3Com® Corp.
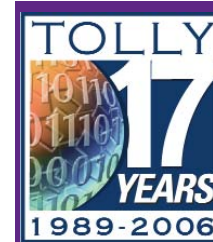## 3Com Switch 5500G-EI
Competitive Performance Evaluation and Feature
Verification Versus Cisco Systems, Inc. Catalyst 3750G

TOLLY 17 YEARS 1989-2006

Test Summary

Premise: In today's enterprise LANs, with a premium placed on real-time applications like voice over IP (VoIP), it is imperative that any switch deployed at the network edge have the ability to offer high performance with minimal frame/packet loss. Significant loss of frames or packets can spell disaster when implementing VoIP and other latency-sensitive applications. Moreover, traffic prioritization and quality of service (QoS) features are a must to ensure high levels of service for these applications. Power over Ethernet (PoE) also is a key feature for edge switches — as it enables switch ports to power VoIP phones, IP cameras, wireless access points, and other gear — and offers the potential to reduce implementation costs significantly.

3Com Corp. commissioned The Tolly Group to measure the Layer 2 and Layer 3 performance of the 3Com Switch 5500G-EI 48-port switch in terms of frame/packet forwarding and percentage of frame/packet loss while handling line-rate traffic in various stack configurations. Additionally, to provide a 'benchmark' comparison, performance testing was done on both the 3Com Switch 5500G-EI and a comparably equipped Cisco Systems, Inc. Catalyst 3750G-48TS Gigabit Ethernet switch.

For Layer 2 performance tests, the percentage of frame loss was measured on two 96-port configurations: a four-high stack using 24-ports per switch, and a two-high stack using 48-ports per switch. Similarly, for Layer 3 performance tests, the percentage of frame loss

Test Highlights

❍ Consistently outperforms the Cisco Catalyst 3750G-48TS switch by achieving significantly lower frame/packet loss in the Layer 2/Layer 3 frame loss tests in both two-unit and four-unit high stack configurations while handling line-rate traffic

❍ Earns multiple Tolly Verified certifications in areas of LAN Switch Core functionality, LAN Switch High Availability and a variety of System Management and User Security functions

❍ Earns First & Foremost distinction for PoE support in a stackable Gigabit Ethernet switch, demonstrating the highest PoE port density in a stackable 48-port GbE switch with full 15.4W PoE capability on all 48 ports

❍ Recognizes IP phones automatically when connected to the switch and dynamically places them into a dedicated voice VLAN (which can enforce higher security and QoS for VoIP traffic)

3Com Switch 5500G-EI 48-port vs. Cisco Catalyst 3750G-48TS
Layer 2 Frame Forwarding Performance (Millions of frames per second) with 100% Line-Rate Traffic across 96 GbE Ports in the Stack as Reported by Spirent SmartFlow 4.7

Source: The Tolly Group, November 2005   *Figure 1*

3Com Switch 5500G-EI 48-port vs. Cisco Catalyst 3750G-48TS
Layer 3 Packet Forwarding Performance (Millions of packets per second) with 100% Line-Rate Traffic across 64 GbE Ports in the Stack
as Reported by Spirent SmartFlow 4.7
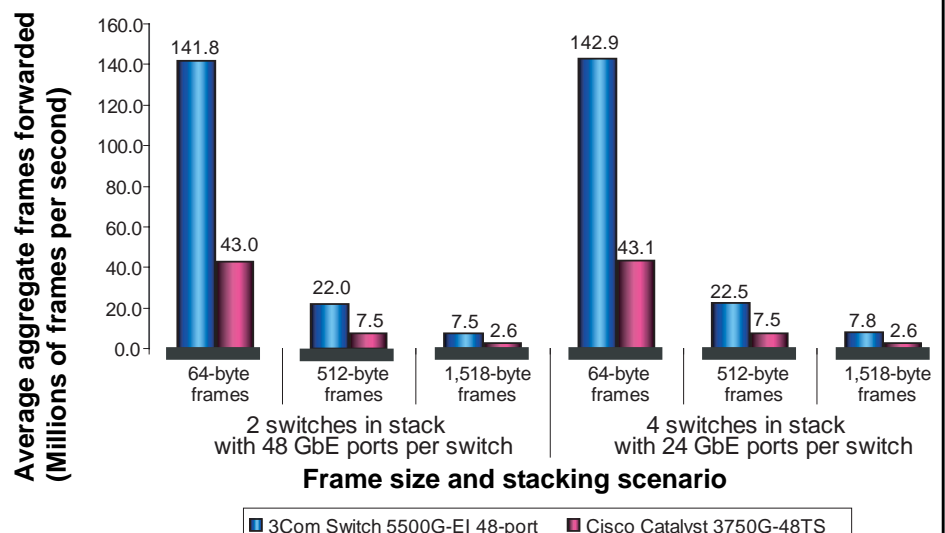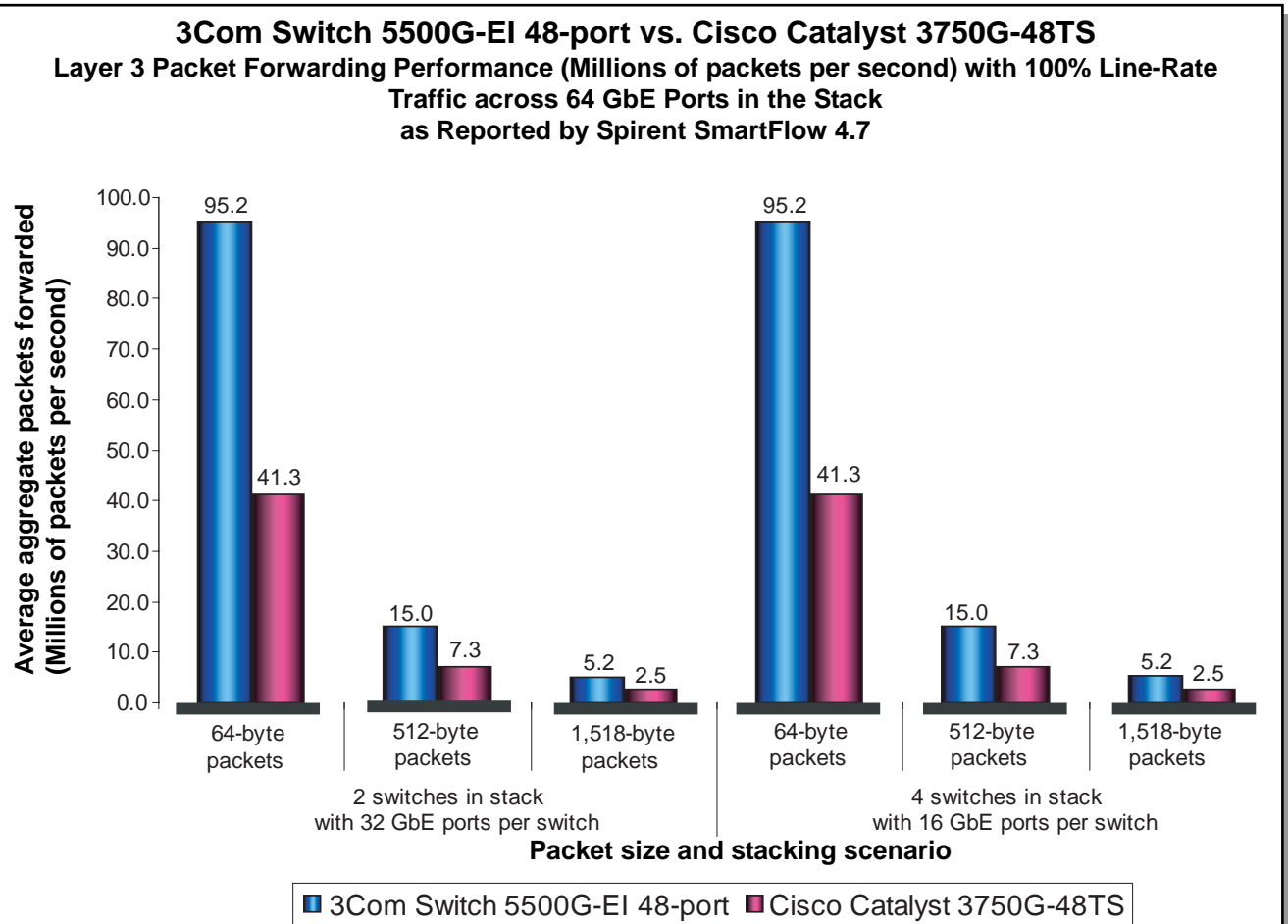
Source: The Tolly Group, November 2005

Figure 2

was measured on two different 64-port configurations: a four-high stack using 16-ports per switch, and a two-high stack using 32-ports per switch.

Tolly Group engineers also verified support for 16 enterprise-class features of the 3Com Switch 5500G-EI under the Tolly Verified certification program, plus two Tolly First & Foremost distinctions.

As part of the feature testing, Tolly Group engineers evaluated the PoE-capable 3Com Switch 5500G-EI PWR 48-port switch for PoE support, including the ability to power pre-standard Cisco IP phones (as these exist in many customer environments today). Engineers also tested the ability of the Switch 5500G-EI PWR to detect VoIP phones automatically and to place

them dynamically into a voice VLAN, which can be configured to provide enhanced security and QoS for VoIP traffic.

Testing took place during November 2005 at 3Com's labs in Marlboro, MA and at The Tolly Group's facilities in Boca Raton, FL.

Tests show that the 3Com Switch 5500G-EI 48-port switch demonstrates consistently superior (lower) frame-loss when compared against the Cisco Catalyst 3750G both at Layer 2 and Layer 3, and, consequently, that the 3Com switch offers as much as 3X the frame forwarding performance of the Catalyst 3750G tested.

Moreover, the 3Com Switch 5500G-EI demonstrated support for a sizable list of enterprise-class fea-

tures and functions that were verified under the Tolly Verified certification program, including the ability to provide power over Ethernet to IEEE 802.3af standard PoE devices and pre-standard Cisco-branded voice over IP (VoIP) phones.

Results

Layer 2 Frame Forwarding

Tolly Group engineers calculated the Layer 2 frame forwarding capacity of the devices under test by measuring frame loss in a 2-unit/4-unit stack while handling line-rate ingress traffic across 96 Gigabit Ethernet (GbE) ports in a full-mesh configuration spanning all 96 ports in the stack — i.e. each port in the stack sends traffic to and receives traffic from every other port in the

stack.

In the 96-port scenario (four switches each with 24 GbE ports), the 3Com Switch 5500G-EI experienced zero frame loss when tested with 64-byte frames, 0.1% frame loss when tested with 512-byte frames and 0.2% frame loss when tested with 1,518-byte frames. By contrast, the Cisco Catalyst 3750G-48TS experienced average frame loss of 69.8% when tested with 64-byte frames, 66.5% when tested with 512-byte frames and 66.1% when tested with 1,518-byte frames.

On a frame forwarding basis, this equates to 142.9 million frames per second (fps) for the 3Com Switch 5500G-EI when tested with 64-byte frames - more than 3X the number of frames forwarded by the Cisco Catalyst 3750G, which forwarded 43.1 million fps.(See Figure 1.) With 512-byte frames, the 3Com Switch 5500G-EI forwarded 22.5 million fps, versus 7.5 million for the Catalyst. And with 1,518-byte

frames, the 3Com Switch 5500G-EI transmitted 7.8 million fps versus 2.6 million fps for the Catalyst switch.

In a second 96-port scenario (two switches each with 48 ports), the 3Com Switch 5500G-EI exhibited between 0.7% to 4% frame loss, while the Cisco Catalyst 3750G experienced frame loss ranging from 66% to almost 70%. While this test scenario is unlikely to be experienced in most production networks today, it helps to demonstrate how the switches perform under instances of extreme traffic load.

On a frame forwarding basis, this equates to 141.8 million fps for the 3Com Switch 5500G-EI when tested with 64-byte frames — again a 3X advantage over the Catalyst 3750G which forwarded 43 million fps. When tested with 512-byte frames, the 3Com Switch 5500G-EI forwarded 22 million fps versus 7.5 million fps for the Catalyst 3750G. And with 1,518-byte frames, the

3Com Corp.

3Com Switch 5500G-EI

Layer2/ Layer3 Performance and PoE Functionality

3Com Switch 5500G-EI forwarded 7.5 million fps versus 2.6 million fps for the Catalyst 3750G. (See Figure 1.)

Layer 3 Packet Forwarding

Next, engineers calculated the Layer 3 IP packet forwarding of the devices under test by measuring packet loss in a 2-unit/4-unit stack while handling line-rate traffic across 64 GbE ports in a full-mesh configuration across all the ports in the stack.

3Com Corporation
Switch 5500G-EI 48-Port
Product Specifications*

Performance
- ❑ Switching capacity : 232 Gbps
- ❑ Forwarding rate: 172.6 Mpps
- ❑ Stacking bandwidth: 96 Gbps full-duplex

Layer 2 switching
- ❑ 16k MAC addresses
- ❑ Latency <10 µs
- ❑ Jumbo Frames

Layer 3 switching
- ❑ RIP v1/v2, OSPF, ECMP
- ❑ 2k RIP routes
- ❑ 8k dynamic; 1k static ARP entries
- ❑ Multicast: PIM-DM, PIM-SM, IGMP v1/v2

Security
- ❑ IEEE 802.1x network login
- ❑ Centralized MAC-based authentication via RADIUS
- ❑ Access Control Lists
- ❑ Packet filtering

Quality of Service (QoS) and Traffic Management
- ❑ 802.1p CoS/QoS on Ingress and Egress
- ❑ Eight queues per port
- ❑ Ingress/egress rate limiting
- ❑ Application/protocol blocking

Stacking
- ❑ Eight switches high up to 448 GbE ports / 16 10GbE
- ❑ Single IP address management
- ❑ 3Com XRN technology:
- ❑ Resilient stacking and fabric links
- ❑ Distributed link aggregation
- ❑ Distributed resilient routing
- ❑ Hot-Swappable switch units

VLANs
- ❑ 4,096 VLANs (IEEE 802.1Q)
- ❑ Auto-VLAN assignment

Link Aggregation
- ❑ 802.1ad Link Aggregation (LACP)
- ❑ 32 groups; Eight ports per group

- ❑ Distributed across stack

Management
- ❑ SNMP v1/v2/v3; RMON; Syslog
- ❑ Telnet; SSH v1.5
- ❑ Embedded Web management

Power over Ethernet (PoE)
- ❑ IEEE 802.af Power over Ethernet
- ❑ Available DC redundant power system (RPS)

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Fax: (508) 323-1111
URL: *http://www.3com.com*

*Vendor-supplied information not verified by The Tolly Group

3Com Switch 5500G-EI 48-port
Tolly Verified Certifications Awarded

Cert. ID	Certification	Category
10501	VoIP Capable Infrastructure (Quality of Service)	LAN Switch Core
10534	Rate Limiting Per Port	LAN Switch Core
10587	QoS - Eight Traffic Queues	LAN Switch Core
10537	Port Access Authorization via MAC Address	LAN Switch Core
10503	Jumbo Frames	LAN Switch Core
10639	Power over Ethernet Provider	LAN Switch Core
10745	Port Mirroring - Cross Blade	LAN Switch Core
10744	Link Aggregation (IEEE 802.3ad) - Cross Blade	LAN Switch High Availability
10518	Dual Firmware Images	System Management
10519	Dual Configuration Images	System Management
10559	User Authentication via IEEE 802.1X	System Security and User Management
10571	User Authentication via RADIUS Server	System Security and User Management
10746	802.1X - Single port, "Per-MAC" Authentication	System Security and User Management
10747	Dynamic VLAN Assignment after Authentication	System Security and User Management
10535	Management Access Authentication via IP Access Control Lists	System Security and User Management
10536	Management Access Authentication via RADIUS	System Security and User Management
	First Gigabit Stackable Switch Hardware Upgradeable PoE Module	First and Foremost
	Foremost PoE Support in a Stackable Gigabit Ethernet Switch: Highest PoE port density with full 15.4W PoE capability on all 48 ports	First and Foremost

Source: The Tolly Group, November 2005　　　　　　　　　　　　　　　　　　*Figure 3*

In a configuration with four switches (16 GbE ports on each switch), the 3Com Switch 5500G-EI experienced zero packet loss for every packet scenario tested. The Catalyst 3750G-48TS, however, exhibited packet loss ranging from 51% to 57% in the same scenario.

On a packet forwarding basis, this equates to 95.2 million packets per second (pps) for the 3Com Switch 5500G-EI when tested with 64-byte packets — a 2X advantage over the Catalyst 3750G which forwarded 41.3 million pps. When tested with 512-byte packets, the 3Com Switch 5500G-EI forwarded 15 million pps
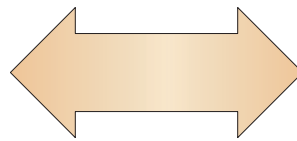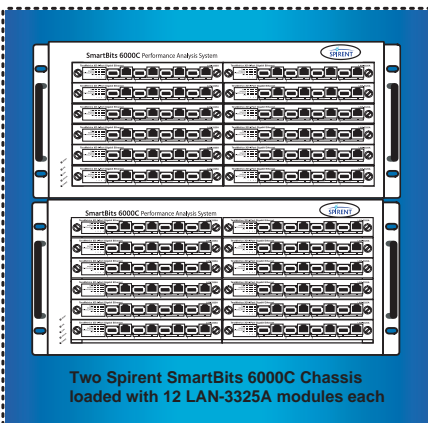
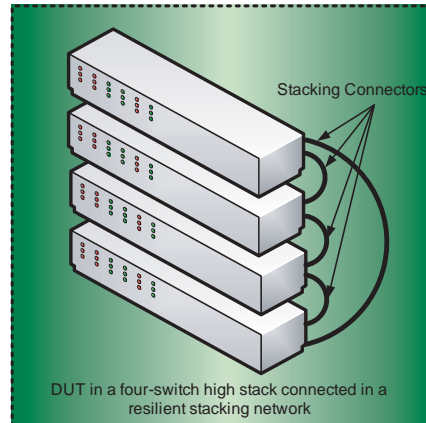### Test Bed for the Layer 2 Frame Loss Test With Four Switches in a Stack
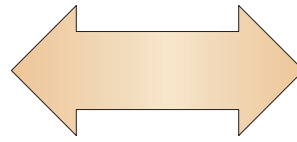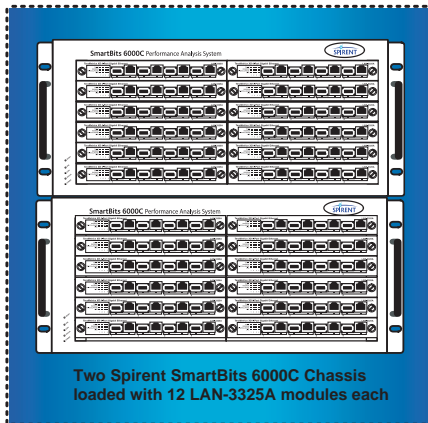
Two Spirent SmartBits 6000C Chassis loaded with 12 LAN-3325A modules each

96 Gigabit Ethernet links connected between the Spirent SmartBits 6000C chassis and the switches in the stack

DUT in a four-switch high stack connected in a resilient stacking network

Stacking Connectors
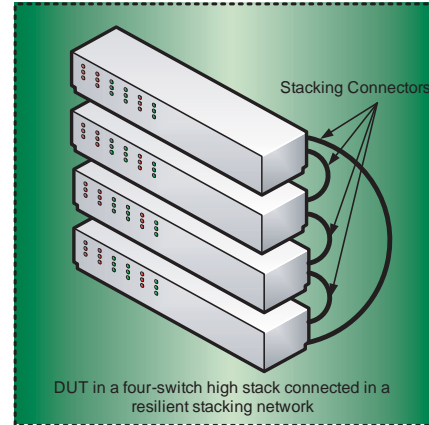
Test Bed for the Layer 3 Frame Loss Test With Four Switches in a Stack

Two Spirent SmartBits 6000C Chassis loaded with 12 LAN-3325A modules each

64 Gigabit Ethernet links connected between the Spirent SmartBits 6000C chassis and the switches in the stack

DUT in a four-switch high stack connected in a resilient stacking network

Stacking Connectors

Note: For the Layer 2 Frame Loss Test, 96 Gigabit Ethernet ports on the Spirent SmartBits were connected to the four-switch stack, with 24-ports per switch in a fully meshed network. Traffic consisted of 64-, 512- and 1,518-byte frames flowing bidirectionally at 100% of line rate.

For the Layer 3 Packet Loss Test, 64 Gigabit Ethernet ports on the Spirent SmartBits were connected to the four-switch stack, with 16 ports per switch in a fully meshed network. Traffic consisted of 64-, 512- and 1,518-byte packets flowing bidirectionally at 100% of line rate.

Source: The Tolly Group, November 2005   *Figure 4*

versus 7.3 million pps for the Catalyst 3750G. And with 1,518-byte packets, the 3Com Switch 5500G-EI forwarded 5.2 million pps versus 2.5 million pps for the Catalyst 3750G. (See Figure 2.)
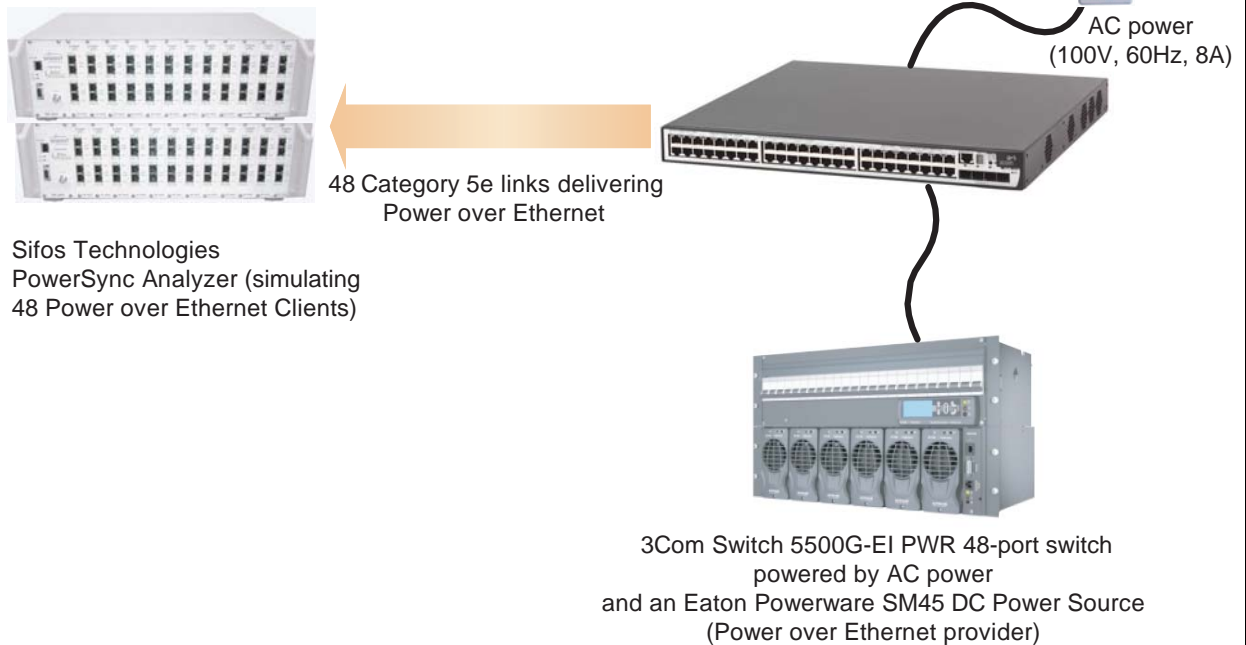
Next, engineers tested a configuration with two switches (32 GbE ports per switch). The 3Com Switch 5500G-EI reported zero packet loss for two of the three packet sizes tested — there was 1% packet loss when tested with 1,518-byte packets. The Catalyst 3750G-48TS, by contrast, had packet loss ranging

from 51% to 59% in this scenario.

On a packet forwarding basis, this equates to 95.2 million pps for the 3Com Switch 5500G-EI when tested with 64-byte packets — a 2X advantage over the Catalyst 3750G which forwarded 41.3 million pps. When tested with 512-byte packets, the 3Com Switch 5500G-EI forwarded 15 million pps versus 7.3 million pps for the Catalyst 3750G. And with 1,518-byte packets, the 3Com Switch 5500G-EI forwarded 5.2 million pps versus 2.5 million pps for the Catalyst 3750G. (See

Figure 2.)

Feature Validation

Tolly Group engineers validated support for LAN switch features to issue Tolly Verified certifications for the 3Com Switch 5500G-EI in the following areas: (A full description of each Tolly Verified certification can be found at: *http://www.tolly.com*) (See Figure 3 for a complete listing of Tolly Verified certifications earned.) Go to *http://www.tolly.com/TVDetail.aspx?ProductID=197*.

Test Bed Setup for the Certifications for PoE Support

AC power
(100V, 60Hz, 8A)

48 Category 5e links delivering
Power over Ethernet

Sifos Technologies
PowerSync Analyzer (simulating
48 Power over Ethernet Clients)

3Com Switch 5500G-EI PWR 48-port switch
powered by AC power
and an Eaton Powerware SM45 DC Power Source
(Power over Ethernet provider)

Source: The Tolly Group, November 2005   *Figure 5*

- **LAN Switch Core.** The 3Com Switch 5500G-EI earned seven certifications, including verification of Jumbo Frames support, Quality of service support for eight traffic queues, per-port rate limiting, power over Ethernet support and more.
- **LAN Switch — High Availability.** The 3Com Switch 5500G-EI earned certification for Link Aggregation (IEEE 802.3ad). This certification verifies that the device implements standards-based Link Aggregation and can create a single logical switch-to-switch link from two or more physical switch ports located on different switches in a stack.
- **System Management.** The 3Com Switch 5500G-EI earned certification for support of Dual Firmware Images, meaning the device can store two firmware images from which to load the system software (as dis-

tinct from the customer configuration) for the device. The switch also earned a certification for dual configuration images, meaning the device can store two images from which to load the customer configuration (as distinct from the system software) for the device.

- **System Security and User Management.** The 3Com Switch 5500G-EI earned six certifications, including certifications for User Authentication via IEEE 802.1X, User Authentication via RADIUS Server and Dynamic VLAN Assignment after Authentication, among others.

The 3Com Switch 5500G-EI was also tested for issuing two Tolly First & Foremost certifications related to Power over Ethernet. (These are discussed further in the next section of this report.)

PoE Support

PoE testing verified the ability of the 3Com Switch 5500G-EI PWR to power IEEE 802.3af standard PoE devices, as well as pre-standard Cisco IP phones using Power over Ethernet. Testing also verified the ability of the 3Com Switch 5500G-EI PWR to detect VoIP phones automatically and to dynamically place them into a dedicated voice VLAN (with the benefit being that the voice VLAN can be configured as appropriate by enterprise users to provide enhanced security and QoS for VoIP traffic on their network).

Note: Although Tolly Group engineers verified the above PoE capabilities using Cisco VoIP phones only, 3Com states that the Switch 5500G-EI PWR has the ability to detect VoIP phones from several manufacturers — including 3Com, Cisco, Pingtel, and Polycom by default — and can be configured to simultaneously detect up to 15 different vendors' VoIP phones.

The Tolly Group also awarded the 3Com Switch 5500G-EI a First & Foremost certification for demonstrating the highest PoE port density tested to date on a stackable switch with full 15.4W PoE capability on all 48 ports.

Engineers also recognized the 3Com switch as the first GbE stackable LAN switch tested by The Tolly Group with support for an upgradeable PoE power module. Essentially, the 3Com Switch 5500G-EI operates as a non-PoE switch when used with its standard power supply, but can be upgraded to a PoE-capable switch by simply swapping its power supply module for a higher-powered PoE power supply module.

Analysis

In today's enterprise, it is important to deploy edge switches that deliver both high performance and advanced enterprise-class features to support emerging applications. Edge switches must provide high throughput with minimal packet or frame loss as well as robust security, traffic prioritization and Quality of Service capabilities to enhance application performance.

Additionally, PoE — which enables switch ports to power VoIP phones, IP cameras, wireless access points, and other gear — is becoming increasingly important with its potential to simplify implementation and ongoing management of power and data cabling infrastructure.

Given the prevalence of multi-vendor networks today — particularly with the convergence of voice and data network infrastructures — it is imperative that edge switches conform to standards to ensure interoperability in both new and existing enterprise environments.

Vendor-specific features, when implemented, should add value without the risk of locking the user into a particular vendor's products. For example, features that simplify implementation and/or automate administrative tasks — such as the ability to dynamically recognize and classify attached devices — can provide tremendous value to enterprises embarking on wide-scale rollout of VoIP and other applications.

Test Configuration and Methodology

For performance tests, The Tolly Group tested a 3Com Switch 5500G-EI, running software version V3.01.00s168 and outfitted with 44 10/100/1000 ports; four dual-personality 10/100/1000 or SFP Gigabit ports; and one expansion module slot. The 3Com Switch 5500G-EI was tested in two primary Layer 2 scenarios, one with a four-switch stack with 24 GbE ports per switch, and the other with two switches in the stack, with each switch supporting 48 GbE ports. According to 3Com, all hardware and software was "production" quality and available to customers.

The 3Com Switch 5500G-EI also was tested in two Layer 3 scenarios, one with a four-switch stack with 16 GbE ports per switch, and the other with two switches in the stack, with each switch supporting 32 GbE ports. In both instances, the 3Com switch was tested against a Cisco Catalyst 3750G, running software 12.2(25)SEB1 and outfitted with 48 Ethernet 10/100/1000 ports and four SFP ports.

The Tolly Group also tested a 3Com Switch 5500G-EI PWR 48-port switch to confirm that the device supports delivery of standard (IEEE 802.3af) Power over Ethernet, as well as the capability to provide power to pre-standard Cisco VoIP phones. The 3Com Switch 5500G-

EI PWR employed software version V3.01.00s168 and was outfitted with 44 in-line power 10/100/1000 ports; four dual-personality in-line power 10/100/1000 or SFP Gigabit ports; and one expansion module slot.

For the Layer 2 frame-loss test, the test bed consisted of the device under test (DUT) in the desired stacking configuration, a Spirent SmartBits acting as a traffic generator, and Spirent SmartFlow software running on a Windows based PC. (See Figure 4). The test traffic generated by the Spirent SmartBits was connected to the appropriate number of ports on the DUT using the appropriate number of Category-5e RJ-45 cables.

For the Layer 2 tests, the switch stack consisted of 96 ports split equally among the two or four switches in the stack. For the Layer 3 tests, the switch stack consisted of 64 ports split equally among the two or four switches in the stack. The switches in the stack were connected in a resilient stacking configuration using appropriate stacking connectors on the back of each switch.

In the Test Setup option of the Spirent SmartFlow application, engineers configured the network topology as full-mesh across all the ports in the stack (each port in the stack sent traffic to and received traffic from every other port in the stack). Engineers also set data packet sizes of 64, 512 and 1,518 bytes, identified a transmitting load at 100% of line-rate, and ran the test for 60 seconds. All tests were run for three iterations and the results were averaged to obtain the frame loss percentage.

For the First and Foremost certifications related to PoE support, engineers enabled PoE support on the 3Com 5500G-EI, connected all the ports on the switch to a Sifos

Technologies PowerSync Analyzer PoE test device using Cat 5e cables. (See Figure 5.) Engineers also connected the switch to both AC and DC power supply sources powerful enough to supply a maximum of 15.4W of power to each connected PoE device on all the 48-ports of the switch. Engineers used the Sifos PowerShell application to measure the PoE power supplied by the switch to each connected PoE device.

Competitor Interaction

The Tolly Group invited Cisco Systems to participate in the test as per The Tolly Group Fair Testing Charter (*http://tollygroup.com/Corporate/FTC.aspx*). Cisco representatives opted not to respond to the invitation. The Cisco equipment used in the test was procured by 3Com

through regular retail channels. Tolly Group engineers checked software release levels to ensure the software was current.

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

Vendor	Product	Web address
Funk Software	Steel Belted Radius	*http://www.funksoftware.com*
Microsoft Corp.	Internet Authentication Server	*http://www.microsoft.com*
Sifos Technologies	PowerSync Analyzer ver. 1.30	*http://www.sifos.com*
Spirent Communications	SmartFlow ver. 4.70	*http://www.spirentcom.com*
Spirent Communications	SmartBits 6000C	*http://www.spirentcom.com*

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Project Profile

Sponsor: 3Com Corp.
Document number: 206102
Product Class: Stackable Gigabit Ethernet switch
Products under test:
- 3Com Switch 5500G-EI, SW V3.01.00s168
- 3Com Switch 5500G-EI PWR, SW V3.01.00s168
- Cisco Systems Catalyst 3750G, SW 12.2(25)SEB1

Testing window: November 2005
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.

The Tolly Group doc. 206102 rev. dmk 04 Jan 06