IPv6 at Verizon Wireless

APNIC 34

Background

- **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**

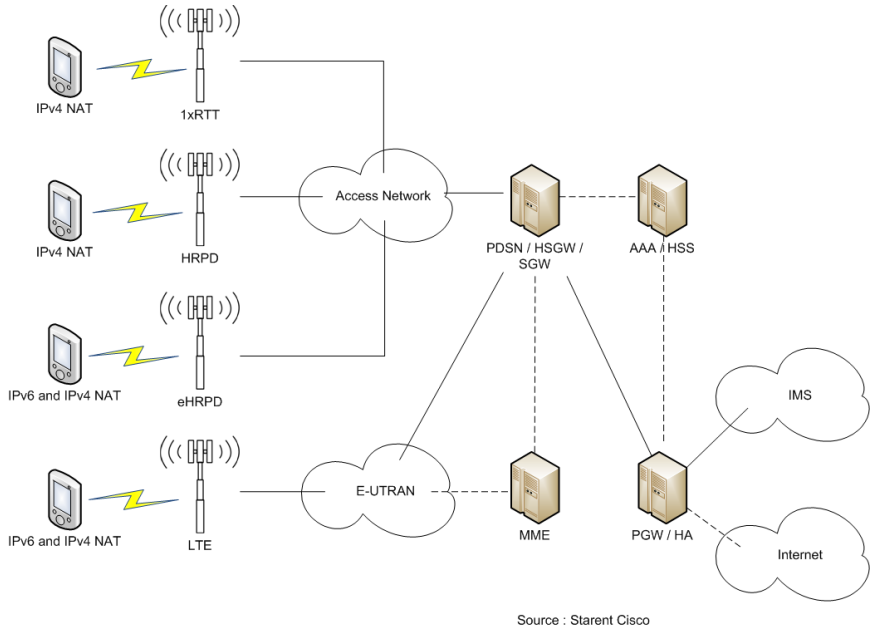
- **IPv6 allows VZW to support accelerated growth of mobile**

LTE and IPv6

- **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)**



Source : Starent Cisco

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 - June 2011

- **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)**

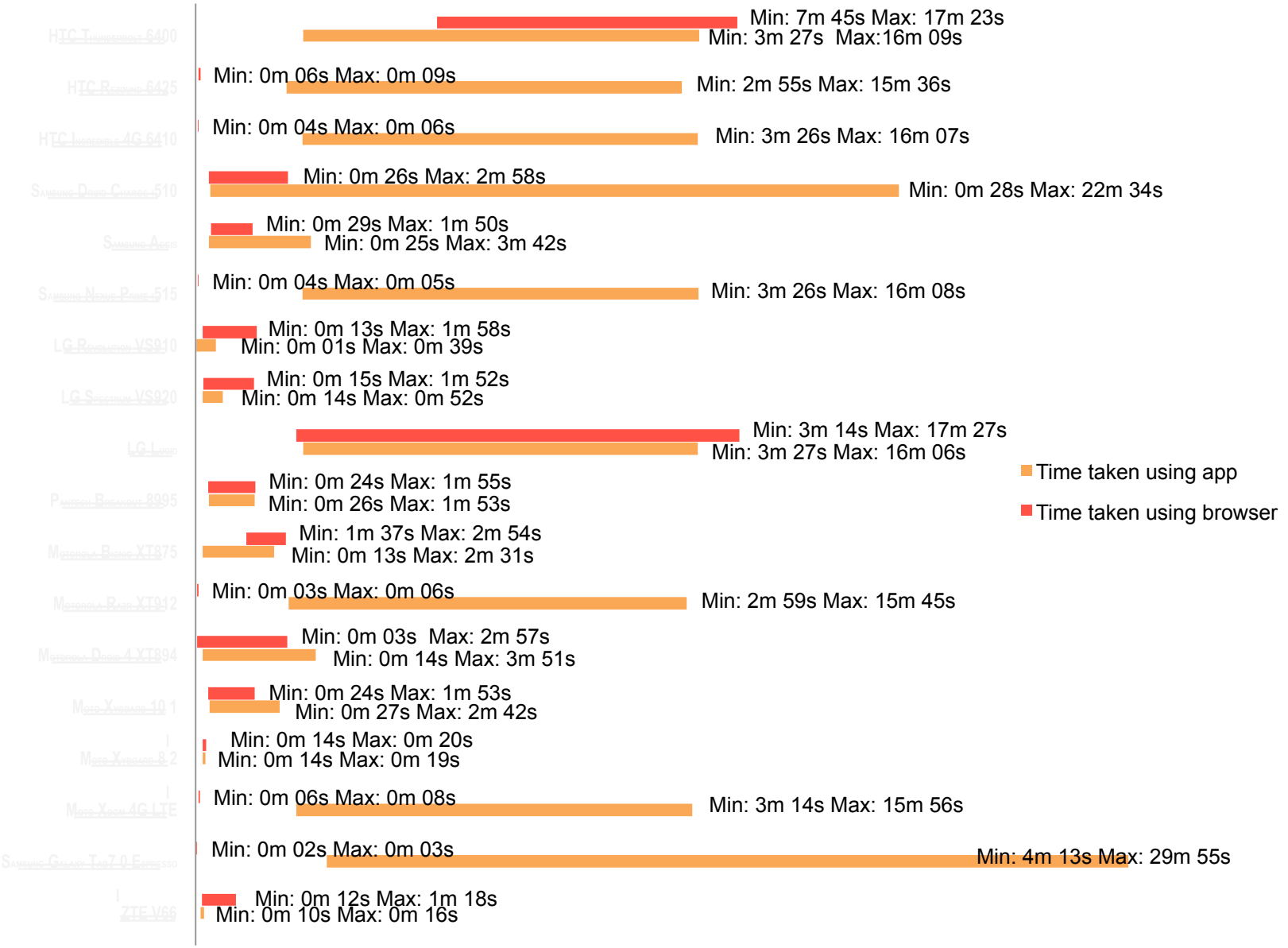
World IPv6 Day – Learning's

- **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 cant 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**

IPv6 to IPv4 Fallback Performance



World IPv6 Launch

- **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**

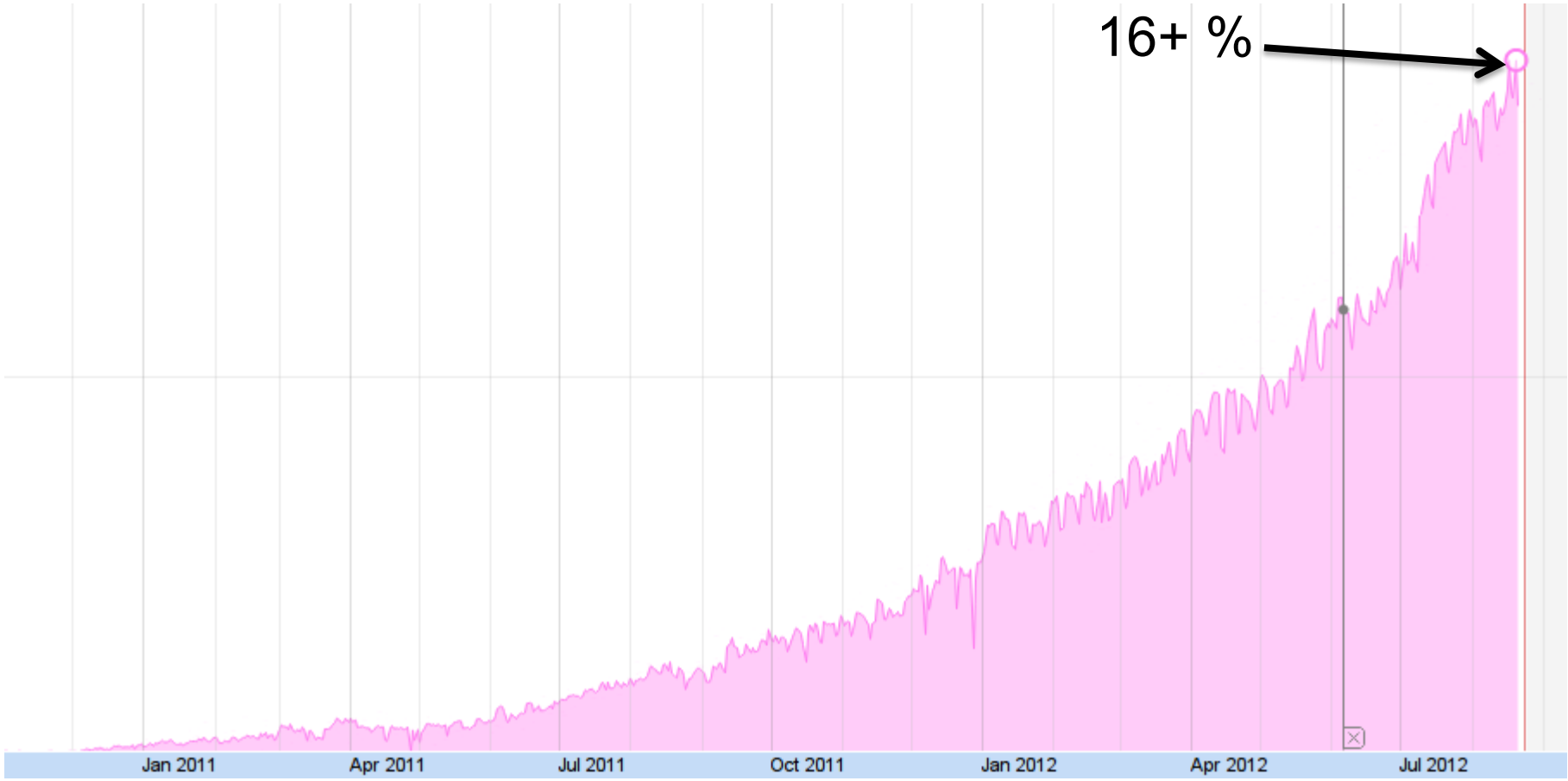
World IPv6 Launch

- **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

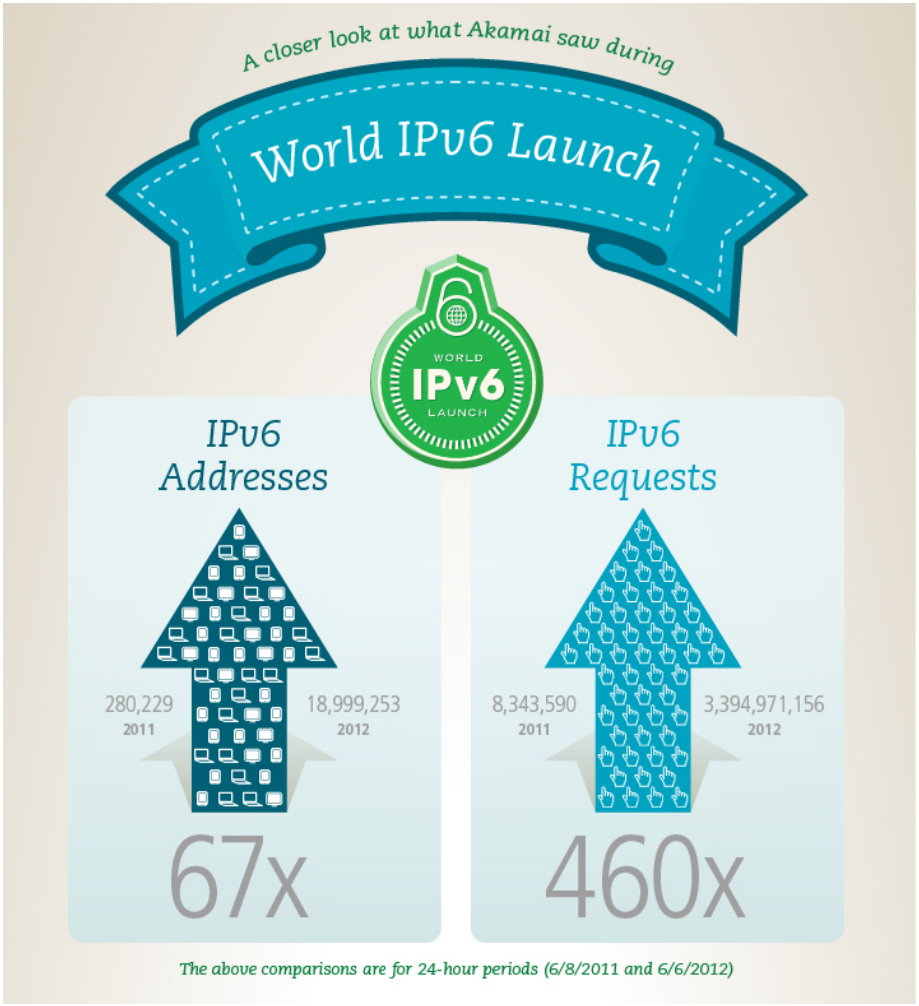
- **Very successful launch, no issues found**
- **50% growth in IPv6 traffic in a little over 2 months**
  - **7.36% IPv6 traffic (per W6L stats on June 8th); 10.64% IPv6 traffic (per W6L stats on Aug 8th)**
  - **10.7% of all measurements for VZW over IPv6 (Google stat from June); 16.6% of all measurements 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**

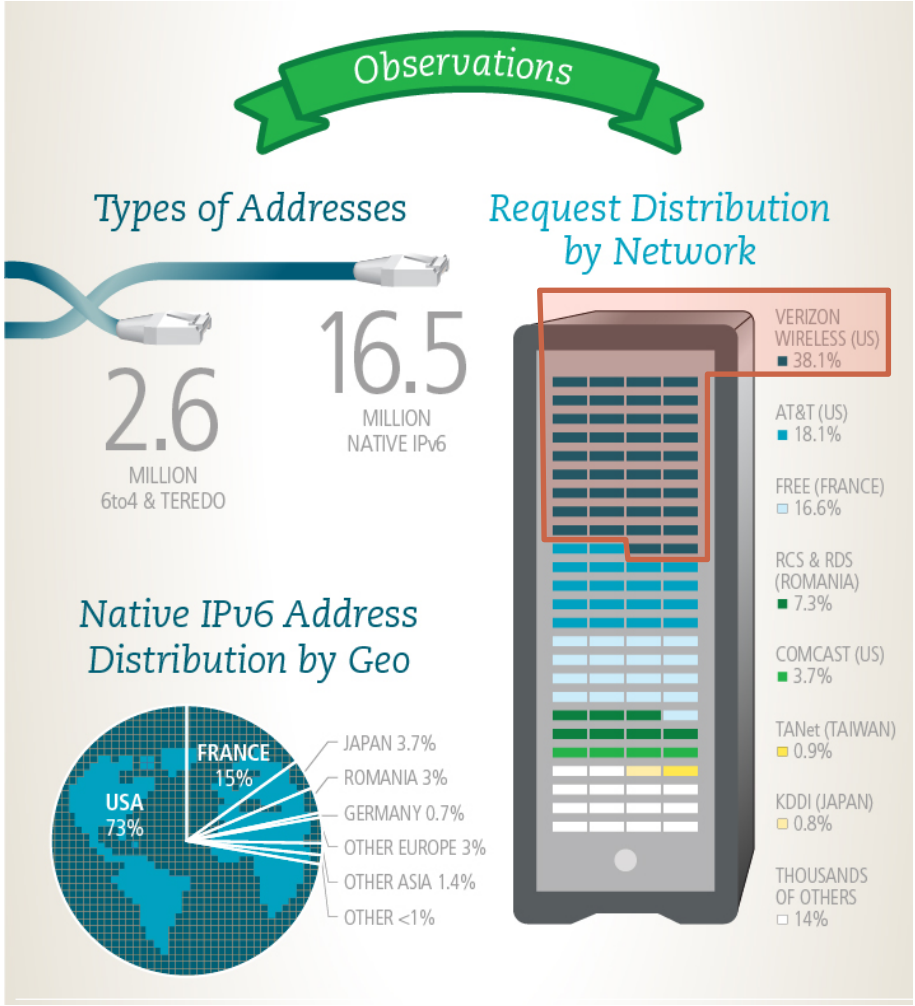
Stats



Source : Google Inc

Stats





Source : Akamai Blog (https://blogs.akamai.com/Akamai_IPv6_Infographic_V3.jpg)

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**