

Intel Corp.

Intel® IXP425 Network Processors

Performance Analysis of VPN Devices



Test
Summary

Premise: Secure IPSec VPN connections through the Internet result in tremendous savings over the cost of a private WAN connection, leased lines, or long-distance phone charges. But these advantages are at the cost of decreased performance from the additional processing required at the gateways to encrypt the outbound traffic and decrypt the inbound traffic. A comprehensive performance analysis can provide networking professionals with the knowledge about how network-processor-based VPN devices reduce the impact of IPSec on data throughput.

Intel Corp. commissioned The Tolly Group to benchmark the performance of several commercially available VPN gateways that utilize the Intel® IXP425 network processor, and compare the performance of those devices against other, generally available products based upon alternative chipsets.

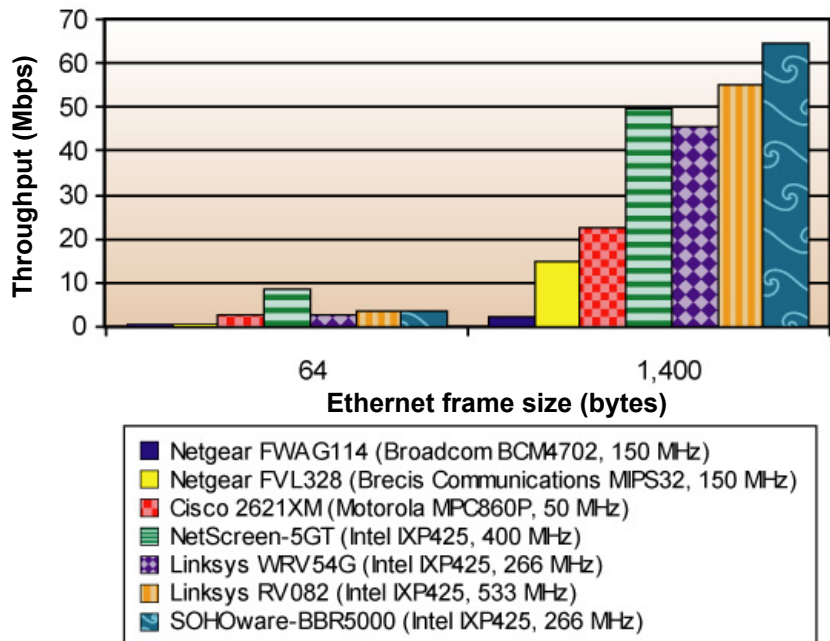
Tolly Group engineers benchmarked the devices under test (DUTs) based on the IPSec VPN performance in three test configurations:

- Gateway-to-gateway (box-to-box) VPN configuration and throughput measurement using Spirent's SmartFlow version 3.10 running on a SmartBits 6000B for a single VPN tunnel;
- Gateway-to-gateway (box-to-TeraVPN) VPN configuration and throughput measurement using Spirent's TeraVPN Tester

Test Highlights

- VPN gateways based on the Intel® IXP425 network processor outperform boxes based on alternative chipsets achieving maximum Layer 2 bidirectional IPSec throughput of 65 Mbps
- Intel IXP425-based VPN gateways exhibit almost three times less performance degradation compared to other products under heavy traffic load in 10 and 50 VPN tunnel configurations
- Intel IXP425-based NetScreen-5GT VPN gateway demonstrates the fastest tunnel setup rate of all products tested, setting up tunnels in just 0.2 seconds on average

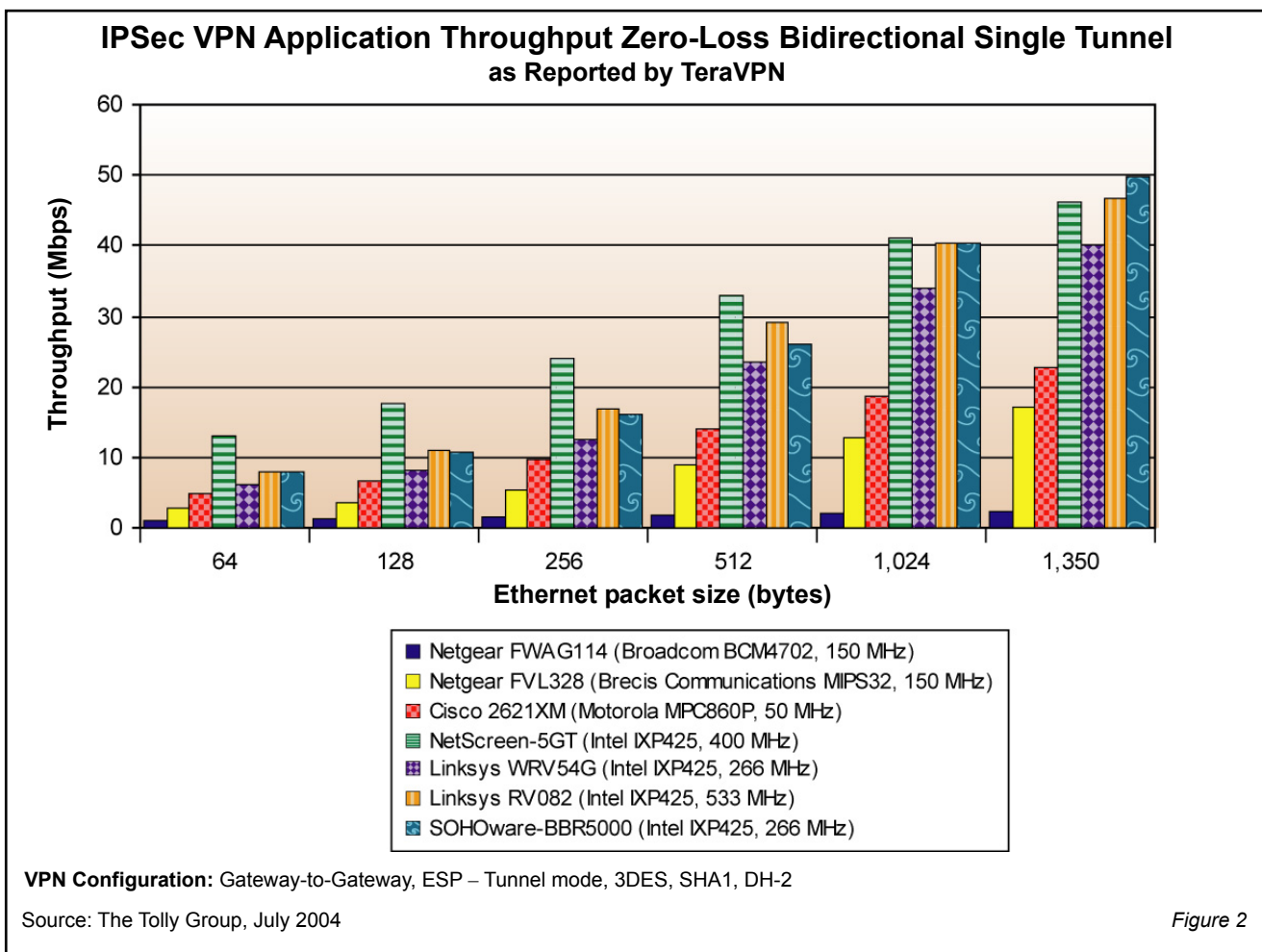
IPSec VPN Application Throughput Zero-Loss Bidirectional Single Tunnel Gateway-to-Gateway as Reported by SmartFlow



VPN Configuration: Gateway-to-Gateway, ESP – Tunnel mode, 3DES, SHA1, DH-2

Source: The Tolly Group, July 2004

Figure 1



version 4.0 running on a SmartBits 6000B for 1, 10 and 50 tunnels;

- Tunnel setup rate for a single VPN tunnel using Spirent's TeraVPN version 4.0 running on a SmartBits 6000B.

The Tolly Group conducted performance tests to validate the Layer 2 throughput of various VPN devices focusing on the CPU/NPU performance using Spirent's SmartFlow and TeraVPN applications running on a SmartBits 6000B. As expected, the two SmartBits applications reported slightly different throughput results, but they both produced very consistent and similar performance trends for all the devices under test. The best performers in

the SmartFlow test were also the best ones in the TeraVPN test. This also proves the integrity and validity of the test.

Among the devices tested, the Intel IXP425-based products outperformed the alternative chipset-based devices (Broadcom BCM4702, Motorola MPC860P, etc) in every scenario.

RESULTS

BIDIRECTIONAL VPN GATEWAY-TO-GATEWAY THROUGHPUT VIA SMARTFLOW

Engineers used Spirent's SmartBits with SmartFlow to direct bidirectional UDP traffic through the

VPN tunnel and measured the throughput for different Ethernet frame sizes — 64 bytes through 1,400 bytes in a Fast Ethernet, full-duplex configuration.

The SOHware BBR5000 (IXP425, 266 MHz) was the best performer in the SmartFlow test, recording the highest bidirectional throughput rate of 65 Mbps for the largest frame size in the single-tunnel configuration. However, the NetScreen-5GT (IXP425, 400 MHz) outperformed all other boxes for the small and medium frame sizes, delivering 8.5 Mbps for the taxing 64-byte frames and almost 14 Mbps for 128-byte frames. That performance represents more than a 3X performance advantage over the nearest non-IXP425-based VPN device. (See Figure 1.)

BIDIRECTIONAL VPN GATEWAY-TO-GATEWAY THROUGHPUT VIA TERAVPN

Tests were performed to determine the data transfer capability of the VPN device under test using the TeraVPN application from Spirent Communications under identical test conditions. The throughput was measured for different data sizes — 64 bytes through 1,350 bytes in a Fast Ethernet, full-duplex environment. The data-forwarding rate was checked for all the test devices across a single VPN tunnel. For VPN devices that can support multiple tunnels, throughput also was measured for 10 tunnels and 50 tunnels to examine the impact of multiple VPN tunnels on the performance of the tested devices.

The SOHOware-BBR5000 (IXP425, 266 MHz) delivered the highest single-tunnel performance of the products tested. In TeraVPN tests, the performance improved as the frame size/data size increased. The performance degradation for smaller packet sizes results from the associated large overhead (header and inter-frame gap). This overhead becomes negligible with larger packet sizes and hence does not reflect significantly on the performance.

Of the seven VPN gateways tested, again the Intel IXP425-based products accounted for the four highest performers in the single-tunnel TeraVPN test. At 1,350-byte packets, the SOHOware-BBR5000 (IXP425, 266 MHz) delivered the highest throughput at 50 Mbps, followed closely by the Linksys RV082 (IXP425, 533 MHz) at 47 Mbps and the NetScreen-5GT (IXP425, 400 MHz) at 46 Mbps.

The Linksys WRV54G (IXP425, 266 MHz) delivered 40 Mbps. By contrast, the closest of the alternative products, the Cisco 2621XM (MPC860P, 50 MHz) delivered 23 Mbps.

The Intel IXP425-based products maintained their lead even at the more taxing 64-byte packets, delivering more than twice the performance of the nearest non-Intel device. (See Figure 2.)

In the 10-tunnel test, the Intel IXP425-based VPN gateways again delivered superior throughput at both small and large packet sizes versus the non-Intel products tested. (See Figure 3.) The Linksys RV082 (IXP425, 533 MHz) delivered the highest throughput at 46 Mbps for 1,350-byte packets, almost 2.5 times more throughput than the nearest non-Intel device. In the 64-byte packet test with 10 tunnels, the NetScreen-5GT (IXP425, 400 MHz) achieved the highest throughput with 14 Mbps, more than 3 times the performance of the nearest non-Intel device.

In the 50-tunnel test, the Linksys RV082 (IXP425, 533 MHz) delivered 35 Mbps of throughput when tests at 1,350-byte packets and the Linksys WRV54G (IXP425, 266 MHz) achieved 27 Mbps at the same packet size. (See Figure 4.) The only other product tested, the Cisco 2621XM managed only 15 Mbps at the 1,350-byte packet test. The Intel IXP425-based products also outperformed the Cisco 2621XM at the 64-byte packet size as well.

Tolly Group engineers also examined the throughput degradation as throughput rates were measured from 1, to 10 to 50 tunnels. For the 10-tunnel test, three Intel IXP425-based VPN gateways outperformed the

Intel Corp.

**IXP425 Network
Processor**

**Performance
Analysis of VPN
Gateways**



Intel Corp. IXP425 Network Processor Product Specifications*

- Member of the Intel® IXP42X product line of network processors for enterprise, small-to-medium enterprise (SME), residential and other networking applications
- Intel XScale® core at up to 533 MHz provides headroom for customer-defined applications
- Integrated hardware acceleration of popular cryptography algorithms (SHA-1, MD5, DES, 3DES, AES) for secure applications
- DSP software library on the Intel XScale core supports up to four voice channels and reduces system cost
- Two high-speed serial (HSS) ports for VoIP SLIC/CODEC or T1/E1
- Two integrated 10/100 Base-T Ethernet MACs with Media Independent Interface (MII) for design flexibility and cost-effective wire-speed performance
- UTOPIA 2 interface with multiple ADSL/G.SHDSL or VDSL support
- 33/66-MHz PCI v2.2 host and option interface for glueless connection of up to four devices
- SDRAM controller supports from 8 to 256 Mbytes of SDRAM memory
- Low system power consumption (1.0 – 1.5 Watt typical)
- USB version 1.1 device controller
- Two high-speed UARTS support up to 921 Kbaud each
- 16 GPIO pins
- 16-bit configurable expansion bus
- Commercial (0° to 70° C) and extended temperature (-40° to +85° C) versions

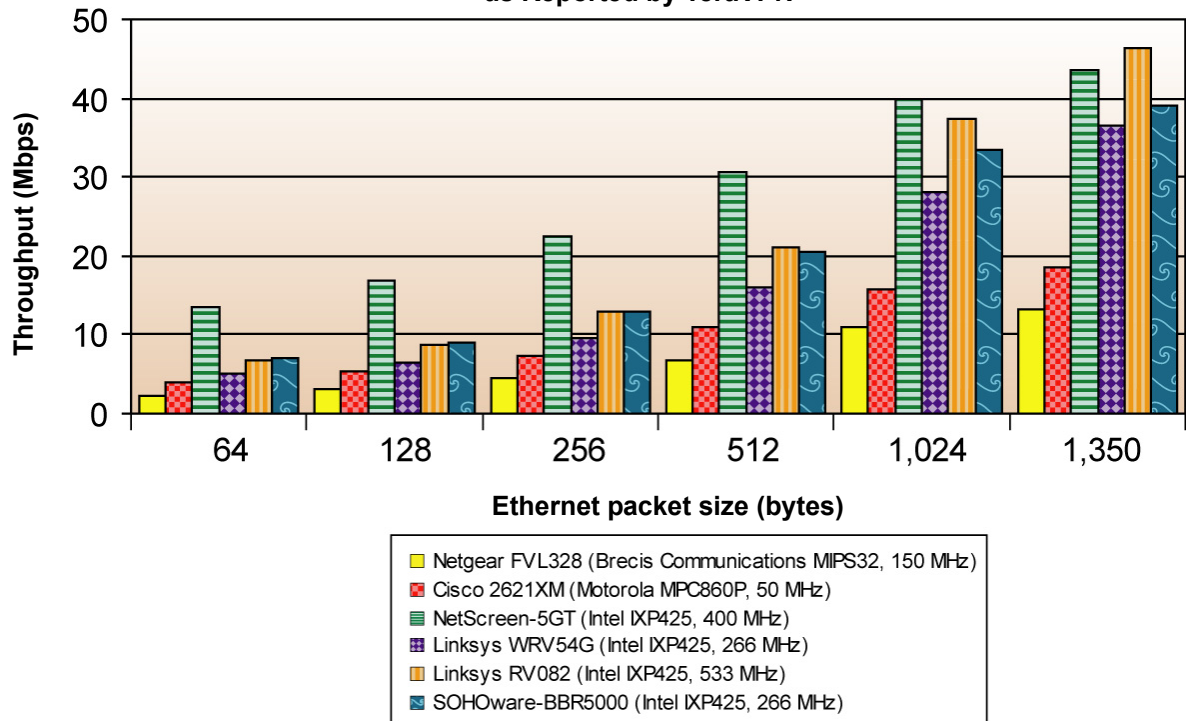
For more information contact your Intel sales representative:

URL:

<http://intel.com/design/network/products/npfamily/ixp425.htm>

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

IPSec VPN Application Throughput Zero-Loss Bidirectional 10 Tunnels as Reported by TeraVPN



VPN Configuration: Gateway-to-Gateway, ESP – Tunnel mode, 3DES, SHA1, DH-2

Note: Each VPN tunnel was created with respective IKE and IPSec security associations. Netgear FWAG114 did not support 10 VPN tunnels.

Source: The Tolly Group, July 2004

Figure 3

competing devices by recording 0.1% to 8% degradation, while the Netgear FVL328 and the Cisco 2621XM degraded by 22% and 18% respectively. (See Figure 5.)

For the 50-tunnel test, in terms of performance degradation from the single tunnel test, two Intel IXP425-based VPN gateways performed better than the Motorola MPC860P-based Cisco 2621XM. Linksys RV082, Linksys WRV54G and Cisco 2621XM supporting 50 tunnels degraded by 26%, 32% and 33% respectively. All other devices did not support the creation of 50 VPN tunnels with corresponding Phase 1 and Phase 2 security associations.

TUNNEL SETUP RATE

Intel IXP425-based products outperformed the competing devices at the VPN tunnel setup rate test by achieving 0.2 seconds to 0.6 seconds for a single tunnel setup time. Only the Motorola MPC860P-based Cisco 2621XM matched the performance with IXP425-based products in this test by recording 0.3 seconds of single tunnel setup time. NetScreen-5GT retained its superior performance over the other DUTs in this test, setting up tunnels at a rate of 0.2 seconds on average. (See Figure 6.)

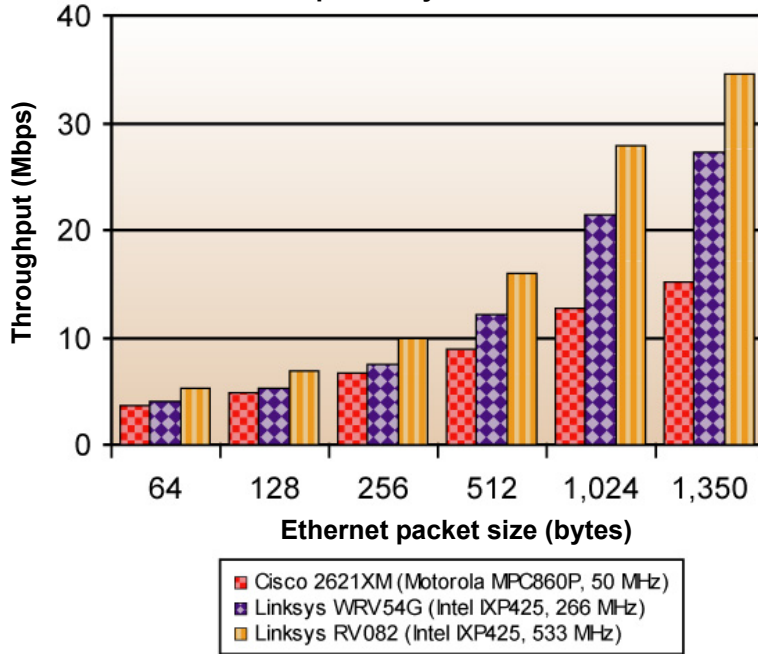
ANALYSIS

Engineers used two different Spirent SmartBits applications –

SmartFlow and TeraVPN – for the throughput measurement. SmartFlow emulates typical end-users, while the TeraVPN emulates the typical VPN gateways and end-users. Therefore, two identical VPN gateways were paired for the SmartFlow testing, whereas, only one VPN gateway was paired with the TeraVPN to set up the VPN tunnels. These two applications also differ with respect to how throughput is calculated and reported.

SmartFlow calculates throughput (RFC 2544) based on the data rate seen at the SmartBits ports, which is without the IPSec header (i.e. the unencrypted data or clear text) in a gateway-to-gateway configuration. TeraVPN calculates the data forwarding rate (RFC

IPSec VPN Application Throughput Zero-Loss Bidirectional 50 Tunnels as Reported by TeraVPN



VPN Configuration: Gateway-to-Gateway, ESP – Tunnel mode, 3DES, SHA1, DH-2
Note: Each VPN tunnel was created with respective IKE and IPSec security associations. Only 3 out of 8 DUTs supported 50 VPN tunnels with respective IKE and IPSec security associations.

Source: The Tolly Group, July 2004

Figure 4

3511) using TCP traffic as the ratio of total data received at the SmartBits ports to the total time for the data transfer. In this case the data received at the SmartBits includes the IPSec header.

It is interesting to note that regardless of the test tool used, the top four performers in VPN throughput tests always remained the same – four Intel IXP425-based products: the SOHOware BBR5000 delivered the highest throughput for large packets in both the SmartFlow test (65 Mbps) and the TeraVPN test (50 Mbps). It was followed closely by the Linksys RV082 (55 Mbps in SmartFlow test and 47 Mbps in the TeraVPN test). The NetScreen-5GT and the Linksys WRV54G rounded out the top four performers. In fact, when it came to handling

small packets (64 bytes), the NetScreen-5GT was the leader in both throughput tests. In the SmartFlow throughput test, the NetScreen-5GT delivered 9 Mbps of throughput and in the TeraVPN test it achieved a throughput rate of 13 Mbps.

The tunnel capacity and tunnel setup rate tests are crucial metrics vendors use to differentiate their products from the competition because they give the VPN gateway vendors an idea about how much headroom is available on the processor and helps them to support processing-intensive applications. Here, just three products scaled up to 50 tunnels – the Linksys WRV54G (Intel IXP425, 266 MHz), the Linksys RV082 (Intel IXP425, 533 MHz) and the Cisco 2621XM

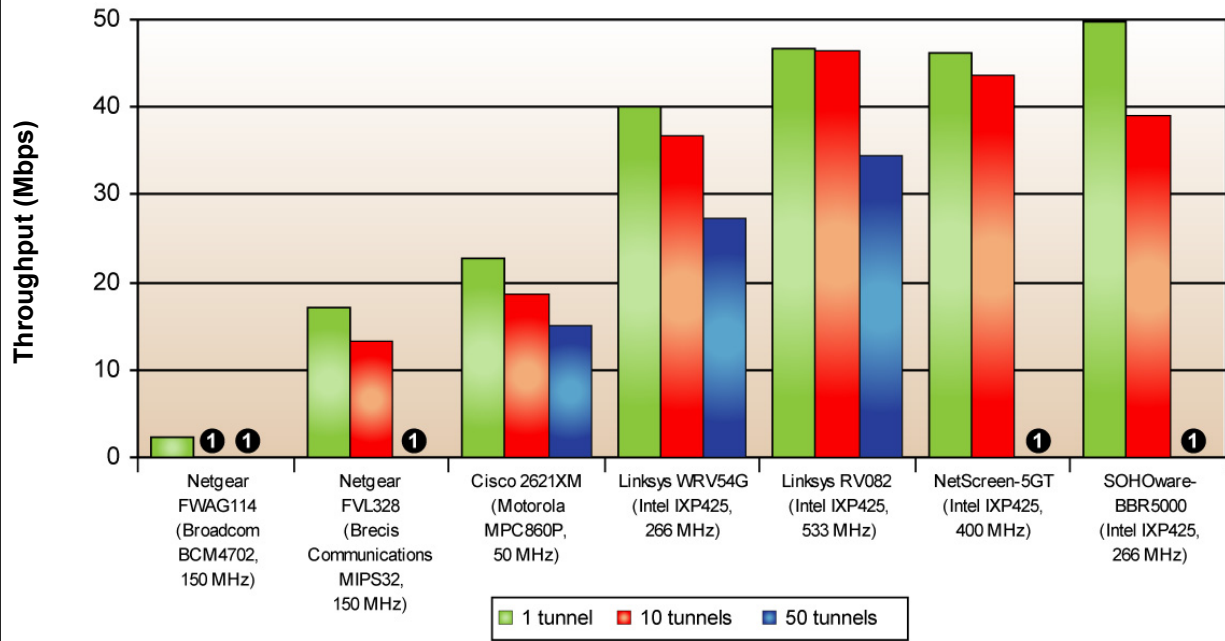
(Motorola MPC860P, 50 MHz). Interestingly, both the Intel IXP425 network processor-based gateways delivered the maximum throughput in the 10 and 50 tunnel tests. The Linksys RV082 and the Linksys WRV54G achieved 46 Mbps and 37 Mbps, respectively, in the 10 tunnel test versus just 19 Mbps for the Cisco device. As those products scaled up to support 50 tunnels, the Linksys RV082 sacrificed just 24% of its throughput to support five times the number of tunnels, achieving 35 Mbps at large-sized packets. The Linksys WRV54G achieved a throughput rate of 27 Mbps when supporting 50 tunnels.

Meanwhile, the Cisco 2621XM managed a throughput rate of just 15 Mbps when supporting 50 tunnels. So, while each of the products is able to scale to support large numbers of tunnels, only the Intel IXP425 network processor-based products were also able to deliver maximum bandwidth on a per-tunnel basis.

TEST CONFIGURATION AND METHODOLOGY

Tolly Group engineers measured the IPSec VPN throughput of the Intel IXP425 network processor-based SOHO and SMB VPN solutions – Linksys WRV54G, Linksys RV082, NetScreen-5GT and SOHOware-BBR5000 in different test scenarios. The engineers compared the performance of the Intel IXP425 network processor-based VPN gateways against alternative chipset-based devices: Broadcom BCM4702 (Netgear FWAG114), Brecis Communications MIPS32 (Netgear FVL328) and Motorola MPC860P (Cisco 2621 XM). Engineers also measured the

Variations in Bidirectional VPN Performance with Respect To The Number of Tunnels for 1,350-byte Packets as Reported by TeraVPN 4.0



① Feature not supported.

VPN Configuration: Gateway-to-Gateway, ESP – Tunnel mode, 3DES, SHA1, DH-2

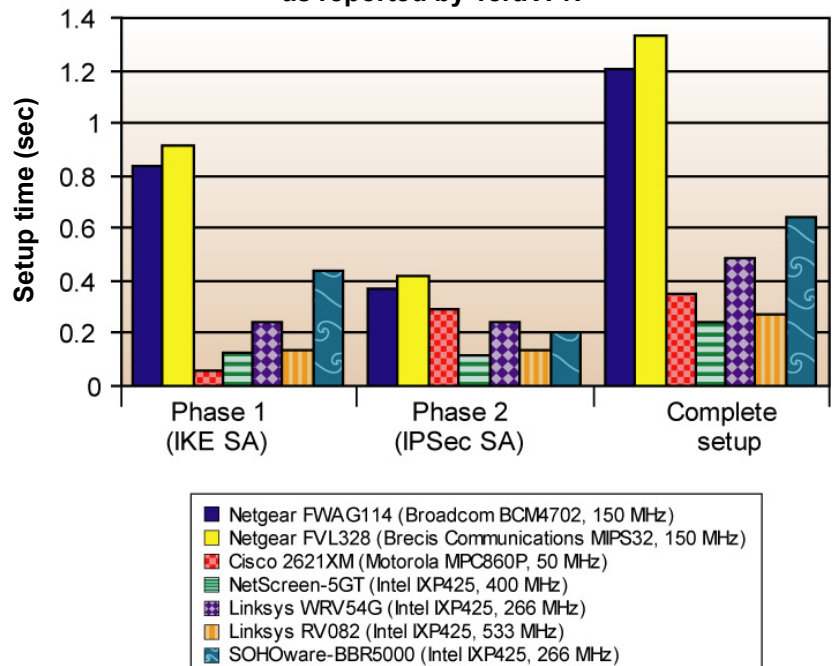
Source: The Tolly Group, July 2004

Figure 5

impact that an increase in the number of VPN tunnels has on the IPSec performance of these devices with 1, 10 and 50 tunnels. Plus engineers measured the setup time (rate) for a single tunnel with each of these devices.

Prior to testing, engineers upgraded the firmware of each device under test (DUT) to the latest version available from the manufacturer’s Web site. All devices under test were subjected to identical test conditions to facilitate significant comparison of results. In all test scenarios, the engineers configured the DUT interfaces with IP addresses appropriate to the test network configuration and created the VPN tunnel based on ESP tunnel mode, DH-2, 3DES/SHA-1 security mechanism. The Security Associations (SAs) used auto IKE main mode with a pre-shared key,

IPSec VPN Application Tunnel Setup Rate as reported by TeraVPN



VPN Configuration: Gateway-to-Gateway, ESP – Tunnel mode, 3DES, SHA1, DH-2

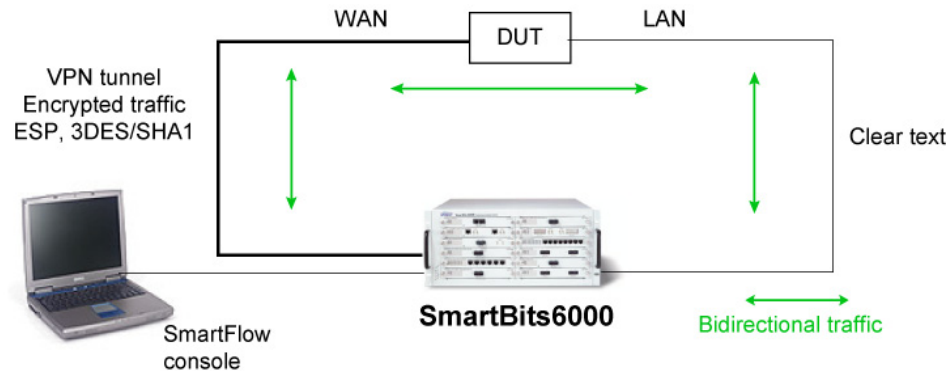
Note: Measurements taken with single tunnel VPN configuration for all the DUTs.

Tunnel setup rates with lower numbers are better

Source: The Tolly Group, July 2004

Figure 6

TeraVPN Test Bed Diagram



Testbed for VPN throughput test using TeraVPN Tester. TeraVPN is a software package (like SmartFlow) that runs on a SmartBits 6000B chassis and uses TeraMetric cards.

Source: The Tolly Group, July 2004

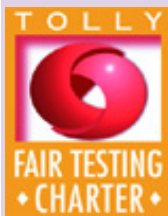
Figure 8

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

Vendor	Product	Web address
Finisar Corp.	Surveyor v5.0	http://www.finisar.com
Spirent Communications	SmartBits 6000B	http://spirentcom.com
Spirent Communications	SmartFlow v3.10	http://spirentcom.com
Spirent Communications	TeraMetrics LAN3301A	http://spirentcom.com
Spirent Communications	TeraMetrics XD LAN3327A	http://spirentcom.com
Spirent Communications	TeraVPN v4.0	http://spirentcom.com

TOLLY GROUP SERVICES

With more than 15 years of testing experience of leading-edge network technologies, The Tolly Group employs time-proven test methodologies and fair testing principles to benchmark products and services with the highest degree of accuracy. Plus, unlike narrowly focused testing shops, The Tolly Group combines its vast technology knowledge with focused marketing services to help clients better position product benchmarks for maximum exposure. The company offers an unparalleled array of reports and services including: Test Summaries, Tolly Verifieds, performance certification programs, educational Webcasts, white paper production, proof-of-concept testing, network planning, industry studies, end-user services, strategic consulting and integrated marketing services. Learn more about The Tolly Group services by calling (561) 391-5610, or send E-mail to sales@tolly.com.



For info on the Fair Testing Charter, visit: <http://www.tolly.com/Corporate/FTC.aspx>

PROJECT PROFILE

Sponsor: Intel Corp.

Document number: 204132

Product class: Network processor for VPN gateways

Products under test:

- Cisco Systems Inc. Cisco 2621XM (Motorola MPC860P, 50 MHz)
- Linksys WRV54G (Intel IXP425, 266 MHz)
- Linksys RV082 (Intel IXP425, 533 MHz)
- Netgear Inc. FVL328 (Brecis Communications MIPS32, 150 MHz)
- Netgear Inc. FWAG114 (Broadcom BCM4702, 150 MHz)
- NetScreen Technologies, Inc. NetScreen-5GT (Intel IXP425, 400 MHz)
- SOHOware Inc. BroadGuard BBR5000 (Intel IXP425, 266 MHz)

Testing window: May/June 2004

Software versions tested:

- Cisco 2621XM Ver. IOS 12.3 (3b)
- Linksys WRV54G Ver. 2.10
- Linksys RV082 Ver. 1.0.11
- Netgear FVL 328 Ver. 1.5 Release 09
- Netgear FWAG114 Ver. 1.0.21
- NetScreen-5GT Ver. 4.0.0 r6.0
- SOHOware BroadGuard BBR5000 Ver. XD 02.01.04

Software status: Generally available

For more information on this document, or other services offered by The Tolly Group, visit our World Wide Web site at <http://www.tolly.com>, send E-mail to sales@tolly.com, call (561) 391-5610.

Information technology is an area of rapid growth and constant change. The Tolly Group conducts engineering-caliber testing in an effort to provide the internetworking industry with valuable information on current products and technology. While great care is taken to assure utmost accuracy, mistakes 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. All trademarks are the property of their respective owners.

The Tolly Group doc. 204132 rev. clk 12 July 04