TEST REPORT

Tolly.

#217112

March 2017

Commissioned by
D-Link Systems, Inc.

D-Link DGS-3630-28TC Layer 3 Stackable Managed Gigabit Switch

Performance Comparison Versus Cisco Systems Catalyst 3650-24TD-E

EXECUTIVE SUMMARY

Stackable L2/L3 managed switches provide scalability and flexibility in a compact form factor. 10GbE uplink ports provide high-bandwidth connections for server or stacking connections. While high-performance is mandatory for such devices, acquisition cost is an important consideration as well.

D-Link Systems commissioned Tolly to evaluate its DGS-3630-28TC switch (24GbE and four 10GbE ports) running the Enhanced Image and compare that to a Cisco Systems Catalyst 3650-24TD-E switch (26 GbE and two 10GbE ports). Tests were conducted using all ports at both layer 2 and layer 3 and included ATIS power consumption measurements.

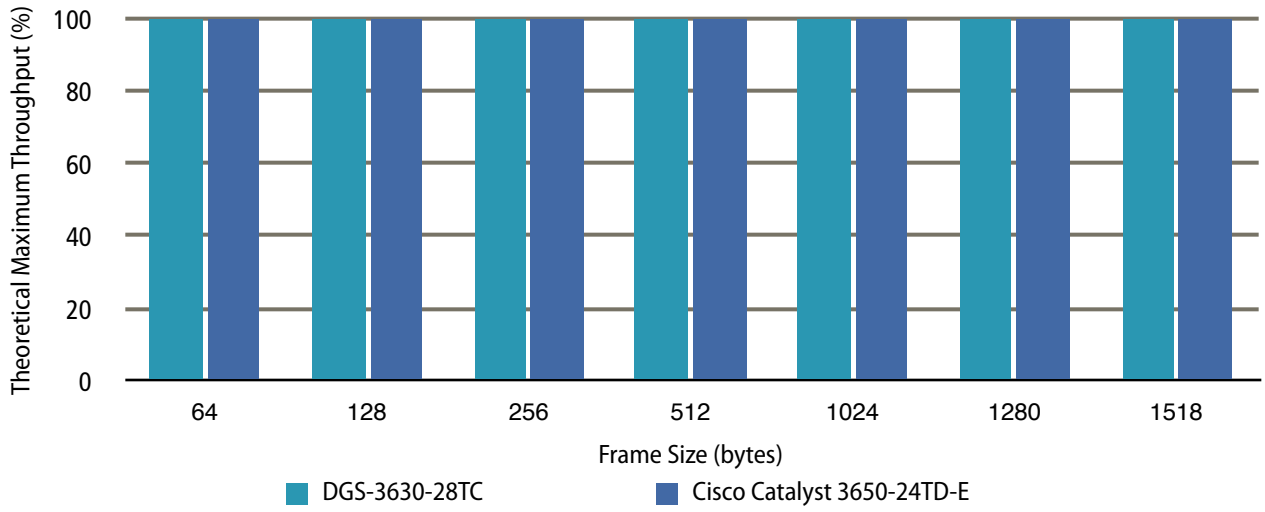
The D-Link Systems switch matched or exceeded the performance of the Cisco Systems Catalyst across all the performance tests. In addition, the D-Link DGS-3630 has a significantly lower purchase price and consumes much less power than the Cisco Systems Catalyst 3650-24TD-E. ...<continued on next page>

THE BOTTOM LINE

The D-Link DGS-3630-28TC delivers:

1. Line-rate throughput across all GbE and 10GbE ports – equivalent to the Cisco Systems Catalyst 3650-24TD-E
2. L2 and L3 latency that is better (lower) than the Cisco Systems switch across all packet sizes tested
3. Cost-per-Gigabit that is 56% lower than the Cisco Systems switch
4. Power consumption that is 38% lower than the Cisco Systems switch using the ATIS model
5. Four 10GbE ports compared to two for the Cisco Systems switch

Layer 2 Gigabit Ethernet Switch Throughput
Across All GbE & 10GbE Ports in a Dual-Mesh Configuration
(as reported by Xena Networks Xena2544)



Note: The D-Link switch was tested with 24xGbE and 4x10GbE ports. The Cisco switch was tested with 26xGbE and 2x10GbE ports.

Source: Tolly, March 2017

Figure 1

Both switches under test provide fixed configurations of at least 24 Gigabit Ethernet (GbE) ports. The D-Link also offers support for four Gigabit SFP or 10GbE SFP+ ports. The Cisco Catalyst switch offers support for two 10GbE ports. Throughput tests were run with all available GbE and 10GbE ports. While switches were tested with a single power supply, both supported a second power supply. See the Test Methodology section for additional details about the systems under test and the specifics of the tests.

L2 Throughput and Latency

Industry-standard RFC 2544 Throughput tests of multiple frame sizes, from 64-bytes to 1518-bytes, proved that the D-Link DGS-3630 switch delivers the same line-rate L2 throughput for each port as the competing switch. See Figure 1.

Because the D-Link switch provides twice as many 10GbE ports as the Cisco switch tested, the D-Link switch provides significantly greater overall switch throughput than the Cisco switch.

The D-Link configuration (24xGbE and 4x10GbE) results in 64Gbps of system throughput. The Cisco configuration (26xGbE and 2x10GbE) results in 46Gbps of system throughput.

Similarly, latency tests showed that the D-Link switch delivered better or equivalent latency when compared with the Cisco Systems switch. See Figure 2.

L3 Throughput and Latency

Industry-standard RFC 2544 Throughput tests of multiple frame sizes, from 64-bytes to 1518-bytes, proved that the D-Link switch delivers the same line-rate L3 throughput as the competing switch. See Figure 3.

Similarly, latency tests showed that the D-Link switch delivered better or equivalent latency when compared with the Cisco Systems switch. See Figure 4.

D-Link Systems, Inc.

DGS-3630-28TC

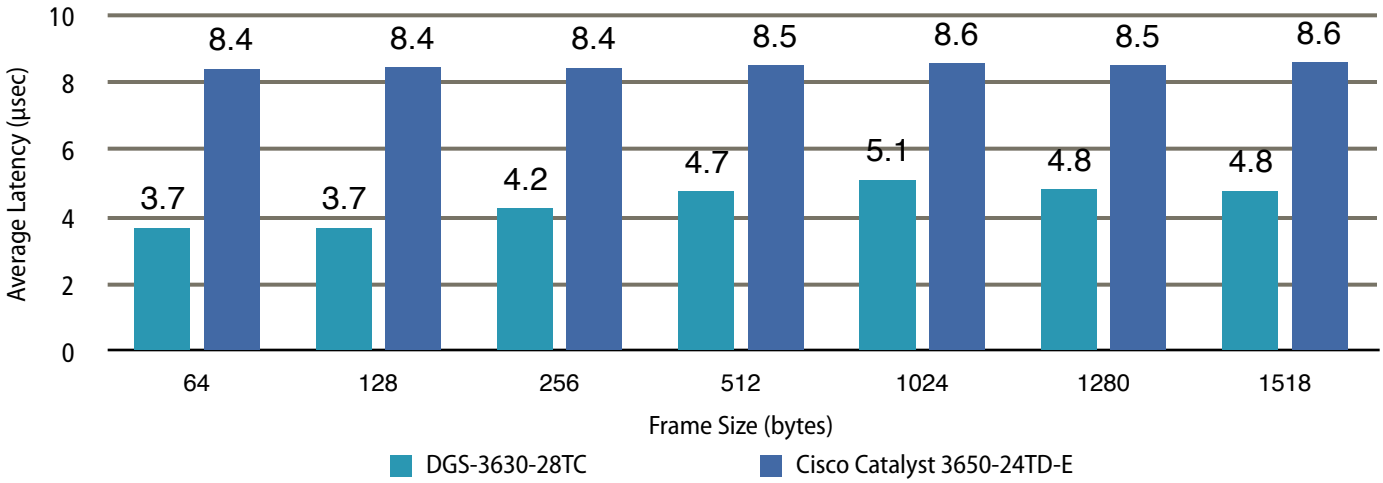
L2/L3 Performance & Power Consumption

Tested March 2017

MAC Address Collision

In order to function properly, switches need to learn the stations addresses, known as MAC addresses, of all the devices communicating across the switch. It is important that switches do not overwrite

Layer 2 Gigabit Ethernet Switch LIFO Latency (µsec)
GbE Port-to-Port Configuration
(Lower numbers are better)
(as reported by Xena Networks Xena2544)

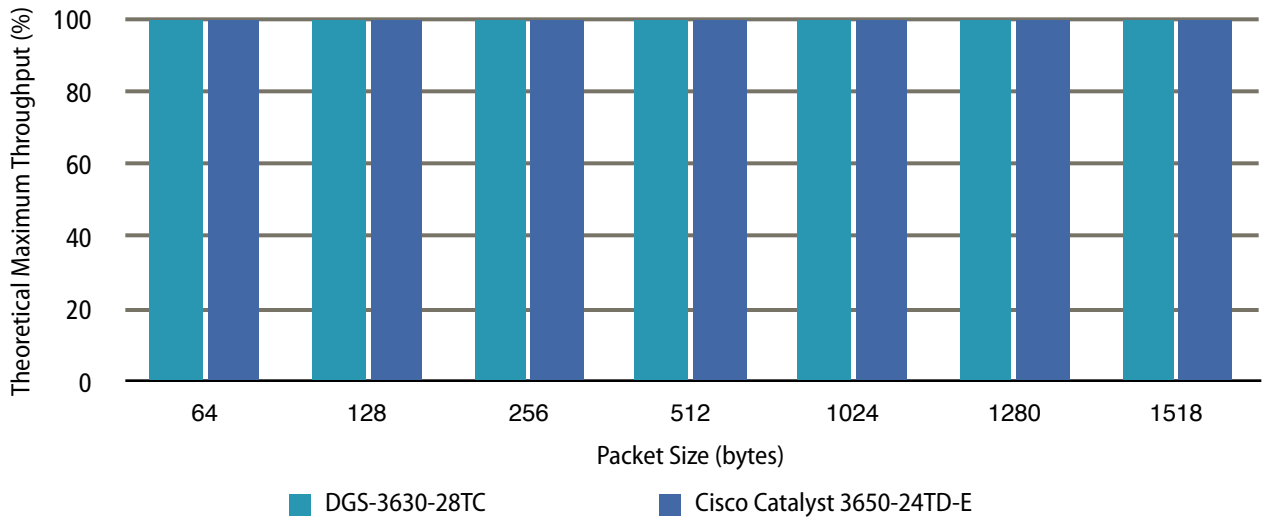


Note: Result is average of port 1 to port 2 and port 2 to port 1. Results do not include time required to store frame/packet.

Source: Tolly, March 2017

Figure 2

Layer 3 IPv4 Gigabit Ethernet Switch Throughput
Across All GbE & 10GbE Ports in a Dual-Mesh Configuration
(as reported by Xena Networks Xena2544)

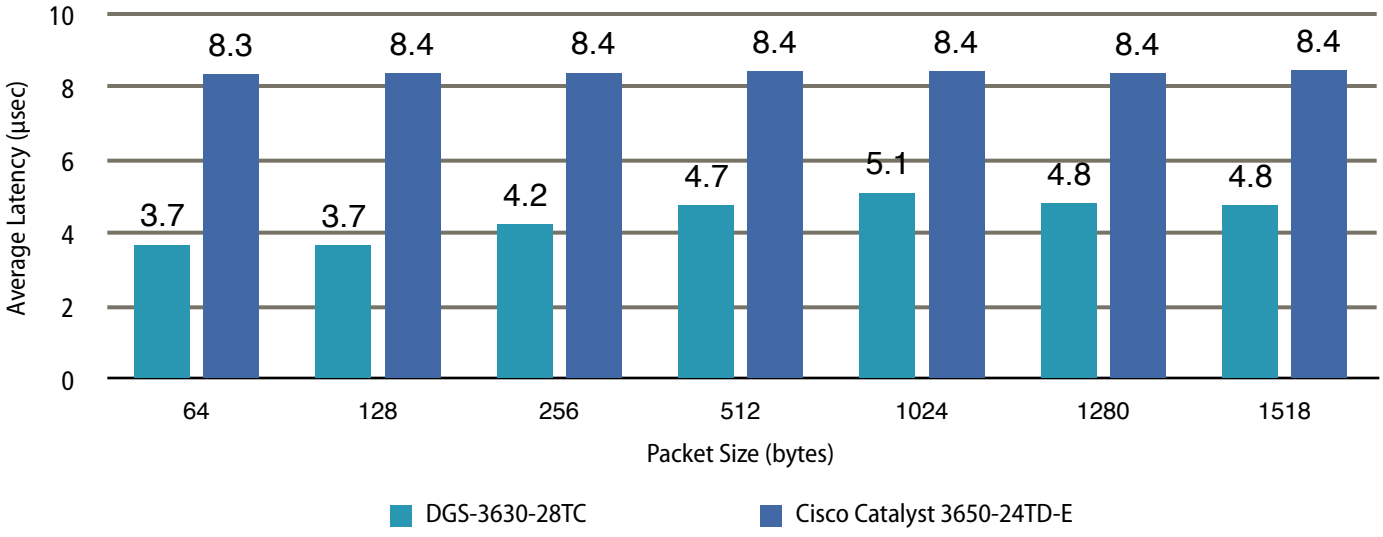


Note: The D-Link switch was tested with 24xGbE and 4x10GbE ports. The Cisco switch was tested with 26xGbE and 2x10GbE ports.

Source: Tolly, March 2017

Figure 3

Layer 3 IPv4 Gigabit Ethernet Switch LIFO Latency (µsec)
GbE Port-to-Port Configuration
(Lower numbers are better)
(as reported by Xena Networks Xena2544)



Note: Result is average of port 1 to port 2 and port 2 to port 1. Results do not include time required to store frame/packet.

Source: Tolly, March 2017

Figure 4

Gigabit Ethernet Switch Power Consumption and Cost Per Gigabit of Throughput

Solution	Power Consumption (W) at ATIS Traffic Loads (lower is better)			ATIS Weighted Average Power (W_{ATIS}) (lower is better)		Cost per Gigabit Per Second of Throughput (user ports only)	
	Idle	10%	100%		% Improvement: D-Link vs. Cisco		% Improvement: D-Link vs. Cisco
D-Link DGS-3630-28TC	33.1	32.9	34.4	33.07	38	$97.62	56
Cisco Catalyst 3650-24TD-E	53.1	53.2	55.3	53.4	N/A	$220.54	N/A

Note: See pricing information elsewhere in this document for details of system prices. Systems tested with single power supply. ATIS value is calculated by as 80% of the 10% load value plus 10% each of the idle and 100% load values. For idle, ports are active (green LED) but no traffic is running.

Source: Tolly, March 2017

Table 1

active addresses and "lose" the address. This could occur if the MAC address storage is not large enough or possibly if the hashing algorithm used for storing addresses causes a new address to overwrite an old one.

Switches were tested up to their advertised MAC address table sizes of 32,768 entries. They were tested first using MAC addresses that were incremented and then tested again with randomly generated MAC addresses.

Both switches were able to store all of the MAC addresses in the incremental test.

With the random test, the Cisco Systems switch missed 91 addresses. The D-Link switch showed better results missing only 37 addresses.

Cost Per Gigabit

Tolly engineers also evaluated the relative cost of the switches by calculating the cost-per-gigabit-per-second of throughput.

As tested, the D-Link switch had a cost of $2,342.99 while the Cisco Systems switch had a cost of $5,733.99. This cost did not include any additional features or maintenance.

For the moment excluding the 10GbE uplink ports and dividing the cost by the number of GbE user ports gave a cost per Gigabit per second of throughput value of $220.54 for Cisco Systems and $97.62 for D-Link. The D-Link cost per user port is 55% lower than the Cisco Systems Catalyst switch. See Table 1.

Taking the total throughput of each switch, user ports and uplink ports, the D-Link cost per Gigabit is $36.61 compared to $124.65 for the Cisco Systems Catalyst switch.

Managed, L2/L3 Gigabit Ethernet Switches Under Test

Vendor	Product	Description	Vendor SKU	GbE Ports	10GbE Ports	CDW Part #	CDW Price	Firmware	Notes
D-Link Systems	DGS-3630-28TC	Gigabit Ethernet L2/L3 Managed Switch	DGS-3630-28TC with Enhanced Image(EI) upgrade	24 (4 are SFP combo ports)	4 (SFP+)	Switch: 4421139, EI upgrade: 4454284	$2,106.00 (switch) $236.99 (EI upgrade) $2,342.99 (total)	1.0.0.032	One power supply. Tested with 24xGbE and 4x10GbE ports.
Cisco Systems	Catalyst 3650-24TD-E	Gigabit Ethernet L2/L3 Managed Switch	WS-C3650-24TD-E	26 (2 are SFP combo ports)	2 (SFP+)	3297088	$5,733.99	03.06.06.E (Hardware V01)	One power supply. Tested 26xGbE and 2x10GbE ports.

Note: CDW (cdw.com) price as of 2017-03-13. Pricing for unit as listed only, no additional maintenance. For the price above, D-Link provides a lifetime/ next-business-day replacement warranty. Both switches support an additional power supply (not tested).

Source: Tolly, March 2017 Table 2

ATIS Power Consumption

Finally, Tolly engineers evaluated the power consumption of the two switches. The ATIS approach dictates that the power consumption of the switch be measured at different levels of activity. A lower ATIS value is a better result indicating lower power consumption.

The ATIS value for the Cisco Systems Catalyst switch was 53.4 compared to only 33.07 for the D-Link DGS-3630. (The ATIS value can be thought of as watts.) This represents 38% lower power consumption for the D-Link switch. The lower power consumption of the D-Link switch provides long-term benefits to the total cost of ownership for the system.

Test Equipment Summary

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

Vendor	Product	Web
Xena Networks	**XenaBay C4-12 Chassis, M6SFP & M2SFP+ Test Modules Xena2544 v2.44**	http://www.xenanetworks.com
Siemon	**Cable Infrastructure**	http://www.siemon.com

Test Setup & Methodology

Switches under test were managed L2/L3 switches and provided at least 24 ports of Gigabit Ethernet (1000Base-T) connectivity and up to four ports of 10GbE connectivity. See Table 2.

All performance testing used all available GbE and 10GbE ports. Default device configurations were used as the basis for all tests. L3 test required basic IPv4 routing configurations for each device.

Performance

Tests were run using Xena Networks test suites in version 72 of the Xena System. A Xena Networks XenaBay C4-12 chassis housed the physical interfaces used in the test. Xena M6SFP and M2SFP+ test modules were used.

L2/L3 Throughput & Latency Tests

The Xena RFC 2544 templates were used for all throughput and latency tests. All tests were run using the following frame sizes: 64-, 256-, 512-, 1024-, 1280-, and 1518-bytes of full-mesh layer 2 or layer 3 traffic as appropriate. All tests were run three times for a duration of one minute each. The average of the three runs was reported.

For the throughput test, the constant loading traffic profile was used with a loss tolerance of zero percent. For all throughput tests, dual-mesh configurations were used. Dual-mesh means that all GbE ports were communicating with all other GbE ports.

For the latency test, the constant loading traffic profile was used and the rate was set to 100%. LIFO (last-in, first-out) latency was measured using two GbE ports. The LIFO measurements do not include the time required to store the frame.

MAC Collision Tests

These tests were designed to illustrate whether the device could accommodate large numbers of MAC (station) addresses in its internal tables. The test had two parts. Incremental: 32K MAC addresses with incremental values were transmitted into the switch; Random: 32K randomly-generated MAC addresses were transmitted into the switch. At the end of each test, engineers reviewed the MAC address table to determine how many addresses were stored. Ixia IxNetwork was used to generate random MAC addresses.

Cost Per Gigabit

Cost per gigabit per second of throughput was calculated by taking price of the system and dividing it by the system throughput. Since the devices provide different numbers of GbE and 10GbE ports, the total system throughput differed. Calculations done both including and excluding the 10GbE ports.

No maintenance, power, taxes or other costs were included in the calculation. For the cost listed, D-Link includes a lifetime, next-business-day warranty. Prices as listed at CDW website. See Table 2.

Power Consumption

ATIS

Tolly engineers benchmarked the power consumption of each solution using all available ports and one power supply.

Testing was conducted in accordance with ATIS document ATIS-0600015.03.2009 - *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products.* In the ATIS calculation, a lower value is better.

The iMIX profile in Xena: (framesize:weight) as 64:58, 576:33, 1518:9

Power was measured using a WattsUp Pro power meter.

Relative Performance Calculation

To calculate how much better one solution is than another, the formula used is 1- (N1/N2) where N1 is the better result and N2 is the worse result. This is multiplied by 100 to give the percentage benefit.

About Tolly

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Interaction with Competitors

In accordance with Tolly's Fair Testing Charter, Tolly personnel invited representatives from Cisco Systems to participate in the testing. Cisco Systems did respond to the invitation.

For more information on the Tolly Fair Testing Charter, visit:

http://www.tolly.com/FTC.aspx

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