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**networktest**

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# Juniper Networks EX Series/ Cisco Catalyst Interoperability Test Results

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### Executive Summary

Juniper Networks commissioned Network Test to assess interoperability between its EX4200 and EX8208 switches and Catalyst 3570-E and Catalyst 6509 switches from Cisco Systems. **In every test case where Juniper and Cisco switches supported the same protocol, the switches correctly forwarded traffic.**

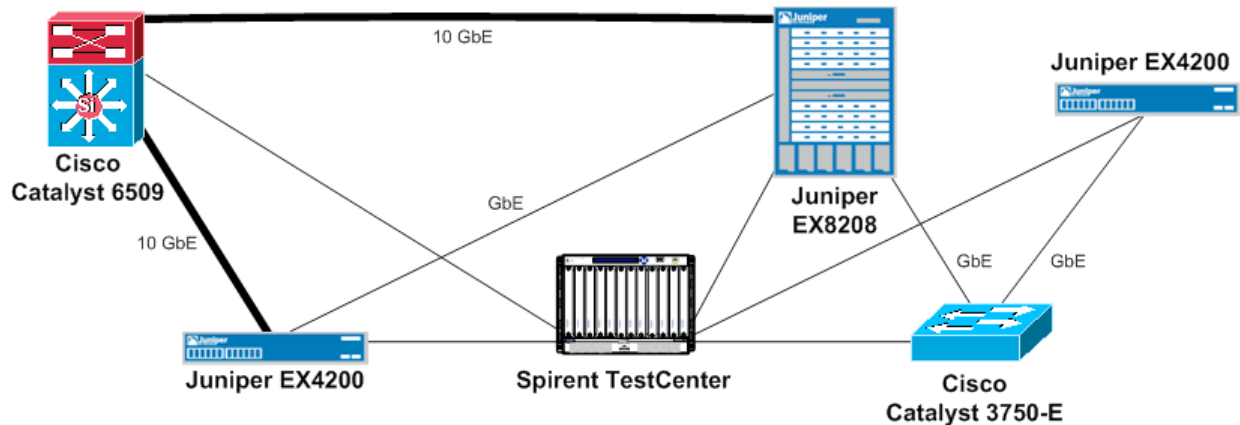
In this evaluation, Network Test validated the interoperability of 15 protocols. The following table summarizes results of interoperability testing.

Juniper / Cisco Protocol Interoperability		
	Juniper EX4200	Juniper EX8200
<b>VLAN trunking</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>Link aggregation</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>Spanning tree protocol</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>Ethernet OAM/802.3ah</b>		
Cisco Catalyst 3750-E	Not tested*	Not tested*
Cisco Catalyst 6509	✓	Not tested*
<b>CDP passthrough</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>LLDP and LLDP-MED</b>		
Cisco Catalyst 3750-E	✓	Not tested*
Cisco Catalyst 6509	✓	Not tested*
<b>L2/L3 jumbo frame handling</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>VRRP</b>		
Cisco Catalyst 3750-E	Not tested*	Not tested*
Cisco Catalyst 6509	✓	✓
<b>Multicast routing / IGMP / IGMP snooping</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>Port monitoring</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓
<b>Remote performance monitoring</b>		
Cisco Catalyst 3750-E	✓	Not tested*
Cisco Catalyst 6509	✓	Not tested*
<b>Redundant trunk groups</b>		
Cisco Catalyst 3750-E	✓	✓
Cisco Catalyst 6509	✓	✓

\* Cases noted as “not tested” refer to situations where either the Juniper or Cisco software image tested did not support a given protocol. Details for each protocol are discussed later in this document. Appendix B lists the software versions tested for each switch.

## Methodology and Results

Network Test used a Spirent TestCenter traffic generator/analyzer to verify that Juniper and Cisco switches would exchange traffic over a variety of layer-2 and layer-3 protocols. The switches were interconnected with a mix of gigabit Ethernet and 10-gigabit Ethernet links, as shown in Figure 1 below.



**Figure 1: Juniper Networks EX Series/Cisco Catalyst Interoperability test be**

## VLAN Trunking

Network Test evaluated interoperability of IEEE 802.1Q VLAN trunking in three ways: forwarding of allowed tagged traffic; forwarding of allowed untagged (native) traffic; and blocking of disallowed untagged traffic.

The Juniper and Cisco switches were configured with three tagged VLANs and one native VLAN, all of which should have passed across the trunk. In addition, Spirent TestCenter generated traffic from a fifth VLAN that was not allowed on the trunk. This last step was taken to determine if switch trunk ports would correctly block disallowed traffic.

In all tests, each pair of Juniper and Cisco switches correctly forwarded traffic that was intended to be forwarded, and did not carry traffic that was not intended to be forwarded.

## Link Aggregation

Network Test evaluated the bundling of up to eight physical ports into one logical port using the IEEE 802.3ad link aggregation protocol, and assessed the dynamic management of ports within a link aggregation group (LAG) using the Link Aggregation Control Protocol (LACP).

An eight-port LAG was configured between two switch pairs, the Juniper EX4200 and Catalyst 3750-E and the Juniper EX8208 and Catalyst 3750-E, all using gigabit Ethernet links. A two-member, 10 GbE LAG was established between two other switch pairs: the EX4200 and Catalyst 6509, and the EX8208

and Catalyst 6509. Spirent TestCenter offered frames destined for ports on the other side of the LAG. In all cases, the Juniper and Cisco switches correctly forwarded traffic.

To assess LACP, Network Test removed and then re-added ports (members) from the LAG to verify that both Juniper and Cisco switches would correctly reconfigure the LAG. A query of LACP status on the command-line interface (CLIs) of each switch during each step showed the switches dynamically reconfigured the LAG as ports were removed or added.

## Spanning Tree Protocol (STP)

Network Test assessed spanning tree with five variations of the widely used loop prevention and redundancy protocol:

1. RSTP (Juniper) / PVST+ (Cisco)
2. MSTP (Juniper and Cisco, using the 802.1s specification)
3. VSTP (Juniper) / PVST+ (Cisco)
4. MSTP (Juniper) / PVST+ (Cisco)
5. MSTP (Juniper) / Rapid-PVST+ (Cisco)

Each test involved three switches: two from Juniper and one from Cisco. The software image tested for the EX8208 did not support VSTP, however, all other permutations of the two Juniper and two Cisco switches were evaluated.

For each protocol variation, Network Test used two criteria to assess interoperability. First, engineers verified spanning tree's loop prevention capabilities by determining that traffic was received only from ports in forwarding state. Second, upon failure of a link Network Test verified that spanning tree correctly redirected traffic onto backup paths that previously had been in blocking state.

This was verified by results from Spirent TestCenter traffic generator/analyzer which showed that the switches move traffic onto ports in "forwarding" state and did not move traffic onto ports in "blocking" state. Spanning tree convergence was verified by disabling one of the Juniper ports, forcing a port formerly in blocking mode to become active and forward traffic. Spanning tree delivered loop-free operation and seamless failover in all five test cases.

## Ethernet OAM/802.3ah

Both Juniper and Cisco switches support the IEEE 802.3ah specification to exchange link discovery and link monitoring information as part of Ethernet operations, administration and management (OAM). These capabilities are critical for service providers rolling out Ethernet in the First Mile (EFM) capabilities and wishing to monitor the status of Ethernet links to customer sites. OAM capabilities are also useful in enterprise deployments, especially for customers with large or far-flung network topologies.

Tests involved configuring Ethernet OAM link monitoring on the Juniper EX4200 and Cisco Catalyst 6509 switches and querying each device to determine if each acknowledged the other's interface. Both Juniper and Cisco switches successfully reported that the other side's interface was up.

Network Test then disabled one interface on the Juniper switch, and verified that both sides correctly reported the change. These results demonstrate that both sides can monitor link status and report on remote faults.

As noted, tests were conducted using the Juniper EX4200 and Cisco Catalyst 6509. 802.3ah features were not supported on the software images tested on either the Juniper EX8208 or Cisco Catalyst 3750-E.

## **Cisco Discovery Protocol (CDP) Passthrough**

The proprietary Cisco Discovery Protocol (CDP) allows sharing of information, such as IP address, model number and power requirements, among connected Cisco devices. Network Test verified the ability of the Juniper EX4200 and Juniper EX8208 switches to “pass through” CDP data between two connected Cisco devices. Transport of this information was validated by enabling CDP on two Cisco devices and verifying via the Cisco switches’ command-line interfaces (CLIs) that they could identify one another.

Network Test also validated CDP passthrough between both Juniper switches and the Catalyst 3750-E and Catalyst 6509.

CDP uses IP multicast, and this required disabling of IGMP snooping on the Juniper switches to ensure forwarding of all multicast traffic. With IGMP snooping disabled, both the Juniper EX4200 and Juniper EX8208 successfully “passed through” CDP messages between pairs of Cisco switches.

## **Link Layer Discovery Protocol (LLDP) and LLDP-MED (Media Endpoint Discovery)**

LLDP, based on the IEEE 802.1AB-2005 specification, is a standards-based method of exchanging device capabilities. Network Test validated LLDP interoperability using Cisco voice-over-IP (VoIP) devices attached to Juniper switches.

Network Test validated LLDP interoperability by attaching two Cisco 7961 phones to a Juniper EX4200 switch and verifying via the EX4200 command-line interface (CLI) that the switch could identify the phones by their model numbers and assigned addresses.

Testing also validated interoperability for LLDP-MED, an extension to LLDP used by many IP phones to register with PBXs and/or proxies. In this case, Network test placed a Juniper EX4200 switch between two Cisco IP phones and Cisco CallManager Express (CME) software running on a Cisco 2821 Integrated Services Router. The phones successfully used LLDP-MED to obtain the voice VLAN ID from the Juniper switch and register with the Cisco CME software, verified by placing a call between the phones.

The software image tested with the Juniper EX8208 did not support power over Ethernet at test time, so LLDP and LLDP-MED interoperability testing was limited to the Juniper EX4200 switch. In practice, IP phones are typically attached to switches at the edge of the network, and these devices are more likely to be fixed-configuration devices such as the Juniper EX4200.

## **Virtual Router Redundancy Protocol (VRRP)**

Network Test verified the ability of Juniper and Cisco switches to use the IETF-standard virtual router redundancy protocol (VRRP). In all VRRP tests, a backup router took over after the failure of a primary router or link.

Testing involved running VRRP on both Juniper and Cisco products, configuring the switches as routers, and breaking a link to determine if failover worked. Both the Juniper EX4200/Catalyst 6509 and Juniper EX8208/Catalyst 6509 router pairs agreed on a virtual IP (VIP) address, as seen via their respective command-line interfaces (CLIs).

Initially, a Juniper device acted as master and a Cisco device as backup. Then Network Test configured the Cisco device to act as master by changing its priority to force VRRP failover. Again, the two sides agreed on VRRP settings.

The results demonstrate that upon failure of an active router or link, Juniper and Cisco devices will work cooperatively to reroute onto a backup link.

VRRP testing involved the Juniper EX4200 and Juniper EX8208 tested with the Cisco Catalyst 6509. The software image tested on the Cisco Catalyst 3750-E did not support VRRP.

## Multicast Routing

Network Test validated the ability of Juniper and Cisco devices to share information about multicast routing topology and to correctly forward multicast traffic.

Multicast testing involved pure routed and mixed routed/switched scenarios. In the routing scenario, Network Test configured Juniper and Cisco devices to run Protocol Independent Multicast-Sparse Mode (PIM-SM) and Open Shortest Path First (OSPF) to carry multicast and unicast routing information, respectively. In the switching scenario, the Cisco device continued to function as a multicast router while the Juniper device functioned in switched layer-2 mode.

For both configurations, Spirent TestCenter transmitted traffic to 10 multicast groups into the Cisco device, and emulated multicast subscribers to all 10 groups on the Juniper device. One additional monitor port was set up on Spirent TestCenter to verify the Juniper device did not flood frames to a non-subscriber port.

In both router/router and router/switch scenarios, the Juniper and Cisco devices correctly delivered multicast traffic to subscribers, and did not flood traffic to non-subscribers.

In addition, Network Test evaluated IGMP and IGMP snooping support while multicast routing was enabled. When operating in Ethernet switching mode, the Juniper devices use IGMP to forward group join and leave requests from subscribers, and IGMP snooping to determine which ports have subscribers attached. Working with IGMPv3 – the most recent version of the multicast distribution protocol – the Juniper switches correctly joined and forwarded multicast traffic in all cases.

## Jumbo Frame Handling

To validate the ability of Juniper and Cisco switches to exchange jumbo Ethernet frames – those larger than the standard maximum of 1,518 bytes – Network Test conducted jumbo tests in both switching and routing modes.

For the switching tests, Spirent TestCenter offered 9,216-byte jumbo Ethernet frames in a bidirectional pattern between Juniper and Cisco switches. For all switch pairs, all devices correctly forwarded jumbo traffic.

For the routing assessment, Network Test configured OSPF routing on both the Juniper and Cisco devices. The OSPF protocol will not exchange traffic unless both routers agree on the same maximum transmission unit (MTU). In this case, with 9,198-byte IP packets inside 9,216-byte Ethernet frames, all Juniper and Cisco devices successfully established OSPF routing adjacencies as expected.

## Remote Port Mirroring

Remote port mirroring allows a network manager to capture traffic to or from a port on one switch and view the captured traffic via a port on a different switch. Juniper asked Network Test to validate interoperability of this useful troubleshooting feature between Juniper and Cisco switches.

Network Test assessed eight permutations of remote port mirroring interoperability:

- Source port on Juniper EX4200 to remote analyzer port on Cisco Catalyst 3750-E, and vice-versa
- Source port on Juniper EX4200 to remote analyzer port on Cisco Catalyst 6509, and vice-versa
- Source port on Juniper EX8208 to remote analyzer port on Cisco Catalyst 3750-E, and vice-versa
- Source port on Juniper EX8208 to remote analyzer port on Cisco Catalyst 6509, and vice-versa

For each permutation, Network Test configured Spirent TestCenter to start a packet capture on the remote analyzer port, and then started an OSPF routing session on the source port being monitored.

In all cases, the switches correctly forwarded all captured traffic to the remote analyzer port.

Network Test also conducted an additional pair of tests with VLAN tagged traffic to determine whether the switches would preserve VLAN ID values across the remotely monitored port. When copying monitored traffic from a Juniper EX4200 to a Cisco Catalyst 3750-E, the VLAN ID of captured frames was preserved. However, traffic captured on the Catalyst 3750-E and remotely monitored on the Juniper EX4200 did not preserve the VLAN tag. A separate traffic capture of the Cisco Catalyst 3750-E's trunk port did not show a VLAN tag for remotely monitored traffic; presumably this is stripped off before copying the frame to the remote analyzer port on the Juniper switch.

## Remote Performance Monitoring (RPM)

Juniper's Remote Performance Monitoring (RPM) feature can perform "health checks" on attached network devices and servers using ICMP, TCP and UDP probes and requests. Network Test validated RPM interoperability by configuring the Juniper EX4200 to monitor roundtrip times between it and attached Cisco Catalyst 3750-E and Cisco Catalyst 6509 switches.

Using RPM with ICMP probes, the Juniper switch monitored round-trip times between it and the Cisco switches as expected. Network Test did not evaluate RPM with the Juniper EX8208, since this feature was not supported in the software image tested on that platform.

## Redundant Trunk Group (RTG)

Juniper's Redundant Trunk Group (RTG) feature allows definition of primary and secondary VLAN trunk ports between switches, and redirects traffic across the secondary trunk if the primary fails. RTG provides an alternative to spanning tree for redundancy. Juniper asked Network Test to validate that RTG would operate between Juniper and Cisco switches with no additional configuration needed on Cisco switches with additional trunk ports.

To assess RTG interoperability, Network Test and Juniper engineers set up four Juniper and Cisco switches in a ring topology and configured RTG on the Juniper switches (EX4200 and EX8208). Aside from defining VLAN trunk ports on the Cisco switches (Catalyst 3750-E and 6509), no additional configuration was needed on the Cisco switches.

Network Test first verified connectivity by generating traffic between random switch pairs using Spirent TestCenter; traffic was observed only on the primary trunk link and not the backup. Then, after

administratively disabling the primary trunk port on the Juniper EX4200, Network Test verified that the switches continued to forward traffic via the secondary trunk port, which took over the primary role. Network Test also verified similar primary/second RTG operation on the Juniper EX8208 switch, again with no extra configuration needed on the Cisco devices. Thus, RTG was fully interoperable between the Juniper EX4200 and EX8200 and the Cisco Catalyst 3750-E and 6509.

## Conclusion

Interoperability testing was successful in every case where both Juniper and Cisco devices supported a given protocol. As noted in the discussion of each the 15 protocols, there were a few isolated cases whether a given Juniper or Cisco image did not support a given feature; no interoperability testing was attempted in these cases. Anytime a protocol was supported in both vendors' devices, interoperability worked as expected. This provides assurance to network professionals considering design or deployment of networks comprised of a mix of Juniper and Cisco switches.

Links to Juniper and Cisco configuration files and software versions used in testing are outlined in Appendix A and B, respectively.

## Appendix A: Configuration Files

This appendix lists URLs for the Juniper and Cisco switch configuration files used to verify interoperability between the two systems. These files are freely available for download from a Network Test FTP server.

A copy of this document as well as all Juniper and Cisco configuration files are available at <http://networktest.com/jnprprip>.

## Appendix B: Software Versions Tested

This appendix lists the software versions tested on all Juniper and Cisco switches in this project.

Juniper EX4200: JunOS 9.4R1.8  
Juniper EX8208: JunOS 9.4R1.8  
Cisco Catalyst 3750-E: IOS 12.2(40)SE  
Cisco Catalyst 6509: IOS 12.2(33)SXH1

## Appendix C: Disclaimer

Network Test Inc. has made every attempt to ensure that all test procedures were conducted with the utmost precision and accuracy, but acknowledges that errors do occur. Network Test Inc. shall not be held liable for damages which may result for the use of information contained in this document.

