IPv6 at Verizon Wireless

APNIC 34
• Largest mobile carrier in US with >94 M subscribers

• Operate LTE and CDMA networks

• Legacy VZW RAN (1x and HRPD) only supports IPv4
  – Originally globally routable IPv4 addresses were assigned to UE, but starting in late 2010 NAT IPv4

• Launched LTE in 4Q 2010

• One of the largest IPv6 networks in existence

• Possibly the highest IPv6 penetration of any mobile carrier the world
Drivers behind move to IPv6

- VZW recognized that IPv6 was a necessity not something “optional”
  - Built the network regardless of IPv6 enabled content

- IPv4 address exhaustion
  - Issue exasperated by modern “always-on” smartphones
  - Workaround: CGN

- IPv4 NAT problematic in certain situations
  - Certain apps / protocols have issues working with NAT
  - Prolongs the move to IPv6
  - IP based auth does not work
Drivers behind move to IPv6

- IPv6 allows us to provide globally routable addresses again
  - No more NAT
  - Higher quality connection

- IPv6 allows VZW to support accelerated growth of mobile
• VZW made a conscious decision to support IPv6 as part of LTE deployment, in fact, we require it
  – Good time to do it as we were starting out fresh
  – Leverage eHRPD to provide transition between old and new RAN while adding support for IPv6 on 3G side

• LTE core addressed using IPv6

• Dual stack support on LTE UE’s
  – For all APN’s (IMS, Internet, etc)
LTE and IPv6

- **IMS APN**
  - IPv6 only
    - UE request v4v6 PDN_TYPE as part of PDN connection req
    - Network assigns IPv6 only for default and dedicated bearers
  - SMS over IMS
  - VoLTE (future)

- **Internet, Admin, App APN’s**
  - Dual stacked
  - Globally routable IPv6 address (/64 prefix)
  - NATed IPv4
  - IPv6 preferred over IPv4
• World IPv6 Day (2011) was first true test of VZW IPv6 network

• Google white lists VZW DNS resolvers and leaves them white listed

• Latent issues start to be uncovered as a result of Google services / apps running over IPv6
  – Peering issues
  – Network issues
  – Device issues
World IPv6 Day – Learning’s

- IPv6 related issues had low customer impact because very little content stayed dual stacked after W6D

- VZW requests Google to take VZW DNS resolvers off the white list while working on issues

- Start of 8 months of hard work from VZW, network vendors and device vendors to fix IPv6 related issues before W6L

- Updates to test methodology for IPv6 related device testing

- Updates to issue detection and resolution (Network and Device)
World IPv6 Day – Learning’s

• Google’s “de-whitelisting” of VZW masks v6 issues

• Leaves VZW with a chicken and egg situation
  – We realized there may be additional latent issues but we can’t effectively weed them out without IPv6 / dual stacked content
  – Lack of content makes it very difficult to find and fix issues
  – NOTE: this is no longer an issue post W6L

• VZW Innovation Center lab pointed to Google DNS resolvers so Google dual stacked services can be tested in lab environment
  – Additional device side bugs uncovered and fixed
  – Some very esoteric bugs uncovered during handover testing
VZW met criteria to join W6L right from beginning

Decision to join / not join was made after ensuring that any known issues would be resolved before W6L

Network expansions caused some minor hiccups few weeks before W6L, but these were quickly resolved
World IPv6 Launch

- Continuous feed of stats on IPv6 provided by key content providers with dual stacked content
- Built robust network-based mechanisms to track and pinpoint IPv6 failures
- Pushed out software updates to multiple devices models to fix IPv6 related issues

- Training and education

- Established daily calls for months before W6L
- War Room setup to support Launch
Post World IPv6 Launch

• Very successful launch, no issues found

• 50% growth in IPv6 traffic in a little over 2 months
  – 7.36% IPv6 traffic (per W6L stats on June 8th); 10.64% IPv6 traffic (per W6L stats on Aug 8th)
  – 10.7% of all measurements for VZW over IPv6 (Google stat from June); 16.6% of all measurements for VZW is over IPv6 (Google stat from Aug)

• 38% of all IPv6 traffic per Akamai measurements are from VZW (more than double of the second highest network)

• VZW continues to see a steady growth of IPv6 as LTE device penetration and IPv6 enabled content increases
Stats

Source: Google Inc

16+ %
A closer look at what Akamai saw during the World IPv6 Launch:

**IPv6 Addresses**
- 280,229 in 2011
- 18,999,253 in 2012

**IPv6 Requests**
- 8,343,590 in 2011
- 3,394,971,156 in 2012

The above comparisons are for 24-hour periods (6/8/2011 and 6/6/2012).

**Types of Addresses**
- 2.6 million 6to4 & TEREDO
- 16.5 million Native IPv6

**Observations**

**Request Distribution by Network**
- AT&T (US): 18.1%
- FREE (France): 16.5%
- RCS & RDS (Romania): 7.3%
- COMCAST (US): 3.7%
- TANet (Tawan): 0.9%
- KDDI (Japan): 0.8%

**Native IPv6 Address Distribution by Geo**
- USA: 73%
- France: 15%
- Japan: 3.7%
- Romania: 3%
- Germany: 0.7%
- Other Europe: 3%
- Other Asia: 1.4%
- Other <1%

Conclusions

• Don’t delay

• Don’t be half-hearted
  – Make sure IPv6 is supported consistently where network seamlessness is available
  – Make the commitment and stick to it regardless of challenges

• Can be done and done well
  – VZW has already done much of the hard work. Network equipment and device OEM’s have learned a lot from IPv6 deployment at VZW
  – Lack of content provider support is no longer the case and/or valid excuse for an operator or device / network infrastructure vendor
Conclusions

- Ensure proper testing on both device and network side
- Ensure there is enough awareness and training from the highest levels to lowest levels of org