

Riverstone Networks, Inc.

XGS 9008 and XGS 9016

10-Gigabit Ethernet Performance Evaluation

Test Summary

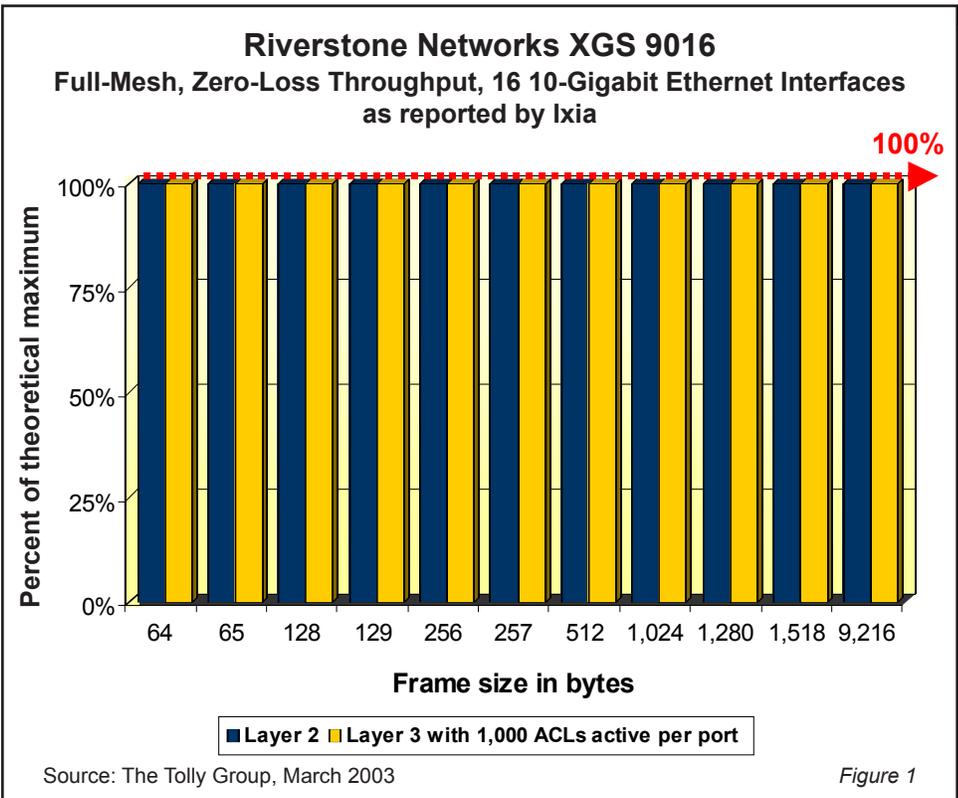
***Premise:** Managers of carrier and complex enterprise networks who deploy 10-Gigabit Ethernet switches need to know that the devices they use can deliver wire-speed, bi-directional zero-loss throughput along with low latency and jitter. Furthermore, performance needs to be tested using standard and non-standard frame sizes in addition to advanced functions – such as Access Control Lists (ACLs) – enabled in order to demonstrate the true device performance under real-world operating conditions.*

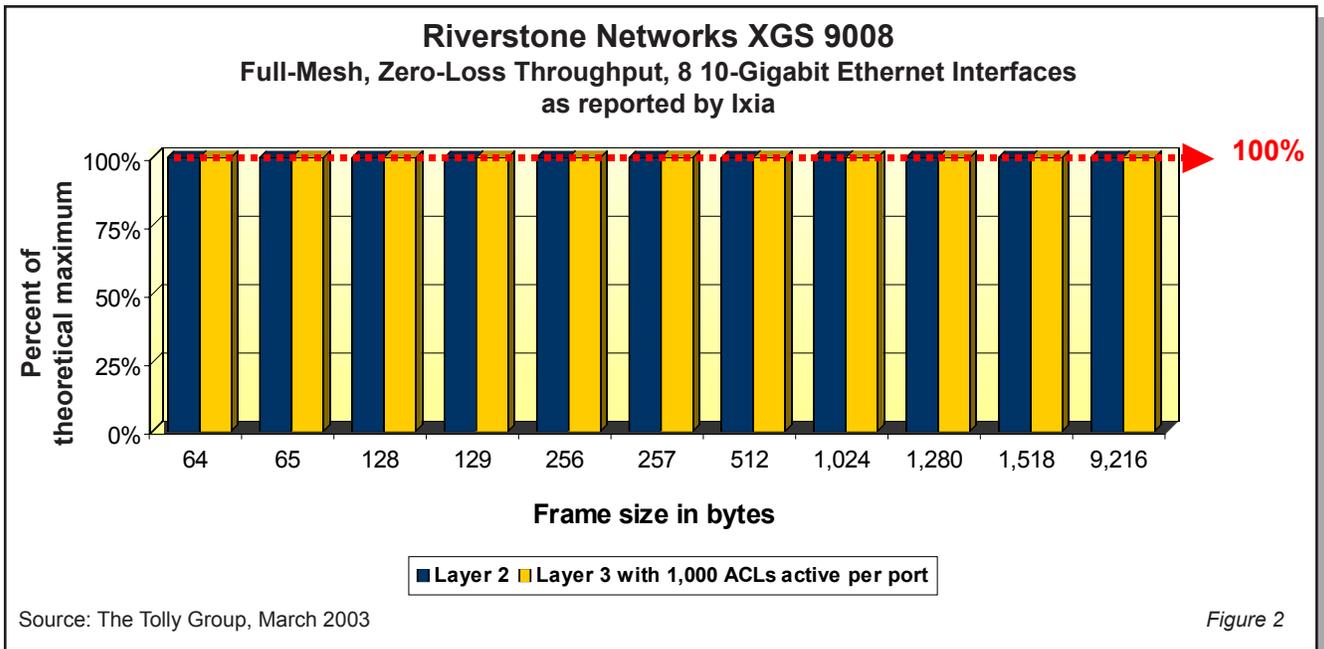
Riverstone Networks commissioned The Tolly Group to evaluate the performance of its XGS 9008 and XGS 9016, both Layer 3 10-Gigabit Ethernet switches. For testing purposes, engineers outfitted the XGS 9008 with eight (8) 1-port 10-GbE interface cards, one switch fabric and a single control module. Engineers outfitted the XGS 9016 with sixteen (16) 1-port 10-GbE interface cards, one switch fabric and a single control module. Additionally, engineers conducted tests with the XGS 9016 outfitted with sixteen (16) 10-port 1-GbE interface cards.

The Tolly Group evaluated the steady state, zero-loss, frame-per-second (fps) throughput, latency and jitter of

Test Highlights

- Achieves wire-speed performance with zero packet loss across all packet sizes tested at Layer 2 and Layer 3
- Demonstrates low latency on both 10-Gigabit and Gigabit Ethernet interfaces at wire speed at both Layer 2 and Layer 3
- Demonstrates sub-microsecond jitter on 10-Gigabit and Gigabit Ethernet interfaces regardless of load, at Layer 2 and Layer 3
- Exhibits no performance degradation in bi-directional or full mesh configurations even when 1,000 ACLs per interface card are active



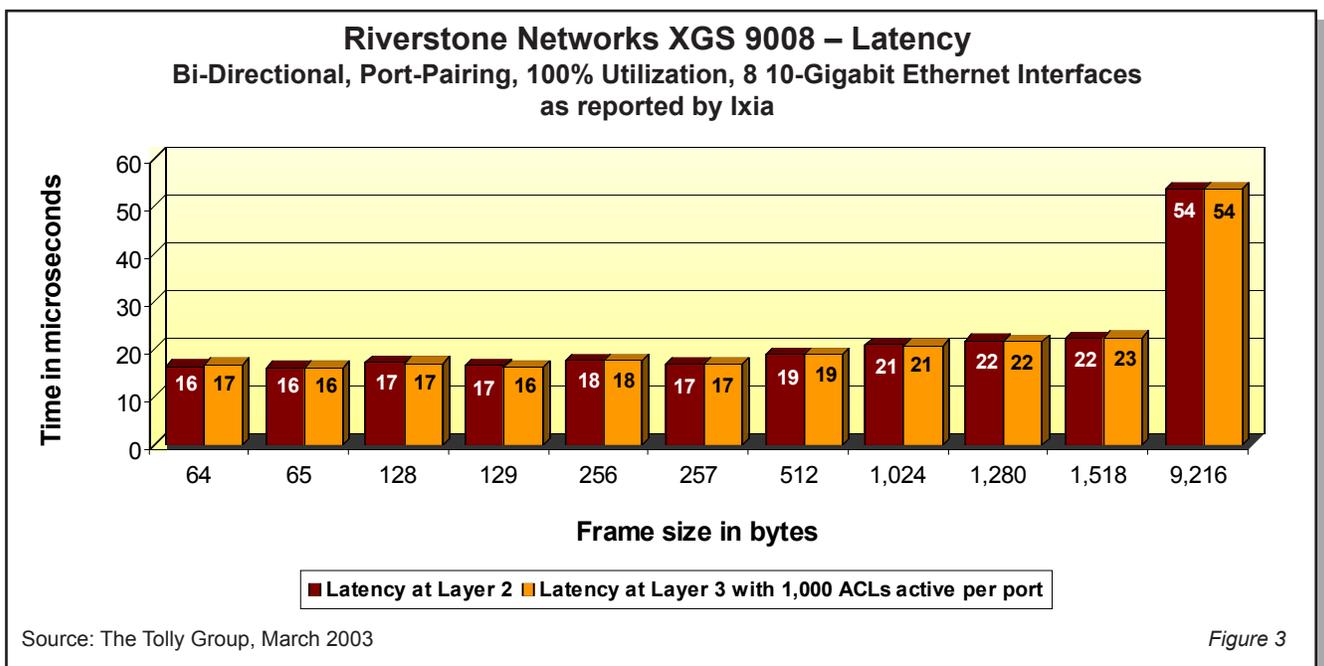


both switches in port-pairing and full-mesh configurations at Layer 2 and Layer 3, and at Layer 3 with access control lists (ACLs) active on the 10-Gigabit Ethernet interfaces. Engineers also conducted tests with Gigabit Ethernet interfaces at Layer 2 only. (Note: Jitter was not reported in a full-mesh configuration.) 10-Gigabit

Ethernet tests included RFC standard frame sizes ranging from 64 to 1,518 bytes, as well as non-standard frame sizes of 65, 129 and 257 bytes, and Jumbo Frames. Testing was performed in March 2003.

Test results show that the Riverstone Networks XGS 9008 and XGS 9016 equipped with 10-Gigabit Ethernet interfaces

offered line rate performance with zero packet loss for all scenarios tested, achieving an aggregate backplane capacity of 160 Gbps and 320 Gbps for the XGS 9008 and XGS 9016, respectively. Testing also demonstrates that both devices offer consistently low latency and jitter at wire-speed for all scenarios tested.



RESULTS

ZERO LOSS THROUGHPUT (10-GIGABIT ETHERNET)

Tolly Group engineers measured the zero-loss bi-directional (full-duplex) throughput of each device under test (DUT), at Layer 2 and at Layer 3 (with and without ACLs active), in both a port-pairing and full-mesh configuration using 64-, 65-, 128-, 129-, 256-, 257-, 512-, 1,024-, 1,280-, 1,518- and 9,126-byte frames (see Test Configuration and Methodology section). Test results demonstrate that both the XGS 9008 and XGS 9016 delivered 100% of the theoretical maximum throughput with zero packet loss. (See Figure 1 and Figure 2.)

LATENCY AND JITTER (XGS 9008)

Tolly Group engineers conducted latency tests on the XGS 9008 in a port-pairing configuration at Layer 2 and Layer 3 with ACLs active using standard and non-standard frame sizes ranging from 64 to 9,126 bytes.

Tests results reveal that the XGS 9008 exhibited consistently low latency ranging from just over 16 microseconds for 64-byte frames to just under 23 microseconds for 1,518-byte frames. Latency results with Jumbo Frames of 9,126 bytes were just under 54 microseconds. Jitter results were consistently below 150 nanoseconds for all tested frame sizes at Layer 2 and Layer 3, except for the smallest frame sizes of 64 through 129 bytes where jitter burst to 325 nanoseconds. (See Figure 3 and Figure 4.)

ZERO- LOSS THROUGHPUT (GIGABIT ETHERNET)

Engineers also swapped out the 10-Gigabit Ethernet interfaces on the XGS 9016 and replaced them with sixteen 10-port Gigabit Ethernet interface cards. Again, engineers tested using a range of standard and non-standard frame sizes ranging from 64 to 1,518 bytes in both port-pairing and full-mesh configurations at Layer 2.

Test results demonstrate that the XGS 9016 delivered 100% of the theoretical maximum bi-directional Layer 2 throughput with zero packet loss. (See Figure 5.)

LATENCY (GIGABIT ETHERNET)

Next, Tolly Group engineers measured the bi-directional latency of the XGS 9016 utilizing a single port pair of Gigabit Ethernet interfaces at Layer 2 with the same range of standard and non-standard frame sizes as used in previous test scenarios.

Results reveal that the XGS 9016 exhibited consistently low latency ranging from just over 16 microseconds for 64-byte frames to just under 23 microseconds for 512-byte frames, increasing to 27.8 microseconds, 30.5 microseconds and 33.1 microseconds for 1,024-, 1,280- and 1,518-byte frames, respectively. (See Figure 5.) Jitter results ranged from 33 nanoseconds for the 64-byte frame size to 210 nanoseconds for the 1,518-byte frames.

**Riverstone
Networks, Inc.**

**XGS 9008 and
XGS 9016**

**Performance
Benchmark**



Riverstone Networks XGS 9008/9016 Product Product Specifications*

XGS 9016

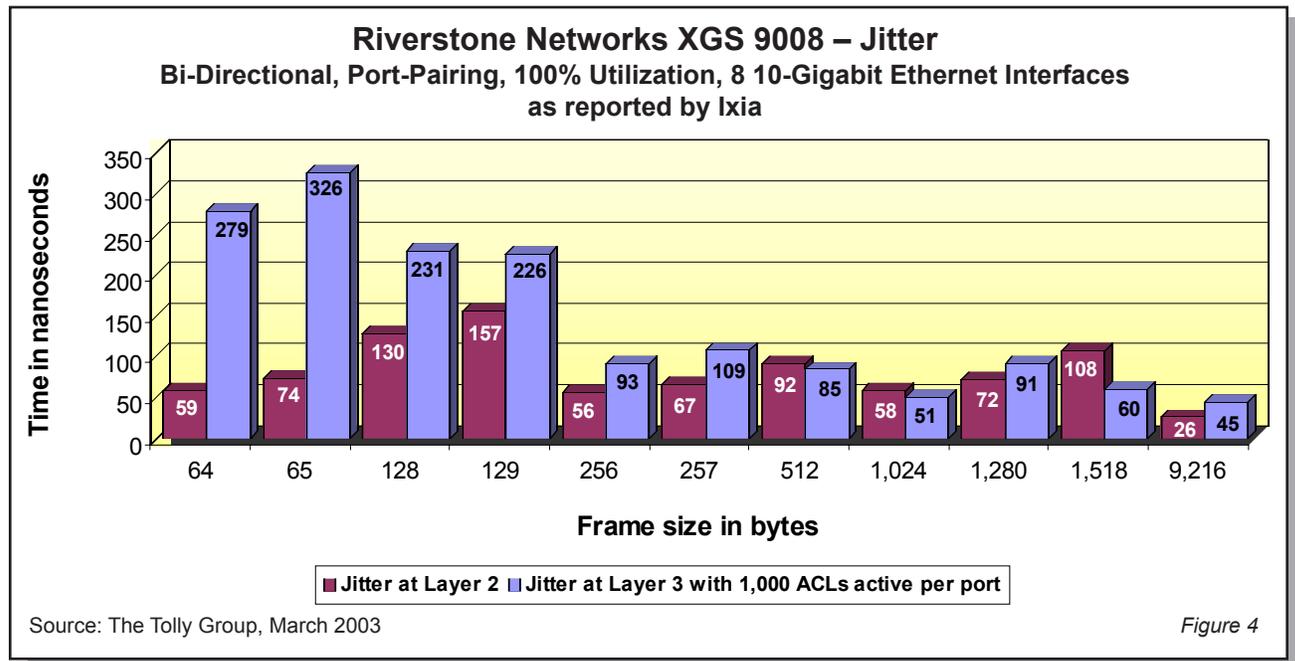
- 22-slot chassis
- 16 dedicated line card slots
- 2 dedicated control module slots
- 2 dedicated fabric modules slots
- 2 expansion slots
- Dimensions:
 - AC system - X9016-CHAC 35" H x 17.25" W x 21" D (88.9 cm x 43.8 cm x 53.3 cm)
 - DC system - X9016-CHDC 33.25" H x 17.25" W x 21" D (84.5 cm x 43.8 cm x 53.3 cm)
- System weight:
 - Fully populated chassis: 314 lbs (143 kg)
- Power:
 - Maximum power dissipation: 2,000W

XGS 9008

- 12-slot chassis
- 8 dedicated line card slots
- 2 dedicated control module slots
- 2 dedicated fabric modules slots
- Dimensions:
 - AC system - X9008-CHAC 22.75" H x 17.25" W x 21" D (57.8 cm x 43.8 cm x 53.3 cm)
 - DC system - X9008-CHDC 21.0" H x 17.25" W x 21" D (53.3 cm x 43.8 cm x 53.3 cm)
- System weight:
 - Fully populated chassis: 199 lbs (91kg)
- Power:
 - Maximum power dissipation: 1,000W

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



ANALYSIS

The deployment of 10-Gigabit Ethernet switches in high performance networking environments such as carrier-class or enterprise cores calls for wire-speed throughput with no packet loss. For these devices, consistency in performance is an important factor whether at Layer 2 or Layer 3 and despite a range of frame sizes or increased functionality, such as ACL filtering. Test results demonstrate that Riverstone Networks XGS 9008/9016 deliver exceptional performance on all fronts.

The Tolly Group tested each switch with frame sizes other than those typically used for performance benchmarks. Real world IP network traffic can include any legal Ethernet frame size (from 64 bytes on up through 1,518 bytes). In throughput tests, both the XGS 9008 and XGS 9016 delivered 100% zero-loss wire-speed throughput across the full range of packet sizes,

including non-standard frames. This is an important factor since performance may suffer, in some cases significantly, when odd-sized, yet legal and real world, frames are used. Furthermore, the capability of the XGS 9008 and the XGS 9016 to perform at wire-speed while handling Jumbo Frames makes it ideal for positioning in data centers as storage over IP begins to emerge.

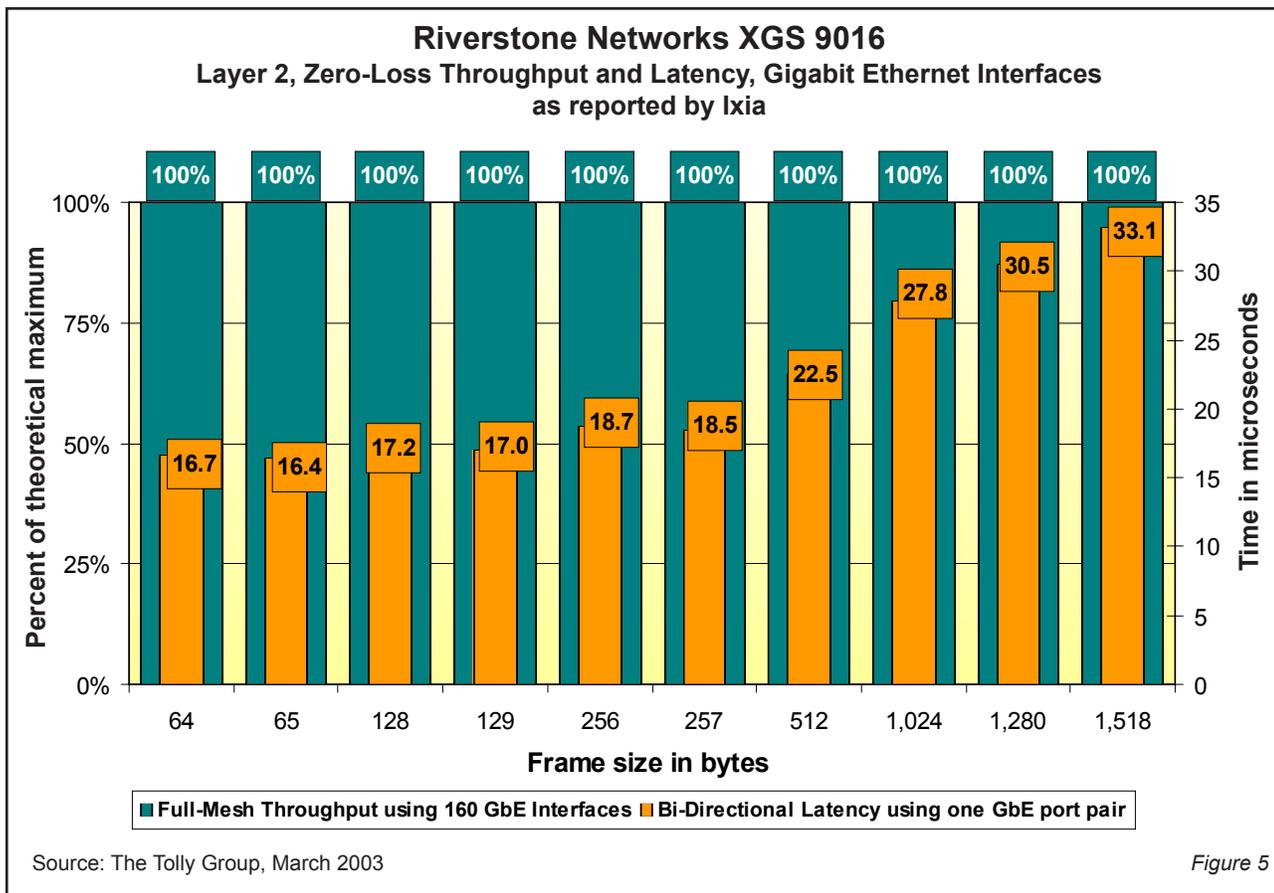
But high bandwidth alone is not enough to service the needs of network architects. Regardless of its operational mode, the XGS 9008 and the XGS 9016 delivered consistent zero-loss wire-speed performance in both the bi-directional port-pairing and full-mesh tests even while performing ACL processing, which users regularly employ for security reasons. Both scenarios represent a more realistic test scenario than tests that simply forward traffic on a port-to-port basis across a switch interface card with no filters present. Furthermore, these tests fully exercised the capacity

of device backplane and demonstrate scalability.

Latency and jitter tests demonstrate that the XGS 9008 and XGS 9016 can provide throughput at rates suitable for latency-sensitive voice traffic, video and other mission-critical applications.

TEST CONFIGURATION AND METHODOLOGY

For performance tests, The Tolly Group employed a Riverstone Networks XGS 9008 and XGS 9016 running beta firmware version 1.0.0.59j. The XGS 9008 was outfitted with eight (8) 1-port 10-GbE interfaces and a single switch fabric and single control module. The XGS 9016 was outfitted with sixteen (16) 1-port 10-GbE interfaces and a single switch fabric and single control module. Additional testing on the XGS 9016 was conducted with sixteen (16) 10-port 1-GbE interfaces and a single switch fabric and single control module.



Tolly Group engineers connected each device under test to an IXIA 1600T traffic generator/analyzer using 1310nm single mode fiber with the 10-Gigabit Ethernet interfaces and 62.5micron multimode fiber with the Gigabit Ethernet interfaces. (See Figure 5.)

Engineers subjected each DUT to steady-state, zero-loss bi-directional, frames-per-second (fps) throughput tests of 64-, 65-, 128-, 129-, 256-, 257-, 512-, 1,024-, 1,280- and 1,518-byte frames at a load of 100% the theoretical maximum at Layer 2 and Layer 3 in both a bi-directional, port-pairing and a full-mesh scheme. Engineers also conducted zero-loss, full-mesh testing of Jumbo Frames (9,216-bytes) in the 10-Gigabit Ethernet interface scenarios on both the XGS 9008 and XGS 9016. For port-pair tests using the XGS

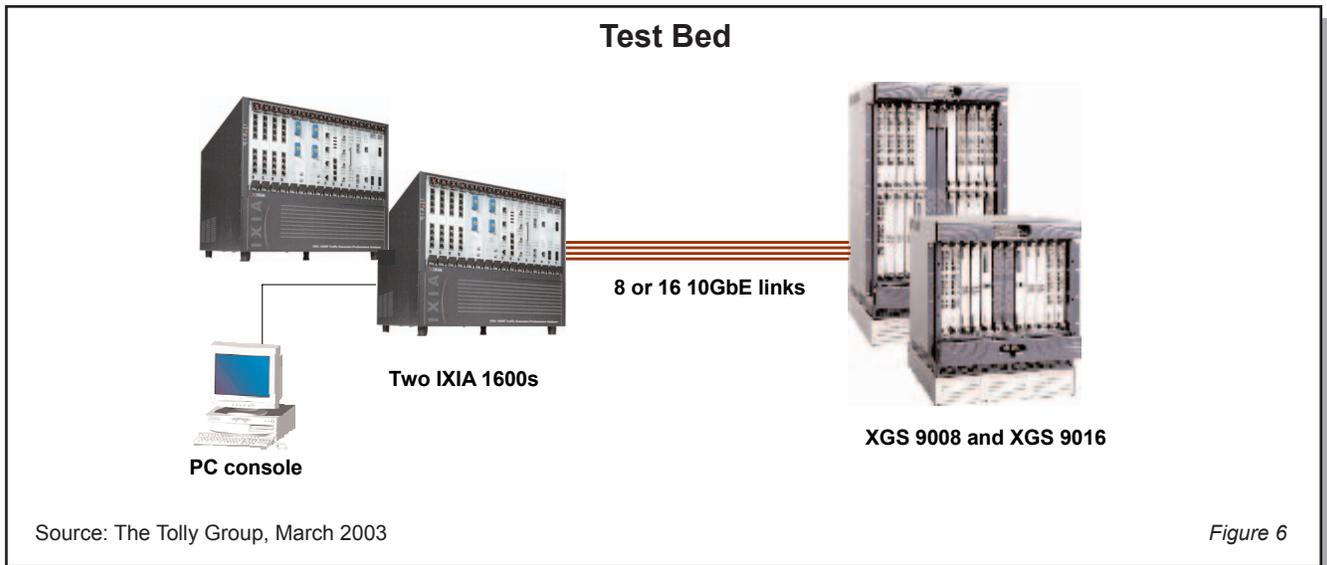
9008, engineers mapped port 1 to port 5, port 2 to port 6, and so on; for the port-pair tests using the XGS 9016, engineers mapped port 1 to port 9, port 2 to port 10, and so on. Full mesh is a configuration in which each port sends traffic to every other port and each port receives traffic from every other port. These tests were steady-state, absolute zero-loss tests. This was more stringent than industry average, where an acceptable loss tolerance of one packet in 100,000 is traditionally used. Latency results were recorded in the bi-directional port-pairing configuration only.

Engineers configured each device for the maximum speed and full-duplex operation; they disabled Spanning Tree, flow control and other ancillary features that otherwise could

impact test performance. They then configured the IXIA 1600T via the ScriptMate interface for the tested frame sizes, interface utilization, test duration and iterations.

Ixia ScriptMate application recorded total transmitted frames and total received frames plus frame loss, if any. ScriptMate also reported the latency and jitter results from the bi-directional port pairing tests of the 10-Gigabit Ethernet interfaces. Tests were run for three iterations of 60 seconds for each frame size and results were averaged.





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

Vendor	Product	Web address
Ixia Communications	IXIA 1600T	http://www.ixiacom.com
Ixia Communications	ScriptMate 3.65.284a EA SP3d	http://www.ixiacom.com
Ixia Communications	LM10GE-LANWAN	http://www.ixiacom.com
Ixia Communications	LM1000SX3	http://www.ixiacom.com

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PROJECT PROFILE

Sponsor: Riverstone Networks, Inc.

Document number: 203105

Product Class: Layer 3 10-Gigabit Ethernet switch

Products under test:

- XGS 9008
- XGS 9016

Testing window: March 2003

Firmware versions tested:

- 1.0.0.59j

Firmware status:

- BETA

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