Measuring IPv6 Deployment

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"Apologies from Geoff"
The story so far...

In case you hadn’t heard by now, we appear to be running quite low on IPv4 addresses!
IANA Pool
Exhaustion

Total address demand
Prediction
Advertised
Unadvertised
IANA Pool
RIR Pool

Address Count (/8s)

Date

In this model, IANA allocates its last IPv4 /8 to an RIR on the 15th April 2011

This is the model's predicted exhaustion date as of the 10th March 2009. The predictive model is updated daily at:

http://ipv4.potaroo.net
Ten years ago we had a plan ...
Oops!

We were meant to have completed the transition to IPv6 *BEFORE* we completely exhausted the supply channels of IPv4 addresses!
What's the revised plan?

- IPv6 Deployment
- IPv4 Pool Size
- Size of the Internet

Today

IPv6 Transition
It's just not looking good is it?
IPv6 Deployment

The new version of the plan is that we need to have much of the Internet also supporting IPv6 in the coming couple of years.
How are we going today with this new plan?
How are we going today with this new plan?

Or: How much IPv6 is being used today?
Can the data we already collect be interpreted in such a way to provide some answers to this question?
How much IPv6 is being used today?

At APNIC we have access to dual-stack data for:
- BGP Route table
- DNS server traffic
- WEB Server access

and the data sets go back over the past 4 years

What can these data sets tell us in terms of IPv6 adoption today?
The BGP view of IPv6
The BGP view of IPv4

![Graph showing the growth of IPv4 entries over time from 2004 to 2009. The y-axis represents the number of active BGP entries (FIB), ranging from 120K to 300K. The x-axis represents the years from 2004 to 2009. The graph shows a steady increase in the number of entries over the years.]
BGP: IPv6 and IPv4
What's this saying?

• Since mid-2007 there appears to have been increasing interest in experience with routing IPv6 over the public Internet
What's this saying?

• V6 is 0.6% of IPv4 in terms of routing table entries
  - Growth is 0.22% p.a., linear
  • IPv6 deployment will reach IPv4 levels in 452 years
  • But the routing domain of IPv4 is heavily fragmented, while IPv6 is not
  - Assuming IPv6 will exhibit 1/3 of the routing fragmentation of IPv4, then IPv6 deployment will fully span the Internet in about 149 years!
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*This seems highly implausible!*
What's this saying?

• Routing is not traffic – the relative level of IPv6 use cannot be readily determined from this BGP announcement data.
Let's refine the question

How much of the Internet today is capable of running IPv6?

One way to answer this is to look at IPv6 routing on a per-AS basis.
IPv6 AS Count

Graph showing the growth of unique ASes from 2004 to 2009, with a significant increase in the number of ASes after 2006.
IPv4 AS Count

![Graph showing the growth of IPv4 AS count from 2004 to 2008. The y-axis represents the number of unique ASes, ranging from 16K to 32K, and the x-axis represents the years from 2004 to 2009. The graph shows a steady increase over time.](image-url)
What's this saying?

The number of AS's announcing IPv6 routes has risen from 2.5% to 4.2% from Jan 2004 to the present day.

4.2% of the networks in the Internet are possibly active in some form of IPv6 activity.
What's this saying?

At a relative rate of update of 0.8% per year, a comprehensive update to IPv6 is only 120 years away.
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At a relative rate of update of 0.8% per year, a comprehensive update to IPv6 is only 120 years away. This too seems highly implausible!
That 4.2% is not uniform

In IPv4 4,002 AS's are transit networks and 26,874 are origin-only.

Of the 4,002 IPv4 transit AS's 687 also have IPv6 routes. 440 of these IPv4 transits are IPv6 stub ASs.

17.1% of V4 Transit AS's also route IPv6.

Of the 26,874 V4 stub AS's 630 also route IPv6. 49 of these IPv4 stubs are IPv6 transit ASs.

2.3% of V4 Origin AS's also route IPv6.
What's this saying?

• The proportion of IPv4 transit ASNs announcing IPv6 prefixes has risen by 3.3% in 12 months.

• At this rate comprehensive IPv6 deployment in the "core" will take only 25 more years.
What's this saying?

- The proportion of IPv4 transit ASNs announcing IPv6 prefixes has risen by 3.3% in 12 months.
- At this rate, comprehensive IPv6 deployment in the "core" will take <5 more years.

This seems highly implausible!
Capability vs Actual Use

As 17% of the number of transit AS's are announcing IPv6 address prefixes, does this mean that 17% of the Internet's "core" is running IPv6 right now?
Capability vs Actual Use

As 17% of the number of transit AS's are announcing IPv6 prefixes, does this mean that 17% of the Internet's core is running IPv6? This seems highly implausible!
DNS Server Stats

• APNIC runs two sets of DNS servers for the reverse zones for IPv4 and IPv6
  – One set of servers are used to serve reverse zones for address ranges that are deployed in the Asia Pacific Area
  – The second set of servers are used as secondaries for zones served by RIPE NCC, LACNIC and AFRINIC
DNS Reverse Query Load

- Examine the average query load for reverse PTR queries for IPv6 and IPv4 zones for each of these server sets
DNS Reverse Query Load

PTR queries per second

IPv4

IPv6

Caution: Log Scale!

2004 2005 2006 2007 2008 2009
Relative DNS Query Load

Graph showing the relative DNS query load from 2004 to 2009, with a linear scale for the y-axis. The graph compares the load between AsiaPac and Other Regions.
What's this saying?

- Reverse DNS queries for IPv6 addresses are around 0.2% of the IPv4 query load.
- AsiaPac IPv6 query load was higher than for other regions to 2008, now lags.
- Query load has increased since 2007.
- The interactions of forwarders and caches with applications that perform reverse lookups imply a very indirect relationship between actual use of IPv6 and DNS reverse query data.
DITL 2008 to Present AP

V6 transit improvements
DITL 2008 to Present RoW

Relative V6 / V4 Query load by Source IP, APNIC

Time of Day (HH:MM)

sec1 2008
sec3 2008
sec1 2009
sec3 2009
What's this saying?

• Best-case improvement in V6/V4 ratios from 2008 is 2x increase in V6 in a year
  - Arguably more improvement if V6 transit improved than from 'growth' in V6

• AP saw bigger increases than RoW
  - Local RTT preference?
Web Server Stats

• Take a couple of dual-homed web servers:
  http://www.apnic.net
  http://www.ripe.net

• Count the number of distinct IPv4 and IPv6 query addresses per day
  – Not the number of 'hits', just distinct source addresses that access these sites, to reduce the relative impact of robots and crawlers on the data and normalize the data against different profiles of use

• Look at the V6 / V4 access ratio

What proportion of end host systems will prefer end-to-end IPv6, when there is a choice?
What happened on the 12\textsuperscript{th} September 2008?
Are you an IPv4 sheep or an IPv6 kiwi?

- Hope we can see as many as kiwis hopping around:
- The value of this experiment:
  - Everyone attempts IPv6 connectivity
  - Enjoy the experiment
  - And share knowledge and information
CNGI高校驻地网IPv6用户数量测试

欢迎访问CNGI高校驻地网IPv6用户数量测试网站！
来自：
来自这个学校共有 0 个人

验证码：__________  3546  （必填）
邮件地址：__________  （选填）

IPv6常用资源链接

Beijing 2008 Olympics  IPTV via IPv6  IPv6 Enabled Webcams  Dancing KAME
IPv6 Google site  v6kivi  Network Time Protocol  IPv6 BitTorrent Clients
上海交大视频直播网  中科大影视无限
RIPE NCC Web Server Stats

www.ripe.net server logs: V6 / V4 daily ratio
Combined Stats

RIPE and APNIC server logs: V6 / V4 daily ratio

0.0% 1.4%
Combined Stats

RIPE and APNIC server logs: V6 / V4 daily ratio
What's this saying?

- Relative use of IPv6 when the choice is available is 0.2% in the period 2004 - 2006
- Relative use of IPv6 increased from 2007 to around 1% today
  - Is interest in IPv6 slowing picking up again?
  - Increased use of auto-tunneling of IPv6 on end host stacks?
Use of IPv6 Transition Tools

- APNIC Web Server Stats
Use of V6 Transition Tools

- RIPE NCC Web Server Stats
Use of V6 Transition Tools

- Combined WebStats
Transition Tools in DNS

• Combined Stats

Use of IPv6 Transition Tools in DNS
What's this saying?

- Up to 25% of IPv6 clients in the Euro/ Mid East Region appear to use access tunneling techniques across an edge IPv4 infrastructure
- The use of IPv6 clients using access tunneling is lower in the Asia Pac region
- Infrastructure DNS is using tunnels
  - Even Teredo
    - (lower pref than v4 in Vista)
Where are we with IPv6?

- The "size" of the IPv6 deployment in terms of end host IPv6 capability is around 10 per thousand Internet end hosts at present

At most!

This observed ratio may be higher than actual levels of IPv6 capability due to:
- Widespread NAT use in IPv4 undercounts IPv4 host counts
- These web sites are tech weenie web sites. More general sites may have less IPv6 clients
- So perhaps the current IPv6 deployment level for end users may be closer to 6 - 7 per thousand
What's the revised plan?

IPv6 Deployment

IPv4 Pool

Size

Size of the Internet

Today

IPv6 Transition

Time
What's the revised plan?

- IPv6 Deployment
- IPv4 Pool Size
- Size of the Internet

Today

IPv6 Transition

0.5% → 100%

Time
Thank You!

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