THE TOLLY GROUP

No. 7303 November 1997

Digital Equipment Corporation
MultiSwitch 900/VNswitch 900
Fast Ethernet and Multi-topology Switching Performance

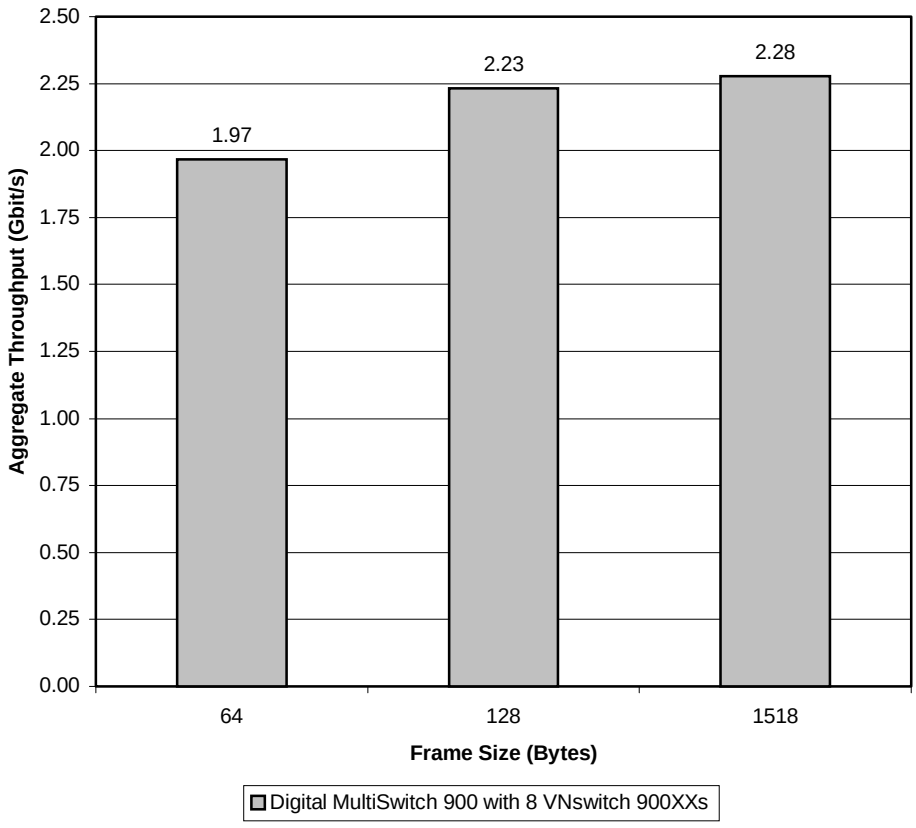
Test Summary

Digital Equipment Corporation commissioned The Tolly Group to benchmark the switching throughput and latency characteristics of the Digital Equipment Corporation MultiSwitch 900 switching chassis. The Tolly Group tested Fast Ethernet switching throughput in a single MultiSwitch 900 chassis configured with eight VNswitch 900XXs as well as throughput and latency in a multi-topology switching configuration involving Fast Ethernet, FDDI, and ATM. Testing was performed in September of 1997.

Test results show that the MultiSwitch 900 delivered aggregate throughput that exceeded 2.2 Gbit/s in single switching chassis performance tests, and delivered wire speed performance and store-and-forward latency as low as 17 microseconds (µs) in MultiSwitch 900 to MultiSwitch 900 multi-topology performance tests.

Test Highlights

- MultiSwitch 900/VNswitch 900 delivers aggregate Fast Ethernet switching throughput in excess of 2.2 Gbit/s
- MultiSwitch 900/VNswitch 900 delivers wire speed switching throughput across multiple topologies including ATM (OC-3) and FDDI
- MultiSwitch 900/VNswitch 900 exhibits store-and-forward latency as low as 17 microseconds (µs)



Source: The Tolly Group, November 1997 *Figure 1*

Test Results

Fast Ethernet Switching Throughput - 26 Streams (32 ports)

The Tolly Group benchmarked the steady-state throughput of the MultiSwitch 900 when forwarding 26 simultaneous Fast Ethernet streams. The goal of this test was to measure the maximum Fast Ethernet switching capacity of a MultiSwitch 900 configured with 8 VNswitch 900XXs. Traffic traversed the switch via inter-module, and intra-module paths (see System Under Test: Configurations for details).

The MultiSwitch 900 forwarded traffic at 99.3% of wire-speed with 64-byte frames for an aggregate switching throughput of 1.97 Gbit/s. Using 128-byte Frames, the MultiSwitch 900 forwarded 99.3% of wire speed (aggregate of 2.23 Gbit/s), and with 1518-byte frames the MultiSwitch 900 forwarded 88.7% of wire speed (aggregate 2.28 Gbit/s). See figure 1.

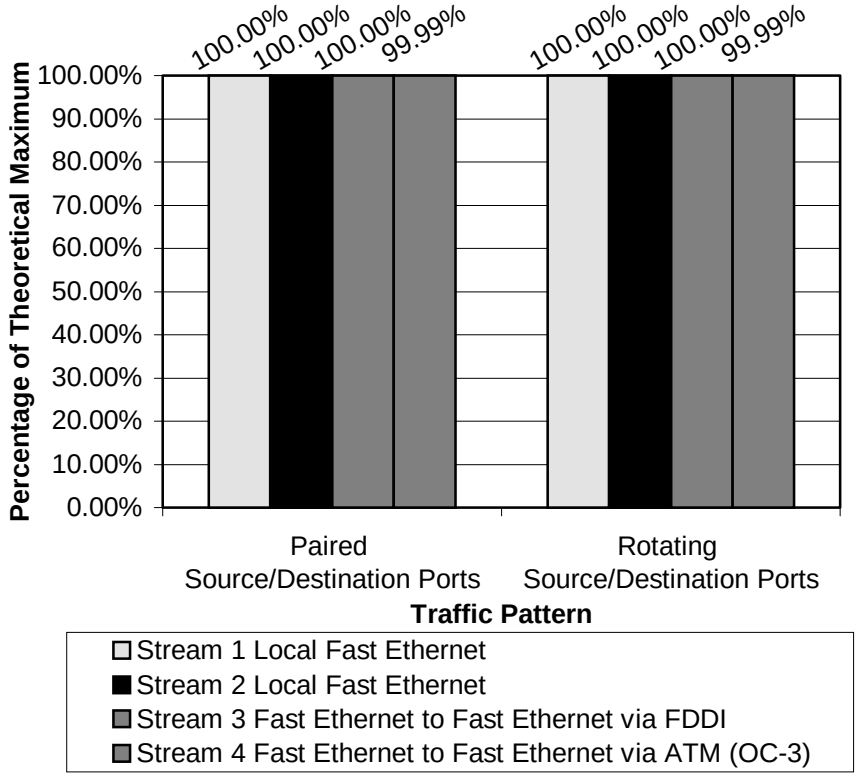
Multi-Topology Performance between two MultiSwitch 900s - 4 Streams (8 ports)

The Tolly Group tested a pair of MultiSwitch 900s (interconnected by both FDDI and ATM (OC-3)) for steady-state throughput and latency characteristics when forwarding four simultaneous streams of Fast Ethernet traffic. The goal of this test was to ensure that all four streams of traffic were received at their proper destination ports and to measure any observed frame loss.

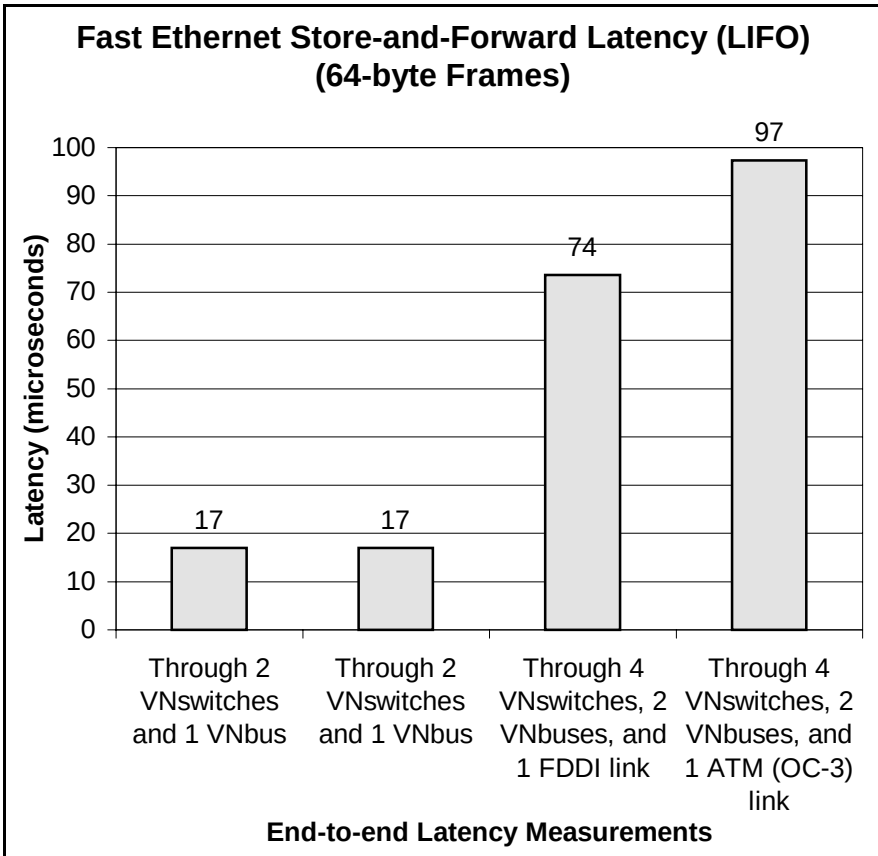
Two streams of traffic (streams 1 and 2) remained local to MultiSwitch 900 #1 and two streams of traffic (streams 3 and 4) were simultaneously forwarded between the two MultiSwitch 900 switching chassis via heterogeneous topologies including ATM and FDDI (see System Under Test: Configurations for details). Testing was conducted with "paired" source and destination ports and "rotating" source and destination ports (see Test Procedure for details).

The MultiSwitch 900 delivered wire speed throughput with zero frame loss across all four streams, using Fast Ethernet's smallest frame size of 64 bytes. This is true for both "paired" and "rotating" destination ports demonstrating that throughput is unaffected by the different traffic patterns flowing through the network (see figure 2).

Additionally the MultiSwitch 900 exhibited low latency characteristics. Streams 1 and 2 exhibited store-and-forward latency (through 2 VNswitch modules and 1 backplane VNbus) of 17 µs for 64-byte frames. Stream 3 exhibited store-and-forward latency



Source: The Tolly Group, November 1997 *Figure 2*



Source: The Tolly Group, November 1997 *Figure 3*

(through 4 VNswitch modules, 2 backplane VNbuses, and 1 FDDI link) of 74 µs. Stream 4 exhibited store-and-forward latency (through 4 VNswitch modules, 2 backplane VNbuses, and 1 ATM (OC-3) link) of 97 µs. See figure 3.

Test Configuration and Methodology

System Under Test: Configuration 1

Tests were conducted for steady-state throughput utilizing 26 simultaneous Fast Ethernet streams on a single MultiSwitch 900 configured with 8 VNswitch 900XXs. Twelve streams were inter-module (i.e., each of the traffic streams exited the MultiSwitch 900 under test through a different module than that through which it entered). The remaining fourteen streams were intra-module (i.e., the traffic streams exited the MultiSwitch 900 under test through the same module through which it entered). All switch ports were configured to operate in Full Duplex mode and there was a combination of uni-directional and bi-directional traffic as depicted by figure 5.

Configuration 2

Tests were conducted between two MultiSwitch 900s for steady-state throughput and latency characteristics utilizing four simultaneous uni-directional Fast Ethernet streams. Note: All 4 Fast Ethernet streams were offered simultaneously to the same VNbus on MultiSwitch 900 #1 as described below (see figure 6). MultiSwitch 900 #1 was outfitted with 3 VNswitch 900EX modules, 1 VNswitch 900EF module and 1 VNswitch 900EA module. MultiSwitch 900 #2 was outfitted with 2 VNswitch 900EX modules, 1 VNswitch 900EF module, and 1 VNswitch 900EA module (see figure 4 for VNswitch family port configurations).

The traffic streams traversed the system under test as follows: streams 1 and 2 entered MultiSwitch 900 #1 via a VNswitch 900EX (Fast Ethernet switch module) and was transported over a single backplane VNbus to a second VNswitch 900EX. The receiving VNswitch 900EX in turn transmitted the streams to the SmartBits analyzer.

Stream 3 entered MultiSwitch 900 #1 via a VNswitch 900EX and was transported across a backplane VNbus to a VNswitch 900EF. At that point it was translated into FDDI and transported to a VNswitch 900EF in MultiSwitch 900 #2. The receiving VNswitch 900EF transported the stream across one of the MultiSwitch 900's backplane VNbuses to a VNswitch 900EX which in turn translated the stream to Fast Ethernet and transmitted it to the SmartBits analyzer.

Stream 4 entered MultiSwitch 900 #1 via a VNswitch 900EX and was transported across a backplane VNbus to a VNswitch 900EA. At that point it was translated into ATM and transported to a VNswitch 900EA in MultiSwitch 900 #2. The receiving VNswitch 900EA transported the stream across one of the MultiSwitch 900's backplane VNbuses to a VNswitch 900EX which in turn translated the stream to Fast Ethernet and transmitted it to the SmartBits analyzer.

Loops were prevented by assigning streams 3 and 4 to separate backplane VNbuses in MultiSwitch 900 #2.

All Fast Ethernet switch ports were configured to operate in Full Duplex mode, both FDDI ports were configured to operate in DAS mode, and both ATM ports were configured to support a single PVC communicating via an FDDI tunneling protocol based on RFC 1483 (Multiprotocol Encapsulation over ATM Adaptation Layer 5). All traffic was uni-directional.

System Under Test: Revision Levels

Single MultiSwitch 900 Tests: One Digital Equipment Corporation

Digital Equipment Corporation

MultiSwitch 900/ VNswitch 900

Switching Performance

THE TOLLY GROUP Up to Spec CERTIFIED

Digital Equipment Corporation
MultiSwitch 900/VNswitch 900
Product Specifications*

The DIGITAL VNswitch 900 is a family of multi-layer, multi-technology enterprise class switching products.

- Aggregate switching of 750,000 packet per seconds per module
- 100,000 pps IP routing per module
- Integral SNMP management and telnet support
- Robust industry standard VLAN support
- 8,192 network addresses
- Firmware upgradable via TFTP
- Fully IEEE 802.1d compliant
- Support for Ethernet, Fast Ethernet, FDDI, ATM, and Gigabit Ethernet

The DIGITAL MultiSwitch 900 system is an eight slot, switching chassis with a unique, technology independent backplane which is scalable up to 5.6 Gbit/s.

- 5.6 Gbit/s aggregate backplane bandwidth
- Integral SNMP management agent
- Supports 192 switched 10Base-T ports
- Supports 16 switched ATM ports
- Supports 16 switched DAS FDDI ports
- Will support up to 8 Gigabit uplinks in first half of 1998
- Supports 128 switched Fast Ethernet ports (mid-1998)
- Supports a wide array of local/wide area routers, remote access products, and shared Ethernet/ Fast Ethernet hub products
- Fully hot swappable N+1 redundant power

For additional information contact:
Digital Equipment Corp. at
800-457-8211 or 978-692-2562
http://www.networks.digital.com

Vendor-supplied information not verified by The Tolly Group

MultiSwitch 900: Model – DMHUB-MB (Note: The suffix "-MB" refers to the MultiSwitch 900 with no power supplies, whereas "-AA" refers to the MultiSwitch 900 with 1 power supply. The "-MB" option is available for customer spare/replacement purposes); Hardware – REV F; ROM – V1.1.6; Software – V5.2.3. Eight VNswitch 900XX (Fast Ethernet Module): Part Number – DVNXX-MX; Hardware – REV A02; Software – V1.6-003.

MultiSwitch 900 to MultiSwitch 900 Tests: Two Digital Equipment Corporation MultiSwitch 900s: Model – DMHUB-AA Hardware – REV F; ROM – V1.1.6; Software – V5.2.3. Five VNswitch 900EX (Ethernet/Fast Ethernet Module): Part Number – DVNEX-MX; Hardware – REV F01; Software – V1.6.002. Two VNswitch 900EF (Ethernet/FDDI Module): Part Number – DVNEF-MM; Hardware – REV A01; Software – V1.6.002. Two VNswitch 900EA (Ethernet/Fast Ethernet Module): Part Number – DVNEA-MX; Hardware – REV A01; Software – V1.6.003.

VNswitch 900 Family Port Configurations

VNswitch 900 Module	Port Configuration
VNswitch 900XX	4 switched Fast Ethernet ports
VNswitch 900EX	12 switched Ethernet ports 2 switched Fast Ethernet ports
VNswitch 900EF	12 switched Ethernet ports 1 switched DAS FDDI port
VNswitch 900EA	12 switched Ethernet ports 1 switched ATM OC-3 port

Source: The Tolly Group, November 1997 *Figure 4*

Test Bed Description

For Performance testing, The Tolly Group used two NetCom Systems Inc. SmartBits Advanced Multiport Performance Test/Simulator/Analyzers consisting of one SMB-1000, and one SMB-10 (firmware version 5.12; SmartWindows Console version 6.20), equipped with 26 100 Mbit/s Fast Ethernet modules model SX-7405 (100Base-TX). For Fast Ethernet monitoring and analysis, The Tolly Group used the SmartBits in conjunction with two Wandel & Goltermann DominoFastEthernet Internetwork Analyzers model DA-350 Version BN 9316/01 running software version 2.2 Patch 1.

The Tolly Group connected the "input" ports of the system under test directly to the traffic generation equipment, and connected the "output" ports directly to the traffic monitoring equipment. Additionally, The Tolly Group connected a DominoFastEthernet "in line" between the system under test and one of the frame generators. A second DominoFastEthernet was placed between the system under test and the traffic monitoring equipment (see figures 5 and 6).

For Latency testing, The Tolly Group used a Wandel & Goltermann DA-30C running RTBench II for Fast Ethernet version 1.1c (a latency and performance benchmarking utility), equipped with two 100Base-T Interface Modules (BN 9305/90.61), two Broadband Analyzer Modules (BN 9305/90.69), and two Protocol Analyzer Modules (BN 9305/00.06).

The Tolly Group connected the generating port of the DA-30C directly to an "input" port of the system under test, and the receiving port of the DA-30C directly to an "output" port of the system under test (see figure 6).

Test Procedure

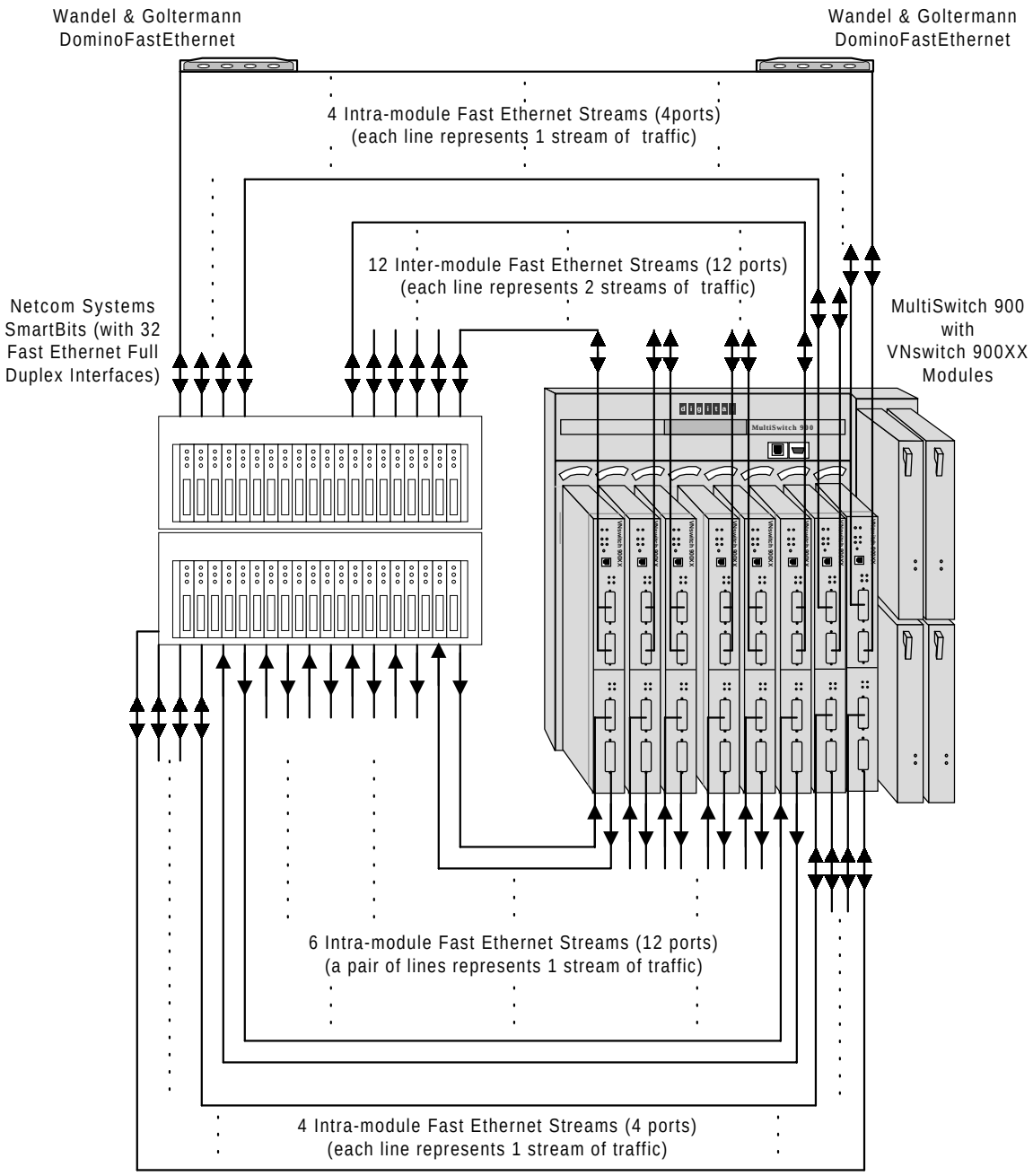
For performance tests, The Tolly Group first calibrated the test equipment to verify the accuracy of results, then recorded frame sizes and frame rates for each test as they were reported by the SmartBits. The Tolly Group also compared input and output frame sizes and rates as the test proceeded on at least one traffic stream with a DominoFastEthernet.

The Tolly Group began by generating traffic on all streams simultaneously at full bandwidth and recording any differences between the offered and received loads on each stream. The Tolly Group considered the system to deliver zero-loss performance if the offered load and received loads differed by less than 2% (the margin of error of the test equipment). If the difference was greater than 2% on any stream, The Tolly Group recorded the aggregate frame loss across all streams (as a percentage of offered load) and reduced the offered load on all streams by the same rate until the offered and received streams differed by less than 2%.

For MultiSwitch 900 to MultiSwitch 900 testing, The Tolly Group utilized two traffic patterns, "paired" source and destination ports, and "rotating" source and destination ports. The term "Paired" source and destination ports, refers to a traffic pattern such that each "input" or source port forwards traffic only to a single and unique "output" or destination port. The term "Rotating" source and destination ports, refers to a traffic pattern such that each "input" or source port forwards traffic to each "output" or destination ports in repeating succession.

For latency tests, The Tolly Group connected a Wandel and Goltermann DA-30C to the traffic stream under

MultiSwitch 900/VNswitch 900XX Fast Ethernet Switching Performance



Source: The Tolly Group, November 1997

Figure 5

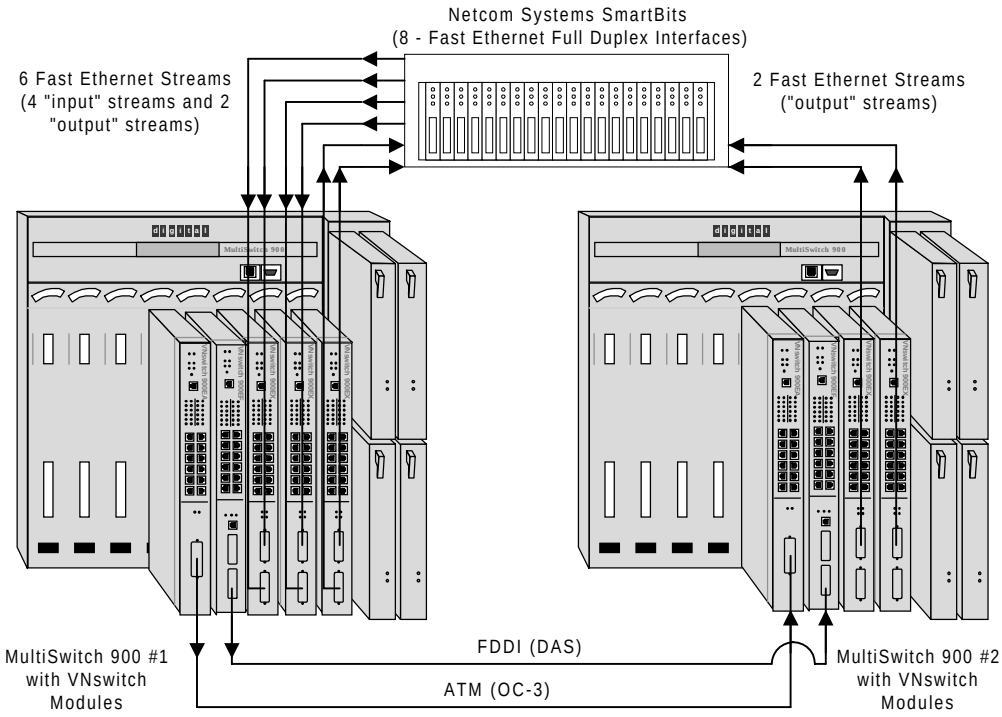
test. The RTBench II utility was configured to conduct 10 iterations of single frame latency tests. The final result for each frame size was reported as the average of the iterations. Note: all latency results were reported as LIFO (Last In First Out).

All test measurements were recorded on Fast Ethernet.

Test Calculations

Frame sizes on Fast Ethernet included 4 bytes of CRC. Theoretical maximum fps rates for Fast Ethernet were calculated by adding 20 bytes to each frame size to account for 0.96 microsecond interframe gap (equivalent to 12 bytes) and preamble (8 bytes). Thus, the maximum Fast Ethernet frame rate in fps for a frame of X bytes is defined by the following formula: (100,000,000 bit/s)/((8 Bits/byte)*(X+20)).

MultiSwitch 900 to MultiSwitch 900 High-Speed Multi-Topology Switching Performance



Source: The Tolly Group, November 1997

Figure 6

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

Vendor	Product	Web address
Netcom Systems, Inc.	SmartBits Analyzer/Tester	http://www.netcomsystems.com
Wandel & Goltermann	DominoFastEthernet DA-350	http://www.wg.com
Wandel & Goltermann	Internetwork Analyzer DA-30C	http://www.wg.com

About The Tolly Group

The Tolly Group provides strategic consulting, independent testing, and industry analysis. It offers a full range of services designed to furnish both vendor and end-user communities with authoritative, unbiased information. *Fortune* 1,000 companies look to The Tolly Group for vendor-independent assessments of critical corporate technologies. Leading manufacturers of computer and communications products engage The Tolly Group to test both pre-production and production equipment.

The Tolly Group is recognized worldwide for its expertise in assessing leading-edge technologies. By combining engineering-caliber test methodologies with informed interpretation, The Tolly Group consistently delivers meaningful analyses of technology solutions. The Tolly Group has published more than 400 product evaluations, network design features and columns in the industry's most prestigious publications.

Kevin Tolly is President and CEO of The Tolly Group. He is a leading industry analyst and is responsible for guiding the technology decisions of major vendor and end-user organizations. In his consulting work, Tolly has designed enterprise-wide networks for government agencies, banks, retailers, and manufacturers.

For more information on The Tolly Group's services, visit our World Wide Web site at ***http://www.tolly.com,*** email to info@tolly.com, call 800-933-1699 or 732-528-3300, or fax 732-528-1888.

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