World IPv6 Launch and Penn

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Megaconference v6
June 6th 2012

World IPv6 Launch

http://www.worldip6launch.org/

Major Internet service providers (ISPs), home networking equipment manufacturers, and web companies around the world are coming together to permanently enable IPv6 for their products and services by 6 June 2012.

Organized by the Internet Society, and building on the successful one-day World IPv6 Day event held on 8 June 2011, World IPv6 Launch represents a major milestone in the global deployment of IPv6. As the successor to the current Internet Protocol, IPv4, IPv6 is critical to the Internet's continued growth as a platform for innovation and economic development.

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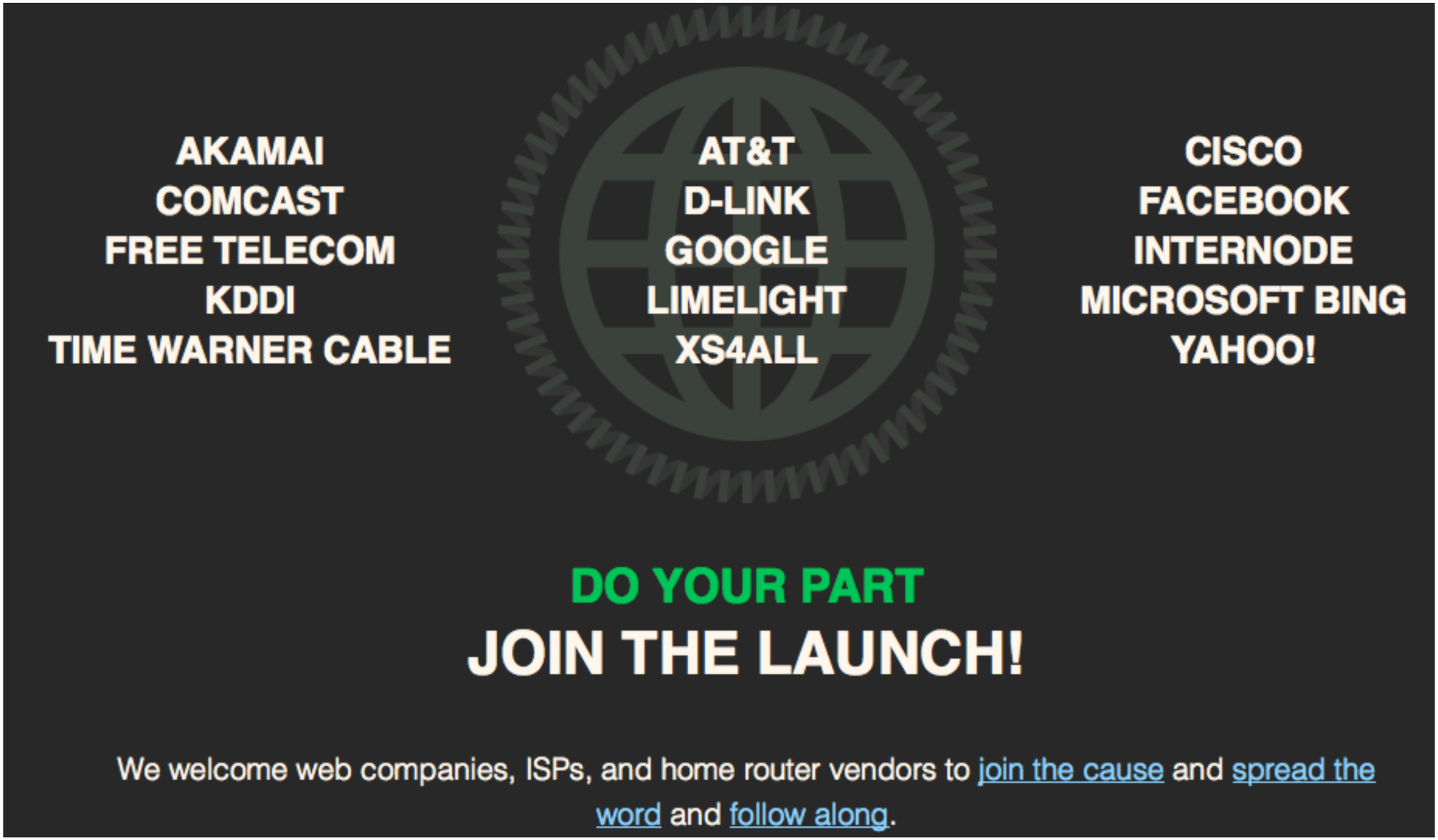
World IPv6 Launch



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Registered Participants

- Website operators: 3,013
- Network Operators: 66
- Home Router Vendors: 5

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Early deployers

- Facebook and Netflix turned on IPv6 a week or so before
- Today, many more have done so ...
- And a subset of the list of registered participants have already been running IPv6 for quite a while

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IPv6 Motivation

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IPv6: Internet Protocol v6

- Version 6: The next generation Internet Protocol
- Much larger address space: 128 bits vs 32 bits
  - (Note: not 4x larger, but 2^{96} times larger!)
- No NAT (goal: restore end-to-end architectural model)
- Scalable routing (some issues with multihoming TBD)
- Other: header simplification, NDP (a better version of ARP), auto-configuration, flow labelling, and more ..
- Note: *IPv6 is not backwards compatible with IPv4*

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IPv6: Internet Protocol v6

- But primary impetus is the much larger address space
- Impending exhaustion of IPv4 addresses
- But Internet continues to grow
  - Not only in terms of the number of users, but also in the number and range of devices being connected to the network
  - The "*Internet of Things*"

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IPv6: Internet Protocol v6

- Adverse consequences of not deploying IPv6:
- IPv4 transfer markets (sanctioned or unsanctioned)
  - March 2011: Microsoft acquired block of 600,000 addresses from Nortel for $7.5 million ($11.25/address)
  - December 2011: Borders books sold a /16 to Cerna for $786,432 ($12.00/address)
- More and more layers of NAT
- Balkanization, and resulting disruption of universal connectivity

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Transition vs Co-existence

- IPv4 isn't going away anytime soon, possibly not for many decades
- So, for most folks, already connected to the IPv4 Internet, ***we are not transitioning to IPv6*** (yet)
- We are ***deploying IPv6 to co-exist with IPv4***
- To allow us to communicate with both the IPv4 and IPv6 Internet

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What you need to deploy IPv6

- Obtain IPv6 address space
  - from your RIR or ISP
- IPv6 connectivity (preferably native) from your ISP
- IPv6 deployment in network infrastructure, operating systems, and applications (may require upgrades)
- IT staff and customer service training

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IPv6 addresses

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IPv4 addresses

- Example: 192.168.7.13
- 32 bits
- “Dotted Quad notation”
- Four 8-bit numbers (“octets”) in range 0..255, separated by dots
- 2^{32} = 4.3 billion (approximate) possible addresses
  - *(Usable number of addresses much lower though: routing & subnet hierarchies - see RFC 3194 - Host Density ratio)*

IPv6 addresses

- 128-bits (four times as large)
- 8 fields of 16 bits each (4 hex digits) separated by colons (:)
- [Hex digits are: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b, c, d, e, f]
- 2^{128} possible addresses (an incomprehensibly large number)

2001:0db8:3902:00c2:0000:0000:0000:fe04

(2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456)

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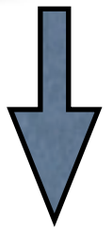
IPv6 addresses

- Zero suppression & compression for more compact format
  - Suppress (omit) leading zeros in each field
  - Replace consecutive fields of all zeros with a double colon (::) - only one sequence of zero fields can be compressed this way

```
2001:0db8:3902:00c2:0000:0000:0000:fe04
```



```
2001:db8:3902:c2::fe04
```

IPv6 DNS records

- **AAAA** ("**Quad-A**") DNS record type is used to map domain names to IPv6 addresses
- IPv4 uses the "**A**" record
- DNS RR type code for AAAA = 28
- There was another record called **A6**, which didn't catch on (and now declared historic by RFC 6563)

```
www.ietf.org.   1800 IN  A     12.22.58.30

www.ietf.org.   1800 IN  AAAA  2001:1890:123a::1:1e
```

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IPv6 Address Types

- **Unicast**
- **Multicast**
- **Anycast**

- Note: there is no "**broadcast**" in IPv6

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Unicast Address Types

- **Global** Unicast Addresses
  - Static, Stateless Address Autoconfiguration, DHCP assigned
  - Tunneled (6to4, Teredo, ISATAP, ...)
  - Others (CGA, HIP, ...)
- **Link Local** Addresses
- **Unique Local Addresses** (ULA)
- **Loopback** (::1)
- **Unspecified** (::)

IPv6 at Penn

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IPv6 at Penn

- IPv6 deployment dates back a while
- MAGPI GigaPoP: 2002
- Penn Campus network: initial deployment 2005
  - Although not extended out to most user subnets then
  - border & core routers, and some IT dept subnets only
- School of Engineering & Applied Science: 2007
- Summer 2011: All the rest of wired subnets deployed
- May 2012: All wireless subnets deployed (~ 200)

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IPv6 services

- DNS
- NTP
- Jabber (XMPP)
- SSH
- Some departmental websites
- H.323 Video conferencing services
  - (by which I'm reaching some of you today!)

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www.upenn.edu

- Main Penn website located on Akamai's global CDN (Content Delivery Network)
- Needed to await Akamai's production IPv6 service offering
- IPv6 turned up, on May 9th 2012 (~ one month ago)

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Central Email

- No IPv6 deployment yet
- Virus scanning and spam scoring outsourced to Message Labs (now Symantec Cloud)
  - So they act as inbound MX, and outbound relay
- Symantec Cloud has no apparent plans to support IPv6
- Considering our options ....

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World IPv6 Day so far

- Going smoothly. Can access many sites: Facebook, Netflix, Bing, etc over IPv6
- One major issue: Google is not returning IPv6 AAAA DNS records to Penn's primary DNS resolver today
  - due to fiber cut incident a week ago that temporarily took out Penn's external IPv6 connectivity
  - And google actively measures client IPv6 connectivity issues and dynamically maintains a AAAA blacklist
  - The fiber cut skewed Penn's numbers, and we need to wait to age out of google's blacklist (~ couple of days)
  - We've since multihomed our external IPv6 connectivity

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World IPv6 Day so far

- Traffic crossing Penn campus border today
  - Peak of 90Mbps inbound (8% of total), and 11Mbps outbound (5% of outbound)

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Questions?

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