Miercom

Lab Testing Summary Report

September 2010

Report 100827

Product Category:

Ethernet Network Switches

Vendors Tested:

Cisco
Blade Network Technologies
Dell
HP Networking
Nortel

Products Tested:

Catalyst 2960; 2960-S; 3750-X-48
Blade RackSwitch G8000
Dell PowerConnect 6248
HP E2610; E5500G
Nortel 4548GT

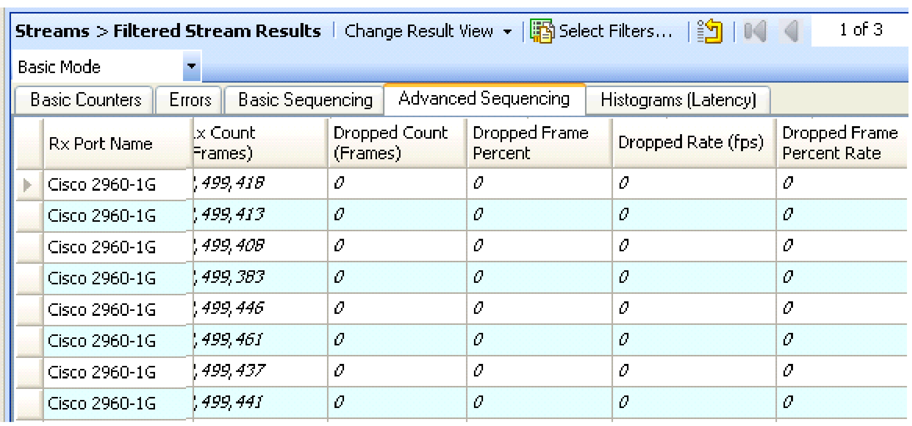
Key findings and conclusions:

- **Cisco Catalyst switches with custom ASICs provide superior performance in egress buffering**
- **Using frame sizes of 64 to 1518 bytes, only a single packet was dropped when the buffer was exceeded on the Catalyst switches under test**
- **Catalyst switches provide strict high priority queuing, protecting voice traffic during periods of oversubscription**
- **During oversubscription, 0% of buffer packets were dropped as compared to the other vendors tested**

Cisco engaged Miercom to conduct an independent verification of the performance advantages that Cisco Catalyst switches have when compared to similar switches from other vendors.

Testing confirmed that the Catalyst switches, which use custom ASICs designed by Cisco, have improved performance characteristics in egress buffering and strict priority queuing when compared to similar products using standard Broadcom chipsets. The Catalyst switches protected high priority traffic according to Quality of Service (QoS) policy during periods of oversubscription. The Cisco switches also successfully handled traffic bursts that exceeded the capacity of the buffer without indiscriminately flushing the buffer, thereby protecting the traffic held in the buffer from being dropped. Contrary, the other products tested would suffer packet loss during oversubscription causing lower throughput and higher call-drop rate despite the appropriate QoS configuration. We examined the Cisco Catalyst 2960, 2960-S, and 3750-X-48P. To demonstrate the effect of the off-the-shelf silicon used by other switch vendors, we examined switches from

Figure 1: Catalyst 2960-1G Filtered Stream Results

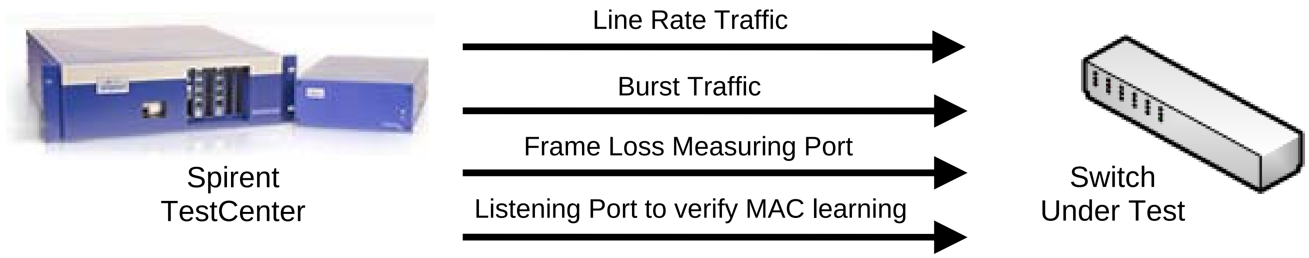


Rx Port Name	x Count Frames)	Dropped Count (Frames)	Dropped Frame Percent	Dropped Rate (fps)	Dropped Frame Percent Rate
Cisco 2960-1G	,499,418	0	0	0	0
Cisco 2960-1G	,499,413	0	0	0	0
Cisco 2960-1G	,499,408	0	0	0	0
Cisco 2960-1G	,499,383	0	0	0	0
Cisco 2960-1G	,499,446	0	0	0	0
Cisco 2960-1G	,499,461	0	0	0	0
Cisco 2960-1G	,499,437	0	0	0	0
Cisco 2960-1G	,499,441	0	0	0	0

Source: Miercom, September 2010

Screen capture showing the results using strict priority queuing on the Catalyst 2960-1G. Note that high priority voice traffic was not dropped during periods of oversubscription.

Test Bed Diagram



How We Did It

To conduct the N+1 Egress Buffering test, we used a Spirent Smartbits 6000C running SmartWindows version 9.50 to send traffic to the switch under test. We sent line rate traffic on one port. Burst frames were sent on a second port. A third port was used to measure any frame loss during the burst, and a fourth port was a monitoring port to ensure that no flooding occurred during the test.

Each switch was configured as a single VLAN. Flow control, CDP, LLDP, and MAC aging were all disabled (with the exception of the Dell switch). Testing was conducted with 64-, 256-, 1024-, and 1518-byte frames.

To conduct the QoS test, Spirent TestCenter was used to drive Voice traffic (on port 3000), HTTP traffic (on port 80), and FTP traffic (on port 20) to 20 ingress ports in order to oversubscribe a single egress port. All traffic streams were monitored for packet loss.

Switches were configured as follows: Voice traffic is highest priority, and gets all the bandwidth it requires. HTTP traffic is assigned 70% of the remaining bandwidth. FTP Data traffic is assigned the lowest priority, and receives 30% of the remaining bandwidth.

Switch models: Cisco Catalyst 2960; 2960-S; 3750-X-48P; Blade BNT G8000; Dell PowerConnect 6248; HP E2610; HP E5500G; Nortel 4548GT

The tests in this report are intended to be reproducible for customers who wish to recreate them with the appropriate test and measurement equipment. Contact reviews@miercom.com for details on the configurations applied to the Switch Under Test and test tools used in this evaluation. Miercom recommends customers conduct their own needs analysis study and test specifically for the expected environment for product deployment before making a product selection.

HP Networking, Nortel, Dell, and Blade Network Technologies. Products tested included both Fast Ethernet and Gigabit Ethernet switches. All were configured with current firmware.

QoS

To deliver good user experience in an enterprise network, certain classes of traffic must be protected during periods of normal network oversubscription. Voice traffic is most sensitive to latency and packet loss, while FTP and Web traffic are affected less. Therefore, voice traffic was given the highest priority in the test scenario.

A network switch whose architecture does not provide strict queue prioritization will allow the user experience to be compromised when oversubscription occurs. Lower priority traffic may cause voice call quality to deteriorate, or calls may be dropped. New calls will not be able to be placed. Such architecture does not provide an effective QoS strategy.

N+1 Egress Buffering

The intent of this test is to show the performance of a switch when the buffer capacity is exceeded. A single packet that exceeds the switch buffer capacity should not cause the buffer to flush. Only the additional packet should be dropped. If a switch performs a buffer flush as a remedy to oversubscription, this undesirable behavior forces data to be retransmitted and may introduce packet loss and reduce network throughput.

Our testing used packet sizes from 64 bytes to 1518 bytes to evaluate the effect of smaller control packets being lost. We tested both within an individual switch processor by directing traffic from ports 1, 2, burst traffic on port 3, monitoring on port 4, and across multiple switch processors by directing traffic from ports 1, 2, burst traffic on ports 25-48 and monitoring on port 4.

The duration of traffic generated on ports 1 and 2 was modified according to packet size. For 64-byte frames, a total of 2 million packets were sent; with

1518-byte frames, a total of 200K packets were sent to maintain a constant test duration.

HP E2610 switch had 2 million 64-byte frames sent at line rate. A burst of packets was sent after 1M of the regular traffic had been sent. 31 packets were dropped, more than the burst traffic. Identifying which port the extra traffic was sent to was irrelevant since the packets were still dropped.

At 256-byte frames, we sent a total of 500K packets of line rate traffic. The burst traffic was 63 packets, within the buffer, and no packets were dropped. When 63+1 packets were sent, the buffer drop was 31 packets, or 48% of the total. See *Table 1 on page 4* for other products and tests.

The Dell PowerConnect 6248 exhibited similar behavior. Since this is a Gigabit Ethernet switch, we sent 20 million packets at line rate, and a burst of 98 packets. No packets were lost. When we sent 98+1 packets to the switch, it dropped 46 packets, a total of 46%. We did notice that when we sent 5 million 1518-byte packets, and sent a burst of 64 packets, the switch did not drop any packets. However, when we sent 65 packets of burst traffic, the switch dropped 3 packets; a total of 4%. We suspect that the switch has been tuned for the maximum MTU size of 1518 packets, which would explain the smaller amount of loss at that frame size. We observed the same behavior with the 1280-byte frame size. We were unable to disable MAC aging on the Dell switch.

In testing of the Cisco C2960-S, at frame sizes of 64 bytes to 1518 bytes, only the single packet that exceeded the buffer capacity was dropped. This was repeatable across the entire range of ports. The Catalyst 2960 also demonstrated the same response to oversubscription, dropping 0% of buffer packets at all frame sizes. Results for the Catalyst 3750-X-48P were equally good.

QoS Strict Priority Scheduling

We looked at the ability of each switch to protect highest priority traffic in accordance with a strict high priority queue. Particular interest was paid to what happens when low priority traffic oversubscribes the switch. For this test, we looked at the Catalyst 2960 and the HP E2610 10/100 Ethernet switches, and the Cisco C2960-S and HP Networking E5500G Gigabit Ethernet switches. A real-world traffic mix consisting of 1/3 voice (port 3000), 1/3 HTTP (port 80), and 1/3 FTP (port 20) traffic was sent to 20 100Mb/1G ingress ports on each switch to oversubscribe a single 1G/10G egress port.

The voice traffic was classified as strict high priority because it is most sensitive to latency and packet loss. The streams were enabled one at a time, starting with the voice traffic, and monitored for any packet loss.

The 10/100 switches with the egress port 2G oversubscribed, the Cisco C2960 only dropped the lower priority HTTP traffic, protecting the high priority voice traffic. See *Figure 1 on page 1.*

The HP E2610 began dropping high priority voice traffic when the egress port was oversubscribed by 1.6 GB, or when 16 ingress ports were used. If additional streams were added to oversubscribe the egress port, this action caused further degradation of the voice traffic. See *Figure 2 below and Figure 4 on page 5.* *(continued on page 5)*

Screen capture of QoS test results for HP Networking E2610. Traffic was dropped across all streams when the switch was oversubscribed. High priority voice traffic was not protected.

Figure 2: HP Networking E2610 Filtered Stream Results

Streams > Filtered Stream Results | Change Result View | Select Filters… | 1 of 3

Basic Mode

Basic Counters | Errors | Basic Sequencing | Advanced Sequencing | Histograms (Latency)

Rx Port Name	x Count Frames)	Dropped Count (Frames)	Dropped Frame Percent	Dropped Rate (fps)	Dropped Frame Percent Rate
Procurve 2610-1G	57,800	44,376	8.836	2,487	8.834
Procurve 2610-1G	57,755	44,370	8.836	2,488	8.837
Procurve 2610-1G	71,147	31,001	6.173	1,737	6.17
Procurve 2610-1G	79,925	22,226	4.426	1,242	4.412
Procurve 2610-1G	80,002	22,188	4.418	1,244	4.418
Procurve 2610-1G	79,953	22,186	4.418	1,243	4.415
Procurve 2610-1G	79,983	22,187	4.418	1,242	4.412
Procurve 2610-1G	79,991	22,188	4.418	1,244	4.418

Source: Miercom, September 2010

N+1 Egress Buffering Test							
			Maximum Buffer Capacity				
Switch and Version Number	Frame Size	Line Rate Traffic	Burst	Dropped	Burst +1	Dropped	%
Cisco C2960 IOS 12.2(53)SE2	64	2,000,000	525	0	526	1	0
	256	500,000	267	0	268	1	0
	1024	100,000	107	0	108	1	1
	1518	100,000	76	0	77	1	1
Cisco C2960-S IOS 12.2(53)SE2	64	20,000,000	121	0	122	1	1
	256	5,000,000	118	0	119	1	1
	1024	1,000,000	47	0	48	1	2
	1518	1,000,000	33	0	34	1	3
Cisco 3750-X-48P IOS 12.2(53)SE2	64	20,000,000	441	0	442	1	0
	256	5,000,000	220	0	221	1	0
	1024	1,000,000	87	0	88	1	1
	1518	1,000,000	62	0	63	1	2
Blade Network Rack Switch G8000 1.0.2.16	64	20,000,000	341	0	342	309	90
	256	5,000,000	168	0	169	155	92
	1024	1,000,000	41	0	42	41	98
	1518	1,000,000	27	0	28	28	100
Dell PowerConnect 6248, 2.0.0.12	64	20,000,000	98	0	99	45	45
	256	5,000,000	92	0	93	45	48
	1024	1,000,000	91	0	92	46	50
	1518	1,000,000	64	0	65	3	5
HP Networking E2610 R.11.54	64	2,000,000	70	0	71	31	44
	256	500,000	63	0	64	31	48
	1024	100,000	60	0	61	31	51
	1518	100,000	60	0	61	31	51
HP E5500G-EI 3Com OS V3.03.02s168p07	64	20,000,000	255	0	256	126	49
	256	5,000,000	252	0	253	126	50
	1024	1,000,000	251	0	252	126	50
	1518	1,000,000	251	0	252	126	50
Nortel 4548GT v5.0.0.002	64	20,000,000	309	0	310	76	25
	256	5,000,000	304	0	305	77	25
	1024	1,000,000	115	0	116	117	101
	1518	1,000,000	76	0	77	79	103

Screen capture of QoS test shows the HP Networking E5500G switch dropping packets at the rate of 1 to 40% when all voice traffic was directed to it. High priority traffic could not be protected during periods of oversubscription.

Figure 3: HP Networking 5500G-10G Filtered Stream Results

Streams > Filtered Stream Results | Change Result View | Select Filters... | 1 of 3

Basic Mode

Basic Counters | Errors | Basic Sequencing | Advanced Sequencing | Histograms (Latency)

Rx Port Name	Rx Stream Id	Dropped Count (Frames)	Dropped Frame Percent	Dropped Rate (fps)	Dropped Frame Percent Rate
3Com 5500G-10G	262144	11,626,232	40.204	185,583	65.923
3Com 5500G-10G	196608	369,447	1.277	6,027	2.14
3Com 5500G-10G	458752	7,879,366	27.247	125,778	44.677
3Com 5500G-10G	131072	10,633,516	36.771	169,199	60.101
3Com 5500G-10G	655360	4,405,022	15.232	70,377	24.998
3Com 5500G-10G	589824	6,442,220	22.277	102,662	36.464
3Com 5500G-10G	393216	6,482,377	22.416	103,394	36.725
3Com 5500G-10G	327680	5,796,919	20.046	92,364	32.807

Source: Miercom, September 2010

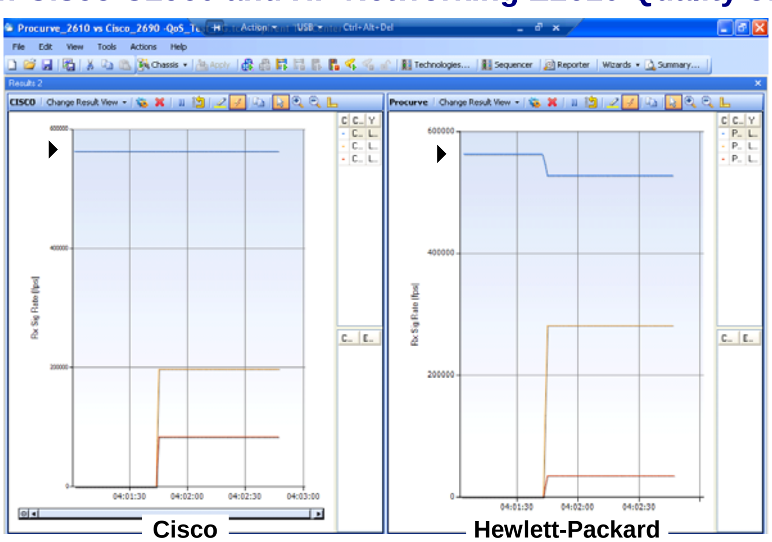
(continued from page 3) Gigabit Ethernet switches were tested next. With the 10GbE egress port oversubscribed at 20G, the Cisco C3750-X protected the high priority voice traffic, with no packet loss. Only the lower priority port 80 and port 20 traffic was dropped.

The HP Networking switch was set up with voice traffic as highest priority, HTTP next, and FTP as lowest priority. With all streams enabled, we saw the HP Networking switch drop packets on all the voice streams at varying rates of 1% to 40%. It was unable to protect the high priority traffic during periods of oversubscription. See *Figure 3.*

Bottom Line

Some switches use off-the-shelf silicon in the design of their products. There may be manufacturing cost advantages to this approach, but as we have seen in these tests, there are also performance limitations when compared to the Cisco Catalyst line of switches with custom ASIC. These performance issues and their effect on overall network performance could negate any initial cost savings. Retransmissions of data due to buffer flushing and reduced network efficiency can result in data loss. The inability to protect QoS leads to degradation of services and frustrated end-users in the enterprise. Cisco Catalyst switches provide IT managers the ability to design and operate their networks efficiently, even during periods of normal oversubscription. They also provide strict high priority queuing, protecting the QoS of high-priority services, such as VoIP. We were pleased with the performance of the Cisco Catalyst switches evaluated in this testing.

Figure 4: Cisco C2960 and HP Networking E2610 Quality of Service



Source: Miercom, September 2010

In this side-by-side comparison chart, the top line represents high priority voice traffic while the middle and bottom lines represent lower priority Web and FTP data traffic. Cisco protected the bandwidth reserved for the voice traffic when low priority traffic was introduced. However, the HP switch surrendered some bandwidth to the Web traffic that resulted in dropped voice calls.

Miercom Performance Verified

Based on the results observed during testing of the Catalyst switches with custom ASICs, we hereby award the Performance Verified certification.

Cisco has engineered the Catalyst switches with custom designed ASICs that allow optimal use of buffering capacity.

The switches provide strict high priority queuing, protecting priority voice traffic during periods of oversubscription. They also successfully managed traffic bursts that exceeded the buffer capacity and did not indiscriminately flush the buffer. We found the Cisco Catalyst switches to show impressive performance in handling oversubscription and protecting high priority traffic.

Catalyst 2960

Catalyst 2960-S

Catalyst 3750-X

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