

Nortel

SMB Data Portfolio

Business Ethernet Switch Series



Test
 Summary

Evaluation of Throughput, Latency and Voice over IP Performance

Premise: Small and medium businesses constantly are looking for products with the best value — that is, having a healthy mix of ease of use, high performance, stringent security, cutting-edge features (such as Power over Ethernet and Voice over IP), and affordable price.

Nortel commissioned The Tolly Group to evaluate its Business Ethernet Switch (BES) portfolio of SMB-class, PoE-capable switches, in terms of data performance and Voice over IP (VoIP) quality.

Tolly Group engineers tested four models in the portfolio — The BES50GE-24T-PWR, the BES120-48T-PWR, the BES220-48T-PWR and the BES1020-48T-PWR. The BES 200 model was tested in both standalone and four-switch stack configurations.

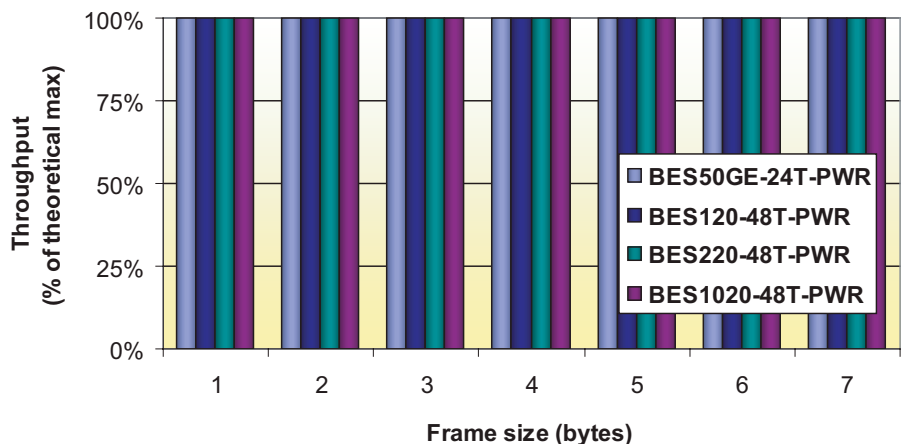
Tests focused on measuring the Layer 2 throughput and standard deviation of latency; as well as VoIP call quality (in terms of MOS, PSQM, PESQ scores) and call completion rate. Tests were conducted in August 2007.

Test Highlights

The BES50, BES100, BES200 and BES1000 models tested:

- ▶ Delivered wire-speed performance across all ports using standard Ethernet frame sizes and port-to-port forwarding
- ▶ Demonstrated very low latency and jitter which is critical for real-time applications
- ▶ Achieved 100% VoIP call setup/completion and the best possible voice quality scores
- ▶ Demonstrated superior stack performance capacity of 14 to 16 Gbps in a four-switch stack for standard Ethernet frame sizes

Layer 2 Bidirectional Throughput of Nortel Business Ethernet Switch Series Models Tested



Note: Traffic was sent at 100% line-rate in port-pair fashion: port 1 sends and receives traffic from port 13, port 2 from port 14, and so on.

Source: The Tolly Group, August 2007

Figure 1

Executive Summary

Nortel Business Ethernet Switch portfolio delivers a compelling mix of line-rate throughput, low standard deviation of latency, stack switching capacity, toll-quality voice and 100% call completion rate for VoIP traffic.

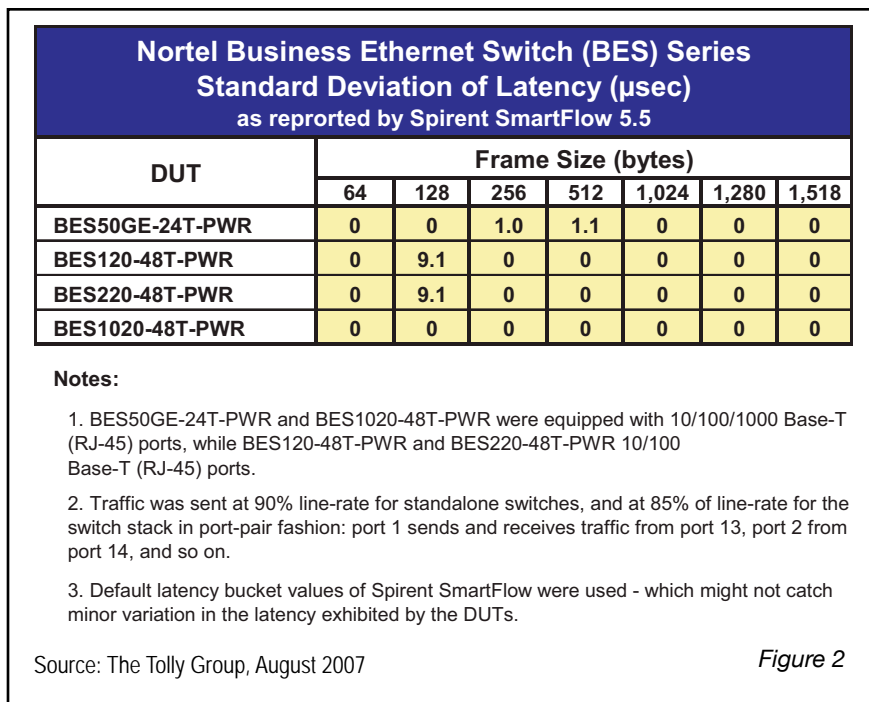
Small- and medium-business networks are adopting new technologies such as Power over Ethernet (PoE) for convenience and Voice over IP (VoIP) for long-distance telephony savings.

As such, products aimed at the SMB market need to deliver the right mix of performance and support for advanced features like PoE and VoIP.

Nortel Business Ethernet Switch (BES) portfolio of SMB-class Layer 2 switches tested demonstrated that they can forward bidirectional Layer 2 traffic consisting of standard Ethernet frames at line-rate, operating in standalone configuration. This means that these switches have sufficient performance headroom for SMB networks to grow.

(Note: Rather than cite the full product name of the switches tested, we cite the switch model group for brevity. Nortel says that all group models are the same other than variations in port density.)

The BES200 switch also demonstrated 8 Gbps of bidirectional stack throughput



(16 Gbps of total switching capacity) using eight 10/100/1000 Base-T stacking ports on a four-switch stack. This provides an easy-to-manage, scalable switch stack with up to 192 10/100 Base-T ports, up to 96 dedicated PoE capable ports to anchor SMB networks as they evolve.

All the BES switches tested also exhibited very low standard deviation of latency —less than 10 microseconds (µsec) —for the standard Ethernet frame sizes tested, implying that the switches provide predictable performance required for converged applications like VoIP.

The BES switches also demonstrated support for “toll-quality” voice and a 100% call completion rate while handling 100 VoIP calls.

The mixture of line-rate throughput, low standard deviation of latency and support for VoIP call traffic shows the BES switches to be very capable of anchoring SMB-class networks.

RESULTS

LAYER 2 THROUGHPUT

Tolly Group tests show that the Nortel BES switches achieved line-rate throughput for standard Ethernet frame sizes, across all ports in a bidirectional port-pairing configuration.

This equates to 24 Gbps (100% of theoretical maximum) bidirectional throughput for all frame sizes (64, 128, 256, 512, 1,024, 1,280 and 1,518 bytes) for the BES50 switch. Similarly, the BES100 and BES200 switches demonstrated 4.8 Gbps (100% of theoretical maximum) bidirectional throughput, whereas the BES1000 achieved a bidirectional throughput of 48 Gbps (100% of theoretical maximum) for all frame sizes mentioned previously.

LAYER 2 STANDARD DEVIATION OF LATENCY

The BES switches were also subjected to tests to measure the

Layer 2 standard deviation of latency.

The standard deviation of latency serves to offer an idea about the variation of latency (called jitter) for different frame sizes at a given load.

The test was performed at 90% of line rate for the standalone switch configurations, and at 85% of line rate for the four-switch stack of BES200 switches.

As shown in Figure 2, the standard deviation of latency for various frame sizes was very low, and ranged between 0 and 9.1 μ sec. Even the four-switch stack of BES200 exhibited very low standard deviation (between 0 and 1.3 μ sec) while handling traffic at 85% of line rate across the stack.

(See the “Test Setup & Methodology” section for more details on this test.)

CALL COMPLETION RATE & CALL QUALITY

The BES switches were tested for VoIP performance in terms of the call completion rate and call quality offered while handling 100 voice calls simultaneously across the switches, in a non-congestion scenario.

Furthermore, traffic was passed from a normal switch port to an uplink port (except on the BES50 which had no uplink ports, and hence used another regular switch port), and vice versa, thus representing scenarios where the BES switches might transport VoIP traffic to and from a branch LAN/WAN router. The Tolly Group believes this call load to be representative of a typical SMB scenario,

and serves to demonstrate the effect (if any) of the switches on voice calls passing across them.

The voice quality was measured in terms of industry-standard metrics like MOS (Mean Opinion Score), PESQ (Perceptual Evaluation of Speech Quality) and PSQM (Perceptual Speech Quality Measurement).

In the testing, all the BES switches achieved a 100% call completion rate (meaning that all the calls were originated, transmitted and terminated properly), and perfect scores on the MOS, PSQM and PESQ metrics, which indicates that the call quality offered to the users would rate as equal to or better than “toll quality.” See Figure 3.

LAYER 2 STACK THROUGHPUT AND SWITCHING CAPACITY

The BES200 switch was tested for throughput and switching capacity in a four-switch stack configuration.

The BES200 switch stack achieved throughput ranging from 90% of the theoretical maximum for the taxing 64-byte frames, to 99% of the theoretical maximum for the largest 1,518-byte frames. See Figure 1.

This meant that the four-switch stack of BES200 switches achieved throughput between 7 Gbps (for 64-byte frames) to approximately 8 Gbps (for 1,518-byte frames).

Put another way, the stack demonstrated a bidirectional switching capacity between 14 Gbps with 64-byte frames, to about 16 Gbps with the 1,518-byte frames.

Nortel

Business
Ethernet
Switch Series



Layer 2
Performance and VoIP
Performance Evaluation

Product Specifications

Vendor-supplied information not necessarily verified by The Tolly Group

Nortel

Business Ethernet Switch Series

BES50GE-24T-PWR:

- 📶 Switch fabric: 48 Gbps
- 📶 10/100/1000 Mbps ports: 24
- 📶 PoE ports: 12
- 📶 Target business users: 50
- 📶 Dimensions: 2.64HX8.61W12.51D
- 📶 Weight: 2.9 lbs. (1.3 kg)

BES120-48T-PWR:

- 📶 Switch fabric: 13.6 Gbps
- 📶 10/100 Mbps ports: 48
- 📶 PoE ports: 24
- 📶 Target business users: 100
- 📶 Dimensions: 1.73HX17.36W14.53D
- 📶 Weight: 11.6 lbs. (5.3 kg)

BES220-48T-PWR:

- 📶 Switch fabric: 13.6 Gbps
- 📶 10/100 Mbps ports: 48
- 📶 PoE ports: 24
- 📶 Target business users: 150
- 📶 Dimensions: 1.73HX17.36W14.53D
- 📶 Weight: 11.6 lbs. (5.3 kg)

BES1020-48T-PWR:

- 📶 Switch fabric: 96 Gbps
- 📶 10/100/1000 Mbps ports: 48
- 📶 PoE ports: 24
- 📶 Target business users: 250
- 📶 Dimensions: 1.73HX17.36LX14.53D
- 📶 Weight: 13.9 lbs. (6.3 kg)

Nortel
195 The West Mall
Toronto, Ontario, CANADA
M9C 5K1
Phone: 1-800-4NORTEL (1-800-466-7835)
URL: <http://www.nortel.com>

TEST SETUP & METHODOLOGY

Engineers tested the following Nortel BES switches:

BES50GE-24T-PWR: A 24-port switch with 10/100/1000 Base-T ports, up to 12 of which can supply PoE. The switch ran boot ROM version 0.0.0.14, boot loader version 0.0.11, software version 0.0.0.26 and hardware version 02.

BES120-48T-PWR: A 48-port switch with 10/100 Base-T ports (up to 24 ports capable of PoE), and two 10/100/1000 Base-T (RJ-45) stacking ports. The switch ran firmware version 1.0.0.1.5, software version v1.2.0.045 and hardware version 0.

BES220-48T-PWR: A 48-port stackable switch with 10/100 Base-T ports (up to 24 ports capable of PoE), and two 10/100/1000 Base-T (RJ-45) stacking ports. The switch as tested, ran firmware version 1.0.0.16, software version v1.2.0.002 and hardware version 01.

BES1020-48T-PWR: A 48-port switch with 10/100/1000 Base-T ports (up to 24 ports capable of PoE) and two 10/100/1000 Base-T (RJ-45) stacking ports. The switch as tested, ran firmware version 1.1.0.5, software version v1.1.0.002 and hardware version 01.

LAYER 2 THROUGHPUT TEST

The test bed consisted of the switches under test configured with either 24 or 48 Fast Ethernet or Gigabit Ethernet ports. For example, the BES50 and the BES1000

Nortel Business Ethernet Switch (BES) Series: VoIP Performance with 100 Calls (SIP and G.711 μ-law) in Each Direction using Two Switch Ports* as reported by Spirent Abacus 3.2				
DUT	Call Completion Rate	MOS score	PSQM score	PESQ score
BES50GE-24T-PWR	100%	4.6	0.0	4.5
BES120-48T-PWR	100%	4.6	0.0	4.5
BES220-48T-PWR	100%	4.6	0.0	4.5
BES1020-48T-PWR	100%	4.6	0.0	4.5

Notes:

- * For all switches except the BES50GE-24T-PWR, one regular switch port and one uplink port were connected to the Spirent Abacus for voice over IP call traffic.
- * BES50GE-24T-PWR does not have uplink ports, hence two regular switch ports were connected to the Spirent Abacus.
- * Best possible score for MOS is 4.6, that for PSQM is 0 and that for PESQ is 4.5.

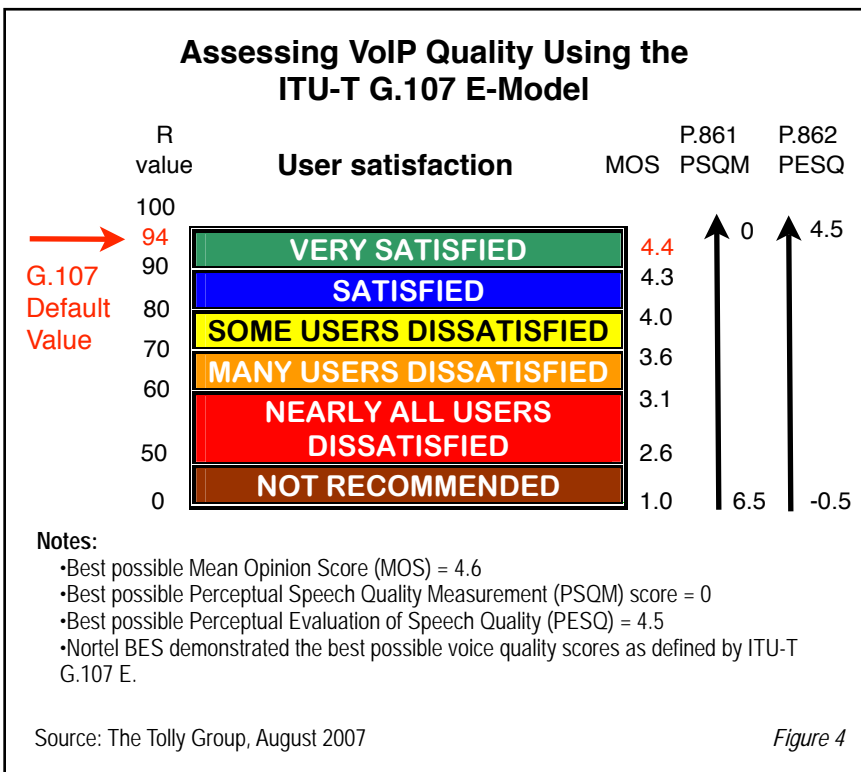
Source: The Tolly Group, August 2007 Figure 3

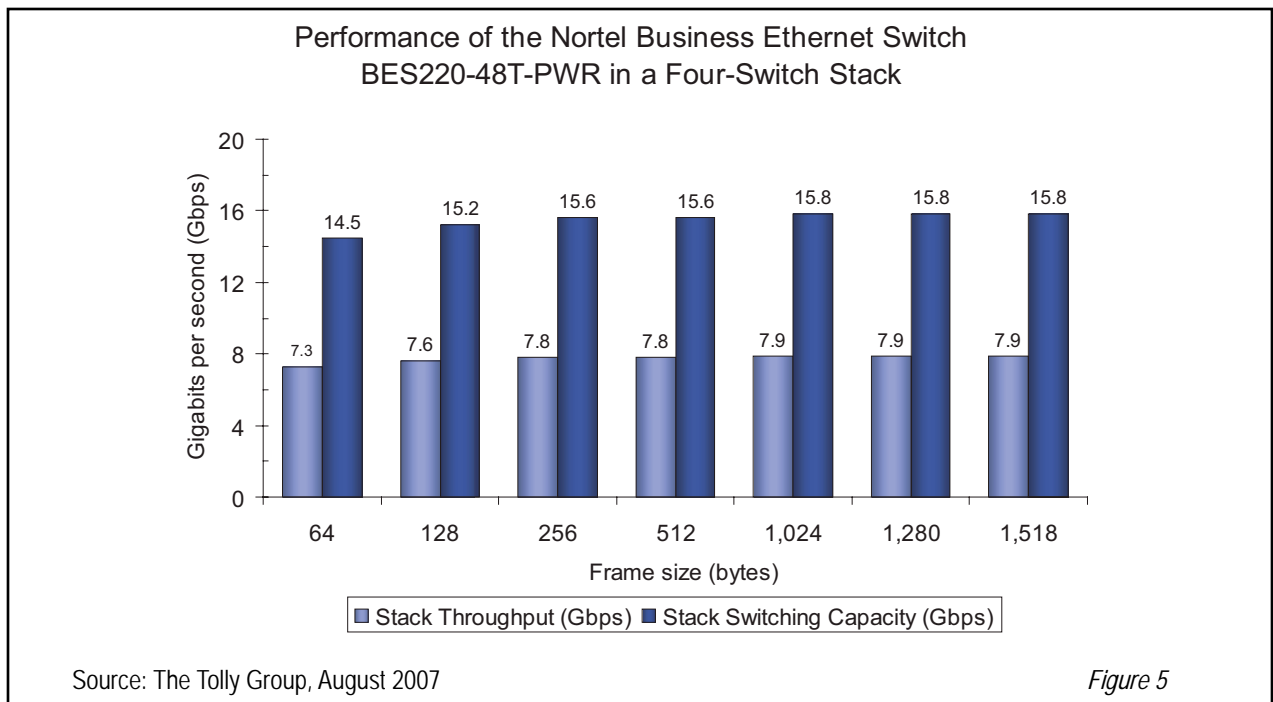
were configured with 24 and 48 10/100/1000 Base-T (RJ-45) ports, respectively, while the BES100 and BES200 switches were configured with 48 10/100 Base-T (RJ-45) ports.

A Spirent SmartBits 6000C traffic generator was used along with SmartFlow 5.5 application to

generate the test traffic consisting of standard Ethernet frames of 64, 128, 256, 512, 1,024, 1,280, and 1,518 bytes.

The switches under test were connected to the SmartBits using the appropriate number of Cat-6 cables. Test traffic was configured to be generated in a port-





pairing fashion, i.e., each switch port sent and received traffic from one other switch port. Test traffic was sent at line-rate appropriate for the interface type on the switch under test, and binary search algorithm was used in the SmartFlow application to determine the maximum bidirectional throughput, with a maximum acceptable frame loss set at 0.001%. The test was run three times on each switch, and the results averaged to obtain the final result.

LAYER 2 STANDARD DEVIATION OF LATENCY TEST

The test bed setup and test traffic mix was identical to the Layer 2 throughput test, except that the BES200 switch in a four-switch stack configuration was also added to the list of devices under test. Test traffic was handled by the two 10/100/1000 Base-T (RJ-45) uplink ports and a pair of similar stacking ports on each switch.

The test traffic was sent at 90% of the line-rate for the standalone switches under test, and at 85% of line-rate when testing the four-switch stack of BES200 switches.

SmartFlow's Latency Distribution test was used, with the default latency bucket settings. Readers should note that the default latency bucket settings in SmartFlow may not detect minor variations in latency in certain setups. The test was run three times and the results averaged.

VOIP CALL COMPLETION RATE AND CALL QUALITY

To test VoIP performance, each switch under test was connected to a Spirent Abacus 5000 using two ports. On all the switches except the BES50, one Abacus port was connected to a standard switch port, while the other Abacus port was connected to an uplink port. On the BES50, two standard switch ports were used due to the lack of uplink ports.

The Abacus generated 100 voice calls in both directions, using the

ICG3 line-card, and using SIP protocol with G.711 μ -law.

No congestion scenario was simulated for this test. The Abacus originated 100 calls in each direction, maintained the calls for one minute, then terminated them, and reported the call completion rate and voice quality via MOS, PSQM and PESQ. The test was repeated three times; the results were averaged.

LAYER 2 STACKING PERFORMANCE TEST

This test was only performed on a four-switch stack of BES200 switches. The test setup was identical to the standalone Layer 2 throughput test, with the exception that the traffic was only input to two 10/100/1000 Base-T (RJ-45) uplink ports on each switch in the stack and forwarded bidirectionally in a port-pairing fashion across the stack using the 10/100/1000 Base-T stacking ports on the back.

The tests were run three times, and the results averaged to obtain the final result.

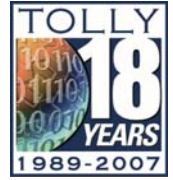
Nortel Business Ethernet Switch Series Models Tested



Source: The Tolly Group, August 2007

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:
 Web: <http://www.tolly.com>,
 E-mail: sales@tolly.com



Test Equipment Summary

Vendor	Product	Web URL:
Spirent Communications	Abacus 5000 v3.2 SmartBits 6000C SmartFlow 5.5	http://www.spirentcom.com

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. In no event shall The Tolly Group be liable for damages of any kind including direct, indirect, special, incidental and consequential damages which may result from the use of information contained in this document

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.

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. All trademarks are the property of their respective owners.