Ethernet Power Study of Cisco and Competitive Products

Introduction

For LAN switching customers to better understand the power consumption of Cisco® Catalyst switches relative to other competitive brands in the market, Cisco commissioned Miercom[1] to analyze the following nine switches:

- Cisco Catalyst 2960 48TC-L
- Cisco Catalyst 2960G-48-TC-L
- Cisco Catalyst 3560E-48PD
- HP ProCurve 2650
- HP ProCurve 3500yl-48G
- Nortel BayStack 5510-48T
- 3Com 5500G-E
- Cisco Catalyst 3750G-48PS
- Cisco Catalyst C3750E-48PD-F

Motivation

Every Ethernet switch requires electricity to function. Efficiency is the measure of power relative to amount of work performed. When products use more power to perform the same amount of work, they are by definition less efficient. Low efficiency creates increased costs for a customer.

How would we calculate the cost incurred by a switch? The calculation is simple:

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Cost incurred = power consumed per hour * cost of power for every
kilowatt (kW) * number of hours the switch is running.
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If we assume the median California rate of $.10 per kilowatt hour (kWh), the cost of power for a switch consuming 100 watts (W) over a period of a year is:

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(0.1 kWh) * ($.10/kWh) * (24 hours) * (365 days) = $ 87.60
(power consumed ) * (cost per hour) * (one year)
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If approximately 5000 such switches were deployed, this becomes an expense of $438,000 per year.

Other factors that should be considered are heat dissipation and the power required to cool down the system. Heat dissipation is calculated in British thermal units (Btus)[2] and is calculated as 3.41 Btus per W of power consumption. An efficient cooling system would consume approximately 0.33 Btus for every Btu cooled, leading to a power consumption of 0.358W for cooling the heat dissipated by 1W. Introducing this factor to our previous calculation, it becomes:

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0.1 * 0.1 * 24 * 365) + (.1 * .1 * 24 *365) * 0.358 = 87.60 + 31.36
= $118.96.
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[1] http://www.miercom.com/?url=company/.
[2] http://en.wikipedia.org/wiki/Btu.

There is another downside to power consumption. Each switch increases the carbon footprint of the organization. The lesser the efficiency of the switch, the greater the footprint. According to PG&E, 0.524 pounds (lb) of carbon dioxide (CO_2) are emitted for every kWh of power consumed. A 100W switch running 24 hours a day emits close to 569 lb of CO_2 every year. Such emissions increase the carbon footprint of an organization drastically. Thus, there exists a strong business and environmental need to study the power consumption of Ethernet switches.

Power Consumption Perspective

This section provides a perspective on power consumption for the average reader.

- 33Wh is the power consumed by a ceiling fan at average speed
- 60Wh is the power that is required to light an incandescent bulb
- 80Wh is the power consumed by an average PC
- 200Wh is the power consumed by an average LCD

Procedure

A traffic generator was used to generate 5 percent and 100 percent throughput streams of bidirectional Layer 2 and Layer 3 traffic to all ports on the switch under test. Frame size was sequenced through 64, 128, 256, 512, 1024, 1280, and 1518 bytes, with a test duration of 30 seconds for each. Tests were conducted to measure power consumption for copper and fiber Small Form-Factor Pluggable (SFP) gigabit interface converters (GBICs). Power consumption with 10 Gigabit Ethernet uplinks was also measured. Power consumption was monitored using a KILLAWATT inline power meter.

Results

Power consumption at idle varied considerably across the switches under test. At the high end of the range were the 3Com 5500G-E and the HP ProCurve 3500yl, drawing 215W and 213W, for 10 Gigabit Ethernet uplinks. Both those switches support Power over Ethernet. At the low end of the range were the Cisco Catalyst 2960 and HP ProCurve 2650, drawing 33W and 51W, respectively. The Cisco Catalyst 3750E, 3750G, 3560, and 2960G and Nortel 5510 filled out the midrange, drawing from 100W to 130W.

Some technical glitches were reported on the HP 3500yl and 2650 switches when mini-GBICs were plugged in. Notably, copper mini-GIBICs triggered a “not a procurve transceiver” fault on the 2650.

Observation

Figure 1 through 3 give an overview of the power consumption trends in the various switches tested.

Figure 1. Power Consumption at 100 Percent Uplink in Layer 2 Switches

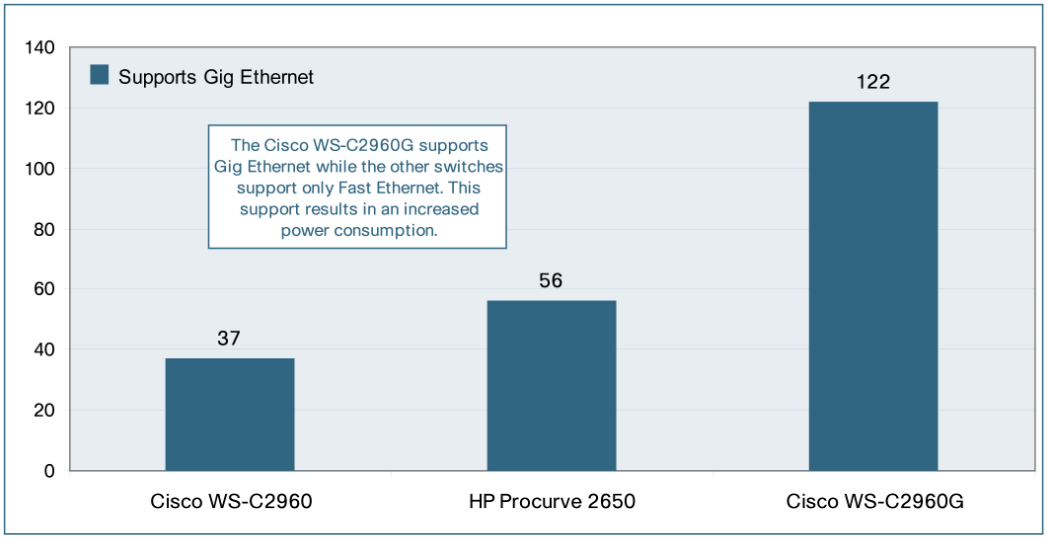


Figure 2. Power Consumption at 100 Percent Uplink in Layer 3 Switches

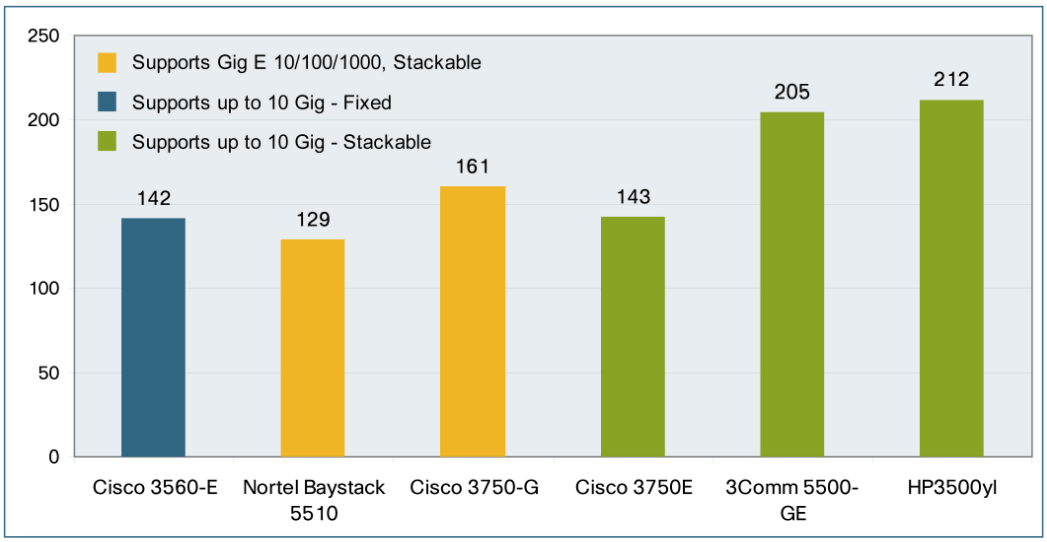
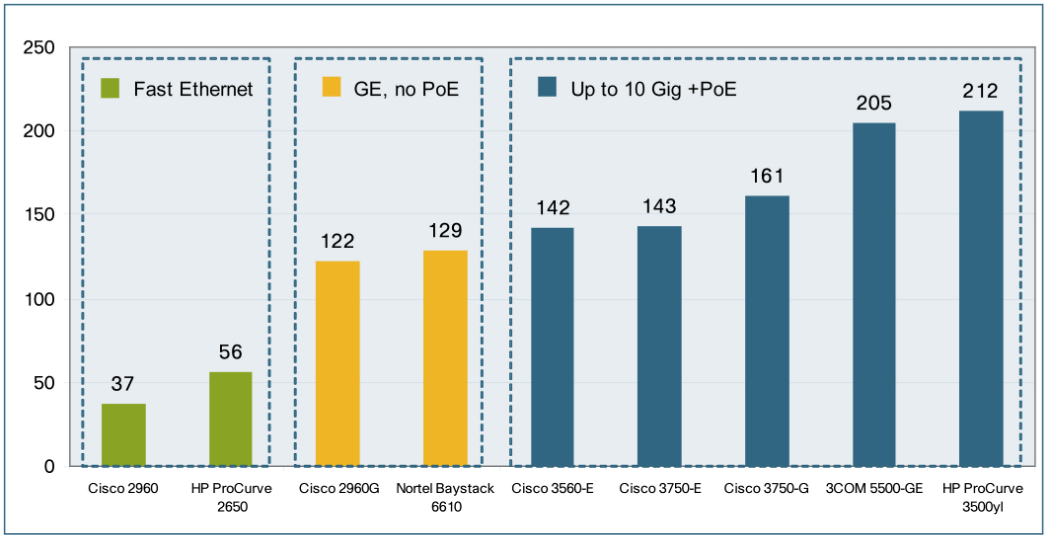
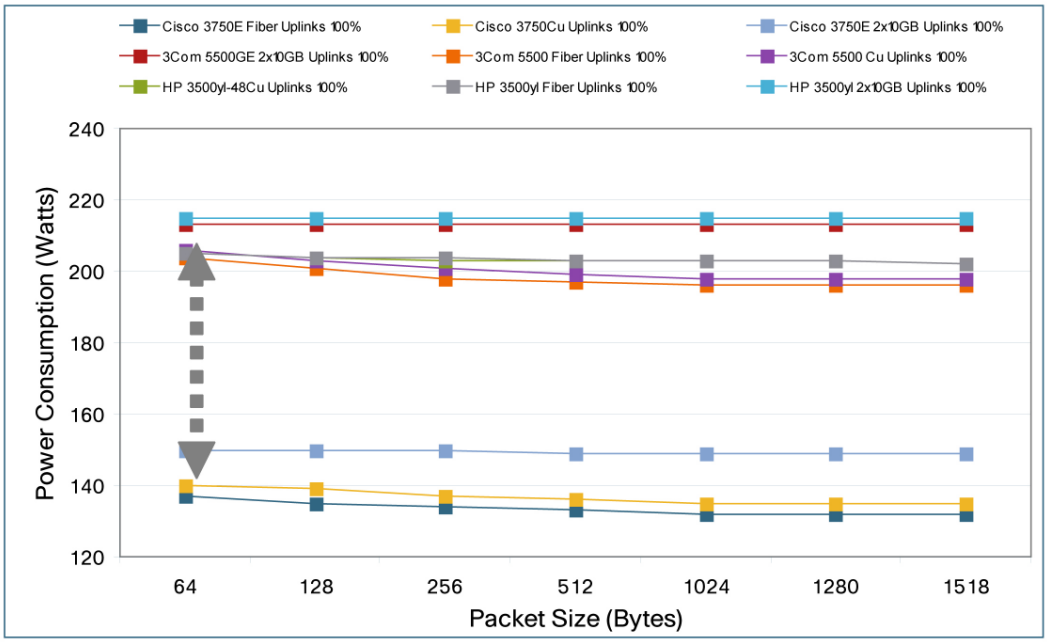


Figure 3. Power Consumption of All the Switches at 100 Percent Uplink



Cisco switches are the most efficient among their contemporaries (Figure 4). This reaffirms the gold medal that these switches received at the product leadership awards 2007.

Figure 4. Comparison of Layer 3 10 Gigabit Ethernet Switches



The Cisco Catalyst 3750E series consumes noticeably less power than the 3Com and HP switches.

These differences can have a drastic effect on revenues over a period of time. To elucidate, consider two three-switch racks, one mounted with the HP 3500yl and the other with the Cisco Catalyst 3750E switch. Table 1 shows their relative costs.

Table 1. Relative Costs

	HP ProCurve 3500yl	Cisco® 3750-E
Power per switch	212 W	143 W
Power in a 3 switch rack	636 W	429 W
Heat dissipated in BTU (1 watt = 3.41 BTU)	2168.76 BTU	1462.89 BTU
Power consumed in cooling 1 BTU	0.105W	0.105 W
Power consumed for cooling	227.71 W	153.60 W
Total power consumed	863.71 W	582.60 W
Cost per Kwh	10 cents	10 cents
Cost per day	$2.07	$1.39
Cost per year	$755.98	$510.36

Over a year the Cisco switch saves close to $245.62. In a five-year period, this saving rises to $1,228.10, and 100 such racks give rise to a saving of about $122,810.

Apart from decreasing the total cost of ownership, reduced power consumption also leads to a decrease in the carbon footprint of the organization. The Cisco Catalyst 3750E, when compared to the HP ProCurve 3500yl, decreases the carbon emission by close to a ton over the period of a year. This can lead to a reduction of 125,258 lb, or 56 tons (0.524 lb of CO2 are emitted for every kWh of power consumed) in CO2 emissions through 100 three-switch racks of Cisco Catalyst 3750E switches.

The power consumption of Cisco Catalyst switches is appreciably lower than that of comparable competitors. This reduces the total cost of ownership and creates less CO2, thus giving organizations a smaller carbon footprint.

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