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Vyatta, Inc.

Vyatta

BGP Performance Evaluation versus
Cisco 7204VXR Router

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Test
Summary

Premise: Over the past decade, the Internet has grown rapidly resulting in a significant increase in the amount of traffic and the size of the Internet routing table managed by service provider and enterprise edge routers. Existing proprietary edge routers are quickly running out of processing power and memory capacity required to keep up with these growing demands. Open-source routing scales to meet growing BGP requirements today and in the future, providing superior performance for a fraction of the price.

Vyatta commissioned The Tolly Group to evaluate its service provider/large enterprise edge routing solution that provides high performance and scalability deployed on an Intel x86 processor-based multi-core hardware platform. An IBM System X3550 system was used as the host processor.

Tolly Group engineers verified the BGP routing scalability (BGP route table capacity, BGP convergence times and BGP peer router capacity) versus Cisco 7204VXR routers with Network Processing Engine NPE-G1 and NPE-G2.

Engineers also measured the Layer 3 bidirectional zero-loss (≤0.001) throughput for various packet sizes in a three-port full-mesh configuration. Results were compared with Cisco 7204VXR routers and used to obtain a price/performance comparison.

Tests were conducted in February 2008.

Test Highlights

▶ Supports BGP route table size of 4.5 million routes

- 3X more than Cisco 7204VXR/NPE-G1 with max. memory
- 1.5x more than Cisco 7204VXR/NPE-G2 with max. memory

▶ Provides BGP convergence time more than 3X faster than the Cisco 7204VXR/NPE-G1 and 2X faster than the Cisco 7204VXR/NPE-G2

▶ Operates at Layer 3 wire speed across three Gigabit Ethernet ports in full mesh when forwarding 512-byte frames or higher while Cisco routers failed to achieve wire speed

▶ Delivers from 4X to 3.3X price/throughput advantages over the Cisco 7204VXR/NPE-G1 and 7204VXR/NPE-G2

BGP Route Table Capacity
as Reported by Spirent TeraRouting Tester 6.0
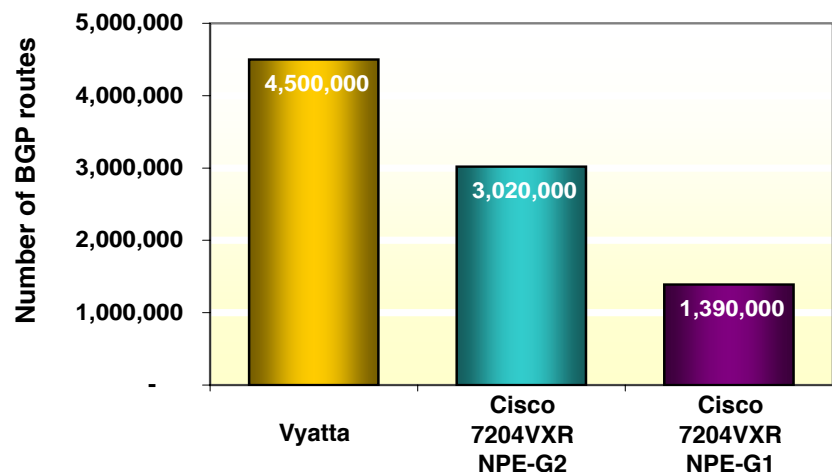
Note: All routers were tested with their maximum supported memory.

Source: The Tolly Group, February 2008   *Figure 1*

Executive Summary

The Vyatta system outperforms the Cisco 7204VXR in BGP convergence times and routing table capacity at a cost savings of over 75%. Vyatta also demonstrates superior price/throughput performance providing more than 3.3X advantage over the Cisco 7204VXR routers tested.

BGP Convergence Time
as Reported by Spirent TeraRouting Tester 6.0

Source: The Tolly Group, February 2008

Figure 2

Today's Internet is growing very fast and as a result the global Internet routing table has grown dramatically. To keep pace with this growth, Internet Service Provider (ISP) and large enterprise edge routers need more processing power and memory to provide the same or better level of services to their users.

However, problems associated with edge router scalability will become more noticeable as the Internet migrates from IPv4 to IPv6. Many of the existing proprietary products require major hardware and software upgrades which are normally very expensive. Without timely upgrades, they easily can become choke points in networks.

Open software solutions that leverage standard x86 hardware can be viable alternatives, offering superior performance when compared to expensive proprietary solutions.
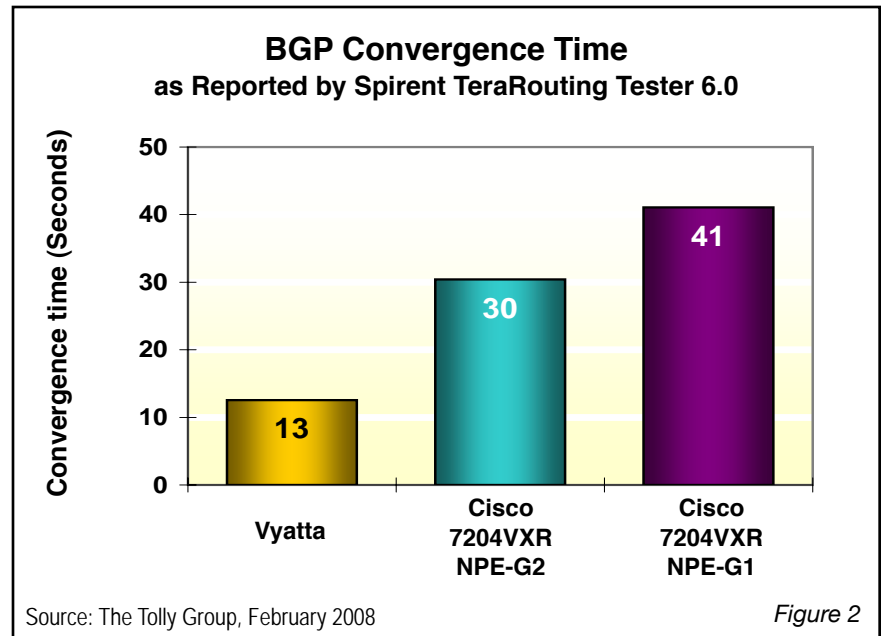
The Tolly Group's hands-on evaluation of the Vyatta solution demonstrates that the vendor's open system running on standard hardware not only can scale better in enterprise or service provider edge deployments, but it also delivers enough headroom for expansion. The structural economic advantage of the open model provides users with a cost-effective way to scale performance that is unattainable with proprietary routing solutions.

Another important benefit of Vyatta's solution is that it decouples software from the underlying hardware and allows users to achieve software feature and service extensibility with a truly open integration environment.

During the test, engineers updated memory on all routers tested to the maximum capacity since memory size has a direct impact on route table capacity. The retail price of the 4-GB memory upgrade for the IBM System X3550, which hosted the Vyatta software, was $259. The retail price to upgrade the Cisco 7204VXR NPE-G1 for the maximum memory (1 GB) was $7,000

and the 2 GB of the memory for the Cisco 7204VXR NPE-G2 cost $8,000. This offers a clear picture of the monetary investment required for Cisco users to upgrade their systems compared to the Vyatta open software solution.

In the BGP route table capacity test, engineers verified that Vyatta supports 1.5X and 3.2X more BGP routes than the Cisco 7204VXR NPE-G2 and 7204VXR NPE-G1, respectively by measuring 4.5 million BGP routes. Given that the increase of BGP route table capacity is the first step toward improving BGP scalability, the Vyatta solution is better positioned to manage Internet growth than the two Cisco routers. (See Figure 1.)

The BGP convergence time test measures how fast the systems respond to network changes. The Vyatta system needs just 13 seconds to converge 250,000 routes between two router peers, while the Cisco 7204VXR NPE-G1 and 7204VXR NPE-G2 reported 41 and 30 seconds, respectively. (Engineers used 250,000 routes since it is representative of the size of a full Internet routing table.) This means that the

Vyatta solution is 2X to 3X more responsive to network topology changes than the two Cisco routers when carrying a full Internet routing table. (See Figure 2.)

In the BGP peer router capacity test, engineers measured that Vyatta supported 80 peer routers that advertised 250,000 routes each. This proves that Vyatta can support 80 BGP peers with each advertising a full Internet routing table.

BGP scalability and responsiveness are two of the most important factors for ISPs when choosing edge routers since BGP is the Internet's underlying protocol. Another critical metric for ISPs is the data-plane performance of network devices.

In the Layer 3 Throughput test, Vyatta achieved wire-speed Layer 3 throughput in a 3-port full-mesh configuration when handling 512-byte packets or higher. The Cisco routers dropped packets even with the larger packet sizes. While the Cisco 7204VXR NPE-G2 performed better than Vyatta and the Cisco 7204VXR NPE-G1 for smaller packet sizes, the retail prices of the Cisco routers were 3.9X to 4.5X higher than the Vyatta software router running on the IBM hardware platform. (See Figure 4.)

Tolly Group engineers also computed a cost of throughput (cost-per-Mbps) value to assess the price/routing throughput. Results show that the Vyatta solution delivered on average 3.3X to 4X better price/throughput over the two Cisco routers tested. (See Figure 5.)

Results

BGP Route Table Capacity

The Vyatta system was compared to the two Cisco 7204VXR routers in terms of the maximum number of BGP routes it can handle with maximum supported memory.

Engineers measured that Vyatta supported 4.5 million BGP routes while the Cisco 7204VXR NPE-G1 and the Cisco 7204VXR NPE-G2 supported 1.4 million and 3 million BGP routes, respectively. This demonstrates that Vyatta is more scalable than the Cisco 7204VXR routers when it comes to handling large Internet routing tables.

BGP Convergence Time

All routers introduce a small processing delay from the time they receive a routing update until the new information makes its way into the routing table. The goal is for this delay to be as small as possible.

During a test of 250,000 route convergence, the Vyatta solution consumed 13 seconds to withdraw routes and reissue new routes. The Cisco 7204VXR NPE-G2 and 7204VXR NPE-G1 consumed 30 and 41 seconds, respectively, to converge to new routes. This demonstrates that Vyatta can process routing updates 2X to 3X faster than the Cisco routers tested.

BGP Peer Router Capacity

Engineers verified that Vyatta scales beyond 80 BGP peer routers while each peer advertised 250,000 routes. Engineers proved that the Cisco 7204VXR NPE-G1 and the Cisco 7204VXR NPE-G2

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BGP Performance Evaluation vs. Cisco 7204VXR Router

Product Specifications

Vendor-supplied information not necessarily verified by The Tolly Group

Vyatta Software Features

- IP and routing protocols: IPv4, OSPFv2, BGPv4, RIPv2, Static routes
- IP address management: Static, DHCP server, DHCP relay, DHCP client
- Encapsulations: Ethernet, 802.1Q VLANs, PPP, PPPoE, MLPPP, Frame Relay, HDLC, GRE, IP-in-IP
- QoS: Classful Queuing, Priority Queuing, Bandwidth Management, Packet Marking
- Load balancing: WAN link load balancing, Multilink PPP, ECMP
- Logging and monitoring: Syslog, SNMPv2c
- Security: IPSec VPN, remote VPN, stateful inspection firewall, Network Address Translation, RADIUS authentication, user accounts and passwords
- High availability: VRRP, IPSec VPN clustering, protocol fault isolation, redundant power supply (hardware system dependent)
- Administration: Integrated CLI, single configuration file, Web GUI, Telnet, SSHv2
- Debugging and Packet Sniffing: Tcpdump, Ethereal packet capture
- Interfaces: PCI/PCI-X/PCI-e and onboard 10/100/1000 Ethernet, 10GbE, T1/E1, T3/E3, ADSL

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URL: http://www.vyatta.com

supported 40 and 100 peers, respectively.

Zero-loss Throughput

Tolly Group engineers tested the Vyatta system (running on an IBM System X3550) against two Cisco 7204VXR routers to measure the zero-loss ($\leq 0.001\%$) bidirectional routing throughput across three GbE ports in a full-mesh configuration.

Engineers tested seven packet sizes ranging from 64 bytes to 1,518 bytes. Vyatta outperformed the throughput offered by the Cisco 7204VXR routers with NPE-G2 and NPE-G1 for packet sizes of 512 bytes or higher.

The Vyatta system achieved wire-speed throughput (3 Gbps of aggregate throughput) for 512 bytes or higher, while the two Cisco 7204VXR routers never

achieved wire-speed performance in any tests. For packet sizes of 256 bytes or lower, the Cisco 7204VXR NPE-G2 achieved higher throughput than the Cisco 7204VXR NPE-G1 and the Vyatta solution.

Engineers also tested the routers in a four-port port-pairing configuration. The Vyatta router was equipped with a four-port network adapter. For the Cisco routers, engineers installed a single-port Gigabit Ethernet Port Adapter (PA-GE) for the fourth GbE port to augment three existing GbE ports.

Test results show that Vyatta performance does not degrade; it achieved aggregate throughput of 4 Gbps for 1,518-byte packets. Both Cisco routers exhibited significant performance degradation since they paired with a low performance GbE Port Adapter. The bidirectional throughput achieved with the Port Adapter was about 300 Mbps. Therefore, the aggregate four-port throughput with the Port Adapter (plus the

theoretical maximum throughput of 2 Gbps from another pair of the ports on the NPE-G1/G2) cannot exceed 2.3 Gbps. (See Figure 3.)

Price/Performance

Pricing for the products tested included the base system, as well as memory upgrades.

With a retail price of $7,952 (for hardware and software), the Vyatta system delivers price/performance from a low of $2.65 per Mbps (512-byte packets or higher) to a high of $13.73 (64-byte packets).

The retail price of the Cisco 7204VXR with NPE-G1 and 1 GB memory was $30,756. This results in a cost-per-Mbps ranging from a low of $10.66 (1,518-byte packets) to a high of $54.29 (64-byte packets).

The retail price of the Cisco 7204VXR with NPE-G2 and 2 GB memory was $35,756. This results in a cost-per-Mbps ranging from a low of $12.47 (1,518-byte packets) to a high of $33.45 (64-byte packets).

When users want to add a Layer 3 GbE routing port, Cisco users are faced with an option to buy a lower performance GbE Port Adapter (PA-GE) at the retail price of $6,000 (www.sparco.com). Vyatta users, by contrast, pay only $197 for a PCI-X or a PCIe-based GbE port since they can leverage the structural cost benefits of the x86 ecosystem without degrading performance.

Test Setup & Methodology

Tolly Group engineers tested Vyatta software version "Glendale (Alpha 2)" running on an IBM System X3550 Server (quad-core Intel Xeon 5355 2.66 GHz, 8 MB cache, 4 GB DDR2-667 and OS: Linux Kernel Ver. 2.6.23). The Vyatta software used in testing

Aggregate Routing Throughput When Handling 1,518-byte Packets Across Four GbE Ports
as Reported by Spirent TeraRouting Tester 6.0
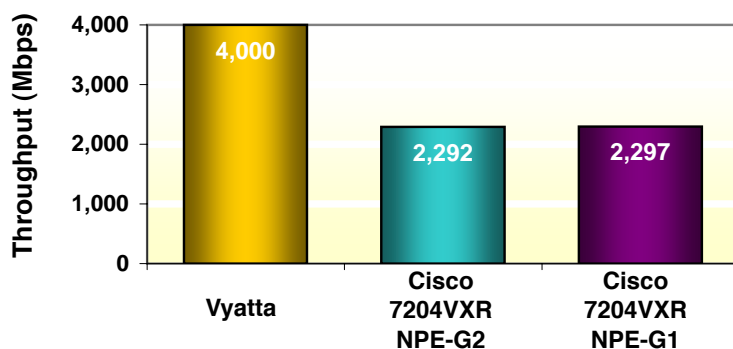
Note: The Vyatta router used a PCIe quad-port GbE network adapter and the Cisco 7204VXR routers used a single port Gigabit Ethernet Port Adapter (PA-GE) as a fourth port option. Based on the Cisco documentation, the PA-GE does not offer wire-rate performance on the Cisco 7200VXR but does offer throughput suitable to WAN aggregation applications. The port-pairing configuration was used for this test (e.g. Port1⇔Port2 and Port3⇔Port4 or PA-GE)

Source: The Tolly Group, February 2008   *Figure 3*

will soon be released as Vyatta Community 4 (VC4). The server was outfitted with an Intel PRO/1000 PT Quad Port Server Adapter to support four GbE ports. Engineers tested the Vyatta router versus a Cisco 7204VXR Router (NPE-G1) with 1 GB DRAM, running software version 12.4(4)T and outfitted with three GbE ports and a Cisco 7204VXR Router (NPE-G2) with 2 GB DRAM, running software version 12.4(15)T3 and outfitted with three GbE ports plus one Fast Ethernet management port.

For the BGP scalability and responsiveness test, engineers employed three test scenarios from Spirent's BGP test methodologies using the TeraRouting Tester application. (www.spirentcom.com/documents/3648.pdf).

Those three scenarios include BGP route table capacity, BGP convergence time and BGP peer router capacity.

For the BGP route table capacity test, engineers configured one of the SmartBits ports to emulate a BGP network topology and the other port to generate the traffic destined to the simulated networks. The tester advertised BGP routes with increments of 10,000 until the router failed to accept any new routes. Engineers measured the maximum number of advertised routes without withdrawn routes and verified from the router's console window.

For the BGP convergence time test, the first port was used for traffic generation at 1,000 pps to measure the convergence time. The other two ports emulated BGP network topologies and advertised redundant routes. Each emulated BGP network advertised 250,000 routes. A link failure was induced using the tester's flapping feature. Engineers measured the time taken for the router to redirect all the traffic to the port with lower preference. All BGP tests were run

three times and the results were averaged.

For the BGP peer router capacity test, engineers configured the router with the appropriate peer router entries and configured the tester to emulate the peers. In this test, each peer advertised 250,000 routes. Engineers increased the number of peers by 10 until failure occurred.

Engineers used Spirent SmartBits chassis/modules and TeraRouting Tester 6.0 software to measure the zero-loss throughput across three GbE ports. The SmartBits generated seven packet sizes: 64, 128, 256, 512, 1,024, 1,280 and 1,518 bytes.

The three GbE ports of each router were connected to a SmartBits test tool directly. The routers and the test tool were configured for basic IP forwarding across three ports in a full-mesh pattern. Each test was run for 60 seconds for three times and the results were averaged.

Detail Price Table for Vyatta
versus Cisco 7204VXR/NPE-G1 and Cisco 7204VXR/NPE-G2

DUT	Parts	Source	Retail price ($)
Vyatta	IBM System X3550 - Quad-Core Xeon E5430 2.66 GHz with 4 GB RAM	sparco.com	2,899.00
	IBM 73GB 15K SAS HD	sparco.com	309.00
	10/100/1000 Mbps Ethernet Interface, PCIe, 4-port (EXPI9404PT)	vyatta.com	797.00
	Vyatta Software Enterprise Subscription for Quad-core CPU (1 Year)	vyatta.com	3,947.00
	Total		7,952.00
Cisco 7204VXR NPE-G1	Cisco 7204 VXR - modular expansion base	sparco.com	6,000.00
	NETWORK PROCESSING ENGINE G1 W/ 3 GE/FE/E PORTS	sparco.com	15,000.00
	TWO 512MB MEM MODULES 1GB TOTAL FOR NPE-G1 IN 7200	sparco.com	7,000.00
	SMARTnet 8x5xNBD for Cisco 7204VXR Router	smartnet4sale.com	2,756.00
	Total		30,756.00
Cisco 7204VXR NPE-G2	Cisco 7204 VXR - modular expansion base	sparco.com	6,000.00
	NETWORK PROCESSING ENGINE G2 W/ 3 GE/FE/E PORTS	sparco.com	19,000.00
	2GB 7200 SERIES NPE-G2 MEMORY SPARE	sparco.com	8,000.00
	SMARTnet 8x5xNBD for Cisco 7204VXR Router	smartnet4sale.com	2,756.00
	Total		35,756.00

Note: The Cisco price information in this figure represents the retail price listed on sparco.com and smartnet4sale.com as of mid-February 2008. Vyatta's price in this figure will be effective with a Subscription Release 3.0 (not released yet) and is higher than the price in the current Vyatta on-line retail store. The price information in this figure represents the retail price.

Source: The Tolly Group, February 2008

Figure 4

### Aggregate Gigabit Ethernet LAN Routing Price/Throughput Analysis of Vyatta vs. Cisco 7204VXR

Model (Price)	Vyatta (US$7,952)		Cisco 7204VXR NPE-G1 (US$30,756)		Cisco 7204VXR NPE-G2 (US$35,756)	
Packet size (Bytes)	Aggregate throughput (Mbps)	Cost per Mbps (US$)	Aggregate throughput (Mbps)	Cost per Mbps (US$)	Aggregate throughput (Mbps)	Cost per Mbps (US$)
64	579	13.73	567	54.29	1,069	33.45
128	1,020	7.79	988	31.12	1,725	20.73
256	1,748	4.55	1,800	17.08	2,404	14.87
512	3,000	2.65	2,318	13.27	2,593	13.79
1,024	3,000	2.65	2,858	10.76	2,747	13.02
1,280	3,000	2.65	2,892	10.63	2,773	12.89
1,518	3,000	2.65	2,885	10.66	2,868	12.47

Note: The price includes the base system with maximum supported memory. For more detailed price info, refer to Figure 4.

Source: The Tolly Group, February 2008   *Figure 5*

The Tolly Group is a leading global provider of third-party validation services for vendors of IT products, components and services.
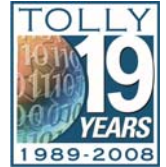
The company is based in Boca Raton, FL and can be reached by phone at (561) 391-5610, or via the Internet at:
Web: http://www.tolly.com,
E-mail: sales@tolly.com

Fair Testing Charter™
Interaction with Competitors

The Tolly Group invited representatives from Cisco Systems to participate in the testing as per The Tolly Group's Fair Testing Charter (See http://tolly.com/FTC.aspx). Representatives from Cisco did not respond to the invitation.

Test Equipment Summary

Vendor	Product	Web URL:
Spirent Communications	SmartBits SMB-600B, LAN-3321A	http://www.spirentcom.com
Spirent Communications	TeraRouting Tester 6.00	http://www.spirentcom.com

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