THE TOLLY GROUP

No. 208264 February 2008

Intoto, Inc.

iGateway Firewall

Software Firewall on Intel Multi-Core

UDP Throughput and HTTP Connection Rate Performance Evaluation

TOLLY Up to Spec CERTIFIED Test Summary

Premise: *While firewalls have historically been deployed between the access router and corporate network, today's enterprises are increasingly deploying firewalls in the enterprise core to better control access among internal network resources and prevent threats. The extremely high throughput requirements within the enterprise core require security devices that do not adversely impact network performance.*

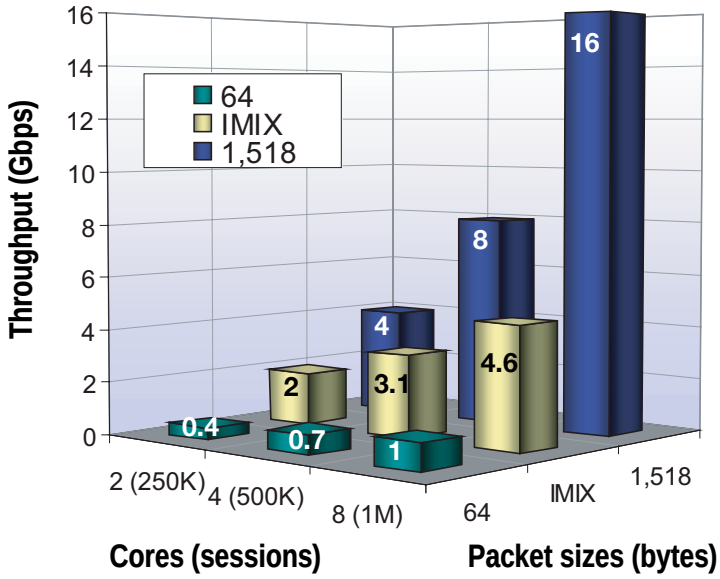
INTOTO, Inc. commissioned The Tolly Group to evaluate the iGateway Firewall. iGateway Firewall is a software-based carrier grade/large enterprise firewall that provides high-performance and scalability while running on off-the-shelf, general-purpose Intel multi-core hardware platforms. The software includes stateful inspection with packet integrity checks, access policies, content filtering, local proxy redirection and DDoS attack prevention. Testing focused on evaluating firewall performance with stateful inspection and access policies.

Tests measured the zero-loss (≤0.001%) aggregate UDP throughput with multiple simultaneous sessions and HTTP connection rate with different policy matching for its eight-core, quad-core and dual-core systems. Tests were conducted in November 2007.

Test Highlights

- Delivers 16 Gbps of aggregate throughput when handling 1,518-byte UDP packets and 1 million concurrent sessions on an eight-core system
- Sets up and tears down over 120,000 HTTP connections per second
- Achieves over 2.2 million packets per second when handling UDP traffic of emulated real-world packet size mix (IMIX)
- Demonstrates linear performance scaling with the number of CPU cores in the system

iGateway Firewall Zero-Loss Aggregate UDP Throughput for Eight-core, Quad-core and Dual-core Systems
as Reported by Ixia IxExplorer



Source: The Tolly Group, December 2007

Figure 1

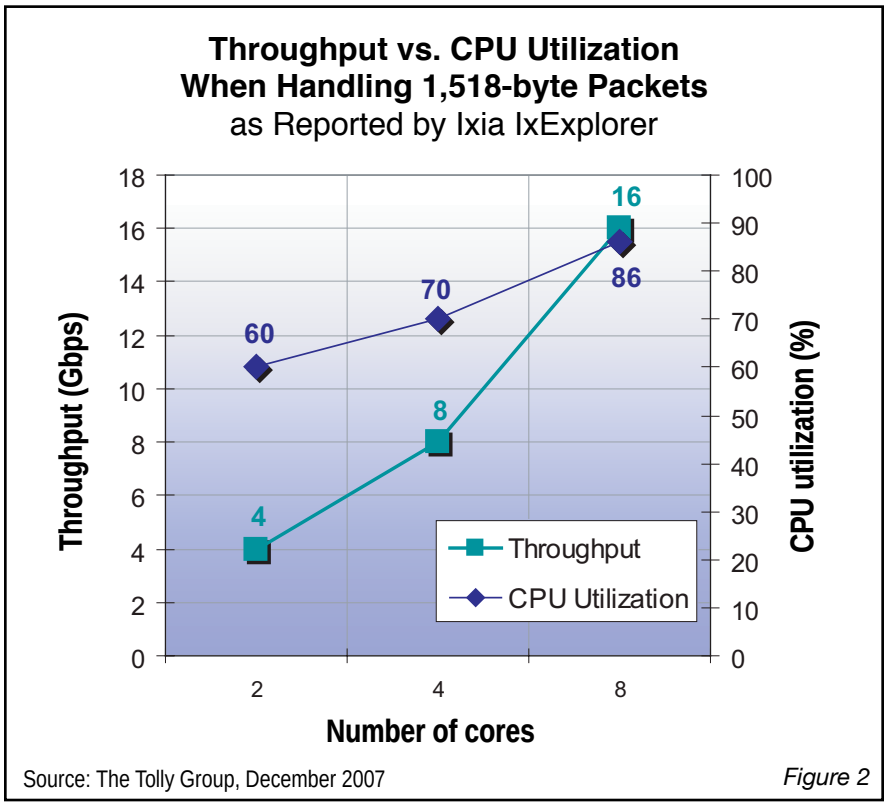
Executive Summary

The Intoto iGateway Firewall achieves high network performance for large enterprises using off-the-shelf Intel multi-core CPU-based server platforms; its performance scales linearly according to the number of Intel CPU cores in the system.

The firewall is a cornerstone to corporate networks and it has the potential to degrade network performance. In this report, Tolly Group engineers focused on validating the performance and the scalability provided by the iGateway Firewall.

iGateway Firewall is a pure software solution that provides comprehensive security. It runs on a wide range of popular processors and optimizes the performance with relatively easy tuning. Engineers validated that iGateway Firewall utilizes Intel's multi-core processors very effectively and in turn provides high performance and linear performance increases with respect to the number of cores.

In a UDP throughput test, engineers proved that the iGateway Firewall supports 16 Gbps of aggregate throughput on an Intel eight-core system when handling 1,518-byte packets and 1 million simultaneous sessions. When handling more realistic mixed packet sizes, iGateway Firewall processed over 2.2 million packets per second.



Source: The Tolly Group, December 2007 *Figure 2*

In an HTTP connection rate test, iGateway Firewall demonstrated that it can set up and and tear down over 120,000 TCP connections without any failed HTTP transactions. Both tests clearly show that the iGateway Firewall's performance scales linearly with the number of cores due to effective utilization of hardware resources.

On the features side, the iGateway Firewall provides access control, protection from DoS and DDoS attacks, and event auditing/logging. Since functionality testing was not the objective of this Tolly Group project, these features were not tested, though Intoto says they were present in the firewall. Additionally, Intoto says the iGateway firewall can be deployed in Layer 2 or Layer 3 mode depending on the IP addressing scheme of the host site. It also supports High Availability in Active-Active and Active-Backup modes of operation. This report focuses on a Layer 3 deployment.

ZERO-LOSS (≤0.001%) UDP THROUGHPUT

Tolly Group engineers measured zero-loss bidirectional throughput across iGateway Firewall eight-core, quad-core and dual-

core systems using 16 (eight public and eight private), eight and four GbE interfaces, respectively, with different numbers of sessions and different packet sizes. This test was conducted with a single access policy which allowed all traffic. Engineers also measured the CPU utilization of the systems during the test.

For the eight-core test, iGateway Firewall achieved 16 Gbps of continuous wire-speed throughput for packets of 1,518 bytes up to 1 million simultaneous sessions with 15%~30% of CPU resources available to handle other tasks.

The iGateway Firewall achieved aggregate throughput of 1.03 Gbps~1.42 Gbps for 64-byte packets and 4.64 Gbps~6.72 Gbps for IMIX packets, depending upon the number of simultaneous sessions supported on the device. (See Figures 1, 2 and 3.) Engineers verified that all eight cores were evenly utilized throughout the test and packets per second (PPS) rates were fairly consistent regardless of packet sizes for any single test unless the performance was limited by the interface capacity. This was proven by test results where PPS rates for 64 bytes and IMIX were fairly similar.

The 1,518-byte results were not limited by the processing power but by the number and the type of interfaces on the platform.

For the quad-core test, iGateway Firewall reported consistent wire-speed performance out of eight GbE interfaces when handling 1,518 bytes from 4 to 500,000 concurrent sessions and 0.73 Gbps~0.95 Gbps and 3.12 Gbps~4.22 Gbps for 64-byte and IMIX packets, respectively.

For the dual-core test, engineers measured 4 Gbps of throughput out of four GbE interfaces used for the test with 1,518-byte packets and up to 250,000 concurrent connections. The CPU utilization rate for this test remained 60%.

(Note: Figure 2 plots CPU utilization against the observed throughput on all three target systems when they were running at full session capacity — i.e. 250K, 500K, and 1 million sessions on dual, quad and eight-core systems, respectively, and processing 1,518-byte packets.)

In another test, with the two and four cores, engineers increased the number of GbE interfaces to 16 and measured 11 Gbps and 15.98 Gbps of UDP throughput, respectively, with a 100% CPU utilization rate.

(Note: Figure 3 lists the detailed throughput characteristics of the iGateway Firewall observed during the test.)

HTTP Connection Rate

Engineers measured the HTTP connection rate of the iGateway

Intoto, Inc.

iGateway Firewall - Software Firewall on Intel Multi-core Server Platforms

UDP Throughput and HTTP Connection Rate Performance Evaluation

Product Specifications

Vendor-supplied information not necessarily verified by The Tolly Group

iGateway Firewall

Performance
- 16 Gbps throughput with 1 million concurrent sessions
- 2.2 million PPS throughput capacity
- 120,000 CPS setup and tear down rate
- Linear performance scaling with number of cores

Security
- Policy-based access control
- DoS/DDoS Prevention
- Application level gateways
- Policy groups
- NAT and NAPT support
- Exhaustive event logging and audit trail

Advanced Features
- Layer-2 and Layer-3 operation
- Content filtering
- High availability
- Stateful failover

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Firewall for eight-, quad- and dual-core systems with different sequences of policy matching in the firewall policy database. One HTTP connection constituted a TCP connection setup, HTTP GET request, 1-byte data response and close by RESET. The connection setup rate test, generally, is the most CPU intensive test and exercises the core functional aspects of the stateful inspection firewall.

Tests show that the eight-core system yielded an HTTP connection rate of 121K, 121K, 111K and 97K connections per second (cps) for 1st, 100th, 500th and 1,000th policy matching.

The quad-core system reported 84K, 81K, 68K and 55K cps and lastly the dual-core system measured 61K, 56K, 42K and 33K cps for the same tests. All results were achieved with zero transaction failures. Not only does this show the high connection rate performance when handling stateful HTTP traffic, but also it proves linear scalability of the firewall performance with the number of CPU cores in the system.

(Note: Figure 4 shows the graphic representation of the connection setup rate data in a 3D format.)

iGateway Firewall Throughput Detailed Characteristics

Session count for (2, 4, 8) cores	Packet size	Throughput (Gbps)		
		2 Cores	4 Cores	8 Cores
2, 4, 8	64	0.60	0.95	1.42
	IMIX	2.70	4.22	6.72
	1518	4.00	8.00	16.00
25K, 50K, 100K	64	0.44	0.74	1.17
	IMIX	2.00	3.31	5.20
	1518	4.00	8.00	16.00
125K, 250K, 500K	64	0.43	0.74	1.10
	IMIX	2.00	3.18	5.06
	1518	4.00	8.00	16.00
250K, 500K, 1M	64	0.43	0.73	1.03
	IMIX	2.00	3.12	4.64
	1518	4.00	8.00	16.00

Source: The Tolly Group, December 2007

Figure 3

Test Setup & Methodology

Tolly Group engineers tested a pre-release Intoto iGateway Firewall version 4.0. The eight-core system was equipped with two Quad-Core Intel® Xeon® processors 5355 at 2.66 GHz. The quad-core and dual-core systems were equipped with two and one Dual-Core Intel® Xeon® processor 5150s at 2.66 GHz. All three systems were equipped with the same remaining hardware and software. Main hardware included consisted of 8 GB DDR2 RAM (667 MHz), a total of 16 Intel NIC ports (Driver: e1000-7.6.9-NAPI) and the Intel® Server Board S5000PSL motherboard. Main software included Fedora Core 6 platform running the Linux 2.6.18.1 BIGSMP kernel.

Tolly Group engineers used an Ixia Optixia XM12 chassis, modules (LSM1000XMV16, LM1000STXS4), IxExplorer 5.0 (for UDP Throughput test) and IxLoad 3.3 (for HTTP Connection Rate test) for traffic generation/analysis.

(Note: Figure 5 depicts the test bed used during the iGateway Firewall performance tests.)

For the UDP Throughput test, engineers configured iGateway Firewall to allow the test traffic in the first outbound policy matching and ran the same test three times for 60 seconds and averaged the readings to obtain the final results. The test utilized a single inbound policy that allowed all traffic by default. A single set of the IMIX packets included seven 64-byte, four 570-byte and one 1,518-byte packets. The multiple sessions were created with the different combinations of source/destination IP and source/destination UDP port numbers.

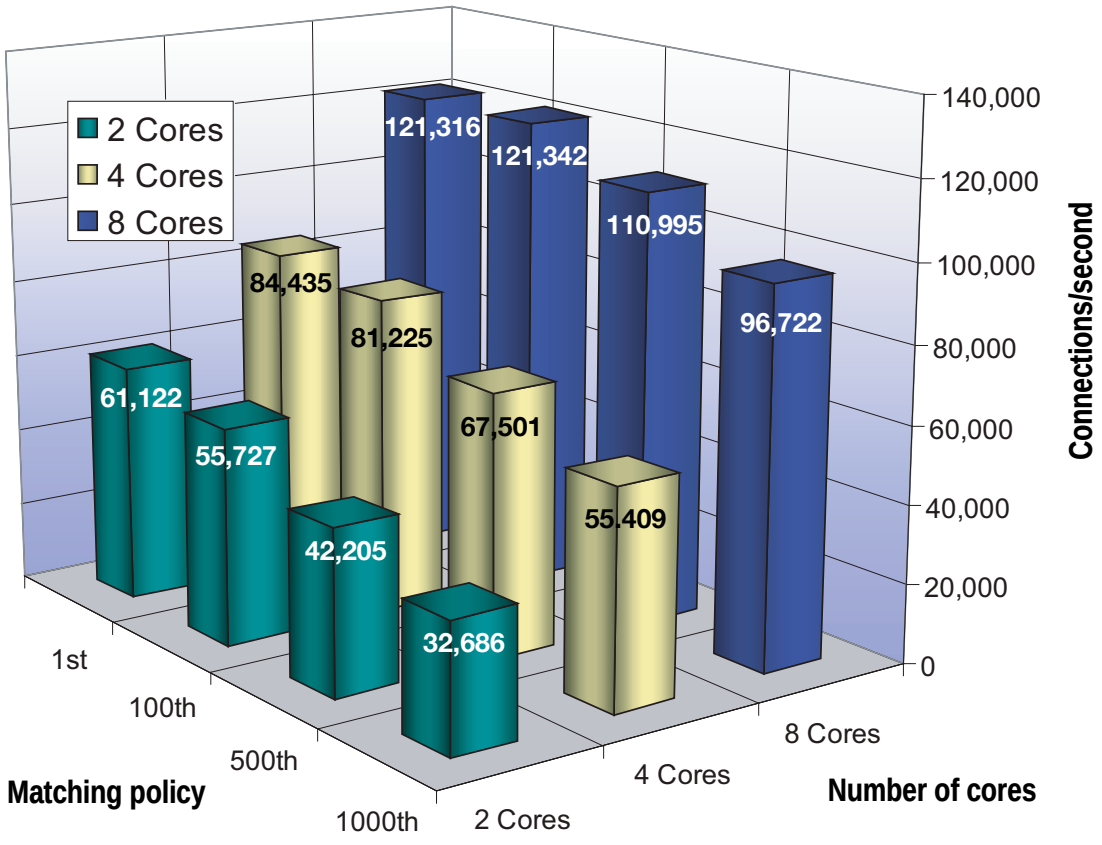
For the HTTP Connection Rate test, engineers configured Ixia IxLoad to send a single HTTP/1.0 GET request, to respond with 1-byte data over the established TCP connection and to close using RESET. Each system was configured with 1,100, 500 and 1,000 ACL rules (with only the last rule allowing test traffic to pass through). Two Ixia ports aggregated into a single iGateway Firewall port represented 16 subnets (eight public and eight private) and over-exercised the systems under test. There were four Layer 2 wire-speed switches used as aggregation switches. The connection rates are the average values from the five minutes of steady state. Engineers ensured that there were no failed transactions during the steady state.

Sponsor Note

This performance test was co-funded by Intel Corp. and Intoto, Inc.

Intel does not control or audit the design or implementation of third-party benchmarks or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmarks are reported and confirm whether the referenced benchmarks are accurate and reflect performance of systems available for purchase.

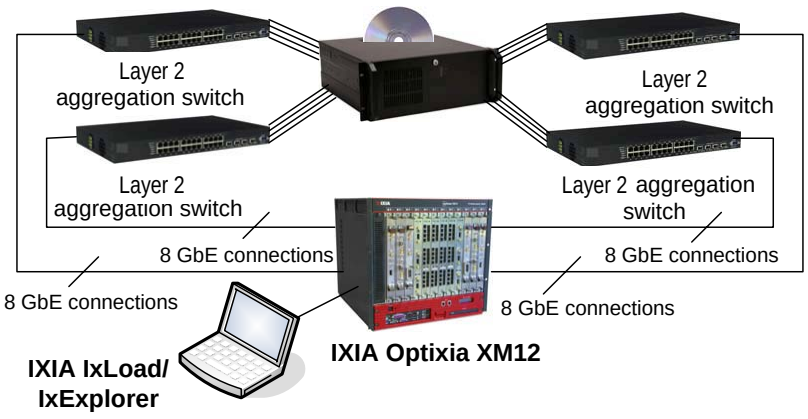
iGateway Firewall Connection Rate for Eight-core, Quad-core and Dual-core Systems with Policy Matching
as Reported by Ixia IxLoad



Source: The Tolly Group, December 2007

Figure 4

Test Bed Diagram



Source: The Tolly Group, December 2007

Figure 5

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
IXIA	Optixia XM12	http://www.ixiacom.com
IXIA	IxLoad 3.30.42.143	http://www.ixiacom.com
IXIA	IxExplorer 5.0.300 build 37	http://www.ixiacom.com

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208264-johbmmt1-cdb-30JAN2008