Dell™, Inc.
PowerConnect 6224/6248
Throughput Evaluation and “Tolly Verified” Verification of Enterprise-class Features and Functions

Premise: Wire-speed Layer 2/Layer 3 throughput is a given in today’s enterprise networks. What sets apart switch offerings is the expance of advanced feature/functions offered standard on models. The inclusion of security, protocol support, resiliency characteristics, support for Power over Ethernet and for Voice over IP, Quality of Service, standards-based link aggregation and more sets enterprise-ready switches apart from less costly devices that deliver the throughput but lack the automation to simplify operation.

Dell commissioned The Tolly Group to evaluate its PowerConnect 6224/6248, two of Dell’s most advanced stackable switch offerings with advanced core switching capabilities and optional 10 Gigabit Ethernet uplinks for the small to medium enterprise and large enterprise edge.

The Tolly Group audited a barrage of tests focusing on security, routing, stacking performance, Power over Ethernet (PoE) and Voice over IP (VoIP), Quality of Service (QoS), 802.3ad Link Aggregation and, finally, Layer 2/3 throughput.

Features and functions were validated under the auspices of The Tolly Group’s Tolly Verified (TV) program. In all, the Dell products received more than 20 TV certifications.

Tests were conducted in January 2008.

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Test Highlights

- Achieves Layer 2/Layer 3 wire-speed throughput when handling frame sizes from 64 bytes to 1,518 bytes over four 10 GbE links
- Provides 15.4W Power over Ethernet (PoE) to power wireless access points, IP telephones, etc.
- Supports advanced authentication methods such as RADIUS, TACACS+ and 802.1X
- Supports IEEE 802.3ad standard for forwarding traffic across multiple aggregated links
- Automates rapid net recovery with support for MSTP and RSTP
- Offers flexible Quality of Service (QoS) options to prioritize traffic

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Dell PowerConnect 6248/6224 Key Functional Areas Certified by The Tolly Group

<table>
<thead>
<tr>
<th>Certified function</th>
<th>Passed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power over Ethernet</td>
<td>✔</td>
</tr>
<tr>
<td>Voice VLAN support</td>
<td>✔</td>
</tr>
<tr>
<td>Resilient stacking</td>
<td>✔</td>
</tr>
<tr>
<td>Security (802.1X, RADIUS, TACACS+)</td>
<td>✔</td>
</tr>
<tr>
<td>Routing (RIP, OSPF)</td>
<td>✔</td>
</tr>
<tr>
<td>QoS (802.1p/Q, flow-based QoS)</td>
<td>✔</td>
</tr>
<tr>
<td>Network resiliency — MSTP and RSTP</td>
<td>✔</td>
</tr>
<tr>
<td>Link aggregation — LACP support (IEEE 802.3ad)</td>
<td>✔</td>
</tr>
<tr>
<td>Layer 2/3 10 GbE zero-loss throughput</td>
<td>✔</td>
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</tbody>
</table>

Source: The Tolly Group, January 2008
Executive Summary

Tests show that Dell’s PowerConnect 6224 and 6248 not only deliver wire-speed, zero-loss throughput, but also provide a wide variety of functions/features to automate security, QoS, VLAN management, network resiliency, protocol support and more to ease the burden on enterprise network managers.

The Tolly Group verified more than 20 major features/functions on Dell’s PowerConnect 6248 and PowerConnect 6224 that enable the switches to automate key security, resiliency, VLAN, QoS, PoE and other services.

Features and functions were validated under the auspices of The Tolly Group’s Tolly Verified certification program that ensure users that features/functions are tested uniformly according to an independent test methodology.

Additionally, The Tolly Group validated that the PowerConnect 6248 delivers 100% of the theoretical maximum zero-loss throughput when handling line-rate traffic across four 10 GbE links. Moreover, tests show the switch introduces very low latencies, which means the PowerConnect 6248 is positioned ideally to support VoIP, video and other latency-sensitive applications central in today’s enterprise networks.

### Functionality

**Power over Ethernet (TV 10639)**

This certification verifies that the PowerConnect 6248P/6224P switches deliver electrical power over Ethernet ports to connected devices.

Tests show that the PowerConnect 6224P tested electrically detects a PoE test interface to an Ixia test tool. Tolly Group personnel also verified that data received on the PoE port was properly forwarded out to a designated destination MAC address as recorded in the forwarding database table. Data was forwarded over the PoE link as long as electrical current was supplied across it.

Tolly Group personnel also verified the “Class” type and validated that it does not change on the PowerConnect. The Tolly Group validated the PowerConnect 6248 delivers 100% of the theoretical maximum zero-loss throughput when handling line-rate traffic across four 10 GbE links. Moreover, tests show the switch introduces very low latencies, which means the PowerConnect 6248 is positioned ideally to support VoIP, video and other latency-sensitive applications central in today’s enterprise networks.

<table>
<thead>
<tr>
<th>TV Number</th>
<th>Test Case Name</th>
<th>Tolly Verified Certification Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>10914</td>
<td>Voice VLAN</td>
<td>Dynamic Voice VLAN</td>
</tr>
<tr>
<td>10513</td>
<td>10/100/1000 auto negotiation</td>
<td>10/100/1000 Auto-Negotiation</td>
</tr>
<tr>
<td>10532</td>
<td>802.1P/Q</td>
<td>VLAN Support (IEEE 802.1Q)</td>
</tr>
<tr>
<td>10533</td>
<td></td>
<td>QoS Recognition (IEEE 802.1p)</td>
</tr>
<tr>
<td>10503</td>
<td>Jumbo Frame Support</td>
<td>Jumbo Frame Support - 9,000+ Byte Frames</td>
</tr>
<tr>
<td>10835</td>
<td>802.3AD Link Agg</td>
<td>Dynamic Link Aggregation - LACP Support (IEEE 802.3ad)</td>
</tr>
<tr>
<td>10507</td>
<td>RSTP, MSTP</td>
<td>Rapid Reconfiguration Spanning Tree Support (802.1w)</td>
</tr>
<tr>
<td>10834</td>
<td></td>
<td>Multiple Spanning Tree Protocol (MSTP) Support (IEEE 802.1s)</td>
</tr>
<tr>
<td>11112</td>
<td>Stack Resiliency Verification</td>
<td>Resilient Stacking Support</td>
</tr>
<tr>
<td>10821</td>
<td>RIP v1/v2</td>
<td>IPv4 - RIP v1 - Routing Protocol Support</td>
</tr>
<tr>
<td>10822</td>
<td></td>
<td>IPv4 - RIP v2 - Routing Protocol Support</td>
</tr>
<tr>
<td>10823</td>
<td>OSPF v1/v2/v3</td>
<td>IPv4 - OSPF - Routing Protocol Support</td>
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<tr>
<td>11110</td>
<td>LLDP-MED</td>
<td>Link Layer Discovery Protocol - Media Endpoint Discovery (LLDP-MED) Support</td>
</tr>
<tr>
<td>10639</td>
<td>PoE 802.3af</td>
<td>Power over Ethernet Provider</td>
</tr>
<tr>
<td>CUSTOM</td>
<td>Single IP management of 12 switches</td>
<td>Support for 48 ports of full 15.4 Watts per port</td>
</tr>
<tr>
<td>11110</td>
<td></td>
<td>Single IP Management of Multiple Switches</td>
</tr>
<tr>
<td>10559</td>
<td>802.1X Authentication support</td>
<td>User Authentication via IEEE 802.1X</td>
</tr>
<tr>
<td>10571</td>
<td>RADIUS support</td>
<td>User Authentication via RADIUS Server</td>
</tr>
<tr>
<td>11111</td>
<td>TACACS+ support</td>
<td>User Authentication via TACACS+ Server</td>
</tr>
</tbody>
</table>

Source: The Tolly Group, January 2008

Figure 2
Connect 6224P even when the Class type on the PoE interface of the Ixia test tool was altered.

Separately, The Tolly Group awarded the PowerConnect 6248P a custom verification for supporting 15.4 Watts of power per port across 48 Ethernet ports.

**VOICE VLAN (TV 10914)**

This certification verified the PowerConnect 6224/6248’s ability to carry IP voice traffic from an IP phone across VLAN environments.

During the test, the PowerConnect 6224 verified the presence of three VLANs (10, 20) on the device, verified that VLAN tagging was in use on applicable interfaces, and verified that voice packets sent from interface “A” were received by an Ixia test port connected to interface “C”.

The Tolly Group also verified that when interface “A” and “B” both were transmitting to “C” at line rate and “A” was sending VoIP packets tagged for VLAN 10 that the traffic was afforded precedence over other packets destined for interface “C”. When non-VoIP packets from interface “A” were presented to interface “C” they were given relative precedence based upon the non-strict priority queue to which they were mapped.

The Tolly Group also awarded the PowerConnect 6248/6224 TV 11110 for its support of Link Layer Discover Protocol — Media Endpoint Discovery Support.

Tests show that the switch uses LLDP-MED discovery packets to automatically learn info such as LAN policies, device location, PoE characteristics, etc of a local device and the devices attached to it.

**QoS: 802.1Q VLAN Support (TV 10532)**

This certification verifies the PowerConnect 6248/6224’s ability to appropriately tag and distinguish between VLANs.

During the test, The Tolly Group verified that traffic from interface “A” was afforded precedence over traffic from interface “B” as both 1-GbE ports were sending packets to interface “C”.

**QoS: 802.1p Tag Support (TV 10532)**

This certification verifies the PowerConnect 6248/6224’s ability to distinguish and prioritize traffic based on the 802.1p Quality of Service standard.

During the test, traffic sent from interface “A” was configured with different 802.1p values ranging from 0 to 7. In each case, The Tolly Group verified if the interface “A” traffic was afforded priority over traffic from interface “B”.

Tolly Group personnel validated QoS priority queues mappings via a management query.

**QoS: Flow-based (Multiple TVs)**

In this test, The Tolly Group verified that the PowerConnect 6224 has the ability to detect patterns in the traffic flows and apply bandwidth and policy restrictions applicable to bandwidth consumption.

The PowerConnect 6224 earned TV 10837 for Layer 3 QoS Trusted Mode (DSCP) Support. That means the switch can distinguish traffic with different priorities based on the DSCP info in the Layer 3 IP header and process traffic according to the DSCP bit settings or ignore it.

The PowerConnect 6224 also earned TV 10893 for DSCP and 802.1p Value Replacement. That means the switch can interchange preference values of frames supporting either 802.1p tags or DSCP bits.
Lastly, the PowerConnect 6224’s flow-based QoS was awarded TV 11114 for Policy-based QoS Enforcement: Traffic Policing. The switch can control outbound traffic flows on a particular interface to avoid congestion by constraining specific traffic to a particular bit rate.

### 802.1X Authentication (TV 10559)

This certification verifies that the Dell switches tested support the 802.1X protocol to authenticate client devices.

In this test, The Tolly Group verified the creation of multiple authentication lists, verified that the Class type of the switch tested did not change when the Class type was changed on an Ixia PoE interface, and verified that the power supplied on each switch interface was accurately recorded and data passed across the interface as long as power was supplied.

Additionally, Tolly Group personnel validated that the current supplied across each interface was accurately recorded and data passed across the interface while current was supplied.

The Tolly Group also validated that each switch interface was in a power overload state, the switch detected the reconnection of each interface and power was supplied to the interface.

### RADIUS Support (TV 10571)

This certification verifies that the PowerConnect 6224 tested can authorize clients via a remote RADIUS server.

During the test, The Tolly Group verified that both Windows and IntermeC, Inc. Odyssey RADIUS clients were able to successfully authenticate against a credential repository on the PowerConnect 6224 when using valid credentials. Once the client was authenticated, traffic flowed between the server and the client.

The Tolly Group also validated that users could login via any of methods: Telnet, HTTP, SSH and SSL.

### TACACS+ Support (TV 11111)

This certification verifies that the Dell switch can provide access control for routers, network access servers and other network devices via one or more centralized authentication servers supporting the TACACS+ protocol.

During the test Tolly Group personnel verified via a protocol analyzer that the TACACS+ packet exchange conforms to the TACACS standard as defined in RFC 1492.

Moreover, The Tolly Group verified that when the proper credentials were submitted to the TACACS+ Server that an authentication success notification was sent to the switch.

### Link Aggregation (TV 10835)

This certification verifies that the PowerConnect 6248/6224 implements standards-based link aggregation, thus providing the ability to increase the switch-to-switch throughput by aggregating multiple links into one logical interface.

In the test, Tolly Group personnel verified that traffic was distributed evenly over the aggregated links. Intraswitch unicast traffic, as well as inter-switch unicast traffic flowed between a PowerConnect 6248 and a Cisco 3750 supporting a Layer 2 link aggregation between four ports. When the cable connected to one of the ports was pulled, traffic was distributed evenly among the remaining three ports.

### RIP V2 (TV 10822)

This certification verifies that the PowerConnect 6248 and PowerConnect 6224 exchange IPv4 routing table information via RIP version 2. All RIP routes from neighboring switches were distributed throughout the network and updated on the PowerConnect’s routing table. In both RIP tests, engineers also sent traffic over learned routes.

### OSPF V2/V3 (TV 10823)

This certification verifies that the PowerConnect 6248 and PowerConnect 6224 exchange IPv4 routing table info via OSPF ver. 2 and 3.

All OSPF routes from neighboring switches were distributed throughout the network and updated on the PowerConnect’s routing table. Dell does offer OSPF version 3 support but it was not tested. Testers also sent traffic over learned routes.

### RSTP Support (TV 10507)

This certification verifies that the PowerConnect 6248 and PowerConnect 6224 can detect a failure of the Layer 2 Spanning Tree via the Rapid Spanning Tree Protocol (IEEE 802.1w) and establish a new tree.

A PowerConnect 6248 was linked to a Cisco 3750 via GbE links. During convergence, traffic was forwarded over the port with the lower port number. Priority attributes were then changed so the port with the highest port number then had the lowest priority. After reconvergence, traffic was forwarded over the port with the lower priority. Again, priorities were changed, this time so the port with the higher priority would have the lowest cost. After reconvergence, traffic was forwarded over the port with the lowest cost. The cable attached to the port with the lowest cost.
cost was pulled. Traffic then flowed over the remaining link.

**MSTP Support (TV 10834)**

This certification verifies that the PowerConnect 6248 and PowerConnect 6224 implements IEEE 802.1s to implement multiple Spanning Tree instances on the same switch to eliminate network loops and reconverge the network in the event of link failure.

In the test, VLANs 10, 20 and 10/20 shared three switching links between the PowerConnect 6248 and a neighboring Cisco switch. Bidirectional traffic flowed across all ports using the links between the devices. The “cost” for all three links (S1, S2 and S3) was the same, and the priority for link S1 and S2 were the same but the priority on S3 was lower.

Following convergence, VLAN 10 traffic was forwarded over the port with the lower port number and link S3 handled VLAN 20 traffic.

**Auto Negotiation (TV 10513)**

The PowerConnect 6248/6224 earned a TV for 10.100/1000 autonegotiation. This certifies that the switch responds properly to various speeds and duplex mode settings from a variety of 10/100/1000 network interface cards and/or LAN switches.

**Jumbo Frame Support (TV 10503)**

The PowerConnect 6248 was awarded a TV for its support of Jumbo Frames. This means the switch can transport frames of 9,000 bytes without fragmentation.

**Layer 2/3 Zero-loss Throughput and Latency**

The Tolly Group validated Layer 2/3 zero-loss throughput on the PowerConnect 6248 switch for frame/packet sizes of 64, 512 and 1,518 bytes.

Measurements were taken across four 10 GbE ports on the PowerConnect 6248 configured in a full-mesh scenario with an IXIA 1600T.

In every instance, the PowerConnect 6248 achieved 100% of the theoretical maximum zero-loss throughput. (See Figure 3.)

In terms of latency, the PowerConnect 6248 introduced extremely low levels of latency, ranging from 9.2 microseconds (μsec) to 12.4 μsec.

**Test Setup & Methodology**

Tolly Group engineers tested the dell PowerConnect 6248 and PowerConnect 6224, with both units running software version 2.0.1.2.

For the purposes of testing, the PowerConnect 6248 was connected to an IXIA 1600T traffic generator and was used often for security, voice VLAN, PoE and QoS tests.

The PowerConnect 6248 was also connected to an IXIA 1600T and it was used for performance testing, as well as for validation of routing protocols, stacking resiliency, network resiliency, routing protocols and link aggregation.

For details on the methodology used for any of the TV certifications, visit The Tolly Group’s TV Web page at: http://www.tolly.com/TV_Home.aspx

For the zero-loss throughput testing, engineers sent bidirectional Layer 2 or Layer 3 (depending upon the test) unicast streams at full line rate from the four 10 GbE test ports using 64, 512 and 1,518 byte frames/packets.

Engineers measured the throughput and latency of the switch using IXIA’s IxAutomate 6.30EA.

Both the throughput and latency tests were run three times each, and the results averaged to obtain the final result.
The Tolly Group is a leading global provider of third-party validation services for vendors of IT products, components and services.

The company is based in Boca Raton, FL and can be reached by phone at (561) 391-5610, or via the Internet at:

Web: [http://www.tolly.com](http://www.tolly.com),
E-mail: [sales@tolly.com](mailto:sales@tolly.com)

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**Test Equipment Summary**

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<thead>
<tr>
<th>Vendor</th>
<th>Product</th>
<th>Web URL</th>
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<tr>
<td>Ixia Communications</td>
<td>IXIA 1600T</td>
<td><a href="http://www.ixiacom.com">http://www.ixiacom.com</a></td>
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<td>Ixia Communications</td>
<td>IxExplorer 5.0.300.55</td>
<td><a href="http://www.ixiacom.com">http://www.ixiacom.com</a></td>
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