



**Detailed Lab Testing Report
DR120119**

**SMB Managed Switch
Comparison
Cisco
D-Link
Hewlett-Packard**

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Miercom

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Contents

1.0 Executive Summary	3
2.0 Overview of Testing	4
2.1 Test Bed Diagram	6
2.2 Test Equipment used	6
3.0 Description of Switches.....	7
4.0 Performance Testing.....	10
4.1 Full Mesh Throughput	10
4.2 MAC Table Size	12
5.0 Resiliency and Security.....	13
5.1 Switch Management Responsiveness with Attacks	13
6.0 Ease-of-Use	15
6.1 Cisco (SF300, SG300, SG200 series).....	15
6.2 Hewlett-Packard (E2520, E2510, E2620, E2810, V1810G series)	16
6.3 D-Link (DES-3052, DES-3052P series).....	19
7.0 Key Features.....	21
8.0 Energy Efficiency	22
9.0 Scalability and Capacity.....	25
10.0 Cost of Ownership Normalized Pricing	26
10.1 Price per Gigabit Comparison	26
10.2 Cost of Switch per PoE Watt	27
11.0 Bottom Line.....	28
12.0 Applicability of These Test Results	30

1.0 Executive Summary

This report discusses the findings of a recent test of web-managed switch products for the SMB (Small and Medium Business) market space. It specifically compares and contrasts the features and performance of the Cisco SF300, SG300, and SG200 series of switches with similar products offered by HP and D-Link.

Overall, we were impressed with the comprehensive set of features, performance, overall power efficiency, and ease-of-use of the Cisco switches. Specifically, we found that Cisco delivered the highest capacity and scalability of configuration parameters including VLANs, MACs, ACLs, and IP routes. The Cisco switches provided the best resiliency when subjected to a DoS attack. Cisco switches can also be seen as more economical when measured using normalized pricing based on Price per gigabit and Price per PoE Watt. In addition, they were the most efficient both in terms of overall energy consumption, and the energy saving capabilities provided. The Cisco switches included in this test were the easiest to configure and implement, forwarded line rate full mesh traffic at all frame sizes with zero packet loss, and provided the most extensive support for IPv6 transitions.

The Cisco switches tested for this report provide the features, performance and support for products used in the SMB environment. Their power saving features, including support for Energy Efficient Ethernet, and the low overall power consumption puts these Cisco products as serious contenders for use in a SMB deployment.

This report sponsored by Cisco Systems, Inc., was produced with data obtained completely and independently as part of the Miercom Ethernet Switch Industry Assessment in which all vendors have equal opportunity to participate and contribute to the test methodology. All vendors involved in these tests were afforded opportunity to represent their products, and vendors still have opportunity to actively participate in the Industry Assessment and challenge any test findings by lab testing.

Bottom line, the Cisco series switches included in this report have demonstrated superiority in the SMB switch market for the areas selected in this analysis.

Rob Smithers

CEO, Miercom

2.0 Overview of Testing

This comparison of web-managed SMB switches from Cisco, Hewlett-Packard, and D-Link is organized in seven sections of analysis and testing including *Performance, Resiliency and Security, Ease of Use, Key Features, Energy Efficiency, Scalability and Capacity, and Cost of Ownership*. We examined products in the Cisco SF300, SG300, and SG200 model families, and compared them to products in the D-Link DES-3052, and HP E2510, E2620 family, E2810, and V-1810 families.

Performance (p 10)

The performance measured full mesh throughput at wire speed to determine the maximum throughput each switch could sustain without incurring frame loss. We also verified that each switch can build to their stated MAC address table size. The CPU utilization was observed and recorded while each switch was learning MAC addresses.

Resiliency and Security (p13)

Resiliency and security of the switches were evaluated using a series of attacks including DoS attacks. The overall switch functionality and switch management responsiveness was observed during these attacks. Each switch with built in security protection measures were tested with and without DoS protection enabled to measure their countermeasure effectiveness.

Ease of Use (p15)

Switch administration testing was conducted to determine the ease-of-use in performing routine tasks involving manual configuration of specific parameters while noting the level of support provided by the web interface versus traditional CLI. We compared the relative ease or difficulty on a switch-by-switch basis. Some of the features that were configured included ACLs (Access Control Lists), VLANs, and Static IP Routing.

Key Features (p21)

A comparison of key switch features considered important for the SMB market, including IPv6 transition support, was performed on each switch to determine the level of support provided.

Energy Efficiency (p22)

The overall energy consumption of the device was measured. Energy saving features were enabled for comparison to determine which device provided the greatest overall energy savings. For those switches that support energy saving features, we calculated the percentage of power saved compared to energy saving options turned off. Of the three vendors, only Cisco currently offers managed SMB switch products which support IEEE 802.3az EEE (Energy Efficient Ethernet); the HP and D-Link switches provided by Cisco for this evaluation did not have this feature. EEE is an innovative way of reducing the power consumption of network devices based on real-world traffic patterns, and end-user behaviors.

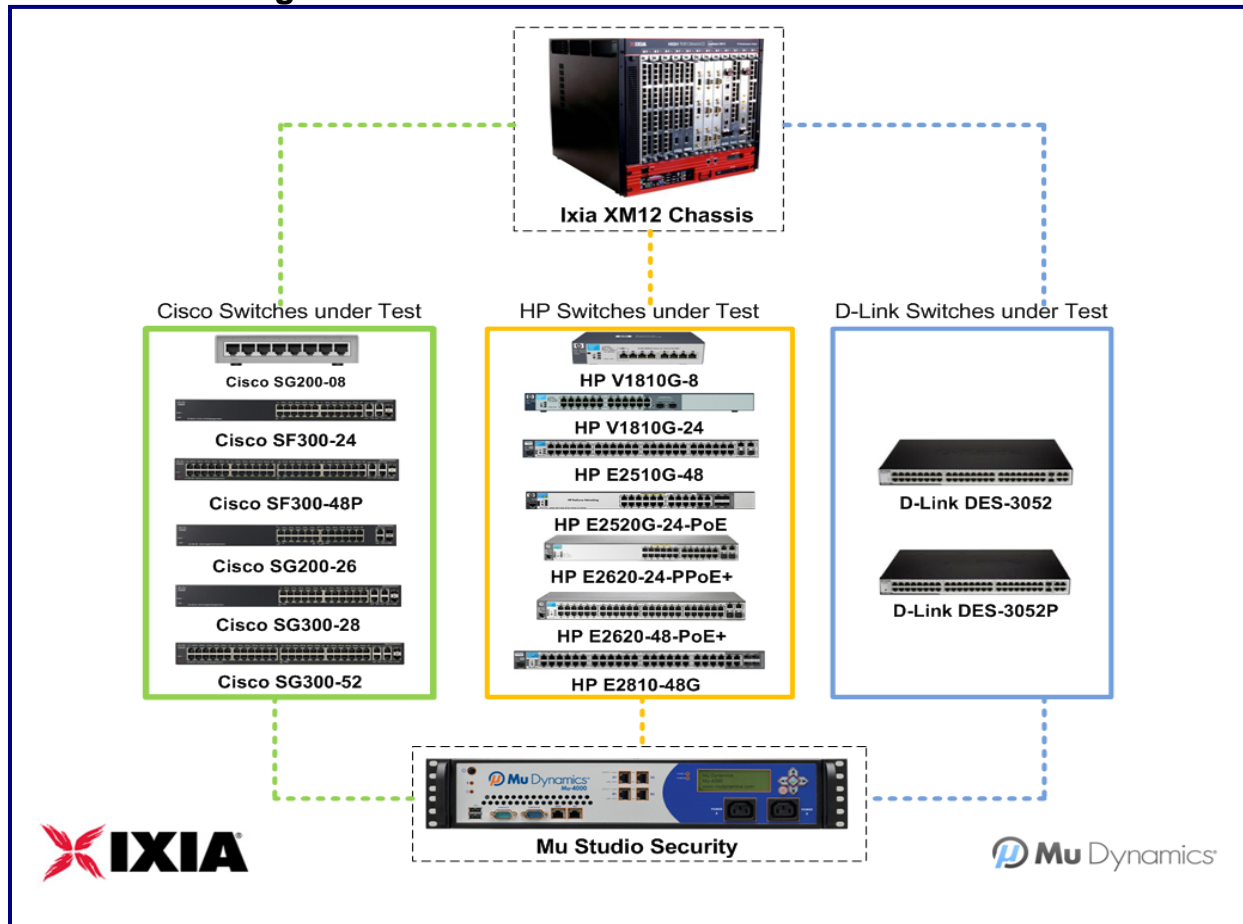
Scalability and Capacity (p25)

The capacity features from all three vendors was compared using published datasheets and a hands-on evaluation. These included the number of IP static routes, number of ACLs, number of VLANs, and the MAC address table size.

Cost of Ownership (p27)

To show why gigabit and PoE enhance the value of the switches, a comparison was made using list prices and applied to watts per gigabit throughput and per PoE watt.

2.1 Test Bed Diagram



2.2 Test Equipment used

Ixia (www.ixiacom.com) is an industry leader in energy efficiency testing of networking equipment. Ixia's unique approach utilizes coordination of energy measurements with network traffic load – allowing energy consumption to be graphed against network traffic volume. Real-world traffic is generated by Ixia's test platform and test applications, principally IxAutomate for layer 2-3 switching and routing traffic.

Mu Studio Security (www.mudynamics.com) provides a complete service assurance solution for determining the reliability, availability and security of IP-based applications and services. The Mu solution is highly automated, with lights-out fault isolation. Speeding the remediation of software flaws, Mu Studio Security provides actionable reports and complete data on any faults. Mu-based testing is managed via a variety of interfaces, including a highly visual Web-based graphical user interface. Testing can also be remotely controlled using REST- or XML-based APIs for integration into common laboratory automation frameworks such as HPQC or STAF.

3.0 Description of Switches

The switches discussed here are used in the SMB market. Each switch has different specifications and features. The switches had 8, 24, 26, 28, 48 or 52 ports with additional gigabit copper or fiber uplinks. Each switch had the latest firmware version installed.

Cisco (SF300, SG300, SG200 series)

The SG300 switches have a feature called Short Reach, which reduces the transmitter power needed for cable lengths of less than 10 meters, and link energy detect features for reduced power consumption when interfaces are not in use.

Additionally, the fanless SG300-28 reduces power usage and has low-noise factor, providing increased flexibility for office deployments.

The SG300 and SF300 models support both Layer 2 and Layer 3 switching.

The SF300 switch series contain link energy detect features but do not support Short Reach.

The SG200 switches only support Layer 2 switching. All SG200 switches are fanless.

Model #	Product Class	PoE	Firmware Version	Uplinks	Energy Save
SF300-24	10/100	No	1.1.2.0	2 10/100/1000 2 combo mini-GBIC slots	Yes
SF300-48P	10/100	Yes	1.1.2.0	2 10/100/1000 2 combo mini-GBIC slots	Yes
SG300-52	GbE	No	1.1.2.0	2 combo mini-GBIC slots	Yes
SG300-28	GbE	No	1.1.2.0	2 combo mini-GBIC slots	Yes
SG200-26	GbE	No	1.1.2.0	2 combo mini-GBIC slots	Yes
SG200-08	GbE	No	1.0.2.0*	N/A	Yes

*This was the latest firmware available for the 8-port device.

All Cisco switches featured in this test were equipped with a Web GUI for easy configuration and had built-in energy saving features.

Hewlett-Packard (V1810, E2520, E2510, E2620, E2810 series)

The HP E2620 switch series support Layer 3 routing. All other V-Series and E-Series switches from HP in this test support only Layer 2 switching with basic static IP routing.

The V-Series switches also have a power saving feature that powers off LEDs after a specified time for lower power consumption.

The E2810 switch has an optional redundant power supply, enabling maximum uptime in case a power supply fails.

Model #	Product Class	PoE	Firmware Version	Uplinks	Energy Saving capabilities
E2620-24-PPoE+	10/100	Yes	RA.15.06.0009	2 10/100/1000 Base-T 2 combo mini-GBIC	No
E2620-48-PoE+	10/100	Yes	RA.15.06.0009	2 10/100/1000 Base-T 2 combo mini-GBIC	No
E2520G-24-PoE	GbE	Yes	J.14.54	4 combo mini-GBIC slots	No
E2810-48G	GbE	No	N.11.52	4 combo mini-GBIC slots	No
E2510G-48	GbE	No	Y.11.16	4 combo mini-GBIC slots	No
V1810G-8	GbE	No	P.2.2	N/A	Yes
V1810G-24	GbE	No	P.2.2	2 combo mini-GBIC slots	Yes

The Hewlett-Packard switches in this test include Web GUIs for configuration.

E-Series switches require the GUI functionality to be enabled using the CLI before it can be accessed.

The V-Series switches have power saving features.

Hewlett-Packards older E2610 switches were also tested and found to be less capable and lower performing than the new E2620 switches discussed in this report.

D-Link (DES-3052, DES-3052P series)

The D-Link DES-3052 and DES-3052P switches are Layer 2 switches equipped with 10/100 Base-T ports and gigabit copper and fiber uplinks. The DES-3052 switch series does not support any advanced power saving features, however it does have a fanless design which allows less power usage, improved reliability and increased deployment flexibility.

Model #	Product Class	PoE	Firmware Version	Uplinks	Energy Saving capabilities
DES-3052	10/100	No	2.00.B27	2 10/100/1000 Base-T 2 Combo SFP	No
DES-3052P	10/100	Yes	2.00.B27	2 10/100/1000 Base-T 2 Combo SFP	No

The D-Link switches are equipped with 48 ports 10/100 copper, and two gigabit copper and two dual-personality gigabit uplinks. Web GUI is supported for administration. These switches do not have additional power saving features.

4.0 Performance Testing

Performance testing was conducted in accordance with RFC 2889 and consisted of loading each switch with traffic in a full mesh configuration. See the following section for details.

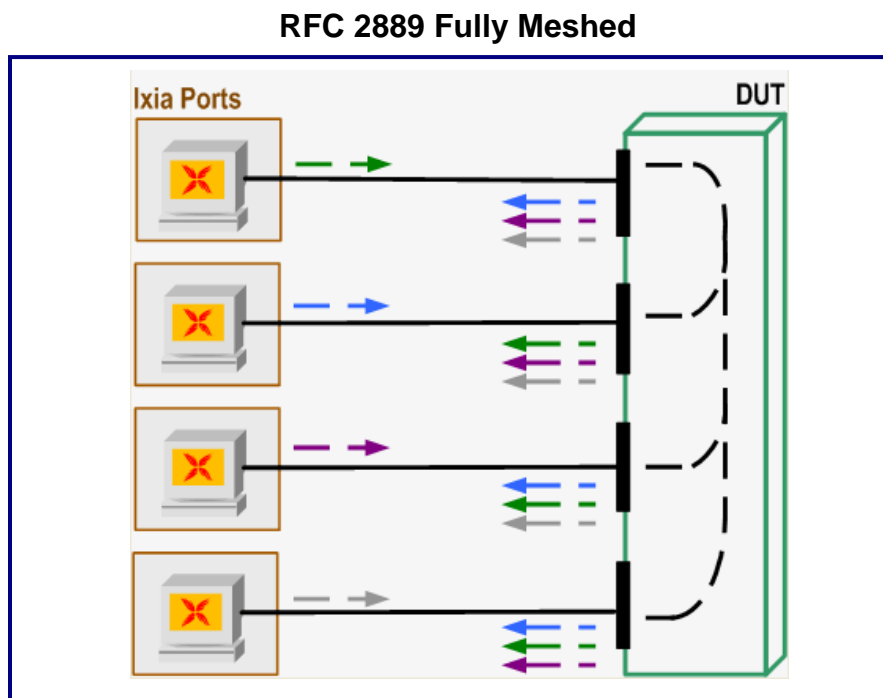
Testing was conducted for 64-byte, 512-byte, and 1518-byte frame sizes. Switch performance metrics recorded for this testing included the maximum throughput and observed frame loss. Performance and responsiveness of the Web GUI while the switch was under load was also monitored during the mesh throughput test.

A MAC hashing test was also performed to validate that each switch can achieve their maximum stated MAC table size. During the MAC learning process, the CPU utilization was monitored and recorded.

4.1 Full Mesh Throughput

The full mesh throughput test verifies cross processor throughput while recording frame loss. Each port on the traffic generator sends traffic to the DUT, while receiving traffic from other ports, as shown below.

The switches were grouped into similar categories to ensure that like switches were tested and compared fairly.



RFC 2889 fully meshed test showing traffic flow between load generator and Device Under Test.

Throughput and Frame Loss

Gig non-PoE			Throughput			% Frame Loss		
			64	512	1518	64	512	1518
Cisco	SG200-08	8-port Gig	46502	58740	60241	0	0	0
	SG200-26	26-port Gig	151134	190906	288425	0	0	0
	SG300-28	28-port Gig	162760	205592	210844	0	0	0
	SG300-52	52-port gig	302269	381813	391568	0	0	0
HP	V1810G-08	8-port gig	46501	58739	60240	.002	.002	.002
	V1810G-24	24-port Gig	139507	176220	180722	.001	.001	.001
	E2510G-48	48-port Gig	279017	352443	361446	0	0	0
	E2810-48G	48-port Gig	279013	352443	361446	.001	0	0
Gig PoE			Throughput			% Frame Loss		
			64	512	1518	64	512	1518
HP	E2520G-24	24-port Gig	139508	176221	180723	0	0	.001
10/100 non-PoE			Throughput			% Frame Loss		
			64	512	1518	64	512	1518
Cisco	SF300-24	24-port 10/100	37202	46992	48193	0	0	0
D-Link	DES-3052	48-port 10/100	51153	64614	66265	.001	.001	.001
10/100 PoE			Throughput			% Frame Loss		
			64	512	1518	64	512	1518
Cisco	SF300-48P	24-port 10/100	51153	64614	66265	0	0	0
D-Link	DES-3052P	48-port 10/100	51153	64614	66265	.001	.001	.001
HP	E2620-24	24-port 10/100	37202	46992	48193	0	0	0
	E2620-48	48-port 10/100	51153	64614	66265	0	0	0

Notes:

The Gig non-PoE Cisco switches did not exhibit any frame loss.

The HP switches in this same category had frame loss ranging from 0% to .002%.

The sole HP 2520G-24 in the gigabit PoE category had .001% frame loss while sending traffic using the 1518-byte frame size.

Cisco 10/100 non-PoE SF300-24 did not have frame loss, while the D-Link DES-3052 had .001% frame loss across all tested frame sizes.

The remaining switches in the 10/100 PoE category had no frame loss, except the D-Link DES-3052P which had .001% frame loss.

4.2 MAC Table Size

The ability of a switch to learn MAC addresses was verified by recording the maximum MAC table size learned. CPU usage while the switch was learning its maximum MAC table was recorded.

The table size was verified by sending random MAC addresses to the switch and viewing the table size in the GUI or CLI. CPU utilization was recorded while the switch was learning MAC addresses. Recording the CPU usage determines how efficient the switch processor is while learning their maximum MAC address table size.

The Cisco 300 series and HP E2620 switches were advertised to achieve 16,000 MAC addresses while the other switches claimed 8,000 MAC addresses. The switches were able to reach their stated MAC table size. The exception was for the HP E2520G-24, E2620-24-PPoE and E2620-48-PoE which achieved less than stated in the datasheet. Exact numbers can be found in the table below.

Both 200 and 300 Cisco series, approached an average of 14% CPU utilization.

The HP E-Series switches reached an average of 21% CPU usage while building the table. Hewlett-Packard V-Series switches could not display the CPU utilization.

The D-Link switches had an average CPU utilization of 11%.

The HP E-Series switches' MAC table size was verified by using the CLI, which is a longer process compared to viewing it in real-time on a GUI. This cumbersome task required more time. There was no option in the GUI to show or print out the MAC table or table size.

MAC Address Table Sizes and CPU Utilization

Configuration	Model	Datasheet Value	Observed Table Size	Learning CPU Usage
24-port 10/100	Cisco SF300-24	16,384	16,383	7%
	HP E2620-24	16,384	15,917	11%
48-port 10/100	Cisco SF300-48P	16,384	16,383	8%
	D-Link DES-3052P	8,192	8,156	9%
	D-Link DES-3052	8,192	8,156	13%
	HP E2620-48	16,384	15,931	38%
24/28-port gigabit	Cisco SG300-28	16,384	16,383	10%
	HP E2520G-24	8,192	7,980	21%
	HP V1810G-24	8,192	8,178	Not Supported
	Cisco SG200-26	8,192	8,192	15%
48/52-port gigabit	Cisco SG300-52	16,384	16,383	11%
	HP E2510G-48	8,192	8,190	30%
	HP E2810-48G	8,192	8,192	28%
8-port gigabit	Cisco SG200-08	8,192	8,190	35%
	HP V1810G-8	8,192	8,116	Not Supported

5.0 Resiliency and Security

5.1 Switch Management Responsiveness with Attacks

The Web GUI on the switch was tested for performance while being subjected to a DoS attack using the Mu-4000 Service Analyzer. This test demonstrates the effectiveness in mitigating attacks that are CPU intensive while maintaining manageability. If the GUI shows significant degradation or lack of responsiveness, it is an indication that other CPU-centric functions may be impacted as well. All switches in this review have DoS protection disabled by default. We tested first with the default settings, and again with security features enabled.

The Cisco SF300 and SG300 Series GUIs were unaffected, and CPU utilization remained about 15%, whether DoS protection was enabled or not.

The Cisco SG200-26 experienced high CPU utilization of up to 89%, and the GUI responses became lethargic.

The SG200-08 GUI became completely unavailable during the DoS attack. This behavior is a known issue, since the hardware for this model lacks support for CPU rate limiting. Therefore the switch is vulnerable to a DoS attack.

The HP E2620 series of switches remained fully operational during the DoS attack against the GUI. CPU utilization on the E2620-24-PPoE was 35% and 43% on the E2620-48-PoE.

The HP E2520G-24-PoE interface remained accessible during attacks, whether or not protective features were enabled. CPU utilization was below 28%.

The HP E2510 and E2810 models did not offer protective features, and both were inaccessible during attacks.

The two HP V-Series switches both became unavailable during the attack. Once the attack subsided, the web GUI was usable again.

Both D-Link switch models DES-3052 and DES-3052P offer DoS protection features, but they were ineffective in our testing. The management GUI became unresponsive during attacks, whether or not these features were enabled.

Full operation of the management interface was restored to the affected switches when the attacks subsided. It is unknown why the protection features did not block the attacks directed at the switch.

Switch Management and CPU usage

Vendor	Models	Operational State	GUI Access	CPU Utilization
Cisco	300 Series	Fully Operational	Fast	15%
	SG200-26	Fully Operational	Slow	89%
	SG200-08	Unknown	Inaccessible	
HP	E2620-24	Fully Operational	Fast	35%
	E2620-48	Fully Operational	Fast	43%
	E2520G	Fully Operational	Fast	28%
	E2510	Unknown	Inaccessible	
	E2810	Unknown	Inaccessible	
	V-Series	Unknown	Inaccessible	
D-Link	DES-3052/P	Unknown	Inaccessible	

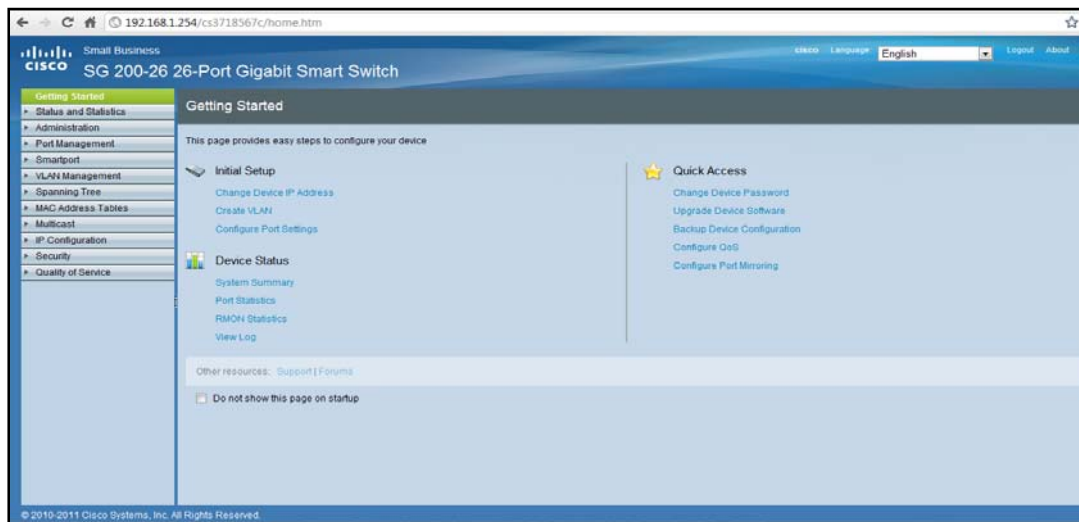
6.0 Ease-of-Use

All switches offered a Web GUI providing administration and monitoring features. Some switches offered more features and settings than others. The following section discusses the differences in Web interfaces. Details about individual vendor utilization of the GUIs are also included.

6.1 Cisco (SF300, SG300, SG200 series)

The Cisco family of switches had a neat and organized Web interface. The menu bar contained all the features needed in easily identified categories for configuration. The following screen shot shows the Getting Started screen that appears after login with the menu bar.

Cisco Getting Started Screen



Cisco Web GUI showing menu options for all configuration settings.

All Cisco switches shared the same interface design. There was one exception for one screen where the SG200-08 showed CPU utilization in numerical format for five seconds, one minute, and five minute averages. The other Cisco products provided instantaneous numerical readouts and included a graph.

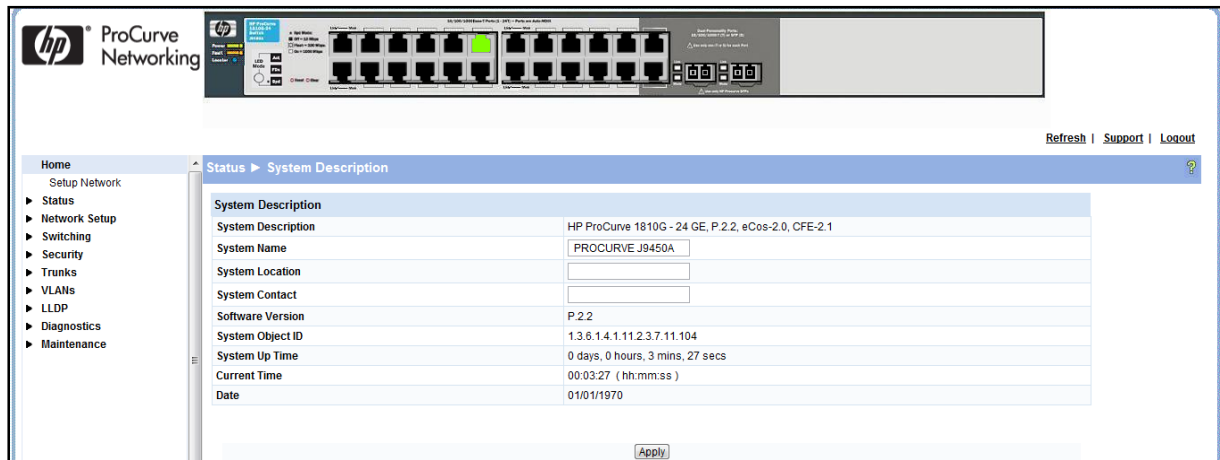
Different features and their configuration within the web interface were examined. The first was the ACL configuration through the GUI interface. This feature was easy to find and implement. The features on the GUI allow the user to set up rules, delete old rules, and set the priority level for the programmed rules of the switch. The Cisco switches were the easiest to configure and implement.

Creating a new VLAN in the Cisco Web interface was easy and intuitive. The menu bar provides an entire section for VLAN Management with options to create a VLAN, change the default settings, assign interfaces to different VLANs, and more. This interface was the easiest to use for configuring and assigning VLANs to the switch.

6.2 Hewlett-Packard (E2520, E2510, E2620, E2810, V1810G series)

The Hewlett-Packard switches came with three different Web interfaces. The V-Series switches, E2620 family switches and remaining E-Series switches each had their own type of web GUI. The V-Series and E2620 series switches had similar GUIs that were up-to-date, easy to use, and easy to navigate. The remaining E-Series switches had a completely different interface using a tabbed format. The E-Series did not provide as many menu options on the home screen as the V-Series and E2620 series switches. In order to configure functions on the E-Series, it was necessary to go to sub-menus and screens. A screenshot of the three interfaces can be seen below.

Hewlett-Packard V-Series Home Screen



V-Series home screen with system description and data input areas.

The V-Series GUI has visible options on the home screen and a status bar that shows the port status of the interfaces. The E-Series GUI menu options are hidden until the appropriate tabs are selected. The E-Series home page does not have a status of the ports like the V-Series and E2620 switch series provides. If the user wants to see the port status on the E-Series GUI, they must go to a status sub-menu.

Configuring VLANs on the V-Series switches was relatively easy. The GUI provides a VLAN category on a side menu bar. In the menu section, VLANs can be added, deleted, and edited.

Hewlett-Packard E2620 Series Status Screen

The screenshot displays the HP Networking GUI for an HP-E2620-48-PoEP switch. The interface is organized into several sections:

- Switch Status:** Shows system name (HP-E2620-48-PoEP), system location, system contact, system uptime (22 hours, 31 minutes, 16 seconds), system CPU utilization (3%), and system memory (134217728 Bytes).
- Unit Information:** Provides product name (HP E2620-48-PoEP Switch(39627A)), IP address (192.168.2.10), base MAC address (10 1f 74 aa b8 40), serial number (CN19DRW04), mgmt server (http://h117007.www1.hp.com/device_help), and version (RA.15.06.0009, ROM RA.15.10).
- VLANs(1 total):** A table showing the default VLAN configuration.

Name	Status	IP Address
DEFAULT_VLAN	Port-based	192.168.2.10
- Alert Log:** A table showing system alerts.

Date & Time	Status	Alert	Description
Mon Jan 1 00:22:34 1990	Warning	High Collision or% drop rate	High collision or drop rate on port 9
Mon Jan 1 00:00:21 1990	Info	First time installation	Important installation information for your switch
- Device View:** A port status graphic showing fan temperature (25°C), EPS (26), and port status indicators (49 ports shown).
- Details:** A table showing port statistics for port 1.

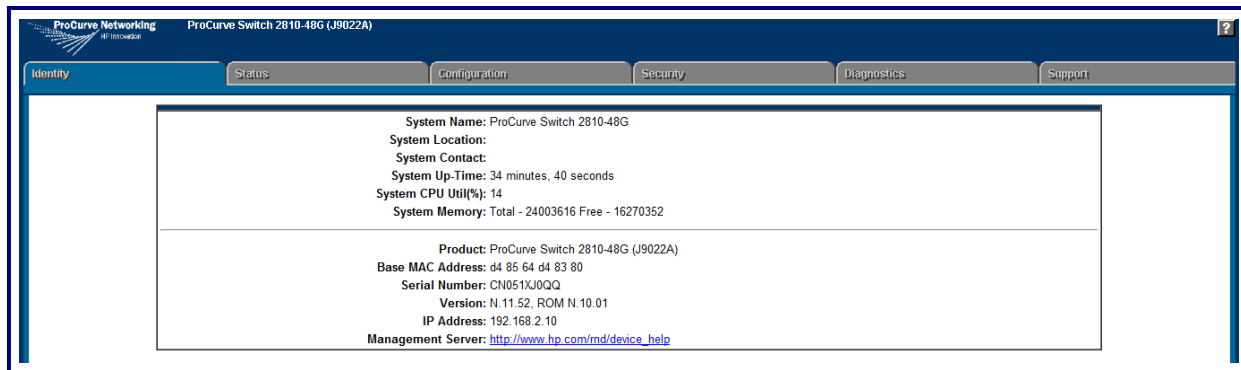
Port Name:	Totals:	Receive	Transmit
Enabled:	Down	4212264804152595814	Bytes :
Type:	10/100TX	Unicast :	2774878 11894887

HP E2620 Series Status screen showing CPU and memory usage, MAC address information and version numbers.

The E2620 series switches have a GUI that is similar to the V-Series GUI. Options such as VLAN management, spanning tree and multicast can be accessed and configured on the same screen without having to go into sub-menus. The GUI has a port status graphic under the status section, allowing administrators to easily identify which ports are active. The collapsible sections on any given page is a unique feature that allows users to hide or unhide certain sections.

ACL configurations could not be made within the GUI on the two E2620 series switches and could only be made within the CLI. The MAC address table is only viewable in the CLI.

Hewlett-Packard E-Series Identity Screen



HP E-Series Identity screen showing CPU and memory usage, MAC address information and version numbers.

Not all of the Hewlett-Packard models tested support ACL configurations. ACL configurations are not available in the GUI and can only be accessed through the CLI.

Configuring VLANs on the E-Series requires the user to select configuration tabs. By selecting the VLAN configuration option, a user can add or remove VLANs from that screen.

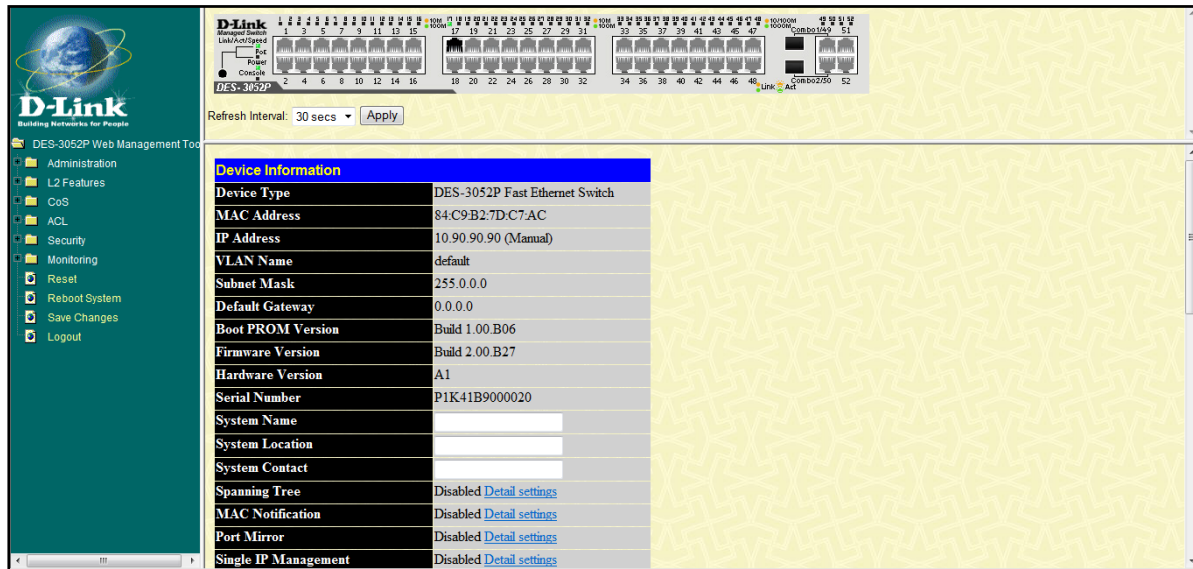
Overall the Hewlett-Packard V-Series and E2620 series switches were much easier to configure than the E-Series switches. The V-Series switches have an intuitive GUI making it easier for configuring. The E-Series switches have a moderately easy GUI, but many features are nested within sub-menus.

6.3 D-Link (DES-3052, DES-3052P series)

Unlike the other vendors, the D-Link GUI was only accessible using Internet Explorer and Firefox. The side menu bar did not load properly when using the Chrome Web browser. Load time for the web interface was slower than the other vendors in this test.

The port status image was a useful tool for quickly identifying which ports were. This helps an administrator quickly identify which ports on the switch are available instead of physically going to the switch and checking the ports.

D-Link Home Screen



Home screen with port status, IP address, MAC address and version numbers.

When trying to configure ACLs on the switch, it was easy to find the option in the GUI interface. On the menu bar, there is an entire ACL category that allows the user to program the individual ACL rules and to delete rules that are no longer needed.

After making configuration changes on the switch, it was easy to save the configuration from an option on the side panel. We liked that the reset, reboot system and logout options were located at the root for easy access.

As with the other vendors, we configured VLAN options. VLANs were fairly easy to configure on the D-Link switches once the section was discovered under the L2 features section.

6.4 Ease-of-Use Summary

All switches in this report came with Web interfaces that are accessible from a Web browser for configuration. Some of the biggest differences between the vendors came into play when dealing with the actual ease-of-use. The Cisco switches, overall, were the easiest interface to use, being up-to-date, fast and intuitive. At no point during the configuration process did we have to hunt for an option that we needed. Section headings were logically written and made it easy to locate specific features while configuring the switch.

Ease-of-use Summary Table

	Cisco	HP	D-Link
GUI ease-of-use	5	3	3
ACLs	GUI and CLI	CLI	GUI and CLI
Responsiveness	5	4	3
MAC Table View	GUI and CLI	V-Series - GUI and CLI E-Series - CLI	GUI and CLI
Browser*	IE, FF, Chrome	IE, FF, Chrome	IE, FF

Ease-of-use was scored on a 1 to 5 scale, with 1 difficult and 5 the easiest. GUI responsiveness was scored on a scale of 1 to 5, with 1 the slowest and 5 the fastest.

**IE: Internet Explorer, FF: Firefox.*

While performing the configurations, we logged into the GUI to look up statistics on the switch, such as how many MAC address were currently stored in the table and what the CPU usage was while performing the test.

The D-Link and the Cisco switches all offered the capability to see the number of MAC addresses in the address table, and to see which port they were assigned. The HP switches only offered this capability on the V-Series.

When dealing with the E-Series HP switches, we had to use the CLI interface to print a list of MAC addresses through the command line and have it output to a log file. This proved to be very cumbersome when trying to compile a list of MAC addresses and compare it to the advertised table size on the data sheet. Overall, the switches provided a good amount of status updates and logs directly accessible from the GUI.

7.0 Key Features

This switch review also looked at the features and functionalities of each switch. Datasheets were used to compile this information and summarized below.

Switch Features

Features	Cisco		HP		D-Link	
	200 Series	300 Series	E-Series	V-Series	DES-3052	DES-3052P
IGMPv3	No	Yes	Yes	No	No	No
Ingress Rate Limiting	Yes	Yes	E2620	No	Yes	Yes
Egress Shaping	No	Yes	No	No	Yes	Yes
VLAN Mirroring	Yes	Yes	No	No	No	No
MAC Multicast	No	Yes	No	No	No	No
MAC VLANs	No	Yes	Yes	No	No	No
IPv6	Yes	Yes	E2520G E2620	No	No	No
IPv6 ACL	No	Yes	No	No	No	No
IPv6 to IPv4	Yes	Yes	E2620	No	No	No
MLD Snooping	Yes	Yes	E2620	No	Yes	Yes
Granular ACLs	No	Yes	E2620	No	Yes	Yes
DoS Protection	No	Yes	E2520G	Yes	Yes	Yes

The Cisco switches supported a variety of features, including IGMPv3, ingress rate limiting, egress shaping, VLAN mirroring, MAC multicast, MAC VLANs, MLD snooping, DoS protection and IPv6 support. IPv6 support included the ability to network IPv6 over IPv4 with Intra-Site Automatic Tunnel Addressing Protocol (ISATAP). Having all of these features and functionalities available on SMB switches helps administrators manage, troubleshoot and secure their networks without having to purchase additional equipment. They are also future proofed by virtue of their IPv6 support.

The HP and D-Link switches both supported DoS protection, which mitigates security attacks that would prevent the switch from functioning. However they did not all support IPv6 in their current firmware version. If a company needs to migrate to IPv6 they would either have to wait for a new firmware version or purchase new equipment.

8.0 Energy Efficiency

All 15 of the switches were measured for power usage under full load. Those switches which had green or energy saving features were tested with and without the green features enabled. This section shows power usage and then compares it with usage when green features were enabled.

Power with Energy Saving Features

Configuration	Model	Power Usage			
		Without Energy Savings	With Energy Savings	EEE	Lowest Used
24-port 10/100	Cisco SF300-24	15.3	15.3	n/a	√
	HP E2620-24-PPoE	27.4	N/A	n/a	
48-port 10/100	Cisco SF300-48P	45.3	45.3	n/a	
	HP E2620-48-PoE	43.7	N/A	n/a	
	D-Link DES-3052	20.3	N/A	n/a	√*
	D-Link DES-3052P	55.2	N/A	n/a	
24/28-port Gigabit	Cisco SG200-26	19.3	18.6	17.2	√
	Cisco SG300-28	20.7	20	18.7	
	HP V1810G-24	21.8	20.6	n/a	
	HP E2520G-24-PoE	35.8	N/A	n/a	
48/52-port Gigabit	Cisco SG300-52	44.8	43.3	41.1	√
	HP E2510G-48	102.4	N/A	n/a	
	HP E2810-48G	103.6	N/A	n/a	
8-port Gigabit	Cisco SG200-08	7.4	7.1	n/a	√
	HP V1810G-8	7.9	7.3	n/a	

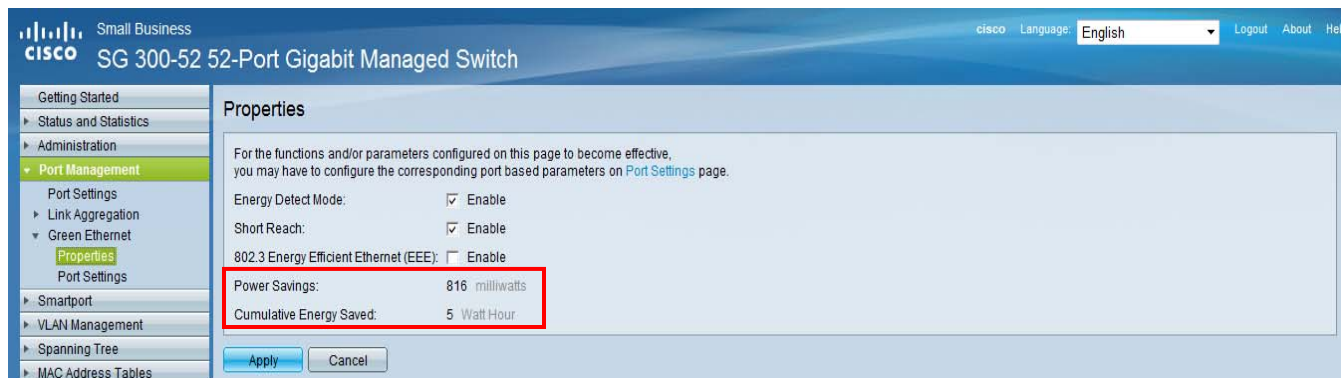
Power used with and without power saving features enabled. Watts were recorded while loading the switch with full mesh throughput traffic at a 512-byte frame size. Power saved ranged from 0 to 1.5 watts. The HP E series switches and two D-Link switches did not support any energy saving features.

** The D-Link DES-3052 was the only switch in this category which is fanless and a non-PoE design.*

Not all switches have energy saving features. All Cisco switches tested have energy saving features that could be toggled on or off.

The Cisco switches included several different features. The first is their Short Reach feature that saves power when the cables being used on the switch are shorter than 10 meters. Our testing was conducted using cable lengths of 4.26 meters that allowed us to utilize the Short Reach feature. This saves power by allowing the switch to reduce the amount of power required when the cable is less than 10 meters, since longer cables require more power to transmit the data.

Power Saving Calculation



The screenshot shows the Cisco Small Business web interface for an SG 300-52 52-Port Gigabit Managed Switch. The left sidebar shows the navigation menu with 'Port Management' expanded to 'Properties'. The main content area is titled 'Properties' and contains the following information:

- Energy Detect Mode: Enable
- Short Reach: Enable
- 802.3 Energy Efficient Ethernet (EEE): Enable
- Power Savings: 816 milliwatts
- Cumulative Energy Saved: 5 Watt Hour

The 'Power Savings' and 'Cumulative Energy Saved' fields are highlighted with a red box. Below the properties are 'Apply' and 'Cancel' buttons.

The Cisco switches support a feature that calculates power savings and cumulative energy savings. This feature is not functional while EEE is enabled.

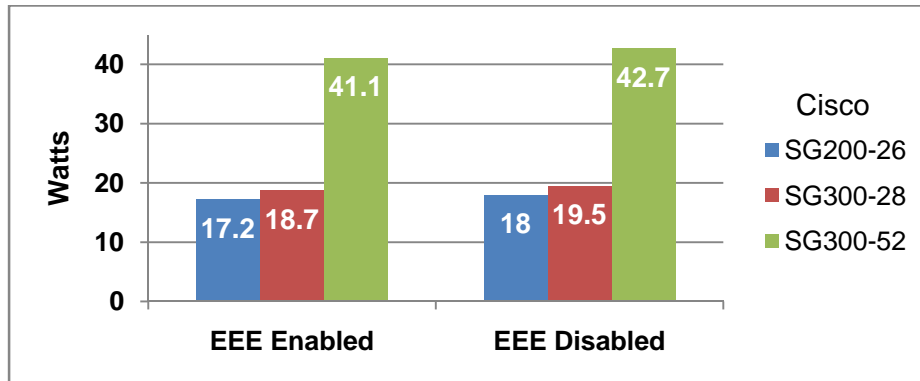
Another Cisco feature is IEEE 802.3az Energy Efficient Ethernet which cuts transmitter power to any interface when the port is either idle or when there is bursty traffic. The HP and D-Link switches evaluated in this comparison do not support this feature.

In order to test the EEE power saving functionality, the first and last ports on the switch were connected to the Ixia XM12 traffic generator, while all the rest of the ports were connected in a snake fashion. For example, ports 2 and 3 are configured on the same VLAN, while port 3 is externally connected to port 4 with a crossover cable. This allows all of the ports on the switch to see the same burst of traffic entering on the first port and exiting on the last port. This configuration was in accordance with a whitepaper released by Cisco and Intel in 2011.

The Ixia traffic generator was configured to simulate laptop/desktop users, which EEE is optimized for. The data pattern consisted of bursty traffic with a low link utilization of 10%. Each burst of traffic consisted of 100,000 64-byte packets, with an inter-packet gap of 100 milliseconds and the bursts occurring every 100 milliseconds.

The Cisco SG200-26, SG300-28 and SG300-52 supported the EEE feature and were tested to compare power consumption with and without EEE enabled. We found the SG200-26 to save 4.5% power with EEE enabled, the SG300-28 saved 4.10% and the SG300-52 saved 4%.

EEE Power Consumption



Comparison of the Cisco EEE-capable switches showing the reduction in power when EEE is enabled.

HP switches support power saving features that allow LEDs on ports to be turned off after a certain time period. This feature allowed the HP switches to save up to 1.2 watts compared to the energy used when this feature was disabled.

While the D-Link switches in this study did not have any power saving features, the DES-3052 model has a fanless design that reduces the amount of power required to run the switch. There are other models of D-Link switches available which do support power savings options.

9.0 Scalability and Capacity

The capacity of the switches was compared by focusing on the number of IP static routes, ACLs, configurable VLANs, as well as maximum MAC table size. The capacities varied by switch and vendor.

MAC tables, ACLs and VLANs are supported by Layer 2 switches, while IP routes are only supported on Layer 3 switches.

Switch Capacity

Configuration	Model	Layer 2		Layer 3	
		MAC Table Size	VLANs	ACL Rules	IP Routes
24-port 10/100	Cisco SF300-24	16,000	4,000	512	32
	HP E2620-24	16,000	512	2048	256
48-port 10/100	Cisco SF300-48P	16,000	4,000	512	32
	HP E2620-48	16,000	512	2048	256
	D-Link DES-3052	8,000	200	256	NA
	D-Link DES-3052P	8,000	200	256	NA
24/28-port gigabit	Cisco SG200-26	8,000	256	NA	NA
	Cisco SG300-28	16,000	4,000	512	32
	HP V1810G-24	8,000	64	NA	NA
	HP E2520G-24	8,000	256	NA	NA
48/52-port gigabit	Cisco SG300-52	16,000	4,000	512	32
	HP E2510G-48	8,000	64	NA	NA
	HP E2810-48G	8,000	256	96	NA
8-port gigabit	Cisco SG200-08	8,000	128	NA	NA
	HP V1810G-8	8,000	64	NA	NA

The MAC table size ranged from 8,000 to 16,000, ACL rules ranged from 96 to 512, VLANs ranged from 64 to 4,000, and IP routes ranged from 16 to 32 across all switches.

The HP E2510, E2520 and V-Series switches do not support IP routes because they are not required on Layer 2 switches. The lack of ACL support indicates that they fall into the category of smart switches (managed switches with limited features), rather than fully managed switches.

10.0 Cost of Ownership Normalized Pricing

Price per Gigabit was calculated by taking the throughput and dividing it by the list price of the switch.

The switches were grouped in similar categories for comparison. The chart below shows the 15 switches with their price per gigabit easier.

10.1 Price per Gigabit Comparison

Gig non-PoE		Ports	Price per gigabit
Cisco	SG200-08	8	\$1.96
	SG200-26	26	\$0.64
	SG300-28	28	\$3.06
	SG300-52	52	\$3.10
HP	V1810G-08	8	\$3.04
	V1810G-24	24	\$1.90
	E2510G-48	48	\$4.55
	E2810-48G	48	\$3.41
Gig PoE		Ports	Price per gigabit
HP	E2520G-24-PoE	24	\$9.10
10/100 non-PoE		Ports	Price per gigabit
Cisco	SF300-24	24	\$4.98
D-Link	DES-3052	48	\$9.50
10/100 PoE		Ports	Price per gigabit
Cisco	SF300-48P	24	\$16.88
D-Link	DES-3052P	48	\$18.10
HP	E2620-24-PPoE	24	\$15.35
	E2620-48-PoE	48	\$34.70

Cost of switch per gigabit ranged from \$.64 to \$34.70. Using only the price per gigabit, Cisco had the lowest value.

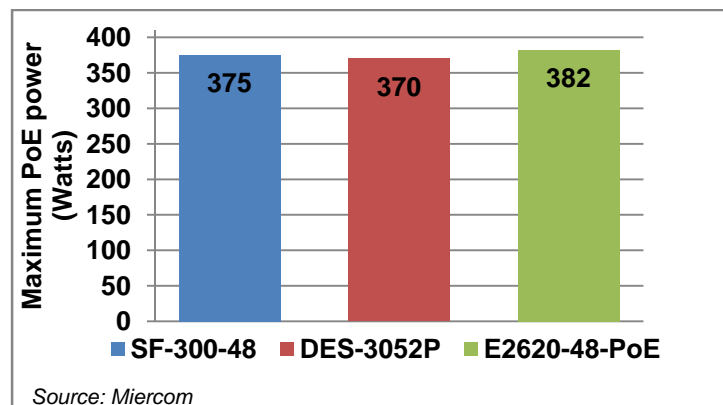
10.2 Cost of Switch per PoE Watt

Cost of Ownership with Normalized Pricing

Cost of Switch per PoE Watt was calculated using the PoE watt from data sheet information and published market prices. To obtain a numerical value, we divided the switch cost by the PoE budget (number of watts allocated for PoE usage). A switch's value increases when more PoE power can be utilized.

The switches with 48 and 52 ports were selected to be compared against each other. We did not include the 24 port switches in the comparison because they do not output as many watts to their PoE ports as the 48- and 52-port switches.

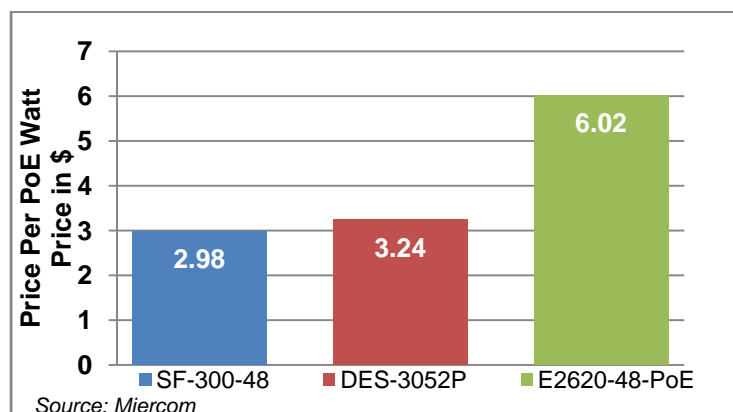
Maximum PoE Power



Maximum PoE power provided by each switch across all ports.

Using switch vendor data sheets, we obtained the published maximum watts a switch can provide for PoE. This was used to calculate the switch cost per PoE watts. This cost price does not reflect any power consumption costs.

Price per PoE Watt



Cisco has the lowest switch price at \$2.98 per PoE watt.

11.0 Bottom Line

There was some interesting data collected during this review. Overall, the Cisco switches had better or equal performance than the other switches. When focusing on MAC learning, the Cisco 300 Series switch firmware doubled the MAC address table size to 16,000 while keeping the CPU usage under 11%. The HP E2620 switch series were also advertised to achieve 16,000 MAC addresses, but in our testing they achieved up to 15,931 with CPU usage at 25%.

Switch Summary

Capacity	Cisco		HP		D-Link	
	200 Series	300 Series	V-Series	E-Series	DES-3052	DES-3052P
MAC Table Size	8K	16K	8K	E-Series: 8K E2620: 16k	8K	8K
VLANs	256	4K	64	E-Series: 256 E2620: 512	200	200
ACLs	N/A	512	N/A	E-Series: 254 E2620: 2048	256	256
IP Routes	N/A	32	N/A	E-Series: 16 E2620: 256	N/A	N/A
IPv6 Transition Support	Yes	Yes	No	Yes	No	No
Energy						
Energy Saving Capability	Yes	Yes	Yes	No	No	No
EEE	Yes	Yes	No	No	No	No
Power Consumption	Low	Low	Moderate	High	Moderate	Moderate
User Interface						
GUI Consistency	Yes	Yes	Yes	No	Yes	Yes
Ease-of-use	High	High	High	Medium	Medium	Medium
Browser Compatibility	IE,FF,C	IE,FF,C	IE,FF,C	IE,FF,C	IE,FF	IE,FF

*Summary results of all switches tested in the review.
IE: Internet Explorer, FF: Firefox, C: Chrome.*

Cisco has an up-to-date GUI making it easy to navigate and configure required parameters. The Cisco interface was able to load on multiple browsers, was extremely responsive with load times, and was very intuitive, requiring almost no idle time while looking for options.

The D-Link switches had the most outdated interface of the three vendors. The D-Link interface did not display properly when using the Chrome browser, had a very slow load time, and was generally not as intuitive as the Cisco interface.

The HP switch web interface did not have a consistent functionality either within the E-Series or V-Series switches. The E-series switches also could not display MAC tables within the GUI. That function required accessing the command line interface.

Cisco SMB gigabit and 10/100 switches had no frame loss when sending full mesh throughput traffic. All other switches tested in this report had minimal frame loss ranging between 0% and 0.002%.

More features and functions were supported by Cisco compared to the other vendors. Having these extra features built in reduces the need to purchase other equipment and it proves they are future proofed with their IPv6 support.

Additionally, the Cisco switches had the lowest switch cost per gigabit compared to all other competitive switches tested. Hewlett-Packard had the highest switch cost per gigabit at \$34.70. The two D-Link switches were middle range at \$9.50 and \$18.10.

Finally, the Cisco switches had energy/power saving options available on all the models included in this report, which contributed to lower overall energy consumption. The Cisco switches were able to save power using the Short Reach cable option, as well as with EEE support. The D-Link switches did not include any features that would save power or reduce watts used. However their switch does operate without fans, reducing the amount of power required to run the switch. The Hewlett-Packard switches provided power saving options on the V-Series switches, but not on the E-Series switches.

The Cisco products were generally better overall than the other switches discussed here. They provided a user-friendly and intuitive interface, and included power save options to reduce energy costs while the switches were operational. This combination of feature-rich design and high performance makes them a good value for SMB customers.

12.0 Applicability of These Test Results

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 Device Under Test and test tools used in this evaluation. Miercom recommends that customers conduct their own needs analysis review with us or any other proven network consultancy and test specifically for the expected environment for deploying new equipment.

This report was sponsored by Cisco Systems, Inc., and the data within obtained completely and independently as part of the Miercom Ethernet Switch Industry Assessment in which all vendors have equal opportunity to participate and contribute to the test methodology. All vendors involved in these tests were afforded opportunity to represent their products, and still have an opportunity to actively participate in the Industry Assessment and challenge any findings.