Miercom

Lab Testing Summary Report

Product Category:

Integrated Services Routers G2

Vendor Tested:

CISCO

Products Tested:

**Cisco 1941W ISR
Cisco 2911 ISR
Cisco 2951 ISR
Cisco 3945 ISR**

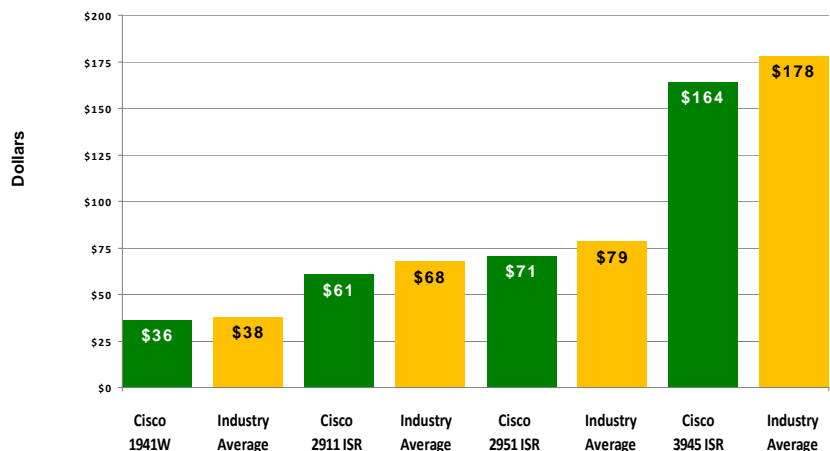Miercom CERTIFIED GREEN ™

Key findings and conclusions:

- **Port prioritization and power management provided by Cisco EnergyWise, via any IP interface, reduces power consumption while sustaining productivity**

- **Testing under maximum CPU load showed minimal impact on Watts/Gbps power usage**

- **ISR G2 routers internal power supplies are rated at 85% efficiency; when used with variable speed fan modules, a reduction is noted for device cooling costs**

- **PoE ports and modules can be programmed to turn on and off to meet demand, effectively reduces power consumption of Integrated Service Router G2**

Cisco Integrated Services Routers Generation 2 models 1941W, 2911, 2951 and 3945, were tested by Miercom for power consumption and efficiency under the Certified Green Test Program. We evaluated the overall environmental impact and examined the green benefits that the Cisco 1941W, 2911, 2951 and 3945 ISR series provide to customers.

The ISR G2 routers proved in hands-on testing and by independent audit, to afford customers with an energy efficient router solution. Cisco technology delivers a standards-based network solution, providing energy-efficient routers that reduce costs and minimize the environmental impact.
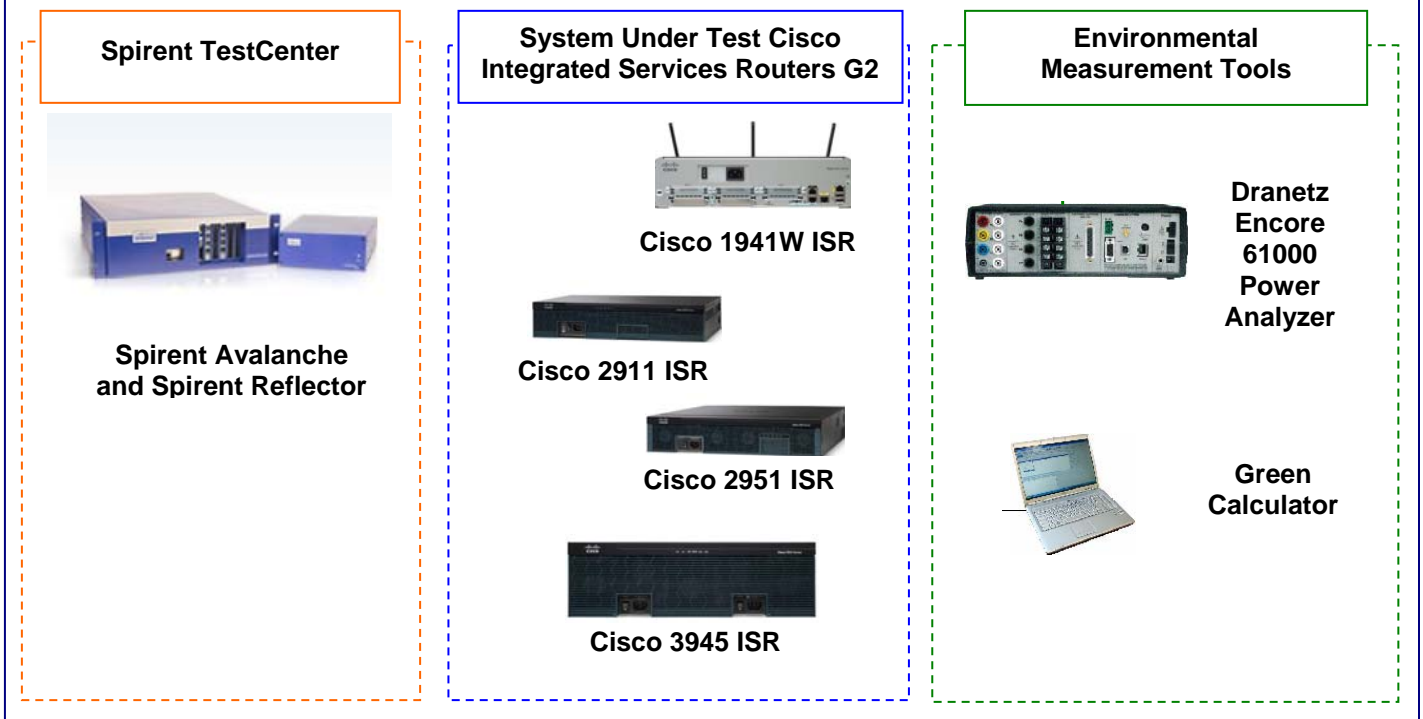
The annual cost for the ISR G2 routers compared to an average cost of routers is shown in *Figure 1.* The Cisco 1941W costs $36 annually, while 2911 and 2951 ISRs save 10% yearly and the 3945 ISR realizes a savings of 8%. An explanation of the cost is

Figure 1: ISR G2 Routers Annual Cost Comparison

Comparison of costs for the ISR G2 routers compared to Industry Averages. The cost is based on 12.5 cents per kWh. An explanation of this calculation appears on page 7 under Business Case.

Test Bed Diagram

Spirent TestCenter

Spirent Avalanche and Spirent Reflector

System Under Test Cisco Integrated Services Routers G2

Cisco 1941W ISR

Cisco 2911 ISR

Cisco 2951 ISR

Cisco 3945 ISR

Environmental Measurement Tools

Dranetz Encore 61000 Power Analyzer

Green Calculator

How We Did It

We tested four models, a representative sampling of the second generation Integrated Services Router family, models 1941W, 2911, 2951 and 3945. Lab testing of each module and HWIC was conducted for power consumption in various configurations under load. The ISR G2 routers were configured and tested with wireless LAN controller modules, 24 port switch modules, and High-Speed WAN Interface Cards (HWICs), one and\or two power supplies. The maximum capacity for the power supplies varied with each model.

Measuring Power Consumption: The power consumption of ISR G2 routers was measured by varying the traffic load and CPU utilization. Power consumption was measured with the Dranetz Encore 61000 Power Analyzer from Dranetz-BMI (www.dranetz-bmi.com) and other power measurement tools. The SUT was loaded with traffic at various rates and packet sizes in accordance with RFC 2544 Benchmarking Methodology for Network Interconnect Development. We sent IMIX traffic through the devices. Power measurements were made at typical 70% load and at 100% or max load.

To calculate an accurate measurement of a device's consumption and the effects of additional modules, we created a profile of the additional power load on the platform, as modules and interconnects were added. Power measurements were recorded at various stages: off, standby, idle, without and without modules, and evaluated the impact on power consumption as each module and interconnect was added.

Generating Traffic: We used the Spirent TestCenter to perform the RFC 2544 throughput tests.

Environmental Analysis: Miercom's environmental review of the Cisco 1941W, 2911, 2951 and 3945 models also entailed an examination of the Cisco company-wide and product-specific environmental impact reduction efforts.

We interviewed the appropriate Cisco personnel regarding the environmental related features of the equipment, applications, business processes and practices for the manufacture, sale and life cycle of the product. Overall analysis includes measured performance, product design and architecture and business practices.

We also used the Ixia XM2 traffic generators from Ixia (www.ixiacom.com), to validate the testbed environment and to establish the baseline for products in this class. Miercom is proud to have Ixia as a partner in its Certified Green Program.

under "Business Case."

The ISR G2 family of routers provides enhanced embedded encryption acceleration, optional firewall, intrusion prevention and integrated application services, while supporting existing WAN, LAN, and security network services, functioning at the network edge, supporting multiple speeds and types of interfaces.

ISR G2 Configurations Tested

Product	1911W Small Branch	2911 Medium Branch	2951 Large Branch	3945 Regional Office
Form/design	Desktop	Rack	Rack	Chassis
Internal Power	1	1	1	2
External Replaceable Power Supply	none	1	1	1
Fan modules/ fans	1/ 1	1/3	1/4	1/5
Hot Swap fans	no	yes	yes	yes
HW Interface Card data/voice	yes	yes	yes	yes
3G WAN	yes	no	no	no
802.11	Corp & guest SSID	no	no	no
Primary Connectivity	Enet WAN	Enet WAN	Enet WAN	Enet WAN
Backup Connectivity	3G WAN	Enet WAN	Enet WAN	Enet WAN
Integrated Switch Ports	8 PoE	16 PoE	24 Poe	48 PoE
IP Phones	8	12	50	120
TelePresence	no	1 low band-width	1 high band-width	1 high band-width
Idle w/o module - Watts observed	31	48.8	57.7	91.3
Stated Idle specified Watts	35	50	70	N/A
Annual running cost*	$36	$61	$71	$164

* Annual running cost based on 12.5¢ kWh; while used for 12 hours daily with varying CPU utilizations. See page 7 for further details.

Cisco EnergyWise

Cisco's EnergyWise technology for power base management and reporting allows IT operations to measure and control the power consumption on the network and attached devices such as IP phones, PCs and access points. Branches can configure policies and prioritize ports for improved power efficiencies.

Power monitoring and management of the Cisco EnergyWise were tested for slots and interfaces of the router. With EnergyWise, the modules could be powered up or turned off with simple commands. Time-of-day policies can be applied by device type, device location, priority of device and other parameters. Based on this policy, PoE power to interfaces was automatically turned on or off at set times.

Using an intelligent network-based approach, EnergyWise allows IT and facilities operations to optimize and control power for the corporate infrastructure when IP-enabled building and lighting controllers are in use. By using EnergyWise to control and manage devices significant cost savings can be realized.
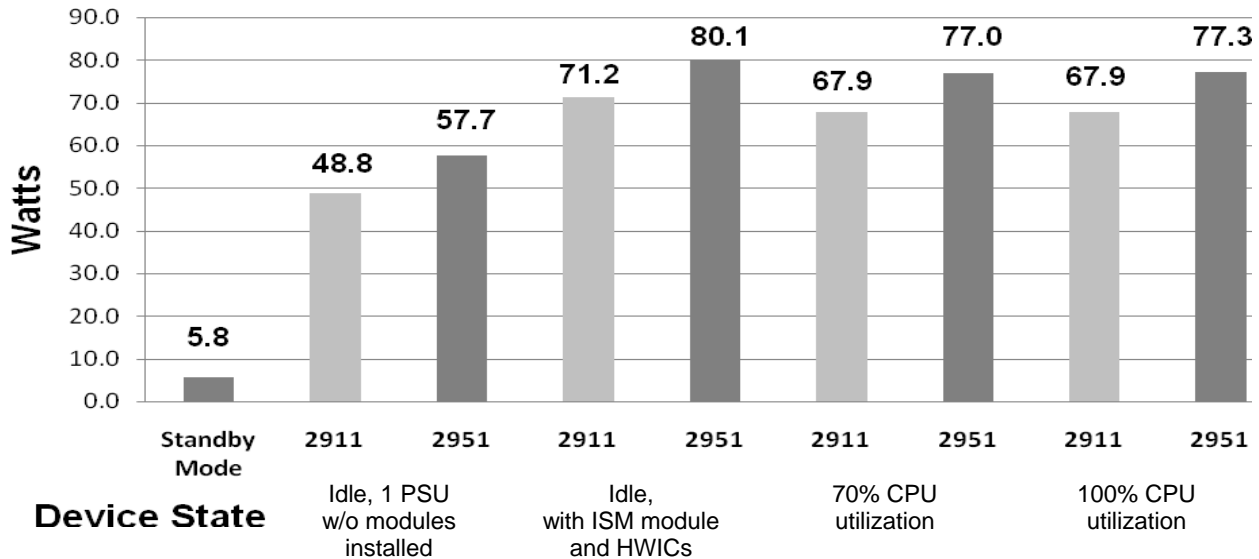
Power Efficiency

The power consumption of the ISR G2 routers was measured with various configurations on four models Cisco 1941W, 2911, 2951, and 3945 ISR.

To verify the accuracy of power consumption and the effects of adding modules, a profile was created of the power load on the platform, as modules and interconnects were added. Power measurements were recorded from off through standby modes, idle with and without modules, and typical CPU usage. IMIX traffic was used to drive up CPU load, increasing the device load. Power measurements were made at typical 70-75% load and maximum 100% CPU load. Both 110V and 220V were measured.

Cisco 1941W ISR
Since this ISR model does not have a standby mode, we verified a zero power draw while off and then powered up the box. During the Cisco IOS load, the 1941W ISR idle power draw was 31 watts without modules. This is 4 watts less than Cisco datasheet specs. When ISM/AP module was added the power use increased to 37 watts.

Figure 2: Cisco 2911 ISR and 2951 ISR Power Profiles

Power consumption was measured for the Cisco 2900 ISR series in various modes including standby; idle w/o modules and with one PSU; idle with ISM module and HWICs installed; and at 70% and 100% CPU utilization, for a 10 minute period using IMIX traffic. Dark represents 2951 ISR while the light shows 2911 ISR wattage.

Adding traffic loads, a marginal increase was noted 37.1 watts for 70% and 37.2 watts at 100% load. Power use under load was based on a data transfer of 10 minutes. Throughput performance was measured simultaneously using an IMIX of 64, 594, and 1518 byte Ethernet frames at 58.3%, 33.3%, and 8.3%, respectively. Using this traffic mix, we observed a throughput of 981 Mbps, for 37.9 Watts/Gbps ratio. The annual energy cost was calculated to be $36.

Cisco 2911 ISR

Only 5.8 watts was used for low-power standby mode. In an idle state with no modules installed 48.8 watts was used.

As shown in *Figure 2,* power consumed was 71.2 watts with an ISM module and HWICs at idle state. When traffic loads were applied, power consumption decreased to 67.9 watts for both 70% CPU load and max CPU load. Throughput observed during this load testing was 1017.89Mbps, providing an efficiency ratio of 49 Watts/Gbps. Annual running costs for the Cisco 2911 ISR G2 was calculated at $61.

Cisco 2951 ISR

Another member of the 2900 series family, the 2951 ISR recorded standby mode of 5.8 watts.

57.7 watts draw was recorded in idle with one power supply and no modules. Stated consumption for this mode is 70 watts. Adding an ISM module and HWICs increased power to 80.1 watts. See *Figure 2.* Stressing the CPU with a 70% load resulted in a measurement of 77 watts, while the maximum CPU load of 100% caused a minimal increase to 77.3 watts. At this CPU loading, we observed IPv4 throughput of 1714 Mbps, which enabled the Cisco 2951 ISR to deliver 45 Watts/Gbps. Annual costs for this model is $71.

Cisco 3945 ISR

The largest router tested from the ISR G2 platform is intended for regional office applications. It supports Cisco EtherSwitch Service Modules, which provides expanded router capabilities by integrating Layer 2 and Layer 3 switching with feature sets that are included in Catalyst 3750E and 2960 series switches. The modular Services Performance Engine motherboard offers increased processing capability as future needs may require. The modularity of this platform offers a unique flexibility. The power usage recorded needs to be compared and contrasted to the additional capabilities afforded by this product.

In standby mode with a single power supply 9.5 watts was used. Adding a second power supply

increased the standby energy consumption to 18.2 watts. At idle with one power supply and no modules 91.3 watts was recorded, and when a second power supply was added online, that figure increased to 120.5 watts, as shown in *Figure 3 on page 6.*

The effect of individual modules on the system load was tested. A fully loaded chassis with no interconnects at idle used 243 watts. Performing throughput testing at 70% and 100% CPU usage resulted in 252.9 watts, and 253.8 watts drawn respectively. At 100% CPU utilization, the 3945 delivered 2989 Mbps. This equates to 84.9 Watts/Gbps. Based on a typical usage profile, the annual cost was $164.

Product Efficiency

Cisco ISR G2 router technology considers the energy efficiency of network infrastructure. Cisco's EnergyWise design focuses on reducing energy consumption through network management. The ISR G2 routers hardware is designed to take advantage of years of technology advances, without the need to replace physical hardware. Multiple capabilities are built into the base hardware, with an optional software upgrade.

The ISR G2 routers maximize IT resources efficiently, using tools for remote alerting, remediation and collaborative administration. The ISR G2 uses several standards-based management and alerting protocols and embedded tools, interacting with a wide range of tools from Cisco and other third parties, including SNMP, Syslog, WSMA, EEM, TR-69, IP SLA, Netflow, XML-PI, GOLD, and RMON.

ISR Network/Switch Management tools include CiscoWorks LAN Management Suite (LMS), Cisco Configuration Professional (CCP), Cisco Security Manager (CSM), Cisco netManager, Cisco License Manager (CLM), and Cisco Unified Communications Management (CUCM) suite. These tools allow the routers to share Management and Switch Fabric resources for even more efficiency.

Except for the Cisco 1941W, the ISR G2 routers tested have a hot swappable fan module. Upgradeable and replaceable, the routers provide

varying operating temperature ranges, with cooling components functioning in various power modes, adjusting the power consumption, allowing for easy replacement and maintenance, reducing energy costs.

The Cisco 3945 ISR provides internal Redundant Power Supplies (RPS) and the Cisco 2900 ISRs require external RPS, offering redundancy and scalability, with the ability to reallocate power for additional devices. The dual RPSs provide either redundancy failover or operation in a PoE boost mode where the power capacity of the platform increases to twice the power to support additional PoE ports. Operational costs and power consumption can be reduced since additional ISR G2 routers are not required when providing power to the maximum number of PoE devices.

EnergyWise provides the individual management of modules as well as PoE at port level. The ISR G2 routers support PoE modules that are used to power phones, access points, and other devices.
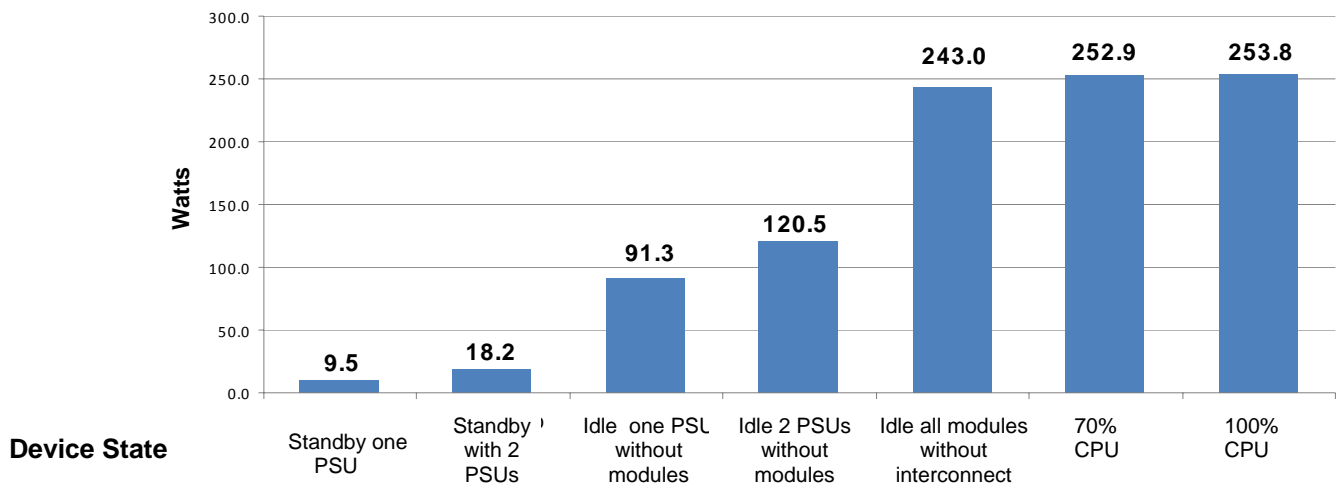
The ISR G2 routers are designed with a low power mode and activity LED indicators. Additionally, the Cisco 2911, 2951 and 3945 ISR G2 routers have a RPS LED, and a PoE LED for displaying the device activity.

The internal power supplies operate at 85% efficiency. As the technology becomes available, newer energy efficiencies will be implemented through hardware and software upgrades, for power management. Cisco EnergyWise will be supported with future IOS software releases. Additional power controls will be available with future interface modules.

The ISR G2 are specifically designed to consume less power. In addition, Cisco's EnergyWise technology allows system components to be selectively disabled during periods of inactivity, minimizing energy consumption.

The Cisco 3900 ISR provides a five-fold improvement. Features such as increased levels of services, innovation, high performance, network agility, EnergyWise efficiency, investment protection, and single IOS Software Universal image, are a few of the improvements that have been incorporated into the new product line.

Figure 3: Cisco 3945 ISR Power Profile

Power consumption was measured in standby with one PSU; standby with two PSUs; idle with one PSU and without modules installed; idle with two PSUs without modules installed; idle with all modules installed and without interconnect; and at 70% and 100% CPU utilization using IMIX traffic.

Business Processes

The Enhanced EtherSwitch Service Modules support EnergyWIse today, allowing power management performed via any IP device connected, without an interface connection. The ISR G2s support extensions to EnergyWise for module power control. The full EnergyWise subsystems, including the module power control will be available in future releases.

Cisco is continually developing new efficient technologies, and their integrated service products are designed to have a minimal impact on the environment. Environmental management systems minimize the impact by reusing, recycling and adopting processes which conserve raw materials, energy and natural resources.

The new Cisco EnergyWise architecture enhances power efficiency by powering off PoE ports and modules during non-working hours and using power levels, it also includes built-in variable speed fan modules.

The Cisco 3945 ISR provides improved media, video, local computer resources for local application flexibility and WAN development. By using existing services such as integrated security, UC, wireless, and applications, branch office expenses can be reduced. The ISR G2

routers use a single IOS image, shared among all devices, reduces tech support costs, with features unlocked using an on-demand services model.

The ISR G2 series routers are environmentally friendly, since the routers can be programmed to power off modules and connected devices, saving energy and reducing the carbon foot print. Additionally, the Cisco 3945 ISR provides the features and services of the Catalyst switches with add-on modules. These modules are smaller, cost less and provide the services needed at the applicable location, while conserving resources—from physical space, additional equipment and the other operational costs of an office.

Green Innovation

Cisco's ISO 14001 Environmental Management System (EMS) provides a continuous cycle of planning, implementing, reviewing, and improving the processes and actions performed to meet business and environmental goals. The EMS influences all aspects of Cisco operations including compliance with environmental requirements and regulations, while driving ongoing improvements to Cisco's environmental performance.

Cisco EnergyWise provides a centralized management for multiple devices with the ability to consolidate building operations in a data center, enhancing the efficient use of resources.

The operating temperature range is designed to meet the needs of a variety of customer installations. The cooling components or sensors of the system can function in varying power modes. By operating fans at a reduced speed when cooling requirements are lower, the overall power consumption is further optimized.

In addition to reducing power consumption, heat generation and cooling requirements, the built-in variable speed cooling fans run at a lower speed also reducing energy consumption. The internal components of the ISR G2 routers are designed to operate at up to 104°F or 40°C at an altitude of 6000 feet for the 1941W, and up to 10,000 ft altitude for the ISR 2911, 2951 and 3945 routers.

Affiliations and Standards

As an active member of the Green Grid, Cisco is working to raise the standards on power efficiency. Cisco is also saving energy by providing electronic manuals, which reduces consumption of natural resources. Additionally, Cisco's process enhanced standards reduce the amount of packaging used on product shipments. The distribution of products from worldwide locations reduces carbon emissions during product delivery.

Cisco is fully compliant with both the Waste Electrical and Electronic Equipment (WEEE) and European Union Restriction of Hazardous Substances (RoHS).

Cisco ISR G2 series routers comply and conform to many international standards. Through ISO 14001, Cisco demonstrates its commitment to pollution prevention, and environmental regulatory compliance. Continual product improvement shows Cisco is concerned about their customers and their community. The ISR G2 series routers comply with IEEE 802.3af.

Business Case

Figure 1 shows the annual cost for the ISR G2 routers as compared to the Industry Average of other vendor routers tested; 6% savings for the Cisco 1941W, 10% savings for both 2911 and 2951 ISR models.

In strict power consumption, the Cisco 3945 ISR realizes an 8% annual savings vs. the Industry

Average. This router offers more advanced features and performance than similar routers in the same class. As previously discussed on page 4, the ISR 3945 supports Cisco EtherSwitch Service Modules, which provide expanded router capabilities by integrating Layer 2 and Layer 3 switching, with the same feature sets which are included in the Catalyst 3750E and 2960 series switches. A modular motherboard offers increased processing capability. The modularity of this platform offers a uniquely flexible form. Therefore the power usage needs to be compared and contrasted to the additional capabilities and benefits provided by this product.

ISR G2 routers redefine branch office routing by offering high performance with advanced levels of services integration functioning at the network edge.

Based on a 12 hour work day (60 hours per week) and being closed on weekends (108 hours), the estimated use is 20 hours with a 100% load, 40 hours with a 70% load and in an Idle/Ready State for 108 hours per week.

Watts from *Figure 2* and *Figure 3* are used to compute the average annual cost. To calculate the cost, multiply the kilowatts used in the appropriate state (idle, 70% or 100%) by the hours in use. Multiply this result by 52 and again by 12.5 cents per kWh (national average electric cost as per EPA).

Certified Green

Miercom conducts environmental analysis on products using a holistic view, considering power efficiency of the product, manufacturing and overall business practices. 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 more comprehensive approach, which reveals true business case savings to customers for the other environmental benefits that a vendor's product may afford, is a better approach.

Competitive index with industry average is achieved by comparing measured results from products in a given class. The significance of this comparison is that it provides an annual running cost for power of a product, and comparison information that will help a consumer evaluate the tested product with regard to relative power efficiency of similar offerings.

Miercom Certified Green

The energy-saving attributes of the Cisco s 1941W, 2911, 2951 and 3945 ISR were evaluated by Miercom in accordance with the Certified Green Testing Methodology. The products achieved sufficient scores in each of the rated criteria to achieve the Miercom Certified Green Award.

Based on our hands-on testing and the verified representations made by Cisco, Miercom confirms that the Cisco 1941W, 2911, 2951 and 3945 Integrated Services Routers G2 are designed to provide enterprise customers effective and environmentally sound Integrated Services Router solution.

Cisco 1941W ISR   **Cisco 2911 ISR**

Cisco 2951 ISR   **Cisco 3945 ISR**

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About Miercom's Product Testing Services

Hundreds of product-comparison analyses have been published over the years in such leading network trade periodicals as Network World, Business Communications Review - NoJitter, Communications News, xchange, Internet Telephony and other leading publications. Miercom's reputation as the leading, independent product test center is unquestioned.

Miercom's private test services include competitive product analyses, as well as individual product evaluations. Miercom features comprehensive certification and test programs including: Certified Interoperable, Certified Reliable, Certified Secure and Certified Green. Products may also be evaluated under the NetWORKS As Advertised program, the industry's most thorough and trusted assessment for product usability and performance.

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