Federal IPv6 Training Overview

Dale Geesey
Chief Operating Officer
Auspex Technologies, LLC
Phone: 703.319.1925
Fax: 866.873.1277
E-mail: dgeesey@auspextech.com
Web: www.auspextech.com

8/24/2015
• 1:00 – 1:50  Introduction to IPv6
  » History
  » IPv6 Protocol Overview
  » World Deployment Status

• 1:50 – 2:00  Break + Q&A

• 2:00 – 2:50  Federal IPv6 Transition
  » Federal IPv6 Transition History
  » Federal IPv6 Transition Policy & Guidance
  » IPv6 Requirements in the FAR

• 2:50 – 3:00  Break + Q&A

• 3:00 – 3:50  NIST USGv6 Program
  » USGv6 Profile
  » USGv6 Testing Program
  » Federal IPv6 Transition Progress Measures

• 3:50 – 4:30  Q&A
INTRODUCTION TO IPV6
Introduction to IPv6: Learning Objectives

• Identify issues that led to the creation of IPv6
• Explain steps taken to extend the life of IPv4
• Describe at least two difference between IPv4 and IPv6
• Explain the value of extension headers
• Identify three network operators with significant IPv6 deployments
History

INTRODUCTION TO IPV6
The Internet Protocol: A Historical Perspective

Len Kleinrock
“Packet Switching” Theory

Larry Roberts
ARPANET

Vint Cerf
TCP/IP

Bob Kahn
TCP/IP

Jon Postel
DNS, Addressing, & Port Numbers
Packet Switching Timeline

1960s
- 1965: Network Proposal by Dr. Larry Roberts
- 1961: "Packet Switching" Dissertation by Kleinrock
- 1969: ARPANET Created
- 1970: NCP Protocol

1970s
- 1972: ARPANET Basic Email
- 1975: TCP Protocol
- 1982: DoD Adopts TCP/IP (IPv4)
- 1989: Commercial Internet

1980s
- 1978: TCP/IP Split
- 1983: DNS
- 1990s
- 1993: IPv6 Introduced

1990s
- 2003: DoD Adopts IPv6

2000s
- 2005: OMB IPv6 Mandate
- 2010: OMB IPv6 Memo

2010s
- 2011: World IPv6 Day
- 2012: World IPv6 Launch
- 2013: IPv6 Traffic >1%

August 24, 2015
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IPv4 Degradation

• IPv4 addresses have run out
  – 4.9 Billion devices currently on the Internet
  – 25+ Billion devices on the Internet by 2020 (Gartner)
  – Not enough addresses to support advanced applications
  – The U.S. is just now becoming a broadband society

• Many steps taken to alleviate the problem
  – Dynamic Addresses (DHCP)
  – Classless Addressing (CIDR)
  – Network Address Translation (NAT)
  – Strict addressing programs
Regional IPv4 Address Run-Down Model

* Source: www.potaroo.net
IPv4 Exhaustion Dates

ICANN – 02/03/2011

08/12/2015

09/14/2012

04/19/2011

06/10/2014

04/27/2019*

* Projected
Lost Promises of The Internet

- Ubiquity
- Peer-to-Peer Communication Model
- Transparency
- Dynamic Routing
- Unique & Stable Addresses
- Address Aggregation
RFC 1550 - IP: Next Generation (IPng) White Paper Solicitation

- Scalability
- Timeframe
- Transition & Deployment
- Security
- Configuration, Administration, and Operation
- Mobile Hosts
- Flows & Resource Reservation
- Policy-Based Routing
- Topological Flexibility
- Support of Communication Media
**IPng: Selection**

- **SIPP Selected**
  - RFC 1752 (1995)
  - Met Most Requirements
  - Similar To IPv4
  - Designated IPv6
    - Initial confusion resulted in first designating it “IPv7”

- **IPv6 Base Protocol**
  - RFC 1833 in 1995
  - RFC 2460 in 1998 (makes 1833 obsolete)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>CATNIP</th>
<th>SIPP</th>
<th>TUBA</th>
</tr>
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<tbody>
<tr>
<td>Complete Specification</td>
<td>No</td>
<td>Yes</td>
<td>Mostly</td>
</tr>
<tr>
<td>Simplicity</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Scale</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Topological Flexibility</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Performance</td>
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<td>Mixed</td>
<td>Mixed</td>
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<td>Robust Service</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Yes</td>
</tr>
<tr>
<td>Transition</td>
<td>Mixed</td>
<td>No*</td>
<td>Mixed</td>
</tr>
<tr>
<td>Media Independence</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Datagram</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Configuration Ease</td>
<td>Unknown</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
<tr>
<td>Security</td>
<td>Unknown</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
<tr>
<td>Unique Names</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
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<td>Access to Standards</td>
<td>Yes</td>
<td>Yes</td>
<td>Mixed</td>
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<td>Multicast</td>
<td>Unknown</td>
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<td>Extensibility</td>
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<td>Service Classes</td>
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<td>Mixed</td>
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<tr>
<td>Mobility</td>
<td>Unknown</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
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<td>Control Protocol</td>
<td>Unknown</td>
<td>Yes</td>
<td>Mixed</td>
</tr>
<tr>
<td>Tunneling</td>
<td>Unknown</td>
<td>Yes</td>
<td>Mixed</td>
</tr>
</tbody>
</table>
IPv6 Protocol Overview

INTRODUCTION TO IPV6
IPv4 Header vs. IPv6 Header

~ 20 Bytes (No Extensions)

- Version (4)
- IHL – Header Length
- TOS – Type of Service
- Length – Size of Datagram
- Identification
- Flags – Fragmentation Flags
- Fragment Offset
- TTL – Time to Live (hops)
- Protocol – Transport Protocol
- Checksum – 16 bit Checksum
- Source Address
- Destination Address
- Options and Padding

40 Bytes
Extensions
### IPv4 vs. IPv6: Functions & Features

<table>
<thead>
<tr>
<th>Function / Feature</th>
<th>IPv4</th>
<th>IPv6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address Space</td>
<td>32 Bit</td>
<td>128 Bit</td>
</tr>
<tr>
<td>Networks</td>
<td>Shared (32 Bit)</td>
<td>1.85 X $10^{19}$ (64 bits)</td>
</tr>
<tr>
<td>Hosts</td>
<td>Shared (32 Bit)</td>
<td>1.85 X $10^{19}$ (64 bits)</td>
</tr>
<tr>
<td>Header</td>
<td>~ 20 Bytes</td>
<td>40 Bytes</td>
</tr>
<tr>
<td>Extensible (Future Growth)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Host Auto-Configuration</td>
<td>Yes (DHCP)</td>
<td>Yes</td>
</tr>
<tr>
<td>Router Neighbor Discovery / Auto-Config</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Security</td>
<td>IPSec Compatible</td>
<td>IPSec (Should)</td>
</tr>
<tr>
<td>Multicast</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Anycast</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Mobility</td>
<td>Possible w/ Routing ∆</td>
<td>Yes</td>
</tr>
<tr>
<td>Flow labels</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Automatic Fragmentation</td>
<td>Yes</td>
<td>Only If Requested</td>
</tr>
<tr>
<td>DNS Record</td>
<td>A</td>
<td>AAAA</td>
</tr>
</tbody>
</table>
**IPv4 vs. IPv6: Addressing**

**IPv4**
- 32 Bit Address Field
  - 4.294 X 10^9 Addresses
  - Shared Net & Host Identifier
    - Subnet-able
  - Typical Allocation:
    - ISP: /24
    - Business: /30
    - Individual: /32

**IPv6**
- 128 Bit Address Field
  - 3.4 X 10^{38}
  - Net & Host Identifier (Each):
    - 64 Bits: 1.85 X 10^{19}
  - Typical Allocation
    - ISP: /32 or larger
    - Business: /48
    - Individual: /48 or /56
  - Micro-allocation:
    - /32 = 2^{32} or
    - 4.294 X 10^9 Nets (1 Internet)
Domain Name Service (DNS)

- An Internet service that translates domain names into IP addresses and vice versa
- Domain names are easier to remember, but Internet routing requires an IP address
- IPv4
  - A Record (IPv4 Address)
  - Associates a domain name with a 32-bit IPv4 address
- IPv6 DNS
  - AAAA or Quad-A Record (IPv6 Address)
  - Associates a domain name with a 128-bit IPv6 address
  - The four “A”s (“AAAA”) are a mnemonic to indicate that the IPv6 address is four times the size of the IPv4 address

* RFC 3596 is the DNS Standard
## IPv6 Features & Functions: Potential Benefits

<table>
<thead>
<tr>
<th>Core Feature / Function</th>
<th>Capability</th>
<th>Benefit</th>
</tr>
</thead>
</table>
| Expanded Address Space       | 3.4 X 10^{38} Addresses  | - Everything uniquely addressable with virtually unlimited resources for everyone  
                              |                           | - A single enterprise can have multiple addressing plans                 |
|                              | Multiple Addresses Per Interface | - Multiple logical network topologies over common infrastructure  
                              |                           | - Multi-service platforms with unique IP addresses per service            |
| Simplified Header            | 40 Byte Fixed Length      | - Enhanced routing and switching performance  
                              |                           | - Improved “hardware-based” processing, e.g. encryption                   |
| Extension Headers            | Extensible & Flexible Protocol | - Augmentation of the protocol and evolutionary enhancements         |
| Authentication & Privacy     | IPSec                    | - End-to-end information assurance, including authentication, security, and attribution |
IPv6 Features & Functions: Potential Benefits

<table>
<thead>
<tr>
<th>Core Feature / Function</th>
<th>Capability</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auto-Configuration</strong></td>
<td>Controlled Configuration</td>
<td>- Defined criteria for local address allocation with access limitations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Defined criteria for global access via a globally unique address</td>
</tr>
<tr>
<td></td>
<td>Router Neighbor Discovery</td>
<td>- Router neighbor identification and configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rapid, Dynamic Network Configuration</td>
</tr>
<tr>
<td></td>
<td>Network Mobility</td>
<td>- Mobile and ad-hoc routing for translating networks and sensor-based networks</td>
</tr>
<tr>
<td><strong>Optimized Routing</strong></td>
<td>MTU Discovery</td>
<td>- Optimized packet sizing for data and multimedia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Streamlined utilization of infrastructure resources</td>
</tr>
<tr>
<td></td>
<td>Multicast</td>
<td>- Improved multicast functionality and performance</td>
</tr>
<tr>
<td></td>
<td>Anycast</td>
<td>- New anycast mechanism for data and resource identification and acquisition</td>
</tr>
<tr>
<td><strong>Flow Labels</strong></td>
<td>Header Labels</td>
<td>- Router, node, host, or application-based flow handing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Improved quality and priority</td>
</tr>
</tbody>
</table>
Extension Headers

IPv6 Packet With No Extension Headers (Next Header = 6)

IPv6 Packet With Two Extension Headers
## IPv6 Address Types

### Unicast

<table>
<thead>
<tr>
<th>Network/Subnet ID</th>
<th>Interface ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 bits</td>
<td>64 bits</td>
</tr>
</tbody>
</table>

### IPv4 Compatible

<table>
<thead>
<tr>
<th>0000 … 0000</th>
<th>0000</th>
<th>IPv4 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 bits</td>
<td>16 bits</td>
<td>32 bits</td>
</tr>
</tbody>
</table>

### IPv4 Mapped

<table>
<thead>
<tr>
<th>0000 … 0000</th>
<th>FFFF</th>
<th>IPv4 Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 bits</td>
<td>16 bits</td>
<td>32 bits</td>
</tr>
</tbody>
</table>

### Link Local (fe80::/64)

<table>
<thead>
<tr>
<th>1111111010</th>
<th>0000 … 0000</th>
<th>Interface ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 bits</td>
<td>54 bits</td>
<td>64 bits</td>
</tr>
</tbody>
</table>

### Multicast

<table>
<thead>
<tr>
<th>Network/Subnet ID</th>
<th>Interface ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 bits</td>
<td>48 bits</td>
</tr>
</tbody>
</table>
IPv6 Addressing Format

- Many ways to write the same IPv6 address
- “::” can be used once to compress consecutive 0’s
- Same
  - 2001:0DB8:0000:0000:0000:0000:0000:0001
  - 2001:DB8:0:0:0:0:0:1
  - 2001:DB8::1
- Same
  - 2001:DB8:0:0:FFFF:0:0:1
  - 2001:DB8::FFFF:0:0:1
Auto-Configuration

- Host Auto-configuration
  - Server Based (stateful/DHCPv6)
  - Non-Server Based (stateless)
- Network/Host Automatic Renumbering
- Stateless Auto-configuration
  1. Link-Local Address Generation
  2. Link-Local Address Uniqueness Test
  3. Link-Local Address Assignment
  4. Router Contact
  5. Router Direction
  6. Global Address Configuration
World Deployment Status

INTRODUCTION TO IPV6
World IPv6 Launch
June 6, 2012

- Participation
  - Websites = 2,608
  - Network Operators = 63
  - Home Router Vendors = 4
  - USG Sites = 20
- USG Domains using IPv6 = 130
  - http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-all.www
- Measurements
  - ISOC: http://www.worldipv6launch.org/measurements/
  - Akamai: http://www.akamai.com/ipv6
<table>
<thead>
<tr>
<th>Network</th>
<th>% IPv6 Traffic</th>
<th>Network</th>
<th>% IPv6 Traffic</th>
<th>Network</th>
<th>% IPv6 Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Louisiana State University</td>
<td>78.78%</td>
<td>University of Buffalo</td>
<td>51.74%</td>
<td>Time Warner Cable</td>
<td>20.10%</td>
</tr>
<tr>
<td>Google Fiber</td>
<td>71.77%</td>
<td>University of Pennsylvania</td>
<td>49.38%</td>
<td>US Dept of Transportation</td>
<td>18.75%</td>
</tr>
<tr>
<td>Verizon Wireless</td>
<td>70.27%</td>
<td>University of Minnesota</td>
<td>47.86%</td>
<td>KDDI</td>
<td>17.59%</td>
</tr>
<tr>
<td>T-Mobile USA</td>
<td>57.55%</td>
<td>Cisco</td>
<td>41.59%</td>
<td>University of Iowa</td>
<td>17.37%</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute</td>
<td>57.64%</td>
<td>Comcast</td>
<td>39.24%</td>
<td>DREN</td>
<td>9.68%</td>
</tr>
<tr>
<td>Virginia Tech</td>
<td>56.93%</td>
<td>CloudFlare, Inc.</td>
<td>33.30%</td>
<td>Georgia Institute of Technology</td>
<td>6.44%</td>
</tr>
<tr>
<td>SPAWAR</td>
<td>56.74%</td>
<td>Tulane University</td>
<td>29.34%</td>
<td>SoftBank BB</td>
<td>3.25%</td>
</tr>
<tr>
<td>ATT</td>
<td>52.10%</td>
<td>Deutsche Telekom AG</td>
<td>28.31%</td>
<td>Sprint Wireless</td>
<td>3.15%</td>
</tr>
<tr>
<td>University of South Florida</td>
<td>51.88%</td>
<td>Hurricane Electric</td>
<td>26.71%</td>
<td>AT&amp;T Wireless</td>
<td>2.46%</td>
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</table>
Google IPv6 End-User Tracking (Global)

North America – 21.04%

## Akamai IPv6 Ranking

<table>
<thead>
<tr>
<th>Rank</th>
<th>IPv6 %</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38.3%</td>
<td>Comcast Cable</td>
</tr>
<tr>
<td>2</td>
<td>35.6%</td>
<td>AT&amp;T Communications Americas</td>
</tr>
<tr>
<td>3</td>
<td>72.6%</td>
<td>Verizon Wireless</td>
</tr>
<tr>
<td>4</td>
<td>18.6%</td>
<td>Time Warner Cable Inc.</td>
</tr>
<tr>
<td>5</td>
<td>23.7%</td>
<td>Deutsche Telekom (formerly T-Systems USA, Inc.)</td>
</tr>
<tr>
<td>6</td>
<td>45.7%</td>
<td>T-Mobile</td>
</tr>
<tr>
<td>7</td>
<td>8.4%</td>
<td>Virtua - DH&amp;C datacenter(TiVIT (formerly Optiglobe Brasil))</td>
</tr>
<tr>
<td>8</td>
<td>21.3%</td>
<td>Telefonica Del Peru</td>
</tr>
<tr>
<td>9</td>
<td>22.5%</td>
<td>Proxad/Free</td>
</tr>
<tr>
<td>10</td>
<td>46.8%</td>
<td>Kabel Deutschland</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>IPv6 %</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34.8%</td>
<td>Belgium</td>
</tr>
<tr>
<td>2</td>
<td>18.9%</td>
<td>Switzerland</td>
</tr>
<tr>
<td>3</td>
<td>18.6%</td>
<td>United States of America</td>
</tr>
<tr>
<td>4</td>
<td>17.3%</td>
<td>Peru</td>
</tr>
<tr>
<td>5</td>
<td>16.9%</td>
<td>Germany</td>
</tr>
<tr>
<td>6</td>
<td>12.4%</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>7</td>
<td>12.3%</td>
<td>Portugal</td>
</tr>
<tr>
<td>8</td>
<td>11.2%</td>
<td>Greece</td>
</tr>
<tr>
<td>9</td>
<td>8.6%</td>
<td>Estonia</td>
</tr>
<tr>
<td>10</td>
<td>8.2%</td>
<td>Czech Republic</td>
</tr>
</tbody>
</table>
Introduction to IPv6: Summary

- IPv6 was created primarily to solve the IPv4 address depletion issue, but additional capabilities were included to help the Internet scale into the future.
- Many steps were successfully taken to extend the life of IPv4, such as the wide spread use of NAT.
- IPv4 and IPv6 has many similarities and differences, examples of differences include a larger address space and the use of extension headers.
- Extension headers are a great example of the “extensibility” of IPv6, they allow for the continued expansion of IPv6 capabilities.
- Almost all network operators have deployed IPv6 and many have a significant percent of IPv6 customers/traffic.
Introduction to IPv6: Review Question and Answers

1. Why was IPv6 created?
2. Name at least two steps taken to extend the life of IPv4?
3. How many bits are in an IPv4 address and how many bits are in an IPv6 address?
4. What type of DNS records are used for IPv4 and IPv6?
5. Which major US Wireless carrier is identified with the most IPv6 traffic?
Introduction to IPv6

BREAK + Q&A
FEDERAL IPV6 TRANSITION
Federal IPv6 Transition: Learning Objectives

• Understand the history of the Federal IPv6 transition
• Describe why “technology Refreshment” is a critical part of the Federal IPv6 transition strategy
• Explain the milestones established in the 2010 Federal CIO IPv6 Memorandum
• Identify Agency assets that need to be transitioned
• Describe the IPv6 requirements in the FAR
Federal IPv6 Transition History

FEDERAL IPV6 TRANSITION
Federal IPv6 Transition Thought Process

• How to transition?
  – Infrastructure first
  – Applications first
• Utilize Agency’s Enterprise Architecture Process (Enterprise Focus)
  – Track progress
  – Show value
• How to pay for it?
  – Existing budget – Technology Refreshment
  – Business case by specific program
• The Real Question: Why Transition to IPv6 in the First Place?
  – Real Answer – It is inevitable!
  – Other Answers (Money/Capability/Security)
• Other Big Question – Why transition now?
  – Government requires a much longer timeframe than industry to integrate new technology
  – Waiting will have a negative impacts on Government & industry
  – No more time
Federal IPv6 Acquisition Focus

Strategy
• Start buying IPv6 immediately
• Technology refreshment
• Roll-in IPv6 over time
• Reduce cost & impact

Results
• Mixed - slow acquisition start
• Pockets of victory
• Vendors adopting IPv6

Federal IPv6 Timeline
- DoD Transition Memo 2003
- 1st Federal and DoD Major IPv6 Milestone 2008
- CIO Memo 2010
- Internal Agency Milestone 2014
- Federal IPv6 Transition Memo 2005
- IPv6 FAR Amendment 2009
- Public Facing Milestone 2012
M-05-22 Requirements & Dates

<table>
<thead>
<tr>
<th>Oct FY06</th>
<th>Nov FY06</th>
<th>Dec FY06</th>
<th>Jan FY06</th>
<th>Feb FY06</th>
<th>Mar FY06</th>
<th>Apr FY06</th>
<th>May FY06</th>
<th>Jun FY06</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

- Assign IPv6 Lead
- Inventory of Existing Routers Switches & Hubs
- Inventory of All Existing IP Devices
- Impact Analysis
- Transition Plan
- Use of IPv6
June 2008 IPv6 Milestone Results

• OMB Public Statement
  - All major USG agencies reported that they successfully demonstrated IPv6 capabilities on their network backbones.

• Reality
  - Most agencies turned IPv6 on
  - Performed basic network tests (ping, trace routes, etc.)
  - Turned IPv6 off

• Bottom Line - IPv6 not operationally ready
  - C&A and security
  - Operational procedures
  - Training
  - Interoperability
  - Etc.

• Is this Success?
  - Yes!
  - First, critical step in the overall transition
Federal IPv6 Transition Policy and Guidance

FEDERAL IPV6 TRANSITION
The Business Case and Roadmap for Completing IPv6 Adoption in US Government

What Does it Cover

1. Federal IPv6 Transition – Progress to Date
2. Federal IPv6 Transition – The Next Steps
3. Leveraging Enterprise Architecture
4. Transition Roadmap and Milestones
5. IPv6 Impact on Federal Initiatives
6. IPv6 in IT Governance and Procurement
Planning Guide/Roadmap Toward IPv6 Adoption within the U.S. Government v2.0

What Does it Cover

1. Federal Transition Components
2. The Business Rationale for IPv6
3. Federal IPv6 Transition: The “To Be” State
4. Leveraging the Common Approach to Federal Enterprise Architecture
5. Transition Steps
6. IPv6 Impact on Federal Initiatives
7. IPv6 in IT Governance and Procurement
The New OMB IPv6 Memo

<table>
<thead>
<tr>
<th>Why</th>
<th>What &amp; When</th>
</tr>
</thead>
</table>
| • Enable key Federal IT modernization initiatives:  
  – Cloud Computing  
  – Broadband  
  – SmartGrid  
• Reduce complexity and increase transparency:  
  – Eliminate NAT technologies;  
• Enable ubiquitous security services:  
  – End-to-end network communications  
  – Foundation for securing future Federal IT systems  
• Enable the Internet to continue to operate efficiently:  
  – Integrated & well-architected networking platform  
  – Accommodate future expansion of Internet-based services | • Procurements:  
  – Comply with FAR requirements  
  – Use of the USGv6 Profile and Test Program  
  – Ensure completeness of IPv6 capabilities  
  – Now  
• Designate an IPv6 Transition Manager:  
  – October 30, 2010  
• External Services:  
  – Public/external facing servers and services  
  – e.g. web, email, DNS, ISP services, etc  
  – Operationally use native IPv6  
  – End of FY 2012 (September 30, 2012)  
• Internal Services:  
  – Applications that communicate with public Internet servers  
  – Supporting enterprise networks  
  – Operationally use native IPv6  
  – End of FY 2014 (September 30 2014) |
OMB IPv6 2010 – 2012

Milestone

- External Services:
  - Public/external facing servers and services
  - e.g. web, email, DNS, ISP services, etc
  - Operationally use native IPv6
  - End of FY 2012 (September 30, 2012)

- Other Publix/External Service
• The 2012 requirement makes sure that Federal information systems are accessible to IPv6-enabled end systems on the public Internet.

• Major access and mobile networks have announced plans to begin connecting customers using IPv6 within the next 2 years.

• The 2012 requirement will ensure that Federal information systems (and their supporting network infrastructure) keep pace with these developments and remain accessible to the emerging base of IPv6-connected users.

Examples of Impacted Applications (2012)

Typical examples of server applications that are publically accessible include*:

• Web servers,
• Email servers,
• DNS,
• FTP,
• Messaging and social media servers.

The 2010 OMB Transition to IPv6 memo states that:

“In order to facilitate timely and effective IPv6 adoption, agencies shall: Upgrade internal client applications that communicate with public Internet servers and supporting enterprise networks to operationally use native IPv6 by the end of FY 2014”

The IPv6 Transition objectives to be completed by the end of FY 2014 (Sept 30 2014) are as follows:

• Internal Client Applications that communicate with public Internet servers must support IPv6,
• Enterprise networks must support IPv6,
• Must operationally use native IPv6.
2014 Target Explained*

- The intent of the 2014 requirement is to ensure that public IPv6-enabled network services that are provided external to an agency, are accessible to USG users residing in their agency enterprise networks.

- The definitions of what is meant by “public” are the same. That is, in this case, the same service that an USG client/application is trying to access, is available to everyone on the Internet.

- The agency clients applications, host operating systems, and supporting networking infrastructure should be IPv6-enabled such that it is possible to establish native IPv6 end-to-end communication between client applications and the external IPv6-enabled public servers/services.

Examples of Impacted Applications (2014)

Typical examples of client applications that access public Internet servers/services include*:

• External web (browsers),
• Email (mail user agents),
• DNS (resolvers),
• Host operating systems,
• Messaging and social media applications that access publicly available network servers are also within scope.

If there is an IPv6-enabled external network service that is currently available to all users of the public Internet, that service must be available to an Agency network user who only has IPv6 capabilities.

This Does not override agency policies that might restrict employee access to such services.

- However: If such a service is permissible to access using IPv4, it must be possible to access the same service using IPv6.

*Source: Federal IPv6 FAQs 11/4/2011*
• Agency Specific 2014 Definition
  – Tailor definition to your agency (with buy-in)
  – Be specific (systems, services, etc.)
  – Can be broad or narrow in scope

• Success Metrics
  – What is expected?
  – When is it expected?
  – How will it be measured?

• Specific Requirements
  – Detailed & Technical
  – Based on agency approach

• Make Execution Progress *(Most Important!)*
  – Cannot plan forever
  – Need quick wins & experience
  – Generate momentum
What operational IPv6 capabilities are required for a simple service such as web browsing?

- OS
- Application(s)
- Addresses
- Network Connectivity
- Routing
- DNS
- Security
- Network Management
- Internet
Example Enterprise Connectivity

- Network Connectivity
- Addressing
- Routing

- DNS
- Data Centers
- Mail

- Security
- Network Management
- Transition Mechanisms

- Applications/Services
- End Devices
- Pilots

IPv4 & IPv6 Internet

Agency WAN

Internet Gateway(s)

Sites

End Devices

Data Centers

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Example Internet Gateway Architecture

- Addressing
- Routing
- Connectivity
- Web
- DNS
- Mail
- Security
- Network Management
- Transition Mechanisms

IPv4 & IPv6 Internet

Carrier/ISP Service

External Gateway (multiple)

Agency Enterprise

Dispatcher

SMTP

Web

Gateway Data Center

Required for 2012 Milestone
Ensuring Gateway Connectivity

IPv4 & IPv6 Internet

IPv6 Internet connectivity in place
Network/security equipment supports IPv6
Block unwanted IPv6 traffic

Completed?

IPv4 & IPv6 Internet

Carrier/ISP Service

Gateway Data Center

External Gateway (multiple)

Router Security Switching Security

Agency Enterprise

SMTP Web

LAN IPv6 operational

Servers/OSs support IPv6 & addresses assigned

 August 24, 2015
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Sample 2014 Execution Timeline

<table>
<thead>
<tr>
<th>Network Connectivity</th>
<th>Key Stakeholders (External)</th>
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<tbody>
<tr>
<td>Core/Backbone Network</td>
<td>Networx or other Carriers Router Vendors</td>
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<tr>
<td>Infrastructure Routers 25%</td>
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<tr>
<td>Infrastructure Routers 50%</td>
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<tr>
<td>Infrastructure Routers 100%</td>
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<table>
<thead>
<tr>
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<td>Internal IPv6 Addresses Allocated</td>
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<table>
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<th>Data Centers</th>
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<tbody>
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<td>Data Center 1 IPv6 Enabled</td>
<td>Networx or other Carriers Router Vendors IT Vendors Service Providers</td>
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<td>Data Center 2 IPv6 Enabled</td>
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<tr>
<td>Data Center 3 IPv6 Enabled</td>
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<tr>
<td>Data Center 4 IPv6 Enabled</td>
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<tr>
<th>Mail</th>
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Sample 2014 Execution Timeline Cont.

<table>
<thead>
<tr>
<th>Sample Agency IPv6 Execution Timeline</th>
<th>Key Stakeholders (External)</th>
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<tr>
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<td>Internal Applications &amp; Services</td>
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<td>End Device Transition</td>
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<td>Server &amp; OS Vendors</td>
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<td>Laptop/Desktop &amp; OS Vendors</td>
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<tr>
<td>User Computers IPv6 Enabled 75%</td>
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<tr>
<td>Enclave Pilot Phase 3</td>
<td></td>
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</tbody>
</table>
IPv6 Levels of Implementation

- IPv4
- Functional
- Operational
- Equivalence
- Superiority
- Dual-Stack IPv6
Other Considerations for 2014 and Beyond

- Translation & Tunneling
- Services/Systems not covered by 2012/2014 Milestones
  - External
    - Telecommuter
    - Mission Services
  - Internal
    - Applications
    - Devices
- When to dual-stack everything
- IPv6-only testing
- IPv6-only environments
- Turning IPv4 off
Federal Information Technology Acquisition Reform Act (FITARA)

- Enhances CIO authority …and accountability
- CFO act agencies …and DoD/Intel to a limited scope
- Establishes common baseline for IT Management
- Utilizes PortfolioStat Performance Metrics
  - Includes tracking agency IPv6 adoption status
How is OMB Managing the Transition

• CIO Council
• Federal IPv6 Task Force
  – Monthly Meetings
  – Interagency Meeting
  – Outreach
  – Agency Transition Managers Checklist
  – Working Groups
  – IAC
  – Other

• NIST USGv6
• FAR
• Direct Agency Contact
IPv6 Requirements in the FAR

FEDERAL IPV6 TRANSITION
11.002(g) - Policy

Unless the agency Chief Information Officer waives the requirement, when acquiring information technology using Internet Protocol, the requirements documents must include reference to the appropriate technical capabilities defined in the USGv6 Profile (NIST Special Publication 500-267) and the corresponding declarations of conformance defined in the USGv6 Test Program. The applicability of IPv6 to agency networks, infrastructure, and applications specific to individual acquisitions will be in accordance with the agency's Enterprise Architecture (see OMB Memorandum M-05-22 dated August 2, 2005).
IPv6 Addition to the FAR – Additional Clauses

7.105 (b)(5)(iii) - Contents of written acquisition plans

For information technology acquisitions using Internet Protocol, discuss whether the requirements documents include the Internet Protocol compliance requirements specified in 11.002(g) or a waiver of these requirements has been granted by the agency’s Chief Information Officer.

12.202 (e) - Market research and description of agency need

When acquiring information technology using Internet Protocol, agencies must include the appropriate Internet Protocol compliance requirements in accordance with 11.002(g).

39.101 (e) - Policy

When acquiring information technology using Internet Protocol, agencies must include the appropriate Internet Protocol compliance requirements in accordance with 11.002(g).
Build an IPv6 Acquisition Process

IPv6 Acquisition Process
Version 1.0
25 July 2011

Barrowed from DOI
Build an IPv6 Evaluation Process

1. Hardware, Software, Service or System
2. Perform Initial IPv6 Analysis
3. Support IPv6 at All?
   - Yes: Proceed
   - No: Support IPv6 Only?
5. Support IPv6 Only?
   - Yes: Perform Detailed IPv6 Analysis
   - No: Document Deficiencies
6. Document Deficiencies
7. Support IPv6 Only?
   - Yes: Proceed
   - No: Support IPv6 Equivalent/Better than IPv4?
8. Support IPv6 Equivalent/Better than IPv4?
   - Yes: Meet DREN III Requirements?
   - No: Proceed
9. Meet DREN III Requirements?
   - Yes: IPv6 Approval
   - No: Proceed
10. IPv6 Approval
11. IPv4 Dependencies Analysis
12. Support IPv6 at All?
   - Yes: Proceed
   - No: Is There an Alternative?
13. Is There an Alternative?
   - Yes: Proceed
   - No: Report Deficiency to Vendor
14. Report Deficiency to Vendor
15. Document Selection Rationale
16. Document Alternative Analysis
17. Document Vendor Roadmap
18. Request Waiver
19. Select Alternative
20. Re-start Process
21. Initiate Waiver Sub-Process
22. Report Deficiency to Vendor
23. Document Selection Rationale
24. Document Alternative Analysis
25. Document Vendor Roadmap
26. Request Waiver

IPv4 Dependencies Analysis

IPv6 Evaluation Process Flowchart
Create an Acquisition Plan

- Conduct market analysis
  - Awareness of IPv6 products/services
- Estimate investment costs
- Obtain authorization to proceed from appropriate agency departments
  - Procurement,
  - Finance,
  - IT,
  - agency head,
  - etc.
- Create a Project Procurement Team
  - Program Manager,
  - Project Manager,
  - Project Subject Matter Experts,
  - Agency Procurement Officer,
  - IPv6 IT experts,
  - Business Partners, Legal experts, Finance, CIO, CFO, etc.
“In accordance with CIO Directives and with agency Enterprise Architecture and Technical Reference Model (TRM), this acquisition requires all functionality, capabilities and features to be supported and operational in both a **dual-stack IPv4/IPv6 environment** and an **IPv6 only environment**. Furthermore, all management, user interfaces, configuration options, reports and other administrative capabilities that support IPv4 functionality will support comparable IPv6 functionality. Respondents are required to include in their response a letter of self-certification that their product has been tested in both a **dual-stack IPv4/IPv6 and IPv6 only environment** and meets this requirement. Agency reserves the right to require the respondent’s products to be tested within an agency or 3rd party test facility to show compliance with this requirement.

In accordance with FAR 11.002(g) and CIO Directives, this acquisition must comply with the NIST USGv6 Profile and IPv6 Test Program. All interested parties responding to this acquisition are required to provide a Self Declaration of Conformance (SDOC) based on the attached “**agency USGv6 Profile xxxx-xxxx**” and in accordance with NIST SP 500-267, NIST SP-273, and NIST SP 500-281.”
“In accordance with CIO Directives and with agency Enterprise Architecture and Technical Reference Model (TRM), this acquisition requires all functionality, capabilities and features to be supported and operational in both a dual-stack IPv4/IPv6 environment and an IPv6 only environment. Furthermore, all management, user interfaces, configuration options, reports and other administrative capabilities that support IPv4 functionality will support comparable IPv6 functionality. Respondents are required to include in their response a letter of self-certification that their product has been tested in both a dual-stack IPv4/IPv6 and IPv6 only environment and meets this requirement. Agency reserves the right to require the respondent’s products to be tested within a agency or 3rd party test facility to show compliance with this requirement.

In addition, respondents are required to certify that they have tested and their product operates on a platform that has an SDOC based on the attached “agency USGv6 Profile xxxx-xxxx” and in accordance with NIST SP 500-267, NIST SP-273, and NIST SP 500-281.”
“In accordance with CIO Directives and with agency Enterprise Architecture and Technical Reference Model (TRM), this acquisition requires all functionality, capabilities and features to be supported and operational in both a dual-stack IPv4/IPv6 environment and an IPv6 only environment. Furthermore, all management, user interfaces, configuration options, reports and other administrative capabilities that support IPv4 functionality will support comparable IPv6 functionality. Respondents are required to include in their response a complete description of how they will include IPv6 requirements in the systems development life-cycle and incorporate both dual-stack IPv4/IPv6 and IPv6 only testing scenarios across all testing activities. Agency reserves the right to require the respondent’s solutions to be tested within an agency or 3rd party test facility to show compliance with this requirement.

In addition, respondents are required to utilize platforms that have an SDOC based on the attached “agency USGv6 Profile xxxx-xxxx” and in accordance with NIST SP 500-267, NIST SP-273, and NIST SP 500-281.”
“In accordance with CIO Directives and with agency Enterprise Architecture and Technical Reference Model (TRM), this acquisition requires all functionality, capabilities and features to be supported and operational in both a dual-stack IPv4/IPv6 environment and an IPv6 only environment. Furthermore, all management, user interfaces, configuration options, reports and other administrative capabilities that support IPv4 functionality will support comparable IPv6 functionality. Respondents are required to include in their response a letter of self-certification that their services have been tested in both a dual-stack IPv4/IPv6 and IPv6 only environment and meets this requirement. All service performance requirements and service level agreements will apply to both IPv4 and IPv6 services. Agency reserves the right to require the respondent’s services to be tested within by agency or 3rd party to show compliance with this requirement.

In addition, respondents are required to certify that they have tested and their product interoperates on a platform that has an SDOC based on the attached “agency USGv6 Profile xxxx-xxxx” and in accordance with NIST SP 500-267, NIST SP-273, and NIST SP 500-281.”
“In accordance with CIO Directives, this acquisition requires the service provider to include IPv6 expertise as part of its support services. Respondents are required to include in their response a description of how they will provide IPv6 expertise as a part of their solutions offering for each area of service being acquired. Agency reserves the right to audit the respondent’s proposed IPv6 expertise”
The formal Federal IPv6 transition started with the DoD Memorandum in 2003 and the later release of the OMB Memorandum in 2005.

June 2008 was the first significant Federal IPv6 transition milestone date where agencies were supposed to demonstrate their IPv6 capabilities.

The OMB 2010 IPv6 Memorandum established specific agency IPv6 operational milestones for public facing services in 2012 and internal services in 2014.

The FAR was updated in 2009 to include IPv6 acquisition requirements.

OMB memorandum in 2005 (and reiterated in 2010) require all agency IT acquisitions to include IPv6 capable products and service.
Federal IPv6 Transition: Review Question and Answers

1. When were agencies required to establish their IPv6 Transition Plan?
2. What two IPv6 guidance documents were developed as a joint effort between industry to help agencies with their transition efforts?
3. What services were included in the OMB 2012 Milestone?
4. What services were included in the OMB 2014 Milestone?
5. What NIST publication and program are identified in the FAR for Agencies to use to acquire IPv6 capable products?
Federal IPv6 Transition

BREAK + Q&A
NIST USGV6 PROGRAM
NIST USGv6 Program: Learning Objectives

- Understand the device types used in the NIST USGv6 Profile
- Name the functional categories in the NIST USGv6 Profile
- Understand who is responsible for defining the IPv6 requirements for an IT acquisition
- Explain how an SDOC is used
- Be able to find and read the NUST USGv6 Deployment Status website
USGv6 Profile

NIST USGv6 PROGRAM
USGV6 – BUILDING PROFILES
• Acquisition Focused (not deployment, operational, etc.)

• Purpose
  – Define a simple taxonomy of common network devices;
  – Define their minimal mandatory IPv6 capabilities and identify significant configuration options so as to assist agencies in the development of more specific acquisition and deployment plans; and,
  – Provide the technical basis upon which future USG polices can be defined.

• Why
  – OMB Directed (05-22)
  – USG-wide benefit from a common definition of IPv6 capabilities
  – Promote confidence and protect IPv6 investments
  – “Raise the bar” of IPv6 security and network protection technologies
  – Existing profiling and testing efforts are insufficient for USG requirements
  – Support IPv6 progression to meeting future USG IPv6 requirements and protect investments
Device Types

**Host**
- Any Node that is not a Router. A Host’s primary purpose is to support application protocols that are the source and/or destination of IP layer communication.

**Router**
- A Node that interconnects sub-networks by packet forwarding. A Router’s primary purpose is to support the control protocols necessary to enable interconnection of distinct IP sub-networks by IP layer packet forwarding.

**Network Protection Device**
- Firewalls or Intrusion Detection / Prevention devices that examine and selectively block or modify network traffic.
Profile Utilizes IETF RCF2119 Terminology

- **Absolute**
  - Must “M”
  - Must Not
  - Shall
  - Shall Not
  - Required

- **Think Hard**
  - Should “S”
  - Should Not
  - Recommended

- **Truly Optional**
  - Optional “O”
  - Recommended
  - Not Recommended

- **Absolute Soon**
  - Should+ “S+”
  - Not in RFC2119

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USGv6 Profile Specific Terminology

- **Specific Line Items**
  - “**M**” = Mandatory  “**O**” = Optional  “**S**” = Should  “**S+**” = Should+ (mandatory in future)
  - c(X,Y) = Configuration Option, if selected then the requirement is “X”, otherwise “Y”
    - Example “c(M,S)” if true then it is “M”, otherwise it is “S”
  - c(X) = Shorthand notation for above, “Y” in this case is considered “O” Optional.

- “**O:n**” = Optional, but must choose “n” options from the set
  - Example “O:1” choose 1 option, “O:3” choose 3 options

- “**Y/N**” = Optional and a simple yes or no selection

- Entire Functional Categories
  - “**M**” (mandatory): Contains unconditional MUSTs and may have Options
  - “**O**” (optional): Does not contain unconditional MUSTs

- “USGv6-V1-Capable” = set of requirements that are unconditionally mandatory
- “USGv6-V1-Compliant” = “USGv6-V1-Capable” + requirements that are mandatory under each of the selected configuration options
### Reading the Node Requirements Table

<table>
<thead>
<tr>
<th>RFC Reference</th>
<th>Requirement</th>
<th>Functional Category</th>
<th>Device Type</th>
<th>Effective Date</th>
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<td>RFC2460</td>
<td>IPv6 Basic Requirements</td>
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</table>
Creating a Product Specific Profile

- **Agency Specific Product Profile**
  - Decide the device type
  - Start with unconditional “M” mandatory set (USGv6-V1-Capable)
  - Add sets of requirements that are “C” conditional (USGv6-V1-Compliant)
  - Add “S” should and “S+” requirements for inclusion (Close)
  - Add “O” optional (USGv6-V1-Agency-Product-Compliant)
    - *Modify any “M”s
    - *Add others

- **How many choices are there?**

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<thead>
<tr>
<th></th>
<th>M</th>
<th>S</th>
<th>S+</th>
<th>C</th>
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<td>12</td>
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<td>9</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
</tbody>
</table>
Is There An Easier Way?

- Yes - use the templates provided in the Profile
  - Host (20 Choices)
  - Router (22 Choices)
  - NPD (4 Choices)
- Common selections
- Shorthand Notation Available, examples:
  - USGv6-V1-Capable+DHCP-client+Sock+DNS-Client+Link=Ethernet
  - USGv6-V1-Capable+SLAAC+Sock+DNS-Client+MIP+Link=PPP+Link=Ethernet
- Is this the best approach?
  - Maybe/Maybe Not
  - Do you need more options?
How to Select Which S, S+, C and O’s to Include

• This is the big question
  – Not really a one size fits all
  – Some profiles will be common across agencies
  – Many will not and may vary based on how much IPv6 you plan to use

• Sources to help select
  – Mission/Agency Requirements
  – Policies
  – Future Planning
  – Testing
  – Engineer Support (Internal/External)
  – NIST
  – Vendors
  – IETF

• Considerations
  – Will it do what I want it to do?
  – Will it do what I do not want it to do?
  – How much will it cost?
  – Security
Interesting Notes

• Expected that agencies will augment and/or modify specifications
  – Meet their own requirements
  – Configuration options
  – Agencies may modify profile conformance requirements
    • Must ensure interoperability with conforming systems
    • No easy way to do this

• Scope of devices and mandatory capabilities
  – Partially Conservative: Lowest common denominator of capabilities common to the USG as a whole
  – Partially Aggressive: Areas for current and future security
  – Options: To make up the difference

• Only addresses IPv6 requirements
  – Cannot stand in isolation
  – IPv4 capabilities, Hardware, Performance, Reliability, Support, etc.
USGv6 Testing Program

NIST USGV6 PROGRAM
Federal IPv6 Product Testing Program

• Tied to Federal IPv6 Product Profile
• Utilizes Suppliers Declaration of Conformity process
• Leveraged by changes to FAR
• Types of Testing
  – Conformance
  – Interoperability
  – Network Protection Device
• 1st/2nd/3rd Party Testing
USGv6 – A Concept in Agency IPv6 Acquisitions

1. OMB
   - Buy IPv6

2. GSA
   - FAR

3. Agency
   - USGv6 Profile

4. Acquisition w/USGv6 Rqmts
   - RFP RFQ

5. NIST
   - USGv6 Testing Program

6. Already Completed?

7. Response w/SDOC

Vendor/Integrator
USGv6 Acquisition Process in a Nutshell

- Provides the ability for an agency to specify what they mean when they say “I want to buy an IPv6 capable/enabled/etc product”
- Pulls from IETF RFCs (and other sources)
- Provides agency with tested products (to some degree)
  - Conformance
  - Interoperability
  - Security
## Tools - Agency Sends out an IPv6 Profile (Part of RFP/RFQ)

<table>
<thead>
<tr>
<th>Spec / Reference</th>
<th>Section</th>
<th>USGv6-V1 Node Requirements</th>
<th>Title / Definition</th>
<th>Status</th>
<th>Year</th>
<th>Condition / Context</th>
<th>Host</th>
<th>Router</th>
<th>NPD</th>
<th>Effective Date</th>
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### Suppliers Declaration of Conformity for USGv6 Products: Declared Capabilities and Test Results Summary

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<th>Spec / Reference</th>
<th>Section</th>
<th>USGv6-v1 Profile Requirements</th>
<th>Configuration Option</th>
<th>Host Router NPD</th>
<th>Test Suite Conformance/NPD</th>
<th>Test Lab / Result ID, Note #, or Component Ref</th>
<th>Test Suite Interoperability</th>
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<td>support of a DNS server application</td>
<td>DNS-Server</td>
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<td>DHCP-Server</td>
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<td>Routing Protocol Requirements</td>
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<td>support for inter-domain (exterior) routing</td>
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<td>support of interoperation with IPv4-only systems</td>
<td>IPv4</td>
<td></td>
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</table>
Federal IPv6 Transition Progress Measures

NIST USGV6 PROGRAM
What is the NIST USGv6 Deployment Status Website?

- [http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-gov.dept](http://usgv6-deploymon.antd.nist.gov/cgi-bin/generate-gov.dept)
- Provides a central place to track the status of the Departments and Agencies
- Currently focused on progress in meeting the 2012 Mandate for all public/external facing services to use operationally use IPv6
- Provides a status for Web, E-mail and DNS (and DNSSEC)
  - Only the primary agency website
What Does it Look Like? High Level
What Does it Look Like? Summary

- Detailed IPv6 & DNSSEC Service Interface Statistics for 2015.08.14 -
What Does it Look Like? Detailed

- Detailed IPv6 & DNSSEC Service Interface Statistics for 2015.08.14 -

<table>
<thead>
<tr>
<th>Domain</th>
<th>Organization</th>
<th>DNS</th>
<th>Mail</th>
<th>Web</th>
<th>Links</th>
<th>DNSSEC</th>
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</thead>
<tbody>
<tr>
<td>gov.thesecondthing</td>
<td>Department of Veterans Affairs</td>
<td>[4] 4/4/4 [0]</td>
<td>[0] 0/0/0 [-]</td>
<td>[1] 0/0/0 [1]</td>
<td>0%/0%</td>
<td>S/V/C</td>
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</tbody>
</table>
How Do I Read DNS?

Estimated number of IPv4 servers/interfaces found. If no name servers are found, the SOA Record (name server) of the parent domain is used and a (P) is indicated. In this example, the agency utilizes 8 DNS servers.

Servers/interfaces with IPv6 address assignments. In this example (5) of the (6) DNS servers have IPv6 addresses.

Servers/interfaces with IPv6 addresses that respond to pings. In this example (4) of the (6) DNS servers respond to IPv6 pings.

Servers/interfaces that are fully operational over IPv6. In this example (1) of the (3) DNS servers are operational over IPv6.

Location of service related to the domain: (I) = Internal to domain (P) = Parent of domain (O) = Outside of domain (M) = Mix of locations
In this example the DNS servers are located in a mix of locations.

August 24, 2015 © 2015 Auspex Technologies
### How Do I Read Mail?

<table>
<thead>
<tr>
<th>Location</th>
<th>Servers/Interfaces</th>
<th>IPv4 MX Records Found</th>
<th>IPv6 Addresses Assigned</th>
<th>IPv6 Pings Responding</th>
<th>Fully Operational IPv6</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>(I)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>P</td>
<td>(P)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>(O)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>(M)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Estimated Number of IPv4 MX Records Found**: If no MX records are found the (A) record is used for the domain. In this example, no MX record was returned so an (A) was used.

- **Servers/Interfaces with IPv6 Address Assignments**: In this example (0) of the (2) Mail (SMTP) servers have IPv6 addresses.
- **Servers/Interfaces with IPv6 Addresses that Respond to Pings**: In this example (0) of the (1) Mail (SMTP) servers respond to IPv6 pings.
- **Servers/Interfaces that are Fully Operational over IPv6**: In this example (0) of the (2) Mail (SMTP) servers are operational over IPv6.
**How Do I Read Web?**

<table>
<thead>
<tr>
<th>Location of service related to the domain:</th>
<th><strong>I</strong> = Internal to domain</th>
<th><strong>P</strong> = Parent of domain</th>
<th><strong>O</strong> = Outside of domain</th>
<th><strong>M</strong> = Mix of locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>In this example the Web server is located outside the domain.</td>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Estimated number of IPv4 web servers/interfaces found. In this example, (2) web servers were found.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web servers with IPv6 address assignments. In this example (1) of the (1) Web servers have IPv6 addresses.</td>
</tr>
<tr>
<td>Web servers with IPv6 addresses that respond to pings. In this example (0) of the (1) Web servers respond to IPv6 pings.</td>
</tr>
<tr>
<td>Web servers that are fully operational over IPv6. In this example (0) of the (1) Web servers are operational over IPv6.</td>
</tr>
</tbody>
</table>

| [2] 0/0/0 [O] |
| [1] 0/0/0 [O] |
| [1]: 1/1/0 [I] |
| [1]: 0/0/0 [O] |
How Do I Read Links

Percent of subdomains referenced that are IPv6 operational:
- 100% / 73%
- 100% / 61%
- 0% / 0%

Percent of all domains referenced that are IPv6 operational:
- 78% / 73%
- 50% / 69%
The Easy Way

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<thead>
<tr>
<th>Color</th>
<th>Description</th>
<th>Status</th>
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<tbody>
<tr>
<td>Red</td>
<td>No IPv6 Service at all.</td>
<td>[A] 0/0/0 [I]</td>
</tr>
<tr>
<td>Yellow</td>
<td>IPv6 deployment started, but not operational (or there is a problem)</td>
<td>[3] 3/3/0 [I]</td>
</tr>
</tbody>
</table>

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NIST USGv6 Program: Summary

- NIST SP 500-267 (USGv6 Profile) was established to provide agencies with relate to vendors what IPv6 requirements/functionality they required.
- The USGv6 Profile covers three device types and twelve functional categories.
- The FAR directs agencies to include IPv6 requirements in their acquisitions based on the USGv6 profile.
- Vendors provide agencies with SDOCs, based on third party lab verification, that show which IPv6 requirements/functionality their products meet.
- The NIST USGv6 Deployment Status Website was established to provide a transparent status on and Agency’s progress in meeting the OMB 2012 IPv6 Milestone.
NIST USGv6 Program: Review Question and Answers

- Identify the three device types covered in the USGv6 Profile?
- Name three functional categories covered in the USGv6 Profile?
- Explain the difference in the USGv6 Profile of a “Mandatory” and “Optional” requirement?
- What document provides an agency with details about which IPv6 requirements/functionality a vendor’s product meets?
- Where can an Agency look to see their status in achieving the OMB 2012 IPv6 Milestone?
TMS Self-Certification

- Log in to the TMS [https://www.tms.va.gov](https://www.tms.va.gov)
- Enter **3949311** in the Search Catalogue field on your TMS home page
- Select the **GO** button
- Select the **Start Course** button
- Select the **Yes** button
- Select the **OK** button
- Select the **Close Window** button
- Complete the Course Evaluation survey that is on your TMS To-Do list.

For assistance, contact the TMS Help Desk [vatmshelp@va.gov](mailto:vatmshelp@va.gov) or 1-866-496-0463
Questions

Dale Geesey  
Chief Operating Officer  
Auspex Technologies, LLC  
Phone: 703.319.1925  
Fax: 866.873.1277  
E-Mail: dgeesey@auspextech.com  
Web: www.auspextech.com  
(IPv6 Enabled)