TEST REPORT

Tolly.

#210137
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Commissioned by
Force10 Networks, Inc.

Force10 ExaScale E-Series E1200i Core Switch/Router

Energy Consumption Evaluation

Executive Summary

Second, perhaps, only to performance, energy efficiency has rapidly become a critical consideration when deciding upon data center network infrastructure. Higher energy consumption is a recurring cost that can add dramatically to operating expense over time. Furthermore, devices that consume more power require more cooling which not only further increases energy costs but impacts the physical design of the data center.

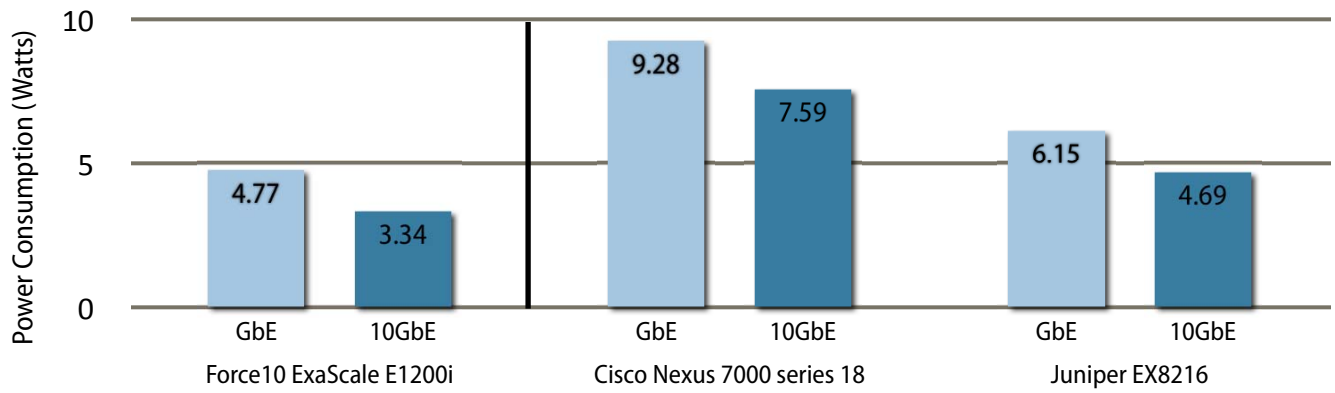
Tolly engineers evaluated the energy consumption of Force10's ExaScale E1200i in both Gigabit Ethernet and 10 Gigabit Ethernet line-rate configurations. Engineers then used energy consumption data based on figures published by Cisco Systems and Juniper Networks to calculate energy requirements for comparable Cisco and Juniper core switches.

The Force10 ExaScale configured with the maximum possible 1,260 GbE ports consumed ~1,000W less energy than the Cisco Nexus maximum configuration of 768 GbE ports. Force10 draws only 4.77W per Gbps of throughout compared with calculations of 6.15W for Juniper and 9.28W for Cisco. The Force10 ExaScale configured with the maximum possible 140 10GbE ports consumed ~1,350W less energy than Juniper and ~5,000W less energy than Cisco. Outfitted with 10GbE ports, Force10 draws only 3.34W per Gbps of throughput compared with calculations of 4.69W for Juniper and 7.59W for Cisco. See Figures 1 and 2 and Table 1.

The Bottom Line

1. Force10 provides higher density line-rate GbE and 10GbE configurations than Cisco or Juniper
2. With Gigabit Ethernet, Force10 consumes 52% less power than Cisco and 22.5% less power than Juniper in Watts per Gbps of throughput
3. With 10 Gigabit Ethernet, Force10 consumes 56% less power than Cisco and 29% less power than Juniper in Watts per Gbps of throughput

Watts per Gbps of Throughput in Maximum Gigabit and 10 Gigabit Ethernet Line-Rate Configurations
Actual Force10 Measurements vs. Cisco/Juniper Vendor-published Data
(Lower numbers are better)



Note: Juniper and Cisco devices were not tested, data was sourced in June 2010 from the Cisco and Juniper websites. Juniper figures are 2/3 of maximum as per Juniper guidelines. Cisco provides maximum and typical. Typical was used. Force10 measurements are for all ports passing traffic at 100% line rate. Calculations assume line-rate performance for Cisco and Juniper. Force10 - 1,260 GbE/140 10GbE ports. Cisco and Juniper - 768 GbE/128 10GbE ports.

Source: Tolly, June 2010

Figure 1

Introduction

Force10 Networks, Inc. commissioned Tolly to evaluate the energy consumption of its ExaScale E1200i Core Switch/Router, a chassis-based system with 14 line-card slots, in both Gigabit Ethernet (GbE) and 10 Gigabit Ethernet (10GbE) configurations.

Power was measured in both configurations, with the system handling a full load of layer 2, 64-byte frames at line rate in a "snake" configuration where the traffic stream is directed in and then out of every port on the device Cisco and Juniper devices were not tested. Tolly engineers used power consumption data published by those vendors to estimate the power consumption of similarly-configured systems.

Summary of Findings

Gigabit Ethernet Line Card

Tolly engineers measured power consumption of the E1200i, fully loaded with 14, 90-port GbE line cards provisioning 1,260 GbE ports, in addition to two Route Processor Modules (RPM) and 10 Switch Fabric Modules (SFM). Without any line cards installed, the system consumed 366W. Tolly engineers then populated all slots with 90-port GbE line cards and and measured 4,091 Watts or ~260 Watts per line card when the base chassis consumption is factored out.

With all links active but without traffic flowing, the Force10 device consumed 4,901W. Finally, handling line-rate, 64-byte layer 2 traffic through all 1,260 ports in a "snake" configuration, Tolly engineers measured 6,005.4W. See Figure 2.

Force10 Networks, Inc.

ExaScale E-Series E1200i Core Switch/Router

Energy Consumption Evaluation

Tested June 2010

Maximum Line-Rate Port Density

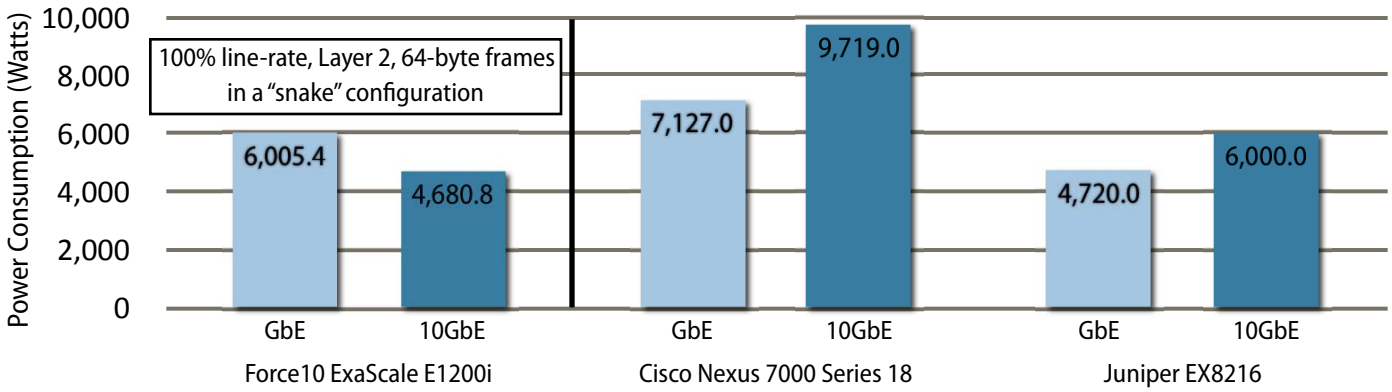
Vendor	Product	1GbE	10GbE
Force10	ExaScale E1200i	1,260	140
Cisco	Nexus 7000 series 18	768	128
Juniper	EX8216	768	128

Note: Force10 tested at maximum configurations. Cisco and Juniper numbers are maximum port configurations without oversubscribing the backplane.
Line-rate throughput is assumed for Cisco and Juniper but has not been validated by Tolly.

Source: Tolly, June 2010

Table 1

Aggregate Core Switch Power Consumption in Maximum Line-Rate Configurations
Actual Force10 Measurements vs. Cisco/Juniper Vendor-published Data
(Lower numbers are better)



Note: Juniper and Cisco devices were not tested, data was sourced in June 2010 from the Cisco and Juniper websites. Juniper figures are 2/3 of maximum as per Juniper guidelines. Cisco provides maximum and typical. Typical was used. Force10 measurements are for all ports passing traffic at 100% line rate. Calculations assume line-rate performance for Cisco and Juniper. Force10 - 1,260 GbE/140 10GbE ports. Cisco and Juniper - 768 GbE/128 10GbE ports.

Source: Tolly, June 2010

Figure 2

Correlating Watts to Gbps of throughput, this measurement translates to 4.77W per Gbps for the 1,260 GbE ports. System estimates built from Cisco's published typical power consumption figures indicate that Cisco would require ~9.3W per Gbps. Similarly, using Juniper's published typical power consumption data, Juniper would require ~6.2W per Gbps. Line-rate throughput is assumed for both Cisco and Juniper devices. See Figures 1 and 3.

10 Gigabit Ethernet Line Card

Tolly engineers repeated the test, this time using an E1200i chassis populated with 14, 10-port 10GbE line cards in place of the GbE line cards. With all 140 10GbE ports in place, Tolly engineers measured 3,756W or ~243W per line card when the base chassis consumption is factored out.

With all links active but without traffic flowing, the Force10 device consumed 3,779.7W - an increase of only .1W per port. Finally, handling line-rate, 64-byte layer 2 traffic through all 140 10GbE ports in a "snake" configuration, Tolly engineers measured 4,681W. See Figure 2.

Correlating Watts to Gbps of throughput, this measurement translates to 3.34W per Gbps for the 10GbE ports. System estimates built from Cisco's published typical power consumption features indicate that Cisco would require ~7.6W per Gbps. Similarly, using Juniper's published typical power consumption data, Juniper would require ~4.7W per Gbps. Line-rate throughput is assumed for both Cisco and Juniper devices. See Figure 1 and Table 2.

Test Bed Setup

For performance tests, Tolly engineers tested a Force10 Networks Inc. ExaScale E-Series E1200i Core Switch/Router running router software version 8.3.1.3. The primary test tool for traffic generation was Ixia's Optixia XM12 chassis, with IxAutomate 6.90 GA and IxExplorer used for data collection and analysis. For power consumption data, a Fluke model 337 True RMS Clamp Meter was utilized to gather both voltage and current metrics.

Test Methodology

Power consumption data was gathered in a variety of configurations, such that Tolly engineers could quantify the power draw of each logical module of the switch. Tolly engineers took measurements at a steady state when the chassis was loaded with an increasing number of line cards, correlating the resulting data to ensure accuracy.

Once the switch was fully populated, Tolly engineers activated all ports, taking measurements when the device attained a steady state with all ports active. From here, Tolly engineers connected the switch to the XM12 traffic generator (with the ports in a "snake" configuration), and began passing traffic. As the device was forwarding 64-byte Layer 2 frames at line-rate, on all ports, the final measurement was taken, and is used as for all comparisons made in the document.

Component Listing: Cisco and Juniper Core Switch Configurations

	Cisco Nexus 7000 Series 18			Juniper EX8216		
Module	Quantity	Model	Typical Power Consumption (W) Per Component	Quantity	Model	Typical Power Consumption (W) Per Component
Routing Engine	2	N7K-SUP1	190	2	EX8200-RE**	67
Switch Fabric	5	N7K-C7018-FAB-1	90	8	EX88200-SF**	50.25
GigE Line Card	16	N7K-M148GS-11L	358	16	EX8200-48F	221.1
10GbE Line Card	16	N7K-M108X2-12L	520	16	EX8200-8XS	301.5
Fan Trays	2	N7K-C7018-FAN	569	2	EX8200-FAN**	335*

Note: Juniper and Cisco devices were not tested, data was sourced in June 2010 from the Cisco and Juniper websites. Juniper figures are .2/3 of maximum as per Juniper guidelines. Cisco provides maximum and typical. Typical was used. * Value inferred from Juniper specified value of 1000W maximum for 2x fan trays. ** Juniper documentation refers to these components only by name and not by model number. Actual component designations may be different.

Source: Tolly, June 2010

Table 2

Competitive Power Consumption

As a basis for comparison, Tolly engineers used publicly available datasheets to model a similarly-equipped core switch from both Cisco and Juniper.

Cisco Nexus 7000 Series 18

The Cisco Nexus 7018 is an 18-slot chassis (two reserved for Supervisor Modules), capable of provisioning 768 GbE ports or 128 line-rate 10GbE ports (Cisco does offer a 32-port 10GbE line card, though the throughput to the chassis is currently capped at 80Gbps). Using Cisco's published power consumption figures, available at http://www.cisco.com/en/US/prod/collateral/switches/ps9441/ps9402/ps9512/Data_Sheet_C78-437759.html, Tolly engineers were able to configure a Nexus 7018 for N+N redundancy, as well as maximum line-rate port density in both cases. Calculating the combined typical power consumption of the switch, comparisons can then be made among the different vendors.

Juniper EX8216

For Juniper's EX8216 Core switch, the same procedure was carried out. Tolly Engineers utilized Juniper's online documentation "Calculating Power requirements for an EX8216 Switch," as a guideline for estimating power consumption under normal operation. That document is available http://www.juniper.net/techpubs/en_US/release-independent/junos/topics/task/configuration/ac-power-ex8216-requirements-calculating.html.

The evaluation called for a DC powered chassis in N+N redundancy, running the latest available software. In the aforementioned document, Juniper states that a chassis, meeting these requirements, equipped with two fan trays, two Routing Engine modules, and eight Switch Fabric modules would have a maximum power draw of 1800W.

Engineers modeled the chassis in both 1GbE and 10GbE configurations, fully-loaded with line-rate modules. Power consumption values for the modules were found on the Juniper web page titled "Power Requirements for EX8216 Switch Components" which is a link within the aforementioned Juniper web document and which lists power consumption values for the 8-port SFP+ and 48-port SFP line cards used in the energy consumption model of 450W and 330W, respectively.

Adding these values to the baseline for the chassis, Tolly engineers calculated 9000W ((16*450)+1800) for the 10GbE configuration, and 7080W ((16*330)+1800), as the maximum power for the 1GbE configuration.

The Juniper document offers the following guidance with respect to actual/typical power consumption: "Using the maximum system power consumption values to calculate the system thermal output often results in overprovisioning the cooling systems. Typical power consumption is about one-third lower than these calculated values."

Thus, engineers used power consumption values 1/3 lower of the maximum values published by Juniper. Taking this into account, we find that the typical power consumption for the 10GbE configuration is 6000 W (9000*(2/3)), and likewise, 4720 W (7080*(2/3))for the 1GbE configuration.

TOLLY™ common TEST PLAN SERIES

The test methodology used for this report relies upon test procedures, metrics and documentation practices as defined in various Tolly Common Test Plans.

To learn more about Tolly Common Test Plans, go to:

http://www.CommonTestPlan.org

Competitive Interaction

While no testing was conducted of Cisco or Juniper products, Tolly did offer to share the energy consumption model with each vendor. Cisco offered corrections to its configuration which are integrated into the published model.

Tolly Fair Testing Charter

A Juniper representative stated that "We are not endorsing any comparisons not based on actual measurements." The representative also noted that Juniper supports only two measurement methodologies: ATIS-TEER and ECR.

For more information about the Tolly Fair Testing Charter, please see:

http://www.tolly.com/FTC.aspx

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Test Equipment Summary

The Tolly Group gratefully acknowledges the providers of test equipment/software used in this project.

Vendor	Product	Web
Ixia	Chassis Type: Optixia XM12 Card Types: LSM10GXM8 Software: IxOS 5.60 EA SP2 IxExplorer 5.60 EA SP2 IxAutomate 6.90 GA Patch 2	http://www.ixiacom.com/
Fluke	Fluke Model 337 True RMS Clamp Meter	http://us.fluke.com

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