



ARIN + NANOG

ON THE ROAD

Chicago, IL

9/1/15

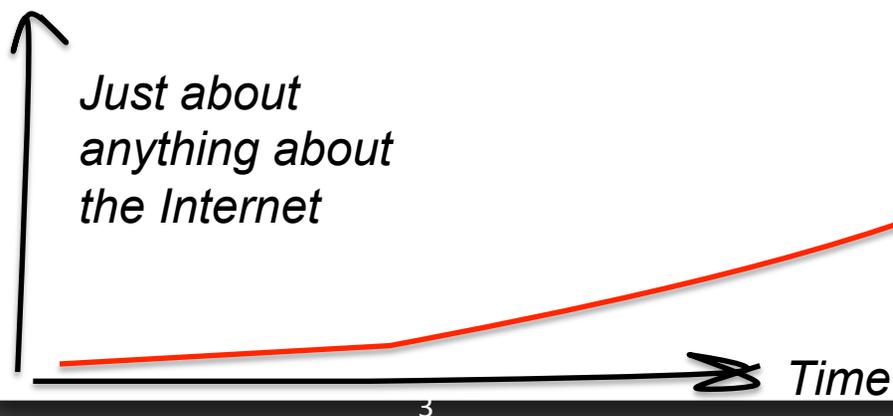
Moving to IPv6

Mark Kosters, Chief Technology Officer

With some help from Geoff Huston

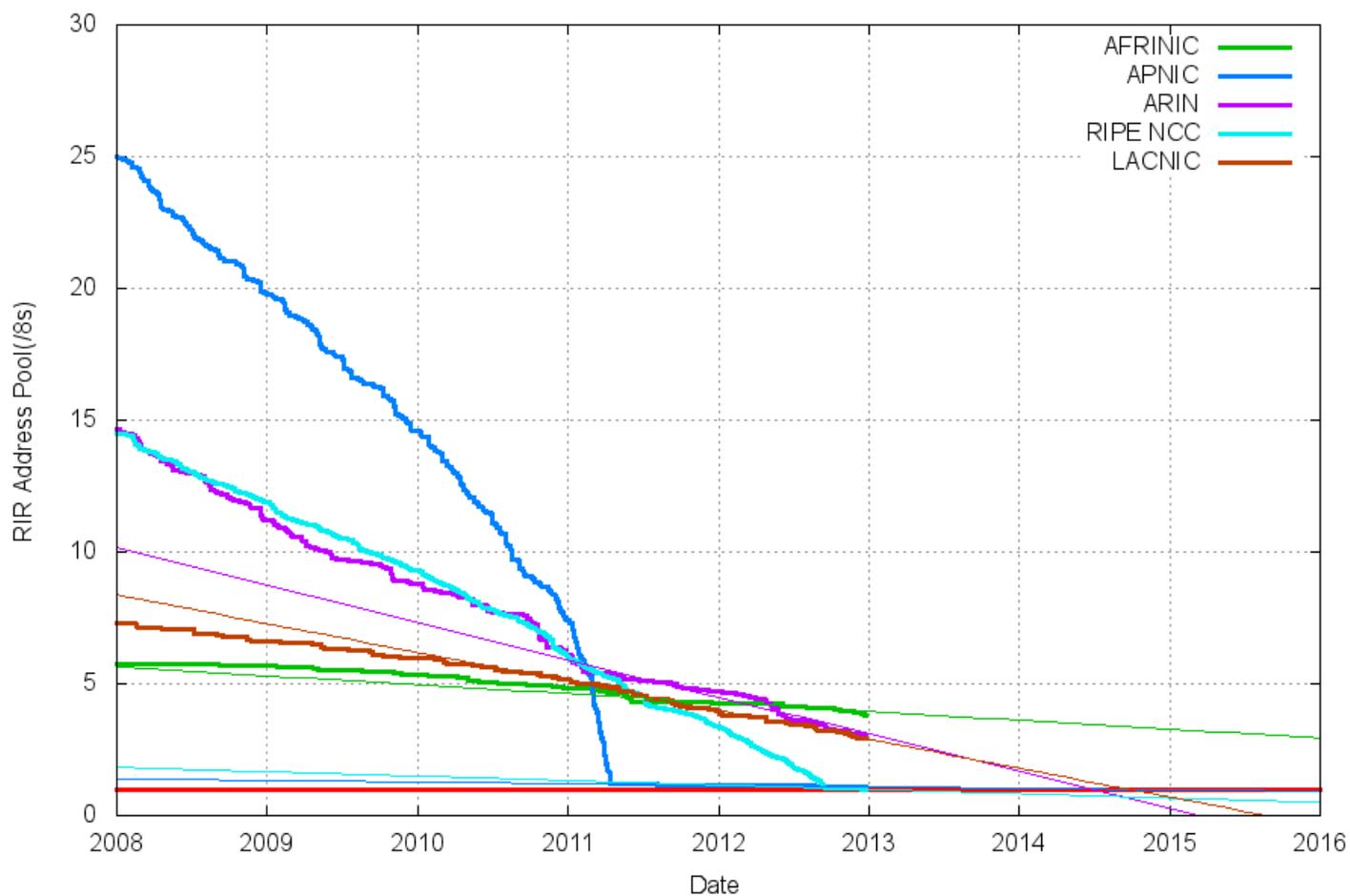
The Amazing Success of the Internet

- 2.92 billion users!
- 4.5 online hours per day per user!
- 5.5% of GDP for G-20 countries

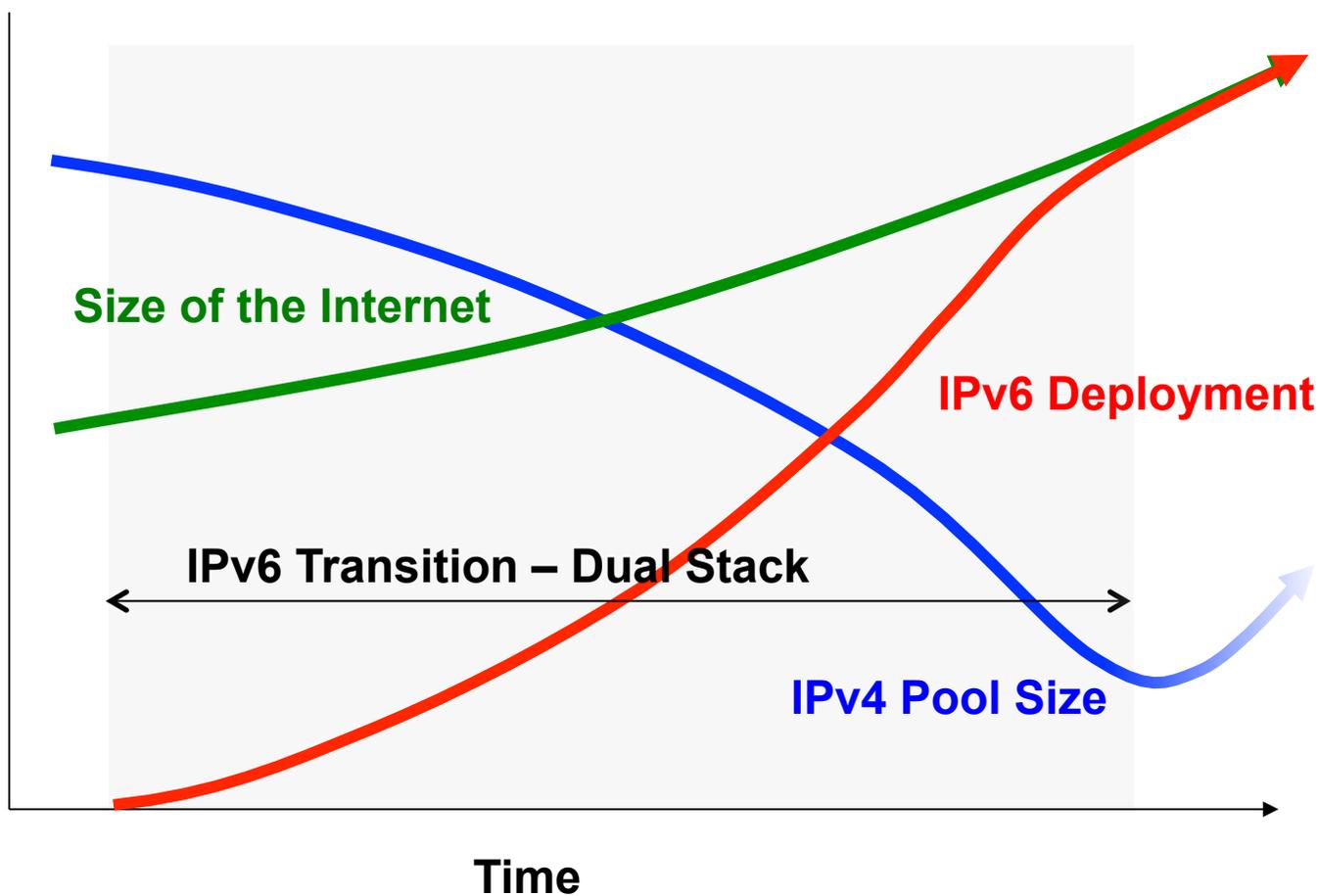


Success-Disaster

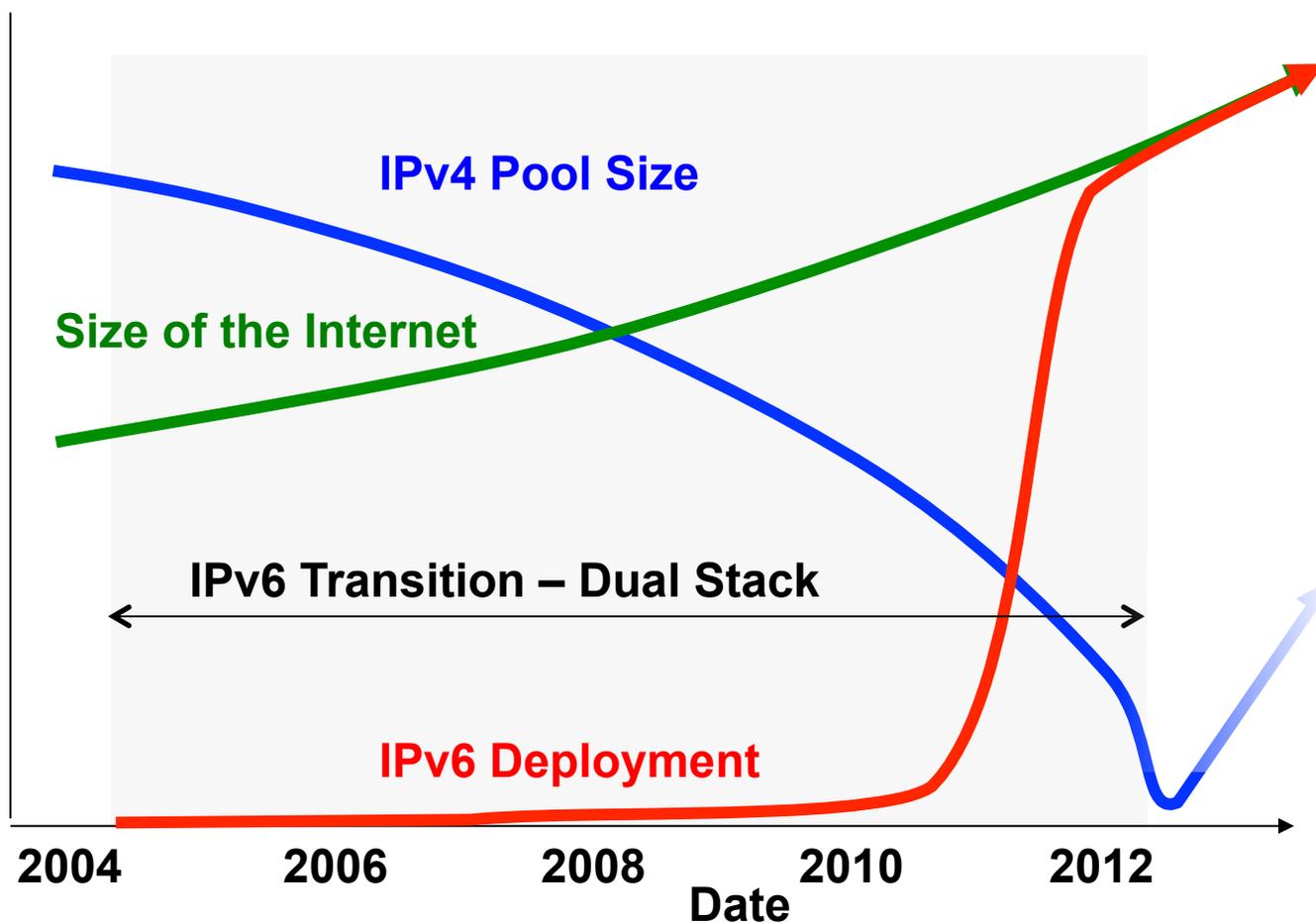
RIR IPv4 Address Run-Down Model



The Original IPv6 Plan - 1995



The Revised IPv6 Plan - 2005

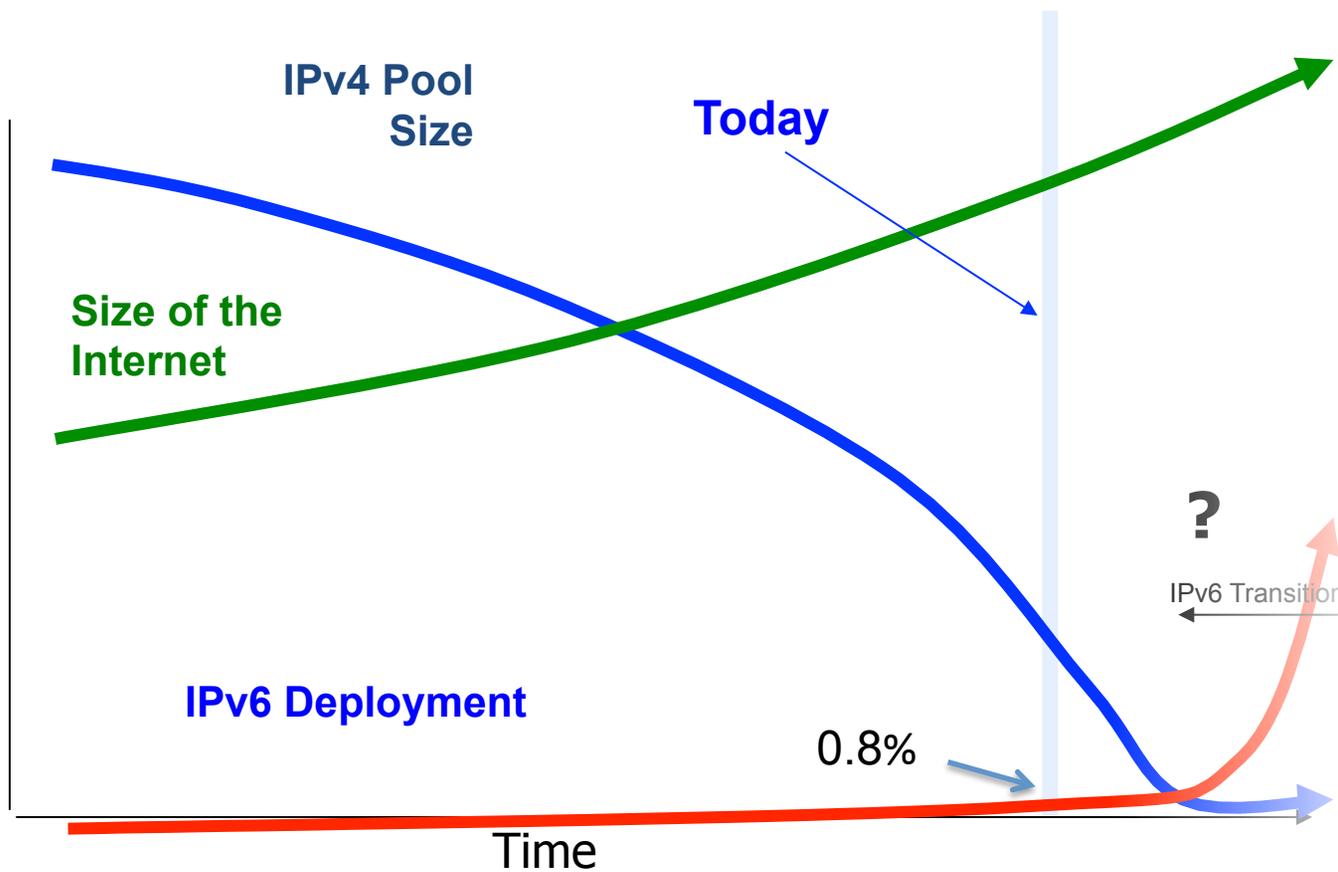


Oops!

We were meant to have completed the transition to IPv6 BEFORE we completely exhausted the supply channels of IPv4 addresses!



Today's Plan



Transition...

The downside of an end-to-end architecture:

- There is no backwards compatibility across protocol families
- A V6-only host cannot communicate with a V4-only host

We have been forced to undertake a Dual Stack transition:

- Provision the entire network with both IPv4 AND IPv6
- In Dual Stack, hosts configure the hosts' applications to prefer IPv6 to IPv4
- When the traffic volumes of IPv4 dwindle to insignificant levels, then it's possible to shut down support for IPv4

Dual Stack Transition ...

We did not appreciate the operational problems with this dual stack plan while it was just a paper exercise:

- The combination of an end host preference for IPv6 and a disconnected set of IPv6 “islands” created operational problems
 - Protocol “failover” from IPv6 to IPv4 takes between 19 and 108 seconds (depending on the operating system configuration)
 - This is unacceptably slow
- Attempting to “bridge” the islands with IPv6-in-IPv4 tunnels created a new collection of IPv6 path MTU Discovery operational problems
 - There are too many deployed network paths containing firewall filters that block all forms of ICMP, including ICMP6 Packet Too Big
- Attempts to use end-host IPv6 tunneling also presents operational problems
 - Widespread use of protocol 41 (IP-in-IP) firewall filters
 - Path MTU problems

Dual Stack Transition

Signal to the ISPs:

- Deploy IPv6 and expose your users to operational problems with IPv6 connectivity

Or

- Delay IPv6 deployment and wait for these operational issues to be solved by someone else

So we wait...

And while we wait...

The Internet continues its growth.

- And without an abundant supply of IPv4 addresses to support this level of growth, the industry is increasingly reliant on NATs:
 - Edge NATs are now the *de facto* choice for residential broadband services at the CPE
 - ISP NATs are now the *de facto* choice for 3G and 4G mobile IP services

What ARIN is hearing from the community

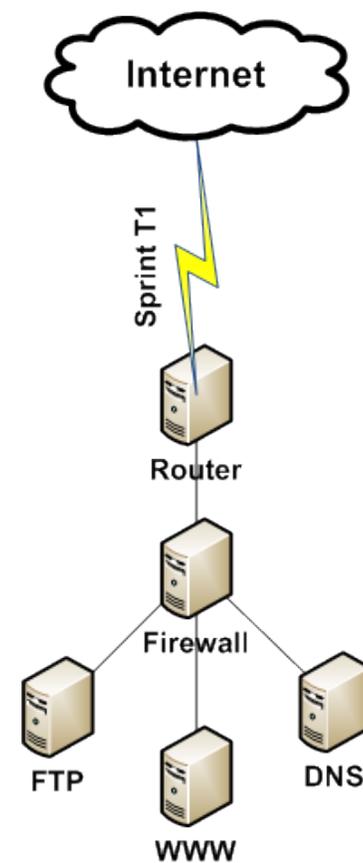
- **Movement to IPv6 is slow**
 - Progress is being made
 - ISPs carefully rolling out IPv6
- **Lots of ISPs purchasing CGN boxes**
- **There is a market for IP space**
 - Rent by month
 - Purchase outright

Why is there little immediate need for IPv6?

- **Some of the claims are either not true or taken over by events**
 - IPv6 gives you better security
 - IPv6 gives you better routing
- **Some positive things**
 - IPv6 allows for end-to-end networking to occur again
 - IPv6 has more address bits
 - It is cheaper per address

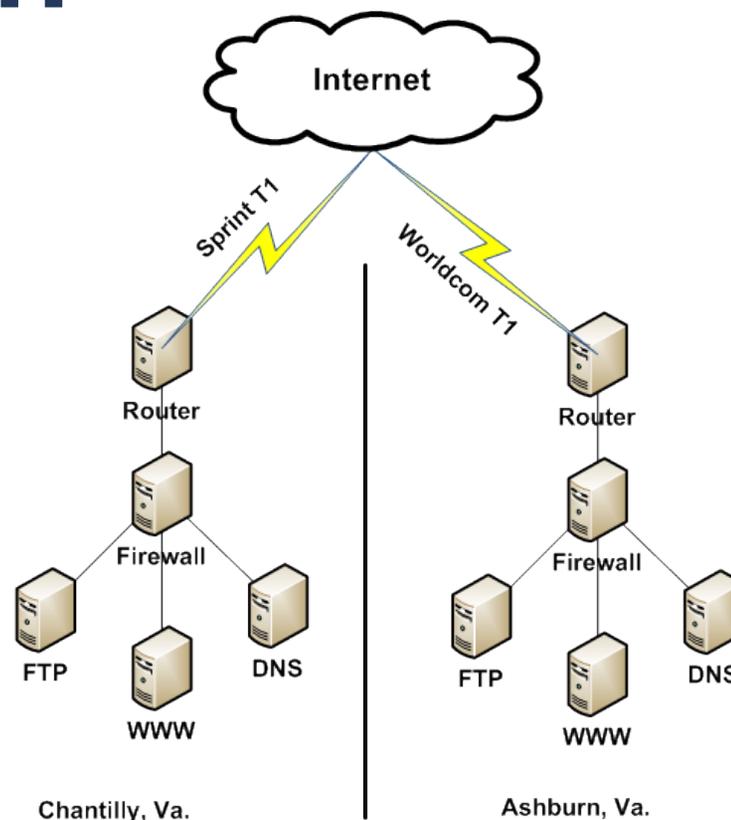
2003: Sprint

- T1 via Sprint
- Linux Router with Sangoma T1 Card
- OpenBSD firewall
- Linux-based WWW, DNS, FTP servers
- Segregated network, no dual stack (security concerns)
- A lot of PMTU issues
- A lot of routing issues
- Service did improve over the years



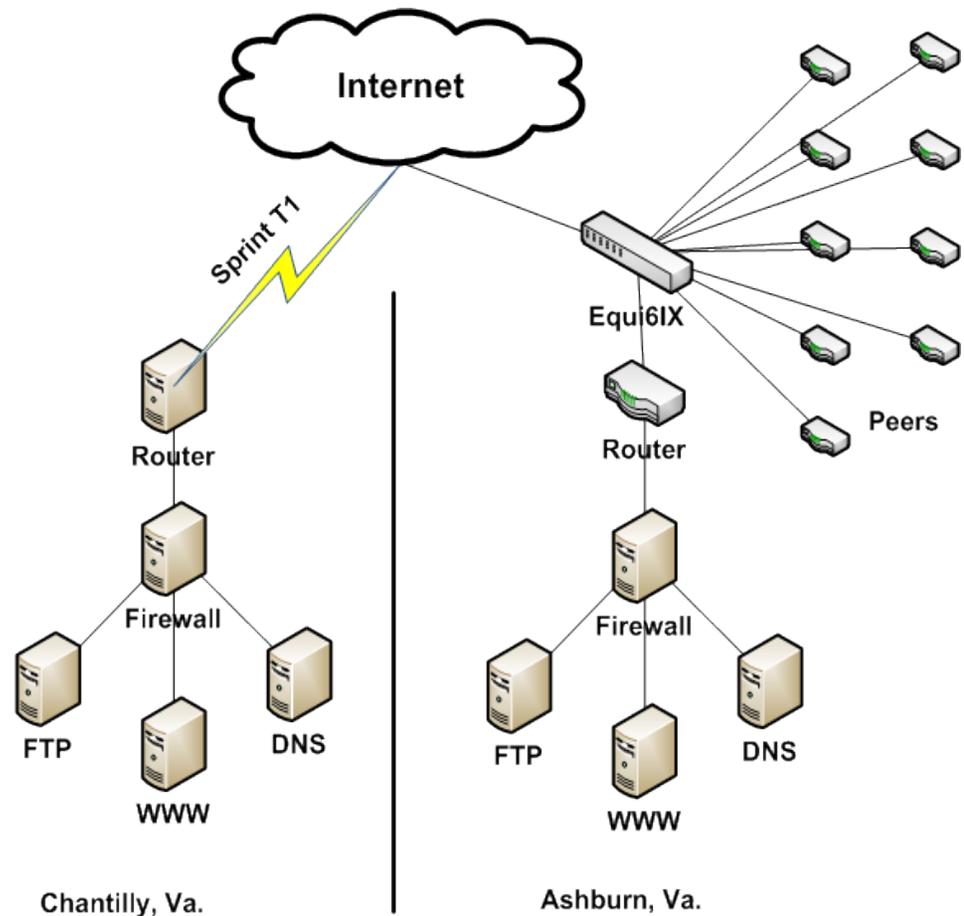
2004: Worldcom

- T1 via Worldcom in Equinix
- Cisco 2800 router
- OpenBSD firewall
- Linux-based ww6, DNS, FTP servers
- Segregated network, no dual stack (security concerns)
- A lot of PMTU Issues
- A lot of routing issues



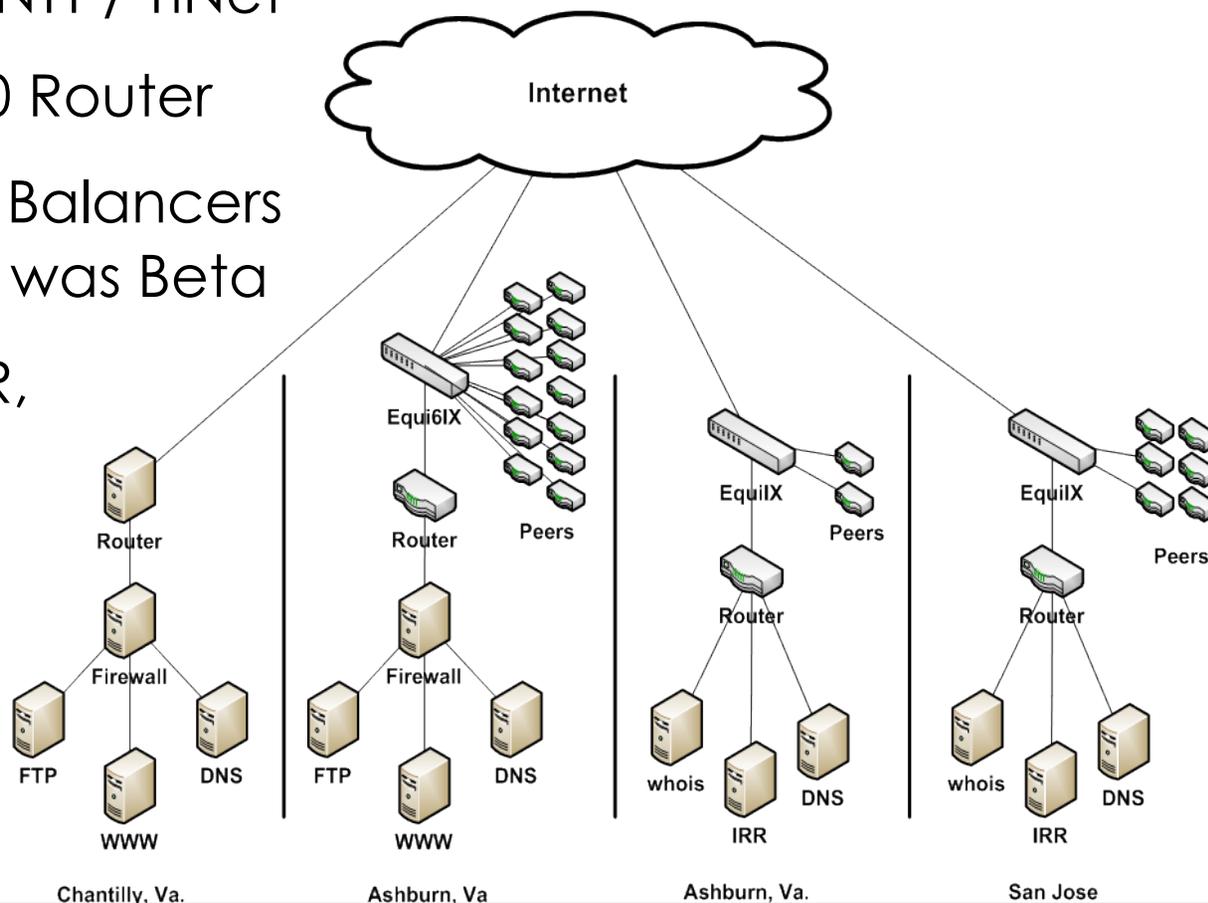
2006: Equi6IX

- 100 Mbit/s Ethernet to Equi6IX
- Transit via OCCAID
- Cisco 2800 router
- OpenBSD firewall
- WWW, DNS, FTP, SMTP
- Segregated Network
- Some dual stack



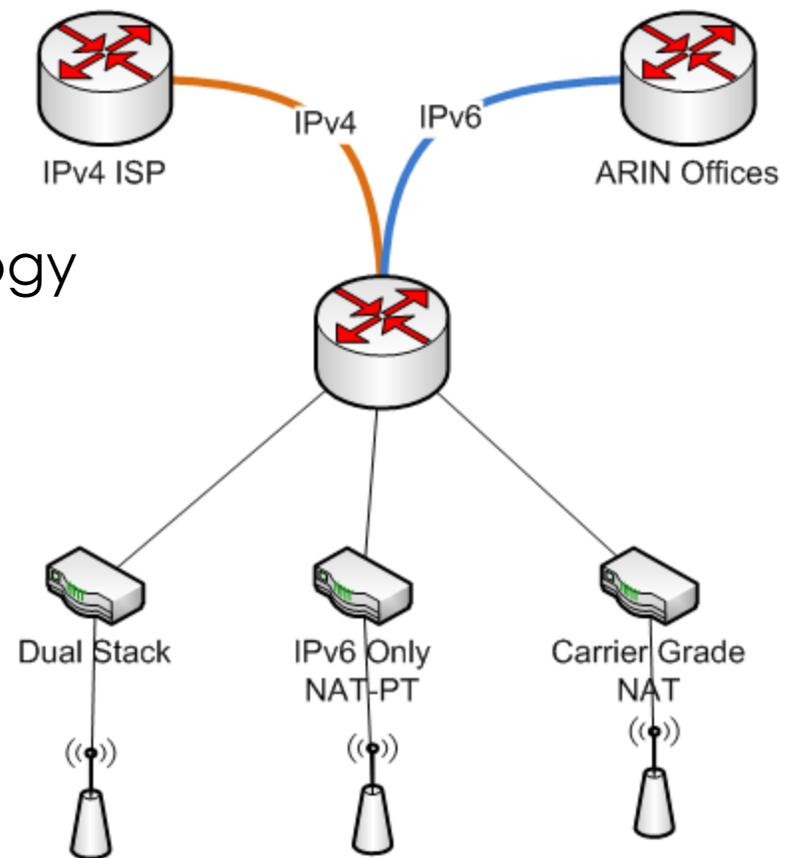
2008: NTT / TiNet IPv6

- 1000 Mbit/s to NTT / TiNet
- Cisco ASR 1000 Router
- Brocade Load Balancers - IPv6 support was Beta
- DNS, Whois, IRR, more later
- Dual stack



Past Meeting Networks

- IPv6 enabled since 2005
 - Tunnels to ARIN, others
- Testbed for transition technology
 - NAT-PT (Cisco, OSS)
 - CGN / NAT-lite
 - IVI
- Training opportunity
 - For staff & members



ARIN's Current Challenges for Networking

- Dual-Stacked Internally
 - Challenges over time with our VPN (OpenVPN)
 - One interface works with v6
 - One does not
- Middleware Boxes
 - Claims do not support reality (“we support IPv6”) Yes, but...
 - No 1-1 feature set
 - Limits ARIN's ability to support new services like https support for Whois-RWS

So why do the move to IPv6?

- IPv4 will get more expensive
- Move to IPv6 will happen when cost is too high for IPv4
- Don't want to be caught with gear that will not support IPv6 before it is end-of-life
- Need to have some experience on IPv6

Call to Action for IPv6

- ISPs should do it now
- Universities should be teaching and making IPv6 available
- Businesses should be asking for IPv6 support for gear and services they purchase
 - Want to be available to all on the Internet
 - If only IPv4 – may miss some IPv6 clientele
- Application developers need to integrate IPv6 support

Call to Action for IPv6

- End users
 - **May be behind CGN**
 - Impacts speed and services
 - Don't want to lose in those real-time games! (CoD gamers in particular)
 - **Ask for IPv6 support**
 - Faster
 - Better application support
 - Less support calls for IPv4

What is ARIN doing about it?

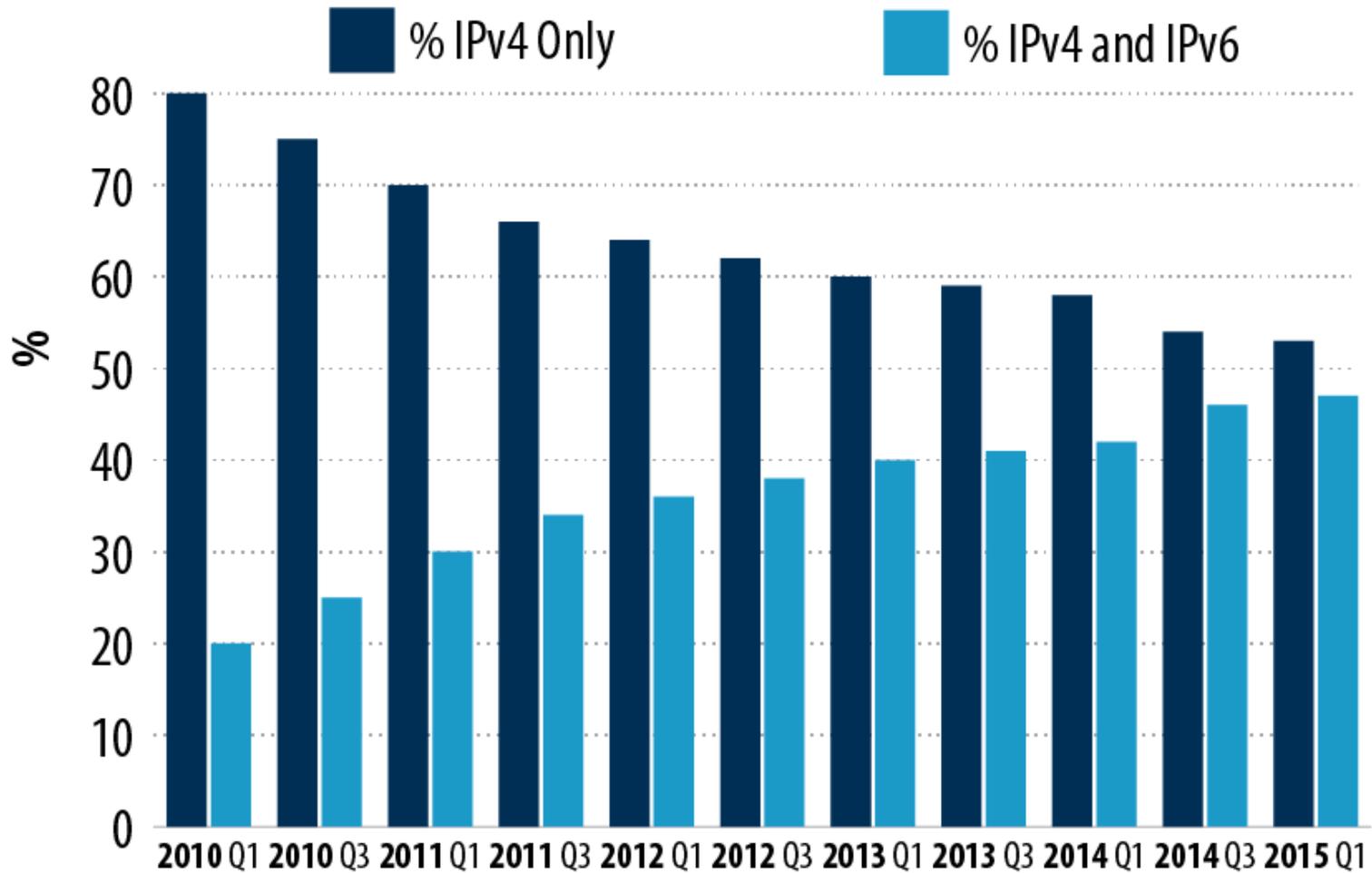
- What we see with Transfers based on market reality
- What we see with IPv6 Allocations



Trends and Observations

- **Comparing the past 12 months over the 12 months prior:**
 - 9% increase in IPv4 requests (3641 > 3981)
 - 18% increase in transfer requests (500 > 648)
 - 2% increase in IPv6 requests (745 > 758)
- **Now that we have run out of IPv4 (or very close to it)**
 - Activity on the Wait List for redistributions from IANA
 - Anticipate a larger number of transfer requests

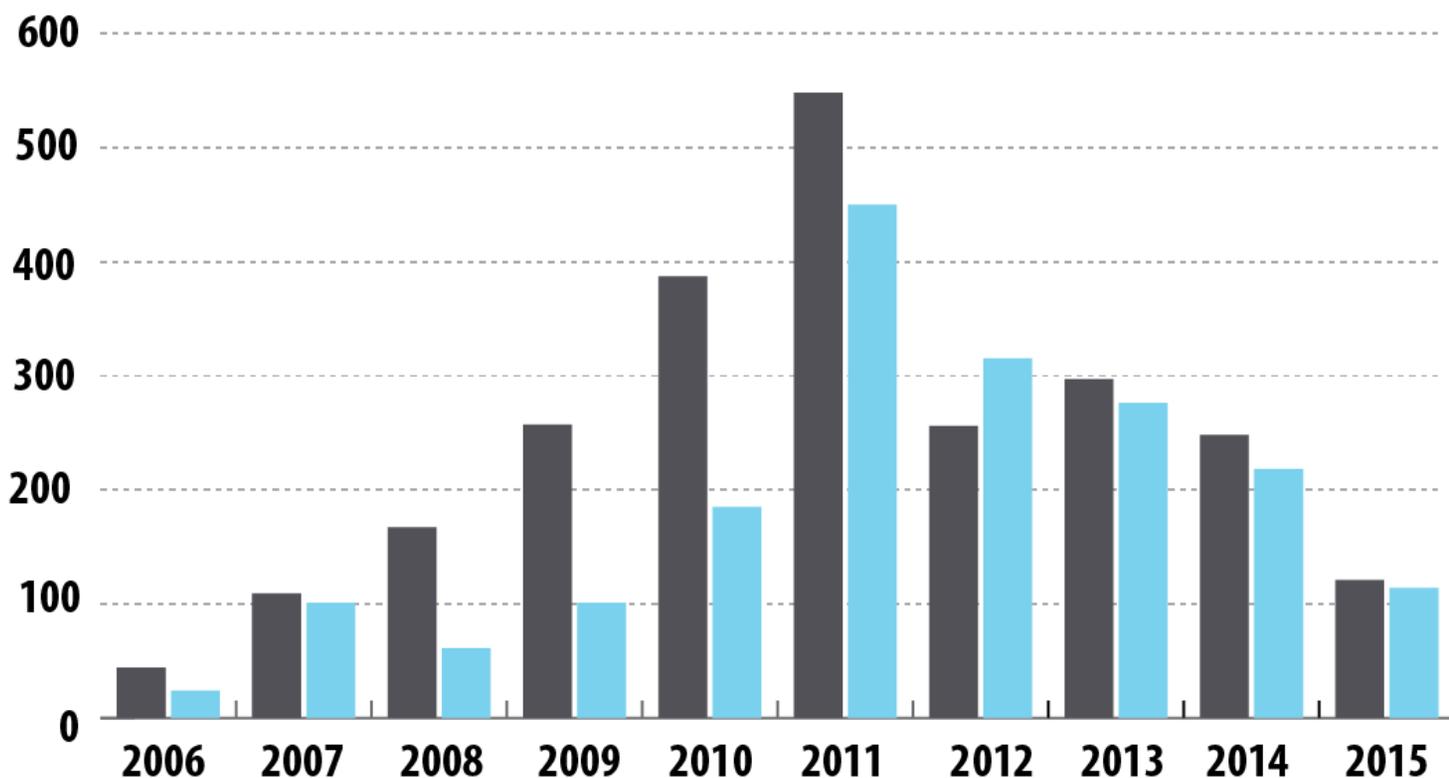
ISP Members with IPv4 and IPv6



5,196 total members as of 31 July 2015

IPv6 over time

■ IPv6 Initial Allocations
■ Total IPv6 Assignments Issued



*As of 30 June 2015

ARIN IPv6 Allocations and Assignments

Get IPv6 from ARIN now!

An advertisement graphic with a dark background and a teal footer. The text is arranged as follows: 'Have IPv4?' in white, 'Getting IPv6 IS EASY!' in teal and white, 'MOST ORGANIZATIONS WITH IPv4 can get IPv6 without increasing their annual ARIN fees.' in white and teal, and 'FIND OUT IF YOU QUALIFY www.arin.net' in white on a teal background.

Have IPv4?

Getting IPv6 IS EASY!

MOST ORGANIZATIONS WITH IPv4
can get IPv6
without increasing their annual ARIN fees.

FIND OUT IF YOU QUALIFY
www.arin.net

Most organizations with IPv4 can get IPv6 without increasing their annual ARIN fees

Learn More

www.GetIPv6.info



IPv6 Info Center

www.arin.net/knowledge/ipv6_info_center.html



www.TeamARIN.net

Operational Guidance

[www.InternetSociety.org/
Deploy360/](http://www.InternetSociety.org/Deploy360/)



www.NANOG.org/archives/



bcop.NANOG.org

[www.hpc.mil/cms2/index.php/
ipv6-knowledge-base-general-info](http://www.hpc.mil/cms2/index.php/ipv6-knowledge-base-general-info)

