THE TOLLY GROUP

No. 205116 June 2005

Nortel
Ethernet Routing Switch 8600 and Ethernet Routing Switch 5520/5530
Performance Evaluation of Nortel Resilient Terabit Cluster Solution

TOLLY 16 YEARS 1989-2005 Test Summary

Premise: *Companies are looking to networks to help increase employee productivity and lower costs. This "help" is typically measured in terms of being able to support converged and collaborative applications. Networks that support these converged and collaborative applications have different requirements than data networks of old. Resiliency, security and intelligence are the major requirements of networks today. Resiliency is a basic requirement. The network must be reliable before trusted applications can rely on it heavily. Nortel's Resilient Terabit Cluster solution offers a highly resilient data infrastructure capable of Terabit throughput with high availability and extremely rapid link failover times.*

Nortel commissioned The Tolly Group to evaluate the Nortel Resilient Terabit Cluster Solution, a combination of resilient hardware and software in the Nortel Ethernet Routing Switch 8600.

Nortel demonstrated the resiliency and rapid failover to alternate paths of the Nortel Resilient Terabit Cluster Solution during link outages. Nortel also demonstrated the aggregate bidirectional switch throughput and latency of the cluster solution, as well as several key functions, including advanced filtering and Universal Serial Bus (USB) configuration support designed to facilitate use of the cluster devices which benefit applications such as ERP, CRM and VoIP.

The Tolly Group conducted all tests in April 2005 at Nortel's Santa Clara, CA. facilities.

Results & Analysis

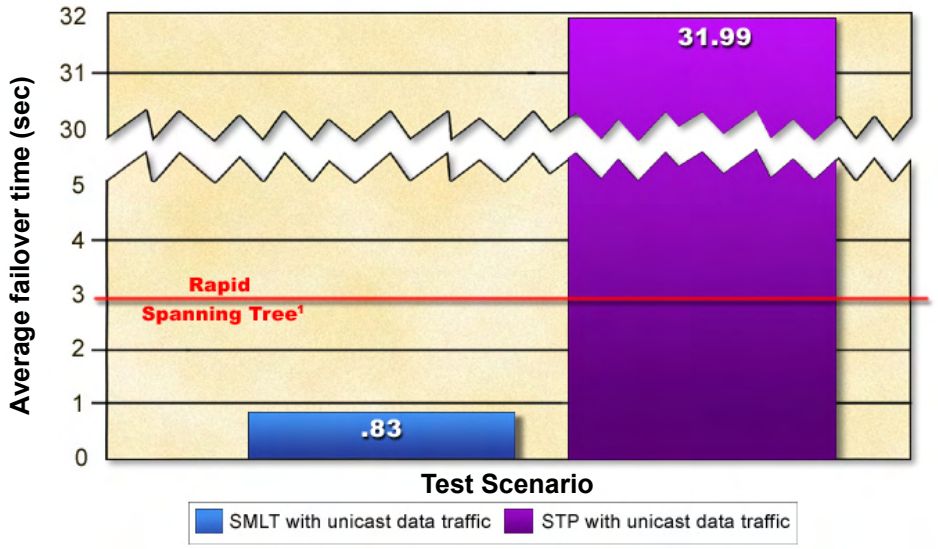
Resiliency

Traditional approaches to combat network link and hardware failure in Ethernet routing networks often rely upon dual-homing of wiring closet switches to network center aggregation

Test Highlights

- Provides high resiliency for multimedia traffic with sub-second recovery from failures while forwarding data traffic in SMLT mode. This is an order of magnitude better than Spanning Tree which requires up to 32 seconds for link recovery.
- Exhibits superior performance of 649 million frames per second bidirectionally with latency of less than 25 µsec, well within the ITU-T G1010 specification for multimedia traffic.
- Furnishes very strong per-port security with up to 10,000 Layer 2-7 filters per chassis (4,000 rules per physical interface).
- Demonstrates ease-of-use and configures easily with built-in USB ports for image download and industry standard CLI.

Comparison of Average Failover Time of STP and SMLT for Unicast Data Traffic in the Nortel Resilient Terabit Cluster Solution
(as Reported by Spirent SmartWindow 8.50)



[1]The Tolly Group's Tolly Verified for Rapid Reconfiguration Spanning Tree Support (802.1w) stipulates that reconvergence time must be less than three seconds. (Tolly Verified 10507)

Source: The Tolly Group, May 2005 *Figure 1*

Layer 2/Layer 3 Performance of Nortel Resilient Terabit Cluster Solution
(as Reported by Spirent SmartFlow 4.60 using 440 Gigabit Ethernet Ports on SmartBits 6000C)

Frame forwarding rate		Average store and forward latency (microseconds)	
Layer 2	Layer 3	Layer 2	Layer 3
649.1 million fps	649 million pps	24.38 µsec	23.8 µsec

Note: Latency was measured at 96% of line rate on a multihop basis, across three hops, in the Resilient Terabit Cluster Solution.

Source: The Tolly Group, May 2005 *Figure 2*

(core) switches and usage of the Spanning Tree Protocol (STP). STP does not easily allow the full use of all network links without resorting to using a complicated multiple spanning-tree group layout. Another approach to combat network link and hardware failures is to introduce IP routing in the network closet to load balance the traffic between the redundant network links.

Rapid Spanning Tree (Active Standby) can be used to reduce the link recovery times associated with STP (Active Standby), but Nortel's Split Multi Link Trunking (SMLT) utilizes all network links and switches simultaneously while providing sub second recovery from link or switch failures. This test compares the network failover times between the scenarios where STP is used to those scenarios where Nortel's SMLT (Active/Active) is used.

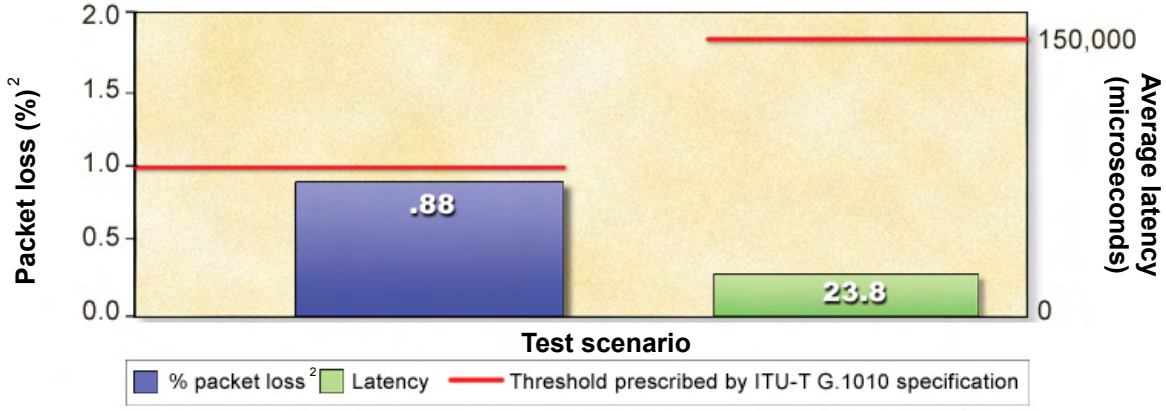
When a network link supporting data traffic was failed in the STP scenario, the link recovered in 31.99 seconds. When a similar data traffic link was failed in the SMLT scenario, the connection recovered in 0.83 seconds. (See Figure 1.) Tests also were performed to measure resiliency for multimedia traffic which requires multicast support. PIM SM (Protocol Independent Multicast – Sparse Mode) was utilized for multicast routing and using SMLT, the failed link recovered in a fraction of the time compared to STP with minimal loss in video frames and quality.

Layer 2/3 Throughput and Latency

The latency and frame loss performance exhibited by Nortel's Resilient Terabit Cluster solution fall within the thresholds prescribed by the ITU-T G.1010 specification, which recommends the frame loss and one-way delay for communication networks to provide various levels of service for multimedia traffic. (For the purpose of this report, we report frames at Layer 2 and packets for Layer 3 results.)

In the Layer 2 frame-forwarding rate performance test, a Spirent SmartBits/SmartFlow traffic generator was used to generate 440 Gbps of traffic (64-byte frames at 655 million frames per second [fps]). There were 22 Nortel Ethernet Routing Switch 5530-24TFD switches divided into two groups: one on the transmitting end, and one on the receiving end. The transmitting Ethernet Routing Switch 5530s connected on one side to test ports generating traffic and uplinked the traffic to the Ethernet Routing Switch 8600 switches to be forwarded to the downstream Ethernet Routing Switch 5530

Layer 3 Packet Loss and Latency of Nortel Resilient Terabit Cluster Solution and Comparison to the ITU-T G.1010 Specification [1]



[1] ITU-T G.1010 specification provides end-to-end tolerance guidelines for frame loss and latency of multimedia applications. The frame loss and latency values exhibited by Nortel's Resilient Cluster Solution are within the G.1010 specified thresholds for business-quality multimedia networks.
[2]Packet loss and latency results were derived from a configuration where each flow was traversing through three different switches.

Source: The Tolly Group, May 2005 *Figure 3*

switches. Test ports received test traffic from the downstream Ethernet Routing Switch 5530 switches and calculated the frames received per second and the percentage of frames transmitted that were lost. Under this full load, the resilient cluster solution achieved an average frame forwarding rate of 649 million frames per second. See Figure 2 and Figure 3.

In a Layer 2 configuration with a load equal to 96% of line rate, the resilient cluster solution showed an average end-to-end Store and Forward latency of 24.38 µsec.

In the Layer 3 packet forwarding rate test, the Spirent SmartBits/SmartFlow traffic generator supplied data at line rate (440 Gbps, or 655 million packets per second [pps] for 64-byte frames). The Nortel resilient cluster solution achieved a packet forwarding rate of around 649 million pps.

In Layer 3 configuration the resilient cluster solution showed an average end-to-end Store and Forward latency of 23.80 µsec.

Security Scalability Evaluation

Nortel engineers demonstrated that Nortel's Ethernet Routing Switch 8600 (running 4.0 code and 8683XLR line cards with Routing and Switching Processor) allowed up to 10,000 Layer 2 through Layer 7 filtering rules to be configured on the switch. Engineers verified the high filter count by checking the switch console that a total of 10,000 filter rules were configured. A maximum of 4,000 filter rules (VLAN-based and/or port-based) can be created on each interface, and a maximum of 10,000 filter rules can be created across the entire chassis.

Configuration and Management

Nortel switches use a command line interface (CLI) that resembles a CLI used by other vendors, including Cisco Systems. This means users don't have to re-train staff who already may be familiar with the CLI and, ultimately, should reduce TCO.

Nortel engineers demonstrated support for USB memory devices on the Ethernet Routing Switch 5530. Engineers demonstrated the ability to upgrade the switch software using a software image stored on a USB memory device. They also demonstrated the ability to upload a switch image binary file to a USB device and the ability to download a switch image binary file from a USB memory device. Engineers also proved that users at a switch console could download an ASCII configuration file from a USB device, and, finally, that an ASCII file format configuration file can be saved to a USB device.

Test Configuration and Methodology

For performance tests, The Tolly Group tested a Nortel Resilient Terabit Cluster Solution consisting of two Ethernet Routing Switch 8600s (running software version 4.0, bootloader image: 4.0) deployed in a two-switch resilient cluster with 22 Ethernet Routing Switch 5530 (software version 4.2.068, firmware version 4.2.0.7, hardware revision: 02) stackable Layer 2 switches.

For failover testing, the test traffic was comprised of 64-byte frames generated at 10,000 frames per second from over 440 SmartBits ports. The test traffic was input from the Spirent SmartBits ports to the Ethernet Routing Switch 5530 which

Nortel

Nortel Resilient Terabit Cluster Solution

Failover Resiliency, Cluster Performance and Functionality Evaluation

uplinked the test traffic to an Ethernet Routing Switch 8600, which routed the test traffic to the appropriate Ethernet Routing Switch 5530 switches downstream. See Figure 4. The test traffic was collected back by the Spirent from the downstream switches.

While test traffic was running, Tolly Group engineers introduced network link failures and measured the time consumed for the network to reconverge and route the traffic over alternate links. The test traffic was transmitted bidirectionally and the failover time for both directions was averaged over three test iterations to obtain the average failover time.

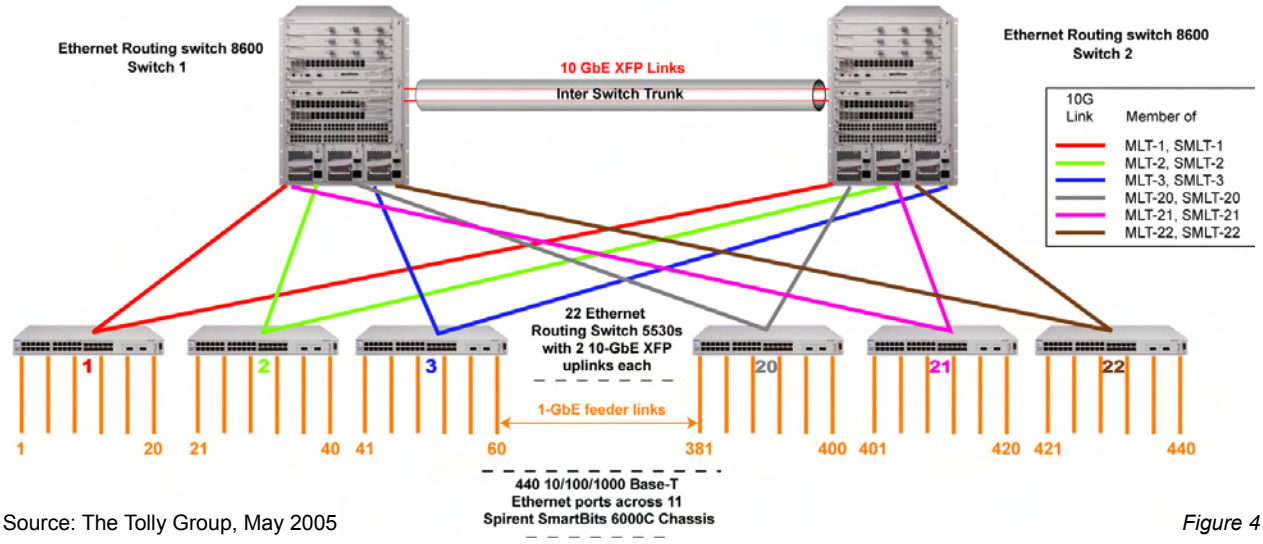
In the Layer 2 frame forwarding rate performance test, the SmartBits generated 440 Gbps of traffic (64-byte frames at 655 million fps). The Ethernet Routing Switch 5530 switches were connected to the Spirent SmartBits ports for the test traffic and the test traffic was uplinked to the Ethernet Routing Switch 8600 switches to be forwarded to the Ethernet Routing Switch 5530 switches downstream. SmartBits received this test traffic from the downstream Ethernet Routing Switch 5530 switches and calculated the frames received per second and the percentage of frames transmitted that were lost.

Switch Design Aims to Lower TCO

The Nortel Ethernet Routing Switch 8600 features a flexible programmable processor, RSP (routing and switching processor), that provides line-rate 10-Gbps packet processing.

The RSP is based on a highly parallel and programmable processing architecture which allows support for future protocol standards through software upgrades. This enables investment protection and a lower TCO for customers through future-proofing the network with the ability to stay current with new standards without hardware upgrades. The RSP can also enable per-port firewalls through thousands of Layer 2-7 filters and access control lists which can be used to block viruses and internet attacks without significant degradation of performance.

Test Bed for Layer 2/3 Performance of Nortel Resilient Terabit Cluster Solution



Source: The Tolly Group, May 2005

Figure 4

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

Vendor	Product	Web address
Spirent Communications	SmartBits 6000C ver 2.60.005	http://www.spirentcom.com
Spirent Communications	SmartFlow ver 4.60.003.0	http://www.spirentcom.com
Spirent Communications	SmartWindow ver 8.50.120	http://www.spirentcom.com

TESTED with SPIRENT

Terms of Usage

USE THIS DOCUMENT ONLY IF YOU AGREE TO THE TERMS LISTED HEREIN.

This document is provided, free-of-charge, to help you understand whether a given product, technology or service merits additional investigation for your particular needs. Any decision to purchase must be based on your own assessment of suitability.

This evaluation was focused on illustrating specific features and/or performance of the product(s) and was conducted under controlled, laboratory conditions and certain tests may have been tailored to reflect performance under ideal conditions; performance may vary under real-world conditions. Users should run tests based on their own real-world scenarios to validate performance for their own networks. Commercially reasonable efforts were made to ensure the accuracy of the data contained herein but errors and/or oversights can occur.

The test/audit documented herein may also rely on various test tools the accuracy of which is beyond our control. Furthermore, the document relies on certain representations by the sponsor that are beyond our control to verify. Among these is that the software/hardware tested is production or production track and is, or will be, available in equivalent or better form to commercial customers.

The Tolly Group provides a fee-based service to assist users in understanding the applicability of a given test scenario to their specific needs. Contact us for information.

When foreign translations exist, the English document is considered authoritative. To assure accuracy, only use documents downloaded directly from The Tolly Group's Web site.

Project Profile

Sponsor: Nortel
Document number: 205116
Product class: Resilient switch cluster
Products under test:

- Ethernet Routing Switch 8600 (with 8692 Switch Fabric and 8683XLR 10-GbE I/O modules)
- Ethernet Routing Switch 5530 and 5520
- Optics: 10-GbE XFP; 850 and 1310 nm

Testing window: May 2005

Software versions tested:

- Ethernet Routing Switch 8600, software version 4.0, bootloader image: 4.0
- Ethernet Routing Switch 5530, software version 4.2.068, firmware version 4.2.0.7, hardware revision: 02
- Ethernet Routing Switch 5520, Software version 4.1.0.04, firmware version 4.1.0.8

Software status: Generally available

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at http://www.tolly.com, send E-mail to sales@tolly.com, call (561) 391-5610.

The Tolly Group doc. 205116 rev. clk 26 Jul 05