THE TOLLY GROUP

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Spirent Communications

SmartBits Cluster/SmartFlow

Layer 2/3 Traffic Generation/Analysis in Large Cluster Networks

Test Summary

Premise: *Vendors and users preparing to deploy high-end LAN infrastructure need to know how that infrastructure will behave under the maximum load – even when the load is greater than what can be generated by any individual test tool. In such a case, test tool 'clustering' can deliver the traffic loads necessary to determine the maximum performance it can get in very large-scale networks.*

Spirent commissioned The Tolly Group to evaluate the scalability produced by clustering its SmartBits, a high port-density network performance analysis system. The SmartBits tests 10/100/1,000 and 10-Gigabit Ethernet, ATM, POS, Fibre Channel, Frame Relay networks and network devices. The SmartBits features test applications for xDSL, cable modem, IP QoS, VoIP, MPLS, IP Multicast, TCP/IP, IPv6, routing, SAN, VPN, Web and security.

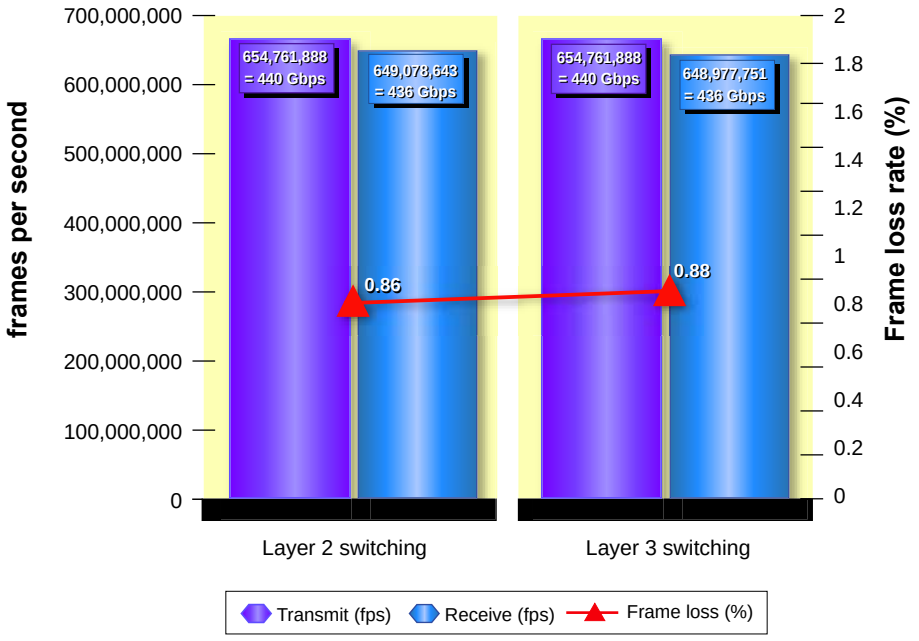
The Tolly Group examined the impact of clustering 11 SmartBits 6000C chassis, each with 40 Gigabit Ethernet ports, to drive a very large-scale LAN infrastructure to peak levels – in this case a Nortel Terabit Cluster Solution. This test was designed to measure the performance of the Nortel Terabit Cluster Solution. As a result, the performance result is indicative of the maximum performance of the Nortel Terabit Cluster Solution and hence does not necessarily reflect the maximum scalability performance of the SmartBits. The Spirent SmartBits can be used for Layer 4-7 network testing using appropriate software such as SmartBits WebSuite and AvalancheSMB, but this report has focused on the SmartBit's scalability and Layer 2-3 testing performance along with the SmartFlow application.

Tolly Group engineers audited all tests, which were conducted in April 2005 at Nortel's Santa Clara, CA. facilities.

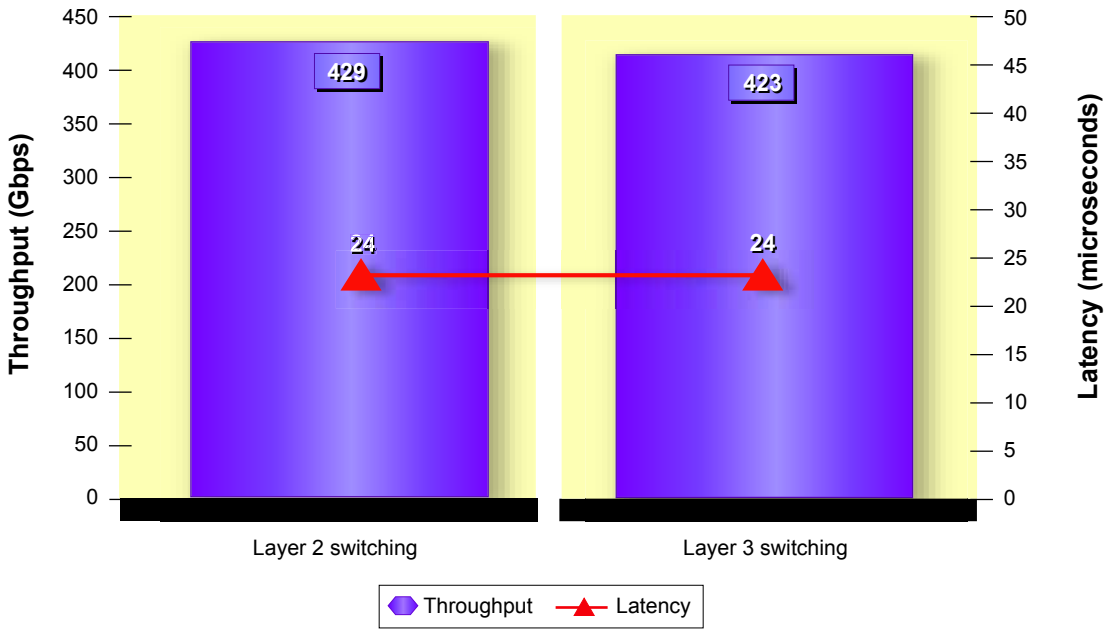
Test Highlights

- Provides high scalability with support for 440 Gigabit Ethernet ports in a single cluster
- Minimizes test time overhead and maximizes efficiency in large-scale environments with its reliable and feature-rich SmartFlow application
- Generates 654 million Layer 2/3 packets per second in a single cluster
- Easy clock synchronization across chassis for one-way latency measurement

Spirent SmartBits Transmit and Receive Frame Rate across Nortel Terabit Cluster Solution
(as Reported by Spirent SmartBits SmartFlow 4.6)



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



Source: The Tolly Group, May 2005

Figure 2

Results

Layer 2 and Layer 3 Frame-Loss Performance Test

Tolly Group engineers set up a single cluster using 11 SmartBits units and SmartFlow application to generate the requisite traffic to measure the bidirectional Layer 2 and Layer 3 switching capability of the Nortel Terabit Cluster Solution using 64-byte frames in an easy and centralized way. SmartFlow is a comprehensive SmartBits solution for testing Layer 2/3 networks and QoS at wire rate with hundreds of ports and millions of flows. In this test, the SmartBits/SmartFlow test cluster emulated 440 Ethernet nodes for Layer 2 test and 440 IP nodes for Layer 3 test. The SmartBits/SmartFlow cluster was configured to transmit 440 Gbps of traffic (64-byte frames at 655 million frames per second [fps]) and receive the pass-through SmartBits traffic across the Nortel Cluster Solution a port-pairing scheme (See Test Configuration and Methodology section for details). Under the 100% theoretical maximum or 440 Gbps load, the terabit cluster solution achieved a frame forwarding rate of 649 million frames per second (436 Gbps) for both Layer 2 and Layer 3 switching. (See Figure 1.) The SmartFlow has reported the comprehensive performance characteristics as well as more detail port or flow-level performance. The SmartFlow has also reported the frame loss (%) of 0.86 and 0.88 for the Layer 2 and Layer 3 switching respectively and in turn, proved that the Nortel Cluster Solution does not have performance degradation for the Layer 3 operation.

Zero-loss (≤ 0.001%) Layer 2 and Layer 3 Throughput

Tolly Group engineers also measured the bidirectional zero-loss (≤ 0.001%) Layer 2 and 3 throughput for 64-byte Ethernet frames. Engineers used the same port-pairing scheme as the Layer 2 and Layer 3 frame-loss performance test described above. In this test, engineers configured SmartBits/SmartFlow to converge to the maximum bidirectional zero-loss throughput by using of SmartFlow's binary search algorithm feature. The SmartBits/SmartFlow results show that the Nortel Cluster Solution delivered 97.5% of the theoretical maximum throughput or an aggregate throughput of 429 Gbps at Layer 2 and 96.3% of the theoretical maximum throughput or an aggregate throughput of 423 Gbps at Layer 3. This equates to 638,392,485 fps at Layer 2 and 630,208,304 fps at Layer 3. (See Figure 2.)

Latency Performance Test

Engineers connected 11 SmartBits 6000C chassis and daisy-chained them for the synchronization in a cluster. In this Layer 2 and Layer 3 latency test, the Nortel Cluster Solution showed an average one-way Store and Forward latency of 24.375 µsec and 23.803 µsec respectively. In this test, the Spirent SmartBits/SmartFlow traffic generator offered test traffic at the rate of 96% of the theoretical maximum (422 Gbps, or 629 million frames per second for 64-byte frames), that is a little lower than zero-loss throughput reported from the previous test.

Analysis

Network architects need to know what the maximum performance capacity is for the high-end resilient cluster network solution they deploy in the real-world networks and how it can perform under the maximum load. Moreover, it would be impractical, not to mention risky to operations, to inject the cluster solution into a production network. However, it is difficult to push the high-end cluster solution to the limit. Network operators never know the limit of the solution unless they are able to oversubscribe the

networks under test. The easiest and mostly best way of doing this is to rely upon test tools that can generate traffic, which is big enough to stress out the networks and real enough to disguise it.

Tests show that the Spirent Communications SmartBits/SmartFlow cluster test solution performed flawlessly at simulating Layer 2/3 network traffic conditions from both the transmitter and receiver side. Traffic generated by this test solution can be used to measure with precision the Layer 2/3 throughput, frame loss, sequencing, packet marking, stray frames and latency of the devices and the solutions considered for use in any large-scale cluster networks currently available.

Not only can the SmartBits/SmartFlow generate line-rate traffic, but it can do so with unique and variable traffic loads and frame sizes per flow, variable MAC/IP/TCP/UDP addresses and configurable Layer2/3/4 headers/payloads that mimic the traffic naturally occurring on real Layer 2/3 networks. Further, the capability to cluster the SmartBits chassis into groups and in turn, to control them as one means that enterprise and service provider network managers can scale Layer 2/3 traffic to levels equal to or more than those on live production networks. Especially, using the SmartFlow Group Wizard and user-oriented flow setup configuration menu, creating multiple traffic flows with different traffic and port patterns in a multiple chassis clustered test bed is as easy and fast as a single chassis configuration.

The 11 SmartBits 6000C chassis were connected in a daisy-chain (which can support up to 16 chassis according to Spirent engineers) for clock synchronization, which is imperative for the accurate one-way latency measurements in the clustered Layer 2/3 test bed.

Test Configuration and Methodology

For performance tests, The Tolly Group used the cluster of the Spirent Communications SmartBits 6000C (running firmware version 2.60) and SmartFlow 4.6 to test a Nortel Terabit Cluster Solution consisting of two Ethernet Routing Switch 8600s deployed in a two-switch resilient cluster with 22 Ethernet Routing Switch 5530 stackable Layer 2 switches. Each SmartBits 6000C chassis was equipped with 10 TeraMetric XD modules (LAN-3325A, firmware version 5.01). The TeraMetrics XD module supports four 10/100/1000 Mbps and Gigabit Ethernet fiber combo ports.

Engineers connected the management interface of 11 SmartBits 6000C chassis and the general PC running SmartFlow software into the same Layer 2 switch for the centralized control. Also, engineers daisy-chained the chassis using chassis expansion ports and powered them up in a correct sequence to synchronize timing across the multiple SmartBits chassis.

Throughout the test, engineers employed a cluster of Spirent SmartBits test systems with SmartFlow to generate bidirectional Layer 2 or Layer 3 traffic into the 440 Gigabit Ethernet ports in a port-pairing configuration (e.g. port 1 to port 221, port 2 to port 222…) using 64-byte Ethernet frame sizes. Tests were run for 60 seconds for each of three test iterations and results were averaged.

The bidirectional test traffic was input from the Spirent SmartBits ports to the Ethernet Routing Switch 5530 which 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.

Spirent

SmartBits/ SmartFlow

Layer 2/3 Traffic Generation/ Analysis and Clustering Capability

For the Layer 2 frame-loss performance test, the SmartBits/SmartFlow generated 440 Gbps of traffic (64-byte frames at 655 million fps) from 440 SmartBits ports, emulating one Ethernet node per port. All SmartBits ports are in the same VLAN group. For the Layer 3 frame-loss test, engineers configured the Nortel 5530 switch for the static routing operation such that all ports have IP addresses assigned and they all are in the different subnets with different VLAN IDs.

For the zero-loss (≤ 0.001%) bidirectional Layer 2 and 3 throughput test, the only difference from the above frame-loss test was that this test used the SmartFlow binary test mode for SmartFlow to find, in a more dynamic way, the maximum Layer 2/3 throughput within the acceptable frame-loss rate (≤ 0.001%).

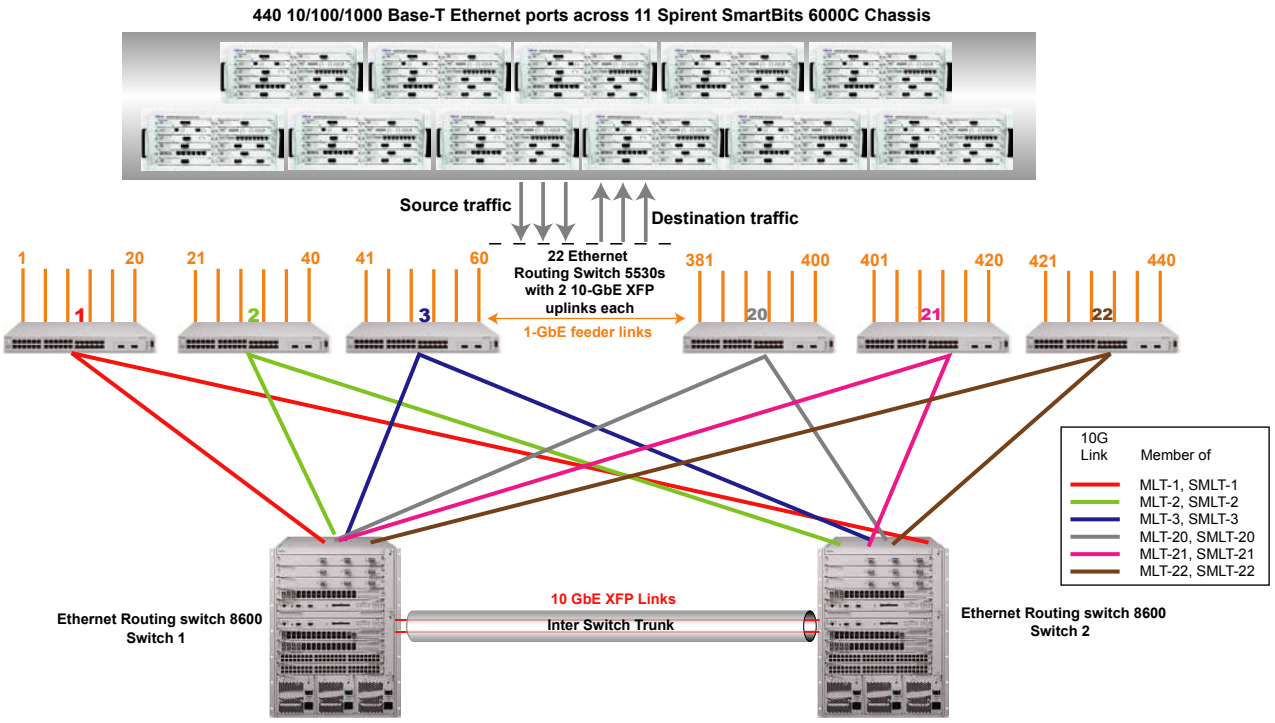
For the latency test, the SmartBits/SmartFlow generated the bidirectional test traffic at the rate 96% of the theoretical maximum throughput or 422 Gbps measured the one-way latency using the Store-and-Forward method. The SmartFlow has an option to report the cut-through latency as well.

Spirent's View: SmartFlow Layer 2/3 QoS Tester for IPv4, IPv6, and Multicast on SmartBits*

SmartBits provides high-performance Ethernet testing simultaneously on tens or hundreds of ports, from 10 Mbps to 10 Gbps. With up to 2,000 streams and 100,000 cyclic flows on each port, very large network configurations are possible. The SmartFlow application is the key performance analysis tool for SmartBits. SmartFlow uses a time-saving wizard-based setup to simplify complex test scenarios, including unicast, multicast, IPv4, IPv6, VLANs (Q-in-Q) and DHCP. Easy to understand results are displayed in graphical, summary, detail or HTML formats. Features include the ability to report frame loss, min/average/max latency, latency distribution and frame sequencing in a single test pass. This provides test efficiencies, as well as insight into "cause and effect" relationships within the device under test.

**Vendor-supplied information not verified by The Tolly Group*

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



Source: The Tolly Group, May 2005

Figure 4

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Project Profile

Sponsor: Spirent Communications
Document number: 205127
Product class: Network Performance Analysis System
Products under test:

- SmartBits 6000C
- SmartBits TeraMetrics XD
- SmartFlow

Testing window: May 2005
Software versions tested:

- SmartBits 6000C ver. 2.6.005
- SmartBits TeraMetrics XD ver. 5.01
- SmartFlow ver. 4.60.003.0

Software status: Generally available

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