Internet Protocol Version 6 (IPv6) at the University of Pittsburgh
What is IPv6

• IPv6 is the next generation Internet transport protocol
• Initially to run side-by-side with IPv4 (it currently does)
• Plan is for IPv6 to eventually supersede and replace IPv4
Why IPv6

- Exhaustion of Internet address space with IPv4
  - NAT has worked with IPv4 so far, but workarounds have been needed to allow some applications to work with NAT
  - NAT creates security “issues”
  - Double and Triple NATs and PATs – IP Fragmentation and checksum issues and with TCP and PAT cascading TCP sequence number issues
- IPv6 brings new and enhanced features
New IPv6 Features

- Many new extension headers
  - Routing Header (Path control)
  - Authentication Header
  - Encryption Header
  - Mobility Header
- 128 bits of address space (as opposed to 32 bits in IPv4)
- State-full and State-less methods to obtain your station address
- Security can be “built-in” (with use of security headers)
New IPv6 Features

- Many new ICMP(v6) message types
  - Neighbor Advertisement and Solicitation *(replaces IPv6 ARP)*
  - Router Advertisement and Solicitation
  - Mobile Prefix Advertisement and Solicitation
  - Node Information Query and Response *(could replace LLDP, PAGP, etc.)*
  - Multicast Functions *(could replace IGMP)*
IPv6 Address Format

• 128 Bits

• PITTNET prefix is

  2620:0102:4000:0000:0000:0000:0000:0000/42

• Always express in Hexadecimal

• Leading and Full 2-byte Zero Suppression is supported (but only once)

  2620:102:4000::/42
IPv6 Addressing and PITTNET

• /42 allows for 77,371,252,455,336,267,181,195,264 nodes on PITTNET if all addresses were used

and it's pronounced like this:

seventy seven septillion,
three hundred seventy one sextillion,
two hundred fifty two quintillion,
four hundred fifty five quadrillion,
three hundred thirty six trillion,
two hundred sixty seven billion,
one hundred eighty one million,
one hundred ninety five thousand,
two hundred sixty four
IPv6 and DNS

- New AAAA record type for FQDN name to IPv6 address resolution

bash-3.2$ nslookup> set type=AAAA>
www.google.com'Server: 136.142.57.10
Address: 136.142.57.10#53
Non-authoritative answer:www.google.com has
AAAAA address 2607:f8b0:400d:c02::63
**PITTTNET and IPv6**

- All user subnets will be /64 as per IPv6 best practice
- Workstation subnets will be stateful DHCPv6 only
  - We won’t support stateful or stateless autoconfig at this time
- RFC 3315 DHCPv6/DDNS is what PITTTNET will support for names (DHCPv6 updates DNS with request name, but domain comes from subnet template)
PITTNET and IPv6

- Workstation zone allocation is currently being implemented

bash-3.2$ ifconfig -aen0:
flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=10b<RXCSUM,TXCSUM,VLAN_HWTAGGING,AV> ether 68:5b:35:b1:80:fd

inet6 fe80::6a5b:35ff:feb1:80fd%en0 prefixlen 64 scopeid 0x4 (Link Local address)
inet 130.49.164.71 netmask 0xfffffffffe0 broadcast 130.49.164.95
inet6 2620:102:4008:1064:d::b808 prefixlen 64 dynamic (Global address)
nd6 options=1<PERFORMNUD> media: autoselect (1000baseT <full-duplex>) status: active
PITTNET and IPv6

• PITTNET support for IPv6 is in dual stack mode
  – Both IPv4 and IPv6 protocol stacks running on hosts
  – You may choose to run either one or both

• No DNS64 at this time

• No IPv4/IPv6 protocol translation at this time

• As IPv4 nears its demise, we will re-examine this
PITTNET and IPv6

Windows IP Configuration

Ethernet adapter Local Area Connection:

Connection-specific DNS Suffix : cssdwkstn.pitt.edu
IPv6 Address : 2620:102:4008:1064:d::4d6b
Link-local IPv6 Address : fe80::1a03:73ff:fe14:1856%14
IPv4 Address : 130.49.164.82
Subnet Mask : 255.255.255.224
Default Gateway : fe80::220:5ff:fe01:100%14
fe80::21c:fff:fe63:1c00%14
130.49.164.65
### PITTTNET and IPv6

- **IPv6 Neighbor table**

```bash
bash-3.2$ ndp -anNeighbor

<table>
<thead>
<tr>
<th>Linklayer Address</th>
<th>Netif</th>
<th>Expire</th>
<th>St Flgs</th>
<th>Prbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2620:102:4008:1064:d::b808</td>
<td>en0 permanent</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fe80::1%lo0</td>
<td>(incomplete)</td>
<td>lo0 permanent</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>fe80::220:5ff:fe01:100%en0</td>
<td>en0 11s</td>
<td>R</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>fe80::6a5b:35ff:feb1:80fd%en0</td>
<td>68:5b:35:b1:80:fd</td>
<td>en0 permanent</td>
<td>R</td>
<td></td>
</tr>
</tbody>
</table>
```
PITTNET and IPv6

- Server zones (for now) will be static IPv6 addresses and Names only

- IPv6 should be downward compatible to “well written” applications with IPv4 transport
  - This is not always the case, so each application must be validated to work properly with IPv4
PITTPNET and IPv6

• Process to bring up a server IPv6
  – Request IPv6 address. If this is the first machine on the subnet requesting IPv6, then a /64 prefix will be assigned to the subnet
  – All machines except for servers/applications validated for IPv6 should have IPv6 disabled
  – AAAA will be assigned with a “temporary” FQDN for testing
PITTNET and IPv6

• Application testing with IPv6
• After validation you may request A and AAAA resolution for the same name (or not, as you prefer)
How do I know if I have functional IPv6?

http://test-ipv6.com

- Test with IPv4 DNS record: ok (1.262s) using ipv4
- Test with IPv6 DNS record: ok (1.252s) using ipv6
- Test with Dual Stack DNS record: ok (0.409s) using ipv6
- Test for Dual Stack DNS and large packet: ok (0.165s) using ipv6
- Test IPv4 without DNS: ok (0.407s) using ipv4
- Test IPv6 without DNS: ok (0.405s) using ipv6
- Test IPv6 large packet: ok (0.309s) using ipv6
- Test if your ISP's DNS server uses IPv6: ok (0.306s) using ipv6
- Find IPv4 Service Provider: ok (1.040s) using ipv4 ASN 4130
- Find IPv6 Service Provider: ok (2.006s) using ipv6 ASN 4130
IPv6 Conclusion

- IPv6 is real, here, and now
- It is unclear what will be the tipping point for IPv6 becoming the predominant protocol for transport on the public Internet, but it is expected that Mobile and IOT will be the main drivers for adoption
- IPv4 isn’t going away anytime soon, but

   BE PREPARED FOR IPV6