Fujitsu Computer Products of America, Inc.
XG2000 Series Switches
10 Gigabit Ethernet Zero-Loss Throughput and Latency Evaluation

Premise: Enterprise server/storage networks demand ultra-fast node-to-node interconnections to support high bandwidth data transfer. Both ultra-low latency and high-density Ethernet switching are required for successful high-performance computing deployment. Demands created by high definition (HD) video files need to transmit very quickly, at a high bandwidth. The key to such deployments is a switch that delivers 10 Gigabit Ethernet throughput without loss and ultra-low latency.

Fujitsu Computer Products of America, Inc. commissioned The Tolly Group to evaluate its XG2000, a fixed 20-port 10 Gigabit Ethernet (10GbE) switch designed to aggregate GbE switch links or link directly to 10GbE-capable servers as a high-speed interconnect. The XG2000 represents the third-generation of Fujitsu’s Layer 2, non-blocking, single-chip 10GbE solutions.

Engineers measured the zero-loss 10GbE throughput of the XG2000 to determine the capability of the device to scale wire-speed throughput across a large number of servers. Engineers also recorded the latency introduced by the XG2000 when handling the frame sizes ranging from 64 bytes to 16,128-byte Jumbo Frames, as well as two sets of mixed frame sizes.

Tests were conducted in July 2007.

<table>
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<th>Test Highlights</th>
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<td>Achieves 100% of line-rate zero-loss 10GbE throughput when tested across 20 full-mesh ports, when handling frame sizes ranging from 64 bytes to 16,128 bytes</td>
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<td>Drops zero frames when sustaining 100% zero-loss line rate across 20 10GbE ports when tested with multiple packet sizes in a full snake configuration</td>
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<td>Demonstrates ultra-low latency, just 337 – 363 nanoseconds (including XFP latency), on average, across mixed frame sizes and fixed frame sizes ranging from 64 bytes to 16,128 bytes at 100% load in a full snake configuration</td>
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Fujitsu XG2000 Layer 2 Zero-loss Throughput Across 20 10GbE Ports in a Full-Mesh Configuration as Reported by Spirent Test Center Application 1.31

Source: The Tolly Group, January 2008
Executive Summary

Fujitsu’s XG2000 delivered zero-loss 10GbE throughput across a variety of fixed packet sizes and mixed packet scenarios while simultaneously introducing ultra-low latency of about 350 nanoseconds or less (including XFP latency). This positions the XG2000 to support high performance computing, node-to-node interconnects for enterprise server and storage, and support service providers for interconnecting video servers and storage devices used for-HDTV.

Tolly Group tests show that Fujitsu’s XG2000 combines ultra-low latency with high 10GbE performance in a compact, 1U form factor. The XG2000 provides the high density 10GbE performance that data center managers require for node to node interconnections that link 10GbE servers or server racks and uplink those devices to the core of the network.

Additionally, the XG2000 delivers the ultra low-latency needed for high performance cluster computing – traditionally the domain of Infiniband and other proprietary technologies. The familiarity with Ethernet means the same personnel that run installed Ethernets can extend those to support 10GbE without additional investments or training required for “non-traditional” technologies.

In Layer 2 forwarding performance tests, the XG2000 achieved line-rate zero-loss throughput for all 14 frame sizes tested – ranging from 64 bytes to 16,128 bytes. Line-rate performance was realized for both a 10GbE, 20-port full-mesh scenario, and a 20-port snake configuration. Even when handling an Internet traffic mix (64, 78, 576 and 1,500 bytes), the XG2000 achieved line-rate throughput. Out of 6,067,080,940 frames of Internet-mix traffic transmitted, the XG2000 did not drop a frame.

From a frame forwarding perspective, the XG2000 forwarded a maximum of 14,880,952 64-byte frames per second for each port, 812,743 frames at 1,518-byte frames per second, and 77,407 frames per second when tested with the maximum frame size of 16,128 bytes.

On the latency front, the XG2000 introduced latency ranging from a low of 339 nanoseconds to 359 nanoseconds (including XFP latency) with 64-byte frames, or 341 nanoseconds on average across the 14 frame sizes tested. When handling an Internet mix of traffic, latency introduced by the switch was just 362 nanoseconds. This proves that XG2000 consistently provides ultra-low latency regardless of the frame sizes used.

Tolly Group engineers measured latency in a snake configuration across 20 ports.

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**Fujitsu XG2000 Cut-Through Switch Latency on a “Per-Switching” Basis Across 20 10GbE Ports in a Snake Configuration as Reported by Spirent Test Center Application 1.31**

Note: The “per-switching” latency was calculated by dividing the measured latency values by the number of switching occurrences. In this test, 10 switching instances occurred while a single frame was transmitted across 20 ports in the snake port pairing configuration. Latency results include latency introduced by onboard XFP optical transceivers and are part of the end-to-end latency experienced by users.

Source: The Tolly Group, January 2008

*Figure 2*
In the snake configuration, there were 10 instances of switching that occurred between ports. To obtain an accurate cut-through latency measurement, engineers divided the total nanoseconds reported by the test tool by 10 to obtain the cut-through switch latency on a “per-switching” basis.

The tandem of ultra-low latency and line-rate performance demonstrates that the XG2000 will not become a bottleneck to data center servers and will help to ensure optimal response times, especially for latency-sensitive applications.

**Layer 2 Forwarding Throughput**

**20 Ports, Full-Mesh Test Scenario**

Engineers configured 20 10GbE ports for the XG2000 and 20 10GbE ports for the Spirent TestCenter SPT-9000A. Engineers configured the test suite for bidirectional full-mesh traffic and configured the test suite to transmit traffic at 64, 128, 256, 512, 1,024, 1,280, 1,518, 4,400, 4,700, 8,000, 9,216, 12,288, 15,360 and 16,128 bytes. Engineers ran the zero-loss throughput test for 60 seconds and recorded throughput and latency for each packet size. Tests were run three times; the results were averaged.

The XG2000 delivered line-rate throughput and ultra-low latency for all test scenarios in the full-mesh test. The Spirent TestCenter Application 1.31 reported the cut-through latency of 3.38 ~ 3.63 microseconds. Engineers divided the reported values by 10 (since there were 10 instances of switching). Therefore, the “per-switching” cut-through latency measured 338 ~ 363 nanoseconds for all frame sizes tested.

**20 Ports, Snake Test Scenario**

For the 10GbE full snake Layer 2 forwarding throughput test, engineers configured 20 XG2000 10GbE ports for cut-through switching mode and two 10GbE ports for the Spirent TestCenter SPT-9000A, and connected the switch port number 1 and 20 to the test tool port 1 and 2, respectively. Switch ports 2/3, 4/5 and so on were directly connected to each other via fiber-optic patch cables through port pair 18/19. Engineers configured the test suite for bidirectional full “snake” traffic (that is, data exiting on a given port was redirected into an adjacent port) and configured the test suite to transmit traffic in the same way as the previous full-mesh test.

Engineers ran the zero-loss throughput test for 60 seconds and recorded throughput and latency for each packet size. Tests were run three times; the results were averaged.

The XG2000 delivered line-rate throughput and ultra-low latency for all test scenarios in the snake test. The Spirent TestCenter Application 1.31 reported the cut-through latency of 3.38 ~ 3.63 microseconds. Engineers divided the reported values by 10 (since there were 10 instances of switching). Therefore, the “per-switching” cut-through latency measured 338 ~ 363 nanoseconds for all frame sizes tested.
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**

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<td>XFP-2001B</td>
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