

Ubiquiti Networks EdgeRouter Lite

Gigabit Ethernet Routing Performance Evaluation Versus

Cisco Systems 3925 Integrated Services Router and Juniper Networks J6350

EXECUTIVE SUMMARY

Ubiquiti Networks' EdgeRouter Lite offers unprecedented price/performance value, providing more than 100X higher performance per dollar than the Cisco and Juniper products compared in this report. With the combination of its broad feature set, advanced hardware platform, and disruptive price the EdgeRouter Lite is positioned to bring enterprise-class performance to a much wider audience.

Ubiquiti Networks commissioned Tolly to evaluate the packet forwarding performance of its new EdgeRouter Lite product and compare that to enterprise-edge products from Cisco Systems and Juniper Networks. Tests showed that the EdgeRouter Lite, priced at \$99 exceeded the performance of the competing devices that, for a basic configuration, cost in the range of \$6,500 to \$7,500. See Figure 1. ...<continued on next page>

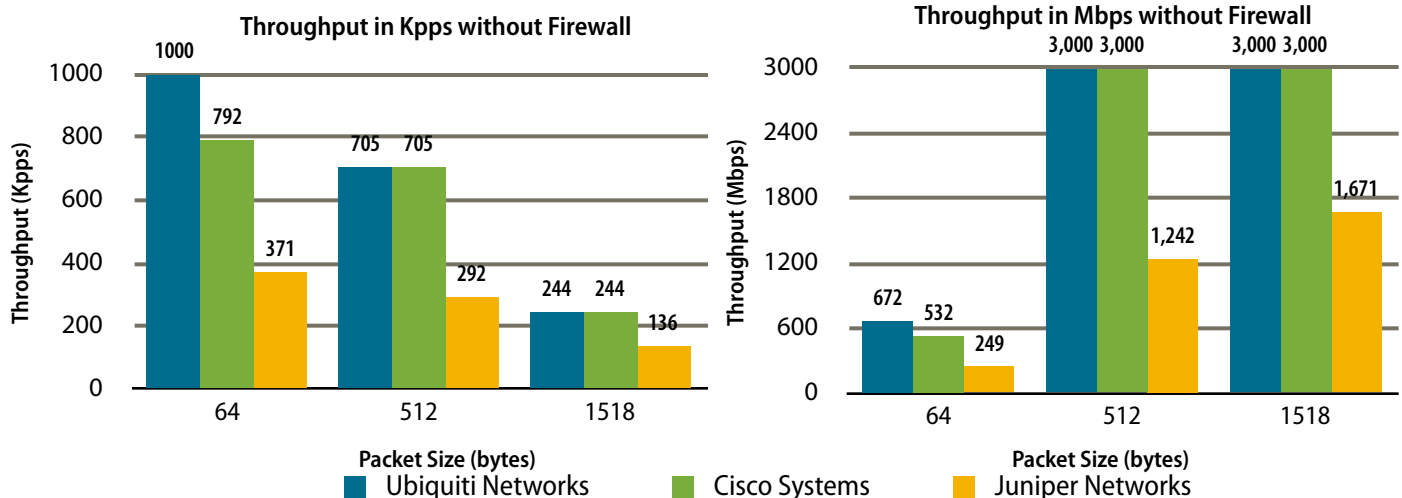
THE BOTTOM LINE

The Ubiquiti EdgeRouter Lite:

- 1 Forwards 1 million packets per second of 64-byte packets
- 2 Forwards at line rate (3Gbps) across three ports with 512-byte packets or higher
- 3 Maintains consistent, high performance even with firewall functionality
- 4 Provides 145X more Kpps per USD than Cisco and 205X more than Juniper

Layer 3 Bidirectional Gigabit Throughput Without Firewall in Mbps and Kpps

As reported by Spirent TestCenter
(Higher values are better)



Note: All products tested using three GbE ports on each DUT. Spirent throughput metrics include 12-byte Ethernet inter-frame gap (IFG). Juniper has a fourth GbE port that was not used in this test.

Source: Tolly, June 2012

Figure 1



Though not part of this evaluation, the EdgeRouter Lite supports many important features such as VLANs, firewall, NAT, OSPF, RIP, BGP, IPv4/v6 static/DHCP addressing, IPsec, L2TP, PPPoE, VRRP, and more. While the Cisco 3925 and the Juniper J6350 also provide expansion slots for legacy WAN interfaces such as T1/E1 and HDLC and support additional routing functions such as IS-IS and PIM-SIM, for customers not requiring such less commonly used features, the Ubiquiti Networks EdgeRouter Lite provides high-performance, low-latency IP routing at an extremely low price.

When results are analyzed in terms of how many thousand packets per second (Kpps) of throughput are delivered per dollar of cost, Ubiquiti Networks delivers 10.10 Kpps/USD compared to between 0.12 and 0.02 for the Cisco 3925 and 0.05 for the

Juniper J6350. The EdgeRouter Lite results are 145X more than Cisco and 205X more than Juniper.

Test Results Performance

Tolly engineers tested the performance of each solution under test with and without a firewall functionality at three packet sizes, 64-byte, 512-byte and 1518-bytes. Throughput was measured in Mbps and Kpps.

Throughput Without Firewall in Kpps

Tolly engineers tested the performance of each solution with three packet sizes. Engineers found the Ubiquiti EdgeRouter

Ubiquiti Networks, Inc.

EdgeRouter Lite

GbE Routing Performance

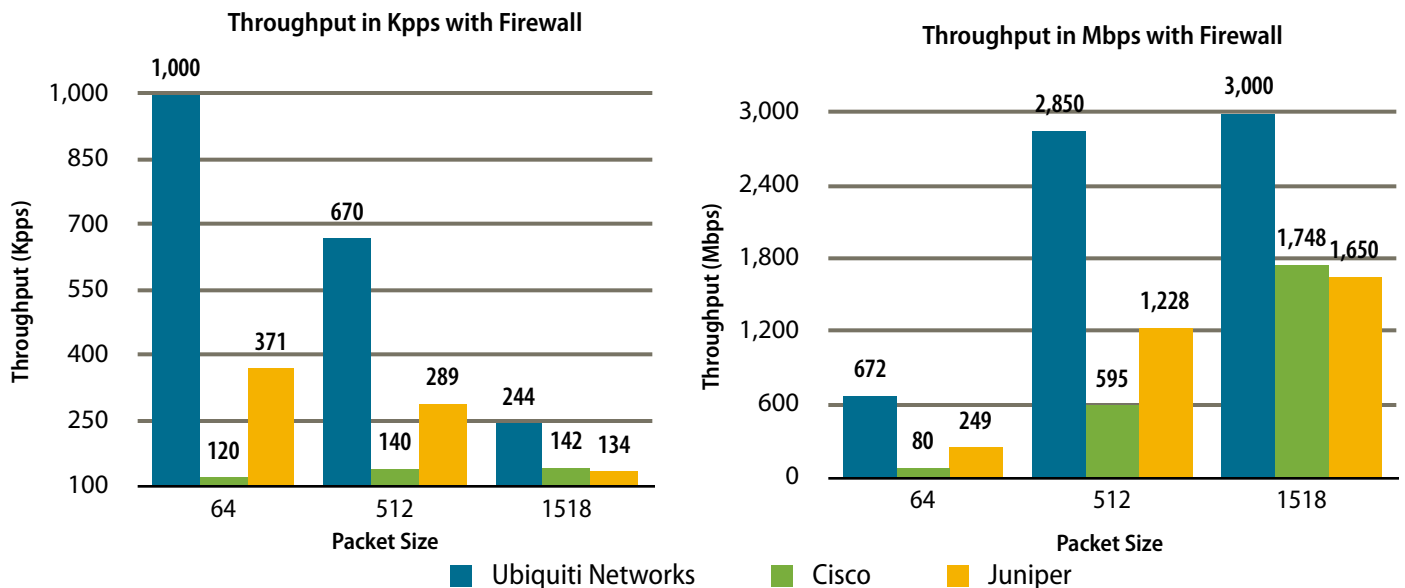


Tested June 2012

Lite delivers consistently higher throughput in both Mbps and Kpps than the Cisco 3925 or Juniper J6350. See Figure 1.

The EdgeRouter Lite performed the best across all packet sizes, forwarding over 1 million packets per second (1000.4 Kpps) of 64-byte packets, 704.9 Kpps of 512-byte

Layer 3 Bidirectional Gigabit Throughput With Firewall in Mbps and Kpps
As reported by Spirent TestCenter
(Higher values are better)



Note: All products tested using three GbE ports. Spirent throughput metrics include 12-byte Ethernet IFG. Juniper has a fourth GbE port that was not used in this test.
Source: Tolly, June 2012

Figure 2



packets and 243.8 Kpps of 1518-byte packets.

For the 512-byte and 1518-byte packet sizes, the Cisco 3925 provided the same performance as EdgeRouter Lite, forwarding 704.9 and 243.8 Kpps, respectively. The Cisco, however, fell short forwarding 64-byte packets with 791.7 Kpps. See Figure 1.

The Juniper J6350 provided the lowest performance across all three packet sizes. Forwarding 371.1 Kpps of 64-byte packets, 291.9 Kpps of 512-byte packets and 135.8 Kpps of 1518-byte packets.

Throughput Without Firewall in Mbps

The EdgeRouter Lite forwarded 672.3 Mbps for the 64-byte packet size, while Cisco and

Juniper forwarded 532 Mbps and 249 Mbps, respectively. See Figure 1.

For the 512-byte and 1518-byte packet size, both Ubiquiti and Cisco demonstrated 100% line rate forwarding at 3000 Mbps.

Juniper demonstrated significantly lower throughput for the 512-byte and 1518-byte packet sizes, at 1,242.2 Mbps and 1,641.1 Mbps, respectively.

Firewall Throughput in Kpps

To assess performance in a real-world scenario, Tolly engineers evaluated each solutions' throughput in Kpps and Mbps with a firewall enabled.

Ubiquiti's performance was unaffected by the addition of a firewall, still delivering the highest throughput across all packet sizes tested. On average, Ubiquiti delivered 3.7X

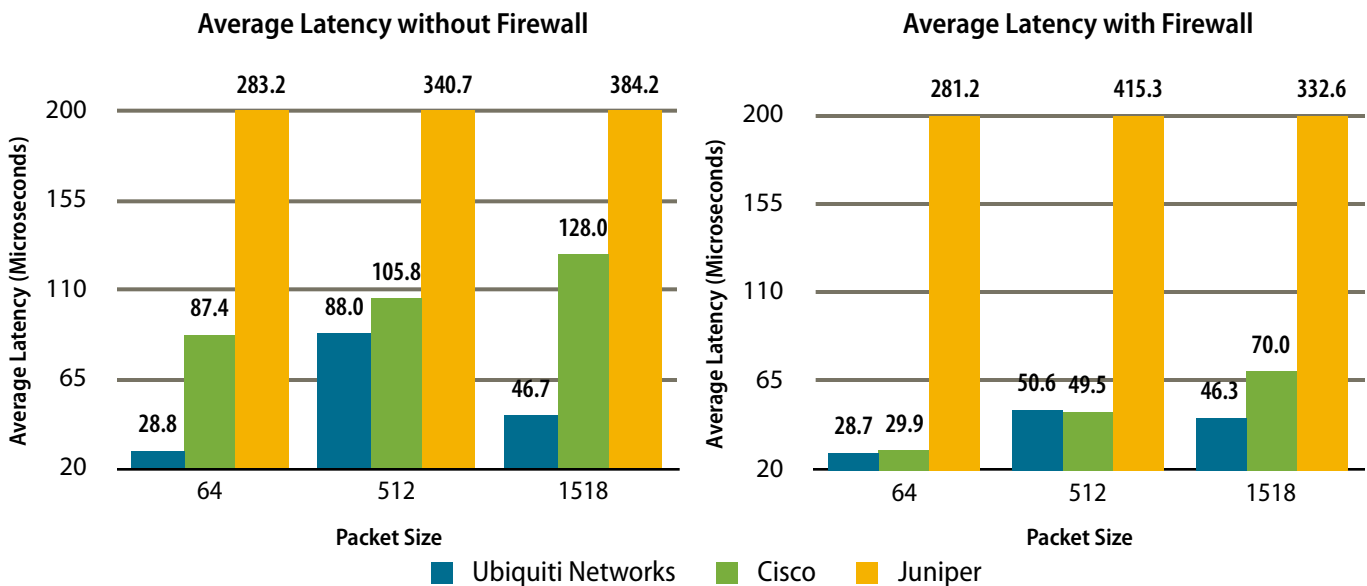
more throughput in Kpps with a firewall than Cisco, and 1.4X more Kpps than Juniper. See Figure 2.

The EdgeRouter Lite forwarded over 1 million packets per second (1,000.4 Kpps) for 64-byte packets, while Cisco and Juniper's performance suffered with the addition of a firewall, each delivering significantly less throughput at 120 Kpps and 371.1 Kpps, respectively for 64-byte packets. See Figure 2.

For the 512-byte packet size, Ubiquiti was able to forward 669.6 Kpps, over 4.5X more than Cisco at 139.9 Kpps and over 2X more than Juniper at 288.6 Kpps.

For the 1518-byte packet size, the EdgeRouter Lite again delivered higher throughput than Cisco and Juniper. Ubiquiti delivered 243.8 Kpps while Cisco and Juniper forwarded 142.1 Kpps and

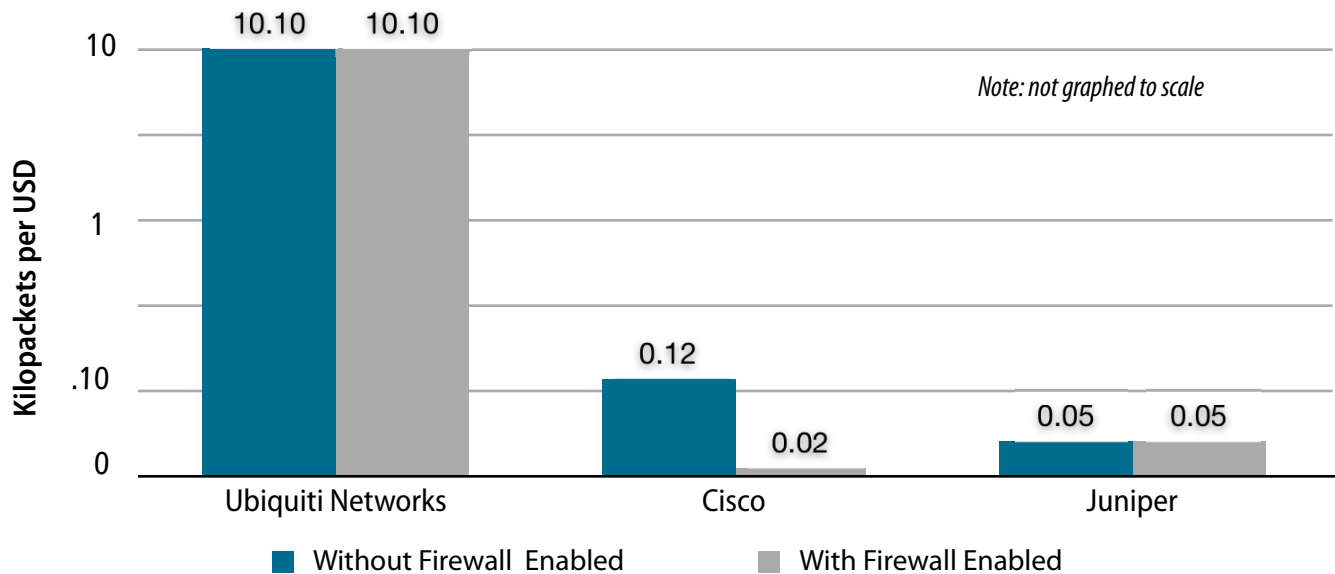
Layer 3 Average Latency (Microseconds)
As reported by Spirent TestCenter
(Lower values are better)



Note: All products tested using three GbE ports. Spirent throughput metrics include 12-byte Ethernet IFG. Juniper has a fourth GbE port that was not used in this test.
Source: Tolly, June 2012

Figure 3

Bidirectional Gigabit Ethernet LAN Routing Price/Performance Comparison: Kilopackets per US Dollar (USD) 64-Byte Packet Size With and Without Firewall Enabled



Bidirectional Gigabit Ethernet LAN Routing (3 Ports) Price/Performance Calculations: Kilopackets per US Dollar for 64-Byte Packet Size						
	Ubiquiti EdgeRouter Lite		Cisco 3925 Integrated Services Router		Juniper J6350 (using 3 of 4 GbE ports)	
	No Firewall	Firewall Enabled	No Firewall	Firewall Enabled	No Firewall	Firewall Enabled
Kilopackets	1000.446	1000.446	791.7	119.97	371.093	371.093
CDW Price (USD)	\$99		\$6,416.99		\$7,534.99	
Kilopackets per USD	10.10	10.10	0.12	0.018	0.049	0.049

Notes: Pricing for Cisco and Juniper was obtained by Tolly engineers from CDW.com in June 2012. The Cisco and Juniper products are modular and the prices quoted are for the most basic models found on CDW and are without WAN interfaces. The Juniper product is equipped with a fourth GbE port that was not included in the testing. As EdgeRouter Lite was in pre-release at the time of this evaluation, its pricing information was provided by Ubiquiti. 1 Kilopacket = 1,000 packets. Service contracts not included.

Source: Tolly, June 2012

Figure 4



134.1 Kpps, respectively.

Firewall Throughput in Mbps

On average, across all packet sizes, the Ubiquiti EdgeRouter Lite forwarded 4.3X more Mbps than Cisco, and 3.7X more Mbps than Juniper. See Figure 2.

The EdgeRouter Lite forwarded 672.3 Mbps 64-byte packets, while Cisco and Juniper forwarded 80 Mbps and 249.4 Mbps, respectively.

EdgeRouter Lite forwarded 2,850 Mbps of 512-byte packets, Cisco forwarded 595.3 Mbps and Juniper forwarded 1,228.1 Mbps.

For the 1518-byte packet size, EdgeRouter Lite demonstrated 100% line rate at 3,000 Mbps, while Cisco and Juniper forwarded 1,748.4 and 1,650, respectively.

Latency

Tolly engineers measured the system latency with and without a firewall enabled. For all packet sizes, Ubiquiti EdgeRouter Lite consistently provided the lowest latency when compared to the Cisco 3925 and Juniper J6350.

Without Firewall

Without a firewall enabled, Ubiquiti's average latency for forwarding 64-byte packets was 28.8 microseconds (μ s), compared to 87.4 μ s for Cisco and 283.2 μ s for Juniper. See Figure 3.

For 512-byte packet sizes, EdgeRouter Lite's average latency was 88 μ s. Cisco was the next lowest at 105.8 μ s, and Juniper again had the highest latency at 340.7 μ s.

For 1518-byte packets, EdgeRouter Lite demonstrated the lowest latency by far at 46.7 μ s of latency, compared to Cisco at 128 μ s and Juniper at 384.2 μ s.

With Firewall Enabled

Tolly engineers enabled a firewall and measured average latency across all three packet sizes. Ubiquiti's performance was unaffected, demonstrating low and in some cases lower latency than without the firewall, across all packet sizes. See Figure 3.

For 64-byte packet sizes, EdgeRouter Lite performed slightly better than its latency without a firewall enabled, demonstrating 28.7 μ s of latency, compared to 29.9 μ s for Cisco and 281.2 μ s with Juniper.

For 512-byte packets, Ubiquiti demonstrated slightly higher latency, at 50.6 μ s while Cisco came in lowest at 49.5 μ s. Juniper demonstrated the highest latency at 415.3 μ s.

For 1518-byte packets, EdgeRouter Lite provided the lowest latency at 46.7 μ s. Cisco was the next lowest at 70 μ s, and Juniper was the highest at 332.6 μ s.

Price/Performance Comparison

Kilopacket per USD

To demonstrate the price/performance value of the Ubiquiti EdgeRouter Lite compared to solutions from Cisco and Juniper, Tolly engineers calculated how many thousand packets per second (Kpps) of throughput are delivered per dollar of cost. The Kpps per dollar calculation uses the highest Kpps throughput data for each solution.

At over 10 Kilopackets per USD (both with and without a firewall) Ubiquiti's EdgeRouter Lite represents the greatest value for customers. Cisco and Juniper retail for significantly more than Ubiquiti's \$99 USD

at \$6,416.99 for Cisco and \$7,534.99 for Juniper. See Figure 4.

The Cisco 3925 ISR delivers .12 Kilopackets per USD without a firewall, and .018 Kilopackets per USD when a firewall is enabled.

The Juniper J6350 provides a slightly better value than Cisco at .049 Kilopackets per USD with and without a firewall enabled.

Test Setup & Methodology

Test Bed Setup

The test bed consisted of the devices under test (DUTs), connected directly to a Spirent TestCenter SPT-2000 traffic generator equipped with one CM-1G-D12 line card equipped with 12 10/100/1000 Dual Media GbE ports.

The devices under test were equipped as detailed in Table 1. Each DUT was connected to the Spirent traffic generator using three GbE ports.

RFC 2544 Performance

Baseline Performance without Firewall

To test the baseline performance of each DUT, engineers reset the devices to their factory default configuration. IP forwarding was enabled, but firewall and connection tracking features were disabled.

Three GbE ports on each DUT were connected to the Spirent TestCenter, and configured in a full-mesh topology - i.e. each port sends and receives traffic from every other port.

The Spirent TestCenter application running on a Windows PC was used to configure the parameters of the test traffic following the methodology specified by RFC 2544. Tests used binary search algorithm to determine the maximum zero-loss throughput for the packet sizes of 64, 512 and 1518 bytes, with protocol set to UDP. Throughput was measured in terms of megabits per second (Mbps) and kilopackets per second (Kpps). Last In First Out (LIFO) algorithm was used to measure the average latency, measured in microseconds (µs).

Each test iteration was run with a 60 second duration, and each test repeated three times to ensure repeatability of results.

Performance with Firewall

To test the performance of each DUT with firewall turned on, engineers reset the devices to their factory default configuration. IP forwarding and firewall features were enabled, but connection tracking features were disabled.

Three GbE ports on each DUT were connected to the Spirent TestCenter, and configured in a full-mesh topology - i.e.

each port sends and receives traffic from every other port.


The Spirent TestCenter application running on a Windows PC was used to configure the parameters of the test traffic following the methodology specified by RFC 2544. Tests used binary search algorithm to determine the maximum zero-loss throughput for the packet sizes of 64, 512 and 1518 bytes and UDP port number 1024. Throughput was measured in terms of Megabits per second (Mbps) and Packets per second (pps). Last In First Out (LIFO) algorithm was used to measure the average latency, measured in microseconds (µs).

On each DUT, 25 stateless firewall rules were configured in the form of Access Control Lists (ACLs) to allow traffic matching a particular UDP port number. The first 24 rules do not match the test traffic, while the 25th rule is configured to allow traffic with the UDP port number 1024, matching that of the traffic. Each packet of the test traffic gets processed by each of the 25 ACLs defined in the firewall component of the DUT.

Each test iteration was run with a 60 second duration, and each test was repeated three times to ensure result consistency.

Test Equipment Summary

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

Vendor	Product	Web
	TestCenter SPT-2000	www.spirent.com

Device Under Test - Version Information		
Device Under Test	Details	Software Version
Ubiquiti EdgeRouter Lite	Three 10/100/1000 Mbps Ethernet ports Dual-core 500 MHz MIPS64 processor with hardware acceleration for packet processing	Version 0.9.5
Cisco 3925 Integrated Services Router	Model C3900-SPE100/K9 Three 10/100/1000 Mbps Ethernet ports	Cisco IOS Software, C3900 Software (C3900-UNIVERSALK9-M) Version 15.1(4)M2, RELEASE SOFTWARE (fc1)
Juniper J6350 Services Router	Four 10/100/1000 Mbps Ethernet ports	JUNOS Software Release [9.2-20090320.0]

Source: Tolly, June 2012 Table 1



About Tolly...

The Tolly Group companies have been delivering world-class IT services for more than 20 years. Tolly is a leading global provider of third-party validation services for vendors of IT products, components and services.

You can reach the company by email at sales@tolly.com, or by telephone at +1 561.391.5610.

Visit Tolly on the Internet at:
<http://www.tolly.com>

Interaction with Competitors

In accordance with Tolly's Fair Testing Charter, Tolly personnel invited representatives from the competing companies to review the testing. Juniper declined to participate and Cisco did not respond.



For more information on the Tolly Fair Testing Charter, visit:
<http://www.tolly.com/FTC.aspx>

Terms of Usage

This document is provided, free-of-charge, to help you understand whether a given product, technology or service merits additional investigation for your particular needs. Any decision to purchase a product must be based on your own assessment of suitability based on your needs. The document should never be used as a substitute for advice from a qualified IT or business professional. This evaluation was focused on illustrating specific features and/or performance of the product(s) and was conducted under controlled, laboratory conditions. Certain tests may have been tailored to reflect performance under ideal conditions; performance may vary under real-world conditions. Users should run tests based on their own real-world scenarios to validate performance for their own networks.

Reasonable efforts were made to ensure the accuracy of the data contained herein but errors and/or oversights can occur. The test/audit documented herein may also rely on various test tools the accuracy of which is beyond our control. Furthermore, the document relies on certain representations by the sponsor that are beyond our control to verify. Among these is that the software/hardware tested is production or production track and is, or will be, available in equivalent or better form to commercial customers. Accordingly, this document is provided "as is", and Tolly Enterprises, LLC (Tolly) gives no warranty, representation or undertaking, whether express or implied, and accepts no legal responsibility, whether direct or indirect, for the accuracy, completeness, usefulness or suitability of any information contained herein. By reviewing this document, you agree that your use of any information contained herein is at your own risk, and you accept all risks and responsibility for losses, damages, costs and other consequences resulting directly or indirectly from any information or material available on it. Tolly is not responsible for, and you agree to hold Tolly and its related affiliates harmless from any loss, harm, injury or damage resulting from or arising out of your use of or reliance on any of the information provided herein.

Tolly makes no claim as to whether any product or company described herein is suitable for investment. You should obtain your own independent professional advice, whether legal, accounting or otherwise, before proceeding with any investment or project related to any information, products or companies described herein. When foreign translations exist, the English document is considered authoritative. To assure accuracy, only use documents downloaded directly from Tolly.com.

No part of any document may be reproduced, in whole or in part, without the specific written permission of Tolly. All trademarks used in the document are owned by their respective owners. You agree not to use any trademark in or as the whole or part of your own trademarks in connection with any activities, products or services which are not ours, or in a manner which may be confusing, misleading or deceptive or in a manner that disparages us or our information, projects or developments.