



Deploying IPv6 at Scale As an ISP

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October 2015

Agenda

- The key questions of IPv6 deployments
 - **Why?**
 - **Who?**
 - **What?**
 - **Where?**
 - **When?**
 - **How?**
- Key learnings from TELUS
- IP Address Planning
- Big Picture Realities (and expectations)
- Enjoy watching it Scale
- Your Questions

Key Questions of IPv6 Deployment

Question	Key IPv6 Deployment Question
Why	Why would you deploy IPv6?
Who	Who will you involve in IPv6 Deployment?
What	What solutions will you employ?
Where	Where will you deploy IPv6?
When	When will you deploy IPv6 for your customers?
How	How will you do a large scale deployment?

Why? *Why are you deploying IPv6?*

- The following matrix summarizes key reasons for IPv6 deployment

Problem	How IPv6 solve this
Running out of IP Addresses	Virtually limitless resource pool
Customers are asking for IPv6	You make your customers happy
Your customer traffic is NATed	Enable end to end path
Your customers use P2P apps	Enable end to end path (assume some users will begin to be dual-stack with native IPv6 + NAT444)
Potential Internet Regulation	Demonstrates to would-be regulators that self-governance works

Who? *Who will you involve in your IPv6 Deployment?*

- Involve the best and brightest from all business areas in your IPv6 Deployments:
 - Network engineering
 - Operations
 - Security
 - System and Application primes
- Make IPv6 a top corporate priority to secure the best resources
- Focus on long term service alignment around IPv6 rather than quick and dirty
- Be inclusive:
 - IPv6 is not a one time effort
 - but will be a new way of doing business

What? *What solutions will you employ?*

- Consider the continuum of IPv4 through IPv6 and aim for end state of IPv6 only (or as close as you can get)
- What is practical varies by service (e.g.. home internet vs. mobile)
- TELUS offers the following services with the following target solutions preparing for launch

Service	Target IPv6 Solution
Consumer Wireless	IPv6 only
Consumer Home Internet	Dual-stack (with NAT444 as needed)
Business Internet	Dual-stack

Where & When? *Where and when will you deploy IPv6?*

- Immediately adapt peering and transit procedures to include IPv6
 - Paves the way for healthy IPv6 connectivity
- Dual stack your client facing resolving DNS servers
- Consider 6PE if you run an IPv4 MPLS core, then native IPv6 at the edge
- Focus development on new networks
- If applicable, start where IPv4 exhaust is most imminent
- Start with high growth services
- Start where you already rely on NAT
- Learn, adapt and deploy more broadly

Where & When? IPv6 Peering

- In 2012 we modified our behaviour to include IPv6 peering by default where peering partners would accept it
- The following graph shows the share of IPv4 and IPv6 for new peering connections each year:

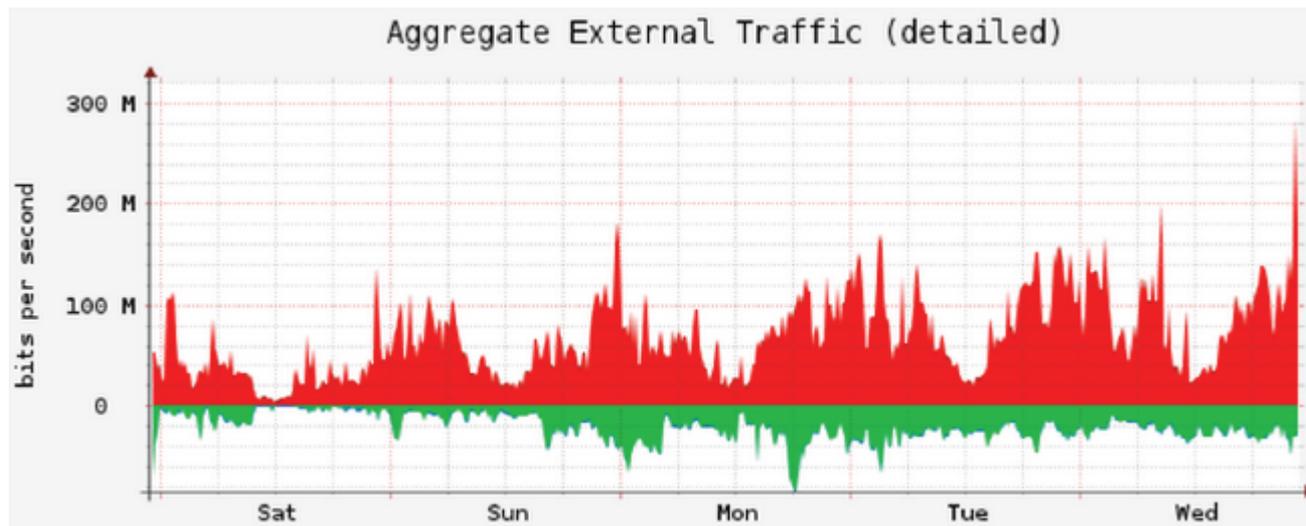


How? *How will you do a large scale deployment?*

- Take opportunities to get experience whenever you can.
- Example: TELUS has provided 7 technical organization conferences with network sponsorship consisting of dual-stack networks beginning with three in Vancouver in 2012
 - ARIN 29: April 2012, Vancouver, BC
 - NANOG 55: June 2012, Vancouver, BC
 - IETF 84: July 2012, Vancouver, BC
 - Several more since
 - Each gave opportunities to gain operational experience in IPv6
 - IETF meeting uncovered missing IPv6 config causing dropped traffic
- Build robust provisioning and support capabilities
- Develop methods for rapid enablement
- Build IPv6 into the scope of all future IP projects

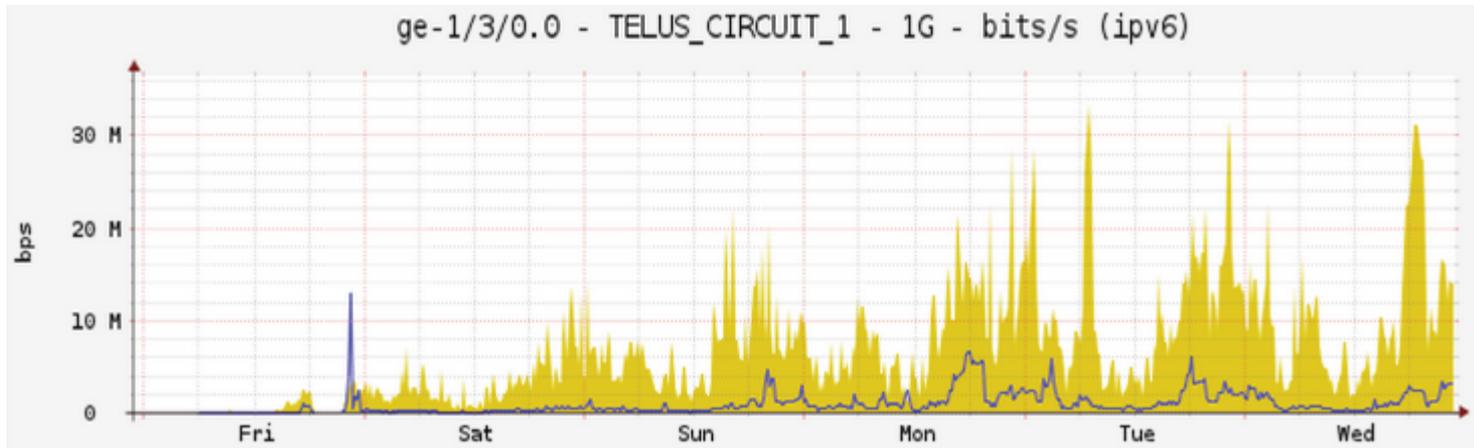
How? *IPv6 Traffic at IETF 88*

- TELUS Provided Network Sponsorship for IETF 88 in Vancouver including IPv6
- We saw the following traffic (combined IPv4 + IPv6)



How? IPv6 Traffic at IETF 88 (continued)

- We saw the following IPv6 Traffic:



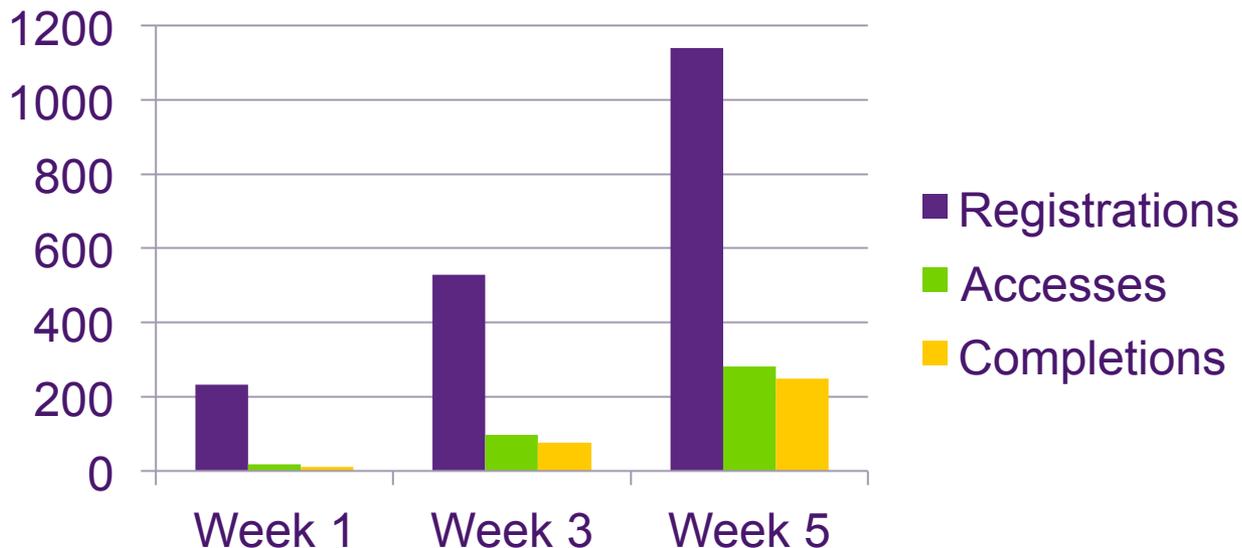
- 10% of traffic was IPv6 (30 Mbps peak IPv6 vs 300 Mbps peak combined)
- Surprisingly low, but there is good news:
 - Not much Netflix and Youtube streaming by IETFers

Key Learnings at TELUS

- IPv6 just works – most users don't even notice
- The network is the easy part – it's layer 8 that's hard
- Policy management, customer records, systems, security are more challenging
- People and processes take some care
- Managing dependencies, interlock with other infrastructure projects
- Invest heavily in communication and training
 - Instructor led training for core teams
 - eLearning for broader teams
 - Company-wide communications
- Take the time to develop a strong IP Address plan with route summarization, geo-location and security in mind
- RIPE Atlas and NLNOG RING probes are useful for verifying and troubleshooting IPV6 connectivity.

Key Learnings: IPv6 Educational Readiness

- Our operational staff needs to be ready for IPv6
- We have recently deployed IPv6 eLearning from Nephos6
- Measuring # of TELUS team members are accessing and completing the eLearning content



Key Learnings: *Challenges*

■ Home Internet:

- Our Home Gateway update to enable IPv6 preceded the network enablement
- To avoid a flood of DHCPv6 / Radius we needed to sequence enablement
- Enable IPv6 in Policy management first, then DHCPv6 Option 18 on access device, then Option 18 on the subscriber profile
- CGN/NAT444 roll-out targeted less sophisticated subscribers
- CGN/NAT444 did break rigidly port seeking applications (desktop sharing)

■ Wireless:

- Different Mobile OS's dictate different strategies on IPv6 enablement by OEM
- LTE Chipset issue dropping data connectivity for several minutes in roaming scenarios
- Own set of MTU challenges

IP Address Planning

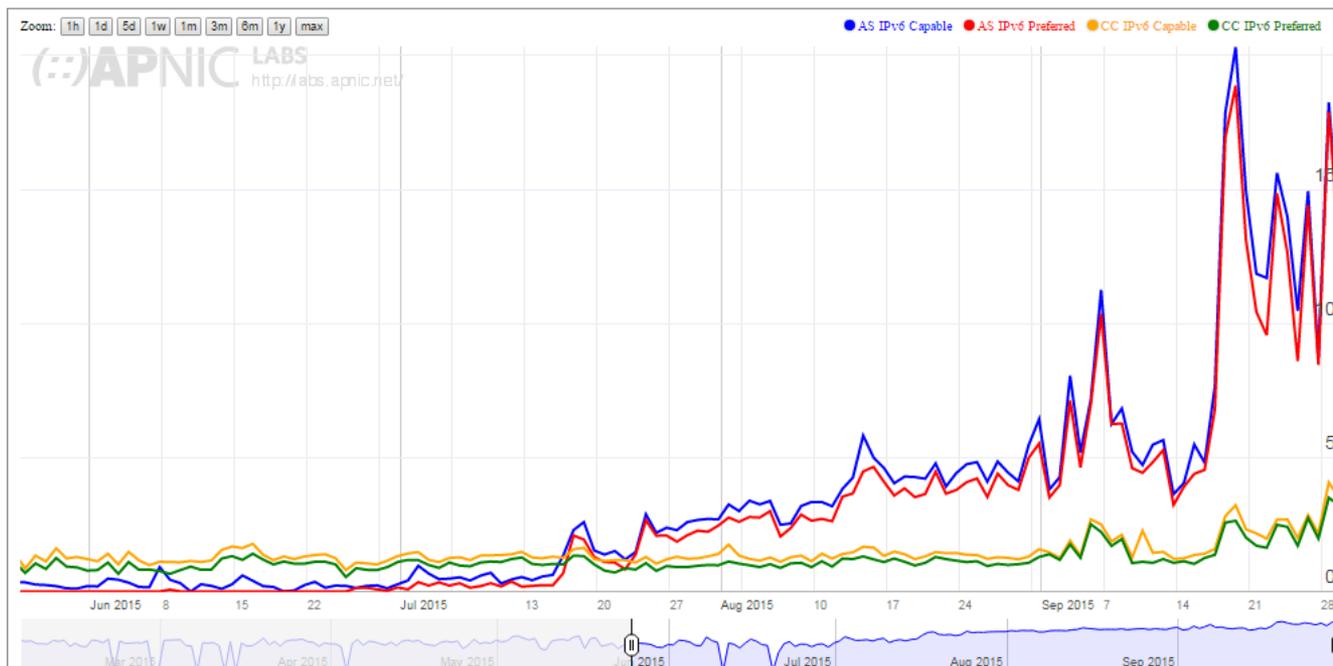
- Use nibble boundary religiously (exploit hex notation)
- Regional blocks for summarization of routes, coarse geo-location
- A little goes a long way:
 - A single /64 can contain all your regional point to points whether /127 or /126
 - A single /64 can contain all your regional loopback IPs you need
 - A single /48 can contain all your regional infrastructure
- Service addressing (quasi-classful)
 - /48 Business LAN, Static Assignments
 - /56 Consumer LAN, DHCP-Prefix Delegation
 - /64 Consumer Mobile Handset, DHCP
- Don't take a chance with ULA
- Enjoy the abundance of unique IP Address space

Big Picture Realities *(and expectations)*

- Not all ISPs will exhaust their IPv4 addresses in the next 3 years
- IPv6 will offer the most reliable end to end path between endpoints as NAT444 is increasingly and necessarily deployed by those ISPs which are exhausting
- Everyone has good reason (content, application, OEM, OS, ISP) to adopt IPv6 for the benefit of end users
- IPv6 traffic will surpass 50% of global Internet traffic within 3 years
- It takes time for an ISP to go from program inception to deployment
- Get going!

Enjoy Watching it Scale

- Once you define the services and handle the details, watch it scale!
- The following is from <http://stats.labs.apnic.net/ipv6/AS852>



Enjoy Watching it Scale

- You might even make a difference for your country
- The following is from Cisco's presentation of Google data <http://6lab.cisco.com/stats/cible.php?country=CA&option=users>



Your Questions





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