IPv4 & IPv6 address allocation
- What are all those numbers about?

“IPv6 for e-business”
Australia, March, 2007

Nurani Nimpuno
APNIC
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
  Not standards development
Services provided by APNIC

- Internet resource distribution & registration
  - IP addresses (IPv4, IPv6), AS numbers, reverse DNS delegations
  - whois.apnic.net

- Training and education
  - IRME, DNS, Routing and IPv6 workshops, Spam & Security tutorials
    - Subsidised for members

- Regional networking
  - Participation and representation
  - IETF, ITU, APT, PITA, APEC, SANOG, ISOC, etc.

- Information dissemination
  - APNIC Meetings
  - Publications
    - Web and ftp site
    - Newsletters, global resource reports
  - Mailing lists (Open for all)

- Policy coordination
  - APNIC Open Policy Meetings
    - 2 per year

- Critical infrastructure services
  - Working with root operators (F, I, J, K, M)
IP addressing
What is an IP address?

• Internet identifier including information about how to reach a location
  - (via the Internet routing system)
  - IP = Internet Protocol
    - (A Protocol is “an agreed upon convention for communication”)

• Public infrastructure addresses
  - Every device must have an IP address
  - Every globally-reachable address is unique
IPv4 and IPv6 addresses

IPv4
- 32-bit* number ($2^{32}$)
  - Addresses available: ~4 billion
  - Example:
    
    202.12.29.142

IPv6
- 128-bit* number ($2^{128}$)
  - Addresses available: 340 billion billion billion billion
  - Example:
    
    FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D

* bit = binary digit
Internet address routing

The Internet

Global Routing Table

<table>
<thead>
<tr>
<th>Prefix</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.128/9</td>
</tr>
<tr>
<td>60.100/16</td>
</tr>
<tr>
<td>60.100.0/20</td>
</tr>
<tr>
<td>135.22/16</td>
</tr>
<tr>
<td><strong>202.12.29.0/24</strong></td>
</tr>
</tbody>
</table>

Announce 202.12.29.0/24

Traffic 202.12.29.0/24

202.12.29.0/24
What is a domain name?

• Easy to remember (well, sort of) name for a computer or service

• Hierarchical structure providing distributed administration

• Not a proper (or useful!) directory service, but a basic mapping service
  – Technical feat is in distribution and scaling
Querying the DNS – It’s all about IP!

Root

198.41.0.4

www.ipv6.org.au

“Ask 128.250.1.21”

“Ask 212.154.242.148”

www.ipv6.org.au

131.181.2.61

128.250.1.21

ipv6.org.au

212.154.242.144

210.84.80.24

210.80.58.34

212.154.242.148

www.ipv6.org.au

“Ask 212.154.242.148”

“Ask 128.250.1.21”

www.ipv6.org.au

www.ipv6.org.au

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www.ipv6.org.au

www.ipv6.org.au
Where do IP addresses come from?

IPv4 IPv6

Allocation

Allocation

Assignment

end user
What else is an IP address?

• IP addresses are…
  – Internet infrastructure addresses
  – a finite Common Resource
  – not “owned” by address users
  – not dependent upon the DNS

• IP does not mean “Intellectual Property”
Internet address management

Resource allocation and assignment
Allocation and Assignment

APNIC

Allocates

to APNIC Member

APNIC Member

Allocates

to downstream

Assigns

to end-user

Downstream

Assigns

to end-user

Customer / End User

APNIC Allocates
to APNIC Member

APNIC Allocation

Member Allocation

Sub-Allocation

Customer Assignments
Policy development

• Industry self-regulatory process
  – Policy is developed by the AP Internet community to suit needs of region

• Decisions made based on consensus
  – http://www.apnic.net/docs/policy/dev/

• Public meetings
  – http://www.apnic.net/meetings/

• Mailing lists
  – http://www.apnic.net/community/lists/
Address management objectives

Conservation
- Efficient use of resources
- Based on demonstrated need

Aggregation
- Limit routing table growth
- Support provider-based routing

Registration
- Ensure uniqueness
- Facilitates troubleshooting
Growth of global routing table

Projected routing table growth without CIDR

CIDR deployment

Dot-Com boom

Sustainable growth?

http://bgp.potaroo.net/as1221/bgp-active.html
Global IPv4 delegations

- IETF reserved: 13.3%
- Central Registry: 36.7%
- IANA reserved: 21.5%
- APNIC: 7.4%
- ARIN: 10.5%
- RIPE NCC: 8.6%
- LACNIC: 1.6%
- AfriNIC: 0.4%
- Experimental, private, etc:

Pre-RIRs: 36.7%
Available: 63.3%
IPv4 Exhaustion

So, are we running out?
Studies in IPv4 exhaustion

- All RIRs make their allocation publicly available
  - [http://www.nro.net/statistics/](http://www.nro.net/statistics/)

- Geoff Huston, chief scientist at APNIC, has studied the IPv4 allocation data
  - Projections based on current and past utilisation rates
  - Three sets of data analysed:
    - IANA allocations to RIRs (IANA IPv4 address registry)
      - Allocation of /8 blocks to RIRs and others
    - RIR allocations to ISPs (RIR statistics files)
      - Allocation of blocks to LIRs
    - ISP announcements (BGP routing table)
      - Amount of address space advertised
Data analysed - IPv4 allocations

http://www.potaroo.net/tools/ipv4/
Data analysed - complete picture

![IPv4 Pool Status](image)

- IANA Allocations
- RIR Allocations
- Advertised
- Unadvertised
- RIR pool
Projection - including all unused pools

*If all IPv4 addresses not in use would be reclaimed and re-allocated
Projection - RIR exhaustion point

As of 5 March 2007
When will we ‘exhaust’ IPv4?

A. When will we stop routing IPv4 in our networks?
   – We will probably still route IPv4 for some decades to come

B. When will the RIRs have no more IPv4 addresses to distribute?
   – Sometime between 2010 and 2013

C. When will IANA have no more IPv4 addresses to pass to the RIRs
   – Sometime between 2009 and 2012
IPv4 exhaustion - conclusions

• *We are not* running out of IP addresses now
  – Projections gives us a few more years
    • No need for Denial, Panic, Anger, Blame shifting, Bargaining…
  – Impossible to predict future
    • Policies change
    • New technologies can emerge
    • Market behaviour can change

• IPv6
  – RIRs support the deployment of IPv6
    • IPv6 is available and ready
  – Transition will take time
  – Necessary to start now!
IPv6 address architecture
Rationale – why IPv6 was developed?

- **Address depletion concerns**
  - Squeeze on available addresses space
    - Probably will never run out, but will be harder to obtain
  - End to end connectivity no longer visible
    - Widespread use of NAT
  - IPv6 provides much larger IP address space than IPv4

- **Increase of backbone routing table size**
  - Current backbone routing table size > 230K
    - CIDR does not guarantee efficient and scalable hierarchy
    - Routing aggregation is still a concern in IPv6
  - IPv6 address architecture is more hierarchical than IPv4
IPv6 addressing

• 128 bits of address space \(2^{128}\)
  – Addresses available: 340 billion billion billion billion

• Hexadecimal values of eight 16 bit fields
  • X:X:X:X:X:X:X:X (X=16 bit number, ex: A2FE)
  • 16 bit number is converted to a 4 digit hexadecimal number

• Example:
  • FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
  – Abbreviated form of address
    • 4EED:0023:0000:0000:0000:036E:1250:2B00
    • \(\rightarrow\)4EED:23:0:0:0:36E:1250:2B00
    • \(\rightarrow\)4EED:23::36E:1250:2B00
    • (Null value can be used only once)
IPv6 addressing structure

- **LIR /32**
- **Customer site /64 - /48**
- **Subnet /64**
- **Device /128**

The IPv6 addressing structure is composed of 128 bits, divided into segments for LIR, customer site, subnet, and device.
Address management objectives

IPv4

- Efficient use of resources
- Avoid wasteful practices

IPv6

- Limit routing table growth
- Hierarchical distribution

Efficient usage

Registration

Minimise overhead

Conservation

Registration

- Ensure uniqueness
- Facilitates troubleshooting

Aggregation

Ease of access to resources
IPv6 initial allocation

• Initial allocation size is /32
  – End site assignments /64 - /48
    • (size is up to ISP)

• Initial allocation criteria
  – ‘Plan’ to connect 200 end sites within 2 years
  – Not be an end-site

http://www.apnic.net/services/ipv6_guide.html
IPv6 portable assignment for multihoming

• New policy to allow IPv6 portable assignment to end-sites
  – Direct assignment to end site
  – Allows end user organisations to get an independent assignment
    • Size: /48, or a shorter prefix if the end site can justify it
    • To be multihomed within 3 months
  – To be implemented 9 March 2007

http://www.apnic.net/docs/policy/ipv6-address-policy.html
IPv6 deployment - Asia

**China**
- China Next Generation Internet (CNGI) project
- National initiative 2002
- CNGI Backbone 3040 giga POPs, 300 campus networks & international links

**Japan**
- IPv6 in actual business services
- IPv6 connections to residential users via tunneling (NTT Communications)
  - [http://www.ocn.ne.jp/ipv6](http://www.ocn.ne.jp/ipv6)
- Multi channels, video-on-demand (Plala & Online TV)

**Korea**
- National initiative: U-biquitous Society
- IPv6 included in strategy for the development of IT and telecommunication industries
- 2006 target: Commercialisation of IPv6 applications & content
IPv6 deployment - Europe

Europe
- EU government initiative to promote IPv6 R&D
- Information Society Technologies (IST) IPv6 cluster
  - [www.ist-ipv6.org](http://www.ist-ipv6.org)
- Nokia: IPv4/IPv6 Dual Stack CDMA mobiles
  - [http://www.nokia.com/A402958](http://www.nokia.com/A402958)
IPv6 deployment - USA

USA
- Transition plan for IPv6
- Jun 2008:
  - All agencies infrastructure to be using IPv6
  - All new IT purchases must be IPv6 compatible
  - Department of Defence (DoD)
    - Plan to transition to IPv6 since Oct 2003
IPv6 Allocations in Asia Pacific 1999

JP  3
KR  2
AU  1
SG  1
Total 7

Map showing IPv6 allocations in Asia Pacific with color-coded regions: Eastern Asia, South-central Asia, South-eastern Asia, Oceania, and Africa.
IPv6 Allocations in Asia Pacific 2000
(cumulative total)

- JP 12
- KR 5
- TW 2
- CN 1
- AU 1
- SG 1
- Total 22
IPv6 Allocations in Asia Pacific 2001 (cumulative total)

JP  29
KR  11
TW  2
CN  1
AU  2
SG  1
HK  1
MY  1
Total  48
IPv6 Allocations in Asia Pacific 2002 (cumulative total)

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IPv6 Allocations in Asia Pacific 2003 (cumulative total)

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IPv6 Allocations in Asia Pacific 2004 (cumulative total)

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IPv6 Allocations in Asia Pacific 2005 (cumulative total)

<table>
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</table>

- Eastern Asia
- South-central Asia
- South-eastern Asia
- Oceania
- Africa
IPv6 Allocations in Asia Pacific 2006 (cumulative total)

<table>
<thead>
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</table>

Legend:
- Eastern Asia
- South-central Asia
- South-eastern Asia
- Oceania
- Africa
IPv6 - Internet for everything!
Thank you

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www.apnic.net

Material available at:
http://www.apnic.net/community/presentations/other.html