World IPv6: Launched!

Leslie Daigle, moderator.
Chief Internet Technology Officer
The Internet Society
We are…

Not at the IETF

- Taking discussion up a level
- Taking any identified work items to the appropriate IETF WGs

“On the air”

- Streaming
- Recording

Stopping at 12:45pm so you can all get back to the IETF…
World IPv6 Launch – June 6 2012

What it was

- Content providers – IPv6 on front door permanently
- Access providers – IPv6 available as regular service, min 1% traffic over v6 to content providers
- CPE vendors – IPv6 on by default

What it was not

- Turning off IPv4

Important takeaways

- IPv6 is launched
- This was a phenomenal collaborative industry effort
Follow us...

http://www.worldipv6launch.org

More blog posts.

More data will be posted by participants

Not too late for access providers to sign up
The Panel

Leslie Daigle (Moderator)
Mat Ford, Internet Society
George Michaelson, APNIC
John Brzozowski, Comcast
Lorenzo Colitti, Google
Lee Howard, Time Warner Cable
Erik Nygren, Akamai
The agenda

Remarks – data from the panelists

Discussion among the panelists

Discussion with the floor
We’ll have to keep a close eye on time...
### Network operator measurements, 11th June 2012

<table>
<thead>
<tr>
<th>Participating Network</th>
<th>ASN(s)</th>
<th>IPv6 traffic</th>
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<tbody>
<tr>
<td>Free</td>
<td>12322</td>
<td>17.35%</td>
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<td>ATT</td>
<td>6389, 7018, 7132</td>
<td>4.06%</td>
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<td>KDDI</td>
<td>2516</td>
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<td>RCS &amp; RDS</td>
<td>8708</td>
<td>16.65%</td>
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<td>7922, 33287, 33401, 33650, 33651, 33652, 33657, 33668</td>
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<td>Verizon Wireless</td>
<td>6167, 22394</td>
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<td>UniNet</td>
<td>4621</td>
<td>13.78%</td>
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<td>CESNET</td>
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<tr>
<td>GARR</td>
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</tr>
<tr>
<td>Karlsruhe Institute of Technology (KIT)</td>
<td>34878</td>
<td>10.91%</td>
</tr>
</tbody>
</table>

Data sources: Google, Facebook, Yahoo! – for details, see [http://www.worldipv6launch.org/apps/ipv6week/measurement/timeline-nets.html#notes](http://www.worldipv6launch.org/apps/ipv6week/measurement/timeline-nets.html#notes)
Websites – breadth and impact

Source: Lars Eggert, http://eggert.org/meter/ipv6
Traffic

Total IPv6 Traffic - monthly

Cur = 3.1 Gbps
Avg = 2.6 Gbps
Max = 4.0 Gbps
Min = 1.2 Gbps

Copyright (c) 2012 AMS-IX B.V.  Updated: Tue Jun 25 14:55:01 2012 CET

Sources: AMS-IX, DE-CIX
George Michaelson
APNIC
How to measure a million end users

• be  www.google.net

Or

• Get your code run on millions of machines
Placement

At low CPM, the advertising network needs to present unique, new eyeballs to harvest impressions and take your money.

– Therefore, a ‘good’ advertising network provides fresh crop of unique clients per day
– Pay for placement of ads, embed measurement in flashcode.
– Result is lots of Unique IP addresses to measure.
What are we finding?

- [http://labs.apnic.net/ipv6_measurement](http://labs.apnic.net/ipv6_measurement)
  - Breakdowns by ASN, Economy, Region, Organisation
- 125+ economies provide >200 samples/interval consistently in weeklies
- 150+ at monthlies.
- 2400 ASN provide graphable data
- Over 35,000 ASN seen during the last year.
Google visualization API

CA
IPv6 preferred: 0.0976467

US
IPv6 preferred: 1.30245
Google visualization API

IPv6 measurements for Canada

| Map | Preference 30 day average | Capability 30 day average | Preference 7 day average | Capability 7 day average | Select an Economy | Sample Count |

IPv6 Preference 30 day moving average
Google visualization API

**IPv6 measurements for the United States of America**

<table>
<thead>
<tr>
<th>Map</th>
<th>Preference 30 day average</th>
<th>Capability 30 day average</th>
<th>Preference 7 day average</th>
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<th>Select an Economy</th>
<th>Sample Count</th>
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**IPv6 Preference 30 day moving average**

- **JSON CSV**
<table>
<thead>
<tr>
<th>Index</th>
<th>ISO-3166 Code</th>
<th>Internet Users</th>
<th>V6 Use ratio</th>
<th>V6 Users (Est)</th>
<th>Population</th>
<th>Country</th>
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<tbody>
<tr>
<td>1</td>
<td>RO</td>
<td>8666554</td>
<td>8.12%</td>
<td>703724</td>
<td>22108557</td>
<td>Romania</td>
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<td>2</td>
<td>FR</td>
<td>49989738</td>
<td>4.03%</td>
<td>2014586</td>
<td>64753547</td>
<td>France</td>
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<tr>
<td>3</td>
<td>LU</td>
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<tr>
<td>6</td>
<td>US</td>
<td>247741029</td>
<td>1.19%</td>
<td>2948118</td>
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<td>7</td>
<td>NO</td>
<td>4576107</td>
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<td>DE</td>
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<td>0.40%</td>
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Date: 19 Jul 2012

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<td>61636463</td>
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### IPv6 measurements for World IPv6 Event 2012

http://labs.apnic.net/ipv6-measurement/W6L

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<td>RCS &amp; RDS</td>
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<td></td>
</tr>
</tbody>
</table>
A word for our sponsors

• Thanks to
  – the Internet Society
  – Google
  – ISC
  – RIPE NCC

• For funding, platform support, collaboration
• Don’t Click on the ad if you see it! (costs more)
John Brzozowski
Comcast
World IPv6: Launched!

ISOC Panel, IETF 84
John Jason Brzozowski, Comcast
July 31, 2012
Transition Update

- Approximately ~2.0% of Comcast’s customers provisioned with native dual stack broadband
  - 100% increase since May 2012
  - ~70% standalone computers
  - ~30% customer home routers
- Split shifting rapidly (~76/~24) as of June 2012
- IPv6 is deployed to approximately 50% of Comcast’s broadband network
- Percentage of IPv6 traffic remains below 1% (and growing) of overall Internet traffic
  - ~6% (peak) of Olympic YouTube traffic on the Comcast network being served to Comcast customers over IPv6
Customer Premise Equipment Breakdown

• Standalone computers
  • Almost exclusively devices running IPv6 capable Microsoft operating systems
  • Microsoft IPv6 capable based devices represent ~65% of all IPv6 enabled customer devices today

• Customer home routers
  • Largely retail customer home routers
  • Open source or other customer home router platforms also supported and interoperable
    • FreeBSD-based, pfSense, Linux-based, etc
  • Detailed analysis of customer home router adoption underway
Adoption

- Estimated traffic percentage per IPv6 enable customer observed up to 40%
  - Bulk of IPv6 traffic represented by YouTube, Netflix, and iTunes App Store
  - Does not include Olympics over IPv6 care of YouTube
- Per device and operating system analysis underway
  - Important indicator of IPv6 adoption across the consumer electronics ecosystem
Customer Experience

• Infrastructure monitoring and reporting
  • Ensures infrastructure serving our customers has IPv4 and IPv6 parity
• Real time reachability validation and verification
  • Based on destination popularity
  • Simulates customer activity
  • Identifies anomalies and issues proactively
• Leverage metrics to manage and measure the IPv6 deployment

![IPv4 and IPv6 time comparison](image-url)
John Jason Brzozowski
john_brzozowski@cable.comcast.com
http://www.comcast6.net
World IPv6 Launch

Lorenzo Colitti
IETF 84
Preparation
Adoption measurements

- Helped power World IPv6 launch:
  - Wrote committee tool, provided data to participant list pages

- IPv6 adoption grew by 150% (2.5x) in the last year
  - On top of already rapid IPv4 growth
  - At this rate, 50% of users will have IPv6 in ~6 years
Brokenness measurements

- Worked with major IPv6 networks to identify / fix issues before launch
  - Not scalable, but necessary before launch

- Warned users with connectivity problems

- Publish and update list of networks Google does not enable IPv6 for
  - Allows website operators to avoid enabling IPv6 in impacted networks
AAAAA filtering
Not a real fix

- Many ISPs with IPv6 connectivity problems used AAAA filtering
  - The underlying problem doesn't go away
  - Disables measurements, so impossible to know when to stop filtering
  - Policy/censorship issues
Collateral damage

% connection failure

% IPv6 native

"Fallback problem" solved

All IPv6 disabled
Not just Japan

A major ISP in Greece

% connection failure
Launch!
IPv6 QPS

+75%
Fiber, cable: RCS & RDS

23%
DSL 6rd: AT&T

- Enabled IPv6 for 1 million subscribers
  - Could reach [5 million by EOY 2012](#)
  - IPv6-enabled customers see 20% of traffic on IPv6
PPP: XS4ALL
LTE: Verizon Wireless
Conclusions
Real impact on whole ecosystem

- World IPv6 Launch participants
  - 3000+ websites
  - 60+ ISPs
  - 4 home router vendors

- Real traffic
  - AT&T: "For our IPv6 enabled customers, we’re seeing more than 20 percent of traffic transition to IPv6..."

- Real deployments
  - everywhere around the world
  - on every access technology
Lee Howard
Time Warner Cable
How do we get to 1% actively using IPv6?

Each block represents 100,000 users.

- 50% of CMs
- 30% of CMTSs
- 50% of OS support IPv6
- 15% have no gateway

1% = 100,000
IPv6 ADOPTION FOR WEB TRAFFIC: OBSERVATIONS FROM WORLD IPv6 LAUNCH

IETF84
Vancouver, Canada

Erik Nygren
Akamai Technologies
July 31, 2012
IPv6 HTTP(S) traffic levels

• Major factors
  • Content availability
  • Client network connectivity
  • Client and CPE device support
IPv6 HTTP(S) traffic levels

• Major factors
  • Content availability
  • Client network connectivity
  • Client and CPE device support

• For Akamai on W6L (2012-06-06) vs. W6D (2011-06-08):

  IPv6 Addresses          IPv6 Requests
  19 million      3.8 billion

  460x           67x

  More Content  x  More Clients  =  More Traffic
Where are clients & how do they connect?

- **By address family:**
  - Teredo: 31,785
  - 6to4: 2,456,126
  - Native + 6RD: 16,511,342

- **Top access networks:** (accounted for 86% of requests)
  - Verizon Wireless (US)
  - AT&T (US)
  - Comcast (US)
  - RCS & RDS (Romania)
  - Free (France)
  - KDDI (Japan)

- **By geography (for Native + 6RD addresses):**
  - US: 73%
  - Europe: 21%
  - Asia: 5.1%
  - Other: 0.4%

Data from 24 hour window on 2012-06-06
IPv6 Malware

- Multiple observed instances of malware supporting IPv6

IPv6 Malware Distribution* vs. IPv6 Address Distribution

Where there are IPv6 clients there is IPv6 malware

*Based on data sample of port scans from 2012-07-25
IPv6 Preference: Measuring Adoption

- Client preference (% requests over IPv6) varies by site
- Most sites saw 2-6% week-over-week growth in June/July

![Graph showing IPv6 preference growth over time for different audiences.]
One year of IPv6 growth in the US

- IPv6 in US is a major factor in increased client adoption
More details at...

www.akamai.com/ipv6

Erik Nygren

My email: ${lastname}@akamai.com
World IPv6: Launched!

Leslie Daigle, moderator.

Chief Internet Technology Officer

The Internet Society