THE TOLLY GROUP

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Nortel

Ethernet Routing Switch 8300 Series

Competitive Performance Evaluation versus Cisco Catalyst 4500 Series with Supervisor Engine V-10GE

TOLLY Up to Spec CERTIFIED Test Summary

Premise: When considering the purchase of modular switches, network managers need to understand the bidirectional performance characteristics of the interface modules as well as the base system's backplane capacity. Buyers also need to know the impact a link or component failure will have on the switch cluster.

Nortel commissioned The Tolly Group to evaluate the Layer 2 switching performance, resiliency and ease of use delivered by the company's chassis-based Ethernet Routing Switch (ERS) 8300 which is deployed in enterprise wiring closets, or as an aggregation or a core switch. The Nortel ERS 8300 modules tested include Switch Fabric Modules, plus 24- and 48-port GbE interface modules and a 10GbE module.

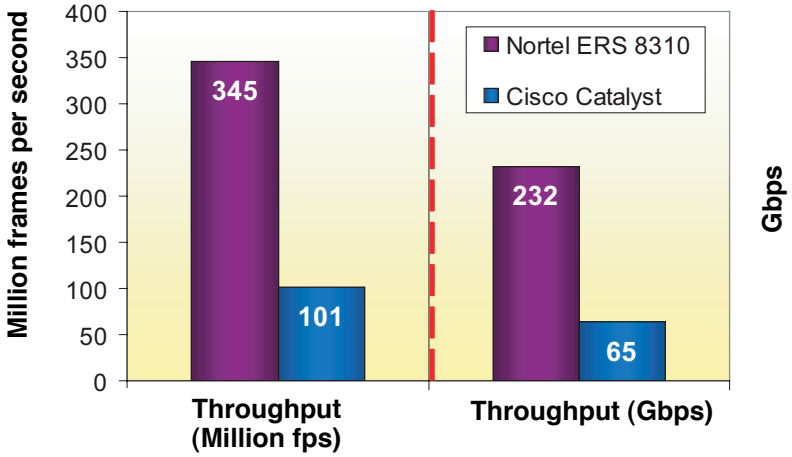
Engineers measured the performance, resiliency characteristics and power consumption of the ERS 8300 and a comparable Cisco Catalyst 4500 chassis-based switch with the maximum allowable equivalency in module configuration.

Engineers also measured resilient performance between the Nortel ERS 8300 running switch clustering and the Cisco Catalyst 4500 running High Availability (HA) solutions. Tests were conducted in January 2008.

Test Highlights

- ERS 8300 forwards 345 million frames per second versus 101 million fps for the Catalyst 4500 when handling 64-byte frames
- ERS 8300 I/O modules demonstrate 75% to 301% higher forwarding rate compared to the Catalyst 4500
- Provides 3X and 5X faster recovery from link and switch outages, respectively, using Nortel's Switch Clustering (SMLT)
- Nortel ERS 8300 Switch Cluster exhibits 8X faster recovery from an active Switch Fabric Module failure compared to a Catalyst 4500 running Cisco's High Availability solution
- ERS 8300 exhibits 12% greater energy efficiency than a Catalyst 4500 resulting in lower power and cooling costs

Zero-loss (≤0.001%) Aggregate Layer 2 Throughput and Frame Forwarding Rate when Handling 64-byte Frames in a Fully Populated Chassis (192 GbE ports + Four 10GbE Ports Tested)
as Reported by SmartFlow 5.50



Note: While both systems were outfitted with four 10GbE ports, Cisco's architecture only allows two active ports from the Switch Fabric Module. Thus, Cisco's results are with two 10GbE ports.

Source: The Tolly Group, January 2008

Figure 1

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Executive Summary

The Nortel ERS 8300 demonstrated higher throughput than the Cisco Catalyst 4500 in a fully populated chassis configuration, as well as the individual module tests while exhibiting faster recovery from link, switch and Switch Fabric Module failures.

A chassis-based LAN switch solution offers a wide range of capabilities that accommodate many network requirements. This solution is intended to meet the needs of the Enterprise network core and edge where high performance and high availability are essential.

Tolly Group test results show that the Nortel ERS 8300 delivered a total switching capacity that is 3.5X higher than the Cisco Catalyst 4500 with a Supervisor Engine V-10GE. This means that the Catalyst 4500 requires a greater investment in hardware to achieve the same capacity as the ERS 8300 and, in turn, consume more space and power in the wiring closet.

Also, the resiliency test results indicate that the Nortel ERS 8300 resiliency solution based on Switch Clustering technology provides 3X to 8X faster fail-over times than the Cisco Catalyst 4500 RSTP and High Availability solutions, depending on the failure scenarios. Some latency-sensitive applications running over the Cisco Catalyst 4500 could drop with as much as 7 seconds of fail-over. This application failure can have direct impact on business applications and functions.

Tolly Group engineers measured the throughput characteristics of the chassis-based Nortel ERS 8300 10-slot switch and the Cisco Catalyst 4500 10-slot switch.

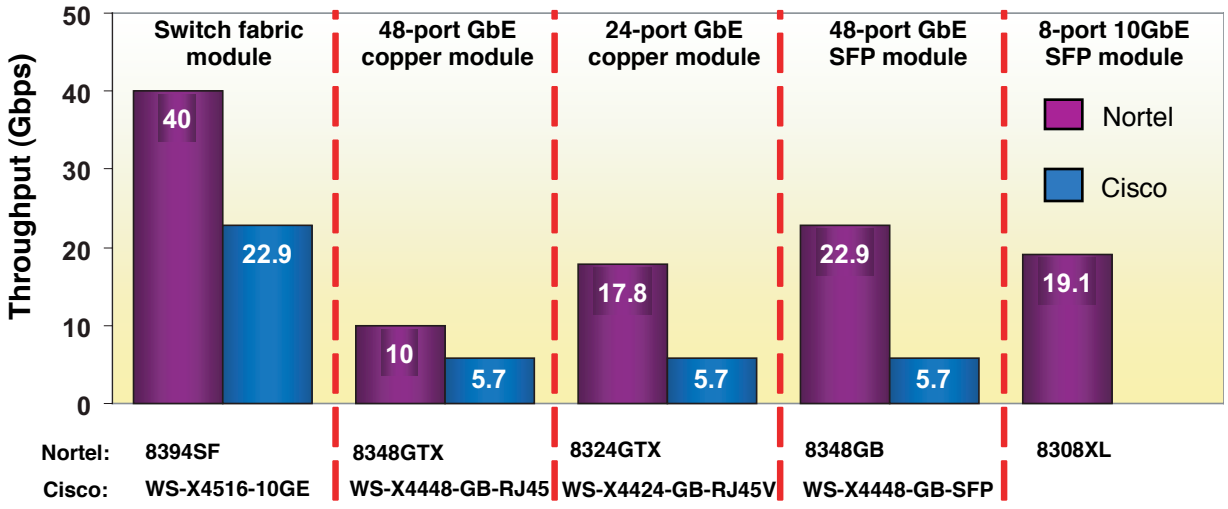
First, engineers measured the zero-loss (≤ 0.001%) Layer 2 throughput using 64-byte frames in a fully populated chassis configuration. Both switches are equipped with two Switch Fabric Modules (SFMs) and eight interface (I/O) modules. The fully populated Nortel ERS 8300 switch achieved 345 million frames per second (fps) or 3.4X higher than the Cisco 4500, which achieved just 101 million fps.

Next, engineers measured the zero-loss (≤ 0.001%) Layer 2 throughput when handling all standard frame sizes from 64-byte to 1,518-byte frames for the SFM and I/O modules. *(For detailed module information, see Test Setup & Methodology section)* In the throughput test, the Nortel ERS 8300 modules outperformed the comparable Catalyst 4500 modules by up to 4X.

Engineers also measured the fail-over time of the Nortel ERS 8300 Split Multi-Link Trunking (SMLT) and Cisco Catalyst 4500 Rapid Spanning Tree Protocol (RSTP) in various failure scenarios. The results show the Nortel ERS 8300 recovered quicker from link and switch failures with an average of 0.7 seconds or 3.2X faster than the Catalyst 4500

Zero-Loss (≤ 0.001%) Layer 2 Throughput (Gbps) for Nortel ERS 8300 and Cisco Catalyst 4500 Modules for 64-byte Frames in Port-Pairing Configuration

as reported by SmartFlow 5.50



Note: For detailed port configuration and test methodologies, refer to the Test Setup & Methodology section in this report. An 8-port 10GbE XFP module was only tested for Nortel.

Source: The Tolly Group, January 2008

Figure 2

which required just 2.9 seconds.

Engineers measured the fail-over time of Cisco's High Availability and Nortel's Switch Clustering technologies; results show the Nortel ERS 8300 recovery was 0.89 seconds or 8X faster than the Catalyst 4500's 7.16 seconds.

In a power consumption test, engineers used a six-slot ERS 8300 and a Catalyst 4500 with a single switch fabric/supervisor module and three I/O modules in each chassis. The ERS 8300 demonstrated lower power consumption thus resulting in a lower TCO compared to the Catalyst 4500.

THROUGHPUT (FULLY-POPULATED CHASSIS)

The Nortel ERS 8300 was compared against the Catalyst 4500 in terms of Layer 2 zero-loss (≤ 0.001%) throughput when handling 64-byte Ethernet frames for a fully populated chassis.

Test results show that the Catalyst 4500 was only able to reach the maximum throughput of 65 Gbps (equivalent to 101 million fps for the 64-byte frames) while the ERS 8300 throughput was 232 Gbps (345 million fps) which is 3.5X better than the Catalyst 4500 result. (See Figure 1.)

THROUGHPUT (INDIVIDUAL MODULES)

For the SFM/supervisor module test, since one of the Cisco Catalyst 4500 supervisor modules was in standby, engineers were able to measure 22.9 Gbps of zero-loss (≤ 0.001%) Layer 2 throughput from one module. Since the Nortel ERS 8300 utilized ports from both SFMs simultaneously, the ERS 8300 achieved 40 Gbps of Layer 2 throughput. *(Note: Each Cisco 4500 supervisor engine consisted of two 10GbE and four GbE ports. Tolly Group engineers used all of the ports for the tests.)*

For the individual I/O module test, engineers measured throughput when two identical modules exchanged traffic across the backplane and then divided by two. For 48-port GbE copper module, 24-port GbE copper module and 48-port GbE SFP module tests, the Nortel 8300 recorded 10 Gbps, 17.8 Gbps and 22.9 Gbps, respectively, whereas the Catalyst 4500 provided throughput of 5.7 Gbps for all modules. Engineers also tested the Nortel-only eight-port 10GbE SFP module at 19.2 Gbps. (See Figure 2.)

Note: The Cisco Catalyst 4500 non E-series does not have a 10GbE module.

SMLT VS RSTP PERFORMANCE

Tolly Group engineers tested the fail-over times of Cisco's RSTP and Nortel's SMLT technology in the event of link or switch failures. The Nortel solution consisted of two ERS 5530 switches as edge switches and two ERS 8300 switches as core switches with SMLT configured, while the Cisco solution consisted of two Catalyst 3750G and two Catalyst 4500 switches using RSTP.

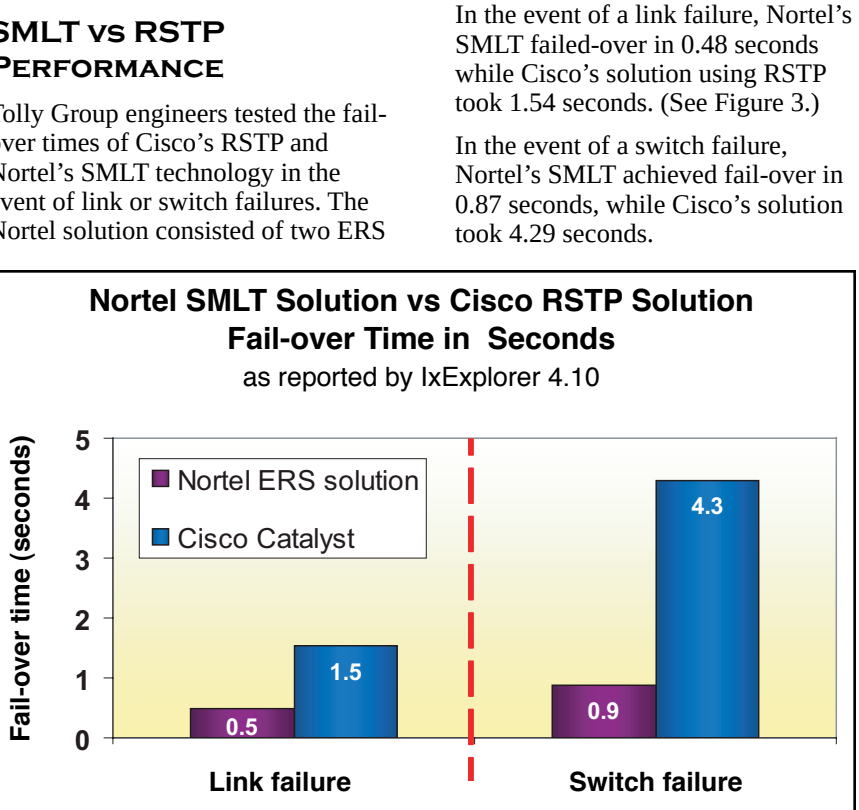
Tests show that the Nortel solution using SMLT demonstrated faster network fail-over/recovery time in the event of a link or a switch failure. In the event of a link failure, Nortel's SMLT failed-over in 0.48 seconds while Cisco's solution using RSTP took 1.54 seconds. (See Figure 3.)

In the event of a switch failure, Nortel's SMLT achieved fail-over in 0.87 seconds, while Cisco's solution took 4.29 seconds.

Nortel

Ethernet Routing Switch 8300

Competitive Performance Evaluation of Chassis-based Switches



Note:
Nortel Ethernet Routing solution: Consists of two ERS 5530 access switches and two ERS 8300 core switches using SMLT for resiliency.

Cisco Catalyst Switch solution: Consists of two Catalyst 3750G access switches and two Catalyst 4500 core switches using RSTP for resiliency.

Source: The Tolly Group, January 2008

Figure 3

Test results show that with the same network topology, Nortel's SMLT achieved significantly faster fail-over compared to the RSTP offered by Cisco. (See Figure 3.)

HIGH AVAILABILITY VS SWITCH CLUSTERING PERFORMANCE

Engineers measured fail-over times when an active SFM failed. To determine how the switches under test respond to the failure of an active SFM, Tolly Group engineers compared the fail-over times of Cisco's High Availability (HA) and Nortel's Switch Clustering solutions. Nortel and Cisco configurations remained the same from previous section (SMLT vs. RSTP), except engineers configured Nortel using Switch Clustering and Cisco using HA with one less switch.

In the event of an active SFM failure, Nortel's solution using Switch Clustering failed-over in 0.89 seconds, while Cisco's solution using HA took 7.29 seconds. (See Figure 4.)

CONFIGURATION AND MANAGEMENT

Nortel switches use the Nortel Networks Command Line Interface (NNCLI) which closely resembles a CLI used by other vendors, including Cisco Systems. This means users don't have to retrain staff who already may be familiar with configuring Cisco and other switches. Ultimately, this reduces the total cost of ownership.

TOTAL POWER CONSUMPTION

In the power consumption calculation, Nortel's ERS 8300 emerged as "Greener" by utilizing 495 watts/hour for power and heat dissipation in a heavily loaded chassis. The Cisco Catalyst 4500 switch in a similar configuration used about 12% more power. (See Figure 5.)

Tolly Group engineers computed the total cost for power consumption for switch operation and heat dissipation over a five-year period. 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. (See Figure 5.)

TEST SETUP & METHODOLOGY

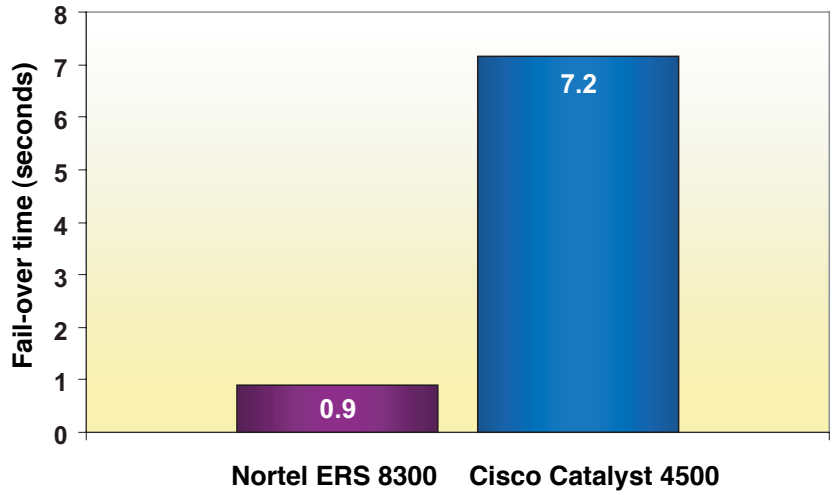
Tolly Group engineers tested the Nortel ERS 8310 chassis-based switch with SFM (8394SF) and I/O modules (8348GTX, 8324GTX, 8348GB and 8308XL). All devices were running software version 4.0.0.0 against the Cisco Catalyst 4510R chassis-based switch with SFMs (WS-X4516-10GE Supervisor Engine V-10GE) and I/O modules (WS-X4448-GB-RJ45, WS-X4524-GB-RJ45V and WS-X4448-GB-SFP) running IOS version 12.2(37)SG.

Engineers used a Spirent SmartBits 6000C with SmartFlow 5.50 software to test Layer 2 zero-loss (≤ 0.001%) performance with bidirectional port-pairing configuration using 64-byte frames. All tests were run for three iterations and the results were averaged.

In the fully populated chassis test, the Nortel ERS 8300 chassis was populated with two SFMs (8394SF) and eight I/O modules (8348GB). 24 GbE ports from each I/O, for a total 192 GbE ports connected to the test tool as well as four 10GbE ports from two SFMs. The Catalyst 4500 was also populated with two SFMs (WS-X4516-10GE Supervisor Engine V-10GE) and eight I/O modules (three units of WS-X4448GB-RJ45, four units of WS-X4524GB-RJ45V and one unit of WS-X4448-GB-SFP).

Nortel Switch Clustering vs Cisco High Availability (HA) Fail-over Time Comparison in Seconds (Switch Fabric Module Fail-over)

as reported by IxExplorer 4.10



Note:
Nortel: Consists of two ERS 5530 access switches and two ERS 8300 core switches with a single 8394SF in each chassis. Nortel solution was running Switch Clustering (SMLT) for resiliency.

Cisco: Consists of two 3750 access switches and one 4510R core switch with dual Supervisor Engine V-10GE. Cisco solution was running High Availability (HA) in its core 4510R chassis.

Source: The Tolly Group, January 2008

Figure 4

See:

www.cisco.com/en/US/docs/switches/lan/catalyst4500/12.2/37sg/configuration/guides/config.html

Due to the Catalyst 4500 architecture limitation, with two SFMs connected, only one module can be in active mode and another module resides in standby mode.

Since the Catalyst 4500 was not able to use the ports from the standby SFM, two 10GbE ports from the active SFM. plus 192 GbE ports, were connected to the test tool.

In the I/O module performance tests, engineers paired two identical modules to ensure bidirectional traffic generated from a SmartBits test tool flowed across the backplane of the switch chassis. They subsequently, divided the results by two to obtain a single I/O module result.

In a paired configuration scenario, engineers tested the Nortel ERS 8300 modules of an 8348GTX (24 GbE ports per module), 8324GTX (20 GbE ports per module), 8348GB (24 GbE ports per module) and the Catalyst 4500 modules of WS-X4448-GB-RJ45 (24 GbE ports per module), WS-X4524-GB-RJ45V (20 GbE ports per module) and WS-X4448-GB-SFP (24 GbE ports per module).

In Layer 2 performance test involving SFM modules, engineers used the same pair configuration as the I/O module tests from above and tested the Nortel ERS 8300 modules of 8394SF (two 10GbE ports per module). For the Catalyst 4500, due to architecture limitations, engineers tested the SFM modules of WS-X4516-10GE Supervisor Engine V-10GE (two 10GbE ports and four GbE ports from the active module and no ports were used from the standby module.)

For comparing the fail-over times of Nortel's implementation of SMLT with Cisco's implementation of RSTP, the test bed consisted of two access switches dual-homed to two core switches, with the access switches and the core switches of the same vendor. (See Figure 6.) Nortel's solution consisted of two Nortel ERS 5530-24TFD switches (SW Ver. 5.0.6.026), each dual-homed to two Nortel ERS 8300 switches using two GbE links.

Cisco's solution under test consisted of two Cisco Catalyst 3750G-16TD access switches (SW Ver. IOS 12.2(25)SEB2), each dual-homed to two Catalyst 4500 switches using two GbE links. An Ixia 1600T traffic generator was connected to the access switches to send test traffic.

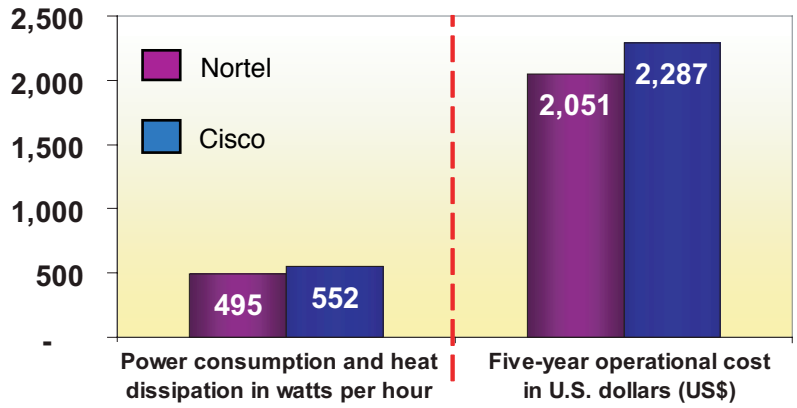
While the traffic was flowing at a steady state, the active link from each switch was failed, and engineers measured the time required for the network to reconverge and start transmitting the traffic on the other link. Also, while the traffic was flowing at a steady-state, the core switch forwarding the traffic was failed, and engineers measured the time required for the network to reconverge. The tests were done three times to ensure repeatability of the results, and the numbers were averaged to obtain the final results.

In comparing Cisco's High Availability with Nortel's Switch Clustering fail-over times, engineers used the previous resiliency test bed for the Nortel test but used one Catalyst 4500 chassis with two SFMs to implement the Cisco's High Availability. For this test, engineers introduced the failure by plugging out the active SFM.

In the power consumption test, engineers used a power measurement tool from P3 International. Nortel's ERS 8306 was used with two units of 8348TX, 8324GTX and a single 8394SF. The Cisco Catalyst 4500 consisted of a 4506-E chassis with one WS-X4516-10GE Supervisor Engine, WS-X4424-GB-RJ45 and 2 units of WS-X4148-RJ.

In both vendor configurations power consumption was measured across all GbE ports with active operational status.

Average Power Consumption of Switches Tested Plus Projected Five-Year Operational Costs in U.S. Dollars

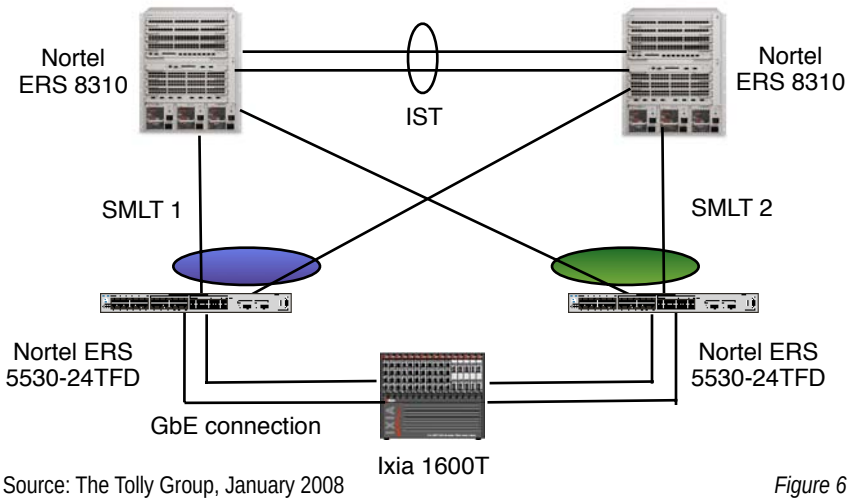


Five-year cost projections are based on the 2006/2007 Average Commercial Electric Price of US$0.0946.

Source: The Tolly Group, January 2008

Figure 5

Test Bed Showing Nortel Ethernet Routing Switch Solution Using SMLT



Source: The Tolly Group, January 2008

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:
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E-mail: sales@tolly.com

Fair Testing Charter™
Interaction with Competitors

The Tolly Group invited representatives from Cisco Systems to participate in the testing as per The Tolly Group's Fair Testing Charter (See http://tolly.com/FTC.aspx). Representatives from Cisco did not respond to the invitation.

Test Equipment Summary

Vendor	Product	Web URL:
Ixia Communications	IXIA 1600T, IxExplorer 4.10	http://www.ixiacom.com
Spirent Communications	SmartBits 6000C, SmartFlow 5.5	http://www.spirentcom.com

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