



University of Pittsburgh

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
```

```
AAAA address 2607:f8b0:400d:c02::63
```




PITNET 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 PITNET will support for names (DHCPv6 updates DNS with request name, but domain comes from subnet template)



PITNET 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 0xfffffe0 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
```



PITNET and IPv6

- PITNET 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



PITNET 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:fef3:1c00%14
                             130.49.164.65
```



PITTNET and IPv6

- IPv6 Neighbor table

```
bash-3.2$ ndp -anNeighbor
```

```
Linklayer Address Netif Expire St Flgs Prbs
```

```
2620:102:4008:1064:d::b808 68:5b:35:b1:80:fd en0 permanent R
```

```
fe80::1%lo0 (incomplete) lo0 permanent R
```

```
fe80::220:5ff:fe01:100%en0 0:20:5:1:1:0 en0 11s R R
```

```
fe80::6a5b:35ff:feb1:80fd%en0 68:5b:35:b1:80:fd en0 permanent R
```



PITNET 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



PITNET 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



PITNET 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