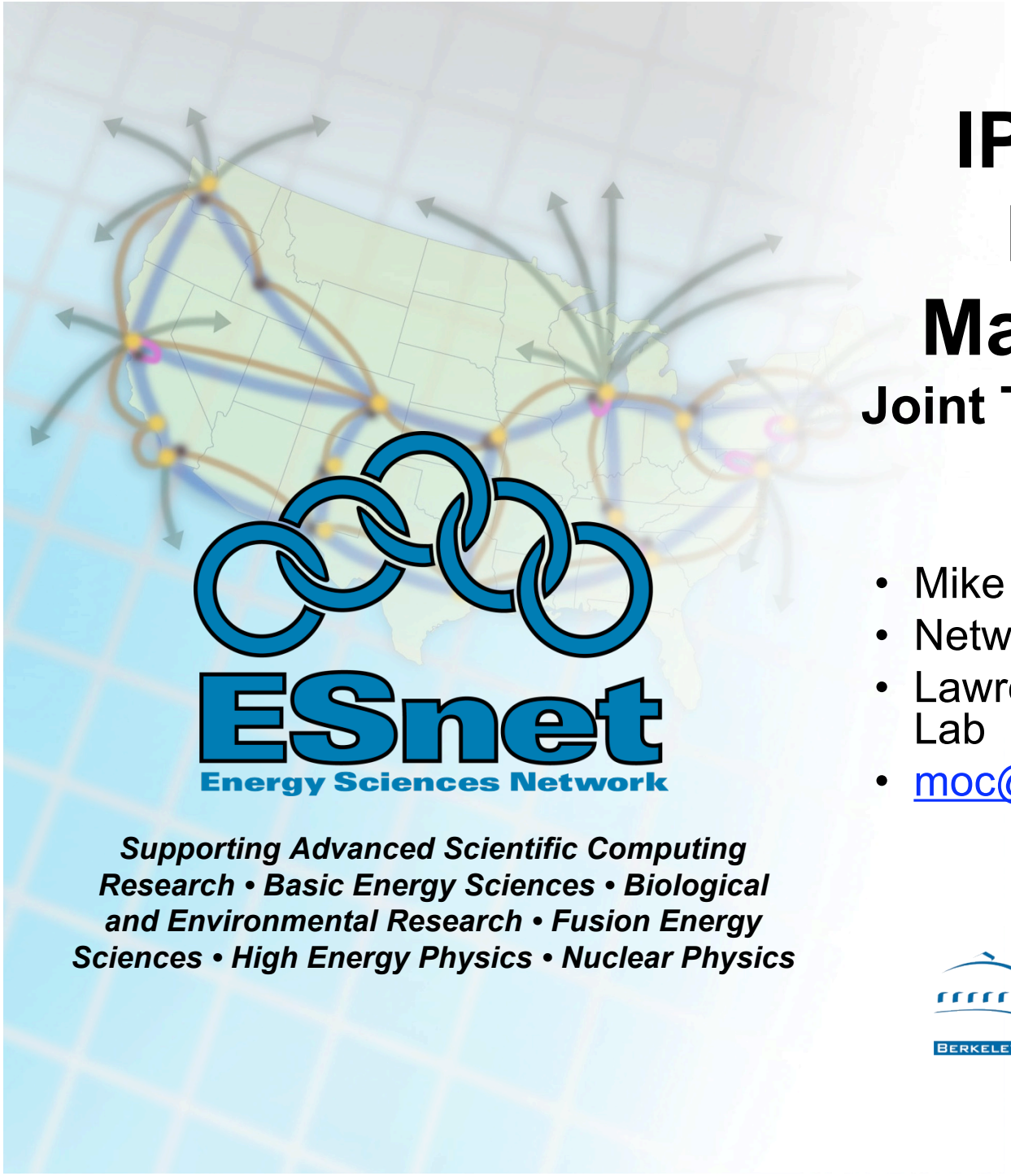

IPv6 SNMP Network Management

Joint Techs Winter 2010

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ESnet
Energy Sciences Network

Supporting Advanced Scientific Computing Research • Basic Energy Sciences • Biological and Environmental Research • Fusion Energy Sciences • High Energy Physics • Nuclear Physics

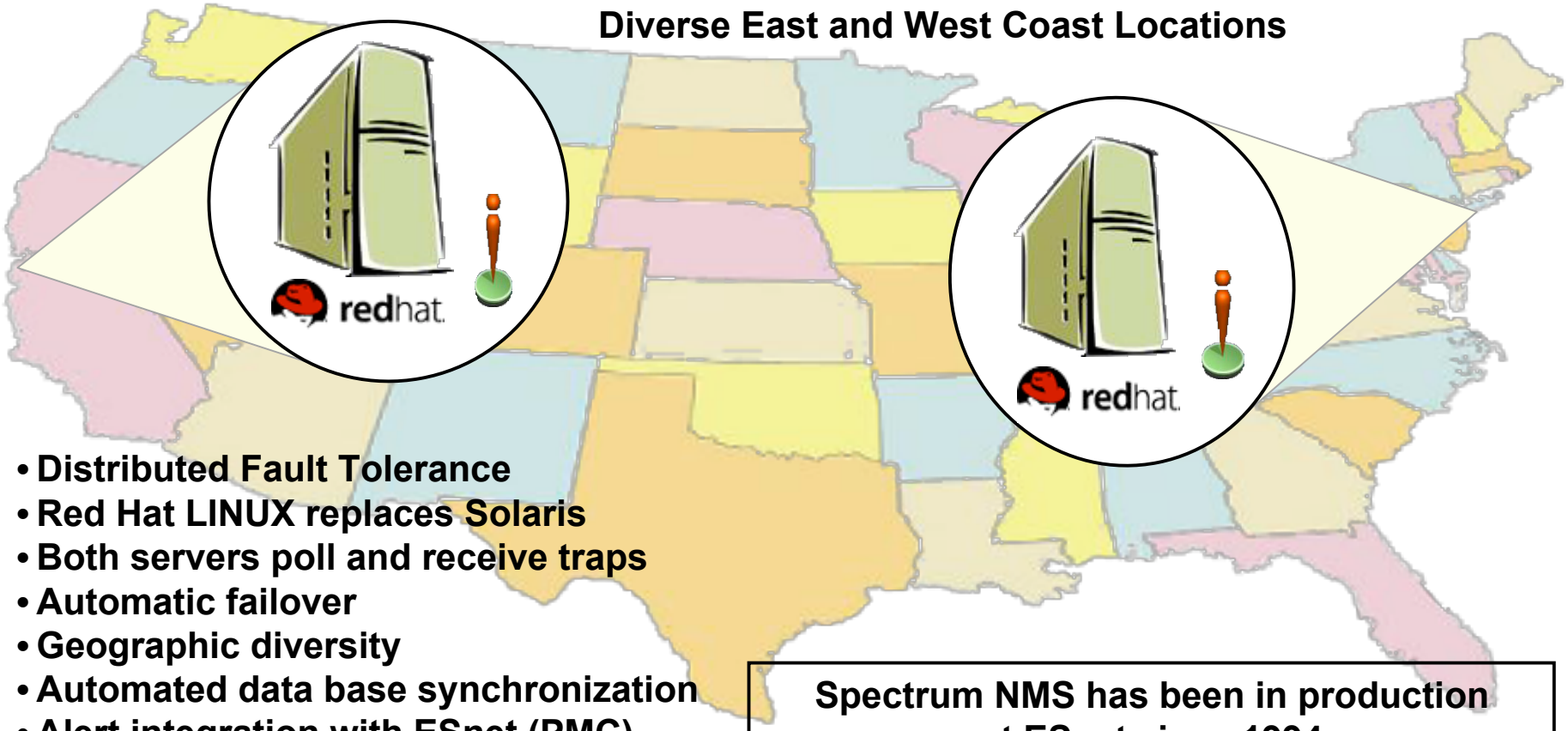
Berkeley Lab

U.S. Department of Energy
Office of Science

Spectrum is the ESnet NMS

Spectrum NMS Servers

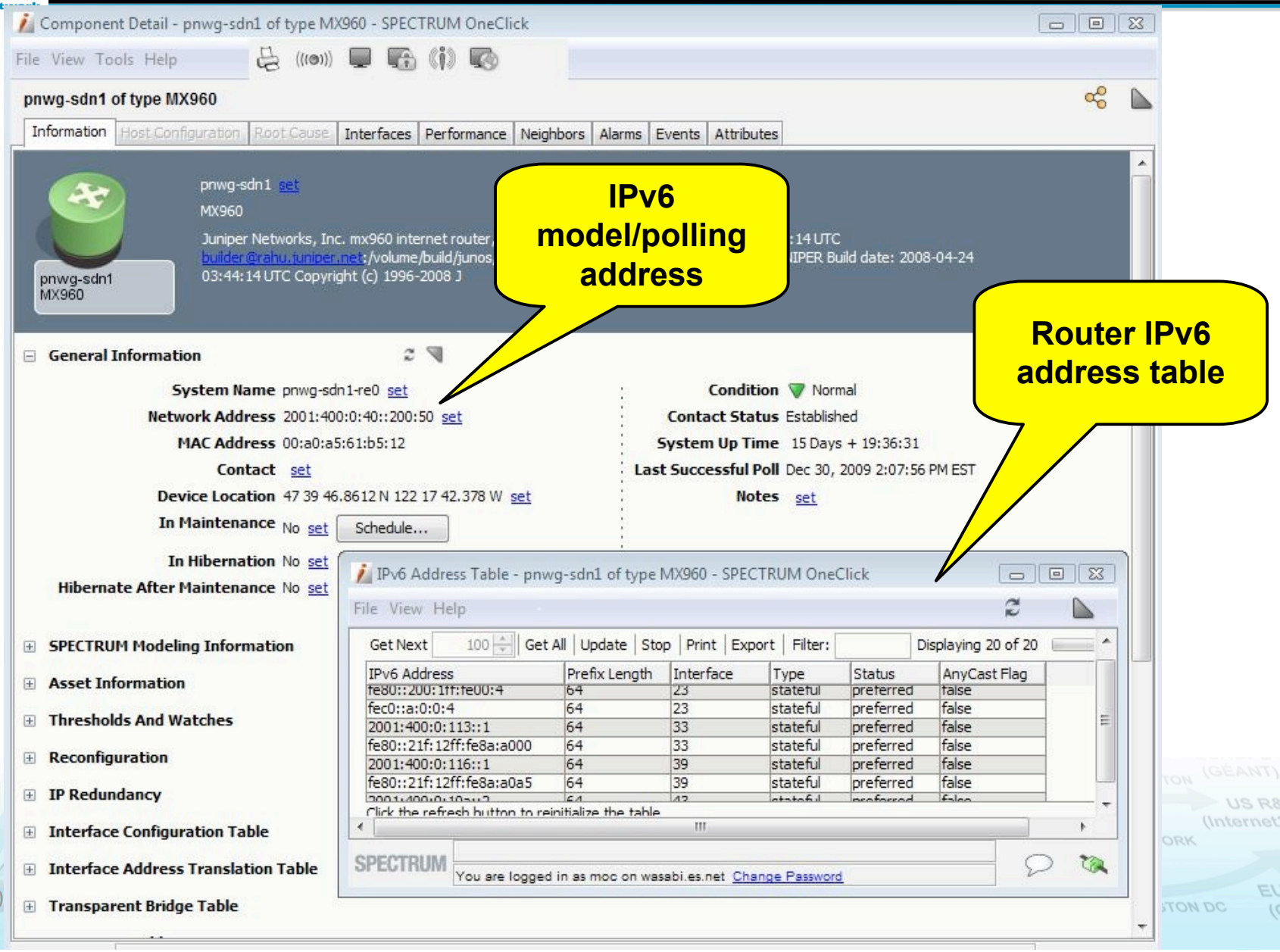
Diverse East and West Coast Locations



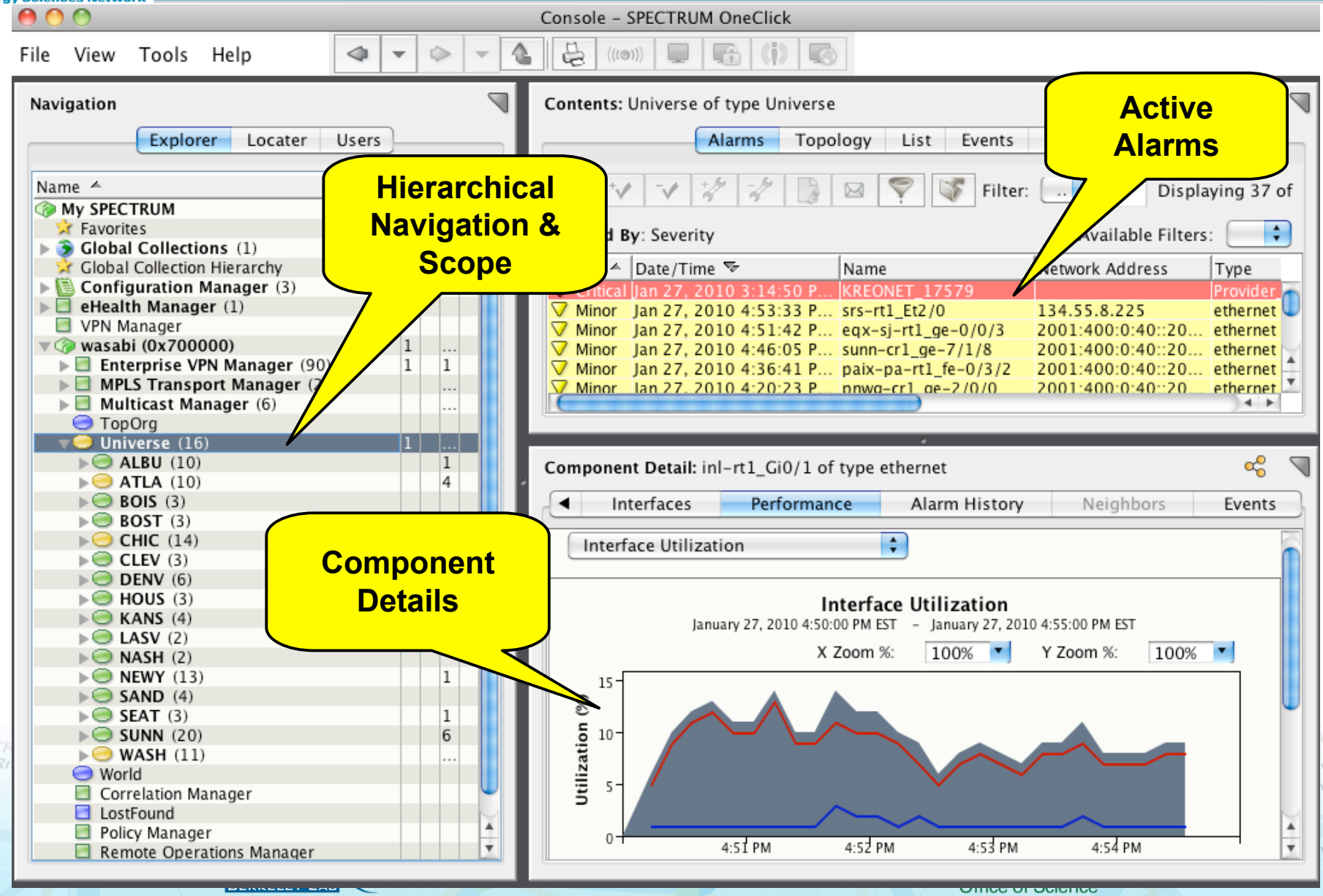
- Distributed Fault Tolerance
- Red Hat LINUX replaces Solaris
- Both servers poll and receive traps
- Automatic failover
- Geographic diversity
- Automated data base synchronization
- Alert integration with ESnet (PMC) Planned Maintenance Calendar

Spectrum NMS has been in production at ESnet since 1994

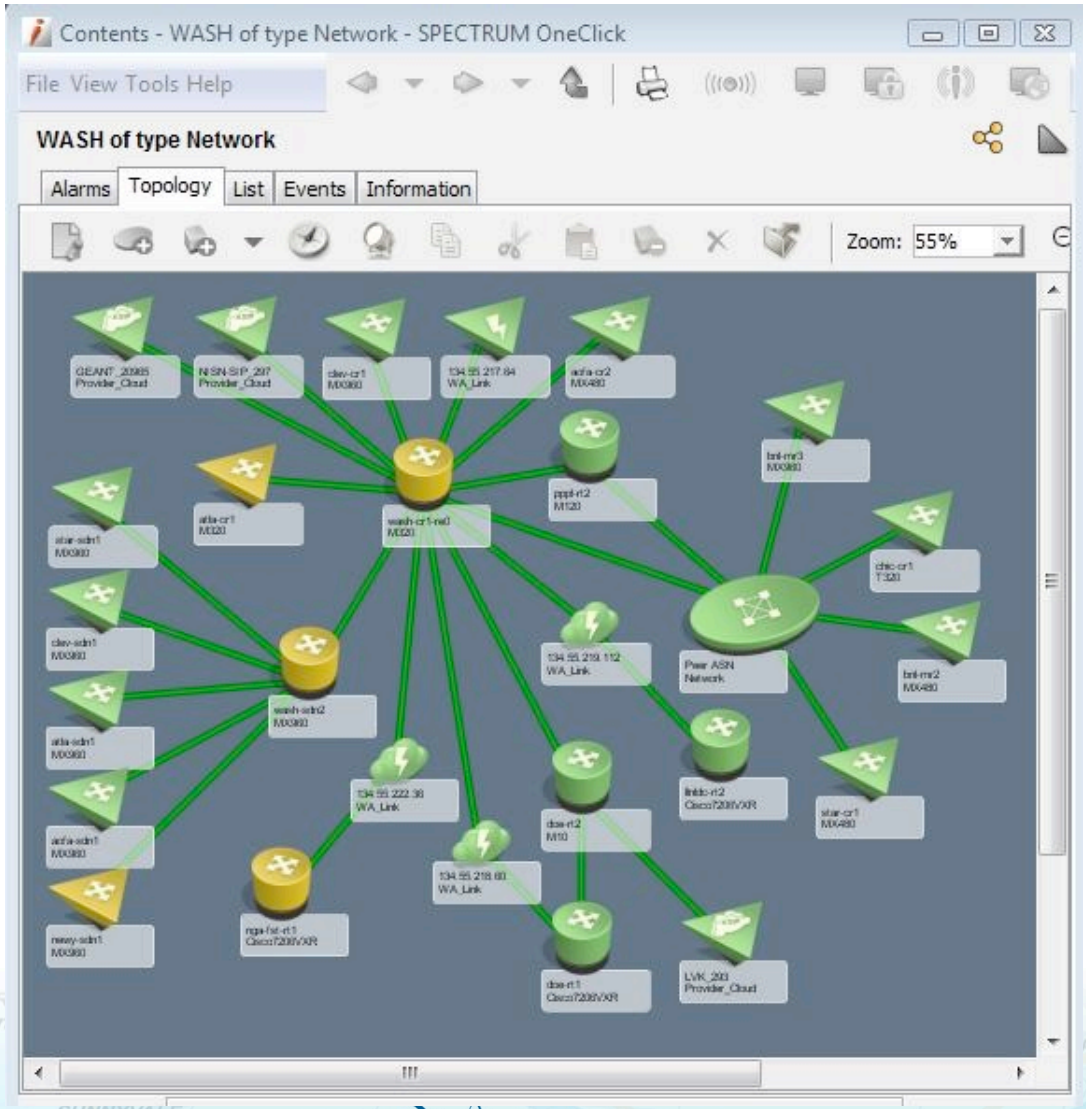
IPv6 Information Example



Alarm View


Console – SPECTRUM OneClick
File View Tools Help
Navigation
Explorer Locater Users
Hierarchical Navigation & Scope
Contents: Universe of type Universe
Alarms Topology List Events
Active Alarms
Filter:
Displaying 37 of
Available Filters:
Date/Time
Name
Network Address
Type
Critical Jan 27, 2010 3:14:50 P... KREONET_17579 Provider
Minor Jan 27, 2010 4:53:33 P... srs-rt1_Et2/0 134.55.8.225 ethernet
Minor Jan 27, 2010 4:51:42 P... eqx-sj-rt1_ge-0/0/3 2001:400:0:40::20... ethernet
Minor Jan 27, 2010 4:46:05 P... sunn-cr1_ge-7/1/8 2001:400:0:40::20... ethernet
Minor Jan 27, 2010 4:36:41 P... paix-pa-rt1_fe-0/3/2 2001:400:0:40::20... ethernet
Minor Jan 27, 2010 4:20:23 P... pnwg-cr1_ge-2/0/0 2001:400:0:40::20... ethernet
My SPECTRUM
Favorites
Global Collections (1)
Global Collection Hierarchy
Configuration Manager (3)
eHealth Manager (1)
VPN Manager
wasabi (0x700000)
Enterprise VPN Manager (90)
MPLS Transport Manager
Multicast Manager (6)
TopOrg
Universe (16)
ALBU (10)
ATLA (10)
BOIS (3)
BOST (3)
CHIC (14)
CLEV (3)
DENV (6)
HOUS (3)
KANS (4)
LASV (2)
NASH (2)
NEWY (13)
SAND (4)
SEAT (3)
SUNN (20)
WASH (11)
World
Correlation Manager
LostFound
Policy Manager
Remote Operations Manager
Component Details
Component Detail: inl-rt1_Gi0/1 of type ethernet
Interfaces Performance Alarm History Neighbors Events
Interface Utilization
Interface Utilization
January 27, 2010 4:50:00 PM EST - January 27, 2010 4:55:00 PM EST
X Zoom %: 100% Y Zoom %: 100%
Utilization (%)
15
10
5
0
4:51 PM
4:52 PM
4:53 PM
4:54 PM

The NMS Topology

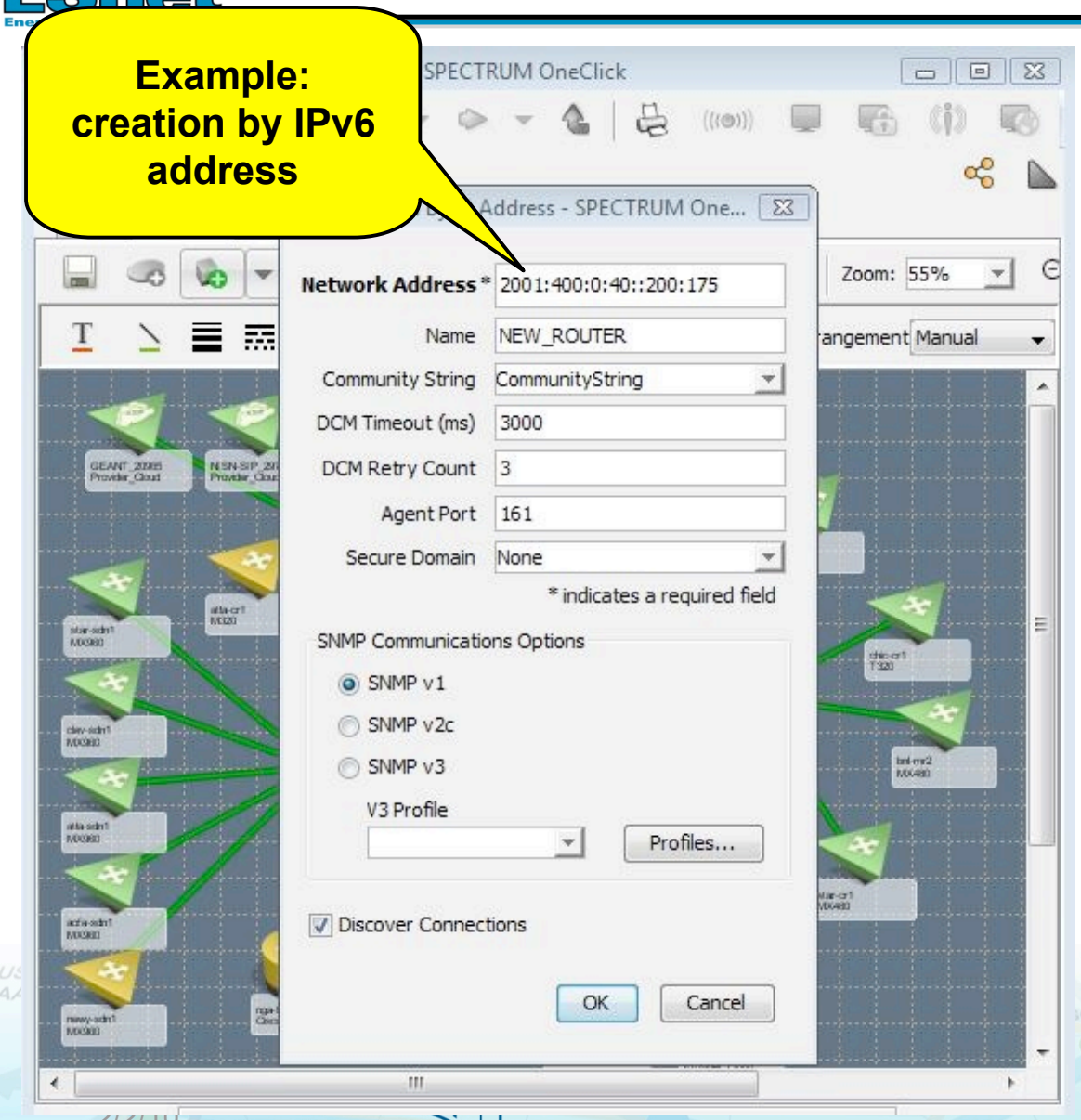


Correctness of the NMS topology:

- **Is the basis for root cause analysis & alarm filtering**
- **Establishes hierarchy**
- **Provides a means of navigation**
- **Is essential for graphical representation of the network**
- **Exploits device relationships**

Networks are inherently "connected"

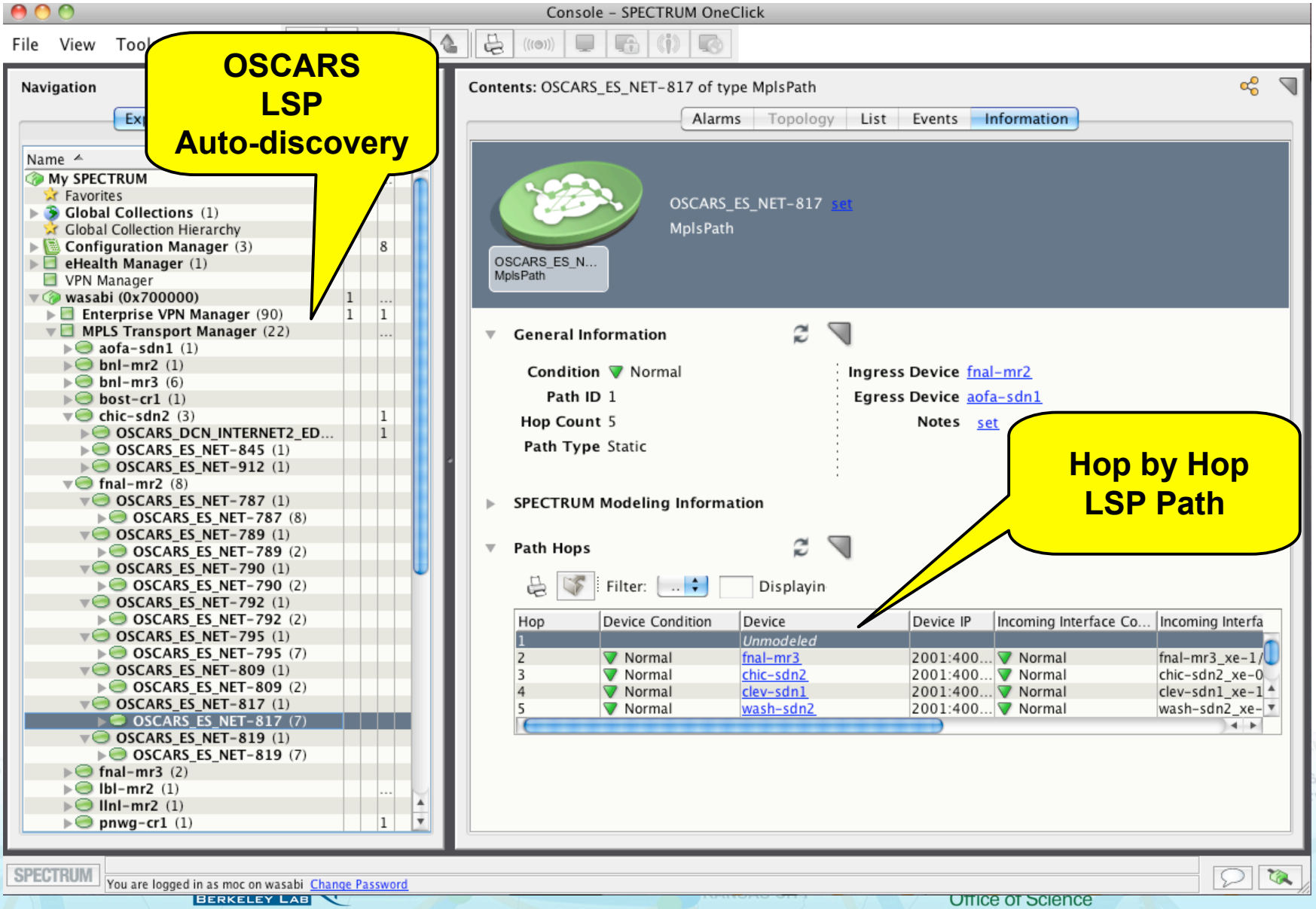
Auto-discovery



- Routers are auto-discovered when Spectrum receives a trap from a new device
- Models are created
- Connections are established
- Initial state is maintenance
- Routers are reconfigured automatically when interfaces are inserted, deleted, etc.

Auto-discovery is a key to achieving and maintaining topology correctness

Monitoring OSCARS MPLS LSPs



IPv6 SNMP Network Management Goals

Achieve functional parity with the previous IPv4 only version of the Spectrum NMS

- Communicate using IPv6 addressing when monitoring router/switch status and receiving real-time router/switch initiated alerts within the ESnet
- Verify the operational status of both IPv4 and IPv6 protocols within the ESnet
- Auto discovery
- Verifying IPv6 connectivity and protocols on all ESnet routers and switches will become consistent and routine

Enablers

- ESnet has a long history of providing IPv6 service to customers
- ESnet network assets are configured to natively support IPv6 addressing and protocols
- Router manufacturer support
- The Spectrum network management system V9.0 supports IPv6, July 2009
  - Polling of SNMP MIBs
  - Handling of asynchronous trap based alerts
  - GUI input & output

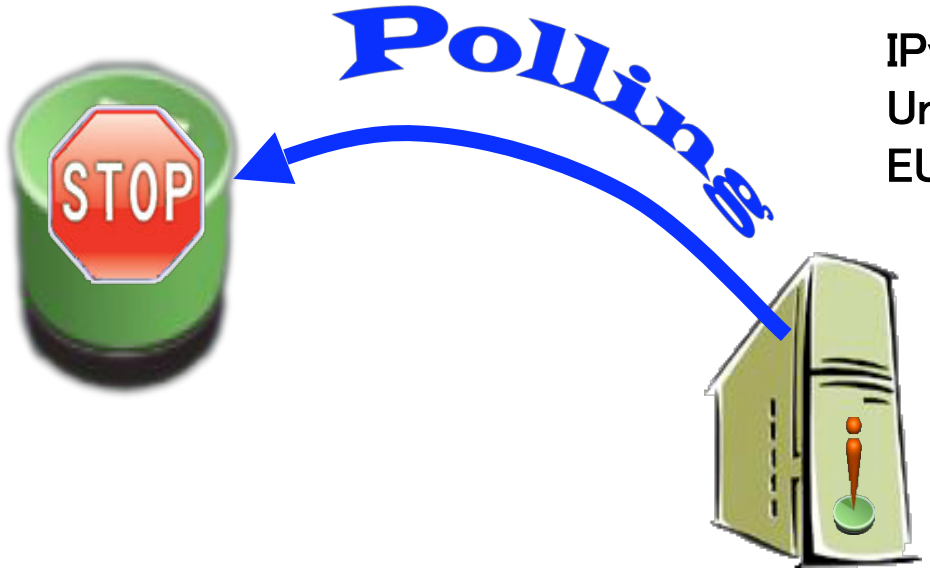
ESnet has seized upon IPv6 based network management as a means to integrate IPv6 addressing and routing into routine operational workflow and processes

ESnet Alpha Test of Spectrum V9.0

- ESnet was the first production network used to test Spectrum IPv6 support, December 2007
- The alpha version of Spectrum worked surprisingly well on all of our Juniper routers, unfortunately not so well on our Cisco's
- Many of the Spectrum GIU components, alarm views, protocol views, component views etc. at that time still needed to be updated to accept and display IPv6 addresses, now completed
- SNMP MIB walks of ESnet Juniper T series routers were used by CA to improve Juniper router modeling in Spectrum, particularly in regard to IPv6
- Alpha tests were run on a Solaris server, ESnet production servers are Red Hat LINUX

IPv6 SNMP and EUI-64 Addressing

The perils of creating an IPv6 addressing plan while stuck in an IPv4 mindset



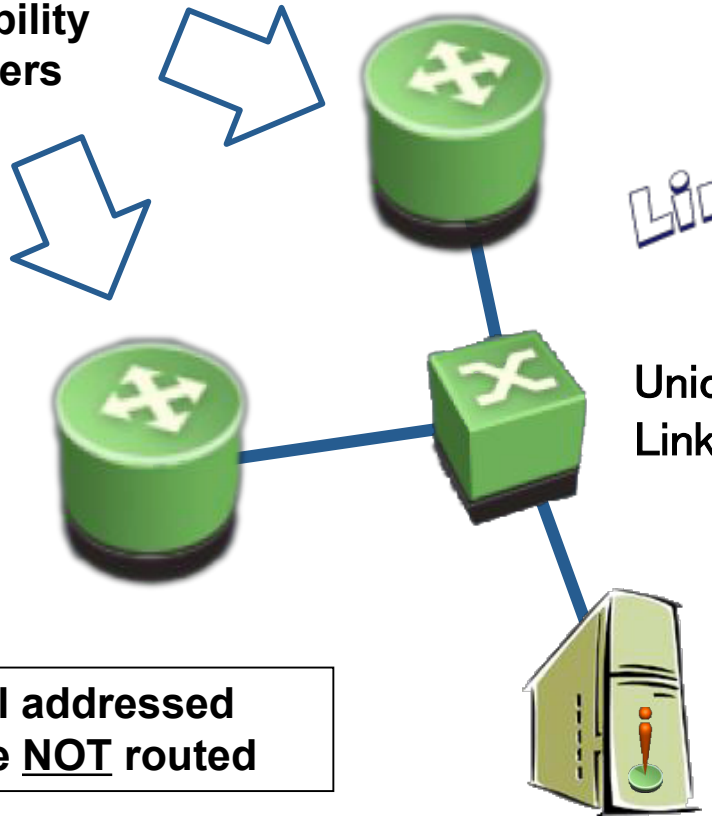
IPv6 NMS Server Interface Addresses
Unicast: 2001:400:3000:5::3/64
EUI-64: 2001:400:3000:5:230:48ff:fed6:2d8/64

The SNMP router ACL (Access Control List) was initially configured in an overly restrictive fashion. It was specific to the IPv6 unicast address allocated for and assigned to the server. Interestingly the Red Hat server used an EUI-64 address for the source of it's SNMP polls and since I did not anticipate this beforehand all of the polling packets were blocked by the router ACL.

High Availability Monitoring Architecture

VRRP – Virtual Router Redundancy Protocol

IPv6 VRRP
High Availability
Dual Routers



IPv6
Link Local Prefix
fe80::/64

Unicast: 2001:400:3000:5::3/64
Link Local: fe80::230:48ff:fed6:2d8/64

Link Local addressed packets are NOT routed

IPv6 VRRP initially would not establish between the routers due to our interface access control lists blocking IPv6 link local addressing

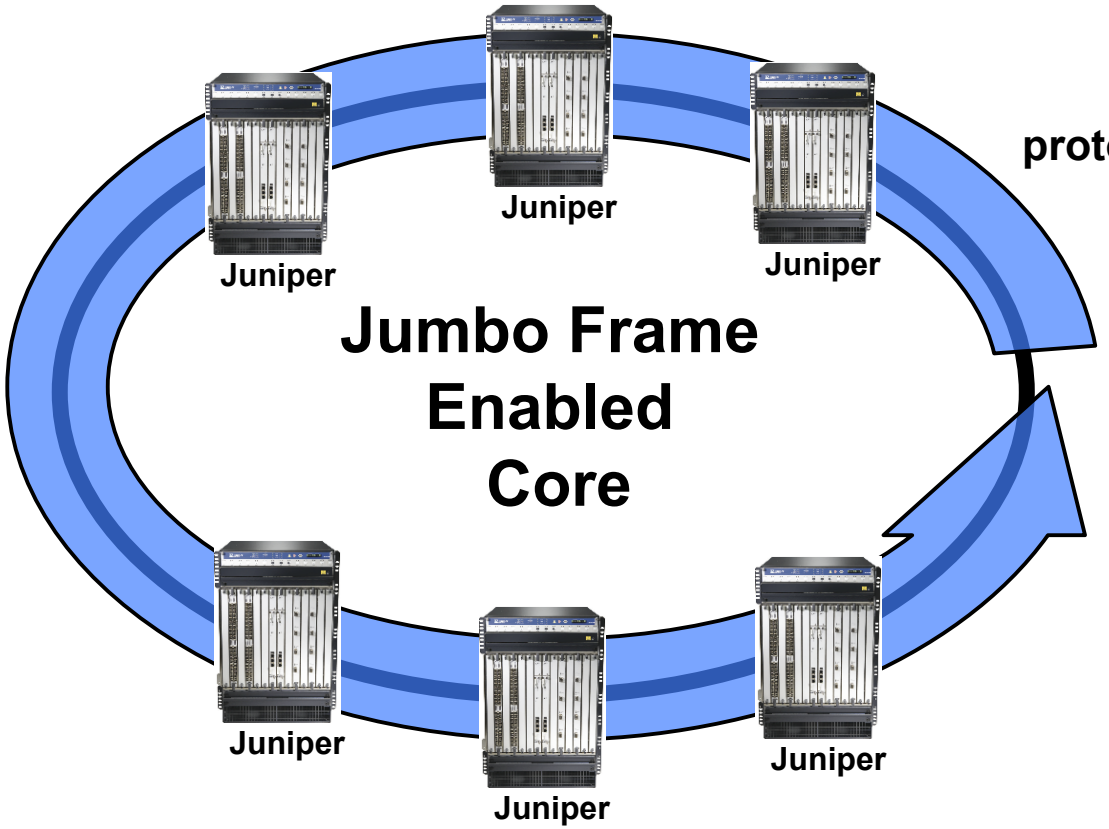
Cisco IPv6 SNMP Support Issues

- ESnet maintains a number of Cisco 7206VXR routers, IOS 12.2
- These routers support IPv6 transport and routing functionality however, according to Cisco, the 12.2 code train does not support IPv6 SNMP (Dec. 2009)
- ESnet has confirmed that the SNMP configuration commands do not support IPv6 addressing

For example:
SNMP server command
SNMP trap host
SNMP ACL

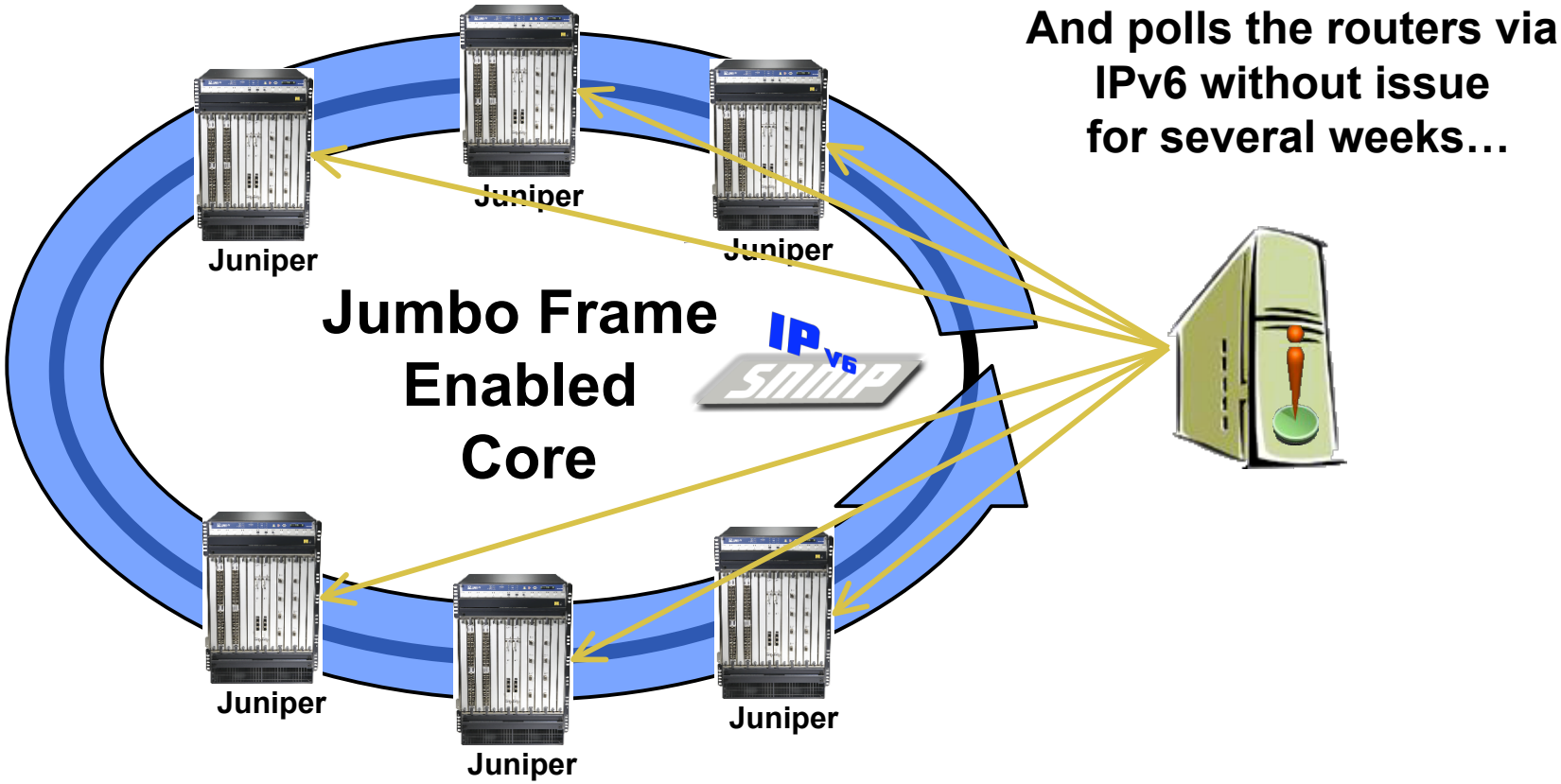
Cisco supports IPv6 SNMP configuration in the IOS 12.3. ESnet has yet to test this.

Core Router Failure PR456161



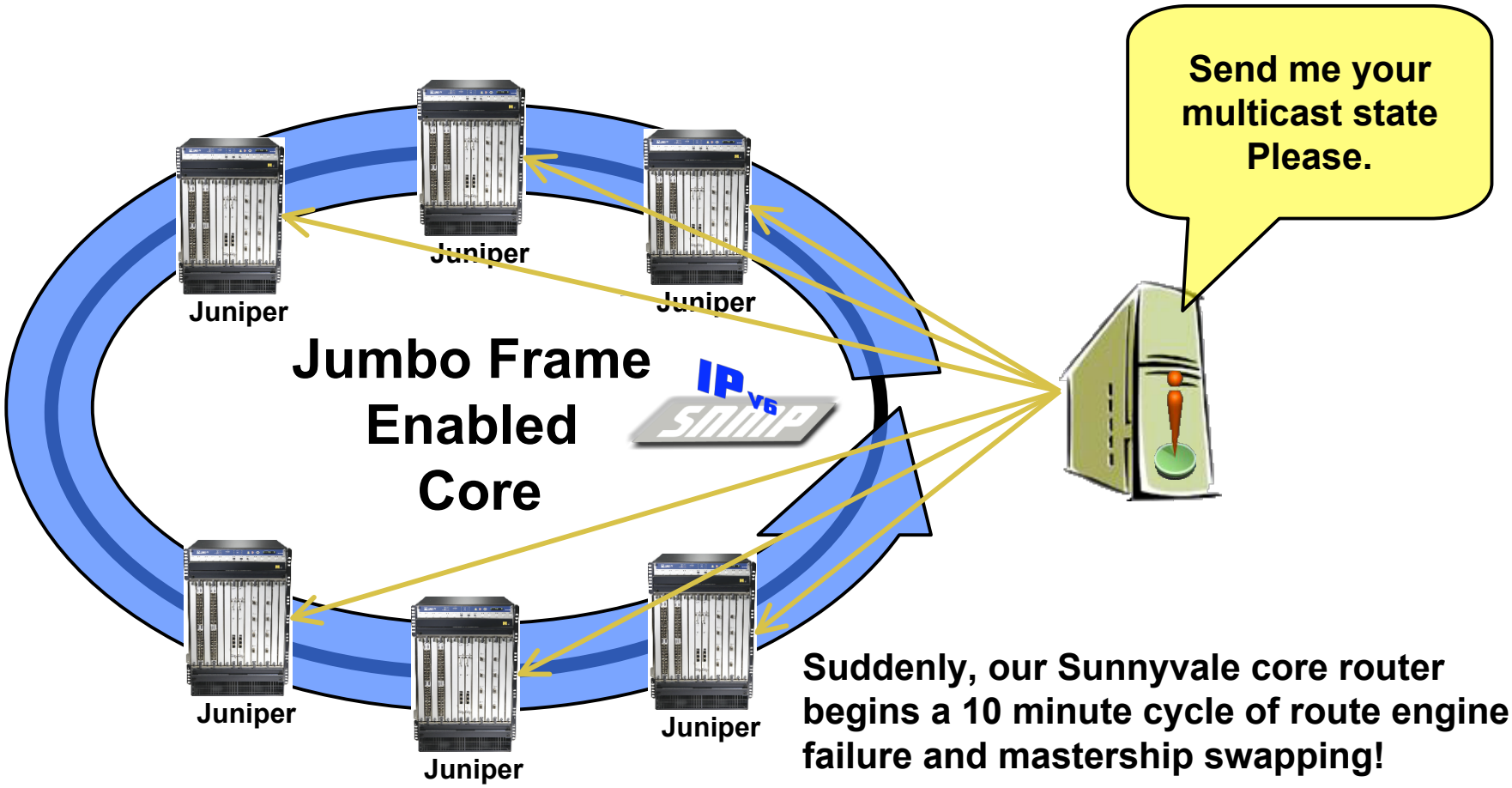
For years the ESnet core Routers ran without issue, Successfully passing IPv6 protocol & control packets between each other.

Spectrum IPv6 NMS is Installed

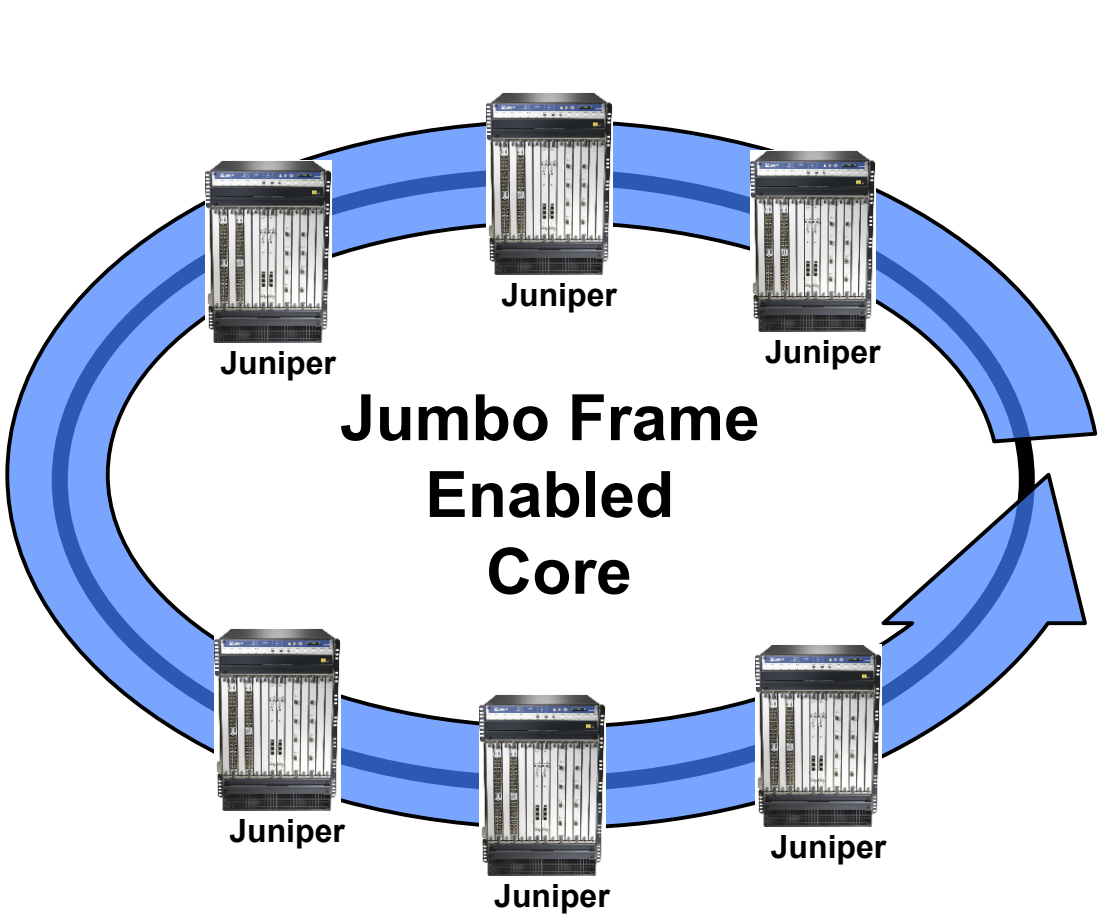


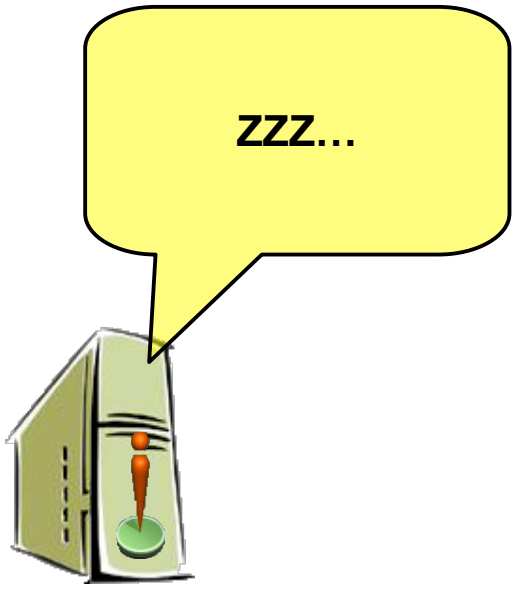
And polls the routers via IPv6 without issue for several weeks…

ESnet Tests Spectrum Multicast Discovery



ESnet Shuts Down Spectrum

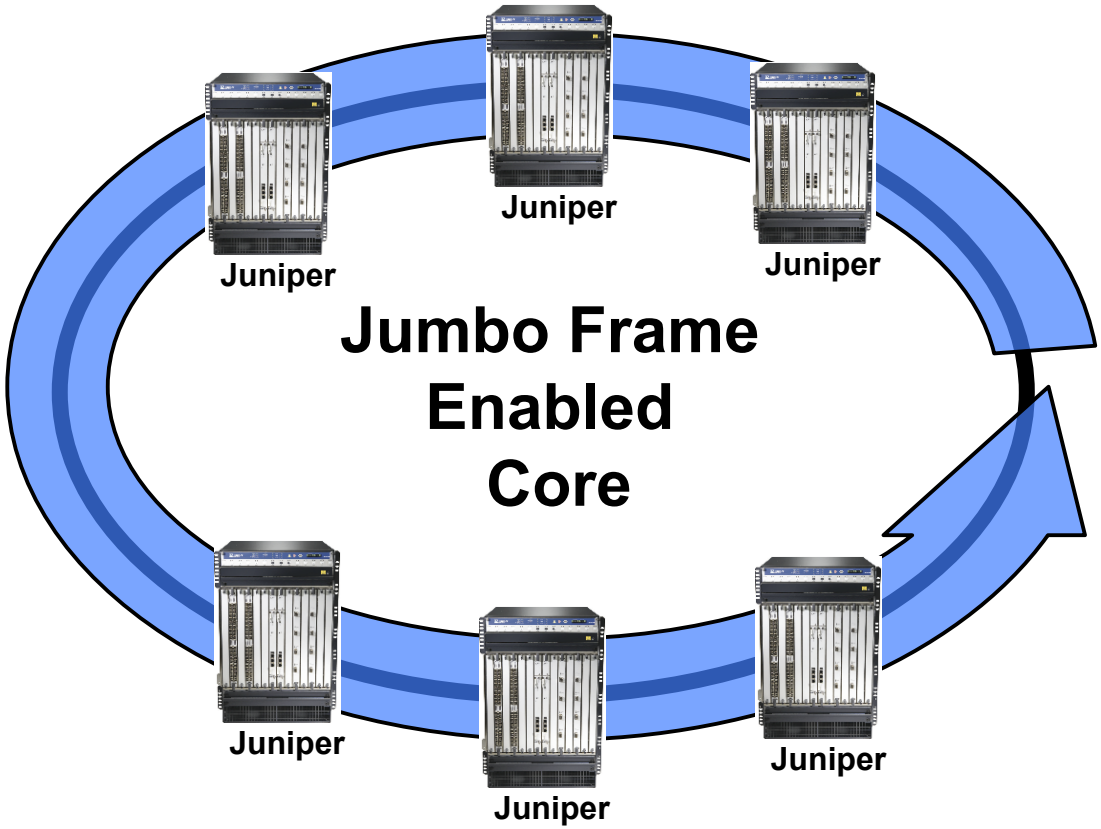




And miraculously, the Sunnyvale router stabilizes!

So What Happened?

How did Spectrum kill our router?



Analysis of the Failure

Juniper case:
2009-0624-0582 IPv6 path MTU discovery
PR 456161 introduced in JUNOS 9.2
June 24, 2009

The Juniper RE (routing engine) had produced a core file that we were able to send to Juniper for analysis. The analysis found a wedged packet in the form of an IPv6 path MTU discovery "packet too big" control packet.

Our core router was sourcing enough data to an IPv6 addressed destination to generate jumbo frame IPv6 packets.

What Changed From IPv4

- Hosts must size IPv6 packets appropriately, transit routers will not fragment IPv6 packets as they do in IPv4.
- If an IPv6 router encounters a packet that is too large to forward, it drops it and sends a "packet too big" ICMP message back to the source.
- IPv6 ICMP "packet too big" messages are forwarded through our routers without issue, but in this case our Sunnyvale router was the destination that had to process the packet.
- When the Spectrum servers' first hop router sent back the IPv6 ICMP "packet too big" message it wedged the core router in Sunnyvale.

IPv6 Path MTU Discovery was introduced in JUNOS 9.2
This would have mitigated the issue.
http://www.juniper.net/techpubs/software/junos/junos94/swconfig-system-basics/ipv6-path-mtu-discovery.html#ipv6-path-mtu-discovery

What Role Did Spectrum Play?

- The Spectrum NMS communicates directly with all of our routers on a regular basis to poll and accept trap based alerts. This server is connected to it's first hop router using a 1500 Byte MTU.

- In this case, the Spectrum NMS was querying each router for it's multicast state and that particular router contained numerous multicast groups several with many sources. This large state transfer from the router toward the server, uncovered the bug.

- Any similarly connected IPv6 router with large enough multicast state tables and a vulnerable version of JUNOS would have crashed in the same way.

- The router recovered by itself because it had redundant routing engines and cycled between them until Spectrum ceased polling the multicast state.

Summary & Next Steps

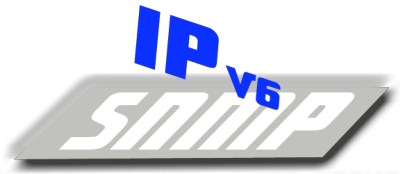
Despite all of the excitement in Sunnyvale, ESnet expects to move ahead with IPv6 addressing completely replacing IPv4 in the Spectrum NMS

IPv6 addresses are not simply longer IPv4 addresses

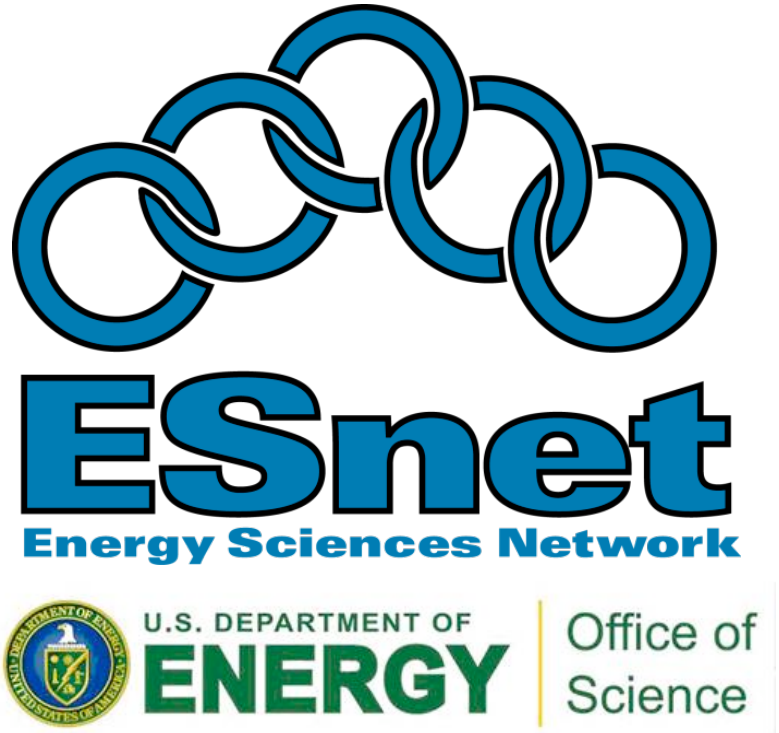
It's really easy for ESnet to test IPv6 SNMP support and we will

IPv6 SNMP management is an easy application that will help to ensure a high level of IPv6 service delivery even if you have only a few customers to keep you honest

ESnet serves IPv6 connected customers today and is ready for more tomorrow



Questions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