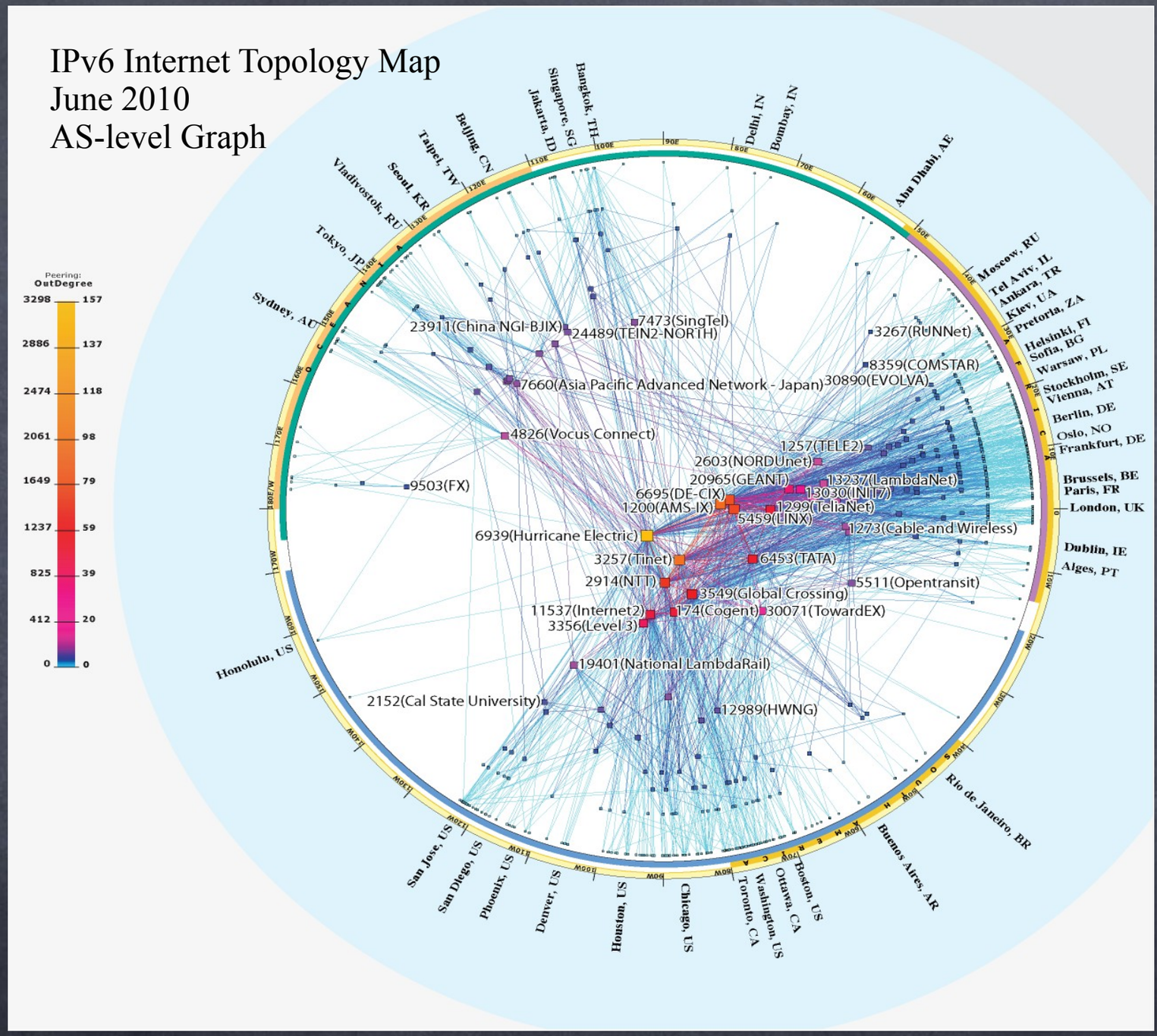
IPv6: hither, thither, and yon



kc claffy

CAIDA
AIMS
9 February 2011

IPv6 Situtational Awareness

- IANA allocated the first IPv6 address in 1999.
- Today, estimates of IPv6 penetration span at at least three orders of magnitude across different sources.
- U.S. Federal government is requiring IPv6 deployment within .gov networks.
- Many attempts to evaluate penetration

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[21] G. Huston and G. Michaelson, "Measuring IPv6 Deployment," 2008. http://www.nro.net/news/cisp-ipv6.pdf.

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[23] M. Leber, "Global IPv6 Deployment Progress Report," 2006. http://bgp.he.net/ipv6-progress-report.cgi.

[24] T. Kuehne, "Examining Actual State of IPv6 Deployment," 2008. http://www.circleid.com/posts/81166_actual_state_ipv6_deployment/.

[25] M. Prior, "IPv6 survey," 2009. http://www.mrp.net/IPv6_Survey.html.

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[28] E. Aben, "Interesting Graph - Networks with IPv6 over Time," November 2010. http://labs.ripe.net/Members/emileaben/interesting-graph-networks-with-ipv6-over-time.

[29] E. Aben, "Measuring IPv6 at Web Clients and Caching Resolvers," Mar. 2010. https://labs.ripe.net/Members/emileaben/.

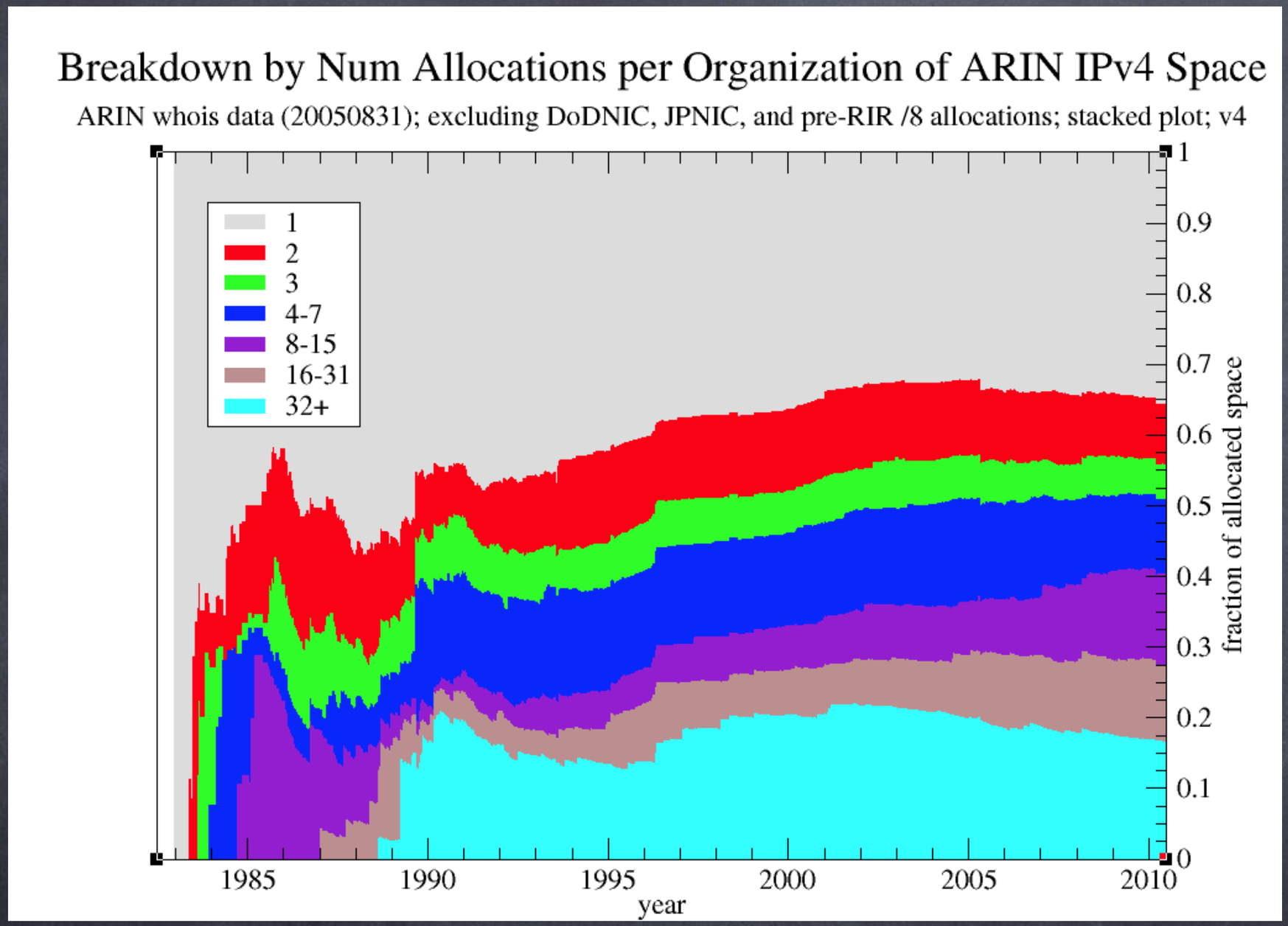
[30] Craig Labovitz, "IPv6 Momentum?." http://asert.arbornetworks.com/2010/10/ipv6-momentum/.

[31] Roch Guerin, "IPv6 Adoption Monitor." http://mnlab-ipv6.seas.upenn.edu/monitor/.

IPv6 Observable Trends

- Current levels of observable IPv6 activity are well below 1%, although up to 7% of global Autonomous Systems announce at least one IPv6 prefix.
- E. Aben, “Interesting Graph – Networks with IPv6 over Time,” November 2010. http://labs.ripe.net/Members/emileaben/
- CAIDA measurements on an OC-192 commercial backbone link in 2010 peaked at .27% IPv6 packets in January. The majority of the monthly one hour bidirectional captures show .002-.003% IPv6 packets.
- Other metrics of interest (not usage) (Huston) show increase since 2006.
- Internet2: working on measurement capability to judge IPv6 growth. (Matt please add something here.)

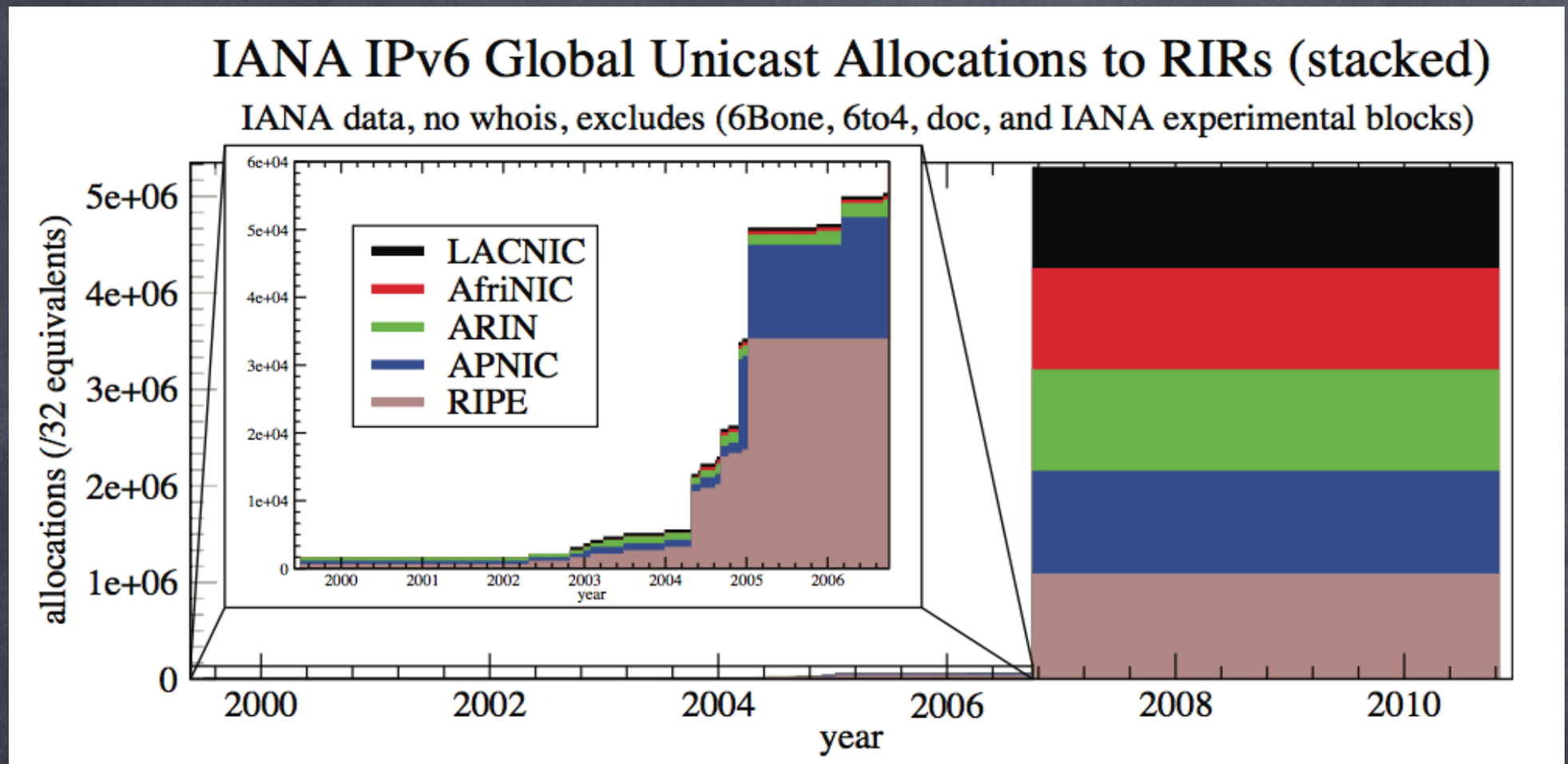
IPv6 Address Allocations



ARIN's IPv4 address allocation patterns for three decades, in terms of how many allocations a receiving organization has (allocations in legend).

Existing rather than new networks drive demand.

IANA IPv6 Allocations

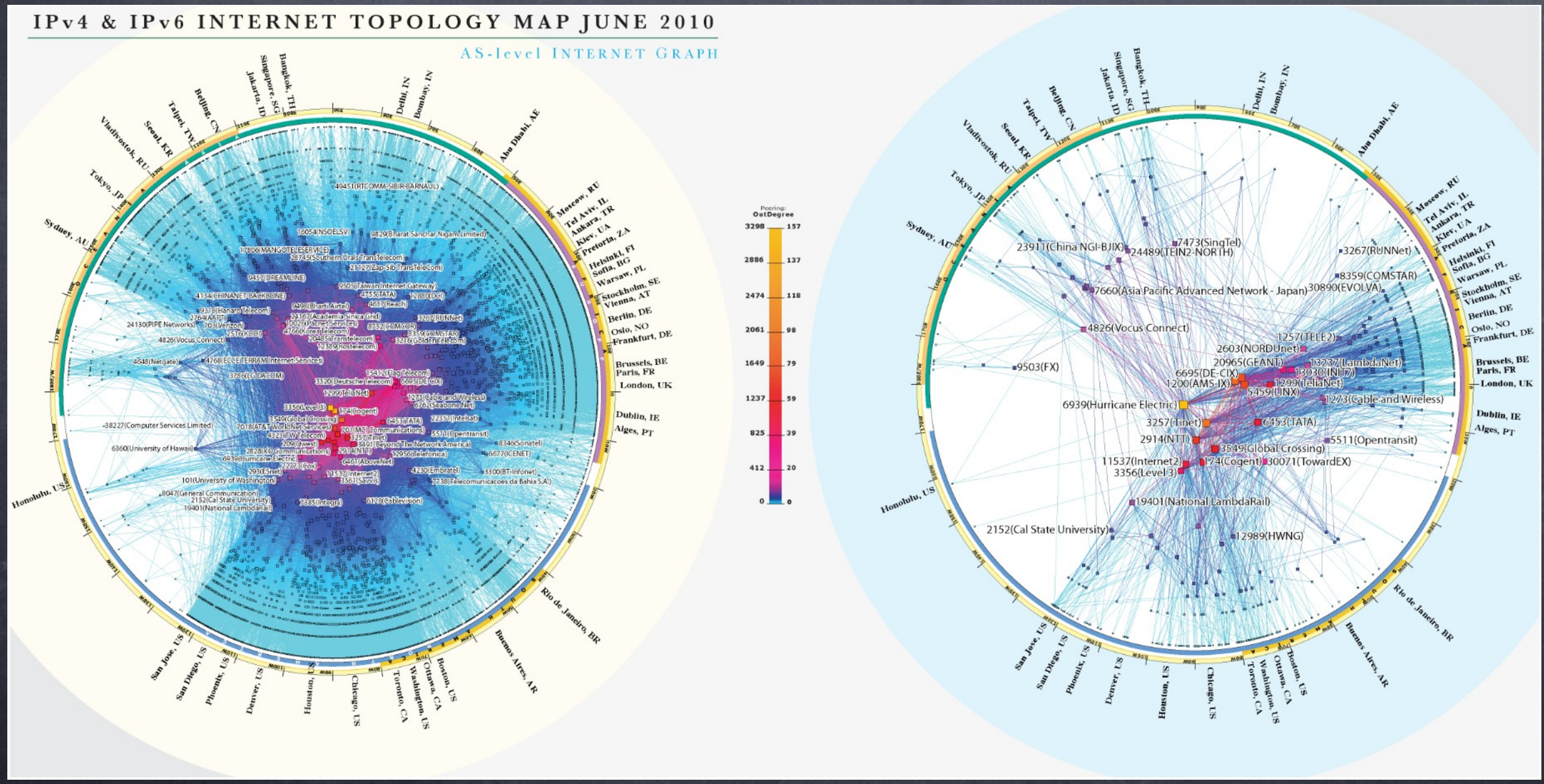


IANA allocation of IPv6 address prefixes to the five regional Internet registries (RIRs).

Left plot zooms in on address allocation until 2006. In September 2006 IANA implemented a new policy to give sufficient IPv6 address to each RIR to support their needs for at least 18 months. No RIR has requested additional IPv6 space since.

U.S. region (ARIN) has historically had significantly lower interest in IPv6 than Europe and Asia, consistent with the U.S. holding the majority of IPv4 space today.

CAIDA 2011 IPv4 & IPv6 Topology Maps



IPv6 Topology Measurements

- CAIDA began measuring IPv6 topology in December 2008 from 6 Ark monitors. We now have 16.
- For the 2010 IPv6 map, CAIDA collected data from 12 Ark monitors located in 6 countries on 3 continents.
- Monitors probed paths toward 307K destinations across 3302 IPv6 prefixes which represent 99.6% of the globally routed IPv6 prefixes seen in Route Views on 1 August 2010.
- Observed 715 AS nodes and 1,672 links.

2010 IPv6 AS-core Map

- Consists of:
- 715 AS nodes
- 1,672 links
- Top degree-ranked ASes differ from IPv4 to IPv6
- IPv4 core in U.S., IPv6 core includes Europe
- Similar average degree
- Similar average shortest AS path distances
- Example: same radius (4) and diameter (8)
- Reflects operational preference for short AS paths

Surveys of RIR members

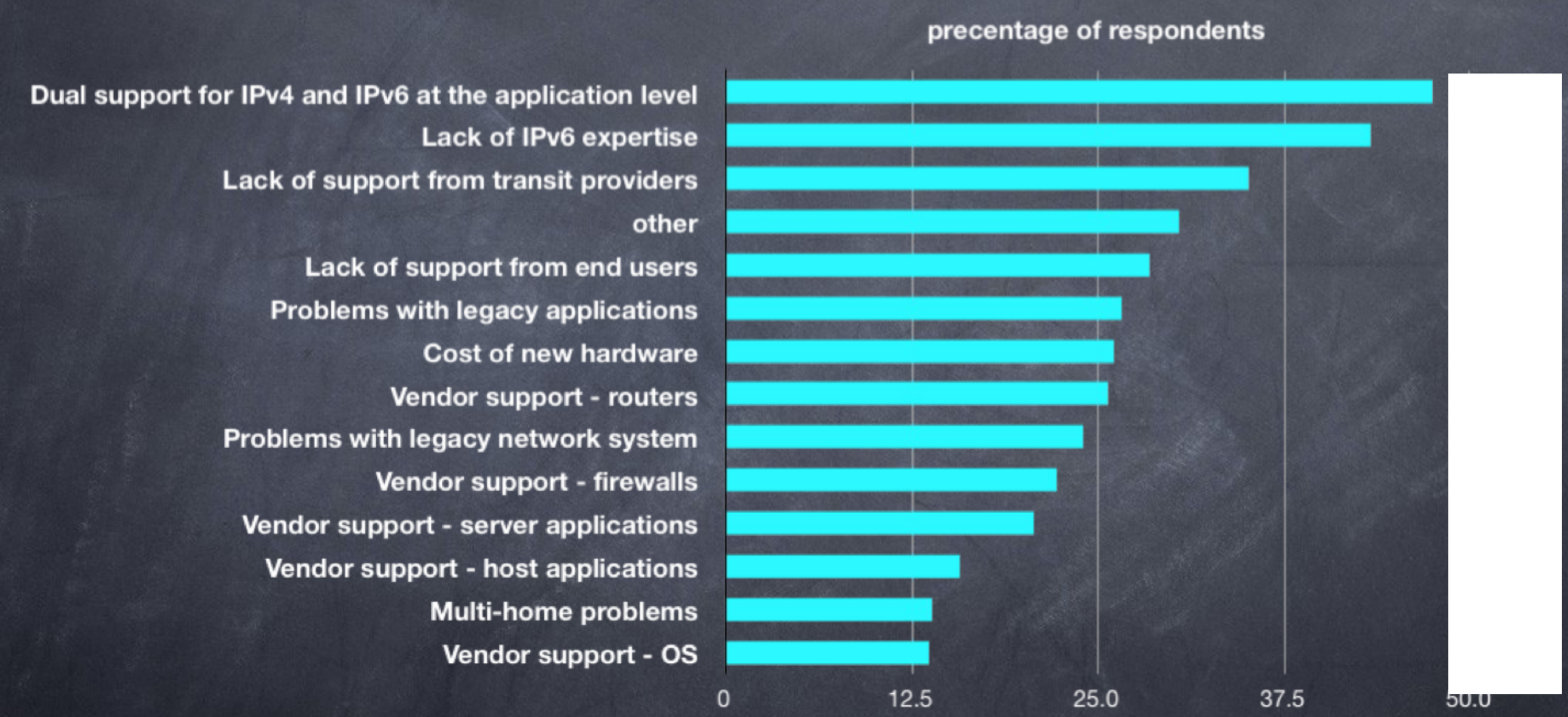
Ask the community what they are doing and thinking.

- March 2008 ARIN/CAIDA survey
  - IPv6 transition only
  - ARIN region only
- Oct. 2008 ARIN/CAIDA survey
  - IPv6 transition and IPv4 transfer
  - ARIN and others

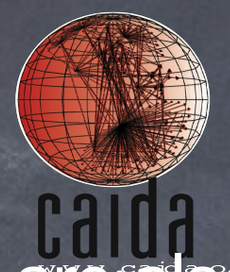
Survey Results

- IPv6 Penetration (low)
- Motivation for Getting Ipv6 (want to be ahead of game)
- Major Hurdles in Setting up Ipv6 (everything)
- Nature of IPv6 Services (routing, dns, web, email)
- Nature of IPv6 Connectivity (native, tunneled, other)
- Expected IPv4 Needs for Next Year (more than we have)
- Plan for IPv4 Exhaustion (transition, wait, NAT, buy IPv4)

Major Hurdles for IPv6



Hurdles for IPv6



“Virtually every box could be checked. Registry policies & procedures are also a serious problem.”

“lack of quality support in residential cpe and middleboxes (firewalls, load balancers, ddos mitigation)”

“The main part of our business is web hosting and there seems little point putting much effort in to hosting on ipv6 if no content consumers have it and all requests will come in as ipv4 anyway (or am I demonstrating the 'lack of ipv6 expertise' here?)”

“we don't see the point, if you're gonna run dual stack anyway, choose something decent, ipv6 is in our opinion one of the more crappier protocols, just like ipv4, doesn't bring anything to switch from crap to crap.”

“Lack of organizational capability to deploy. IT = triage. We only spend time working on things that are "broken". Until IPv4 is "broken" or causes a problem, most IT shops.. probably won't migrate, even if there was reasonable benefit. I also..lack trust that [sysadmins and developers] are sufficiently educated in IPv6. .. These guys still hard-code IPv4 addresses into applications and configuration files. Too many joe-blow admins out here.”

“Why spend the money if there is no extra profit?”

Hurdles for IPv6

Here's a data point for you: I'm working on a new product inside @@@@. After 18 months of development, we still don't have IPv6 in the lab to find out if the supposedly IPv6-friendly code we've been writing works. I called the engineering support people and they told me I could set up an IPv6 tunnel to Amsterdam if I wanted to experiment with it... I told them to call me back when my local router does IPv6, I've got no patience to tunnel bull$&!#.

I'm a networking professional working for a so-called leader. I don't have IPv6 on my desktop, and I've never, to my knowledge, used an IPv6 node in my entire career. Not at home, not at work. Maybe my phone is speaking it, but I'd never know.

IPv6 is not going to take off. It'll all be gross NAT hacks for the forseeable future, i.e. for 10, 15 years. I'm not a rocket scientist, but I'm a reasonably plugged-in guy. If nothing in my home/professional life has ever prepared me to learn IPv6 until today nothing will for a decade more, even IPv4 exhaustion.

Proposed Tasks

Measurements that would add insight:

(1) IPv6 topology: from core to edge:
extracting, annotating,validating topology inferences
better characterization of edge (Emile's talk);
(2) Correlate deployment with socioeconomic parameters:
address allocation patterns
economic evolution, e.g., AS relationships
geography, demographics, organizational characteristics
(3) Quantify IPv6 performance:
converter characteristics
performance myths and realities
workload characteristics.