IPv6 in Internet2 (“Abilene”)

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Topics

- Internet2="Abilene"; what is Abilene?
- What have we done with IPv6?
- How did we do it?
- How are we helping it along?
- What's missing?
- What problems have we seen?
- What next?

Internet2 network = “Abilene”

What is Abilene?

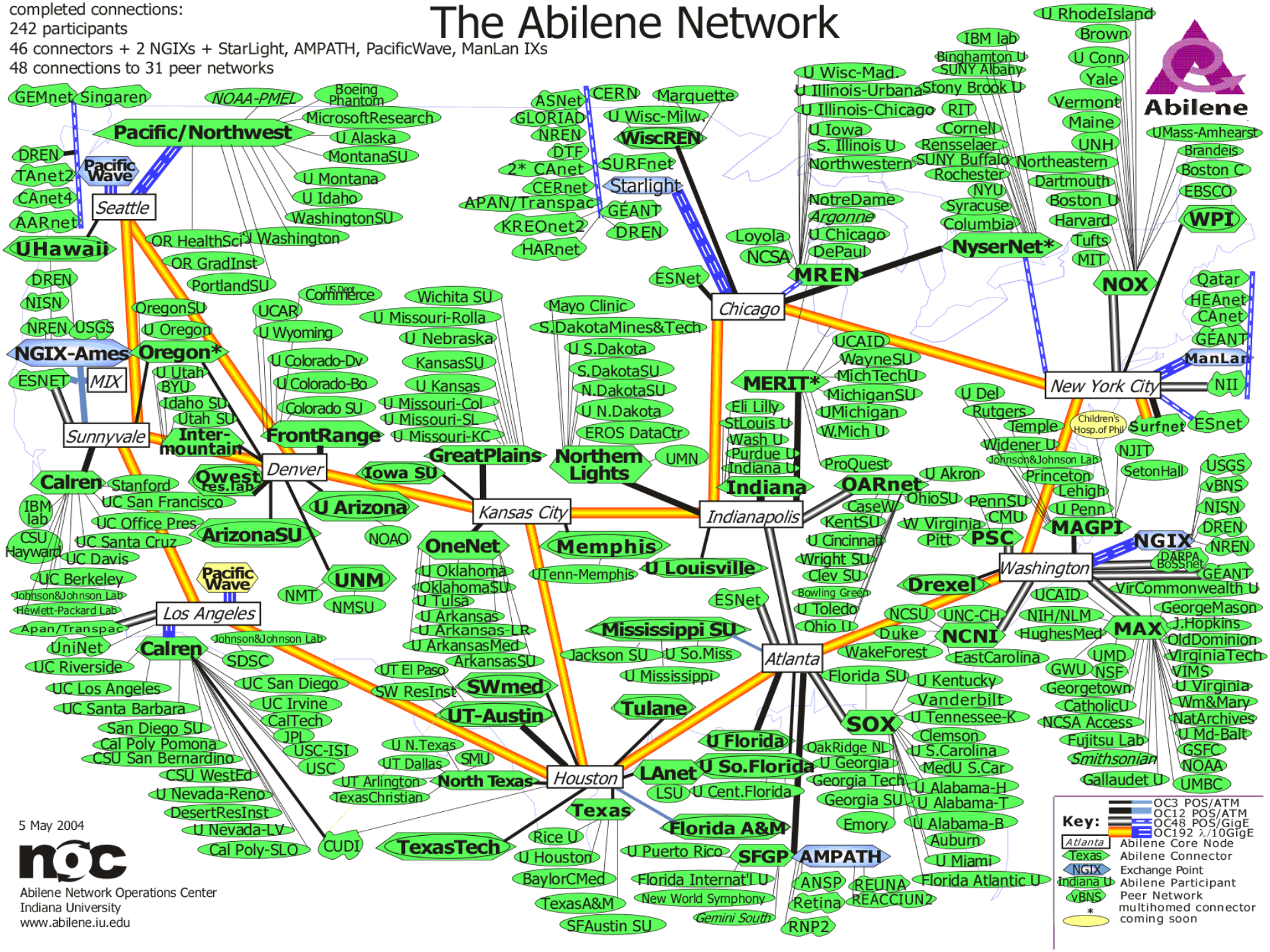
- Internet2 does more than networks—Abilene is an I2 “project”
- The primary university R&E network in the US
- Abilene is owned by US universities
- Became operational in 1998
- Abilene is operated by Indiana University for Internet2
- National-footprint OC192 backbone with 11 “core” locations

What is Abilene? (continued)

- Ipv4 connections:
  - 46 connections (oc3-oc192/10GE) to 242 member universities + >100 ‘sponsored’ institutions (e.g. Smithsonian, Gemini telescopes, medical centers) + 33 state R&E networks + many 100s of other colleges, universities, K-12s, libraries, labs, etc.
  - ‘gigapops’: regional R&E aggregators, regional networks
  - 6 connections to R&E exchange points: PacificWave (Sttl), NGIX-DC, StarLight (Chi), MaeWest (NGIX-Ames), Ampath (Miami), MANLAN(NYC)
  - 48 connections to 31 peer R&E networks (domestic & foreign)
- Some non-university members (research labs)
- Lots of support for ‘advanced protocols’
- No ‘commodity-internet’ peering except for ‘advanced’ protocols (multicast, IPv6)

completed connections:
242 participants
46 connectors + 2 NGIXs + StarLight, AMPATH, PacificWave, ManLan IXs
48 connections to 31 peer networks

The Abilene Network



5 May 2004

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www.abilene.iu.edu

Abilene (Internet2) is not an IPv6-only network.

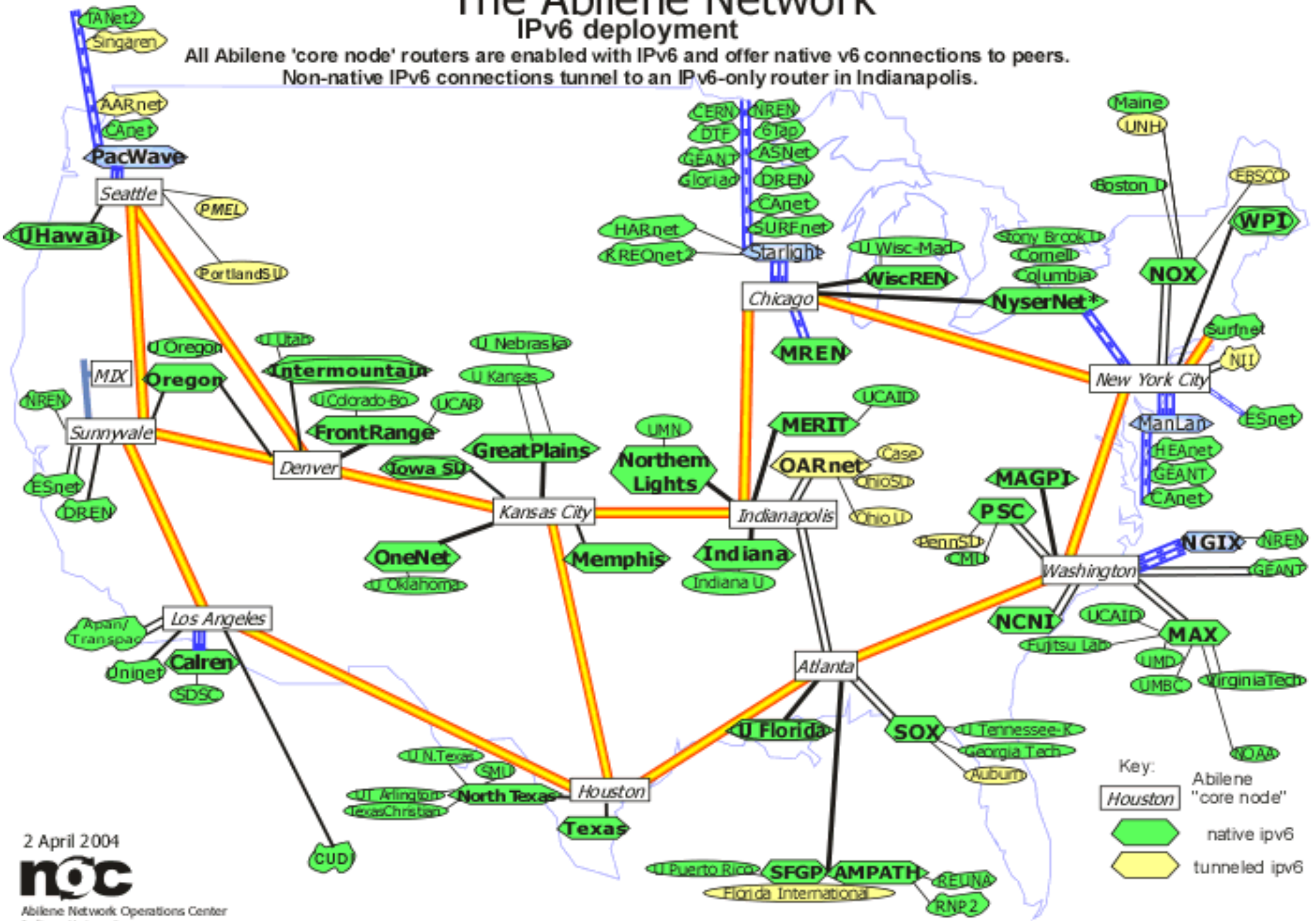
IPv6 on Abilene

- Native IPv6 on dual-stack routers
  - 2001: Cisco GSR
  - 2002: Juniper T640
  - A few old tunneled connections (~5)
  - v6 on the same path and interface as v4
- IS-IS IGP for v4 & v6 (see www.nanog.org/mtg-0306/browning.html)
- Full IPv6 routing table (511 prefixes)
- V6 Connections:
  - 28 (/52) connections to gigapops and exchanges
  - 29 (/48) connections to peer networks
- Small amounts of v6 multicast

The Abilene Network

IPv6 deployment

All Abilene 'core node' routers are enabled with IPv6 and offer native v6 connections to peers.
Non-native IPv6 connections tunnel to an IPv6-only router in Indianapolis.



2 April 2004

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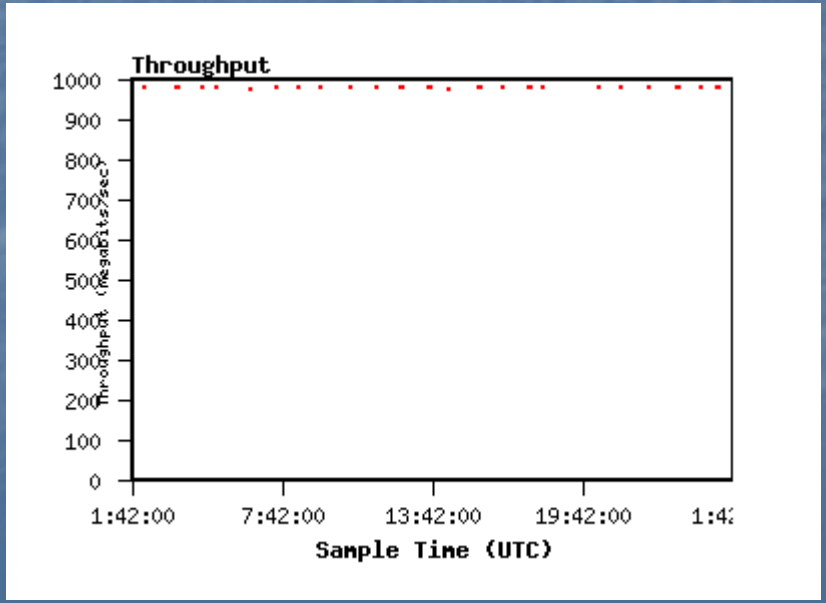
www.abilene.iu.edu/images/v6.pdf

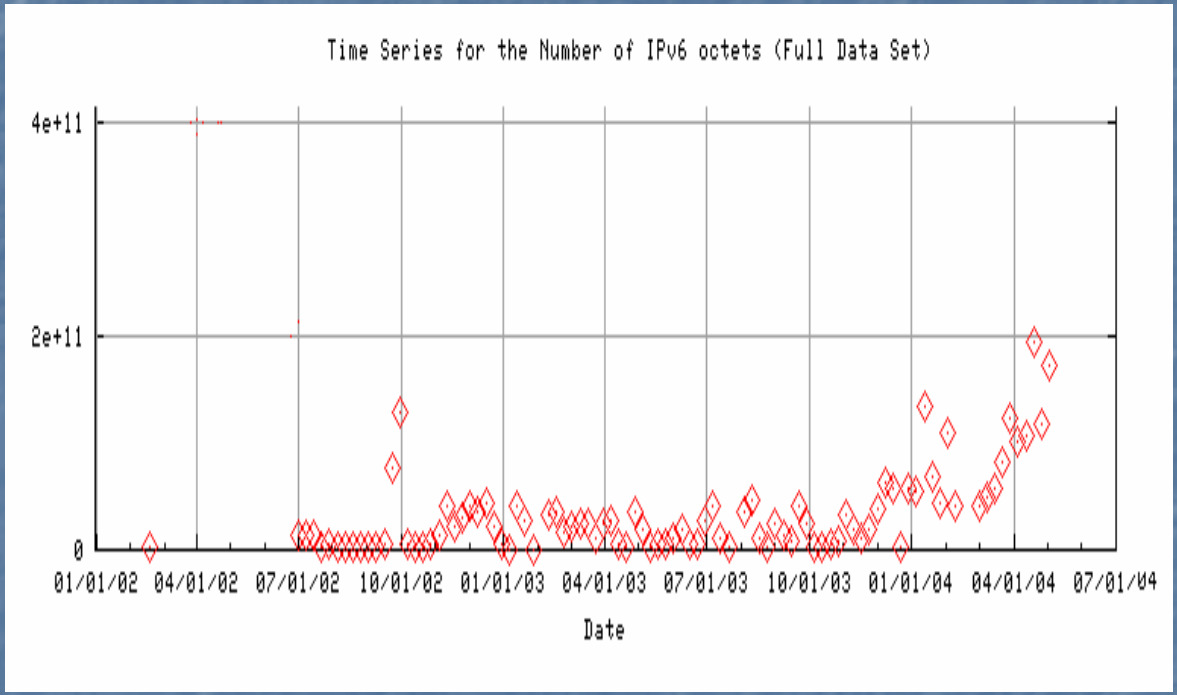
Performance

- V6 performance ≈ v4 performance across the backbone and LANs
- Regular ≈1Gbs flows with 1Gb NICs
- 8-9Gbs flows cross-country and international (e.g. SCinet)
- Example: DC-SNV w/ 1Gbs NICs (see Internet2 “Observatory”)



Growth

- Slow growth in traffic, greater in 2004
- Slow growth in # of prefixes



How are we helping v6 along?

- Infrastructure support: help create an environment where it works very well
- Early adoption: first 6bone, then native
- ‘Open’ policy for v6
- 6to4 gateways
- Measurement, support
  - “observatory”

Helping (continued)

- Provide addresses to I2 users from I2 /32 block
  - /40 to gigapops, /48 to campuses (no addresses for peer networks)
- Demonstrations that it *does* work well: performance, functionality
- Education
  - Internet2 working group
  - Conference encouragement; extra publicity for those who jump on bandwagon
  - Basic-configuration “cookbook” on webpage
  - “hands-on” advanced-technology workshops

Internet2 IPv6 hands-on workshops

- 1½-2-day workshop, about 12 conducted so far
- Very low cost
- Regional, convenient for local people
- Intended to bootstrap campuses into use
- Create your own lab v6 network from scratch:
  - Some history & theory, but aggressively practical
  - Router setup
  - Addressing considerations
  - Routing protocols (IGP, EGP) and considerations
  - Oriented toward Cisco and Juniper users
  - Some intro to applications' v6 support
  - Some campus-architecture considerations (e.g. parallel vs dual)
  - Some exposure to tough topics (e.g. multihoming)
- Agenda, slides: I2 IPv6 working group ipv6.internet2.edu

Internet2 IPv6 policy

- AUP-free for IPv6:
  - Any v6 prefix accepted from peers or connectors, except:
    - ‘sanity’ filters: no default, scoped
    - Prefix ranges: 2001 prefxes not > /48
  - All v6 transit allowed
- Purpose: help bootstrap it
- How long? Until it’s well-established

- BGP community to indicate less-desirable paths (tunnels)

What's missing?

- Counting, measurement:
  - No v6 MIB support in routers: we can do throughput & latency (via tools/apps), but not packets or bytes
  - So per-interface counts are difficult
  - We're currently using JunOS per-interface firewall filters
- No v6 netflow (implications for meas. & security)
- Multicast: no interdomain solution
  - Single-RP, currently in France
  - Embedded RP will probably solve this
- Multihoming
- No RADB support for v6 (at least from Merit)
  - They're working on it

Problems?

- Besides ‘missing’ things, very little attributable explicitly to IPv6...
- “It just works!”

Internet2 IPv6 Future

- More exchange-point connections
  - PAIX (bay-area)
  - Pacific Wave (Los Angeles)
- Multicast
- “Ipv6 everywhere by 2006”
  - All connectors
  - All campuses—and pervasively beyond edges

References

- Abilene home: abilene.internet2.edu
- I2 IPv6 WG: ipv6.internet2.edu
- Abilene Observatory: abilene.internet2.edu/observatory/
- Abilene NOC: www.abilene.iu.edu
- I2 Technologies-by-connection summary: abilene.internet2.edu/observatory/connection-technologies.html