THE TOLLY GROUP

No. 201100 January 2001

Hewlett-Packard Co.

Procurve Switch 2524 versus Cisco Systems, Inc. Catalyst 3500 (3524) Series XL Switch and 3Com SuperStack II Switch 3300 TM Layer 2 Fast Ethernet/Gigabit Uplink Switching Competitive Evaluation

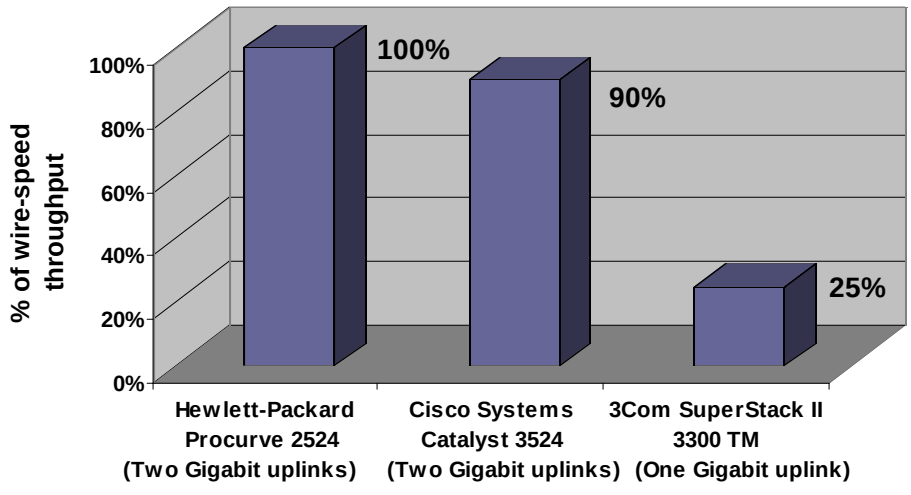
Test Summary

Premise: *Customers who deploy Layer 2 switches need to know that the backplane capacity, the switching fabric used to interconnect ports, is non-blocking. When these switches are integrated into their network they can transport data at wire speed with no packet loss when handling bidirectional traffic. Furthermore, these switches should maintain wire-speed performance of a variety of packet sizes from 64- to 1,518-bytes in partial-mesh configurations in conjunction with high-speed uplinks.*

Hewlett-Packard Co. commissioned The Tolly Group to evaluate the Layer 2 switching performance of its Procurve Switch 2524, a 24-port 10/100 Ethernet switch with two Gigabit Ethernet fiber uplink ports. The Tolly Group was also commissioned to compare these results to the Layer 2 performance of a Cisco Systems, Inc. Catalyst 3500 (3524) Series XL Switch with two Gigabit Ethernet fiber uplink ports and a 3Com Corp. SuperStack II Switch 3300 TM with a single Gigabit Ethernet copper uplink port, both 24-port, 10/100 Ethernet switches. The Tolly Group engineers measured the throughput of each of the aforementioned switches directing traffic from 10 Fast Ethernet ports to a single Gigabit

Test Highlights

- Delivers wire-speed throughput with two Gbe uplinks in tests of Layer 2 traffic of 64-byte packets; compared to Cisco's Catalyst 3524 with two Gbe uplinks that delivered 90%, and 3Com's SuperStack II 3300 TM that delivered 25% with one Gbe uplink
- Performs wire-speed throughput with two Gbe uplinks in tests of Layer 2 traffic of 512- and 1,518-byte packets; 26% better than Cisco's Catalyst 3524 with two Gbe uplinks and 340% more than 3Com's SuperStack II 3300 TM with one Gbe uplink
- Demonstrates a peak backplane capacity of 8.8 Gbit/s, compared to the Cisco Catalyst 3524 at 7.0 Gbit/s; and the 3Com SuperStack II 3300 TM at 2.0 Gbit/s; all using 512- and 1,518-byte packets



Note: For 64-byte packets, the maximum aggregate throughput is measured in packets-per-second (pps).

Source: The Tolly Group, January 2001 *Figure 1*

Ethernet port in a partial-mesh configuration, and directed the remaining Fast Ethernet ports in a full-mesh configuration. Tests were conducted for packet sizes of 64, 512 and 1,518 bytes for all devices under test. Testing was performed in December 2000.

Test results show that the Hewlett-Packard Procurve Switch 2524 demonstrated non-blocking wire-speed performance in all Layer 2 tests of 64-, 512- and 1,518-byte packets while its competitors' results showed they can handle from 25- to 90-percent of the theoretical maximum.

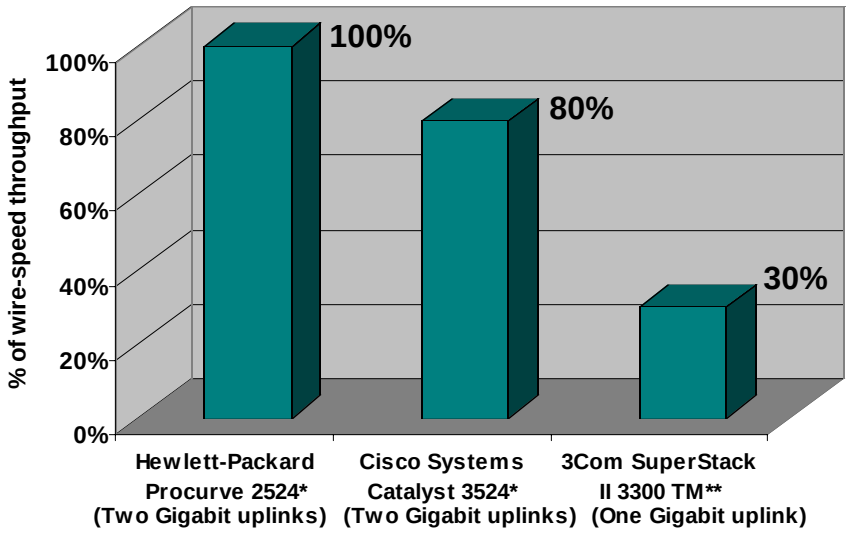
Results

Layer 2 10/100 Throughput Using 64-byte packets

The Tolly Group measured the throughput of all three devices under test in a configuration where 10 Fast Ethernet ports were connected to each available Gigabit Ethernet port. All remaining ports were configured for full mesh (each port is sending traffic to every other port and each port is receiving traffic from every other port).

In tests using 64-byte packets, the Hewlett-Packard Procurve Switch 2524 demonstrated wire-speed throughput or an aggregate of 6,547,619 packets-per-second (pps). The Cisco Systems Catalyst 3524 switch delivered 90% of the wire-speed through-put or an aggregate of 5,906,772 pps. The 3Com SuperStack II Switch 3300 TM delivered 25% of the wire-speed throughput or 1,264,881 pps. Unlike the Hewlett-Packard and the Cisco Systems devices, the 3Com

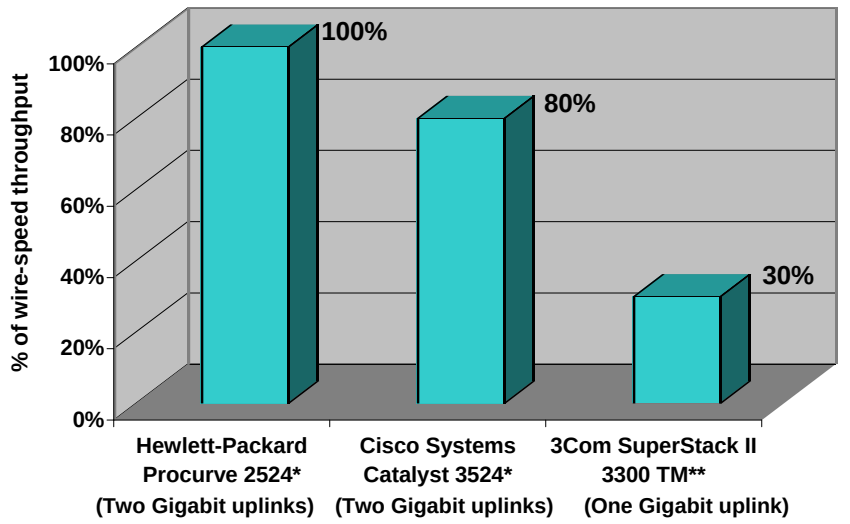
Aggregate Layer 2 System Throughput:
24-port Fast Ethernet Switches (512-byte packets)



* Theoretical wire-speed backplane maximum for this device in a full-mesh configuration (each port is sending traffic to every other port and each port is receiving traffic from every other port) has a capacity of 8.8 Gbit/s.
** Theoretical wire-speed backplane maximum for this device in a full-mesh configuration (each port is sending traffic to every other port and each port is receiving traffic from every other port) has a capacity of 6.8 Gbit/s.

Source: The Tolly Group, January 2001 *Figure 2*

Aggregate Layer 2 System Throughput:
24-port Fast Ethernet Switches (1,518-byte packets)



* Theoretical wire-speed backplane maximum for this device in a full-mesh configuration (each port is sending traffic to every other port and each port is receiving traffic from every other prots) has a capacity of 8.8 Gbit/s.
** Theoretical wire-speed backplane maximum for this device in a full-mesh configuration (each port is sending traffic to every other port and each port is receiving traffic from every other prots) has a capacity of 6.8 Gbit/s.

Source: The Tolly Group, January 2001 *Figure 3*

device supports only a single Gigabit Ethernet uplink, thus reducing the maximum amount of traffic it might process. The percentage noted is relative to each device's maximum. See figures 1 and 4.

Layer 2 10/100 Throughput Using 512-byte packets

The Tolly Group engineers also measured the throughput of the three competing devices using 512-byte packets in the same configuration where 10 Fast Ethernet ports were connected to a single Gigabit Ethernet port and all remaining ports were configured for full mesh.

Test results show that the Hewlett-Packard Procurve Switch 2524 demonstrated wire-speed throughput or an aggregate of 1,033,834 pps. The Cisco Systems Catalyst 3524 delivered 80% of its maximum throughput or an aggregate of 827,068 pps. The 3Com SuperStack II Switch 3300 TM delivered 30% of its maximum or 239,794 pps. See figures 2 and 4.

Layer 2 10/100 Throughput Using 1,518-byte packets

Finally, engineers tested each device while using 1,518-byte packets and found that in the same configuration as above, the Hewlett-Packard Procurve Switch 2524 delivered wire-speed throughput or an aggregate of 357,607 pps. The Cisco Systems Catalyst 3524 switch handled 80% of the wire-speed throughput or an aggregate of 286,086 pps and the 3Com SuperStack II Switch 3300 TM performed at 30% of wire-speed throughput or an aggregate of 82,901 pps. See figures 3 and 4.

Analysis

The steady-state performance test employed by The Tolly Group in this benchmark allowed engineers to gauge the level of traffic that the backplane of a Layer 2 switch can handle before any packets are dropped. This level of traffic provided a high-water mark for capacity at the offered packet size.

The theoretical maximum backplane capacity that can be demonstrated in a given test is determined by the number, speed and duplex mode of the switch ports. In the test methodology conducted for this analysis by The Tolly Group, the configuration of 24, full-duplex 100 Mbit/s ports allows a maximum of 4.8 Gbit/s of throughput. This is in addition to the throughput from the full-duplex Gigabit Ethernet uplinks, of which the Hewlett-Packard Procurve Switch 2524 and the Cisco Systems Catalyst 3524 switch, each have two. The 3Com SuperStack II 3300 TM only has a single Gigabit Ethernet uplink. This means that the maximum aggregate throughput (i.e. all ports running at wire speed with full-duplex traffic) of the Hewlett-Packard Procurve 2524 and the Cisco Systems Catalyst 3524 are 8.8 Gbit/s, while the total throughput capacity of the 3Com SuperStack II 3300 TM is 6.8 Gbit/s.

Even at the smallest packet size, the Hewlett-Packard Procurve Switch 2524 delivers performance that matches the theoretical packet rate of its port configuration. For small packet sizes (64 bytes) that is 6,547,619 pps and for

Hewlett-Packard Co.

Procurve Switch 2524

Competitive Evaluation

Hewlett-Packard Co.
Procurve Switch 2524
Product Specifications*

- 9.6 Gbit/s switch fabric integrated on-chip: high-performance, non-blocking architecture
- Hewlett-Packard Auto-MDIX: automatically adjusts for straight-through or crossover cables on all 10/100 and 100/1000 ports
- Two transceiver slots for Gigabit-SX, Gigabit-LX, 100/1000-T, Gigabit stacking, or 100-FX transceivers
- Stack of up to 16 switches including the 1600M, 2400M, 2424M, 2512, 2524, 4000M, and 8000M
- RMON and extended RMON
- Web interface
- IEEE 802.3ad LACP (Link Aggregation Control Protocol) standard trunking
- 802.1Q VLAN tagging and port VLAN support
- Group VLAN Registration Protocol (GVRP)
- IP multicast (IGMP)
- Lifetime warranty for as long as you own the product, with next business day advance replacement (available in most countries)
- IEEE 802.1p prioritization
- CDP and TACACS+ (future free software update)
- 802.1x and RADIUS network login (future free software update)

For more information contact:
Hewlett-Packard Co.
8000 Foothills Boulevard
Roseville, CA 95747
URL: http://www.hp.com/go/procurve

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

larger packets (1,518 bytes) that is 357,607 pps or 8.8 Gbit/s of full-duplex throughput. Cisco does well also with 5,906,772 pps and 7.9 Gbit/s of the maximum throughput of 64-byte packets and for larger packets (1,518 bytes) that is 286,086 pps or 7.0 Gbit/s. Both of these switches have backplane capacities and forwarding speeds well above the levels that are likely ever to be encountered.

3Com, however, is another story. For starters, the fact that it has only one Gigabit Ethernet uplink reduces its maximum capacity to 6.8 Gbit/s full duplex. Even with the "best case" large packets scenario, it was only capable of forwarding 30 percent or 2.6 Gbit/s across all ports. Given that a single full-duplex Gigabit Ethernet port can drive 2 Gbit/s of traffic, it is conceivable that the stack might encounter conditions where the backplane is oversubscribed.

While actual network traffic is a complex mixture of variously-sized packets, The Tolly Group followed the de facto industry standard practice, which is to benchmark using streams of uniform-sized packets. The packet sizes chosen for the test included both the smallest and largest supported by Ethernet– these represented the worst and best case scenarios, respectively.

In the best-case scenario, all ports are offered 1,518-byte packets. This reduces the packet-processing load and should maximize a product's performance by allowing it to stream the large data loads. The 1,518-byte packets are the largest legal packet size (excluding VLAN tagged packets) capable of being transmitted over Fast/Gigabit Ethernet networks. Packets of this size typically represent those used in large-file transfers and backup transfers over networks. Additionally, 1,518-byte packets are easier for switches to process since the data payload outweighs the packet overhead by an approximate factor of 20. Nonetheless, it is important that a switch have the capability to transport packets of all sizes.

For these tests engineers also measured each switch using 512-byte packets. This packet size requires more processing than the aforementioned packet size because the header information is again outweighed by data payload, but now only by a factor of approximately eight. This packet size is used in a variety of applications and networking protocols, thereby making it necessary for all Layer 2 switching devices to be able to handle these traffic flows.

Engineers also offered streams of 64-byte packets–the worst-case scenario. Sending the smallest legal packet size forces a Layer 2 switch to handle a very high packet rate of up to 148,810 pps for each of the 100 Mbit/s ports and 1,488,095 pps for each of the 1Gbit/s ports.

The Hewlett-Packard Procurve Switch 2524 was shown to operate at wire speed in a full-mesh configuration with a backplane capacity of 8.8 Gbit/s when forwarding 64-, 512- and 1,518-byte packets. This ensures that customers can deploy the switch in a variety of high-performance networks and guarantee that the switch will forward traffic to its destination with no packet loss even during periods of heavy network utilization.

The highest total throughput produced by the Cisco Systems Catalyst 3524 switch was 7.9 Gbit/s, which is 11% lower than the Hewlett-Packard Procurve Switch 2524. The 3Com SuperStack II 3300 TM switch showed a backplane capacity of 2.0 Gbit/s in the best-case scenario, 233% lower than the Procurve Switch 2524.

Test Configuration and Methodology

In this round of tests, The Tolly Group benchmarked three 24-port Fast Ethernet Layer 2 switches. Each of these switches was additionally outfitted with either one or two Gigabit Ethernet uplink ports. The switches were: a Hewlett-Packard Co. Procurve Switch 2524 firmware version F.01.07 with two fiber Gigabit Ethernet uplinks; a Cisco Systems, Inc. Catalyst 3500 (3524) Series XL Switch version 12.0 with two fiber Gigabit Ethernet uplinks; and a 3Com Corp. SuperStack II 3300 TM version 2.51with one copper Gigabit Ethernet uplink. Each device under test was connected to one of the following: a Spirent Communications SmartBits SMB-2000 Advanced Multiport Performance Tester/ Analyzer/Simulator, a 20-port network traffic simulator equipped with 20 Spirent Communications ML-7710 Fast Ethernet cards; or a Spirent Communications SmartBits SMB-10, a 20-port network traffic simulator expansion chassis equipped with four

Products under test	Aggregate throughput for 64-byte packets			Aggregate throughput for 512-byte packets			Aggregate throughput for 1,518-byte packets		
	Packets per second	Gbit/s	Percentage of theoretical maximum	Packets per second	Gbit/s	Percentage of theoretical maximum	Packets per second	Gbit/s	Percentage of theoretical maximum
Hewlett-Packard Procurve Switch 2524 (Two Gigabit uplinks)	6,547,619	8.8	100%	1,033,834	8.8	100%	357,607	8.8	100%
Cisco Systems 3500 (3524) Series XL Switch (Two Gigabit uplinks)	5,906,772	7.9	90%	827,068	7.0	80%	286,086	7.0	80%
3Com SuperStack II 3300 TM (One Gigabit uplink)	1,264,881	1.7	25%	239,794	2.0	30%	82,901	2.0	30%

Source: The Tolly Group, January 2001

Figure 4

Spirent Communications GX-1405B fiber Gigabit Ethernet cards revision 2.25.001, two Spirent Communications GX1420B copper Gigabit Ethernet cards, and four Spirent Communications ML-7710 Fast Ethernet cards.

For tests, engineers connected 10 Fast Ethernet ports to each Gigabit Ethernet port and the remaining Fast Ethernet ports in a full-mesh configuration.

Both devices were running Spirent Communications SmartWindows version 7.00 on a 400-MHz AMD K6 CPU PC clone with 64 Mbytes of RAM. The PC served as the SmartBits console and was running Microsoft Corp. Windows NT Service Pack 5. See figure 5.

Each device under test was configured for maximum speed (100 Mbit/s for Fast Ethernet ports and 1000 Mbit/s for Gigabit Ethernet ports) and full-duplex operation while Spanning Tree, Flow Control and all other ancillary functions were disabled.

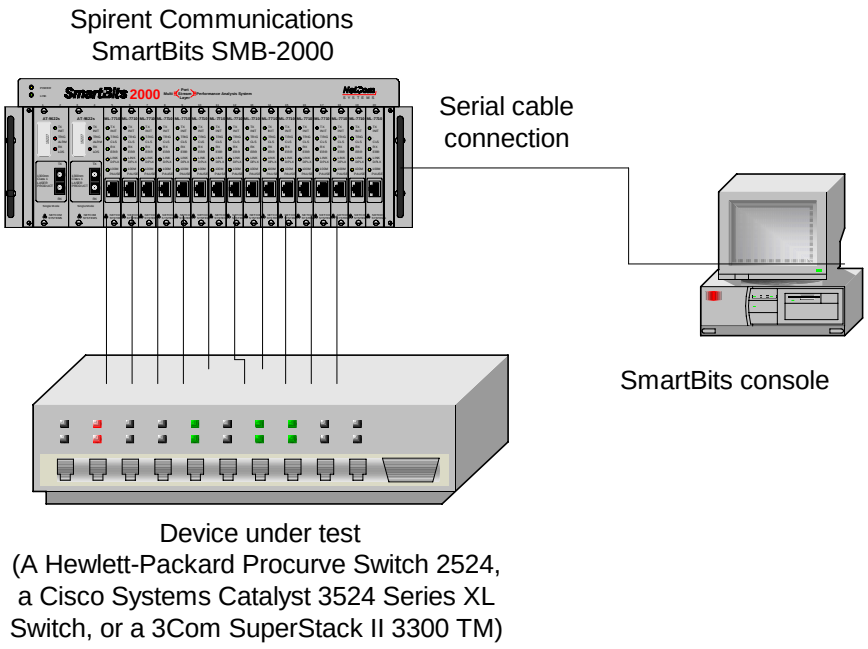
The Tolly Group engineers used the SMB-2000 chassis to generate Layer 2 traffic in a full-mesh configuration for all ports in three testing scenarios, the first using 64-byte packets. Subsequent tests were conducted with 512- and 1,518-byte packets. Tests ran for three iterations lasting one minute each and the total transmitted packets, total received packets, and the packet and percent loss, if any, were recorded as reported by SmartBits.

Equipment Acquisition and Support

The Tolly Group contacted executives at Cisco Systems Inc. and 3Com Corp. and invited them to provide a higher level of support than available through normal channels. Cisco did not respond to several invitations from The Tolly Group. 3Com agreed to provide a higher level of support than normally offered through traditional channels.

Results were shared with 3Com who neither acknowledged nor disputed their accuracy. For a more complete understanding of the interaction between The Tolly Group, Cisco Systems Inc. and 3Com Corp., check out the Technical Support Diary for Competitive Products Tested posted on The Tolly Group's World Wide Web site at

Test Bed



Source: The Tolly Group, January 2001

Figure 5

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

Vendor	Product	Web address
Spirent Communications	SmartBits SMB-2000	http://www.spirentcom.com

Since its inception, The Tolly Group has produced high-quality tests that meet three overarching criteria: All tests are objective, fully documented and repeatable.

We endeavor to provide complete disclosure of information concerning individual product tests, and multiparty competitive product evaluations.

As an independent organization, The Tolly Group does not accept retainer contracts from vendors, nor does it endorse products or suppliers. This open and honest environment assures vendors they are treated fairly, and with the necessary care to guarantee all parties that the results of these tests are accurate and valid. The Tolly Group has codified this into the Fair Testing Charter, which may be viewed at http://www.tolly.com.

Project Profile

Sponsor: Hewlett-Packard Co.
Document number: 201100
Product Class: Layer 2 switches
Products under test:

- Hewlett-Packard Co. Procurve Switch 2524 v. F.01.07
- Cisco Systems, Inc. Catalyst 3500 (3524) Series XL Switch v. 12.0
- 3Com Corp. SuperStack II Switch 3300 TM v. 2.51

Testing window: December 2000
Additional information available:

- Technical Support Diary

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 info@tolly.com, call (800) 933-1699 or (732) 528-3300.