networktest

HP-Cisco Interoperability Test Results

August 2014

Executive Summary

HP commissioned Network Test to assess interoperability between its enterprise switch/routers and those of Cisco Systems. Working with an extensive test bed that included popular core- and access-layer devices, Network Test successfully validated interoperability of 15 key protocols used in enterprise networks. Eighteen individual tests involved IPv4 and IPv6; switching and routing; and unicast and multicast traffic. **For all protocols described here, the HP and Cisco switch/routers correctly forwarded traffic.**

The following table summarizes results of interoperability testing.

HP / Cisco Protocol Interoperability									
	HP 10504	HP 5406R	HP FlexFabric 5900AF	HP 5500-HI		HP 10504	HP 5406R	HP FlexFabric 5900AF	HP 5500-HI
BGP					**Multicast switching and routing**				
Cisco Catalyst 6509-E	✔	✔	✔	✔	Cisco Catalyst 6509-E	✔	✔	✔	✔
Cisco Catalyst 4507R	✔	✔	✔	✔	Cisco Catalyst 4507R	✔	✔	✔	✔
Cisco Catalyst 3850	✔	✔	✔	✔	Cisco Catalyst 3850	✔	✔	✔	✔
CDP					**OSPF (IPv4 and IPv6)**				
Cisco Catalyst 6509-E	✔	✔	✔	✔	Cisco Catalyst 6509-E	✔	✔	✔	✔
Cisco Catalyst 4507R	✔	✔	✔	✔	Cisco Catalyst 4507R	✔	✔	✔	✔
Cisco Catalyst 3850	✔	✔	✔	✔	Cisco Catalyst 3850	✔	✔	✔	✔
Jumbo frames (L2 and L3)					**Spanning tree protocol**				
Cisco Catalyst 6509-E	✔	✔	✔	✔	Cisco Catalyst 6509-E	✔	✔	✔	✔
Cisco Catalyst 4507R	✔	✔	✔	✔	Cisco Catalyst 4507R	✔	✔	✔	✔
Cisco Catalyst 3850	✔	✔	✔	✔	Cisco Catalyst 3850	✔	✔	✔	✔
Link aggregation					**VLAN trunking**				
Cisco Catalyst 6509-E	✔	✔	✔	✔	Cisco Catalyst 6509-E	✔	✔	✔	✔
Cisco Catalyst 4507R	✔	✔	✔	✔	Cisco Catalyst 4507R	✔	✔	✔	✔
Cisco Catalyst 3850	✔	✔	✔	✔	Cisco Catalyst 3850	✔	✔	✔	✔
LLDP					**VRRP**				
Cisco Catalyst 6509-E	✔	✔	✔	✔	Cisco Catalyst 6509-E	✔	✔	✔	✔
Cisco Catalyst 4507R	✔	✔	✔	✔	Cisco Catalyst 4507R	✔	✔	✔	✔
Cisco Catalyst 3850	✔	✔	✔	✔	Cisco Catalyst 3850	✔	✔	✔	✔

Methodology and Results

Figure 1 illustrates the test bed used to validate HP-Cisco interoperability. The HP and Cisco switch/routers used a two-tier design commonly found in enterprise campus networks, with separate devices at the core and access layers. Variations on this design are possible: Some enterprises add a middle distribution layer with switches such as the HP 5406R or Cisco Catalyst 4507R; and some smaller enterprise networks use the HP FlexFabric 5900AF as a core device.

A Spirent TestCenter traffic generator/analyzer emulated clients and servers, and externally verified interoperability of the various protocols.

Except where otherwise noted, tests involved connections between each layer of the network, thus validating interoperability of each protocol using every device on the test bed. Also, unless otherwise noted, tests also used multiple redundant connections between switch/routers to exercise link aggregation, spanning tree, and routing protocols.

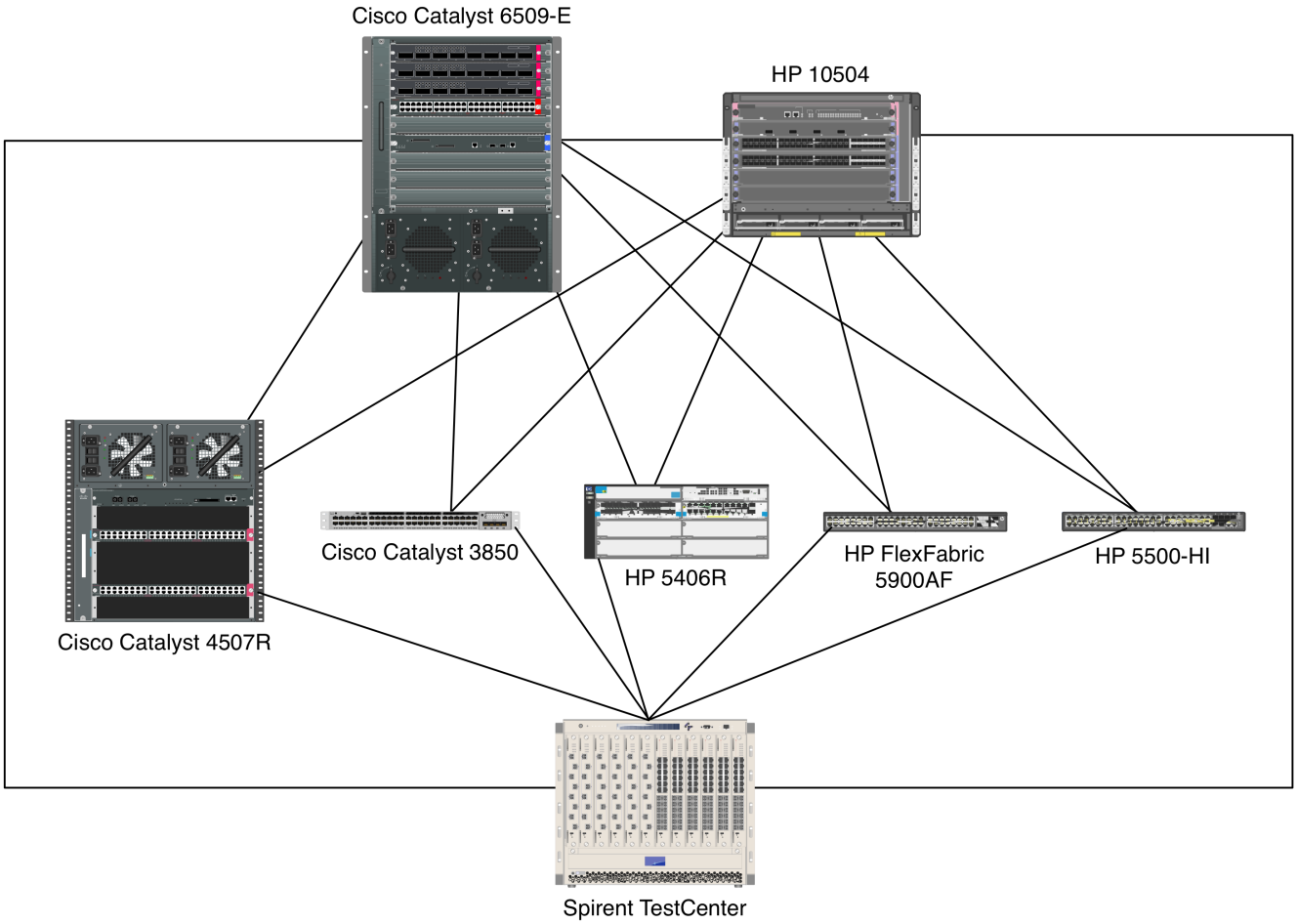

Figure 1: The HP-Cisco interoperability test bed

Border Gateway Protocol (BGP)

The Border Gateway Protocol (BGP) is the method that connects organizations to the global Internet. As described in RFC 4271, BGP treats each organization's network as an "autonomous system" (AS) and connects that system to all other such systems on the Internet.

Network Test validated BGP interoperability by enabling the protocol on all HP and Cisco core and access devices. This is more stressful than BGP in production settings, since the protocol typically only runs at the perimeter of an organization's network.

Emulating BGP routers, the Spirent TestCenter test instrument advertised routes to each device. **In all cases, the HP and Cisco devices successfully established BGP sessions and correctly propagated routing information.**

Cisco Discovery Protocol (CDP)

The proprietary Cisco Discovery Protocol (CDP) allows sharing of information, such as IP address, model number and power requirements, among connected devices. Although CDP is Cisco-proprietary, HP Networking devices also support it. Network Test verified the ability of all HP and Cisco switches to share information using CDP.

Engineers validated transport of this information by enabling CDP on all switches and verifying via the switches' command-line interfaces (CLIs) that they could identify one another. **In all cases, HP and Cisco switches correctly identified one another's capabilities using CDP.**

Jumbo Frame Switching and Routing

Jumbo Ethernet frames – those larger than the standard maximum length of 1,518 bytes[1] – are commonly used for bulk data-transfer applications such as backups, storage, and disaster recovery. To validate the ability of HP and Cisco switch/routers to exchange jumbo frames, Network Test offered these frames in both switching and routing modes.

In the switching and routing tests, Spirent TestCenter offered 9,216-byte jumbo Ethernet frames using a "partially meshed" topology, meaning all traffic offered to HP devices was destined to Cisco ports and vice-versa. **All HP and Cisco devices correctly switched and routed traffic consisting of jumbo frames.**

1. Recent versions of the 802.3 Ethernet specification have extended the maximum "envelope" frame length to 2,000 bytes to allow for multiple VLAN headers and various encapsulation methods. However, the specification's maximum "basic" frame length remains at 1,518 bytes.

Link Aggregation

Network Test evaluated the ability of HP and Cisco devices to bundle multiple physical ports into one logical port using the IEEE 802.1AX link aggregation protocol[2].

Engineers configured the HP and Cisco devices to set up link aggregation groups (LAGs) between all switches. Specifically for this test, engineers then disabled any redundant paths through the network, forcing traffic to be forwarded across each LAG. Spirent TestCenter offered bidirectional traffic to each HP switch, destined to all Cisco switches, and vice-versa. **In all cases, the HP and Cisco switches correctly forwarded traffic using link aggregation.**

Link Layer Discovery Protocol (LLDP)

LLDP, based on the IEEE 802.1AB specification, is a standards-based method of exchanging device capabilities. Network Test verified LLDP interoperability between all combinations of HP and Cisco switches.

To validate interoperability, engineers enabled LLDP on each device and then asked each switch to show information about its neighbors. **In all cases, HP and Cisco switches correctly identified one another's capabilities using LLDP.**

Multicast Switching and Routing

Streaming media, conferencing, financial quote services and many other applications are making increasing use of IP multicast. Network Test validated the ability of HP and Cisco equipment to share information about multicast topology both in switched and routed environments.

In the switched scenario, engineers configured all HP and Cisco devices in layer-2 mode and enabled IGMP snooping. In the routed scenario, all devices used the Protocol Independent Multicast-Sparse Mode (PIM-SM) routing protocol and OSPF to carry multicast and unicast routing information, respectively.

In both scenarios, a Spirent TestCenter port attached to the Cisco Catalyst 6509-E offered traffic destined to 10 multicast groups while other test ports attached to all other switches emulated subscribers to all 10 multicast groups. Engineers also attached one additional monitor port to each subscriber switch to verify they did not flood multicast frames to non-subscriber ports.

The HP and Cisco devices correctly delivered multicast traffic to subscribers in both switched and routed configurations, and did not flood traffic to non-subscribers.

In addition, Network Test evaluated IGMP snooping support while PIM-SM multicast routing was enabled. When operating in Ethernet switching mode, the HP and Cisco devices use IGMP reports to determine which switch ports have subscribers attached. Engineers verified the HP and Cisco switches correctly populated IGMP snooping tables and forwarded multicast traffic in all cases.

2 The IEEE first described link aggregation in the 802.3ad specification. In 2008, the IEEE transferred link aggregation into its 802.1 group and published a new 802.1AX-2008 specification.

OSPF for IPv4 and IPv6

IP routing is a given in enterprise networks, and by far the most commonly used interior gateway protocol is Open Shortest Path First (OSPF).

To validate OSPF interoperability between HP and Cisco devices, engineers enabled OSPF on all switch/routers on the test bed, and then configured Spirent TestCenter to emulate OSPF routers attached to each device.

This is a more rigorous and stressful topology than is commonly found in most enterprise networks, where IP routing often is found only on core devices. Here, every switch/router – including those at the access layer – brought up OSPF routing sessions and forwarded traffic to and from networks advertised using OSPF.

Engineers conducted these routing tests twice, with IPv4 and IPv6 variations. In IPv4 testing, engineers configured OSPFv2, while IPv6 testing used the newer OSPFv3 variant of the protocol.[3]

In these tests, Spirent TestCenter emulated OSPF routers attached to every switch/router. After bringing up an OSPF session, these emulated routers used OSPF to advertise networks "behind" them, and then offered traffic to and from these networks.

For this interoperability test to work successfully, HP and Cisco switch/routers would need to share routing information to forward traffic to these emulated networks. That is exactly what happened: **All HP and Cisco devices not only established OSPF sessions over IPv4 and IPv6, but also forwarded all traffic to all networks with zero frame loss observed.**

Spanning Tree Protocol (STP)

The spanning tree protocol serves as a key loop prevention and redundancy mechanism in enterprise networks. Over the years it has been refined with updates, such as rapid spanning tree (RSTP) to reduce convergence time and multiple spanning tree (MSTP) to form a separate spanning tree instance for each VLAN. In addition to these standards-based methods, Cisco switches use proprietary variants called per- VLAN spanning tree plus (PSVT+) and Rapid PVST+.

Network Test verified HP-Cisco interoperability using three variations of spanning tree:

- PVST+ (HP)[4] / PVST+ (Cisco)
- MSTP (HP) / PVST+ (Cisco)
- MSTP (HP and Cisco, using the IEEE 802.1s specification)

For each variation, engineers set up redundant connections between all devices, thus forcing spanning tree to select a root bridge and place device ports in either blocked or forwarding states. Engineers then offered traffic to each device using Spirent TestCenter and verified that traffic was received only from an intended port in forwarding state.

Engineers then administratively shut down forwarding-state ports to force recalculation of the spanning tree,

3. IETF RFC 2328 describes OSPFv2 and RFC 5340 describes OSPFv3. While the basic mechanics of OSPF are identical in both versions, OSPFv3 introduces new link-state advertisement (LSA) types; removes addressing semantics from OSPF headers; generalizes flooding; and removes OSPF-layer authentication, among other changes.
4. Tested with RPVST+ on all HP switches except the HP 10504, which ran MSTP.

thus enabling ports that previously were in a blocking state. Engineers verified correct spanning tree operation by observing Spirent TestCenter port counters and by examining the command-line interface (CLI) output for spanning tree on each device. **In all of the various STP permutations tested, spanning tree delivered loop-free operation and seamless failover.**

Virtual Router Redundancy Protocol (VRRP)

Network Test verified the ability of HP and Cisco devices to provide router failover using the Virtual Router Redundancy Protocol (VRRP). As defined by the Internet Engineering Task Force (IETF) in RFC 5798, VRRP provides a standard method by which multiple routers select Master and Backup roles, with a Backup router taking over from a Master in the event of a router or link failure.

Testing involved all seven HP and Cisco devices as shown in Figure 1, with VRRP running on the HP 10504, the HP 5406R, the HP FlexFabric 5900AF, and the Cisco Catalyst 6509-E. The devices running VRRP agreed on a virtual IP (VIP) address, verified by examining their respective CLIs.

Initially, the HP 10504 acted in the Master role and the Cisco Catalyst 6509-E acted as Backup. Then engineers configured the Cisco device to take over as Master by changing its priority to force VRRP failover. Again, the two sides agreed on VRRP settings, and traffic counters on Spirent TestCenter showed devices forwarding traffic after the failover.

Engineers repeated this exercise three times, pairing the HP 10504, HP 5406R, and HP5900 with the Cisco Catalyst 6509-E. In each case, failover worked as expected.

The results demonstrate that upon failure of an active router or link, HP and Cisco devices work together using VRRP to reroute traffic onto a backup link.

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.

Engineers configured four VLANs on each switch, and configured trunk ports between switches to allow traffic from two VLANs as tagged frames and a third VLAN as untagged frames. To determine if switches would correctly block disallowed traffic, engineers did not include the fourth VLAN ID in the list of allowed VLANs.

Spirent TestCenter then offered untagged traffic to each HP and Cisco access and distribution switch in a bidirectional pattern. **In all cases, traffic counters on the Spirent test instrument verified that HP and Cisco switches correctly forwarded VLAN traffic that was intended to be forwarded, and did not carry VLAN traffic that was not intended to be forwarded.**

Conclusion

Interoperability testing was successful in every case where HP and Cisco devices supported a given protocol, both for open standards and for Cisco-proprietary protocols. As these results show, network professionals considering HP switch/routers to replace or augment Cisco equipment can successfully deploy heterogeneous networks.

Appendix A: About Network Test

Network Test is an independent third-party test lab and engineering services consultancy. Our core competencies are performance, security, and conformance assessment of networking equipment and live networks. Our clients include equipment manufacturers, large enterprises, service providers, industry consortia, and trade publications.

Appendix B: Software Releases Tested

This appendix describes the software versions used on the test bed. Network Test conducted all benchmarks in May 2014 at HP's labs in Roseville, California, USA.

Component	Version
HP 10504	Comware Software, Version 7.1.045, Release 2111P02
HP 5406R	ProVision Software, KB.15.15.0006
HP FlexFabric 5900AF	Comware Software, Version 7.1.045, Release 2307
HP 5500-HI	Comware Software, Version 5.20.99, Release 5501P01
Cisco Catalyst 6509-E	IOS 12.2(33)SXI13
Cisco Catalyst 4507R	IOS 15.0(2)SG7
Cisco Catalyst 3850	IOS-XE 03.02.03.SE
Spirent TestCenter	4.41

Appendix C: Disclaimer

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