime

#### IPv4 Address Space Report (Geoff Huston)

This report is generated automatically on a daily basis, and reflects the application of best fit models to historical data relating to the growth in the address space advertised in the BGP routing table. The underlying assumptions made in this predictive model is that the previous drivers in address consumption will continue to determine future concumption rates, and that growth in consumption rates will continue to operate in a fashion where the growth rate is constant rather than increasing or decreasing.

- Complete Exhaustion of all available IPv4 Address Space: September 2040
- Exhaustion of the IPv4 Unallocated Address Pool

November 2018







Don't make all those Hostmasters redundant, just yet. We will need them...

APNIC

## What about IPv6?

- RIRs support the deployment of IPv6
  - Transition will take time
    - Necessary to start now
    - IPv4 was slow to start, but grew exponentially over the last 10 years
  - Don't get left behind!
    - Be future ready!



# "Internet for everything"

- No longer just "Internet for Everyone"
- "Peer to peer" between any pair of devices, not just people on computers
  - appliances, automobiles, buildings, cameras, control units, embedded systems, home networks, medical devices, mobile devices, monitors, output devices, phones, robots, sensors, switches, VPNs

- **APNIC**
- No more NAT ("fog on the Internet")
- Eventually, every device will be connected to the Internet
  - and every device will need an address

# Concluding thoughts...

- IP address management
  - Result of 20 year evolution on the Internet
    - Supported Internet growth to date

#### We are not running out of IP addresses now

- But impossible to predict future
- Start IPv6 now transition will take time!

**APNIC** 

 Responsible management essential to keep the Internet running

## Thank You

# Nurani Nimpuno APNIC