IPv6 Implementation at a Network Service Provider

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R. Kevin Oberman
Sr. Network Engineer

Who Are We?

ESnet is the network provider for the Department of Energy's Office of Science

- ESnet is a networking pioneer with nearly a quarter century of networking
  - Began as MFEnet in 1976
  - Became ESnet with broader mission in 1986
  - Started support of BGP4 and modern peering in 1994
  - Multicast support since 1995
- Provide network connectivity to DOE Science funded laboratories and research projects
- Provides full commercial connectivity with over 100 commercial peers
- ESnet is transit free

Pioneered IPv6

ESnet has pioneered IPv6 since its inception

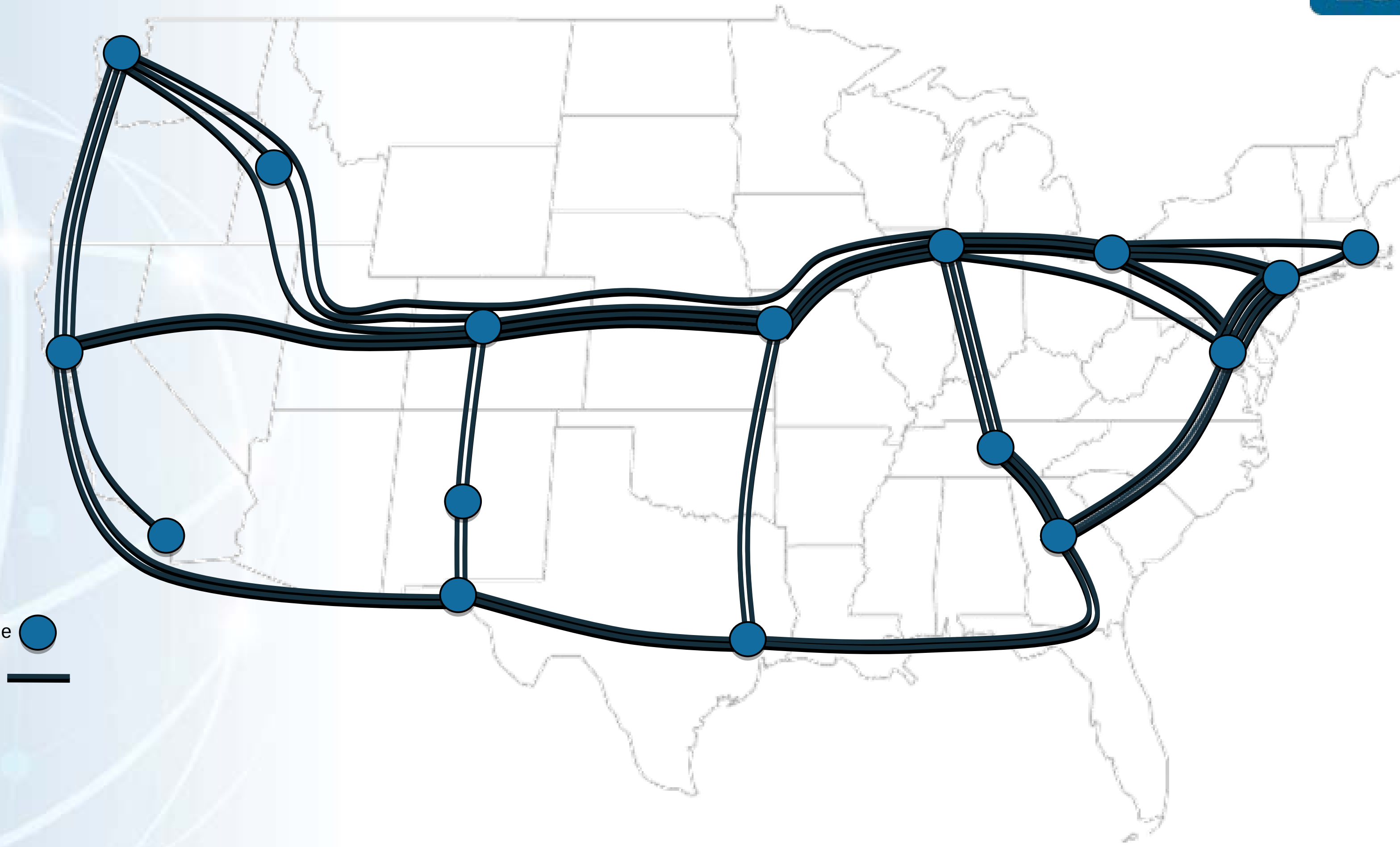
- ESnet started working on IPv6 in 1996
  - Tony Hain and Bob Fink chaired the main IPng IETF working groups
  - ESnet worked closely with Sun, Digital, Kame, and Cisco in the development and testing of IPv6 developmental code
  - Instrumental in the development of the 6-Bone
  - Partnered with Viagenie to create 6Tap, the first IPv6 Internet Exchange
  - Received the first production IPv6 address allocation from ARIN
    - First production addressed system, hershey.es.net still sits in my office in Berkeley.

IPv6 Status

IPv6 is a fully supported production service of ESnet

- Since 2004
- Available to all sites and peerings
- ESnet web services, NTP, DNS, and mail use IPv6
- Currently we are our own best customers
  - That is changing
  - Sites are adding IPv6 connectivity
  - Even a couple of IPv6 services

ESnet4 Backbone Topology



IPv6 Implementation

- IGP is ISIS
  - Common implementation for many protocols
  - Security advantages
- iBGP advertizes IPv6 over a common mesh with IPv4
  - Be careful of next-hop self
  - Not all route vendors support this
- eBGP is all native
  - ESnet does not use tunnels

Internal use

ESnet uses IPv6 whenever possible (and it usually is)

- Our mail and web services are IPv6
- DNS is IPv6
- NTP is IPv6
- Network management uses IPv6 (SNMP)
  - Fully implemented on CA Spectrum Network Management system
- Console access to most systems is ssh over IPv6

Site support

- Provide technical assistance for sites implementing IPv6
- Provide address space (Provider aggregable) in /48 chunks

IPv6 Peering

- No significant differences between IPv6 and IPv4 peering
- Most major providers now have some level of IPv6 capability
- Some run full dual stacks on peering routers
- Some still depend on tunnels to reach a limited number of dual-stack routers
- Some provide IPv6 only at a limited number of locations

The situation has improved significantly in the past 12 month for commercial providers

Issues with IPv6 support

- Many management tools do not yet support IPv6
  - This is changing, but rather slowly
  - Will change must more quickly when customers start demanding FULL IPv6 feature parity
    - (you all do that already, don’t you?)
- Not much of a registry for IPv6 routing information
- Many peering monitoring tools have limited or buggy IPv6 support
- You need an addressing plan (or two or three)

IPv6 Addressing Plans

- Addressing plans are crucial to successful deployment
  - The are seldom easy
  - Will need occasional adjustment
  - May even require full replacement
    - This can almost always be avoided
- Design the addressing plan for you logical topology
- Always allocate more bits than you need!
  - Addresses are plentiful and cheap
  - Don’t be penny wise and pound foolish
- Assignments should be on nibble boundaries

The problem that is SLAAC

- SLAAC is StateLess Address Auto Configuration
  - SLAAC seemed like a good idea
    - Simplifies readdressing
    - Does not need a DHCPv6 server, only a router
- SLAAC is a bad idea
  - Removes control
  - Adds vulnerabilities
  - Lack ability to provide added information like:
    - DNS servers
    - NTP servers
    - Fallback gateways
- Eats the last 64 bits of the address

You Can't Say "NO!" to SLAAC

- Inherent in IPv6 design
- Systems often become RAs by accident
- Turning it off essentially turns off IPv6
  - Demand RA-Guard to block rogue RAs

IPv6 Security

It was often claimed that IPv6 has better security than IPv4

There is little or no basis for this!

- IPv6 implementations have far less testing to find vulnerabilities
- IPv6 is often not treated correctly by firewalls and filters
- IPv6 has the dread Next Header system which allows “hiding” malicious headers beyond the reach of most routers
- Hacker have been using IPv6 for some time and know it well
  - Often not used for hacking, but as a means of hiding activities
- Ping-pong DOS attacks are often easy
  - But they are easy to prevent/fix

Summary

- IPv6 generally works well on modern routing equipment
- Extra fees to run IPv6 are vanishing
- IPv6 is easy to set up in a backbone
- Mostly can be handled exactly like IPv4
- Your Address plan is important
- SLAAC is evil (Did I mention RA-Guard?)
- Many management and security tools are weak or simply don’t support IPv6
- IPv6 presents security concerns (though most are similar to IPv4)
- The hard part of IPv6 is the services
  - Network folks have the easy part