What is AARNet?

- AARNet is Australia's Academic, Research and Education Network, a not for profit owned by the universities and CSIRO. It's been around in many guises since 1989
- It operates a high capacity DWDM network covering all the major capital cities of Australia and extensive regional coverage
- It offers diverse high capacity paths across those links, with dual diverse PoPs in the major cities.
- The IP backbone is currently a diverse and redundant 10 Gbps design

AARNet's operating environment

- AARNet has operated a native dual stack IPv4/Ipv6 Network since 2003
- Core Network is DWDM with 10G diverse redundant backbone design for IPv4/IPv6
- Tunnels have been phased out except for the IPv6 Broker service to the Australian public and 6to4 etc
- National footprint covering Australia with national peering and on-net provided content
- International footprint covering 5 PoPs in the US and Singapore, with extensive IPv4 and IPv6 peerings, both R&E and commodity

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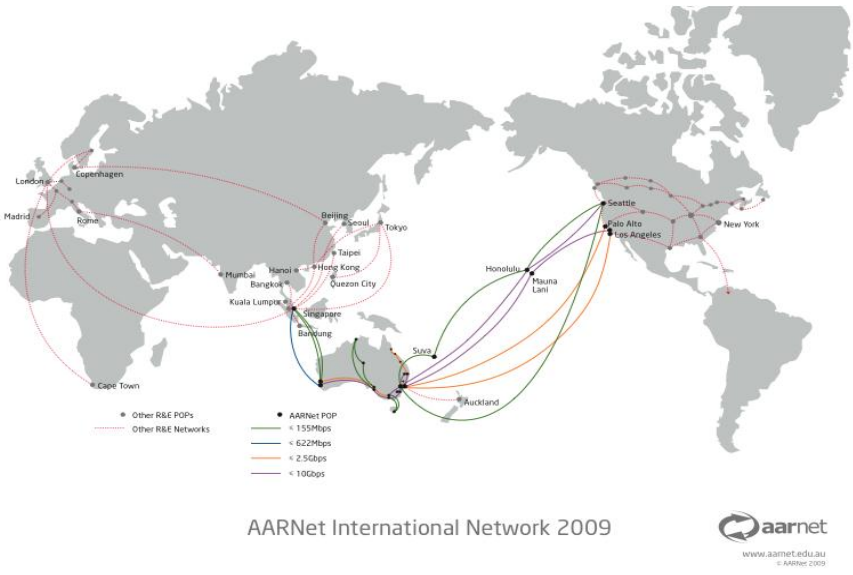


By way of Introduction

- This is not a technical talk about IPv6
- IPv6 is ready, for the most part, to deploy now, especially in a dual stack environment
- Quite a lot of content is readily available
- I would like to share some experiences of
  - Our measurements of IPv6 traffic
  - Where the R&E world stands
  - Where we might be going

Customer Connections

- Most large customers have plenty of IPv4 space
- AARNet encourages dual stacked connections – the default
- AARNet is adding more schools and other bodies to the network
- We are now certified by the NBN – the National Broadband Network – and this will lead to a broader customer base
  - Running out of IPv4 address space for newer customers… Not crisis level **yet**

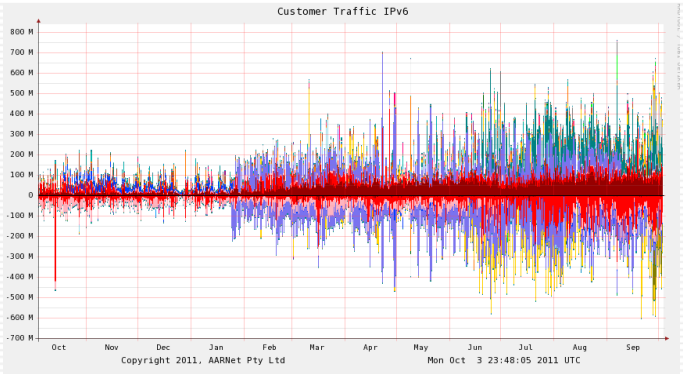
Customers and IPv6

- Only a small group of customers have extended IPv6 into their network on a full production basis – Monash University has been an exemplar in that.
- A number of institutions still see IPv6 as a testbed
  - Sometimes only used by specific researchers
  - Sometimes only extended to the IT department of a university
- IPv4 address space is still reasonably plentiful at a major institutional level
- Consequently IPv6 traffic is ~1% of total traffic
  - It is increasing – but slowly

Content

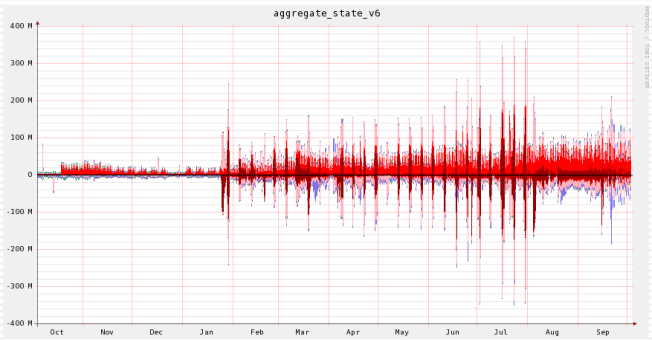
- We host a number of archives available through IPv6 on mirror.aarnet.edu.au
- We are Google white-listed and so both Google and YouTube resolve to an AAAA records
- We host Akamai caches that are IPv6 enabled
  - However very little traffic
- Continuing to work with and encourage content delivery over IPv6 for CDN and peer networks

Lies, damned Lies and Statistics



- An optimistic but “real” view
- Unfortunately the values are for **maximum bps** through the period, to and from customers.

Another view…



- A more pessimistic view, but growth is still visible
- Values are average bits per second per day through the period – grossly underestimates diurnal peaks.
- ‘Best’ value is between the two views

IPv6 numbers

Using the IPv6 Netflow data we can estimate:

•13,500 individual IPv6 addresses source traffic within AARNet per day
- Hard to specifically quantify because of varying IPv6 addressing schemas.
- They do about 150-200 Mbps of IPv6 traffic on average

•Google whitelisting and YouTube videos go a long way in explaining this.

•AARNet backups and content delivery are significant.

•IPv6 Bittorrent seems very much smaller than anticipated – not quite the killer app yet!

•It is small number compared to the million or so IPv4 users and traffic is still miniscule compared to IPv4

2011 – A Significant Year

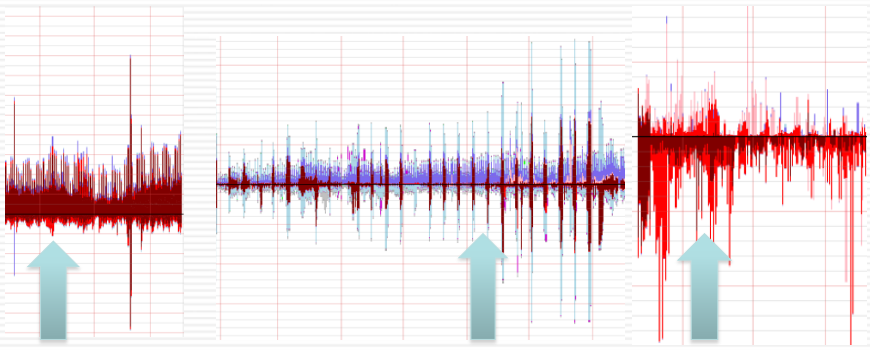
- IPv4 address pools are exhausted!
  - IANA exhausted the IPv4 free pool on February 3rd
  - RIR's exhausted their unallocated pools
  - APNIC implements it's final /8 policy
- The first World IPv6 Day!
  - June 8th 2011, organised by ISOC

World IPv6 Day

- A trial of IPv6
- Google, Facebook, Akamai, Yahoo, Limelight and others giving AAAA records to the world
- Only Google (whitelist) and Limelight now provide AAAA records
- Boring and that was good! No major issues seem to have happened.
- **Did it make an impression?**

Can you spot World IPv6 Day below?

If I gave you the date scale that would be cheating…

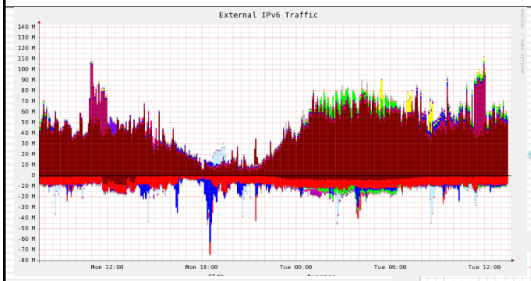


AARNet External IPv6 traffic

AARNet all IPv6 traffic

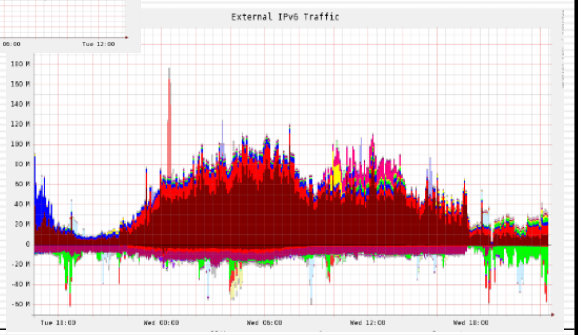
AARNet 6to4 traffic

More colourful than usual



Using Netflow v9 non-sampled by source external AS

June 7th 2011



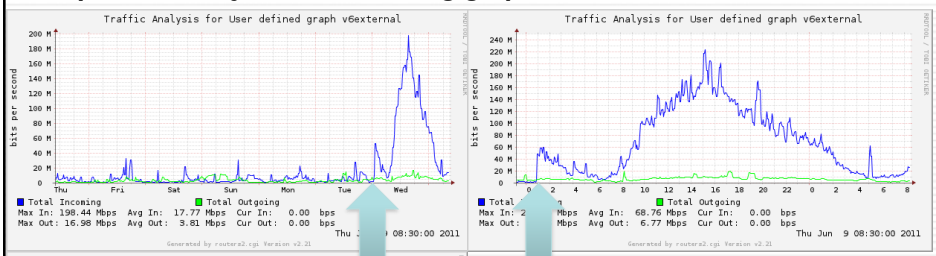
June 8th 2011

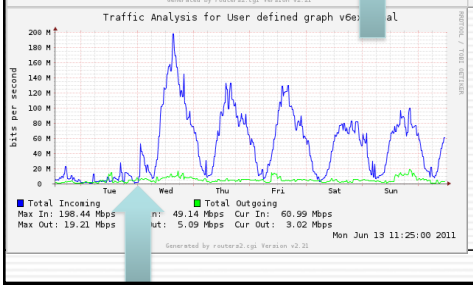
More sources but traffic levels only slightly increased ~ 20%

Times are UTC

But elsewhere … JANET (UK)

Spot IPv6 Day on the following graphs…





The UK was on BST, not GMT!

No Google/YouTube whitelisting

Persistent effects due to DNS/caching

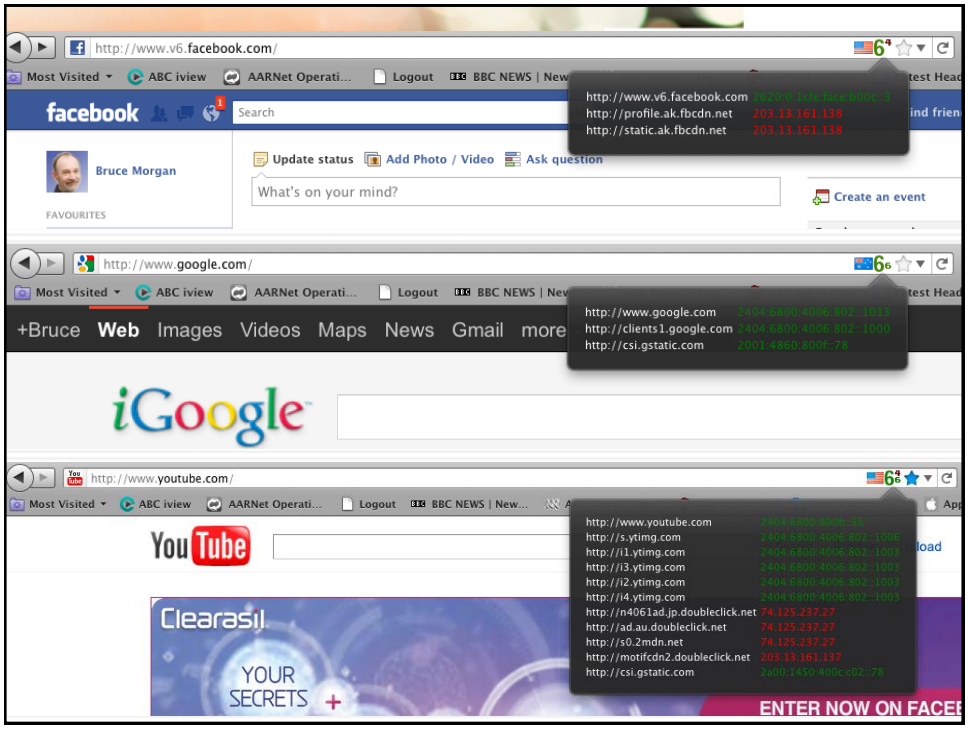
Credit: JANET(UK) – Rob Evans blog

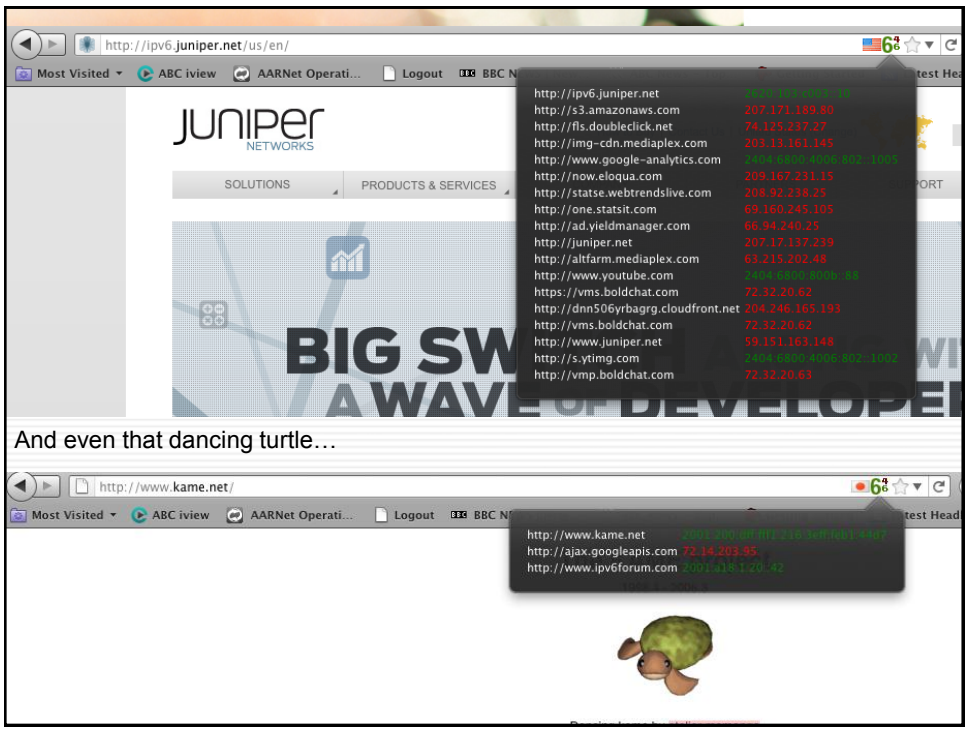
IPv6 day on AARNet

- IPv6 day had little impression on general traffic patterns for us
- A flurry of IPv6 peering requests the few days prior.
- Most participants turned on AAAA records for the day only
  - It was turned off when the day ended
  - Akamai IPv6 traffic was minimal but ongoing
  - Limelight have continued
  - No discernable effect on Google/YouTube traffic as whitelisted already
- There was a certain amount of tokenism
  - Many sites had IPv6 enabled only for their front pages.
    - Any navigation beyond that went to IPv4 only sites
    - Images and other content were often still IPv4 only
- Encouraged by large number of smaller content providers in Australia that have turned on IPv6.

IPv6 day measurements

- CAIDA Archipeligo (ARK) machines on the AARNet network running IPv6 provided information on Australian paths/connectivity for RIPE on World IPv6 Day.
  - http://v6day.ripe.net/cgi-bin/index.cgi
  - Only IPv6 measurement points in AU were on AARNet ☹
  - Please support IPv6 measurements when enabling IPv6!
    - http://www.caida.org/projects/ark/
- Check out what protocols URLs actually use (especially next World IPv6 Day)
  - Try out the IPvFox FireFox addon!!!
  - https://github.com/Dagger0/IPvFox
    - Try, on an IPv6 enabled network:
    - http://www.v6.facebook.com/
    - http://ipv6.google.com/
    - http://www.kame.net/





And even that dancing turtle…

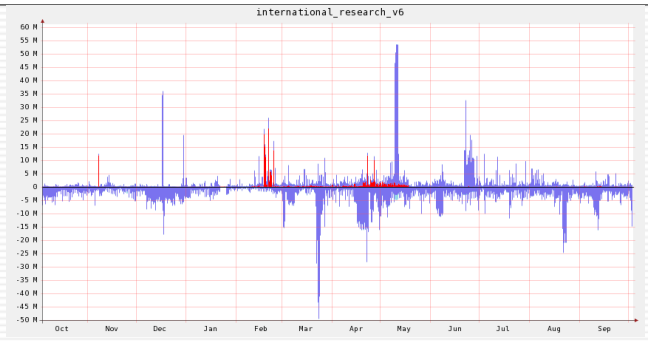
So where is IPv6 connectivity?

- Dual stack deployments often hide real connectivity issues
- Using IPv6 **only** allows you to better understand many issues
- Turn off IPv4 on your IPv6 connected machine
- See your mileage against your own network infrastructure and services
- Check out the IPv6 -> IPv4 gateway services that are freely available
  - Usually only involve setting a specific IPv6 DNS resolver
  - http://aa.net.uk/kb-broadband-ipv6-nat64.html
  - http://ipv6.lt/nat64_en.php
- Check out what is still broken on your network

IPv6 and the R&E world

- IPv6 has a long history of deployment in the R&E World, first using tunnels and now in a dual stack environment (2003 onwards). There are also implementations of solely IPv6 deployments
- Uptake of IPv6, though deployed in the network cores, has however been laboriously slow at the institutional level.
- The R&E networks of developed countries have large allocations of IPv4 addresses for historical reasons
  - Little incentive to move to IPv6
- The R&E networks in developing countries are deploying more IPv6 because of IPv4 addressing issues.
- There has been talk for a while of “what is the killer app for IPv6?”

AARNet's international research IPv6



- Most of the IPv6 R&E traffic is through TEIN (purple) to Asia and also Europe
  - Little traffic to the US (red)
  - An inverse reflection on available IPv4 address space?
- R&E traffic is not leading the way anymore by volumes – see previous slides on volumes

Not without trying… the US

- The US led the way with the deployment of IPv4 from the DARPA networks
- The R&E organisations of the US, particularly Internet2, have pushed IPv6 strenuously with working groups and publications
- Excellent guides to deployment of IPv6
  - The recent Alaska Internet2 workshop slides are worth viewing
    - ***http://www.internet2.edu/workshops/i pv6/2011/Alaska.zip***
- So why hasn't IPv6 been more heavily deployed?
  - See Stephen Wolff's sldes IPv6 in U.S. R&E Networks
  - ***http://www.apan.net/meetings/India2011/Session/Slides/IPv6/1-2.pdf***

Too much IPv4 address space still available

China CNGI-CERNET2

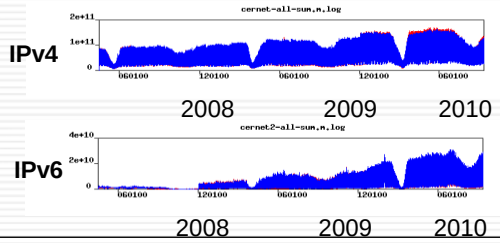
China took the step of developing CNGI the Chinese Next Generation Internet that uses solely IPv6 in 2003, 6 major backbones, five commercial and one operated by CERNet, called CNGI-CERNET2

CNGI-CERNET2 has 25 PoPs, a 10 Gbps backbone with 200 institutions connected

It has a user-base of about 2 million staff and students, compared to CERNET's 20 million users.

IPv4 and IPv6 Traffic levels on CERNET

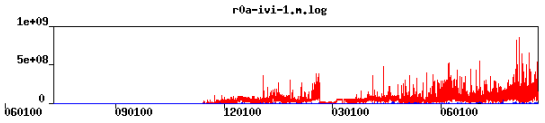
IPv6 traffic is about 10% of IPv4 at the moment and increasing



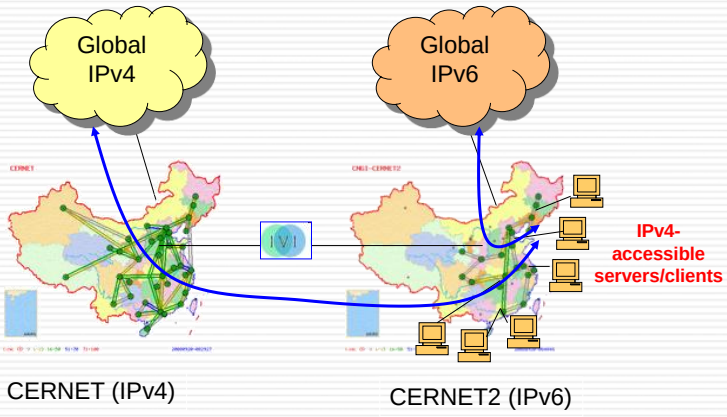
Credit: Xing Li, CERNET

IVI

- There's a problem when you build IPv6 only networks
  - How do you talk to the rest of the (IPv4) internet?
- **IVI** (Stateless NAT64**)** translation is used to address this issue within CNGI-CERNET2
  - SLAAC cannot be the basis for an addressing scheme for this as it uses it's own specific format.
- IPv4 is seen as the killer app for IPv6!
- Currently 200 IVI stateless gateways introduced
  - Aggregate traffic is about 800 Mbps
- For more information about IVI see:
  - http://www.jp.apan.net/meetings/1108-NewDelhi/Xing.ppt



IVI

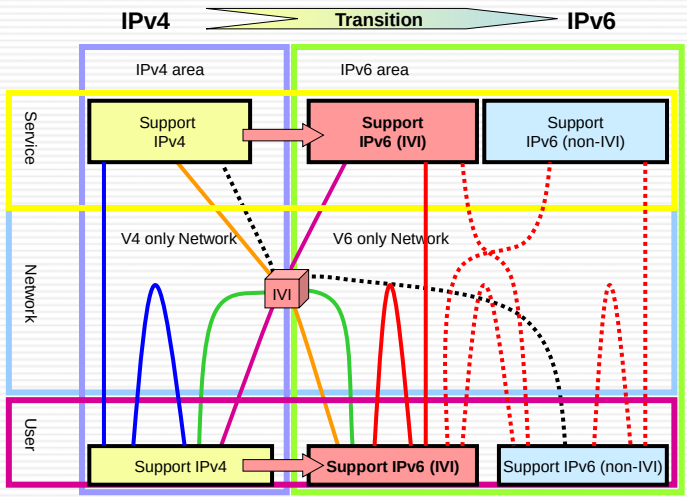


Credit: Xing Li, CERNET

IVI at the IETF

- **RFC6052**: IPv6 Addressing of IPv4/IPv6 Translators
- **RFC6144**: Framework for IPv4/IPv6 Translation
- **RFC6145**: IP/ICMP Translation Algorithm
- **RFC6146**: Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers
- **RFC6147**: DNS64: DNS extensions for Network Address Translation from IPv6 Clients to IPv4 Servers
- **I-D**: The CERNET IVI Translation Design and Deployment for the IPv4/IPv6 Coexistence and Transition

IPv4/IPv6 transition



Credit: Xing Li, CERNET

Where from here? The short term…

- On a per-capita basis IPv6 usage/deployment in AARNet is comparable to R&E networks worldwide.
- Maintenance of full connectivity is prime concern
- Dual stack IPv4 NAT/native IPv6 seems inevitable in short run for newer customers. (Those newer/smaller customers currently NAT anyway)
- No IPv4 allocations available in short/medium term – IPv4 addresses must be used sparingly.
- Continue to push for IPv6 adoption at both a services and client level

Penetration of IPv6 at Institutions

- The network is mission critical to Universities
  - A change from the “good old days” where experimentation was common
- FUD involved with changing the network – change management processes can sometimes be stifling
- Cost involved in moving the network to being IPv6 enabled in terms of knowledge, experience, systems and equipment
- Does IPv6 win out easily in this environment?
  - Often not. Partial implementations are often the case.
- But there are some success stories

Still Issues within AARNet

- Some services are only available via IPv4 ☹
- Mail still with Messagelabs and IPv4 only
  - Assurance that it will be fixed soon…
- Routing policy
  - Issues with RPSLng for IPv6:
  - Basic functionality available
  - Still not fully supported in irrtoolset v5 eg network ranges
  - RPSL itself has policy definition issues eg static IPv6 routes
  - Advanced functionality difficult
  - Managed to script around it to provide congruent IPv4/IPv6 policy

Some IPv6 issues

- Management of IPv6 traffic is still an issue
- IPv6 SNMP OIDs lacking eg
  - BGP monitoring
  - Interface IPv6 traffic
- IPv6 Netflow concurrently with IPv4 is difficult with current hardware and software platforms.
  - IPv6 Netflow v9 is collected but at different collection points to IPv4.
  - This should change soon as products get deployed

Bringing it all back home…

Users don't care about the plumbing – we assume it works

We like to name things

My son, a young teenager, is one of the biggest users of IPv6 in Australia

He likes YouTube

He does about 0.6 Mbps **average IPv6** traffic per month!

If all Australians did that we would do an **average** of **12Tbps** of **IPv6**!

Credits

JANET – Rob Evans
http://webmedia.company.ja.net/edlabblogs/developmenteye/2011/06/13/world-ipv6-day-damp-squib-or-roaring-success/

CERNET – Xing Li

http://www.jp.apan.net/meetings/1102-HK/xing.pdf
http://www.jp.apan.net/meetings/1108-NewDelhi/Xing.ppt

Google

http://www.google.com/intl/en/ipv6/