IPv6 Campus Deployment Updates

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Campus Deployment Updates Panel

- Shumon Huque, University of Pennsylvania

- Alan Whinery, University of Hawaii

- Randy Bush, Internet Initiative Japan

- Focus: move beyond talking about IPv6 just in the network and into applications and services also.

Mark Prior's deployment survey

http://www.mrp.net/IPv6_Survey.html

Reader   Weather   GCal   Wikis ▾   Home ▾   Work ▾   IETF ▾   Shorten with bit.ly

Survey

www.mrp.net/IPv6_Survey.html

Internet2 Members

Organisation (domain)	Web	Mail	DNS	NTP	XMPP
American University (american.edu)	FAIL	FAIL	0/0/2	FAIL	
Arizona State University (asu.edu)	FAIL	FAIL	0/0/9		
Arkansas State University (astate.edu)	FAIL	FAIL	0/0/2		
Auburn University (auburn.edu)	FAIL	FAIL	0/0/3	FAIL	
Baylor College of Medicine (bcm.edu)	FAIL	FAIL	0/0/4		
Baylor University (baylor.edu)	FAIL	FAIL	0/0/4	FAIL	
Binghamton University (binghamton.edu)	FAIL	FAIL	0/0/3		
Boston College (bc.edu)	FAIL	FAIL	0/0/2		
Boston University (bu.edu)	FAIL	FAIL	0/0/3	FAIL	
Bowling Green State University (bgsu.edu)	FAIL	FAIL	0/0/4	FAIL	
Bradley University (bradley.edu)	FAIL	FAIL	0/2/4		
Brandeis University (brandeis.edu)	FAIL	FAIL	0/0/9	FAIL	FAIL
Brigham Young University (byu.edu)	FAIL	FAIL	0/0/3		
Brown University (brown.edu)	FAIL	FAIL	0/0/3	FAIL	

	Web	Mail	DNS	NTP	XMPP
University of California, Berkeley (berkeley.edu)	www.ipv6	FAIL	4/6/6	Stratum 2	
University of California, Davis (ucdavis.edu)	FAIL	FAIL	0/0/3	FAIL	
University of California, Irvine (uci.edu)	FAIL	FAIL	0/0/2		FAIL
University of California, Los Angeles (ucla.edu)	SUCCESS	SUCCESS	3/3/4	Stratum 1	SUCCESS
University of California, Office of the President (ucop.edu)	FAIL	FAIL	0/0/3	FAIL	
University of California, Riverside (ucr.edu)	FAIL	FAIL	2/4/4	Stratum 2	
University of California, San Diego (ucsd.edu)	FAIL	FAIL	0/0/4	FAIL	FAIL
University of California, San Francisco (ucsf.edu)	FAIL	FAIL	0/2/4		
University of California, Santa Barbara					

Internet2 Research and Education Network Members

Organisation (domain)	Web	Mail	DNS	NTP	XMPP
3ROX (Three Rivers Optical Exchange) (3rox.net)	SUCCESS	SUCCESS	0/1/3	Stratum 2	
CENIC (Corporation for Education Network Initiatives in California) (cenic.org)	FAIL	FAIL	0/0/3	FAIL	
Florida LambdaRail, LLC (FLR) (flrnet.org)	FAIL	FAIL	0/0/2		
GPN (Great Plains Network) (greatplains.net)	FAIL	FAIL	0/0/4		
Indiana GigaPoP (indiana.gigapop.net)	FAIL	FAIL	0/2/3	FAIL	
KanREN (Kansas Research and Education Network) (kanren.net)	SUCCESS	SUCCESS	2/2/2	Stratum 3	SUCCESS
LEARN (Lonestar Education and Research Network) (tx-learn.net)	FAIL	FAIL	0/0/2		
LONI (Louisiana Optical Network Initiative) (loni.org)	FAIL	FAIL	0/0/3		
MAGPI (magpi.net)	SUCCESS	FAIL	2/2/2	Stratum 3	SUCCESS
MAX (Mid-Atlantic Crossroads)					

More comprehensive examination

Would be useful to have a more comprehensive, systematic categorization of IPv6 network & application services available and used at the campuses. What is the list of common applications? Which are IPv6 capable? Are they production or non-production? What is the scope (eg. department, entire campus, etc)? ...

These panels may be one way of doing this.

Application Services

- DNS (authoritative, recursive)

- Web (HTTP)

- Email (SMTP, POP, IMAP, Submission)

- Time services (NTP, SNTP)

- Remote Login (SSH, Telnet, ...)

- Instant Messaging (XMPP, SIMPLE, ...)

- VoIP (SIP or any other protocol based)

- Authentication (Kerberos, PKI, Web-ISO systems ..)

- Directory (LDAP, ...)

More Services

- Address Assignment (SLAAC, stateless/stateful DHCPv6)

- RA-Guard, SEND, DHCPv6 filtering

- Network Management (SNMP)

- Traffic accounting, characterization systems (MRTG, Arbor Peakflow, Netflow v9/IPFIX, ...)

- IPsec in IPv6

- Disaster Recovery considerations

Middleboxes

- Firewalls

- IDS

- VPNs

- Server Load Balancers

- etc

Transition & Coexistence Mechanisms

- NAT-PT (deprecated)

- NAT64, DNS64

- IVI

- Dual Stack Lite

- A+P

Multi-homing

- Provider-Independent (PI, portable) address space?

- Future possibilities:

  - SHIM6

  - LISP (Locator/ID Separation Protocol)

  - IRTF RRG (routing research group) work

Network

- Border, Core, Distribution, Edge, ...

- Percentage of subnets/routed-interfaces

- How many server & enduser subnets?

  - How many of those are outside central IT?

- Estimated number of IPv6 capable devices connected to native IPv6 infrastructure

- How much native vs tunnelled traffic

University of Pennsylvania update

Documentation

- http://www.upenn.edu/computing/ipv6/

- Penn IPv6 Deployment Strategy paper:

    - http://www.upenn.edu/computing/ipv6/strategy.html

Penn Deployment Timeline

- Initial deployment began in our GigaPoP, MAGPI (late 2002)

- Penn campus deployment began 2005

- Work ongoing (of course)

MAGPI GigaPoP

- PA Address space from Internet2 /40

- Routing: IS-IS, MBGP-4

- Stateless Address Autoconfiguration

- Services: DNS, NTP, SSH, Web

- Multicast (work in progress)

- Provides IPv6 to UPenn, Princeton, NJEdge

University campus

- Production deployment began 2005

- Started with PA space delegated from MAGPI (2001:468:1802::/48)

- Later obtained PI space from ARIN - 2607:f470::/32

- Renumbering still in progress

Campus Network

- Routing: IS-IS, M-BGP4

- Border, core, & many distribution routers

- Growing # of enduser & server subnets

- All campus subnets by the end of FY'11?

- Engineering School: almost all subnets

  - drivers: teaching & research; eliminate tunnels

External connectivity

- Singly homed today via MAGPI and Internet2

- 2 Commercial ISPs: Level-3 & Cogent

  - examining IPv6 options through them

  - Level3: "beta" tunneled IPv6 service today, "limited" (?) native service at end of 1Q

  - Cogent: native or tunneled service today, depending on location & connection type

Address Assignment

- Servers: static addresses

- Endstations

  - Stateless autoconfig (mainly)

  - DHCPv6 (planning)

Application Services

- Campus Wide Production Services:

  - DNS

  - NTP

  - Jabber (XMPP)

DNS

- Authoritative DNS - ISC BIND

- Campus resolver - ISC BIND

- DNS Content Management system

  - Homegrown, custom protocol

  - Supports AAAA and v6 PTR records

Authoritative DNS

Looking at upenn.edu referral answer from EDU nameservers

```
$ dig @192.5.6.30 +norecurse www.upenn.edu a

;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 1895
;; flags: qr; QUERY: 1, ANSWER: 0, AUTHORITY: 4, ADDITIONAL: 6


;; AUTHORITY SECTION:
upenn.edu.                    172800   IN       NS       dns1.udel.edu.
upenn.edu.                    172800   IN       NS       dns2.udel.edu.
upenn.edu.                    172800   IN       NS       noc2.dccs.upenn.edu.
upenn.edu.                    172800   IN       NS       noc3.dccs.upenn.edu.


;; ADDITIONAL SECTION:
dns1.udel.edu.                172800   IN       A        128.175.13.16
dns2.udel.edu.                172800   IN       A        128.175.13.17
noc2.dccs.upenn.edu.          172800   IN       A        128.91.254.1
noc2.dccs.upenn.edu.          172800   IN       AAAA     2001:468:1802:102::805b:fe01
noc3.dccs.upenn.edu.          172800   IN       A        128.91.251.158
noc3.dccs.upenn.edu.          172800   IN       AAAA     2607:f470:1003::3:3
```

referral

glue

DNS resolver service

- IPv6 capable campus recursive resolvers available, but ...

- No easy way to distribute them (don't do DHCPv6 yet, and not all clients can even do DHCPv6, like Mac OS X)

- If someone asks, we tell them, and they manually configure the addresses

Application Services

- Services posing impediments:

  - Web (Akamai)*

  - E-mail (Message Labs/Symantec)

*Disclaimer: I wasn't involved in Akamaizing the Penn website, and this is probably not the place to discuss the topic of whether querier-specific DNS responses are good or evil, so I'm not going to do that (today).

Web

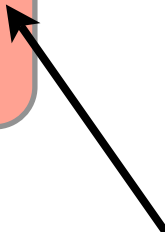## Penn website via Akamai IPv4, as viewed from Penn

```
;; QUESTION SECTION:
;www.upenn.edu.            IN A

;; ANSWER SECTION:
www.upenn.edu.       300 IN CNAME  www.upenn.edu.edgesuite.net.
www.upenn.edu.edgesuite.net. 19482 IN  CNAME  a536.g.akamai.net.

a536.g.akamai.net.       20  IN  A   128.91.34.234
a536.g.akamai.net.       20  IN  A   128.91.34.233
```

Penn-campus Akamai nodes, located on IPv6 capable network, so IPv6 possible in theory.

Web

Penn website IPv6 view, via Akamai:

```
;; QUESTION SECTION:
;www.upenn.edu.            IN  AAAA

;; ANSWER SECTION:
www.upenn.edu.         300 IN  CNAME  www.upenn.edu.edgesuite.net.
www.upenn.edu.edgesuite.net. 19482 IN  CNAME  a536.g.akamai.net.
```

No address records returned. No official IPv6 plans have been announced by Akamai.

We had been talking privately with Akamai about a possible trial IPv6 on the Penn campus Akamai nodes. But latest answer (1/28): "No IPv6 rollout plan in the immediate future. However, we'd be glad to work with you in rolling out IPv6 when we start the phased rollout".

E-mail

- Central mail service uses Message Labs

  - inbound/outbound virus scanning, and SPAM scoring

  - from our Message Labs rep: *"IPv6 is not currently on our roadmap" (June 2009)*

  - Mail access/submission? (IMAP, POP, webmail)?

    - we might start with these first

Application Services

- Kerberos

- RADIUS

- CoSign/Shibboleth (Web ISO, federation)

- LDAP

Kerberos

- Server implementation: MIT Kerberos

- Production server names not yet IPv6 addressable

- We do have IPv6 specific server names

  - kerberos{1,2,3}.ipv6.upenn.edu

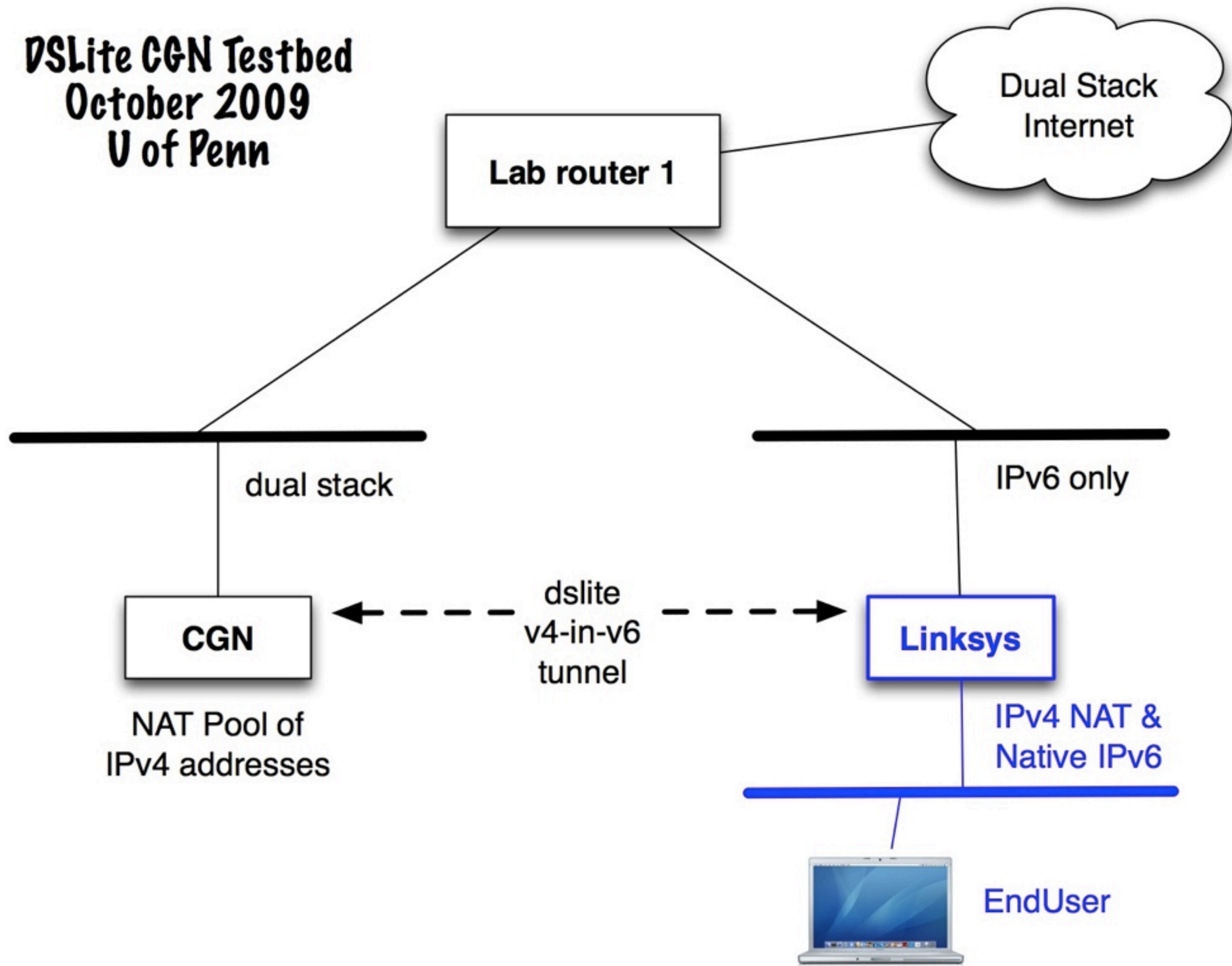- Users can manually install client side configuration files that use them

CoSign

- Web ISO system (umich, weblogin.org)

- Login server support not there yet

- Web application servers can be deployed on IPv6 and will be able to authenticate users with CoSign

- Our Shibboleth deployment uses CoSign as IDP (bottleneck) - I've heard other work is needed to support it.

IPv6-IPv4 Transition

- Trial deployment of DualStack Lite on campus, with Comcast & Engineering school faculty, as an experiment/research project.

- http://tools.ietf.org/html/draft-ietf-softwire-dual-stack-lite-02

- It's more likely that Penn will deploy something like NAT64 & DNS64 though, ie. enable v4-only and v6-only devices to communicate.

DSLite CGN Testbed
October 2009
U of Penn

Lab router 1

Dual Stack
Internet

dual stack

IPv6 only

CGN

dslite
v4-in-v6
tunnel

Linksys

NAT Pool of
IPv4 addresses

IPv4 NAT &
Native IPv6

EndUser

Questions/Comments?

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