TEST REPORT

Tolly.

#213144

November 2013

Commissioned by
Ruijie Networks Co., Ltd.

Ruijie Networks Virtual Switching Unit (VSU) Technology

Stacking Convergence Performance Evaluation versus H3C Technologies (an HP Company)

EXECUTIVE SUMMARY

Nowadays, enterprise network availability is critical to business operations. For example, communications, transaction, and office automation systems all rely on the IP network infrastructure. In order to guarantee business operation, a stable and reliable IP Infrastructure is essential to the enterprise. The latest Virtual Switching Unit (VSU) stacking technology from Ruijie Networks can not only simplify network design but, more importantly, can also significantly improve network convergence time.

Ruijie Networks Co., Ltd. commissioned Tolly to evaluate the failover performance of their VSU technology, which can virtualize multiple switches into one centrally managed switch, versus H3C's Intelligent Resilient Framework 2 (IRF2) technology. Four different failover tests were conducted in two-member stack configurations. Tolly engineers found that Ruijie's VSU demonstrated faster convergence time, especially in a ring to chain topology, when a stacking cable fails. In all three test runs, the convergence time was less than 1.14ms, which is about 1% of H3C's convergence time in that same scenario. See Table 1.

...<*Continued on next page*>

THE BOTTOM LINE

The Ruijie Networks' VSU technology:

1. Delivered 121X faster stack convergence time than the H3C solution under test in a stacking link failure scenario (1.14ms vs. 139.4ms)
2. Delivered a flexible and cost-effective virtualization solution using GbE, 10GbE or 40GbE ports to stack
3. Delivered fast convergence time for adding/removing a stack member, master switch failure, VSU link failure, uplink failure, etc.
4. Supported Ruijie VSU stacking with 8 40Gbps stacking links between two S12000 switches

Two-Member Stack Tests - Convergence Performance
Ruijie VSU vs. H3C IRF2
(as reported by Spirent TestCenter v4.10)

	Convergence Time (ms)	Ring --> Chain[1] (stacking link failure)	Uplink failure[2]	Active switch failure[4]	Standby switch failure[4]
Ruijie VSU with RG-S5750-24GT/8SFP-E	Maximum	1.14 ms	5.3 ms	5.4 ms	5.3 ms
	Average	1.13 ms	2.5 ms	3.2 ms	3.3 ms
H3C IRF2 with S5500-28C-EI	Maximum	139.4 ms	262.3 ms[3]	5.2 ms	5.4 ms
	Average	109.7 ms	247.3 ms[3]	3.1 ms	3.6 ms

Note: 1.In the ring topology, there were two 10Gbps stacking links between two switches. The test results were the same for unplugging either link with Ruijie VSU. According to the test results, with the same topology setup and test traffic as VSU, H3C IRF2 used one of the two stacking links to pass traffic. The result was 0ms for unplugging the stacking link without traffic. The reported result is from tests with the stacking link passing traffic failed. 2. Two uplinks total with one per switch. Failure of either uplink was tested. 3.According to H3C, the results in an all H3C/HP test environment averaged 6.6ms. 4. The active switch failure tests and standby switch failure tests used a different version of firmware as other tests. See the System Under Test table for details. 5. Ruijie switches used 10GbE fiber cables as stacking cables. H3C IRF2 technology supports vendor specific CX4 stacking cables and modules as well as standard Ethernet cables and ports. A CX4 stacking module with 10Gbps CX4 stacking cables was used for H3C. H3C IRF2 results using 10GbE ports and cables may be different than the results reported here. 6. Each test was run 3 times.

Source: Tolly, July 2013

Table 1

Executive Summary (con't...)

Unlike many other vendors' stacking technologies which require using specific proprietary stacking modules and cables, Ruijie VSU can use any of the GbE, 10GbE or 40GbE ports on the switch as stacking ports. This allows users with limited budgets to leverage the advantages of switch virtualization. Tolly engineers found that the convergence time for eight-member stacks using, alternately, 10GbE and GbE cables to be within 3.3ms of each other on average. See Table 2.

Between two switches, Ruijie VSU currently supports using up to 8 40Gbps links to stack as maximum. Tolly engineers verified this using two Ruijie RG-S12010 switches.

The automatic update feature was also verified. When a switch with older firmware joined a VSU group that was running newer firmware, the switch's firmware was automatically updated before joining the VSU group.

Test Results

Performance

Two-Member Stack Tests

Tolly engineers tested convergence time of the Ruijie VSU technology with Ruijie RG-S5750-24GT/8SFP-E switches versus the H3C IRF2 technology with H3C S5500-28C-EI switches in four scenarios with a two-switch stack configuration. See Table 1.

Engineers tested convergence time for scenarios with the stacking link failure, uplink failure, active switch failure and standby switch failure.

In a ring-to-chain topology, the Ruijie VSU provided up to 121X faster convergence time for a stacking link failure than the H3C IRF2 (1.14ms vs. 139.4ms). Tolly engineers noted that H3C reports an IRF2 failover time of 163ms for a stacking link failure in a different testbed setup[1].

For uplink failure tests, two Ruijie switches provided industry standard link aggregation uplinks/downlinks to the switches under test as shown in Figure 1.

Ruijie Networks Co., Ltd.

Virtual Switching Unit (VSU) Technology

Convergence Performance Evaluation

Tested July 2013

Eight-Member Stack Tests - Ruijie VSU Convergence Performance
10GbE stacking links vs. GbE stacking links
(as reported by Spirent TestCenter v4.10)

RG-S5750-24GT /8SFP-E	Convergence Time (ms)	Ring --> Chain (stacking link failure)	Uplink failure	Active switch failure	Standby switch failure	Add a stack member[1]	Online firmware update[2]
10GbE stacking cables (Copper and Fibre)	Maximum	1.9 ms	0.5 ms	9.7ms	10.3 ms	0 ms	0 ms
	Average	1.8 ms	0.3 ms	8.5 ms	5.6 ms	0 ms	0 ms
GbE stacking cables (Copper)	Maximum	4.1 ms	0.5 ms	12.9 ms	10.8 ms	N/A	N/A
	Average	2.8 ms	0.4 ms	11.8 ms	8.7 ms	N/A	N/A

Note: 1. Traffic passed through the switch stack using aggregated uplinks and downlinks on the switches. When the new member joined the switch, the traffic did not have frame loss. Only tested with 10GbE stacking cables.
2. When a switch with older firmware was joined into a stack with newer firmware, the new member's firmware was updated automatically. The switch then joined the stack seamlessly. Only tested with 10GbE stacking cables.
3. Each test was run three times to ensure accuracy and obtain an average. See the Test Methodology section for additional details.

Source: Tolly, July 2013 Table 2

[1] http://www.h3c.com.cn/About_H3C/Company_Publication/IP_Lh/2009/Six/Home/Catalog/200910/650643_30008_0.htm (Chinese)

In this scenario, the Ruijie solution was up to 48 times (or 257ms) faster convergence time from an uplink failure than H3C. Subsequent to initial publication of this report, H3C/HP contacted Tolly and provided documentation that indicated an average failover of 6.6ms for HP IRF technology with HP S12500 data center core switches in a testbed where all of the switches - systems under test and uplink/downlink switches - were H3C/HP switches.

For active switch and standby switch failures, the Ruijie convergence times were similar to those of H3C. Tolly engineers noted that H3C reports an IRF2 failover time of 3.9ms for active switch failover and 5.0ms standby switch failover[2]. These times are slightly higher than the times measured in this Tolly test. See Table 1.

Eight-Member Stack Tests

10GbE Stacking vs. GbE Stacking

10GbE transceivers, vendor-specific stacking modules and cables can represent a significant cost in a deployment, in addition to the purchase of the switches themselves. Tolly validated that other than the commonly used high performance 10GbE and 40GbE ports, the GbE service Ethernet ports on Ruijie switches can also be used to stack. So it is possible for users to leverage the advantage of switch virtualization without any additional cost.

Tolly engineers tested the Ruijie VSU in an eight-member stack scenario to prove that the convergence performance obtained with GbE ports on the VSU is similar to the performance obtained with 10GbE ports.

Tolly engineers verified that Ruijie's VSU technology supported quick failover in different scenarios such as adding a stack member, master or standby switch failure, VSU link failure or uplink failure by using either 10GbE or GbE ports to stack on the RG-S5750-24GT/8SFP-E switches.

Additionally, Tolly engineers verified that Ruijie's VSU technology could support 40GbE links by linking a pair of RG-S12010 switches via 8 40GbE links.

Test Setup & Methodology

Test Environment

Eight Ruijie RG-S5750-24GT/8SFP-E switches were tested. The Ruijie RG-S12010 was used to illustrate 40GbE stacking connectivity.

For H3C, two H3C S5500-28C-EI switches were used. (H3C is an HP company[3].)

In the two-member stack tests, Ruijie switches used 10GbE fiber cables as stacking cables. H3C IRF2 technology supports both vendor specific stacking cables and modules as well as standard Ethernet cables and ports. A CX4 stacking module with 10Gbps stacking cables was used for H3C.

In the eight-member ring --> chain test (stacking link failure test), switches 1 through 8 were connected in series and then switch 1 was connected back to switch 8.

Traffic passed into the stack on member 2 and passed out of the stack from member 6. These switches were selected for ingress and egress points because they represented

About Ruijie Networks

Ruijie Networks (stock code: SZ: 002396) is a leading network solution supplier of China. We focus on customer benefits and strive to improve the network application experience of our customers through continuous technological innovation. Ruijie Networks provides end-to-end network solutions for telecom carriers, financial services, government agencies, education and enterprises to create values for customer networks.

Ruijie Networks has over 38 branch offices with sales and service covering Asia, Europe, North America, and South America. Ruijie Networks is the only data communication company certified as an innovative enterprise in China. With continuous improvement on the innovative road of independent R&D, Ruijie Networks leads and promotes the development of cutting-edge network technologies worldwide.

For more information on Ruijie Networks enterprise switches solution, please visit our company website, or scan the QR code below:

Learn more about Ruijie Switches

Source: Ruijie Networks, August 2013

[2] http://www.h3c.com.cn/About_H3C/Company_Publication/IP_Lh/2009/Six/Home/Catalog/200910/650643_30008_0.htm (Chinese)

[3] http://www.h3c.com/portal/About_H3C/News/Corporate_News/201004/670331_1515_0.htm

the longest data path between any two switches in this configuration.

In the two-member ring --> chain test, traffic passed into the stack on member 1 and passed out of the stack from member 2.

In all other tests, traffic passed through the stack using the aggregated uplinks and downlinks.

In all tests, multiple source and destination MAC addresses were used for the test traffic.

Test Methodology

Convergence Time

By convention, convergence time is determined by the length of time that traffic flow is interrupted after a change is made in the network topology - such as the presence of a link failure.

The time is calculated using a known frame rate. In this test that rate is 100Mbps of 128-byte frames as 84,460 frames/second. The formula used is: (convergence time) = (end-to-end frame loss) / (end-to-end traffic frame rate).

The flow of traffic across switches belonging to a stack cannot necessarily be verified externally. Any tests, however, need to use external test tools to generate the traffic used to measure the convergence time.

Because the traffic feeding the ports being used to provide the measurement may not be representative of the traffic flow across all stacking ports, care must be taken when evaluating the results. Especially in the case of an eight-switch stack, the possibility exists that the measurement can represent an extreme best-case or worst-case value. Thus, in cases where small differences in convergence time could impact application performance, Tolly recommends testing the switch convergence time using the actual application to be deployed over the switch stack.

In the comparison tests, the same traffic was used with the same switch topology setup. And the same link/switch members were failed to make for a fair comparison.

Two-Member Stack Tests

Two switches were stacked using two 10Gbps stacking links as a ring topology.

To simulate the stacking cable failure, Tolly engineers unplugged either stacking cable and recorded the frame loss.

To simulate the uplink failure, Tolly engineers unplugged the uplink from the active switch 3 times and from the standby switch 3 times.

To simulate active and standby switch failure, Tolly engineers unplugged the power cord of the switch.

Eight-Member Stack Tests

Eight Ruijie RG-S5750-24GT switches were stacked in a ring topology with 10GbE or GbE stacking links.

In the stacking cable failure test, test traffic from Spirent TestCenter was passed into the VSU group on member 2 and out from member 6. Different stacking cables were unplugged during the test and similar results were documented.

8 x 40Gbps Stacking Links Support

Two Ruijie RG-S12010 switches were stacked using eight 40Gbps links connecting eight 40GbE ports on each switch.

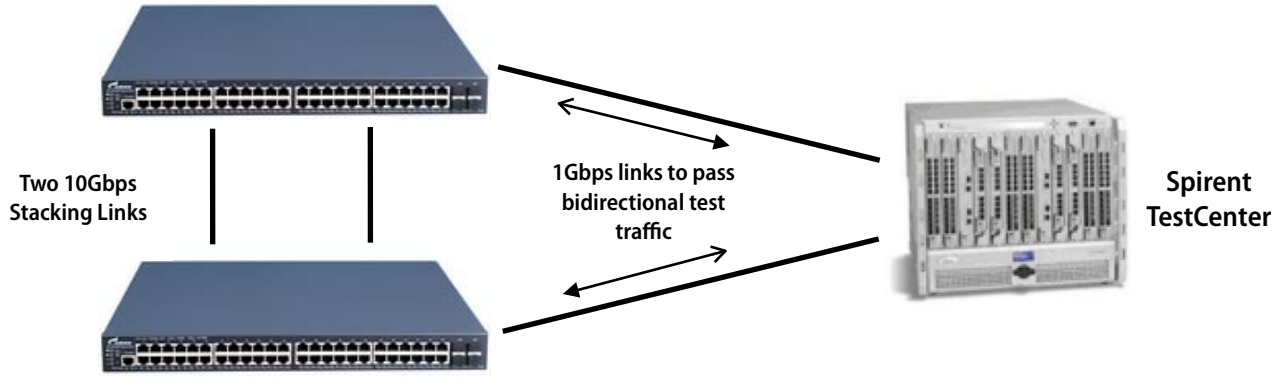
Systems Under Test

Vendor	Model	Version
Ruijie Networks Co., Ltd.	RG-S5750-24GT/8SFP-E	RGOS 10.4(3b16) Release(146239)
Ruijie Networks Co., Ltd.	RG-S12010-Iseries	RGOS 10.4(3b17)p1 Release (147298)
H3C Technologies Co., Ltd.	S5500-28C-EI (with a CX4 Hardware REV.A stacking module in SubSlot 2)	Comware version 5.20, release 2208

Note: In the active switch failure scenario and the standby switch failure scenario in the two members stack convergence performance tests, a Ruijie internal update was used to the firmware. Ruijie noted that this update will be included in the next public firmware update. Inclusion not verified by Tolly.

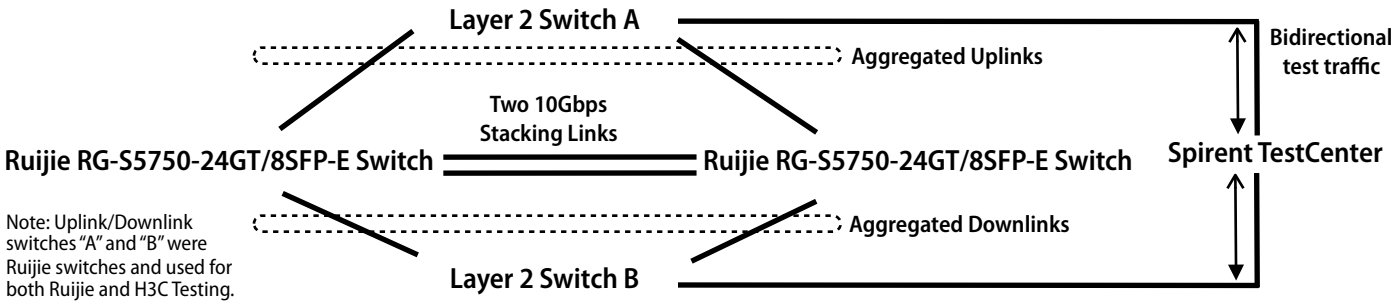
Source: Tolly, July 2013 Table 3

Test Bed for the Two-Member Stack Ring --> Chain Test



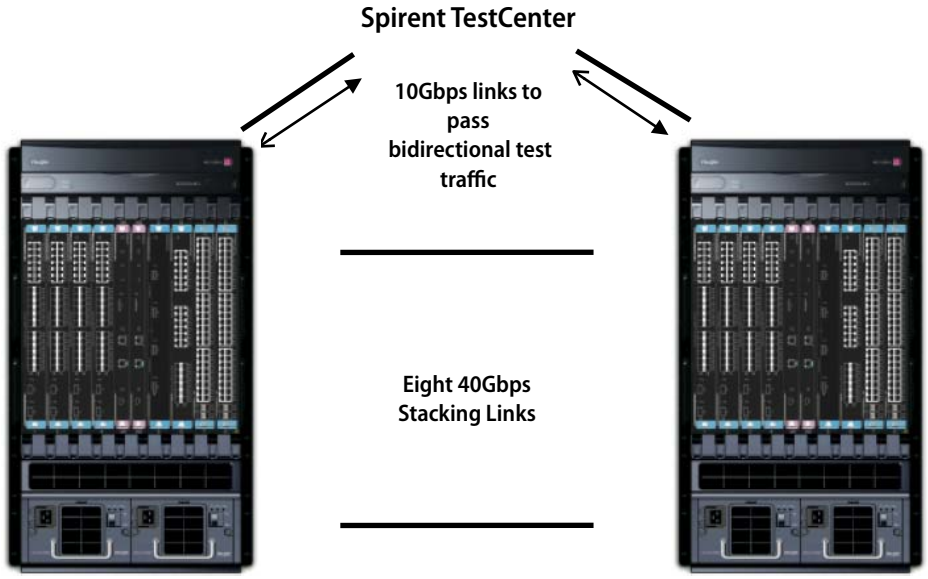
Ruijie RG-S5750-24GT/8SFP-E Switches

Test Bed for All Other Two-Member Stack Performance Tests



Note: Uplink/Downlink switches "A" and "B" were Ruijie switches and used for both Ruijie and H3C Testing.

Test Bed for Verifying the Support of Eight 40Gbps Stacking Links



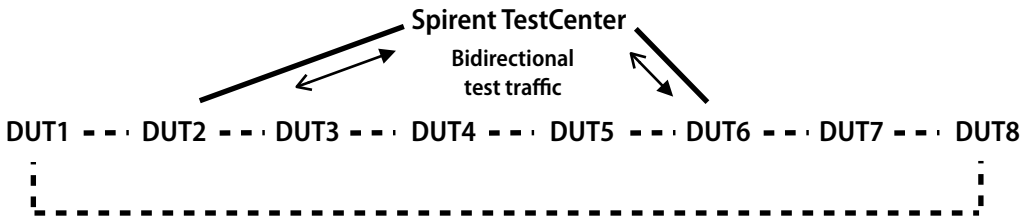
Ruijie RG-S12010 Switch

Ruijie RG-S12010 Switch

Source: Tolly, July 2013

Figure 1

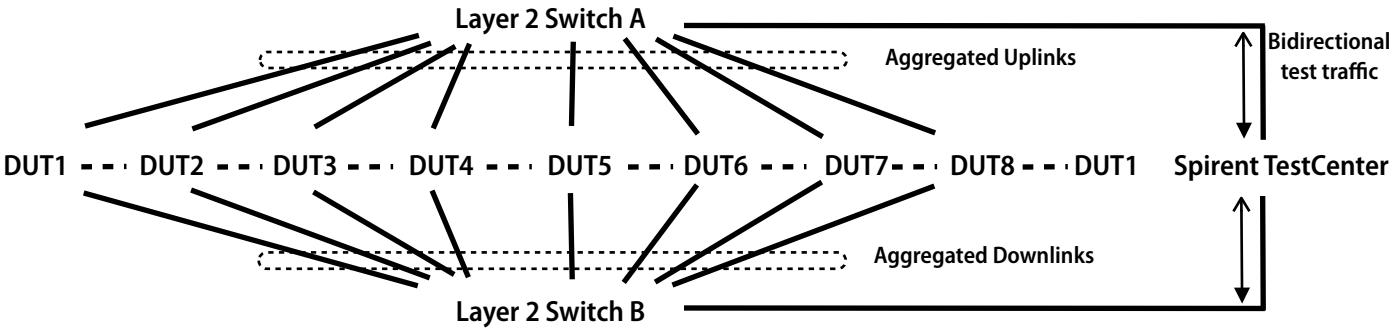
Test Bed for the Eight-Member Stack Ring --> Chain Test



GbE or 10GbE Stacking Links

DUT1 to DUT 8 Ruijie RG-S5750-24GT/8SFP-E switches.

Test Bed for All Other Eight-Member Stack Performance Tests



GbE or 10GbE Stacking Links

DUT1 to DUT 8 Ruijie RG-S5750-24GT/8SFP-E switches. Two DUT1 in the figure are the same switch. DUT 8 connected back to DUT1 to create a ring topology.

Source: Tolly, July 2013

Figure 2

Test Equipment Summary

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

Vendor	Product	Web
Spirent	**TestCenter 11U v4.10**	http://www.spirent.com

Ruijie Networks Virtual Switching Unit (VSU) Overview

Information provided by vendor, not necessarily verified by Tolly

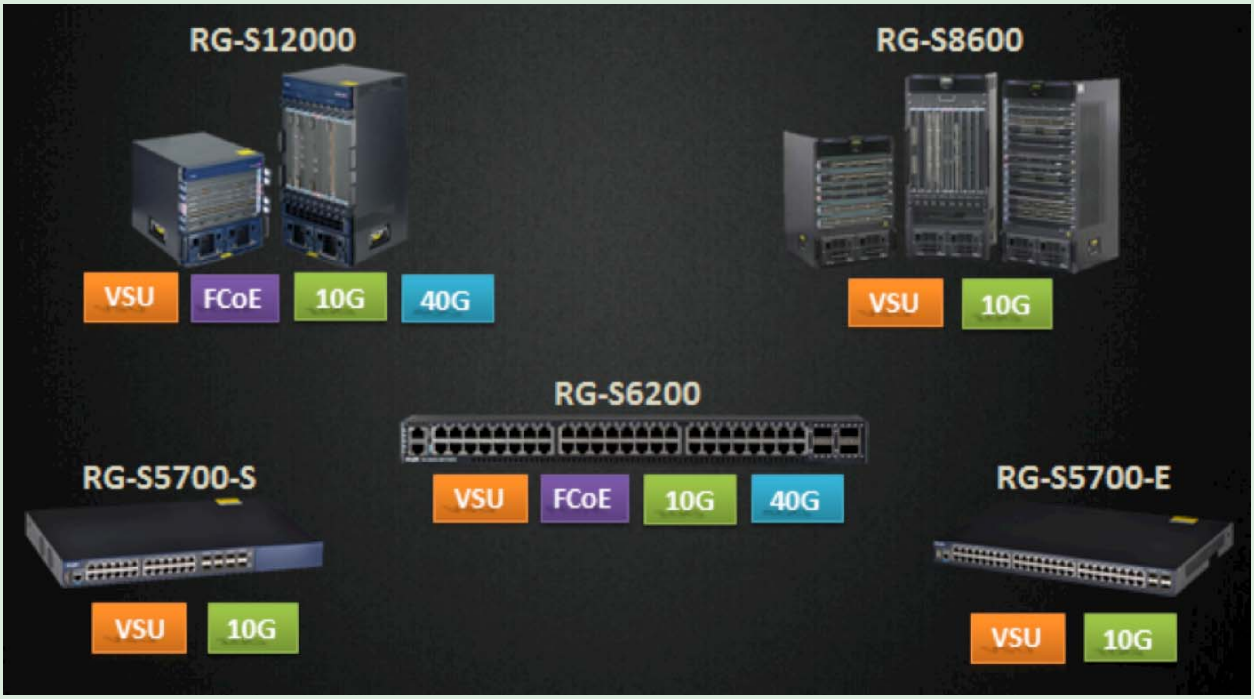
Ruijie Virtual Switching Unit (VSU) provides a unified data plane, unified configuration, and single IP address management for the whole virtualized switch group. The advantages of switch virtualization include lower total cost of ownership (TCO) and higher availability through simplified management as well as multi-chassis link aggregation

Ruijie VSU provides stacking up to 8 switches which can be virtualized into one logical unit. Designed with high reliability and availability, zero business interruption while any VSU member leaving or joining into the VSU group.

Ruijie VSU support seamless failover feature which guarantee all time-sensitive IP Applications & Communications system can be failover smoothly without interruption. Ruijie VSU provide as fast as 1.16ms and 6.6ms under stacking link failover and uplink failure scenario respectively.

Taking advantage of Ruijie VSU's flexibility to use any of Ethernet port type for stacking formation, Ruijie VSU stacking bandwidth is unlimited. With the adoption of 40G Ethernet, stacking bandwidth can be up to 320G (8 VSU Link * 40G).

To provide investment protection, unlike many other vendors' stacking technologies which require using specific stacking cables, Ruijie VSU can use fibre or copper Ethernet cables on GbE, 10GbE or even 40GbE service Ethernet ports to stack. This makes users with limited budget also able to leverage the advantage of switch virtualization.



Note: Ruijie S5700/S6200 series switches support up to 8 stack members. Ruijie S12000 series chassis switch support up to 2 stack members at the moment.

Source: Ruijie Networks, September 2013

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 E-mail 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 H3C Technologies Co., Ltd. to participate in the testing. H3C did not respond to the invitation. After initial publication, H3C contacted Tolly to dispute certain results. Tolly reviewed the results and has: added clarifying notes, added an H3C/HP result that differed significantly from Tolly results, and confirmed that other results were in range with results published on the H3C website. See report text for details.

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.

213144-spvhjfs1-yx-mts-2013-12-16-VerS