Internet – as it has grown and is growing SANOG 18 KEYNOTE

Hurricane Electric
IPv6 Native Backbone – Massive Peering!

SANOG 18

Pokhara, Nepal – 14th September 2011

Martin J. Levy, Director IPv6 Strategy
Hurricane Electric

Welcome to your Internet; nurture it well

- Agenda
  - Know history; study history; enjoy history
  - The future; or at least one version of the future
  - Transition (the focus on IPv6 part)

RFC791

1981

January 1st

NCP → TCP

1983

DNS

1984

NNTP

NSFnet

MX Records

1986

10,000 hosts

UUnet founded

1987

First computer worms distributed via the Internet

1988

NSFnet upgrades to T1's (1.544 Mbps)

1989

ARPAnet name goes away

1990

CIX

1991

WWW

NSFnet upgrades to DS3's (45 Mbps)

1992

InterNIC Mosaic

1993

IETF kicks off IPng (IPv6)

1994

GROWTH!!!!

1995 1996 1997 1998
1999 2000 2001 2002
2003 2004 2005 2006
2007 2008 2009 2010

World IPv6 Day

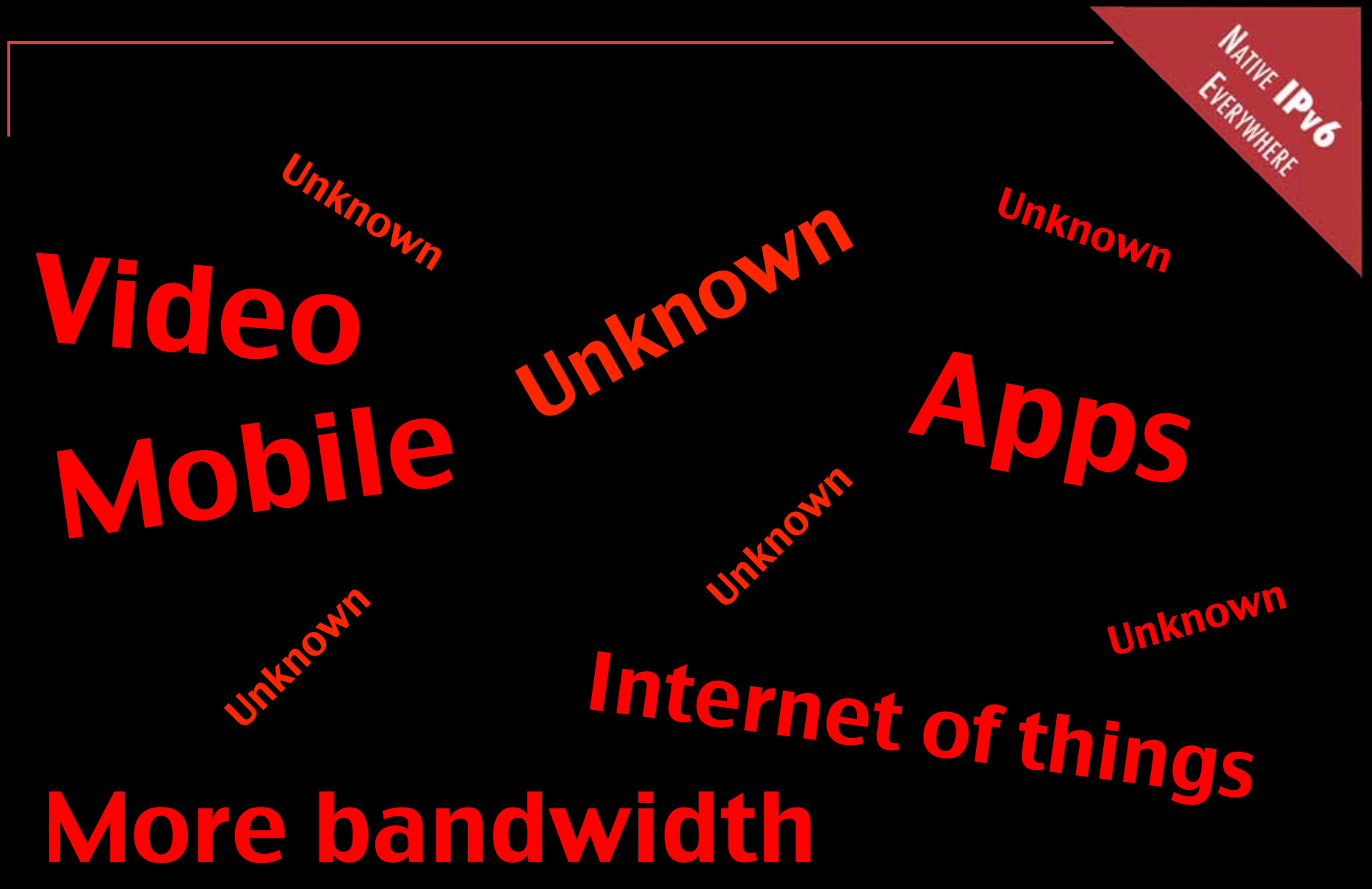
IANA runout

APNIC runout

2011

More things than we can imagine!

2012


Native IPv6 Everywhere
Unknown
Unknown
Unknown
Video
Mobile
Apps
Unknown
Unknown
Unknown
Internet of things
More bandwidth

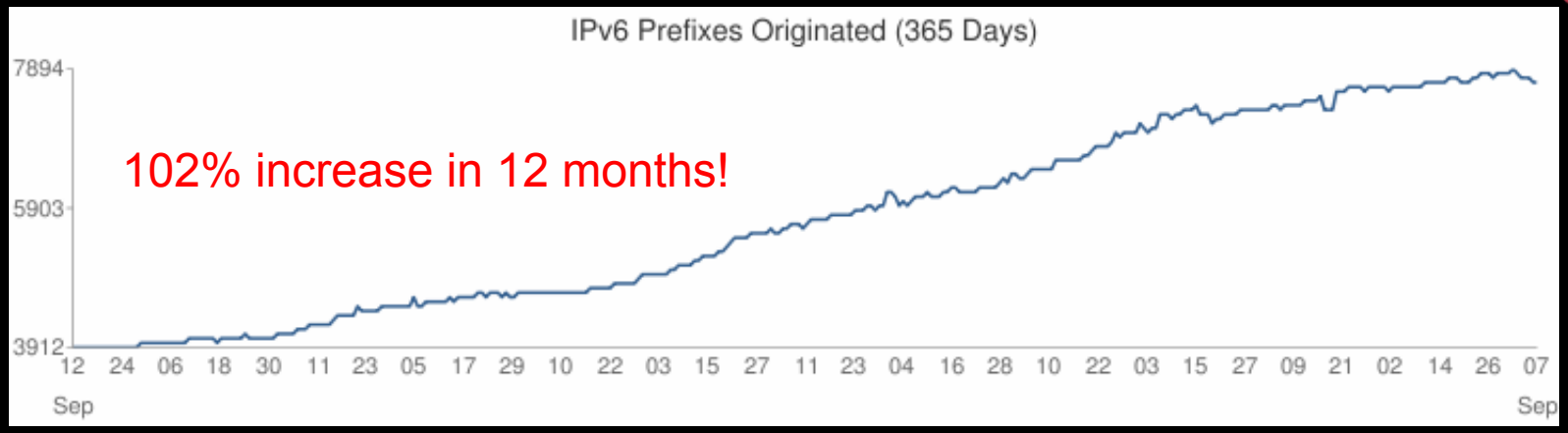
IPv6 is not a future subject …

- IPv6 and why it's ready now …
  - Is the IPv6 global Internet ready for real work?
  - World IPv6 Day (W6D) and it's global traffic
  - Motivating people to enable IPv6
  - Summary

Does IPv6 have global coverage?

(Is the IPv6 routing table ready for real world use?)

Is IPv6 routing/interconnect/peering prevalent?



http://bgp.he.net/report/prefixes#_prefixes

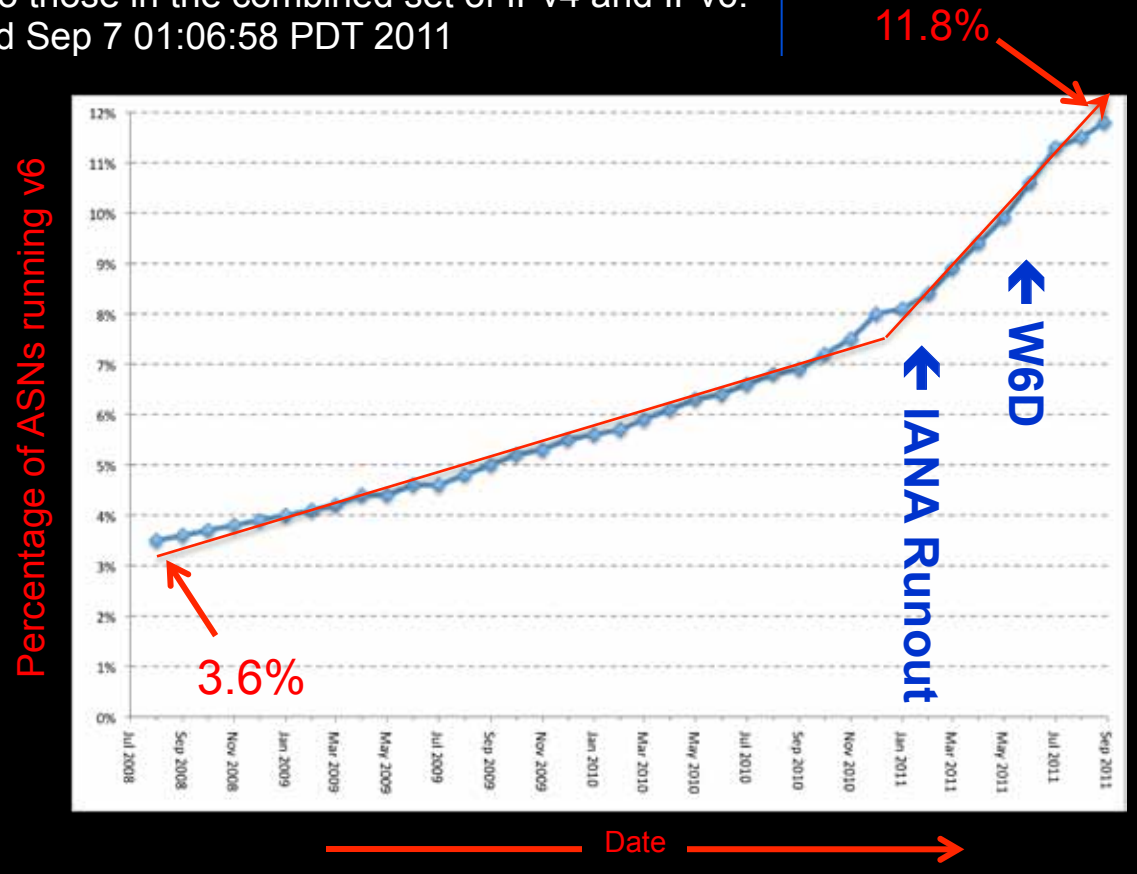
http://bgp.he.net/report/prefixes#_networks

IPv6 measured at via BGP ASNs with IPv6

http://bgp.he.net/ipv6-progress-report.cgi

Networks Running IPv6
We can measure the percentage of networks running IPv6 by comparing the set of ASes in the IPv6 routing table to those in the combined set of IPv4 and IPv6.
IPv4 and IPv6 RIBs Last Parsed: Wed Sep 7 01:06:58 PDT 2011

IPv4 Ases: 38,889
IPv6 ASes: 4,592
ASes using only IPv4: 34,394
ASes using only IPv6: 97
ASes using IPv4 and IPv6: 4,495
ASes using IPv4 or IPv6: 38,986
Percentage of ASes (IPv4 or IPv6) running IPv6: 11.8%

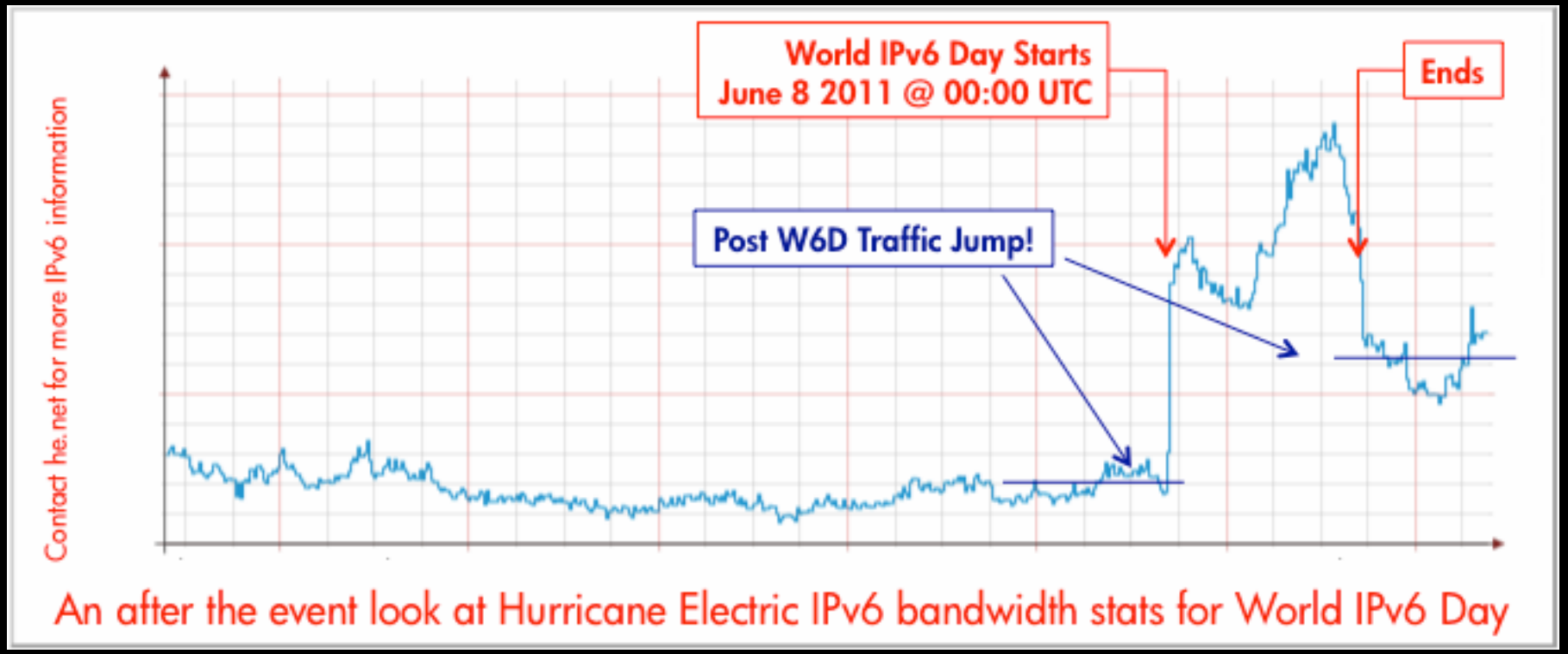


World IPv6 Day

(Not just IPv6 Day, World IPv6 Day)

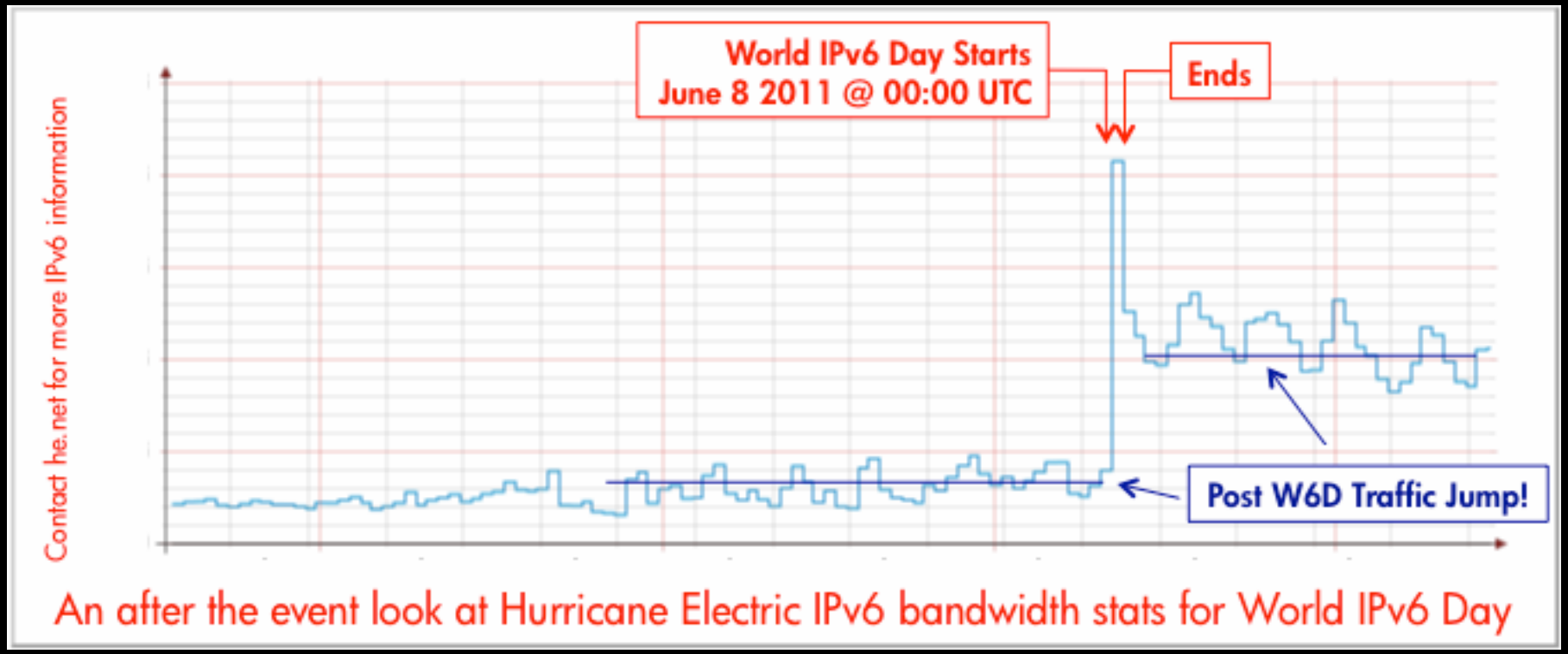
World IPv6 Day and real IPv6 traffic

- World IPv6 Day was about enabling web-based traffic for IPv6
  - Focus on content providers
  - Web (port 80 & 443 TCP traffic) plotted below



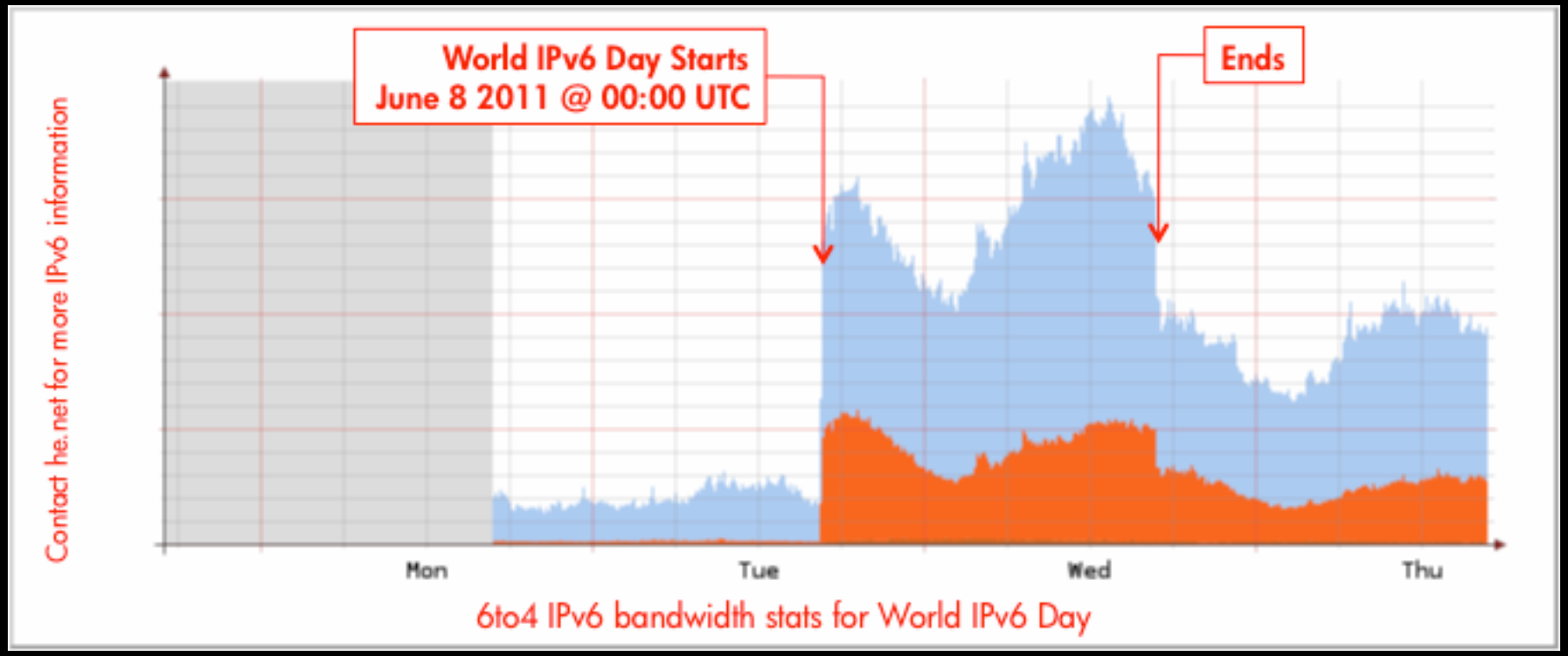
World IPv6 Day and real IPv6 traffic

- Long term win since W6D in IPv6 traffic levels
  - That means there are both content and eyeballs in play



Hurricane Electric W6D and translation traffic

- Yes – there is 6to4 traffic
  - Lots of traffic on Hurricane Electric's backbone!
- Measured on the largest 6to4 global deployment (with Teredo included)
  - AMS ASH CHI FMT FRA HKG LAX LON MIA NYC PAO PAR SEA SIN SJC STO TYO

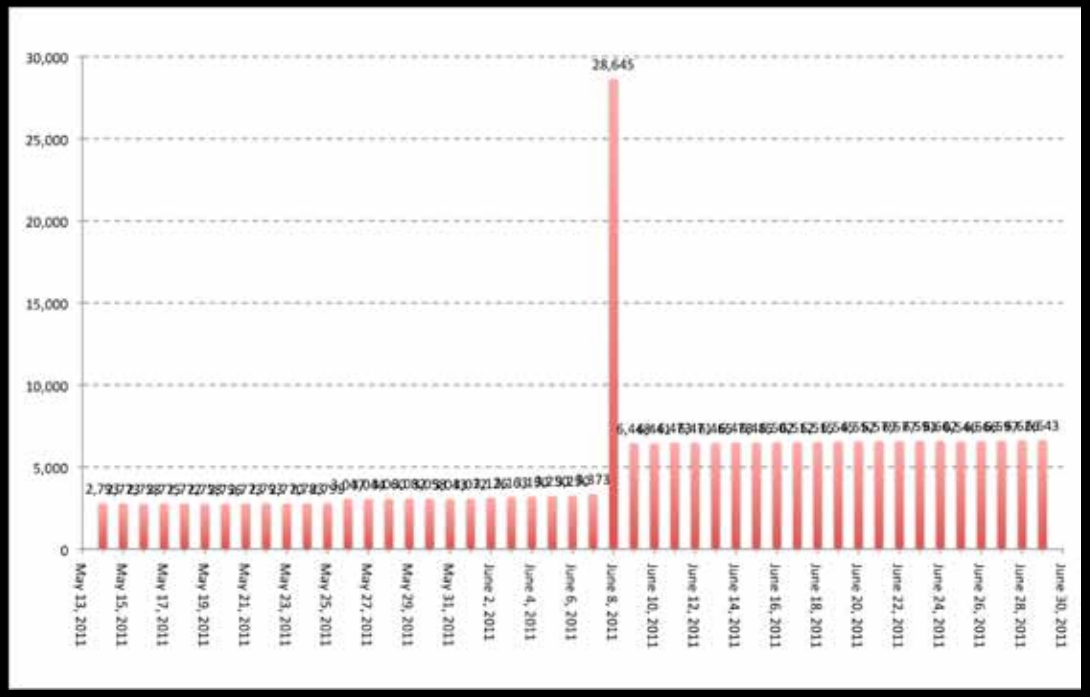


IPv6 measured on the Alexa 1m list

http://bgp.he.net/ipv6-progress-report.cgi

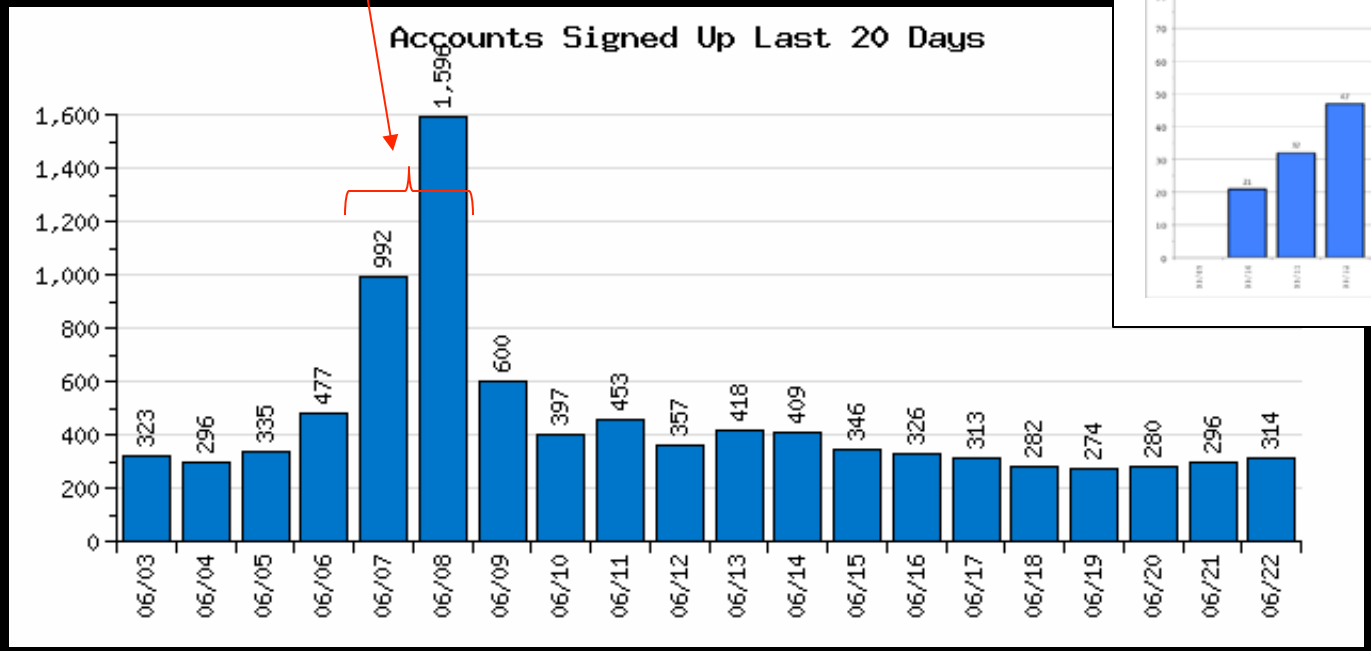
Top Websites Running IPv6
A very quick way to measure IPv6 deployment for websites is just to check for a AAAA record in DNS.
Alexa Top 1 Million Domains Downloaded:
Sun Aug 28 00:00:05 2011
Alexa Top 1 Million Domains Processe(
Sun Aug 28 00:37:44 2011

Alexa 1M raw domains:
1000000
Alexa 1M raw with a direct IPv4 address: 942156
Alexa 1M raw with a direct IPv6 address: 9595



World IPv6 Day – tunnelbroker.net users

June 7th 2011 / June 8th 2011
A large jump in new accounts
(shows a great interest in IPv6 on W6D)



Smaller effect
March 2008

Hurricane Electric W6D – Observed issues

- PMTU & ICMP6 blocking
  - Heard again and again all over the net
  - Enabling IPv6 (for the first time) with too-aggressive filtering
- Two failure modes
  - Pre W6D testing – normally on “ipv6.example.com”
  - During W6D – affected “www.example.com”
- Trigger points?
  - Testing from Teredo or 6to4 enabled end-nodes
  - Real-world tunnels
- ICMP6 re-explained
  - Teredo requires end-node to respond to a ping to initiate protocol
  - This breaks classic enterprise firewall/filter setups
  - Consensus is that elements ahead of server perform this function

Hurricane Electric's Free IPv6 Certification Program

http://ipv6.he.net/certification/

Hurricane Electric – IPv6 Certification (learning?)

- Prove that you have IPv6 connectivity
- Prove that you have a working IPv6 web server
- Prove that you have a working IPv6 email address
- Prove that you have working forward IPv6 DNS
- Prove that you have working reverse IPv6 DNS for your mail server
- Prove that you have name servers with IPv6 addresses that can respond to queries via IPv6
- Prove your knowledge of IPv6 technologies through quick and easy testing

http://ipv6.he.net/certification/

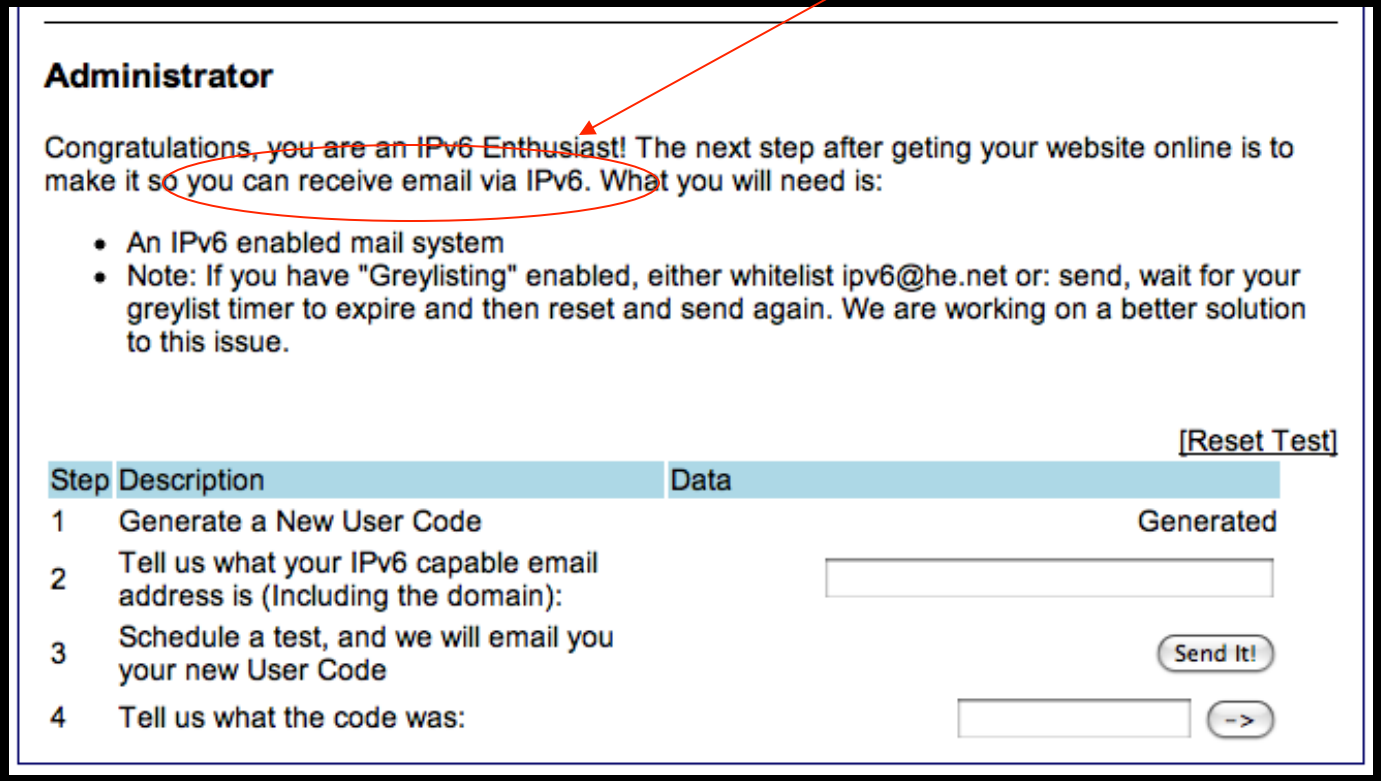
- the format of IPv6 addresses
- AAAA records
- reverse DNS for IPv6
- the IPv6 localhost address
- the IPv6 default route
- the IPv6 documentation prefix
- the IPv6 link local prefix
- the IPv6 multicast prefix
- do an IPv6 ping
- do an IPv6 traceroute
- common IPv6 prefix
- and more!

36,500++ Certifications!

Hurricane Electric – IPv6 Certification (sample test)

http://ipv6.he.net/certification/

The test – to send and receive IPv6 emails



Administrator

Congratulations, you are an IPv6 Enthusiast! The next step after geting your website online is to make it so you can receive email via IPv6. What you will need is:

- An IPv6 enabled mail system
- Note: If you have "Greylisting" enabled, either whitelist ipv6@he.net or: send, wait for your greylist timer to expire and then reset and send again. We are working on a better solution to this issue.

[Reset Test]

Step	Description	Data
1	Generate a New User Code	Generated
2	Tell us what your IPv6 capable email address is (Including the domain):	
3	Schedule a test, and we will email you your new User Code	Send It!
4	Tell us what the code was:	->

Hurricane Electric – IPv6 Certification Levels

Newbie Test
This is a basic level test of the information here. With this primer at hand these questions should be a snap for you.

Enthusiast Test
This test validates that you have an IPv6 capable machine setup that can browse the web via IPv6, as well as the fact that you have a web server setup that can serve files via IPv6.

Administrator Test
This test validates that your SMTP server is able to accept mail over IPv6

Professional Test
This test validates that Reverse DNS for the IPv6 address of your SMTP server is properly configured.

Guru Test
This test validates that your nameservers have AAAA records for themselves and that these nameservers can be queried over IPv6 for your domain.

Enthusiast Questionnaire
These are a few questions to gauge interest and usage level for IPv6 and gather data as to your experiences with IPv6 deployments.

Administrator Questionnaire
These are a few questions to gauge interest and usage level for IPv6 and gather data as to your experiences with IPv6 deployments.

Professional Questionnaire
These are a few questions to gauge interest and usage level for IPv6 and gather data as to your experiences with IPv6 deployments.

Guru Questionnaire
These are a few questions to try to gauge interest and usage level for IPv6 and gather data as to your experiences with IPv6 deployments.

Enthusiast Technical Test
This test covers technical knowledge of ping and traceroute commands on Linux and Windows.

Administrator Technical Test
This test covers technical knowledge of DNS and general IPv6 topics.

Professional Technical Test
This test covers technical knowledge of well known IPv6 prefixes and expands on your understanding of IPv6 related Linux and Windows commands.

Guru Technical Test
This test covers technical knowledge of IPv6 routing and IPv6 related protocols.

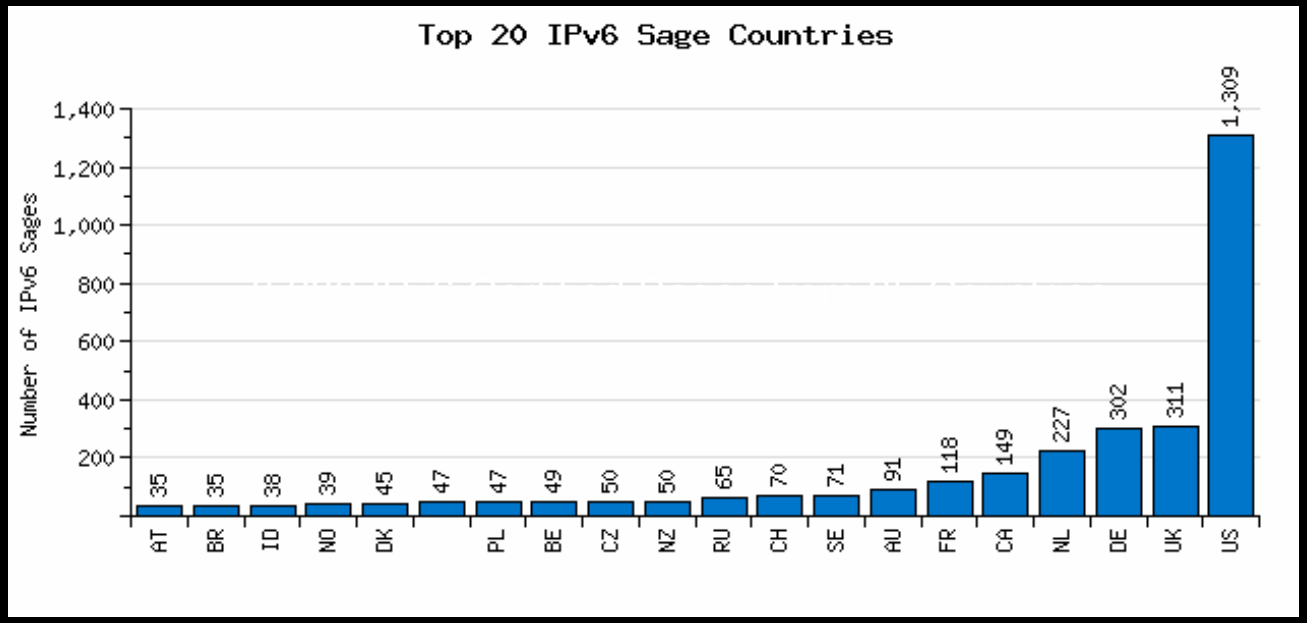
Explorer Test
This test validates that you have Native or Tunneled IPv6.

Sage Test
This test validates that you have IPv6 Glue at your registrar

Hurricane Electric – IPv6 Certification – Sages

EU (European Union)	1,474
United States	1,309

Europe	1,684
North America	1,471
South America	61
Asia	207
Africa	16
Oceania	155
Unknown	36
TOTAL	**3,630**



http://tunnelbroker.net/usage/sages_by_country_and_state.php

Sage level is the highest level obtainable.

Hurricane Electric – IPv6 Certification – Sages

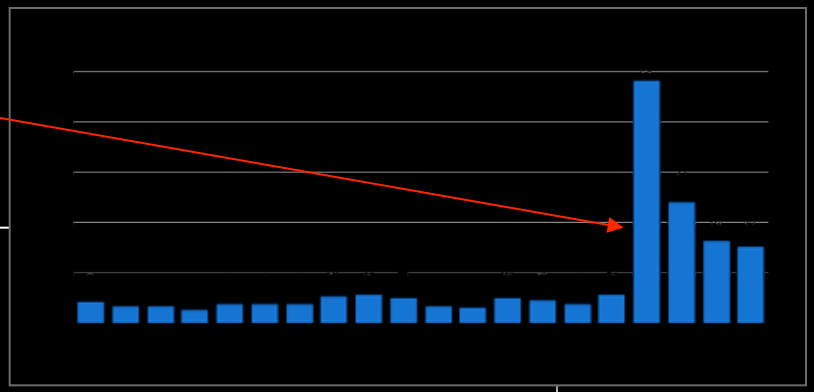
IPv6 Certification (on a lighter note) …

Motivating people to think about IPv6

… maybe t-shirts will help?

Hurricane Electric – IPv6 and t-shirts?

Hurricane Electric sends email saying "free IPv6 t-shirt" for sage-level users



From: <ipv6@he.net>
Date: Thu, May 27, 2010 at 11:32 PM
Subject: Hurricane Electric IPv6 Update
…
* Attention Sages!

Hurricane Electric would like to send you an "IPv6" T-shirt!

Please log into http://ipv6.he.net/certification/, and verify your address information which will only be used for shipping out this T-shirt.

After making certain it is correct (remember to click "Update Info" if you made changes, before validating), you will see T-shirt size selections for S/M/L/XL/XXL, and a button that will submit your preferred shirt size and log that you have validated your address.

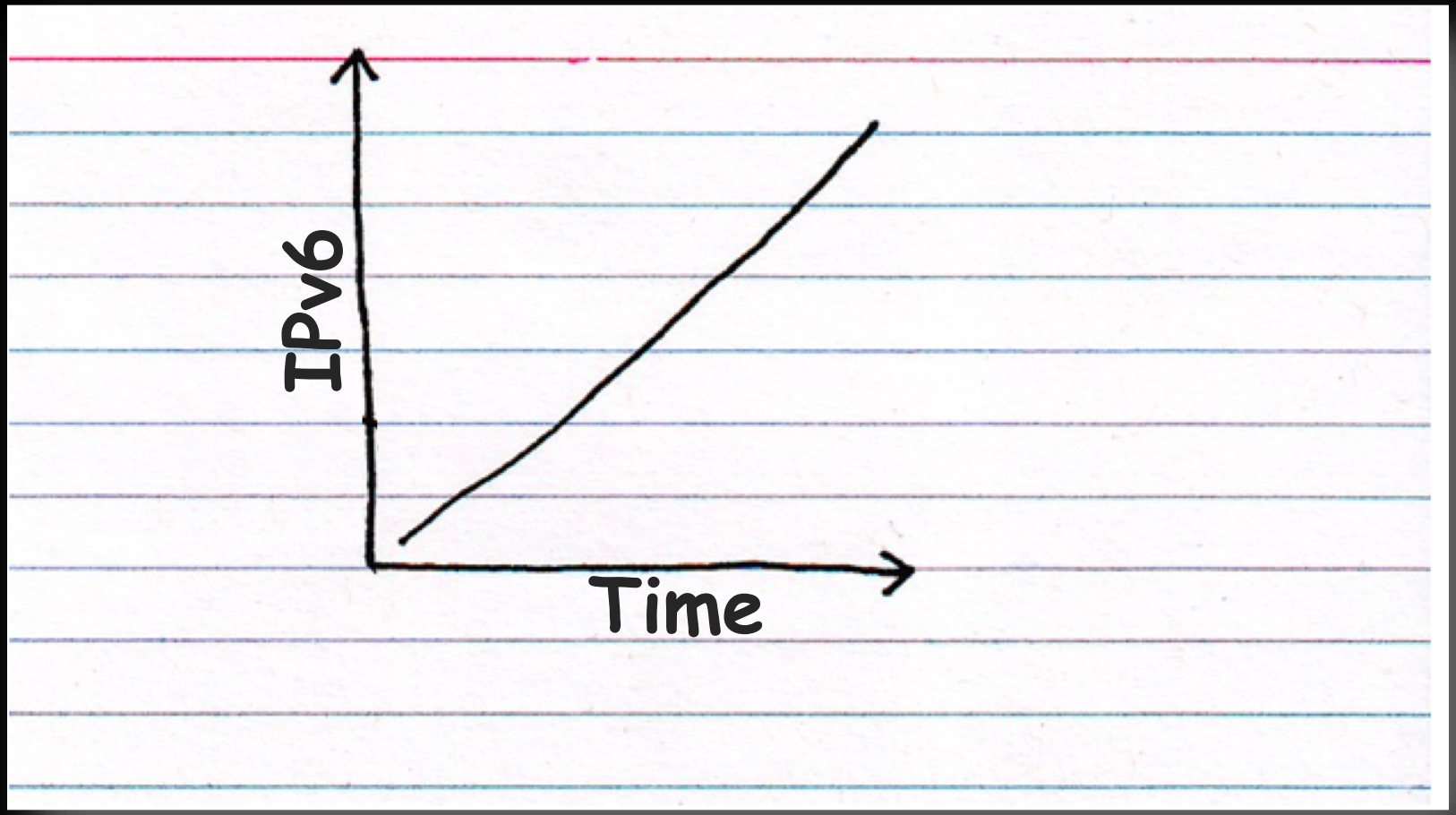
This is optional, and will only be sent to validated addresses.

We'll be adding on some points to your score for Sages that want to get a T-shirt!

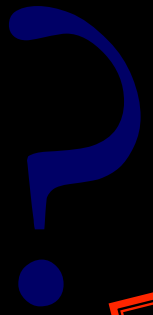
We are looking to get the t-shirts out around the end of June. We need make sure to get enough of each size before sending them out to all of you. …

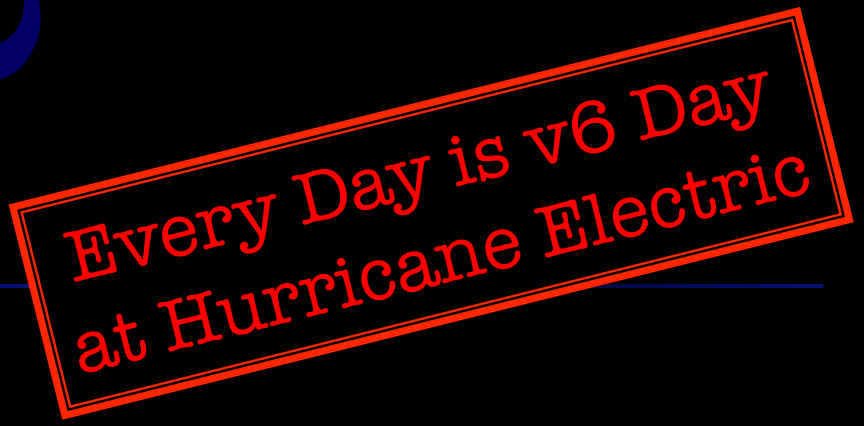
Final thought …

Summary – Have a positive IPv6 mindset



Q&A





Contact:

Martin J. Levy
Director, IPv6 Strategy
Hurricane Electric
760 Mission Court
Fremont, CA 94539, USA
http://he.net/

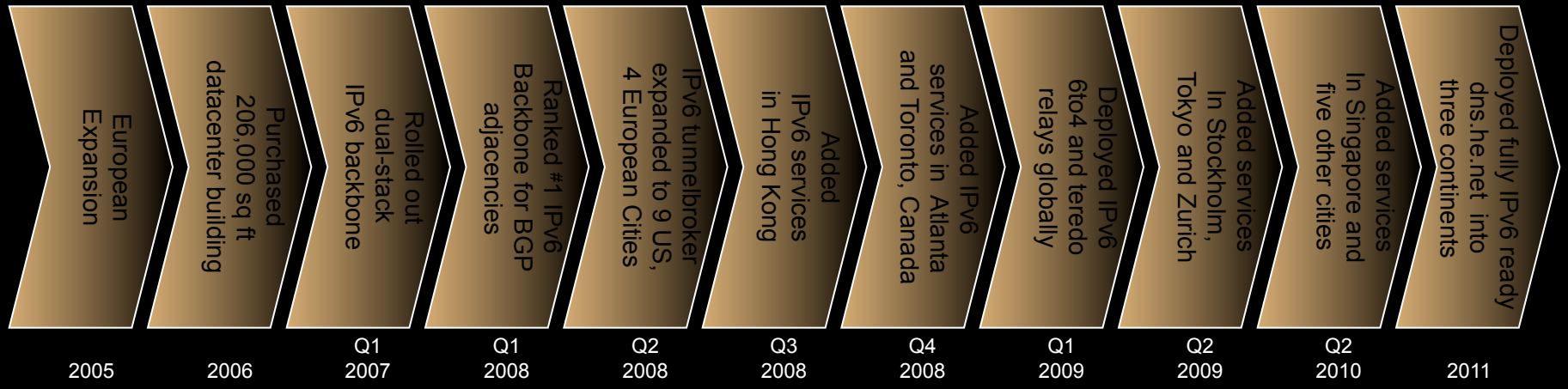
martin at he dot net
+1 (510) 580 4167

Support slides …

Hurricane Electric

Hurricane Electric – Roots and History

- Founded 17+ years ago - ISP & datacenter operator
  - 1994 – Roots within the Silicon Valley high-tech community
  - 1999 – Expanded IPv4 network nationwide in the US
  - 2001 – Started IPv6 native and tunnel connectivity (http://tunnelbroker.net)
  - 2006 – Full "technology refresh" enabled native dual-stack IPv6 backbone
  - 2008 – Became largest IPv6 backbone globally (> 1Gbps IPv6 traffic level)



  - 2009 – Continued expansion into Asia; enabled IPv6 6to4 & Teredo global service
  - 2010 – Added more geographic coverage; expanded IPv6 6to4 and DNS service
  - 2011 – Stop talking about IPv6; just talk about the "Internet"

Hurricane Electric – IPv6 Network Reach

NATIVE IPv6 EVERYWHERE

All Hurricane Electric POPs are full IPv6 Native routing and peering

EQUINIX · DE-CIX · SIX · amsix · LINX · HKIX · CORESITE · telx · terremark · AS6939 · LONAP · NL-ix · torix · netnod · TELEHOUSE · ·ANAP··· · swissix

IPv6 peering at all major peering points in US, Europe & Asia. Private and public peering capacity at 10Gbps and above.