THE TOLLY GROUP

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Nortel

Ethernet Routing Switch 2500 & 4500 Series

Evaluation in "Green-IT" environments vs. Cisco Catalyst 3560G/E & 3750G/E Series & HP ProCurve 2600 Series

TOLLY Up to Spec CERTIFIED Test Summary

Premise: *When considering the purchase of standalone PoE switches, network managers need to know the day-to-day operating costs associated with these devices to determine the energy consumption or how "green" is the device.*

Nortel commissioned The Tolly Group to evaluate the company's Ethernet Routing Switch (ERS) 4550T-PWR and 4548GT-PWR with Redundant Power Supply 15 (RPS 15), as well as the ERS 2526T-PWR and ERS 2550T-PWR to determine the price per port for delivering PoE, switch power consumption and heat dissipation.

Tolly Group engineers also measured the cost to deliver full PoE (~15.4W) on all ports simultaneously for the Nortel ERS switches tested versus Cisco Catalyst 3560G-48PS, 3750G-48PS, 3560E-48PD, and 3750E-48PD; and HP ProCurve 2626-PWR and 2650-PWR switches. Tests did not focus on the Cisco 2960 Series and HP ProCurve 2800/2900 Series since PoE was not supported on those devices at test time.

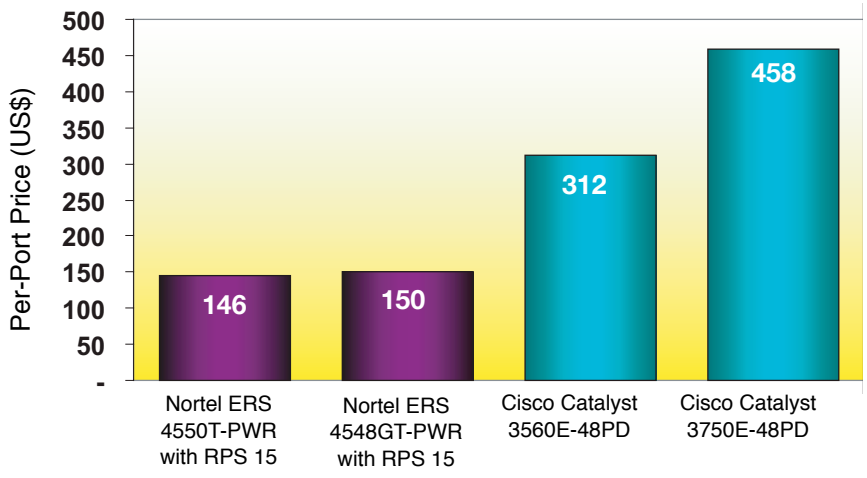
Engineers also verified the PoE power management tool of Nortel-only products via CLI, Java Device Manager (JDM) and Web-based management.

Without any external power supply attached to the tested devices, engineers measured the power consumption for a switch at factory default mode to determine how much the national average commercial electric cost over three years of continuous operation. Based on switch power consumption results, engineers calculated associated cooling costs from heat dissipation for all switches tested. Tests were conducted in October 2007.

Test Highlights

- ERS 4500 Series offers 62% lower price per port than Cisco E Series switch tested in a 48-port scenario running full power PoE (~15.4W) across 48 ports
- ERS 4500 Series offers 63% lower price per port than Cisco non-E Series switch tested in a 48-port switch running full power (~15.4W) in half of the switch ports
- ERS 2500 Series offers 51% lower price per port than HP ProCurve 2600 Series in a 24/48-port switch running full power PoE (~15.4W) across 12 ports
- Nortel's PoE switches were the "greenest" using 56% less power than Cisco devices tested and 41% less power than HP devices tested

Price Per-Port to Deliver Full Power (~15.4W) Simultaneously Over 48 PoE Ports — Nortel vs. Cisco
as reported by Sifos PowerSync Analyzer



Source: The Tolly Group, October 2007

Figure 1

Executive Summary

The Nortel ERS 2500 and 4500 series demonstrated the lowest per-port price for delivering ~15.4W on PoE ports and Nortel switches tested were the "greenest" of all switches tested.

From cost savings per PoE port to consuming the least energy, the Nortel ERS 2500 and 4500 series are proving to be the most price and energy concise among all vendors in this evaluation.

Tolly Group engineers validated the price per port to deliver ~15.4W across all ports in a 48-port switch. The results show an average savings of US$237 per PoE port when using the Nortel ERS 4550T-PWR and 4548GT-PWR with an RPS 15 against Cisco Catalyst 3560E-48PD and 3750E-48PD.

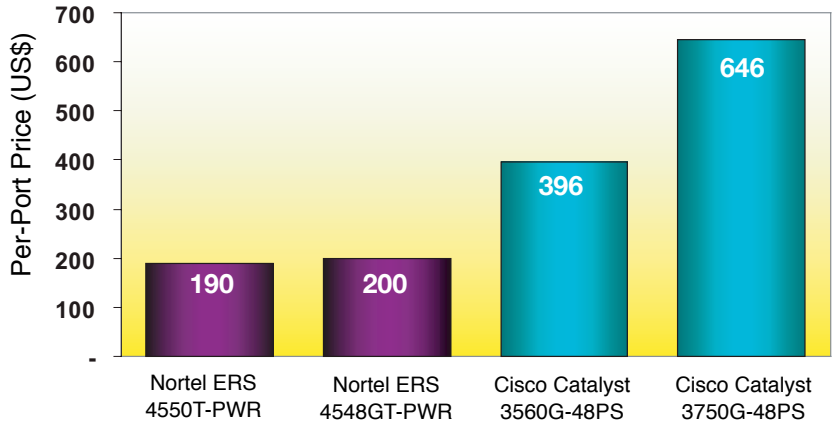
When engineers tested 21 full-power PoE ports on the Nortel ERS 4500 Series and the Cisco Catalyst 3560G-48PS and 3750G-48PS switches, they found that the Cisco devices, on average cost US$326 more on a per-port basis.

Cost savings aside, The Tolly Group's hands-on evaluation found that network managers can take advantage of the multiple PoE power management features offered on the Nortel PoE switches. Engineers were able to configure the Nortel ERS PoE switches to set the power threshold, power usage priority, and different PoE classes. Plus the Nortel ERS showed a quick recovery, less than 15 seconds, when a PoE port had to shut down to protect the PoE switches.

Environmentally friendly device characteristics, such as low power consumption and heat dissipation, are becoming key criteria for switch deployments, especially those providing PoE.

Tolly Group engineers calculated that the average three-year operational costs for the Nortel 2500 switches ($112) are 41% less than the three-year operation cost for HP switches ($190). The Nortel 4500 switches ($139) are 56% less costly than the average price of the Cisco switches ($313.5) over a three-year period. This proves that the Nortel switches were the "greenest" featuring greater energy efficiency than HP/Cisco switches tested resulting in low operational (power and cooling) costs.

Price Per-Port to Deliver Full Power (~15.4W) Simultaneously Over 24 PoE Ports — Nortel vs. Cisco
as reported by Sifos PowerSync Analyzer



Note: Nortel ERS 4550T-PWR and 4548GT-PWR were able to provide simultaneous full power (~15.4W) to 21 PoE ports; the Cisco Catalyst 3560G-48PS and 3750G-48PS delivered full power to 24 ports.

Source: The Tolly Group, October 2007

Figure 2

Results

Cost of Delivering Full Power PoE

Tolly Group engineers measured the number of PoE ports that can support full power (~15.4W) simultaneously and divided the number of full-power ports into the MSRP price to derive the cost per port of delivering full-power PoE.

Supporting 48 PoE ports, the Nortel ERS 4550T-PWR with RPS 15 achieved the lowest price per PoE port at US$146, while the Nortel ERS 4548GT-PWR with RPS 15 cost US$150 per port. This is 50% to 55% less than the per-port prices for the Cisco Catalyst switches. The per-port prices for the Catalyst

3560E-48PD and 3750E-48PD were US$312 and US$458, respectively. (See Fig. 1.) On 24-port switch models tested, the Nortel ERS 4550T-PWR and 4548GT-PWR, without the RPS 15, supported 21 full power PoE ports and delivered an average per-port price of around US$195. For the Cisco Catalyst 3560G-48PS and 3750G-48PS, the cost per port was US$396 and US$646, respectively. (See Figure 2.)

Supporting 11 full power PoE ports, the Nortel ERS 2526T-PWR and 2550T-PWR achieved per-port prices of US$109 and US$163, respectively. The cost per port for an HP ProCurve 2626-PWR and 2650-PWR was US$192 and US$367, respectively. (See Figure 3.)

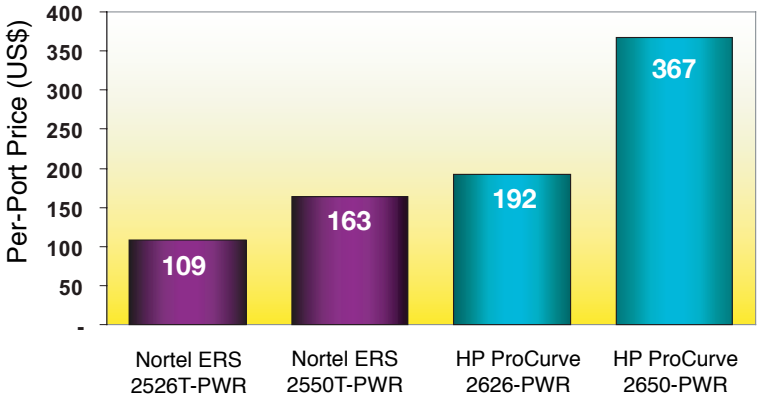
PoE Power Management

All Nortel ERS switches tested demonstrated that manageability can be handled through a command line interface (CLI), Java Device Manager and Web-based interfaces. Tolly Group engineers verified the flexibility of controlling the Nortel power features using different platforms.

Engineers verified the set up of power features on every port for power priority and power threshold. Tests show that the Nortel interfaces display a bounty of useful information regarding PoE status on each port.

Engineers also verified the effectiveness of the power priority setting for Nortel. In limiting the availability of the power of the device under test (~15.4W) and defining two levels of priority (low and critical) on two ports, engineers confirmed the accuracy of the Nortel power management since the lower priority PoE port did not power up.

Price Per Port to Deliver Full Power (~15.4W) Simultaneously Over 12 PoE Ports (Nortel vs. HP)
as reported by Sifos PowerSync Analyzer



Note: Nortel ERS 2526T-PWR and 2550T-PWR were able to provide simultaneous full power (~15.4W) to 11 PoE ports and HP ProCurve 2626-PWR and 2650-PWR delivered full power across 12 ports.

Source: The Tolly Group, October 2007

Figure 3

Nortel

ERS 2500 & 4500 Series

Price vs.
PoE Performance, Power Management and Three-Year Power Consumption

Total Power Consumption

Every network manager faces the question of how much power a switch in a data center will consume over a period of time. In today's environmentally conscious world, prolonged power consumption is referred to how "green," or efficient the device is with regard to power consumption. Tolly Group engineers measured just that with the switches tested.

In the power consumption calculation, Nortel emerged with the "greenest" products by using an average of 38 kilowatts per hour (kWh). The Cisco and HP ProCurve switches tested used about 1.7X to 2.25X more power.

Tolly Group engineers computed the total cost to power the switches tested individually over a three-year period. Tolly Group engineers used the national average price of commercial electricity in the U.S. during 2006/2007 as a primary reference to calculate the power consumption costs for each device.

Results showed the Nortel ERS 2526T-PWR consumed the least power and, consequently, cost the least to operate (US$102) over the three-year period, while the

Cisco Catalyst 3560E-48PD came in as the highest cost to operate at US$344. The cost of supplying power to the Nortel switches was 41% to 56% less than the HP and Cisco switches, respectively.

Aside from power consumption, cooling also is a cost consideration. As more power is used to operate devices, the more heat created and the more cooling needed. Tolly Group calculations show that the Nortel ERS 2526T-PWR uses the least power for cooling — only US$25 over a three-year period, while a Cisco Catalyst 3560E-48PD needed the most power for cooling at US$85 over the same three-year period.

The cooling (or heat dissipation) ratio was obtained from an article titled "Power and storage: the hidden cost of ownership – Storage Management," available at: http://findarticles.com/p/articles/mi_m0BRZ/is_10_2%203/ai_111062988

The overall operational cost related to switch power supply and cooling (heat dissipation) costs, validated that the Nortel switches are "greener" than the competitive products tested.

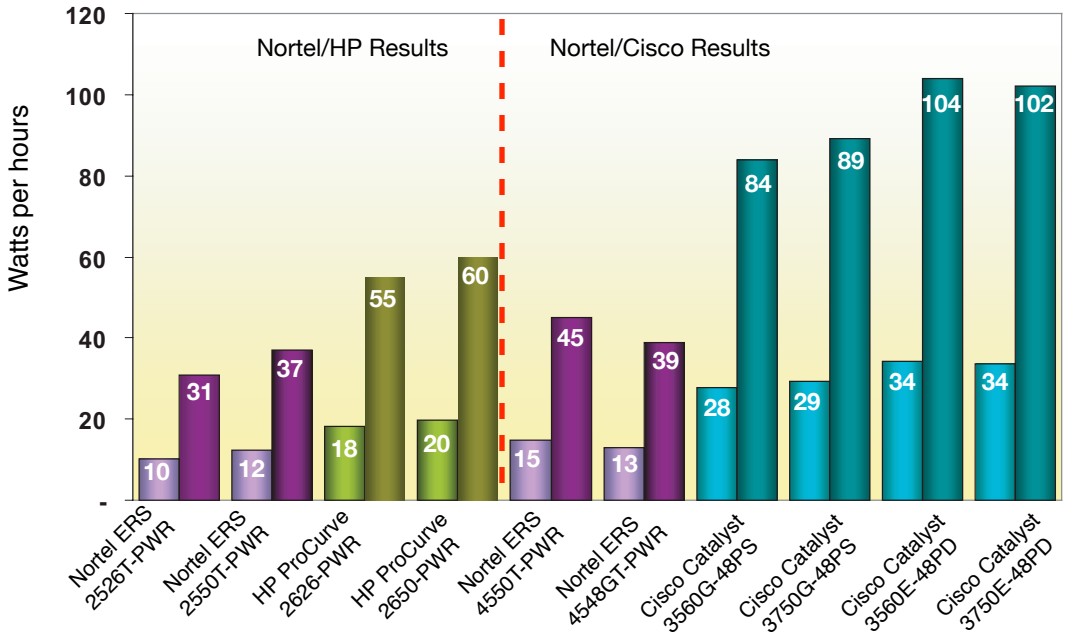
Test Setup & Methodology

Tolly Group engineers tested PoE performance on Nortel ERS 4550T-PWR with and without RPS 15 (5.0.0.002), 4548GT-PWR with and without RPS 15 (5.0.1.000), 2526T-PWR (4.0.0.000), and 2550T-PWR (4.0.0.000) against Cisco Catalyst 3560G-48PS (12.2(25)SEE2), 3750G-48PS(12.2(25)SEE2), 3560E-48PD (12.2(35)SE2), and 3750E-48PD (12.2(35)SE5); and HP ProCurve 2626-PWR (H.08.98) and 2650-PWR (H.08.60). Engineers used two units of Sifos PSA-1200 with PowerSync Analyzer Interactive 3.0 to measure the full power (~15.4W) and half power (~7.6W) for the switches tested.

Cost versus PoE Performance

Engineers used a Sifos PowerSync Analyzer test tool to measure the maximum number of ports on the tested switches that can simultaneously provide full power to PoE ports. In addition, engineers also gathered the retail prices (MSRP) for all the devices

Average Power Consumption in Watts per Hour for Switch Operation and for Cooling Associated with Heat Dissipation
as reported by Kill A Watt



Note: Left bar of each pair represents power used for heat dissipation (converted back from BTU/hr); right bar represents Watts used for switch power. Both results are expressed in Watts per hour.

Source: The Tolly Group, October 2007 *Figure 4*

from www.sparco.com, an authorized reseller for the products tested. With the above pricing and PoE performance data, engineers performed a comparison of cost versus PoE performance.

PoE Power Management

In this test, engineers focused on the Nortel ERS 2500 and 4500 series PoE power management features from CLI, Java Device Manager (JDM), and Web-based interfaces. Engineers used a Windows XP SP 2 laptop with Java Runtime Environment (JRE) 1.5 to verify Nortel's JDM on the PoE management and Internet Explorer (IE) 6.0 to verify the Web-based power management.

Total Power Consumption

Engineers used the Kill a Watt (P4400), a power measuring tool from P3 International, to record the kilowatt hours (kWh). Before measuring the kWh used by each device, engineers configured all the switches in factory default mode and only started recording the power when each switch was fully powered-up. (See Figure 4.) Engineers then calculated the power required for heat dissipation.

Engineers used the national average retail price of commercial electricity, sourced from Energy Information Administration of the Official Energy Statistics from the U.S. Government (US$0.0946 cents per kilowatt hour, 1995 to 2006) to calculate the cost of operating a switch over three years.

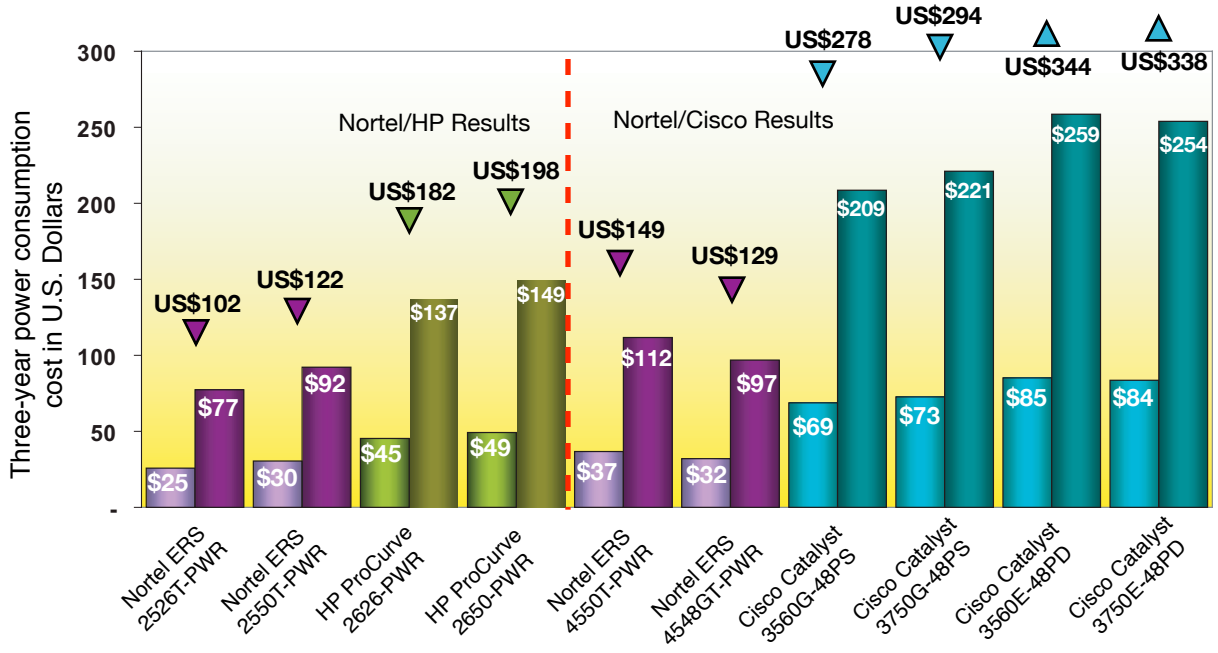
Vendor Interaction

The Tolly Group invited representatives from Cisco Systems and HP ProCurve to participate in the testing as per The Tolly Group's Fair Testing Charter.

Tolly Group shared test methodologies, device under test info, and test tool data with the HP ProCurve team for review. HP ProCurve did not respond with an official comment.

Representatives from Cisco did not respond to the invitation.

Three-Year Operational Cost of Switches Tested in Default Mode Based on 2006/07 Commercial Average Electric Price

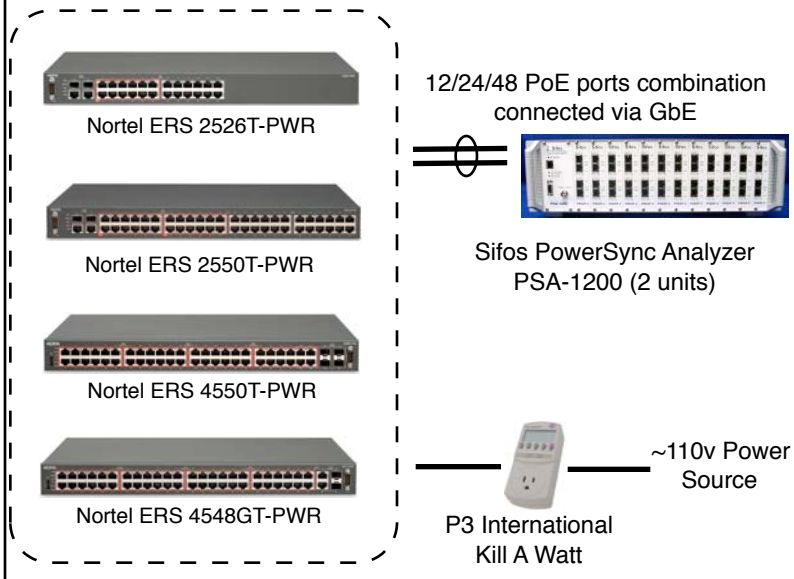


Note: Left bar of each pair represents three-year cost for power used in heat dissipation (converted back from BTU/hr); right bar represents three-year cost to power switch. Triangle points represent the three-year costs related to switch power consumption and heat dissipation. Calculations based on national average retail price of commercial electricity: US$0.0946 cents per kilowatt hour (1995 to 2006).

Source: The Tolly Group, October 2007

Figure 5

Test Bed Diagram



Source: The Tolly Group, October 2007

Figure 6

The Tolly Group is a leading global provider of third-party validation services for vendors of IT products, components and services.

The company is based in Boca Raton, FL and can be reached by phone at (561) 391-5610, or via the Internet at:
Web: http://www.tolly.com,
E-mail: sales@tolly.com

Test Equipment Summary

Vendor	Product	Web URL:
P3 International	Kill A Watt	http://www.p3international.com
Sifos Technologies, Inc.	PSA-1200	http://www.sifos.com
Sifos Technologies, Inc.	PowerSync Analyzer 3.0	http://www.sifos.com

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