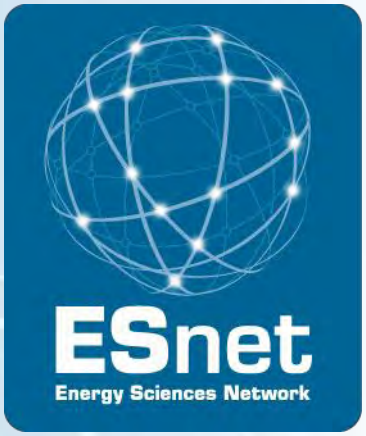

IPv6: Its Time is Now

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Overview

- Review of issues leading to IPv6
- Why IPv6 now?
- The OMB IPv6 Mandate
- IPv6 Overview and Issues
- IPv6 and DOE Organizations
- Requirements
  - Networks
  - Hosts
  - Services
- Suggested path to compliance

The Internet Today

- Today's Internet is a rapidly expanding web of at least hundreds of millions and probably billions of computers
- Each computer must have a unique address so that it can be found
- The current protocol that handles this is IPv4
  - Developed in the 1970s before the first PC when a network of even a few tens of thousands computers was an order of magnitude larger than the developers were expecting to ever have to deal with
  - IPv4 addresses are 32 bits and represented as four decimal numbers separated with dots
    - E.g. 192.168.38.118

Growth of the Internet

- Starting in the 1990s the Internet moved from a US Government sponsored project to a commercial entity
  - The “Information Super Highway” was born
- The addressing system in use at that time would allocate half of the available addresses to only 126 organizations
- The growth of the Internet was going to exhaust the available space in a VERY short time
- Two techniques save the Internet
  - Classless addressing to allow much more efficient use of the space
  - Network Address Translation (NAT) to allow several systems to share a single public address
- Work started on a replacement for IPv4…IPv6

Why IPv6 Now?

The Internet is out of addresses!

- Better use of addresses has extended the life of IPv4 for almost two decades
  - Time has finally run out
    - No workable, scalable methods have been found to further extend IPv4 life
- All IPv4 addresses have been assigned to regions
  - The last Asian assignment will be made later this year
  - The last North American assignment will be made in about a year
- Systems with only IPv6 capability will start appearing soon after that
- OMB has mandated IPv6 for public access!

The OMB Mandate

- The OMB has mandated that government services support IPv6
  - Not really a transition as IPv4 is not going away
  - Will assure that government resources are not constrained as IPv6-only systems start to appear
- All public Internet services on government systems must be reachable via IPv6 by the end of FY'12
- All Internet services on government systems must be reachable via IPv6 by the end of FY'14
- DOE services and those of DOE laboratories are covered by the mandate

The 2012 OMB Mandate

- Services covered include:
  - Web
  - Mail
  - DNS
- Only services that are publicly available are covered
  - Services requiring authentication are not covered
  - Services intended for a closed audience and not linked from pages that are intended for public access are not covered
    - Primarily excludes collaboration web services

The 2014 OMB Mandate

- By the end of FY'14, ALL network services must be IPv6 capable
  - This does not mean that IPv4 is going away any time soon
  - It does not mean internal or external users are required to use IPv6
  - It means that any system that uses IPv6 can reach all services with no need to use IPv4 at all

What makes IPv6 different

- Uses longer addresses
  - IPv4 32 bits 192.168.156.218
    - 4.3 billion addresses
  - IPv6 128 bits 2001:400:3E5:4D74:259A:F486:20:18A
    - 340 sextillion or **$340*10^{36}$ addresses!**
- It is generally very similar to IPv4
- Is NOT compatible with IPv4!
  - IPv4 systems cannot talk directly to IPv6 systems
  - Systems may (and currently do) run both protocols

Is the v6 Address Space REALLY That Big?

- IPv6 assumes 64 bits per network and 64 bit for the systems in that network
  - Real effective space becomes 64 bits
    - 18.44 quintillion or **$18*10^{18}$** networks
    - That's still a LOT of addresses
- Currently 7/8s of the space is reserved for future use
  - Leaves addresses for "only" 2.3 quintillion (**$2.3*10^{18}$**) networks
  - Remaining space can be used when/if needed
    - Just in case we (the network engineers) got it wrong

Other important differences

- Supports automatic addressing and easier re-addressing
  - Requires StateLess Automatic Address Configuration (SLAAC)
  - Depends on support for multiple addresses per interface
  - No other way to provide gateway address to a system
    - DHCPv6 will not do this! (Yet)
  - Last 64 bits are “EUI-64” encoding of the MAC (Ethernet) address or random string
- Relies on ICMPv6 for normal operations
  - You can’t simply block ICMPv6 and expect the network to function

What About NAT?

- Network Address Translation (NAT)
  - Used to allow the use of private, non-unique addresses inside of a network without exposing them externally
  - Allows one public IPv4 address to be used by an entire network
  - Used by almost all home networks
  - Often used for entire private enterprises excluding public services
- IPv6 does NOT support Network Address Translation (NAT)
  - NAT was not intended for any purpose other than saving on address utilization
  - Too often perceived as a security enhancement
    - Actually, “statefull inspection” (required by NAT) aided security

Can IPv6 computers talk to IPv4 ones?

- They can't communicate directly from IPv4 to IPv6
- They can run both IPv4 and IPv6 at the same time
  - Referred to as "dual stack" networking
- Various technologies are in development to allow IPv6-only system to communicate with IPv4 only systems
  - None approaches the flexibility and robustness using a single protocol
  - Unlikely to be well maintained in the long run

Is the Internet “broken”?

- Popular press has described the Internet as “broken” due to the lack of addresses
- The Internet is NOT broken today.
  - It is limited by the lack of addresses which will make growth difficult and very expensive
  - Will limit the flexibility of the Internet
  - Will reduce the robustness of the Internet

This does not break any of the existing Internet

It does mean that something has to change

What does the network need?

- Mandate discusses **services**
  - Functioning IPv6 connectivity is required for services to be available
  - Providers must support IPv6
  - All internal networks needed to reach IPv6 services (2012) must have native IPv6 capability
- Critical infrastructure must support IPv6
  - Network management
  - Security
  - Accounting

Host requirements

- There is NO requirement for any systems not providing services or access to services support IPv6

Service requirements

- Must run on an IPv6 capable platform
- Must have IPv6 enabled and configured
- All content available via IPv4 must also be available via IPv6
- May be on an separate platforms or VMs
  - This allows IPv4 services to remain unmodified
  - Avoids any disruption that might result from adding IPv6 capability to a system currently providing IPv4 services
  - Tunnels are not allowed
    - Native IPv6 only

DOE IPv6 Taskforce

- Chaired by Samara Moore for the Under Secretary
- Participation by all DOE programs, the CIO, and laboratories
- Developing the DOE response for input to OMB
- Developing scope for FY2012 OMB milestone
  - Define services covered (DNS, Web, Mail)
  - Report to OMB by June of this year
- Defining training requirements for both procurement and technical personnel
- Developing status display to allow easy check on IPv6 compliance status of individual organizations within DOE

Before Starting to Implement IPv6

- IT Infrastructure issues are almost always the single largest issue
- Infrastructure issues can cause major delays and failures
- Careful planning is needed to avoid these
- Staff training is essential
- Security, administration and management tools needed must be IPv6 capable
- Those using these tools must be familiar with the many differences that will be seen with IPv6. They will look different

General Steps for support of IPv6 services

- Develop a list of public services
- Confirm the ability of all service providers to provide IPv6 routing
- Set up training for network technical personnel
- Determine the type of IPv6 address space you need
- Determine the amount of space you will need
- Design an addressing plan (and expect to re-design it)
- Audit all network hardware for IPv6 capabilities
- Establish IPv6 connectivity with your network provider(s)
- Decide if you will use StateLess Address AutoConfiguration (SLAAC)

General Steps for support of IPv6 services

- Enable IPv6 on all network equipment between your CE router and the servers which will be providing public IPv6 services
- Test all network management and security tools for proper operation on IPv6 (Security, administration, operations, and accounting)
- Enable IPv6 access to DNS
  - IPv6 supported on all commonly used name servers
  - Don’t forget to add NS records to parent (dotgov.gov)
  - Enable other services
    - Mail
    - Web

General Steps for support of IPv6 services

- Test, test, and test some more
  - Test from outside of your firewall
  - Test from an external system (at another site)
  - Test for all providers
- Add IPv6 addresses to DNS (This is the BIG step)
- These steps and suggestions for how to take them may be found at the ESnet IPV6 Transition Checklist
  - This checklist is provided as an aid to implementing IPv6 services and is purely advisory

Areas Likely to Require Attention

- Hosts (other than WinXP and MacOS) and newer routing/switching gear are NOT likely to have significant issues
  - WinXP must run dual-stack and IPv6 must be mnually enabled
  - MacOS does not have native support for DHCPv6
- Security gear (firewall, IDS/IPS, monitoring) may either lack IPv6 support or have severe limits on it
  - Limits are most likely either restricted features or reduced performance for IPv6
  - Limits may not be an immediate issue, but need attention to avoid problems as IPv6 traffic grows
- Staff training

Problems to Expect

- Lots of bugs!
  - IPv6 tools and services have not been heavily tested
  - Many undetected bug and security vulnerabilities likely exist
- Many tools may perform poorly with IPv6
- Operations differences may confuse personnel familiar with using the same or similar tools with IPv4
- Provider issues
  - Reliability may be lower
  - Connectivity may be uneven
  - Nothing you can really do about this other than change providers
  - Should improve quickly

Summary

- IPv6 readiness must become a priority in the next year
- The goal is to provide the public with complete access to all DOE resources intended for the general public over an IPv6 infrastructure
- IPv6 is not a huge change, but will take careful planning
- DOE IPv6 Transition Taskforce is developing goals and plans to assist DOE organizations to be in compliance with OMB requirements
- There are some basic steps that can guide organization through the process of becoming IPv6 ready
- There are areas which require more attention
- There are come common problems that can be expected