Miercom

Lab Testing Summary Report

September 2011

Report 111013

Product Category:

Ethernet Fabric

Vendor Tested:

AVAYA

Products Tested:

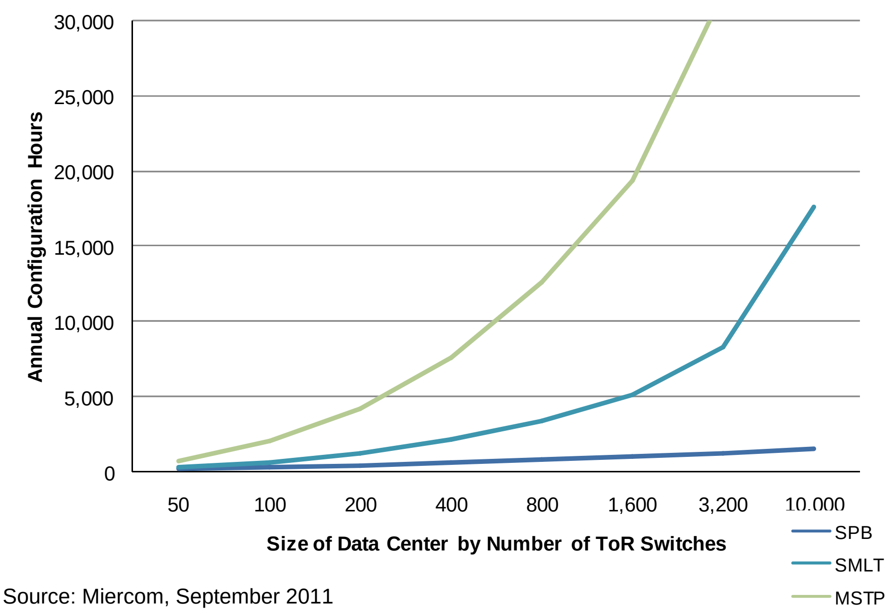
Shortest Path Bridging (SPB) Protocol

Key findings and conclusions:

- Shortest Path Bridging shortens configuration time by up to 7 times over SMLT and up to 25 times over MSTP when implemented in a large data center
- SPB reduces complexity of service application implementation and number of devices affected, thereby reducing chances for configuration errors
- VMware VMotion migration performance using SPB is equivalent to that observed when using SMLT
- Data center resiliency of SPB delivers sub-second convergence times during failover/failback

Avaya engaged Miercom to validate the advantages provided to data center implementations by Shortest Path Bridging Mode (SPB or SPBM) protocol. We compared SPB to Routed Split Multi-Link Trunking (RSMLT) and Multiple Spanning Tree Protocol (MSTP). Test metrics included time required to configure new application services and the complexity of configuration. In our testing, we found that SPBM considerably simplified the process of configuring large data center networks. In addition, fewer devices need to be configured manually, reducing the opportunity for configuration errors. We also performed resiliency tests, and evaluated the performance of VMware VMotion over SPBM.

Figure 1: Inter Data Center VLAN Provisioning Time Requirements



Source: Miercom, September 2011

As data center sizes scale in terms of Top of Rack switches, the time and complexity to configure with SPB is linear compared to Trunking and Spanning Tree protocols.

IEEE 802.1aq Shortest Path Bridging is an Ethernet fabric protocol which is an evolution to protocols such as RSMLT and MSTP. It provides simplified network provisioning and maintenance by requiring only the network elements which edge devices are connected to be configured. This saves time, reduces complexity, and minimizes the chance of errors being introduced during the configuration process.

VLAN Configuration and Documentation

Tests were performed for various aspects of VLAN creation, with the number of steps and the time taken to perform these steps measured and recorded. The objective was to show the reduction in time and complexity of using SPBM to create cross-data center VLANS via the switch Command Line Interface (CLI) to support an application across bi-coastal data centers. We compared this with traditional methods using RSMLT and MSTP. We also determined how the reduction in complexity affected the probability of introducing errors into the configuration, which adds to troubleshooting time and possible outages for end users while the issue is resolved. As any change made to a data center configuration needs to be tightly controlled and managed, we also evaluated the time required to document the changes made for each configuration. Documentation was recorded using Microsoft Visio and Excel applications.

We began with configuration of a data center VLAN. Creating a VLAN across the two data centers in our test bed with SPB, involved configuration of only the SPB-capable Top-of-Rack (ToR) switches. Configuration of the ToR switches took 3.8 minutes each, including documentation. Aggregation and mission-critical core switches did not need to have their configuration modified manually. They are configured automatically and no additional load balancing needs to be performed. Configuring only four devices in this case, instead of the ten in our test bed required with other protocols, also reduces the possibility of mistyping a command, or making other configuration errors, such as assigning the wrong interfaces to a VLAN.

Configuring the same VLAN across two data centers using SMLT required us to touch all the devices in the data center. Configuration of each Top-of-Rack switches took 3.3 minutes, including documentation of the change. We also had to manually configure the aggregation switches, which each took 2.8 minutes. Configuration of the core switches was also required, which took 2.6 minutes each to accomplish. Five devices in each data center, for a total of 10 devices, needed to be configured manually for our test environment. The increase in time to configure a VLAN using SMLT was one and a half times as much as that required to configure using SPB.

Using MSTP to configure the same VLAN across two data centers also requires touching all the devices in each data center. In addition, load balancing across the data centers must also be performed manually for both the ToR and the aggregation switches. The time required to load balance the network was measured and added to our configuration results. We observed that configuration of the VLAN on each Top-of-Rack switch took 4.6 minutes. Adding the VLAN to each of the aggregation switches took 11.8 minutes. Configuration of the core switches also took 10.8 minutes each. Therefore, with the additional time to configure each device, and the additional number of devices that must be touched to perform the VLAN creation, MSTP required four times as much time to configure across our test environment as that required for SPB.

The reductions in time and complexity offered by SPB begin to add up to significant IT savings as data center sizes scale. Based on our test measurements, we examined what impact each of the different protocols tested have on the annual costs of maintaining a data center using additional information regarding data center change rates provided by subject matter experts (SME) at Avaya.

A graphical representation of the relative impact of each one of the configuration protocols can be seen in *Figure 1* on page 1. Specific number of annual IT hours by protocol is shown in *Table 1* on page 4.

We examined the impact of data center growth as seen in terms of the number of ToR switches, with VLAN change rate as a % of ToR change. For our analysis, we considered ToR switch counts across two data centers starting at 50 switches, and doubling in increments to a maximum of 10,000 switches. Based on input from SMEs at Avaya, we assumed that for a 100% increase in ToR switch count from 50 to 100, the VLAN change rate is 50%. For every 100% increase in ToR count thereafter, the VLAN change rate decreases by 5%, so that the VLAN change rate is 10% for a data center size of 10,000 ToR switches.

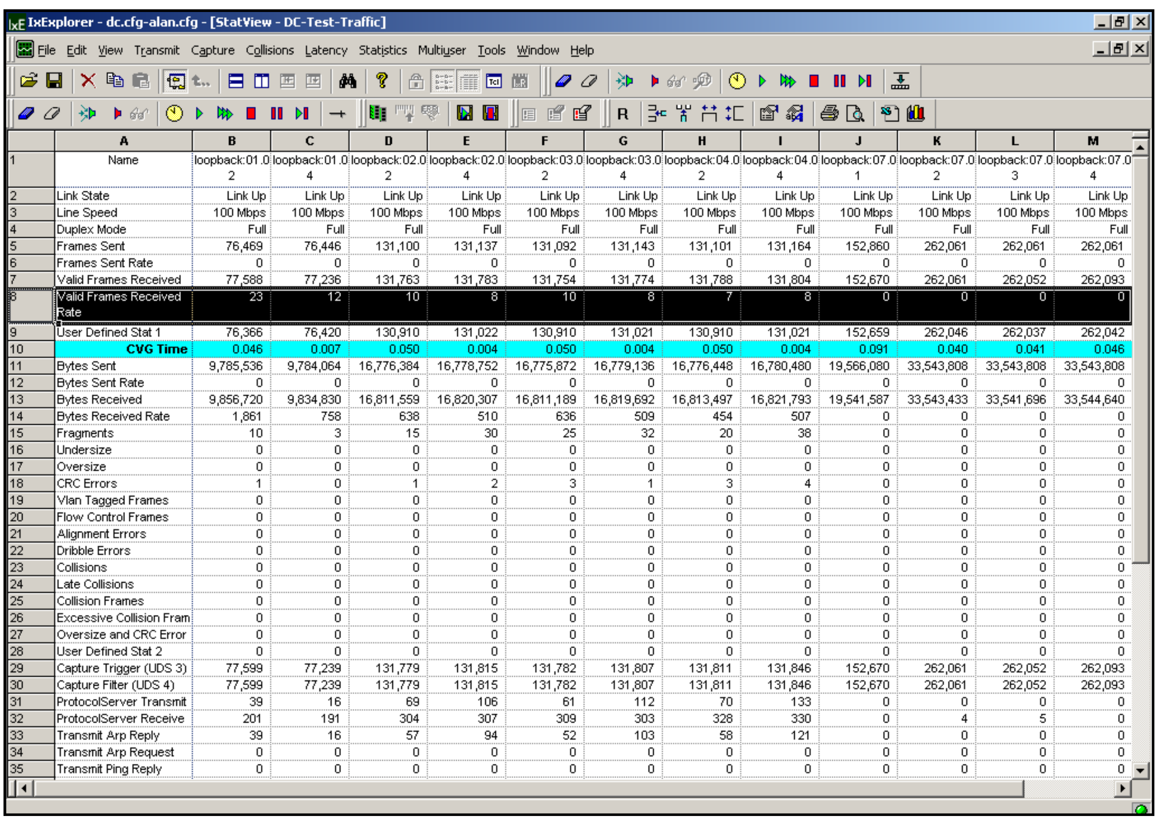
To determine the cost savings advantage provided by the SPB protocol over SMLT and MSTP, we assumed a fully-loaded IT salary of $100,000. This equates to an hourly labor rate of $48. This was applied against the time required to perform the VLAN configurations to develop a reasonable estimate of the cost savings realized on an annual basis by using Shortest Path Bridging.

Some interesting data to emerge from this is that for a 200 Top of Rack switches across two data centers, SPB takes three times less than SMLT to configure a VLAN, resulting in estimated savings of $50,000 per year. Compared to Multiple Spanning Tree Protocol, SPB takes 10 times less long to configure, which results in savings of close to $200,000 per year.

When the number of Top-of-Rack switches swells to 3,200, SPB configuration is seven times shorter to configure than SMLT, and 25 times shorter than Spanning Tree, delivering potential savings of $387,000 and $1,500,000, respectively, on an annual basis. For a mega data center of 10,000 ToR switches, with over 2,000 VLAN changes being done annually, SPB is 11 times shorter in the amount of time to configure than SMLT, saving an estimated $840,000 and 46 times shorter than MSTP, saving over $3M.

These figures demonstrate that a significant cost savings can be realized by data centers that implement Shortest Path Bridging to configure their networks, as compared to legacy protocols, especially as the data center scales. In addition, fewer devices need to be configured manually, including mission-critical core switches, with an associated reduction in opportunities for configuration-related errors to be introduced into the network.

Figure 2: Resiliency of Data Center Switch Link Failure



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Name	loopback:01.0 2	loopback:01.0 4	loopback:02.0 2	loopback:02.0 4	loopback:03.0 2	loopback:03.0 4	loopback:04.0 2	loopback:04.0 4	loopback:07.0 1	loopback:07.0 2	loopback:07.0 3	loopback:07.0 4
2	Link State	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up	Link Up
3	Line Speed	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps	100 Mbps
4	Duplex Mode	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full	Full
5	Frames Sent	76,469	76,446	131,100	131,137	131,092	131,143	131,101	131,164	152,860	262,061	262,061	262,061
6	Frames Sent Rate	0	0	0	0	0	0	0	0	0	0	0	0
7	Valid Frames Received	77,588	77,236	131,763	131,783	131,754	131,774	131,788	131,804	152,670	262,061	262,052	262,093
8	Valid Frames Received Rate	23	12	10	8	10	8	7	8	0	0	0	0
9	User Defined Stat 1	76,366	76,420	130,910	131,022	130,910	131,021	130,910	131,021	152,659	262,046	262,037	262,042
10	**CVG Time**	0.046	0.007	0.050	0.004	0.050	0.004	0.050	0.004	0.091	0.040	0.041	0.046
11	Bytes Sent	9,785,536	9,784,064	16,776,384	16,778,752	16,775,872	16,779,136	16,776,448	16,780,480	19,566,080	33,543,808	33,543,808	33,543,808
12	Bytes Sent Rate	0	0	0	0	0	0	0	0	0	0	0	0
13	Bytes Received	9,856,720	9,834,830	16,811,559	16,820,307	16,811,189	16,819,692	16,813,497	16,821,793	19,541,587	33,543,433	33,541,696	33,544,640
14	Bytes Received Rate	1,861	758	638	510	636	509	454	507	0	0	0	0
15	Fragments	10	3	15	30	25	32	20	38	0	0	0	0
16	Undersize	0	0	0	0	0	0	0	0	0	0	0	0
17	Oversize	0	0	0	0	0	0	0	0	0	0	0	0
18	CRC Errors	1	0	1	2	3	1	3	4	0	0	0	0
19	Vlan Tagged Frames	0	0	0	0	0	0	0	0	0	0	0	0
20	Flow Control Frames	0	0	0	0	0	0	0	0	0	0	0	0
21	Alignment Errors	0	0	0	0	0	0	0	0	0	0	0	0
22	Dribble Errors	0	0	0	0	0	0	0	0	0	0	0	0
23	Collisions	0	0	0	0	0	0	0	0	0	0	0	0
24	Late Collisions	0	0	0	0	0	0	0	0	0	0	0	0
25	Collision Frames	0	0	0	0	0	0	0	0	0	0	0	0
26	Excessive Collision Fram	0	0	0	0	0	0	0	0	0	0	0	0
27	Oversize and CRC Error	0	0	0	0	0	0	0	0	0	0	0	0
28	User Defined Stat 2	0	0	0	0	0	0	0	0	0	0	0	0
29	Capture Trigger (UDS 3)	77,599	77,239	131,779	131,815	131,782	131,807	131,811	131,846	152,670	262,061	262,052	262,093
30	Capture Filter (UDS 4)	77,599	77,239	131,779	131,815	131,782	131,807	131,811	131,846	152,670	262,061	262,052	262,093
31	ProtocolServer Transmit	39	16	69	106	61	112	70	133	0	0	0	0
32	ProtocolServer Receive	201	191	304	307	309	303	328	330	0	4	5	0
33	Transmit Arp Reply	39	16	57	94	52	103	58	121	0	0	0	0
34	Transmit Arp Request	0	0	0	0	0	0	0	0	0	0	0	0
35	Transmit Ping Reply	0	0	0	0	0	0	0	0	0	0	0	0

*The row showing **CVG Time** shows that the data center switch exhibited sub-second convergence times for link failure when configured using Shortest Path Bridging.*

Source: Miercom, August 2011

Resiliency

To verify the resiliency of SPBM, tests were performed where a single link on the switch was failed over, as well as the entire switch. Ixia XM12 was used to generate the traffic flows, and monitors received traffic for any loss. We performed this test for a data center switch, a core switch and an access layer switch. As seen in *Figure 2*, we observed in each case only sub-second outages during failover events. This performance was equivalent to the failover performance observed for the network when configured using SMLT.

VMware VMotion

In order to verify the correct operation of VMware VMotion on a network configured using SPBM, a test was conducted where VMotion was configured and a migration from one video server host to another was performed. These types of migrations are executed by data center staff as needed and are usually made during a maintenance window.

Creation of the data center VLAN, in preparation for the migration, took 8 minutes 54 seconds. The video server host played a video file that was streamed to multiple clients. The clients were monitored for any disruptions to the video playback. We observed that the actual migration took 2 minutes 38 seconds to move from the first hosting server to the second. Therefore the total time to complete this process was 11 minutes 32 seconds. Migration from the second server host back to the initial one was observed to take 2 minutes 30 seconds. We noticed a slight glitch in the video playback to all clients at the conclusion of the migration process. Analysis revealed that a single ping was lost as the migration process concluded. This performance was similar to that seen when the network was configured using SMLT. However, configuring the VLAN in preparation for migration using SMLT requires touching every switch in the network, increasing the chance of errors being introduced during the process.

Bottom Line

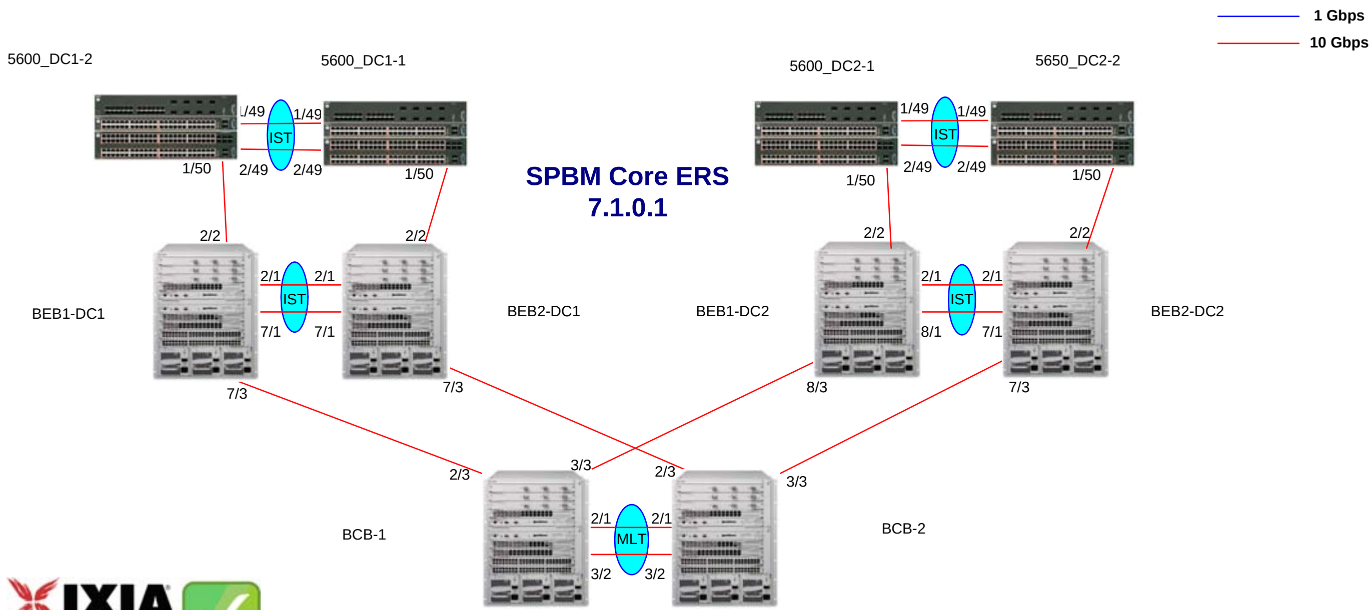
Shortest Path Bridging Mode (SPBM) was shown to provide a significant reduction in time and complexity required to perform VLAN creation. These savings advantages become significant as data centers scale in numbers of Top of Rack switches. SPB supports virtualization, and maintenance tasks such as migration of virtualized servers using VMware VMotion perform as well as with earlier protocols. SPB provides an additional advantage in that network configuration prior to a scheduled migration is simpler.

Table 1: Annual IT Hours to Configure VLANs across Two Data Centers

Protocol	Number of ToR Switches							
	50	100	200	400	800	1,600	3,200	10,000
SPB	191	286	415	581	784	1,020	1,275	1,546
SMLT	292	645	1,234	2,121	3,430	5,150	8,249	17,638
MSTP	770	2,037	4,232	7,564	12,628	19,293	31,805	70,891

Number of annual IT hours consumed for configuring VLANs across two data centers made up of the specified number of ToR switches. Shortest Path Bridging Mode protocol used fewer man hours than either the SMLT or MSTP protocol.

Test Bed Diagram



How We Did It

Our sample test environment represented two redundant data centers. Each data center consisted of the following devices:

Two Avaya 8600 top of rack switches with software version 7.1.0.1

Two ERS 8010 data center aggregation switches with software version 7.1.0.1

One ERS-8010 core switch with software version 7.1.0.1

One Access distribution switch ERS 8010 with software version 7.1.0.1

In addition, four edge switches provided services to end users:

Avaya 8310 with software v4.2.3.3

Avaya 2550T-PWR with software v4.4.0.010

Avaya 4526GTX-PWR with software v5.5.0.058

Avaya 5520-48T-PWR with software v.6.2.2.025

Video traffic for the VMotion migration testing was provided by a server playing an .avi video file using VLC media player. Four client laptops received the stream through the edge switches.

Resiliency testing was performed using an Ixia XM12 running IxOS 5.00.300.55 to generate traffic flows and monitor received traffic using IxExplorer.

The tests in this report are intended to be reproducible for customers who wish to recreate them with the appropriate test and measurement equipment. Current or prospective customers interested in repeating these results may contact reviews@miercom.com for details on the configurations applied to the system under test and test tools used in this evaluation. Miercom recommends customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a selection.

Miercom Tested

Based on our hands-on testing and observations, Shortest Path Bridging Mode protocol provides many advantages to a large data center implementation. Key findings included:

- Shortest Path Bridging shortens configuration time by up to 7 times over SMLT and up to 25 times over MSTP when implemented in a large data center
- SPB reduces complexity of service application implementation and number of devices affected, thereby reducing chances for configuration errors
- VMware VMotion migration performance using SPB is equivalent to that observed when using SMLT
- Data center resiliency of SPB delivers sub-second convergence times during failover/failback

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