



Lab Testing Summary Report

November 2013

Report 131112

Product Category:

Power Efficient Switches

Vendor Tested:



Products Tested:

**WS-C2960X-48TD-L
and
WS-C2960XR-48TD-I
Switches**



Key findings and conclusions:

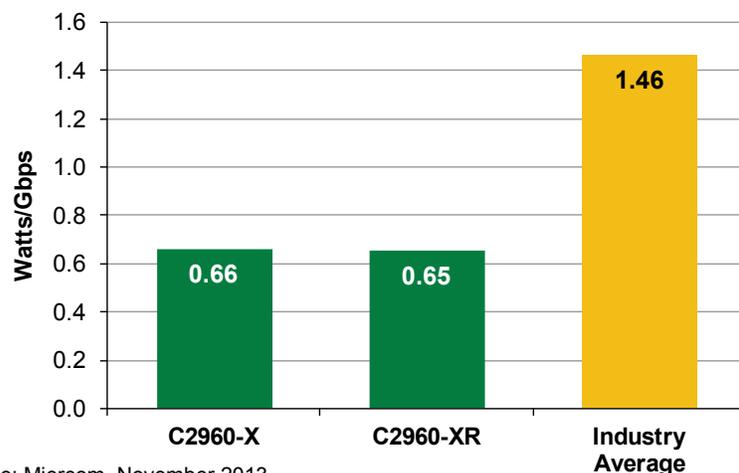
- Cisco Catalyst 2960-X and Cisco Catalyst 2960-XR switches saved over 50% in annual energy operating costs compared to the Industry Average
- Cisco Catalyst 2960-X and Cisco Catalyst 2960-XR consumed 55% less energy in Watts/Gbps than the Industry Average
- Energy Efficient Ethernet allowed power savings of more than 29% for both switch models during low link utilization
- Variable speed fans and wide range of operating temperatures (0-113° F or -5-45° C) reduced power consumption
- Cisco EnergyWise monitored and controlled PoE/PoE+ device power consumption to reduce energy cost. For example, the IP phones and wireless access points could be turned off automatically after business hours or placed into energy saving mode to save energy

Cisco's Catalyst WS-C2960X-48TD-L and WS-C2960XR-48TD-I Gigabit Ethernet switches were evaluated by Miercom under the Certified Green program for power consumption and energy efficiency. Overall environmental impact and business-enabling green benefits of the Layer 2 and Layer 3 switches were also analyzed.

The Cisco Catalyst 2960-X and 2960-XR switches are designed to be used in branch office/campus environments. They are offered in configurations of 24 or 48 copper Ethernet ports with 4x1GE SFP or 2x10GE SFP+ uplink ports. There is also an optional stack module to enable the stacking of eight switches as a single virtual switch.

The 2960-X switches support static routing of Layer 3 traffic and have a single fixed power supply of up to 740W of PoE power that can be augmented with an external redundant power supply. They are available with Cisco IOS LAN Base or LAN Lite.

**Figure 1: Cisco Catalyst 2960-X and 2960-XR Switches
Power Efficiency – Watts/Gbps at 100% Load, 1518-byte Frame Size**



Source: Miercom, November 2013

Using a 1518-byte frame size with 100% Layer 2 traffic load, testing showed both switches to be 55% more efficient in power consumption, measured in Watts/ Gbps, than the Industry Average.

The 2960-XR switches support static and dynamic routing of Layer 3 traffic and have a field-replaceable, hot swappable modular power supply. They also offer inline power redundancy with an optional second internal, field-replaceable hot swappable power supply. The 2960-XR switches are available with Cisco IOS IP Lite images.

Hands-on testing and analysis proved the C2960-X and C2960-XR to be highly economical, easy-to-manage and energy-efficient Layer 2 and 3 switching solutions.

Power-Saving Functionality

The Catalyst 2960-X and 2960-XR switches provide several innovative energy-saving features. They are stackable and support Energy Efficient Ethernet (EEE). Other features include Cisco EnergyWise, Switch Hibernation Mode, Downlink Hibernation Mode, a wide temperature operating range and variable-speed cooling fans.

All switches in the C2960-X Series are stackable via the optional FlexStack-Plus hot-swappable module. The maximum number of units that can be stacked is eight.

The C2960-X and C2960-XR switches utilize the IEEE 802.3az (EEE) feature, allowing energy saving during periods of low link utilization. Testing verified that with EEE enabled, the C2960-X model reduced power consumption by up to 29.3% (13.1 watts) and the C2960-XR model saved 31.4% (13.6 watts) of power.

The new Cisco Switch Hibernation feature allows the C2960-X and C2960-XR switches to sleep when idle or with very low traffic. It is programmable and can be configured on daily work schedules.

Cisco Switch Hibernation can be controlled by either using a local console on the switch or from a central location by using the Cisco EnergyWise management solution. For the Cisco Switch Hibernation test, a sleep schedule was configured. Cisco Switch Hibernation reduced the power consumed for the Catalyst 2960-X model by 84% from 44.3W at link idle to 7.2W at idle. Similarly, tests showed that for the C2960-XR, power consumption was reduced by about 81% from 43.7W at link idle to 8.4W. The switches remained in Hibernation mode until scheduled for wake up. The switches can be awakened earlier than scheduled by simply pressing the mode button on the front of the unit.

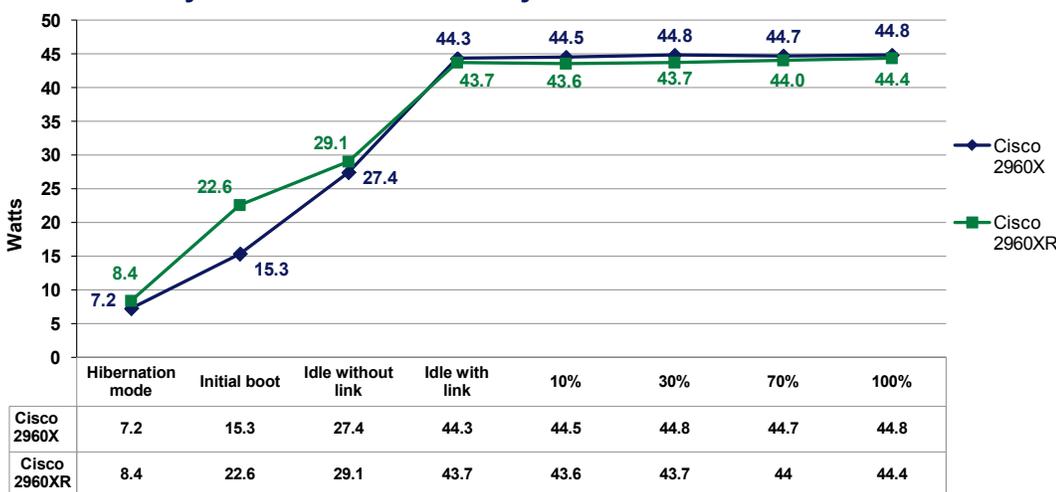
Cisco EnergyWise manages energy usage of devices on networks. It monitors, controls and reports energy use of IP-connected equipment. It is also used to configure the power-saving features, such as Cisco Switch Hibernation, in the C2960-X and C2960-XR switches.

Power Profile

The power profile shows the energy used by the switches handling Layer 2 traffic with various loads using 1518-byte frame size with EEE disabled.

The C2960-X used 15.3 watts at initial boot and 44.3 watts at idle with link. Energy use slightly increased as the traffic load increased.

**Figure 2: Cisco Catalyst 2960-X and 2960-XR Power Profile
Layer 2 Traffic with 1518-Byte Frame Size**



Source: Miercom, November 2013

The Power Profile shows the energy used with the C2960-X and C2960-XR switches handling Layer 2 traffic of various loads and a 1518-byte frame size. EEE is disabled. Energy used with all links up and idle was 44.3 watts for the Catalyst 2960-X and 43.7 watts for the C2960-XR. As traffic load increased, energy usage of both switches increased gradually.

Table 1: Layer 2 Power Consumption of the Cisco Catalyst 2960-X Switch

Power Consumption in Watts of the WS-C2960X-48TD-L Switch at Frame Size:					
	256-byte	512-byte	1518-byte	9216-byte	IMIX
Hibernation Mode	7.2				
Initial Boot	15.3				
Idle without Link	27.4				
Idle with Link	44.3				
10%	44.6	44.6	44.5	44.5	44.7
30%	44.9	44.9	44.8	44.8	44.9
70%	45.1	45.1	44.7	44.7	45.0
100%	45.2	45.1	44.8	44.8	45.1

Power consumption measurements of the C2960-X switch using Layer 2 traffic across various frame sizes under varying loads and conditions.

Source: Miercom, November 2013

The C2960-XR used 22.6 watts at initial boot and 43.7 watts at idle with link. For the complete power profile, see *Figure 2* on *page 2*.

Power Consumption

The Cisco Catalyst 2960-X and 2960-XR 48-port switches were tested using Layer 2 and Layer 3 traffic with 64-, 128-, 256-, 512-, 1024-, 1518-, 9216-byte and IMIX frame sizes. The power consumption was measured while the switch was booting, during switch hibernation and at idle with no link and 10%, 30%, 70% and 100% traffic load. All measurements were done with EEE disabled.

The power consumption is shown in comparative charts in *Table 1* and *Table 2* (on *page 4*).

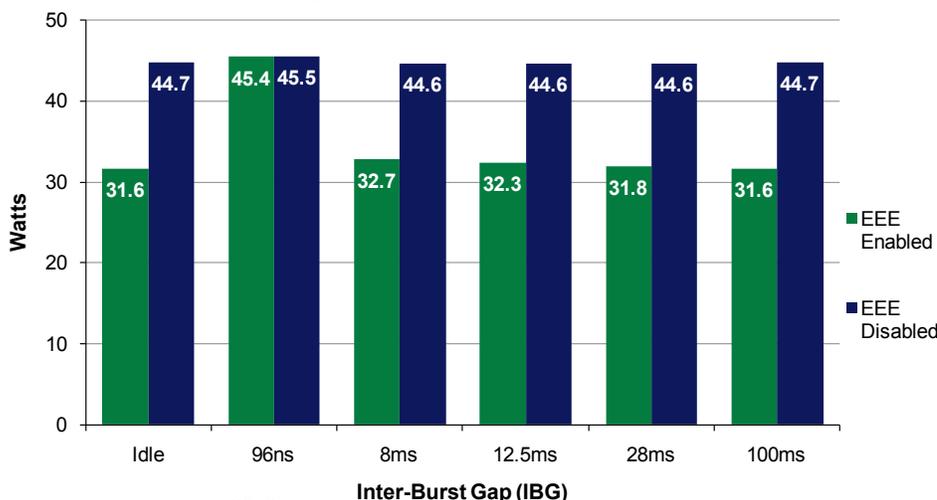
All 48 ports on the C2960-X and the C2960-XR support EEE. With EEE enabled, power use was reduced during times of little or no network traffic. EEE was tested by sending Layer 2 traffic with

varying Inter-Burst Gaps (IBG) between each burst of 1,000 frames. It was observed that the length of the IBG impacted power consumption. The longer the IBG, EEE was more effective with less power consumption. The C2960-X and the C2960-XR were tested with EEE enabled and disabled modes. The maximum power savings between EEE enabled and disabled occurred with an IBG of 100ms. It was 13.1 watts (29.3%) for the C2960-X and 13.6 watts (31.4%) for the C2960-XR. See *Figure 3* and *Figure 4* (on *page 4*) for the power savings between EEE enabled and EEE disabled for each IBG tested.

Product Performance

Miercom measures and keeps track of trends in the industry average values for power consumption on networking products. These calculations consider frame size in the traffic mix - preferably IMIX, traffic utilization percentage, and available uplinks and modules.

Figure 3: Cisco Catalyst 2960-X Power Consumption, EEE Enabled and Disabled



Source: Miercom, November 2013

For the C2960-X switch, the maximum power savings between EEE enabled and disabled occurred with an Inter-Burst Gap of 100ms. The savings was 13.1 watts. A 64-byte frame size was used.

Table 2: Layer 2 Power Consumption of the Cisco Catalyst 2960-XR Switch

Power Consumption in Watts of the WS-C2960XR-48TD-I Switch at Frame Size:					
	256-byte	512-byte	1518-byte	9216-byte	IMIX
Hibernation Mode	8.4				
Initial Boot	22.6				
Idle without Link	29.1				
Idle with Link	43.7				
10%	43.7	43.7	43.6	43.6	43.7
30%	44.0	43.9	43.7	43.7	43.9
70%	44.5	44.3	44.0	44.0	44.3
100%	45.0	44.7	44.4	44.3	44.6

Power consumption measurements of the C2960-XR switch with Layer 2 traffic using various frame sizes under varying loads and conditions.

Source: Miercom, November 2013

The industry average also involves the latest available products on the market. End of life cycle (EOL) products, once previously included in the averages, have been removed.

It is reasonable to expect the average industry power consumption for Ethernet switches to change over time.

The performance of each switch was compared to the Industry Average using Watts/Gbps at 100% load and Layer 2 1518-byte frame size. The C2960-X consumed 0.66 Watts/Gbps, while the C2960-XR switch consumed 0.65 Watts/Gbps. *Figure 1* on *page 1* shows power efficiency of the switches under test and the Industry Average.

Compared to the Industry Average, both switches use less power to provide greater throughput. The C2960-X switch used 29.0% less power with the C2960-XR using 30.1% less. The power efficiency of the two switches was the same as we observed

equivalent throughput for both. The throughput of the C2960-X was 67.11 Gbps and 67.85 Gbps for the C2960-XR.

Product Efficiency

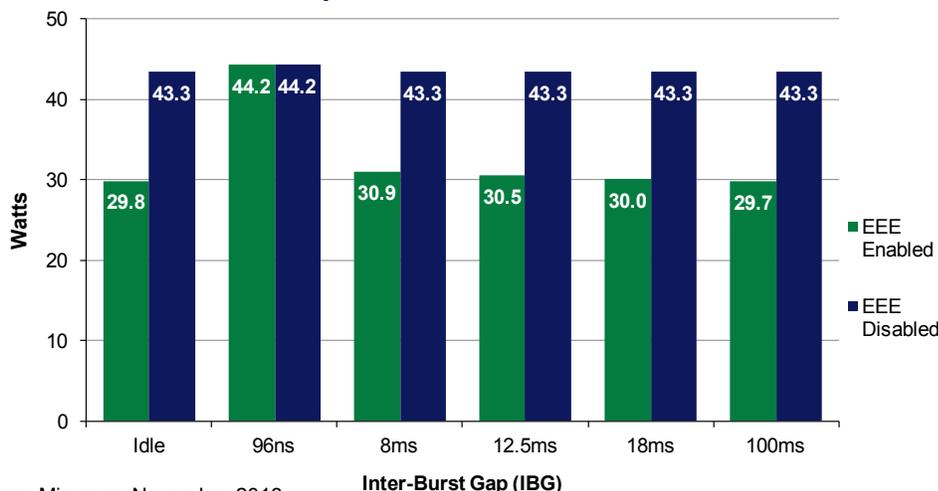
The wide temperature operating range of the C2960-X and the C2960-XR, which is 0° to 113° F (-5° to 45° C), contributes to a reduction in power consumption.

When cooling is needed, it is provided by variable-speed fans. Therefore, in addition to power consumption being minimized, reduction of noise in the workplace is an added benefit.

Business Processes

Cisco reduces waste output by engineering products that use fewer materials to operate. Cisco products can be upgraded, refurbished and recycled instead of being disposed, thereby decreasing landfill waste.

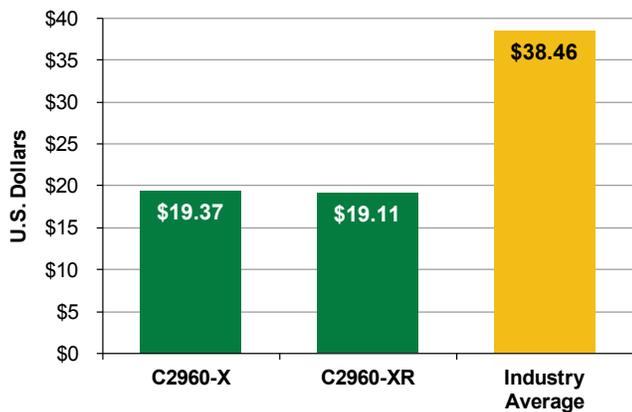
Figure 4: Cisco Catalyst 2960-XR Power Consumption, EEE Enabled and Disabled



Maximum power savings between EEE enabled and disabled for the C2960-XR switch using 64-byte frame size occurred with an Inter-Burst Gap of 100ms. The savings was 13.6 watts.

Source: Miercom, November 2013

Figure 5: Cisco Catalyst 2960-X and 2960-XR Switches Annual Cost compared to Industry Average



Source: Miercom, November 2013

Annual cost to operate the Cisco Catalyst 2960-X switch was calculated to be \$19.37, a savings of \$19.09 from the Industry Average of \$38.46. The Catalyst 2960-XR costs \$19.11 to operate, a savings of \$19.35 compared to the Industry Average. Both the C2960-X and the C2960-XR switches save 50% in annual costs when compared to the Industry Average.

Cisco aims to reduce both operational and environmental costs by offering new ways of communication and manageability. The company believes that it is necessary for employees in disparate locations to collaborate productively on work, a green alternative to travel, to reduce emissions and keep the environment sustainable.

Green Innovation

Cisco is the market leader on energy savings initiatives in products, services and solutions via holistic innovation. Cisco's green innovations include Cisco EnergyWise and SmartGrid. Cisco's intent is to increase customer awareness of how to lower equipment operating costs and to minimize the carbon footprint of its products.

Cisco's EnergyWise Suite saves power by controlling power consumption of network devices directly and other network connected devices including phones, printers, monitors, virtual servers, HVAC systems and more – not just the Cisco devices. SmartGrid is a combination of products, technologies, services and business partners that optimize communication, improve resiliency and reduce the operational cost and complexity of the energy grid. Cisco's EnergyWise Management software now manages on-premise and cloud-based enterprise energy management platforms, further reducing operating costs.

Reducing the amount of paper, plastic and metal that ship with products, Cisco has replaced these materials with more environmentally friendly solutions, such as using 100% recyclable materials and removing non-essential materials including magnets, rubber feet and generic cables.

Business Case

The annual running cost is calculated based on the assumed use of the switch in a branch office environment. The switch was calculated to operate 12 hours daily during the typical work week. Of those 60 hours, it would operate 100% for 10 hours and at 70% for the remaining 50 hours. For the other 108 hours (48 hours on the weekend and 12 hours each weekday), the switch would be considered idle/ready.

For the annual cost calculation, two power measurements were used; traffic running at 70% and 100% of capacity with EEE disabled.

As shown in *Figure 5*, both the Catalyst 2960-X and 2960-XR significantly lower annual running costs when compared to the Industry Average. The approximate annual savings is \$19.09 for the C2960-X switch, which is a 49.6% savings compared to the Industry Average, and a savings of \$19.35, or 50.3%, for the C2960-XR.

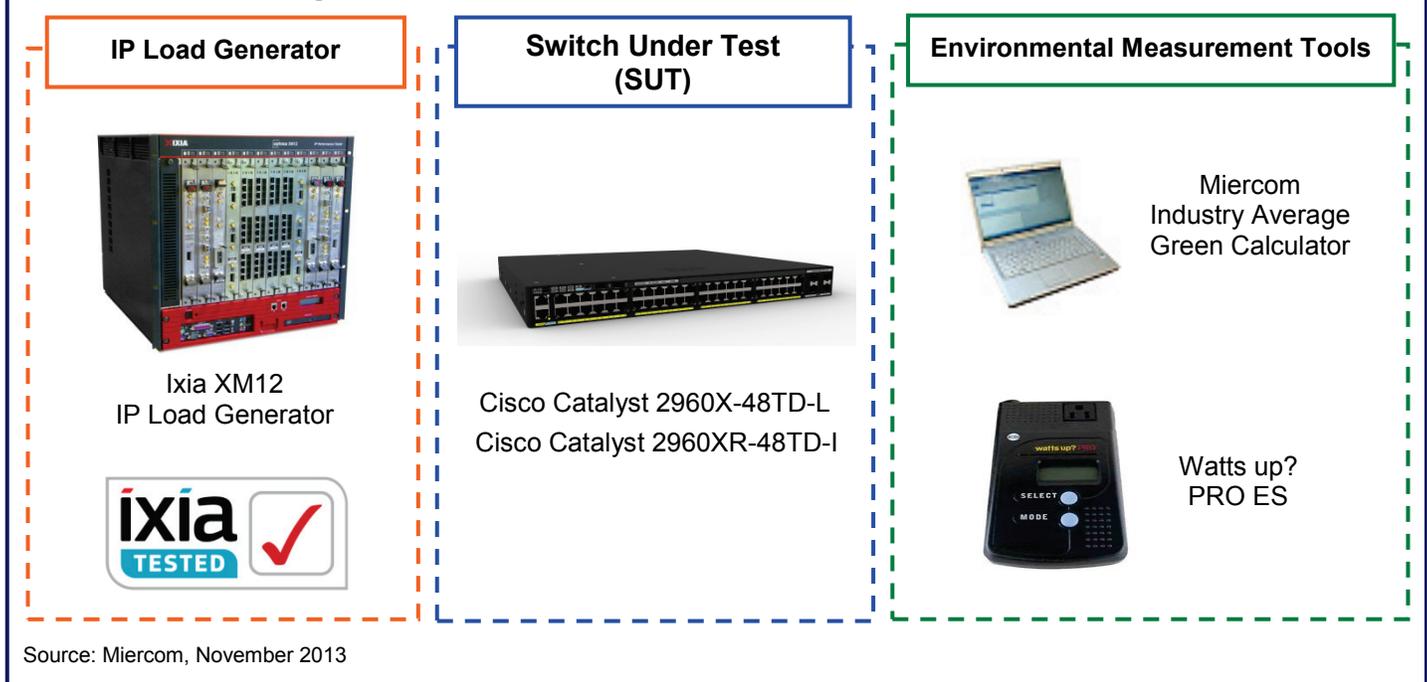
Industry Average is based on the testing of 48-port 1GE switches (non PoE) with fiber uplinks and 1GE copper interfaces. Vendors with products included in the Industry Average calculation include Brocade, Cisco, Dell, D-Link, Extreme, HP and Netgear.

Certified Green

Miercom conducts environmental analysis on products using holistic view, considering power efficiency, manufacturing and other factors which are part of the product and its lifecycle. Power consumption and power efficiency are very important metrics for comparing products and are typically all that are discussed in other organizations' green reports. We believe a better approach is to take a comprehensive look that reveals the true business-case savings that result from the other environmental benefits a product may afford.

Competitive indexing versus the Industry Average is achieved by comparing measured results from products in a similar class. This comparison provides one view of the annual power cost for an evaluated product and can help to determine if it affords an overall advantage for power efficiency.

Test Bed Diagram



How We Did It

The Cisco Catalyst 2960X-48TD-L and the Catalyst 2960XR-48TD-I were evaluated for environmental impact by looking at their individual components as well as special features and capabilities. Testing focused on power consumption and efficiency. A full audit was conducted to analyze the overall product-specific environmental impact.

Measuring Power Consumption: The power consumption of the C2960-X and the C2960-XR was measured with varying network and link loads that are typically experienced in a real-world deployment. Power consumption was measured using a Watts up? PRO ES (www.wattsupmeters.com). The switches were loaded with traffic at various rates and frame sizes in accordance with RFC 2544 Benchmarking Methodology for Network Interconnect Development.

Power consumption measurements were taken during boot-up, idle and loads of 10%, 30%, 70% and 100%. Power consumption was measured while running Layer 2 traffic from an XM12 traffic generator from Ixia (www.ixiacom.com). Traffic was applied to each of the 1 and 10 GbE uplinks while stressing the switches with the features they support. All power measurements were taken at 110 volts and 60 Hz frequency. In addition, power measurements were also taken for varying frame sizes -- small to jumbo -- to analyze any change in power consumption.

Miercom recognizes Ixia 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 routing and switching Layer 2-3 traffic and IxLoad for Layer 4-7 application traffic.

Environmental Analysis: Miercom's environmental review of the C2960-X and the C2960-XR also entailed an examination of the Cisco company-wide and product-specific environmental impact reduction efforts. Analysis includes comparisons to industry averages for competitive products that were also tested.

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 customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection.

Miercom Certified Green

Miercom evaluated the Cisco Catalyst 2960-X and 2960-XR switches in accordance with the Certified Green Testing Methodology. The Gigabit Ethernet switches met the required energy-saving criteria to earn the Miercom Certified Green Award.

Based on hands-on testing and the verified representations made by Cisco, Miercom confirms that the Catalyst 2960-X and the 2960-XR are highly energy-efficient Layer 2 and Layer 3 switching solutions.



Cisco Catalyst 2960-X and Catalyst 2960-XR Switches



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