networktest

HP-Cisco Data Center Interoperability Test Results

April 2015

Executive Summary

HP commissioned Network Test to assess interoperability between its data center switches and those from Cisco Systems. Working with an extensive test bed that included core and top-of-rack devices, Network Test successfully validated interoperability of 10 key protocols used in enterprise and service provider data centers (involving 13 tests total, accounting for multiple protocol versions). Testing covered IPv4 and IPv6; switching and routing; and related layer-2 and layer-3 protocols. **For all protocols described here, the HP and Cisco data center devices interoperated successfully and correctly forwarded traffic.**

The following table summarizes results of interoperability testing.

HP / Cisco Data Center Protocol Interoperability

	HP FlexFabric 7904	HP FlexFabric 5700	HP FlexFabric 5900AF	HP FlexFabric 5900CP	HP FlexFabric 5930		HP FlexFabric 7904	HP FlexFabric 5700	HP FlexFabric 5900AF	HP FlexFabric 5900CP	HP FlexFabric 5930
BGP (IPv4)						**LLDP**					
Cisco Nexus 9504	✔	✔	✔	✔	✔	Cisco Nexus 9504	✔	✔	✔	✔	✔
Cisco Nexus 7010	✔	✔	✔	✔	✔	Cisco Nexus 7010	✔	✔	✔	✔	✔
Cisco Nexus 5548	✔	✔	✔	✔	✔	Cisco Nexus 5548	✔	✔	✔	✔	✔
BGP-MP (IPv6)						**OSPFv2 (IPv4)**					
Cisco Nexus 9504	✔	✔	✔	✔	✔	Cisco Nexus 9504	✔	✔	✔	✔	✔
Cisco Nexus 7010	✔	✔	✔	✔	✔	Cisco Nexus 7010	✔	✔	✔	✔	✔
Cisco Nexus 5548	✔	✔	✔	✔	✔	Cisco Nexus 5548	✔	✔	✔	✔	✔
CDP						**OSPFv3 (IPv6)**					
Cisco Nexus 9504	✔	✔	✔	✔	✔	Cisco Nexus 9504	✔	✔	✔	✔	✔
Cisco Nexus 7010	✔	✔	✔	✔	✔	Cisco Nexus 7010	✔	✔	✔	✔	✔
Cisco Nexus 5548	✔	✔	✔	✔	✔	Cisco Nexus 5548	✔	✔	✔	✔	✔
Jumbo frames (L2 and L3)						**Spanning tree protocol**					
Cisco Nexus 9504	✔	✔	✔	✔	✔	Cisco Nexus 9504	✔	✔	✔	✔	✔
Cisco Nexus 7010	✔	✔	✔	✔	✔	Cisco Nexus 7010	✔	✔	✔	✔	✔
Cisco Nexus 5548	✔	✔	✔	✔	✔	Cisco Nexus 5548	✔	✔	✔	✔	✔
Link aggregation						**VLAN trunking**					
Cisco Nexus 9504	✔	✔	✔	✔	✔	Cisco Nexus 9504	✔	✔	✔	✔	✔
Cisco Nexus 7010	✔	✔	✔	✔	✔	Cisco Nexus 7010	✔	✔	✔	✔	✔
Cisco Nexus 5548	✔	✔	✔	✔	✔	Cisco Nexus 5548	✔	✔	✔	✔	✔

Methodology and Results

Figure 1 illustrates the test bed used to validate HP-Cisco interoperability. The HP and Cisco switches used a two-tier design commonly found in data centers, with separate layers for core and top-of-rack (ToR) switches.

The HP FlexFabric 7904 core switches used Intelligent Resilient Framework (IRF) technology to appear to the rest of the network as a single device. IRF not only eliminated the need for spanning tree between HP core devices, but also resulted in a single configuration file and a single network element to manage. The Cisco Nexus 7010 switches used a Virtual PortChannel (VPC) to provide redundant connections to HP FlexFabric ToR switches.

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

Except where otherwise noted, tests involved every device on the test bed. Also, note the redundant links between all devices. Unless otherwise noted, tests used these redundant connections between switches to exercise link aggregation, spanning tree, and routing protocols.

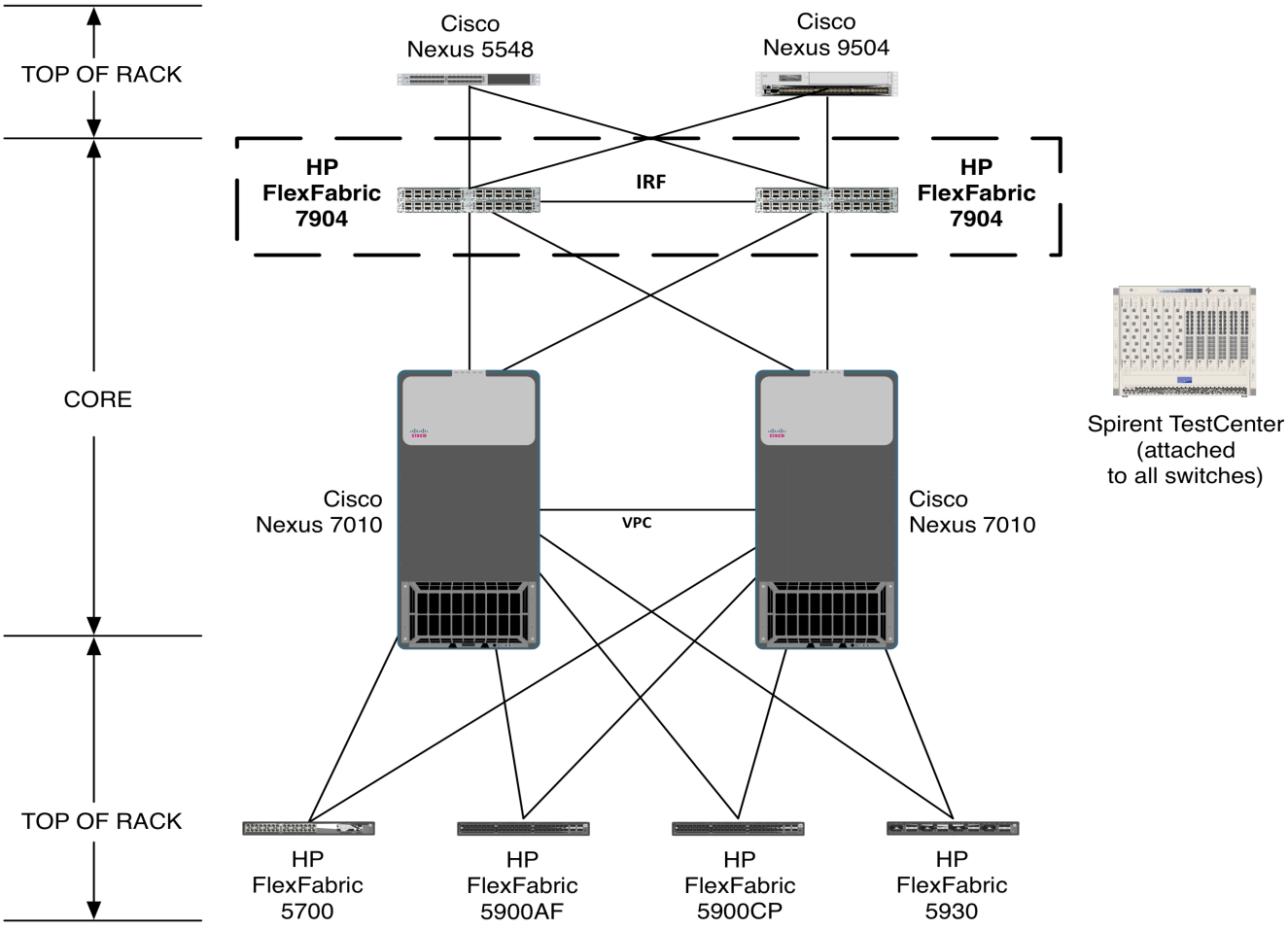

Figure 1: The HP-Cisco data center interoperability test bed

Border Gateway Protocol (BGP) for IPv4

The Border Gateway Protocol (BGP) 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 HP and Cisco core and top-of-rack devices. Emulating BGP routers, the Spirent TestCenter test instrument advertised routes using BGP. **In all cases tested, the HP and Cisco devices successfully established BGP sessions and correctly forwarded traffic to and from networks learned using BGP.**

Border Gateway Protocol-Multiprotocol Extensions (BGP-MP) for IPv6

In addition to the BGP for IPv4 tests, test engineers validated BGP interoperability using routed IPv6 traffic. RFC 4760 describes BGP-MP, a set of multiprotocol extensions to BGP for carrying topology information about multiple network-layer protocols, including IPv6. As with the IPv4 tests, the Spirent TestCenter test instrument brought up peering sessions, advertised routes using BGP-MP, and then offered traffic destined to all routes. **All HP and Cisco devices correctly forwarded IPv6 traffic to and from networks learned using BGP-MP.**

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 in data centers for applications such as backups, storage, and disaster recovery. To validate the ability of HP and Cisco data center devices 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 data center 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 at both the core and ToR layers of the data center network. 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 core and ToR 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.**

OSPFv2 for IPv4

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

To validate OSPF interoperability between HP and Cisco core and top-of-rack devices, engineers enabled OSPF on switches and then configured Spirent TestCenter to emulate OSPF routers.

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, OSPF also ran between HP and Cisco top-of-rack and core switches. RFC 2328 describes version 2 of the OSPF protocol, the version used in IPv4 routing.

In these tests, Spirent TestCenter emulated OSPFv2 routers. 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 switches would need to share routing information to forward traffic to these emulated networks. That is exactly what happened: **All HP and Cisco data center devices corrected forwarded all traffic to and from networks learned using OSPFv2.**

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.

OSPFv3 for IPv6

OSPF routing remains a popular choice for IPv6 networks, especially within the data center. RFC 5340 describes OSPF version 3, which is specifically designed for IPv6 traffic. While the basic mechanics of OSPF are unchanged for IPv6, OSPFv3 introduces new link-state advertisement (LSA) types; removes addressing semantics from OSPF headers; generalizes flooding; and removes OSPF-layer authentication, among other changes.

The OSPFv3 test procedure was similar to that for OSPFv2: Spirent TestCenter emulated OSPF routers attached to HP and Cisco top-of-rack and core switches. 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. The only difference in this case was that the test instrument offered IPv6 routes and IPv6 data traffic.

For this interoperability test to work successfully, HP and Cisco switches would need to share routing information to forward traffic to these emulated networks. That is exactly what happened: **All HP and Cisco data center devices correctly forwarded IPv6 traffic to and from networks learned using OSPFv3.**

Spanning Tree Protocol (STP)

The spanning tree protocol serves as a key loop prevention and redundancy mechanism. 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 (PVST+) and Rapid PVST+.

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

- Rapid PVST+ (HP) / Rapid 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 also successfully forced selection of core devices as root bridges using priorities.

Engineers verified correct spanning tree operation by observing 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. Further, HP and Cisco data center devices agreed on a manually configured root bridge.**

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 tagged 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 traffic to all VLANs on 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 data center devices supported a given protocol, both for open standards and for Cisco-proprietary protocols. As these results show, network professionals considering HP switches to replace or augment Cisco equipment can successfully deploy heterogeneous data center network designs.

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 January and February 2015 at HP's labs in Houston, Texas, USA.

Component	Version
HP FlexFabric 7904	Comware Software, Version 7.1.045, Release 2133
HP FlexFabric 5700	Comware Software, Version 7.1.045, Release 2416
HP FlexFabric 5900AF	Comware Software, Version 7.1.045, Release 2416
HP FlexFabric 5900CP	Comware Software, Version 7.1.045, Release 2416
HP FlexFabric 5930	Comware Software, Version 7.1.045, Release 2416
Cisco Nexus 7010	NX-OS 6.2(8)
Cisco Nexus 5548	NX-OS 7.1(0)N1(1a)
Cisco Nexus 9504	NX-OS 6.1(2)I2(2)
Spirent TestCenter	4.45

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. All trademarks mentioned in this document are property of their respective owners.

networktest

Network Test Inc.

31324 Via Colinas, Suite 113 • Westlake Village, CA 91362-6761 • USA
+1-818-889-0011 • http://networktest.com • info@networktest.com