THE TOLLY GROUP

No. 204117 March 2004

# Analog Devices, Inc.

## Fusiv-Vx200

## Competitive Firewall and VPN Performance Analysis

1989 - 2004 15 Years TOLLY

Test Summary

***Premise:*** *Consumer broadband connections are evolving rapidly to carry more than traditional data with voice and, soon, video services. Core access technology must offer high-performance data throughput while having sufficient processing power available for next-generation services.*

Analog Devices, Inc. (ADI) commissioned The Tolly Group to benchmark the performance of the ADI Fusiv-Vx200 network processor, implemented in a reference platform, and compare that performance with commercially available products based upon rival chipsets. The ADI Fusiv-Vx200 was tested against a Linksys WRV54G broadband access router with an embedded Intel Corp. IXP425 network processor. The ADI device also was tested against a NetScreen Technologies, Inc. NetScreen-204.[1] Engineers examined a third network processor — Texas Instrument's TNETV2020 as implemented by Nippon Telegraph & Telephone East Corp.'s WebCaster V100.[2]

Tolly Group engineers used the industry-accepted Spirent SmartFlow test suite to gauge the Fast Ethernet firewall and VPN throughput of the devices. NetIQ's Chariot application simulator also was used to derive "real-world" firewall application throughput. Finally, tests were run on the ADI device to validate that steady-state

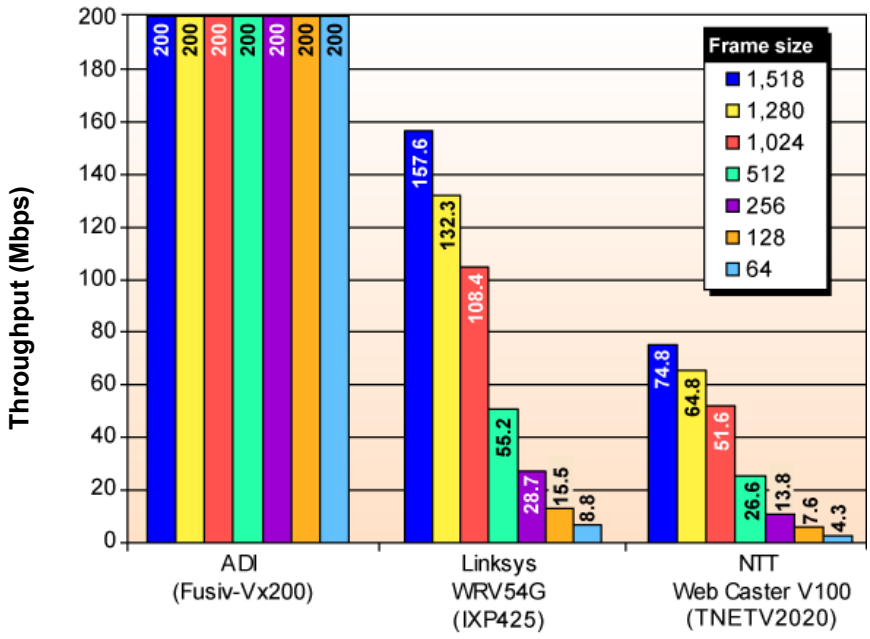
[1]NetScreen does not explicitly identify the source of the core technology for this device. It is assumed that it is based on proprietary NetScreen technology.

[2]The NTT product was sourced from Japan as no U.S. domestic product was readily available. The Tolly Group independently verified that the device contained a TI TNETV2020AGDS processor. The configuration of the device was done with the help of a translator as the configuration interface was in Japanese.

## Test Highlights

- Delivers wire-speed firewall throughput and near wire-speed VPN throughput
- Achieves 31 times the small-packet "mixed system" VPN throughput of Intel and 3.8 times more throughput than the NetScreen-204
- Preserves the main CPU in Fusiv-Vx200 for running any vendor application since it is not involved in the packet processing after achieving steady-state flows

**Bidirectional UDP Zero-Loss (≤ 0.001%)**
**Firewall Aggregate Throughput**
**(Single Policy, Single Session)[1]**
**as Reported by SmartFlow 3.10**




[1] The ADI Fusiv-Vx200 can scale up to 64,000 sessions.

Source: The Tolly Group, March 2004 *Figure 1*

**Test Results Summary**
**(Average of Three Test Run Values)**

| DUT | Frame size (bytes) | Firewall throughput (Mbps) – zero loss (≤0.001%), single policy/single session | | IPSec VPN throughput (Mbps) – zero loss (≤0.001%), ESP, 3DES/SHA1[1] | | File (10MB) transfer throughput |
|---|---|---|---|---|---|---|
| | | Unidirectional | Bidirectional | Unidirectional (DUT-to-ADI) | Bidirectional | |
| ADI (Fusiv-Vx200) | 64 | 100 | 200 | 60.63 | 79.06 | |
| | 128 | 100 | 200 | 74.69 | 114.92 | |
| | 256 | 100 | 200 | 84.53 | 152.18 | |
| | 512 | 100 | 200 | 91.21 | 182.42 | |
| | 1024 | 100 | 200 | 95.43 | 190.86 | |
| | 1280 | 100 | 200 | 96.13 | 192.26 | |
| | 1518 | 100 | 200 | 96.48 | 192.96 | 156.36 |
| NetScreen-204 | 64 | 76.33 | 71.2 | 24.06 | 20.78 | |
| | 128 | 100 | 124.06 | 38.83 | 34.76 | |
| | 256 | 100 | 200 | 62.03 | 57.26 | |
| | 512 | 100 | 200 | 84.18 | 87.5 | |
| | 1024 | 100 | 200 | 95.43 | 128.98 | |
| | 1280 | 100 | 200 | 96.13 | 143.04 | |
| | 1518 | 100 | 200 | 96.48 | 147.96 | 147.96 |
| Linksys WRV54G (Intel IXP425) | 64 | 8.83 | 8.76 | 3.25 | 2.56 | |
| | 128 | 15.76 | 15.5 | 5.78 | 4.82 | |
| | 256 | 29.49 | 28.67 | 10.7 | 9.32 | |
| | 512 | 56.33 | 55.16 | 20.32 | 17.18 | |
| | 1024 | 96.04 | 108.37 | 37.07 | 33.36 | |
| | 1280 | 99.75 | 132.27 | 44.45 | 40.4 | |
| | 1518 | 100 | 157.58 | 47.97 | 43.2 | 105.51 |
| NTT Web Caster V100 (TNETV2020) | 64 | 1.38 | 4.26 | N/A | N/A | |
| | 128 | 2.91 | 7.62 | N/A | N/A | |
| | 256 | 5.59 | 13.82 | N/A | N/A | |
| | 512 | 10.95 | 26.56 | N/A | N/A | |
| | 1024 | 21.29 | 51.64 | N/A | N/A | |
| | 1280 | 26.27 | 64.77 | N/A | N/A | |
| | 1518 | 31.24 | 74.84 | N/A | N/A | 35.81 |

[1] For VPN tests, a maximum frame size of 1,400 bytes was used.

Source: The Tolly Group, March 2004

*Figure 2*

traffic could flow without the participation of the main CPU. Testing was performed in February 2004.

Test results show that the ADI Fusiv-Vx200 exceeds the throughput of the other devices tested in both firewall and "mixed" VPN (i.e., ADI communicating to the other vendor's device) throughput tests. Tests also illustrated that the ADI Fusiv-Vx200 can continue processing traffic when the main CPU is taken offline.

## Results

### Firewall Packet Throughput

Spirent SmartFlow test results show that the ADI Fusiv-Vx200 delivers wire-speed, Fast Ethernet throughput at all packet sizes from 64 bytes through 1,518 bytes. The device's performance matches or exceeds that of the purpose-built NetScreen-204 security appliance and is significantly greater than the Intel and TI implementations especially at smaller packet sizes. (See Figure 1 and Figure 2.)

In unidirectional tests, only the ADI Fusiv-Vx200 delivered wire-speed throughput at all packet sizes. The NetScreen-204 did so at all sizes except 64-byte packets where it delivered 76.3 Mbps. The Intel IXP425-based Linksys WRV54G delivered wire-speed only when processing 1,518-byte packets but over 95% for 1,024- and 1,280-byte packets. Throughput dropped dramatically with smaller packet sizes with only 8.8 Mbps at 64-bytes and up to 56.3 Mbps at 512-bytes. The TNETV2020-based NTT WebCaster V100 also delivered its maximum throughput with 1,518-byte packets, offering only 31.2 Mbps. Throughput dropped from there with just under 11 Mbps for 512-byte packets and only 1.4 Mbps for 64-byte packets. (See Figure 2.)

The same test was run using bidirectional traffic. ADI Fusiv-Vx200 results scaled linearly with the device delivering wire-speed or 200 Mbps full-duplex. (See Figure 3.) At 256-byte packets and greater, the NetScreen-204 also scaled linearly and delivered wire-speed throughput. With 128-byte packets, the NetScreen-204 topped out at 124 Mbps and its aggregate throughput at 64-bytes actually dropped approximately 5 Mbps below its unidirectional throughput now delivering 71.2 Mbps.

The Intel IXP425-based Linksys WRV54G implementation showed nearly identical aggregate throughput at all packet sizes up to and including 512 bytes indicating, perhaps, a packet processing bottleneck. At larger sizes, its aggregate throughput was anywhere from roughly 10% to 60% greater than in the unidirectional test. The throughput of the TI implementation more than doubled in bidirectional tests but the unidirectional throughput was so low that the bidirectional results, still, were the lowest of all devices tested. The throughput ranged from 4.26 Mbps at 64 bytes to a maximum of 74.8 Mbps with 1,518-byte packets.

### "Mixed" IPSec VPN Packet Throughput

Tests were run pairing the ADI Fusiv-Vx200 first with an identical ADI system and then with the NetScreen-204 followed by the Intel IXP425-based Linksys WRV54G. (*Note: The Web Caster V100 was not tested in the VPN configuration since the device does not support VPNs.*) These tests not only illustrate that the ADI device can complete a VPN tunnel in tandem with these devices but demonstrate that the throughput between a pair of ADI Fusiv-Vx200-based systems would exceed that of either "mixed" configuration. The VPN tunnels used 3DES encryption and SHA1 for the IPSec session. As with firewalls, both unidirectional and bidirectional tests were run using Spirent SmartFlow. SmartFlow measures unencrypted traffic. Due to IPSec header overhead, it is theoretically impossible to achieve 100% of Fast Ethernet throughput. Consequently, 1,518-byte "maximum" size packets would be fragmented automatically into two packets by the VPN gateway and thus reduce throughput even further. Therefore, the maximum packet size used in VPN testing was 1,400 bytes.

The paired Fusiv-Vx200 based systems saturate the 100-Mbps Fast Ethernet link on the upstream port for all packet sizes for unidirectional tests and for all packet sizes above 64 bytes for bidirectional flows (200 Mbps aggregate). (See Figure 4.) The throughput reported by SmartFlow does not include the IPSec header in the throughput calculations in a box-to-box VPN configuration test setup. If we consider the 50-byte IPSec header, the ADI device's data rate of 60.63 Mbps observed with 64-byte frame will be equivalent to 96.72 Mbps and 96.48 Mbps with 1400-byte frame will be equivalent to 99.88 Mbps. Therefore, the ADI device is capable of delivering data at near wire speed with IPSec VPN. The NetScreen device saturated the WAN only for unidirectional flows. For packet sizes larger than 1,024 bytes for smaller sizes the NetScreen device did not perform at wire speed of the

**Analog Devices, Inc.**

**Fusiv-Vx200 Network Processor**

**Firewall and VPN Performance**

**Analog Devices, Inc.**
**Fusiv-Vx200**
**Product Specifications***

- 32-bit, 200-MHz RISC processor with 16KB instruction cache, 8KB data cache
- DSP subsystem with 160 MIPS processing power (with Fusiv-Vx200)
- Five 200-MHz Accelerator Processors each with 8KB program memory, 2KB data memory
- Hardware crypto engines for DES, TDES, AES, SHA-1, SHA-256 & MD5 algorithms
- Hardware engines for DH, RSA and DSA algorithms (with NP 230)
- True random number generator and pseudo random number generator
- Accelerator processor for buffer management
- Seven-channel independent DMA to perform memory-to-memory and memory-to-peripheral data transfers
- Enables FIPS 140-2, Level-3 (with NP 230)
- Flashless boot through SPI EEPROM
- General-purpose timers
- On-chip External Bus Interface Unit (EBI) for SDRAM, asynchronous RAM and FLASH
- Supports multiple Ethernet interfaces, 3 x 10/100 MII (without UTOPIA), 2 x 10/100 MII (with UTOPIA)
- 66-MHz, 32-bit, PCI 2.2 Interface, which can work both in "host" and "device" modes
- USB 1.1 interface
- UTOPIA L1/L2 interface with 31 PHY support
- Synchronous Serial Interface (SSI) for high speed serial or HDLC Communication
- Two Asynchronous Serial Port (UART)
- Serial Peripheral Interface (SPI)
- IEEE 1149.1 compliant JTAG
- Temperature Range: – 40 deg C to +85 deg C

**For more information contact:**
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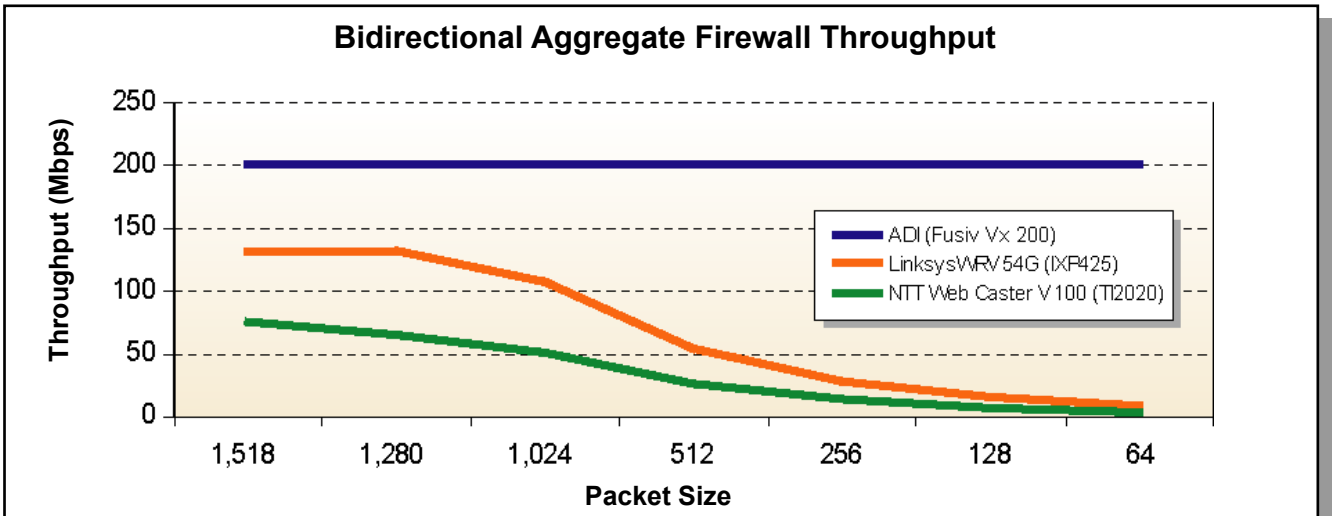
San Jose, CA 95110
USA
E-mail: nmp_marketing@analog.com

*Vendor-supplied information not verified by The Tolly Group




Source: The Tolly Group, March 2004

*Figure 3*

WAN link. For bidirectional flows the NetScreen device did not saturate the WAN link for any packet size.

### Firewall Application Throughput

Using the same device configuration as for the packet test, Tolly Group engineers ran an application throughput test simulating bidirectional file transfer using NetIQ Chariot. The ADI Fusiv-Vx200 delivered the highest throughput at 156 Mbps with the NetScreen-204 less then 10 Mbps lower. The Intel IXP425-based Linksys WRV54G delivered 105 Mbps while the TI-based Web Caster V100 trailed the pack delivering approximately 36 Mbps of aggregate throughput.

### CPU-Independent Steady-State Packet Processing

In order to validate ADI's claim that the main CPU is not required for steady-state packet forwarding (and thus available to service other value-add functions), The Tolly Group conducted the following test.

Using SmartBits, traffic was run through the ADI platform and started the SmartFlow test. After a few packet transfers (to allow steady flow traffic) the CPU was stopped using a MAJIC debugger (Multi-processor advanced JTAG interface controller by Embedded Performance Inc.) that provides 'start' and 'stop' operations. The CPU stoppage was confirmed using the CLI interface as it did not allow any operation on the device. But the SmartFlow test continued and the results showed no performance degradation (with reference to the earlier results obtained through the firewall testing). This is attributed to ADI's capability of processing the traffic without the main processor being involved, once the steady flow is achieved.

### Analysis

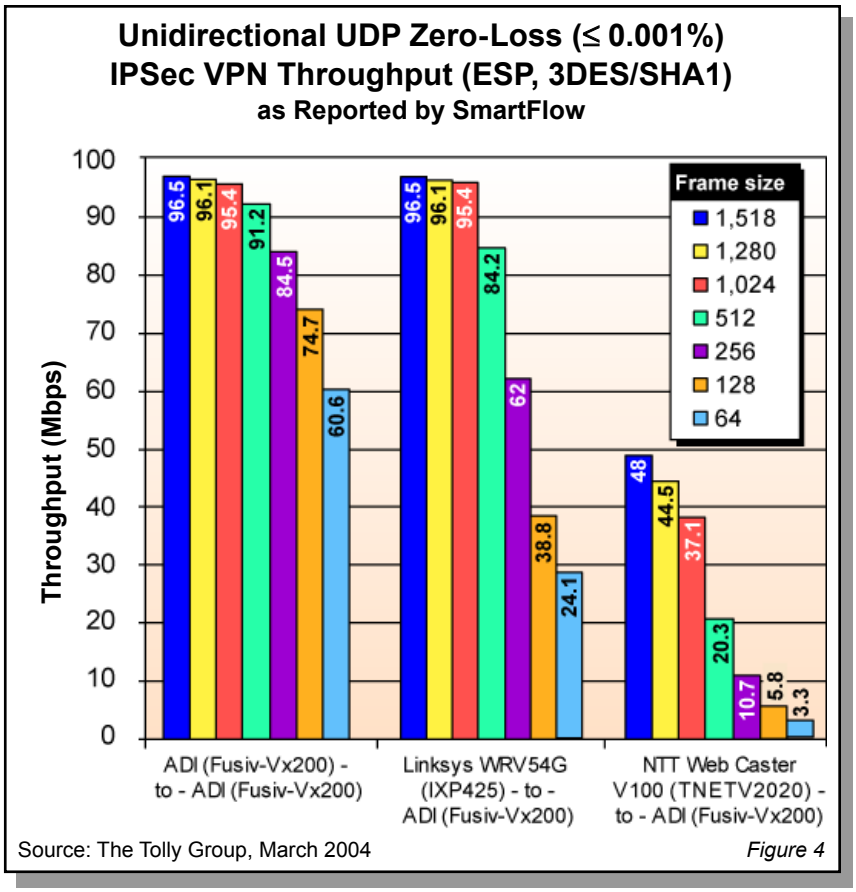
Anlaog Devices's Fusiv-Vx200 is a system-on-a-chip, incorporating a RISC processor with peripheral interfaces such as the Ethernet 10/100 MII, PCI, SPI and UART. The device also has an External Bus Interface Unit for SDRAM, FLASH, Aynchronous RAM and GPIO and a dedicated Ethernet Accelerator Processor per Ethernet/ATM port (EAP) for per-packet processing. Its protocol accelerator provides data-centric routing with VPN. The Tolly Group tested the reference platform with Fusiv-Vx200 that had three built-in 10/100 Ethernet MAC controllers that can be used for LAN or WAN.

As the spread of broadband services fuels the demand for "triple-play" implementations, that is, voice/video/data, the processing demands on the consumer premises device will continue to increase. Simultaneously, the demand for secure communications continues to rise. Both firewall and VPN functions increase the workload of the broadband access device. Firewalls must "filter" every packet and compare the header information with a rule base prior to forwarding. With VPNs, the access device must encrypt/decrypt each packet that traverses the VPN. Depending on how these functions are implemented, they could result in degraded throughput.

The ADI implementation delivered higher firewall and VPN throughput than even the purpose-built NetScreen device and dramatically higher throughput than the Intel or TI implementations. Clearly, the ADI technology can deliver more than enough throughput for current and even next generation broadband services. By offloading steady-state packet processing, the ADI main CPU stands ready for use in value-add functions like VoIP and video processing.

### Related Tests

The Intel IXP425 was recently the subject of testing that was reported in document 203141. That document focused on 802.11 wireless throughput with and without WEP encryption as well as LAN-to-LAN application




Source: The Tolly Group, March 2004 *Figure 4*

performance without firewall functionality enabled. Testing contained in this document neither overlaps nor contradicts that testing.

## Test Configuration and Methodology

For performance tests, The Tolly Group tested a reference platform incorporating an Analog Devices, Inc. Fusiv-Vx200 equipped with three Fast Ethernet interfaces. The performance of the ADI platform in terms of the firewall, VPN and file transfer throughputs were compared against that of an Intel IXP425-based Linksys WRV54G and Texas Instruments TNETV2020-based NTT WebCaster V100. The performance was also compared with that of NetScreen-204 security appliance.

For the firewall performance test, engineers disabled the NAT and using SmartBits/SmartFlow, measured the steady state, zero-loss (≤ 0.001%) UDP throughput using various Ethernet frame sizes (64, 128, 256, 512, 1,024, 1,280 and 1,518 bytes) on a single rule/single session firewall with unidirectional and bidirectional traffic.

Engineers prepared for the test by connecting the device under test (DUT) with the SmartBits interfaces and SmartFlow console. The DUT was configured to have a single firewall policy to allow any-to-any traffic. Engineers next configured SmartFlow to execute the test at the appropriate load and configurations. SmartFlow recorded all results and used its binary search algorithm to find the actual maximum zero-loss throughput. The test was conducted for both unidirectional and bidirectional traffic through the DUT.

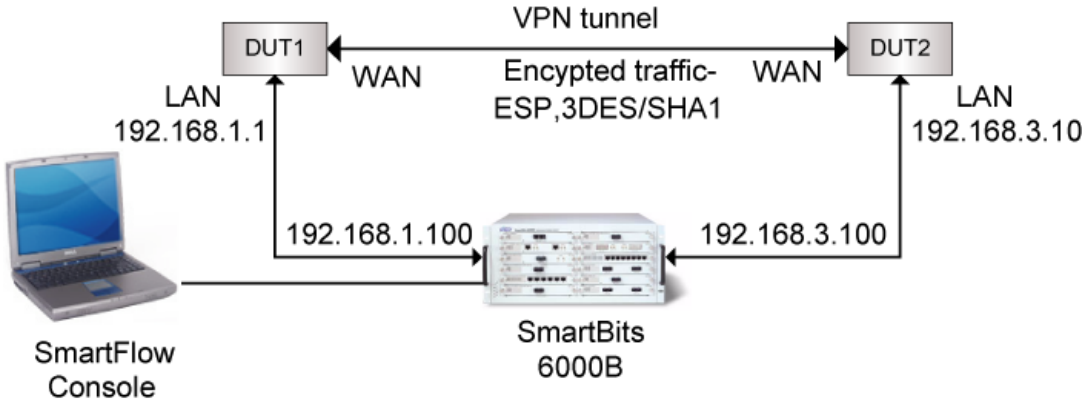
On the VPN front, engineers measured the IPSec VPN throughput over a single VPN tunnel between a pair of ADI platforms that provided encryption/decryption of the test traffic. The VPN tunnel was established with ESP, 3DES/SHA1. SmartBits/SmartFlow measured the IPSec VPN throughput for various Ethernet frame sizes (64 bytes through 1,400 bytes) received through the VPN tunnel for both unidirectional and bidirectional traffic. The throughput was also measured for the VPN tunnel between a pair of 'mixed' boxes – one end being the ADI platform and the other end being the Linksys WRV54G or NetScreen-204 with the same test configuration.

Engineers measured the firewall application throughput using IXIA's Chariot v4.3 test suite with the application script High_Performance_Throughput.scr (suitable for testing the maximum throughput on high speed networks – 100 Mbps and higher – with a file size of 10MB) and End Point v5.0. The Chariot simulated a 10-MB file transfer between two end points connected through the DUT and reported the bidirectional aggregate TCP throughput associated with this traffic at the end of the test duration of 3 minutes. A Dell Computer Corp. Dimension DIM2350 computer with Pentium®4 (2 GHz, 512MB RAM) processor running Windows XP Professional/SP 1 was used as the Chariot console and two IBM ThinkPad laptops with Intel® Pentium M processor (1.5 GHz, 256MB RAM) running Windows XP Professional/SP 1 as the End Points.

## Equipment Acquisition and Support

All competitive products were acquired through normal commercial channels. Because tests used consumer-class, "shrink-wrap" products no special technical support was used. Because the NTT product implemented only a Japanese-language user interface, The Tolly Group utilized a Japanese-proficient individual to translate configuration information.

## Test Bed for Bidirectional VPN Throughput Test




Source: The Tolly Group, March 2004

*Figure 5*

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

| Vendor | Product | Web address |
|---|---|---|
| Embedded Performance Inc. | MAJIC EDB v2.3f | www.epitools.com |
| NetIQ Corp. | Chariot v4.3 | www.netiq.com |
| NetIQ Corp. | End Point v5.0 | www.netiq.com |
| Spirent Communications | SmartBits 600B | www.spirentcom.com |
| Spirent Communications | SmartFlow v3.10 | www.spirentcom.com |

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## Project Profile

**Sponsor:** Analog Devices, Inc.
**Document number:** 204117
**Product class:** Network Processors in reference or commercial implementations
**Products under test:**

- Analog Devices Fusiv-Vx200 ver 20040114
- NetScreen Technologies NetScreen-204 Security Appliance Ver 4.0.0 rel. 6.0
- Linksys Corp. Linksys WRV54G 2.10 (Intel IPX425)
- NTT WebCaster V100, ver 1.00.007 (Texas Instruments' TNETV2020)

Testing window: February 2004
Software status:

- ADI – pre-release
- All others – generally available

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