Lab Testing Summary Report

February 2015

Report 141222

Product Category:

Power Efficient Switches

Vendor Tested:

CISCO

Products Tested:

Catalyst 2960 CX and Catalyst 3560 CX Switch Series

Key findings and conclusions:

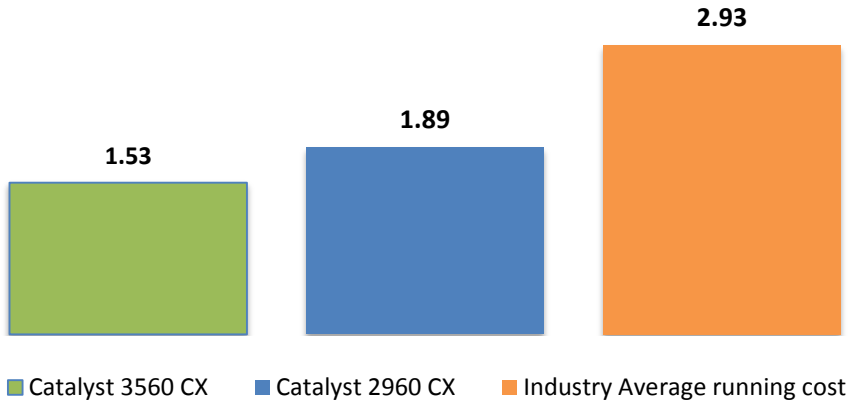
- **Tests found that the Cisco Catalyst 2960 CX Series consumes up to 35 percent less power than the Industry Average for functionally equivalent switches**
- **Compared to the Industry Average, the Catalyst 3560 CX Series can reduce annual energy costs up to 48 percent**
- **The Catalyst 2960 CX Series is 32.6 percent more energy efficient, and the Catalyst 3560 CX is 47.9 more energy efficient, than the Industry Average devices**
- **The Cisco switches operate over a broad temperature range – 23 to 121º F (-5 to 49.4º C) – requiring less cooling; additionally, with fanless technology, the switches consume less energy and generate less noise.**

Cisco Catalyst 2960 CX and Catalyst 3560 CX Series switches were evaluated under the Miercom **Certified Green** program for power consumption and energy efficiency. Miercom engineers assessed the switches' overall environmental impact and business-positive green benefits they offer.

Testing was performed on the Cisco Catalyst 2960 CX with ten 1GE copper and two 1GE SFP ports on the switch. The Catalyst 3560 CX switch was configured with fourteen 1GE copper and two 1GE SFP ports for the testing. The 2960 CX switches feature eight downlink and four uplink ports. The 3560 CX Series features twelve downlink and four uplinks ports.

Cisco Catalyst 2960 CX and Catalyst 3560 CX Series are compact switches that also support advanced security and numerous services – including voice and video settings, for remote endpoints. The "fanless" design of these switches makes them especially environmentally

Figure 1: Cisco C2960 CX and C3560 CX Switch Series Relative Annual Cost Comparison (USD $)



Source: Miercom, February 2015

The annual electrical-consumption cost for the Cisco C2960 CX switch was calculated to be $1.89 for 12 ports, compared to the Industry Average of $2.93. This represents a 36-percent savings for C2960 CX compact switches. The C3560 CX delivers a 48 percent cost savings.

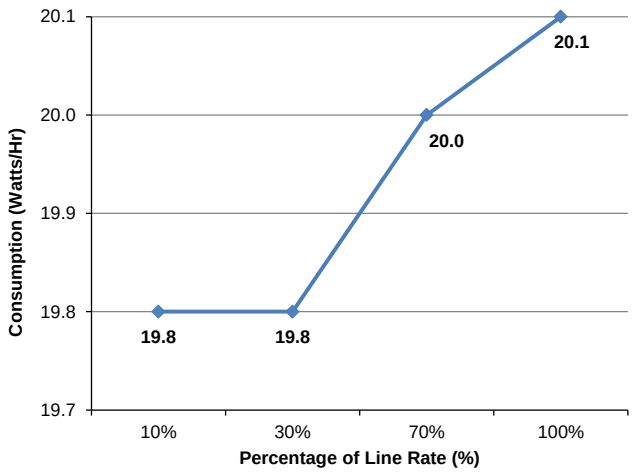
friendly, as well as noise-free.

Some models of Catalyst 3560 CX Series also support PoE+, which can save considerably on wiring costs and reduces cable clutter. The Catalyst 3560 CX Series supports Layer 3 routing, Cisco TrustSec (for controlling access to corporate data via access control policies), and Media Access Control security (MACsec).

Power Consumption

Power consumption of the Cisco Catalyst 2960 CX and Catalyst 3560 CX Series switches was measured with traffic applied on all ports with various percentage loads and frame sizes.

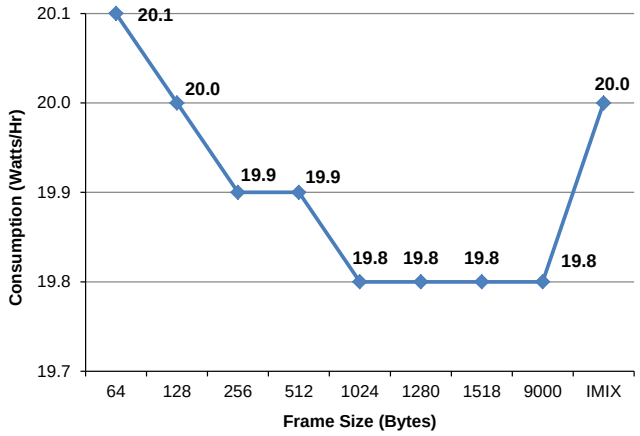
Figure 3: Cisco C2960 CX Power Consumption 64-byte Frame Size - Varied Load Levels



Source: Miercom, February 2015

There was only 0.3 Watts/Hr difference in power consumption between 10-percent and 100-percent traffic loads with the Cisco Catalyst C2960 CX.

Figure 2: Cisco C2960 CX Power Consumption Watts/Hr at 100% Line Rate



Source: Miercom, February 2015

Power-consumption measurements underscore the C2960 CX switch's consistency in power usage. As normal, slightly less Watts/Hr is consumed as frame size increases.

Energy usage was recorded while the switch was booting, while idle with no link, idle with link, and with 10-, 30-, 70- and 100-percent traffic loads. Power consumption was recorded while delivering 64-, 128-, 256-, 512-, 1024-, 1280-, 1518-, and 9000-byte (jumbo) frames, and IMIX traffic (with varied packet sizes in 'real-world' proportional mixes). Tests were repeated to ensure accurate results. Power consumption is shown in *Tables 1 and 2* and in *Figures 3, 4* and *5.*

Cisco Catalyst 2960 CX and Catalyst 3560 CX support Energy Efficient Ethernet (EEE), a green feature that reduces power consumption during low link utilization. EEE reduces overall power when an EEE-supported device is connected to the switch.

Table 1: Power Consumption in Watts of the Cisco Catalyst 2960 CX Switch at Different Frame Sizes

	Frame Size (Bytes)								
Layer: L2/L3	**64**	**128**	**256**	**512**	**1024**	**1280**	**1518**	**9000**	**IMIX**
Initial Booting	12.5								
Idle with No Link	16.1								
Idle with Link	19.6								
10% Line Rate	19.8	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7
30% Line Rate	19.8	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7
70% Line Rate	20.0	19.9	19.8	19.8	19.8	19.8	19.8	19.8	19.8
100% Line Rate	20.1	20.0	19.9	19.9	19.8	19.8	19.8	19.8	20.0

Table 2: Power Consumption in Watts/Hr of Cisco Catalyst 3560 CX Switch at Different Frame Sizes

	Frame Size (Bytes)								
Layer: L2/L3	**64**	**128**	**256**	**512**	**1024**	**1280**	**1518**	**9000**	**IMIX**
Initial Booting	12.8								
Idle with No Link	16.5								
Idle with Link	21.2								
10% Line Rate	21.2	21.2	21.2	21.2	21.2	21.2	21.3	21.3	21.3
30% Line Rate	21.2	21.2	21.3	21.3	21.3	21.3	21.3	21.4	21.4
70% Line Rate	21.5	21.4	21.5	21.4	21.4	21.4	21.4	21.5	21.6
100% Line Rate	21.7	21.6	21.6	21.5	21.5	21.5	21.5	21.6	21.7

All 10 copper ports on the Catalyst 2960 CX and all 14 copper ports on the Catalyst 3560 CX support EEE and decrease power to a specific port during times of little or no network activity.

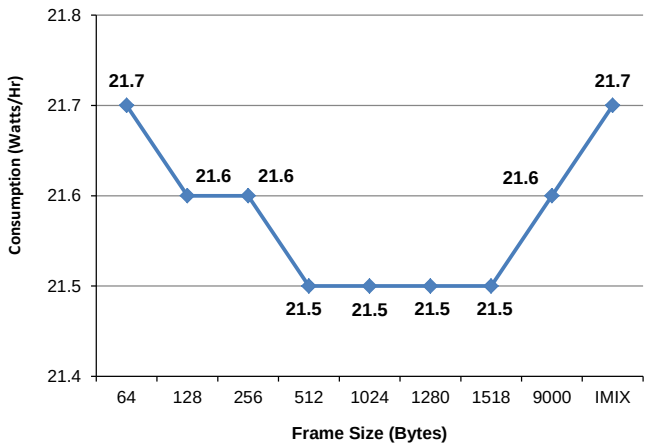
We tested EEE in both switch models by connecting them to another EEE-configured switch. We observed 15 percent power savings in the Catalyst 2960 CX and 18 percent power savings in the Catalyst 3560 CX when the switches were linked but idle. See *Figure 6* on *page 4.*

Power Performance

Power-consumption characteristics of the Cisco Catalyst 2960 CX and 3560 CX switches were compared to the Industry Average (IA) using Watts/Gbps at 100 percent load for Layer 2 and Layer 3 processing of 64-byte frames. We observed that both switch series consume virtually the same amount of power whether performing Layer-2 switching or Layer-3 routing.

The Cisco Catalyst 2960 CX and 3560 CX consumed 1.76 and 1.36 Watts/Gbps, respectively, compared to the Industry Average of 2.5 Watts/Gbps.

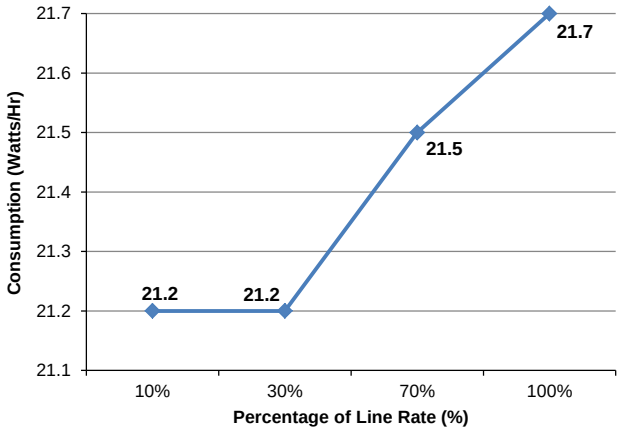
Figure 5: Cisco C3560 CX Power Consumption Watts/Hr at 100% Line Rate



Source: Miercom, February 2015

Power consumption performance proves the switch consistency in power usage. Switch consumed less Watt/Hr with the increase of frame size as expected.

Figure 4: Cisco C3560 CX Power Consumption 64-byte Frame Size - Varied Line Rates

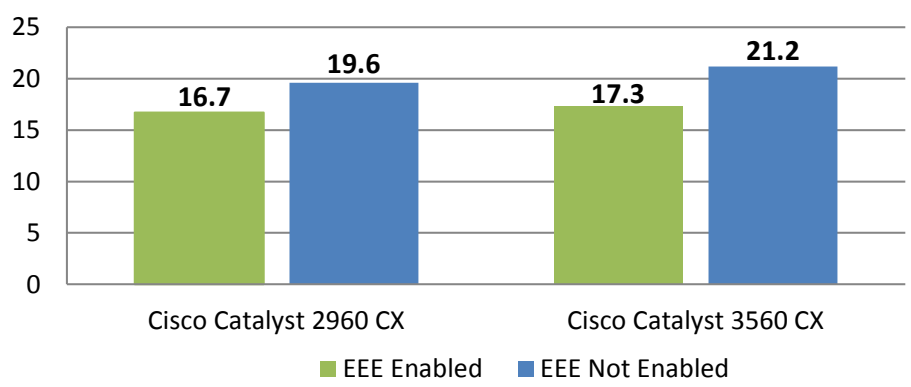


Source: Miercom, February 2015

The Catalyst C3560 CX demonstrates the same power efficiency at all traffic load levels. There was only 0.5 Watts/Hr difference between low and high load levels.

Switch Model	Efficiency Improvement over Industry Average
Catalyst 2960 CX	32.6%
Catalyst 3560 CX	47.9%

Figure 6: Energy Efficient Ethernet (EEE) Power Consumption in Watts/Hr



Source: Miercom, February 2015

EEE can save as much as 18 percent in power consumption with the Catalyst 3560 CX series and 15 percent with the Catalyst 2960 CX Series switches when those switches remain in idle mode.

The Industry Average is calculated from the power-consumption figures reported on the vendors' data sheets for the HP 2915, the Juniper EX2200-C, and the Brocade 6450-C switches. All of these switch models are in the same compact-switch category as the Cisco switches tested.

For the equivalent amount of traffic throughput, Cisco switches use less power – 29.6 percent less with the Catalyst 2960 CX and 45.6 percent less with the Catalyst 3560 CX – for sending one Gbps, when compared to the current industry average of 2.50 Watts/Gbps. See *Figure 5.*

Product Efficiency

The Cisco Catalyst 2960 CX and 3560 CX Series also demonstrated consistent power usage under varying traffic levels. As 64-byte-frame load on each port increased from 10 to 100 percent, the wattage used increased only 0.3 Watts/Hr for the 2960 CX and 0.5 Watts/Hr for the 3560 CX. As frame size grew the power consumed was even less. See *Figures 2* and *5*.

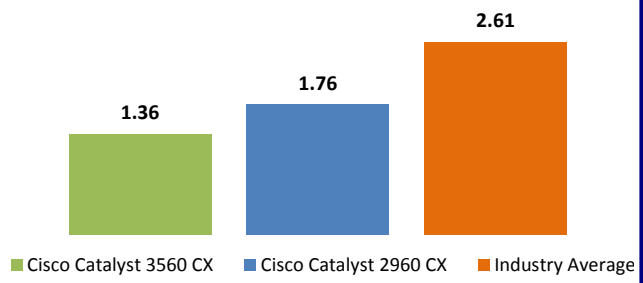
Being able to operate between 23° and 113° F (-5° and 45° C) allows the switches to be deployed in a tough range of temperature. Fanless operation reduces the noise levels.

In addition, a 'hibernation mode' using EnergyWise puts the switch to sleep after a period of inactivity, where it consumes less power than it does in active mode. The EEE standard allows for less power consumption during periods of low data activity.

The Cisco switches are fully manageable in a variety of ways: through a secure Web browser interface, via the CLI (command-line interface) over a serial console connection, or via Telnet or SSH (Secure Shell) session. Additionally, the switches can be incorporated into and managed using Cisco Catalyst Infrastructure tools, and also easily integrate with other network management systems using industry standard protocols including SNMP, sFlow and RMON.

RMON is accomplished by using standard SNMP to track essential network functions. Ingress and egress port monitoring facilitate network troubleshooting. Virtual cable tests show visibility

Figure 7: Cisco C2960 CX and C3560 CX Relative Power Efficiency (Watts/Gbps)



Source: Miercom, February 2015

The chart above shows the relative power efficiency of the Catalyst 2960 CX and Catalyst 3560 CX Series switches, compared to the Industry Average, in Watts/Gbps, at 100 percent load for 64- byte frames.

into cable problems.

To take advantage of new energy efficient technologies, the Catalyst 2960 CX and 3560 CX Series switches can be reconfigured with software updates. Interface modules can also be updated with technological advances via software updates.

Business Processes

Cisco uses life-cycle assessments (LCA) to estimate GHG (greenhouse gas) emissions associated with its products. LCA analyses, which can cover all or selected life-cycle phases, help Cisco:

- Facilitate more informed selection of environmentally preferable materials
- Assess the materiality of various contributors to environmental impact
- Understand the impact of power consumption on a product's environmental footprint
- Compare assembly and test scenarios to help develop more energy-efficient manufacturing processes
- Inform packaging and accessory kit projects on the trade-offs of alternative materials and the positive environmental impact of reducing materials
- Understand the relative carbon efficiency of different modes of transport for moving our products from manufacturing to logistics centers and on to our customers.

Cisco has additionally adopted Design for Environment (DfE), incorporating environmental design principles into its products and manufacturing processes, so that less raw material, packaging, and transportation are used, and product refurbishment and recycling are more effective. DfE focuses on:

- Energy efficiency (minimum 80 per cent efficient power supply and efficient component selection)
- Hazardous materials
- Design-for-recyclability and upgradability
- Recycling marking on plastic components (ISO 11469, SPI codes) for ease of sorting during recycling
- Packaging and fulfillment (reduction of materials and package volume as well as logistics impacts)
- Design for longevity.

Global environmental regulations and Cisco's interest in reducing the impact of the materials used in manufacturing products and in its supply chain have helped spur the development of its Controlled Substances Specification. This outlines the controlled substances and any conditions of use, regulatory restrictions, such as Restriction on Hazardous Substances (RoHS), substances to be reported and phased out, and substances under study for potential inclusion on the controlled substances list.

Business Case

The annual running cost was calculated on conservative methods based on the projected use of the switch in a business environment running 24/7 at 100% load using a 64-byte frame size. A rate of 12.9 cents per kWh, currently considered the national average, was used. Specific calculations may vary depending upon the rate in other areas.

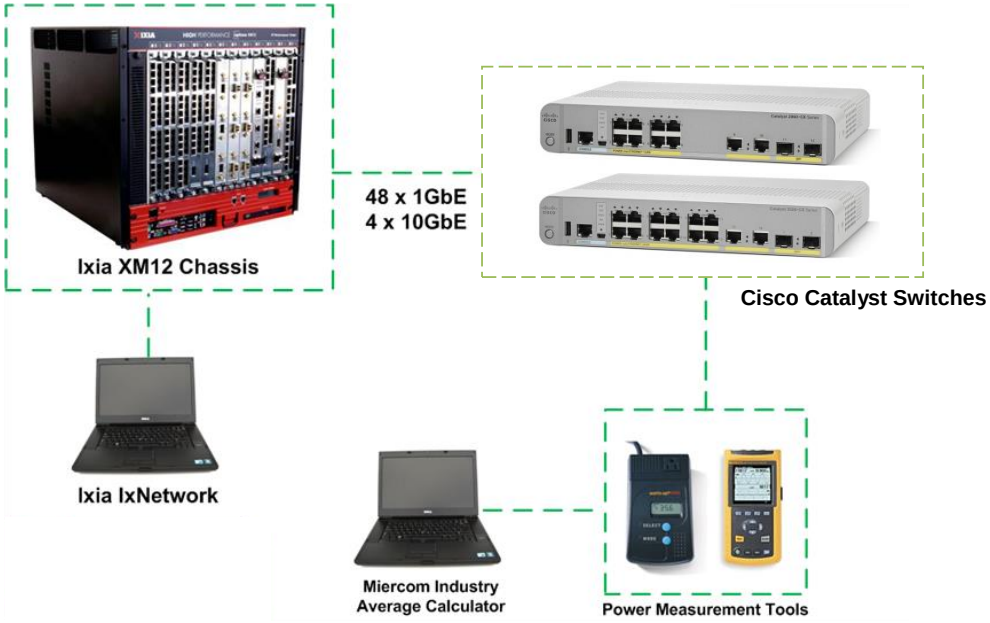
As shown in *Figure 1* on *page 1*, the Cisco Catalyst 2960 CX and 3560 CX switches have lower running costs. The dollar amount savings is approximately $1.04 per Gbps for the Catalyst 2960 CX Series switch and $1.40 per Gbps for Catalyst 3560 CX Series switch on an annual basis. On average, the Catalyst 2960 CX switches can save 35% and Catalyst 3560 CX switches can save 48%.

Certified Green

Miercom conducts environmental analysis on products using a holistic view, considering power efficiency, manufacturing, and other factors that are part of the product and its lifecycle. Power consumption and power efficiency are key metrics when comparing products. Miercom believes in a comprehensive approach, which reveals the true business case savings including other environmental benefits that the product may afford.

Competitive indexing with an industry average is achieved by comparing measured results for products in a similar class. This comparison allows a single view of the annual cost for power consumption of a product, and comparison information that will help the user understand if the evaluated product affords an overall advantage for power efficiency.

Test Bed Diagram



Source: Miercom, December 2014

How We Did It

Cisco Catalyst 2960 CX and Catalyst 3560 CX series were evaluated for environmental impact by looking at the individual components as well as their special features and capabilities. Testing focused on the power consumption and efficiency of the product. A full audit was conducted to analyze the overall product specific environmental impact.

Lab testing was conducted for power consumption under load. Measurements and audit results were verified with site survey assessments. Catalyst 2960 CX was configured and tested using 10 x 1GE and 2 x 1GE SFP ports. Catalyst 3560 CX was configured and tested using 14 x 1GE and 2 x 1GE SFP ports.

We measured power consumption changes by transmitting various traffic loads while the switches had power saving features enabled and disabled. Specifically, we measured the power consumption at idle with no traffic, no links, partial load and full load under all standard frame sizes between 64-bytes to 9216-bytes. Power consumption of the Cisco Catalyst switches was measured with varying network and link loads that the switches would typically experience in a real-world deployment. The SUT was loaded with traffic at various rates and packet sizes in accordance with RFC 2544 Benchmarking Methodology for Network Interconnect Development.

Power consumption was measured while running Layer 2 and Layer 3 traffic from the Ixia XM12 traffic generator. Miercom recognizes Ixia (http://www.ixiacom.com/) as 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 IxNetwork for Layer 2 and 3 switching and routing traffic.

Miercom recommends customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection. Miercom engineers are available to assist customers for their own custom analysis and specific product deployments on a consulting basis. Contact Miercom Professional Services via reviews@miercom.com for assistance.

Miercom Certified Green

The energy-saving attributes of the Cisco Catalyst 2960 CX and 3560 CX Series Switches were evaluated by Miercom in accordance with the Certified Green Testing Methodology. The switches met the required criteria to achieve the Miercom Certified Green Award.

Cisco Catalyst 2960 CX and 3560 CX Series switches give customers a highly economical, manageable and energy efficient Layer 2/Layer 3 switching solution. Utilizing the latest silicon technology and energy efficient design, Catalyst 2960 CX and 3560 CX leverage green features to promote environmentally sound network practices.

Catalyst 2960 CX Series

Catalyst 3560 CX Series

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