IPv6 at Penn State

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- Background on PSU
- Status at PSU
- Addressing plan
- Positive developments at PSU

Some background

- Founded in 1855
- 92,000 students
- 10th largest public university in the US
- 22,000 full-time faculty & staff
- 7th largest employer in PA
- 24 locations + medical center + World Campus

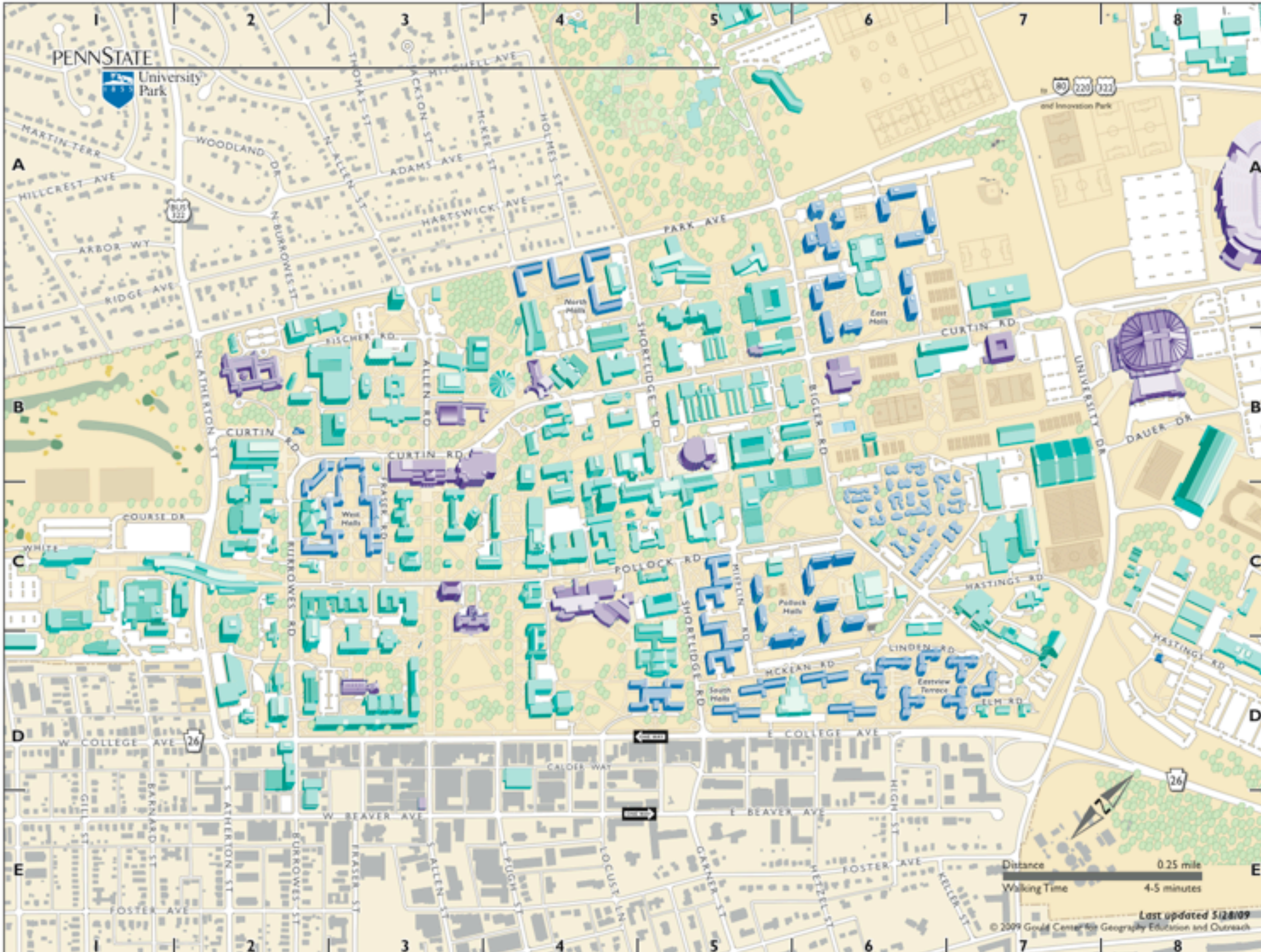

NY
Erie,
The Behrend College
Shenango
DuBois
Pennsylvania
College of
Technology
Wilkes-Barre
Worthington-
Scranton
Hazleton
OH
University
Park
Beaver
New
Kensington
Altoona
Schuylkill
Lehigh
Valley
Greater
Allegheny
Harrisburg
Hershey
Berks
Abington
NJ
Carlisle
Great Valley
York
Brandywine
Fayette,
The Eberly Campus
Mont Alto
MD
WV
VA
DE

Intercampus Network

Current

University Park Campus

- Half of enrolled students (43,000+)
- ~280 buildings including 61 dorms, the largest stadium in the US, and a nuclear reactor
- 1.5 square miles


PENNSTATE
University Park
MITCHELL AVE
MARTIN TERR
WOODLAND DR
HILLCREST AVE
ADAMS AVE
HARTSWICK AVE
ARBOR WY
RIDGE AVE
PARK AVE
THOMAS ST
JACKSON ST
McKEE ST
HOLMES ST
N ALLEN ST
N BURROWES ST
FISCHER RD
N ATHERTON ST
CURTIN RD
ALLEN RD
SHORTLIDGE RD
BIGLER RD
North Halls
East Halls
West Halls
FRASER RD
COURSE DR
WHITE
BURROWES RD
POLLOCK RD
MIFFLIN RD
Pollock Halls
HASTINGS RD
LINDEN RD
McKEAN RD
Eastview Terrace
ELM RD
South Halls
UNIVERSITY DR
DAUER DR
to 80 220 322 and Innovation Park
W COLLEGE AVE
E COLLEGE AVE
CALDER WAY
W BEAVER AVE
E BEAVER AVE
GILL ST
BARNARD ST
S ATHERTON ST
BURROWES ST
FRASER ST
S ALLEN ST
S PUGH ST
LOCUST LN
GARNER ST
HETZEL ST
HIGH ST
FOSTER AVE
KELLER ST
N
Distance 0.25 mile
Walking Time 4-5 minutes
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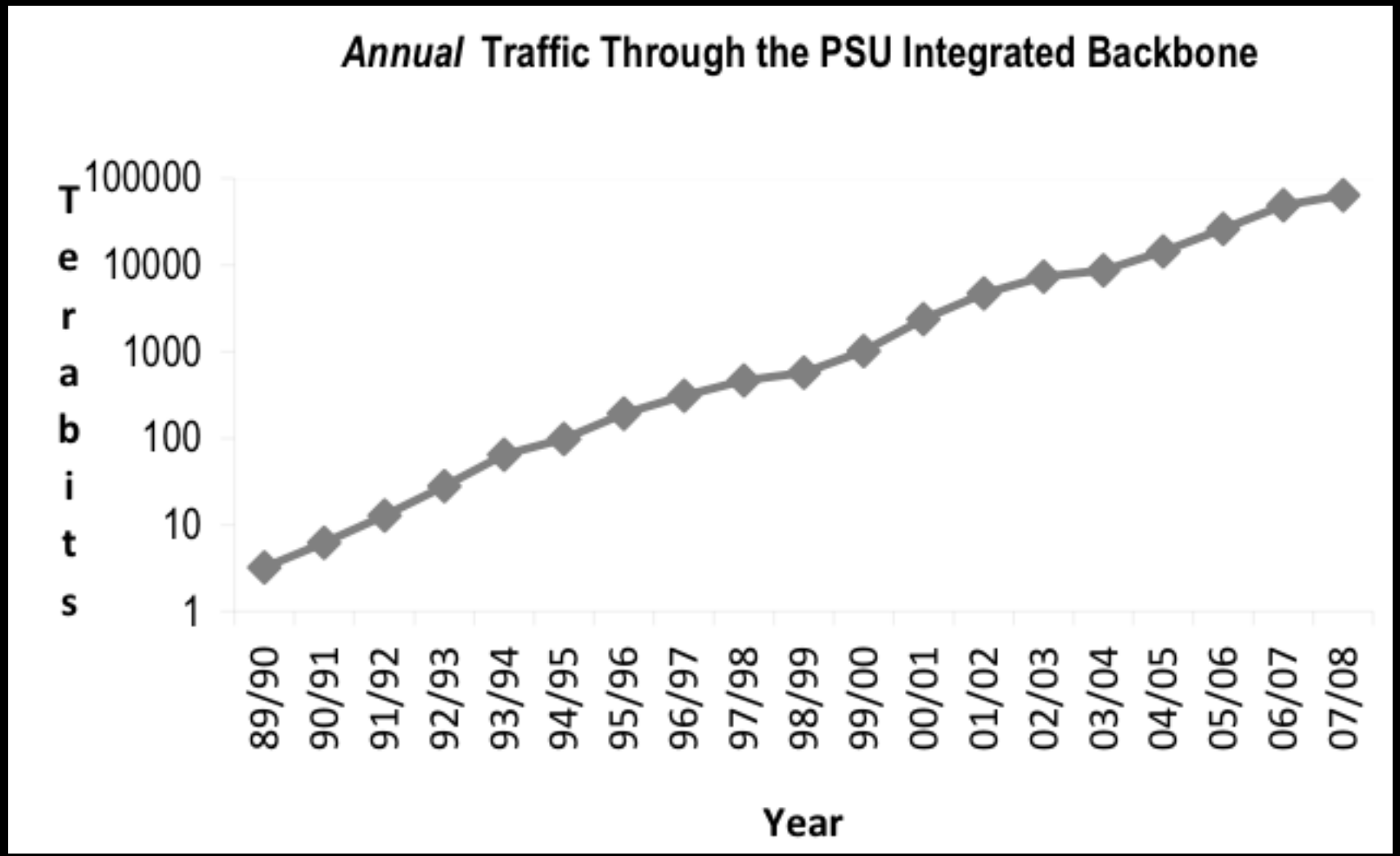
A B C D E
1 2 3 4 5 6 7 8

The Integrated Backbone

- Supports voice (VoIP), video, data
- Supports ~1,100 connections
  - ~550 centrally managed LANs
- Based on Cat 6500's
- External connectivity to commodity Internet, Internet2, National Lambda Rail


Annual Traffic Through the PSU Integrated Backbone
Terabits
100000
10000
1000
100
10
1
89/90
90/91
91/92
92/93
93/94
94/95
95/96
96/97
97/98
98/99
99/00
00/01
01/02
02/03
03/04
04/05
05/06
06/07
07/08
Year

Major growth areas

- Wireless
  - New /18 from ARIN
- $1.2 billion 5-year capital expansion project
  - datacenter expansion
  - new construction

Millennium Science Complex
275,000 sq. feet.

IPv6: A long, slow history

Initial native IPv6 trials in 2004-05:

"A successful native IPv6 field trial was conducted during this reporting period, and plans to make this new version of Internet Protocol available to Integrated Backbone customers at Penn State are forthcoming."

```
$ whois -a 2610:8::

OrgName:  The Pennsylvania State University
OrgID:   PSU-2
Address:  105 USB 2
City:    University Park
StateProv: PA
PostalCode: 16802
Country:  US

NetRange:  2610:0008:0000:0000:0000:0000:0000:0000 - 2610:0008:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR:    2610:0008:0000:0000:0000:0000:0000:0000/32
NetName:  PSU-IB
NetHandle: NET6-2610-8-1
Parent:   NET6-2610-1
NetType:  Direct Allocation
NameServer: OTC2.PSU.EDU
NameServer: ISENGARD.CSE.PSU.EDU
Comment:
RegDate:  2006-01-13
Updated:  2006-01-13
```

IPv6 Developments

- The Integrated Backbone supports IPv6 at line speed.
  - Replaced remaining Juniper M10s with Cisco Cat 6500s in 07-08.
- Our upstream provider has native IPv6 from multiple providers.
- Deploying native dual-stack IPv6. No plans for tunnels or translators.

IPv6 Addressing Plan

- Goals:
  - Reflect hub-and-spoke topology
  - Support route aggregation
  - Reserve lots of space for future growth

IPv6 Addressing Plan

- Split the /32 into two /33s
  - “Live” /33 for production
  - “Reserved” /33 for future growth
- Further split the “live” /33 into /34s:
  - /34 for University Park campus
  - /34 for other locations

IPv6 Addressing Plan: University Park

- Further split the U. Park /34
  - "Live" /35 for production
  - "Reserved" /35 for future growth
- From the "live" /35s, make /39s to each hub site at U. Park:
  - Each hub gets a "live" and a "reserved" /39
  - From each /39, make /64s for end-users

IPv6 Addressing Plan: Other Campuses

- Split the “non-U. Park” /34
  - “Live” /35 for production
  - “Reserved” /35 for future growth
- Each campus gets between a /37 to a /42 depending on size

/58 -vs- /64s

- Central networking wanted to use a /58
- Production services group wanted individual /64s for flexibility
- Multi-month deadlock

ULA Addresses

- Registered a /48 with the SixXS database
- Assign a /54 to each U. Park hub site and to each non-U. Park campus
- Used for internal-only services
- No plans to deploy to end-users

Status at PSU

- 123 allocated public /64s
  - Almost all at University Park
  - Almost all in central IT
- Mostly infrastructure, few services
  - University wiki is IPv6-enabled
  - Joined Google IPv6 pilot in April 09
- No v6-only networks yet, for policy reasons

Infrastructure status

- 3 of 6 root PSU DNS servers answer on IPv6.
  - 697 / 1076 sub-domains
  - 111 sub-domains have 100% IPv6 DNS
  - 5 units outside of central IT have deployed IPv6 DNS.
- 2x NTP stratum 2 servers answer on IPv6
- 6 / 215 sub-domains have IPv6-enabled MX

LAN Addressing Plans

- Some units use stateless autoconf
- Some use static addresses
  - Some match to IPv4, some don't
- No one doing much with DHCPv6
- No plans for SEND
- Recommending against privacy addresses

Central IT Audit

- Commissioned by Deputy CIO
- January - May 09
- Found much more IPv6 readiness than expected
- Problems are more motivational than technical

Security

- Most IPv6 threats have a direct analogue in IPv4: DOS, tunneling, MAC address hijacking, etc.
  - Don't believe the FUD.
- But there's not feature-parity between IPv4 and IPv6 security devices.
- We're deploying IPv6 on our central IDS, app scanning, and network monitoring services.

Security Specifics

- Firewalls are a mix of Cisco PIX and ASAs, as well as Nokia + Checkpoint. Also sw firewalls on Windows XP, Vista, OS X, and Linux.
- Recent versions of Snort and Nessus support IPv6.
- Use NDPmon.
- Cisco VPNclient 4.9 doesn't support IPv6. We're switching to 802.1x for wireless.

Successes

- Few hardware limitations
- Most units running sufficient software versions
- IPv6-only LANs are very close to being viable
- Several units began IPv6 deployment processes, despite lack of mandate.

Current challenges

- Lack of deployed first hop redundancy protocols
- Lack of feature parity for L2-L3 security services
- Equipment upgrades in some units
- Vendor delays
- Perception of IPv6 as a production service

Reactions

- Finally, it's "When" not "If"
  - But still no sense of urgency.
  - Not yet viewing IPv4 as strategic resource
- Discussion of security, but no good solutions.
- "IPv6 is a network issue."

Recommendations

- Start now.
- Treat IPv6 as production, even if it isn't.
- Put IPv6 on your desktop. Complain if it breaks.
- Audit and test.

Questions?

Resources

- IPv6 Addressing Plans panel at Internet2 Joint Techs - http://events.internet2.edu/2008/jt-lincoln/sessionDetails.cfm?session=10000081&event=281