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WAN Optimization for Data Transfer in Branch to Headquarter Scenarios

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WAN OPTIMIZATION FOR DATA TRANSFER IN BRANCH TO HEADQUARTER SCENARIOS

By

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Abstract

WAN OPTIMIZATION FOR DATA TRANSFER IN BRANCH TO HEADQUARTER SCENARIOS

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Introduction

Business requirements have impelled IT organization to deploy their applications over wide area network (WAN) connections to increase productivity, provide ubiquitous access, enhance collaboration, and reduce costs. Although application deployment over WAN connections provides considerable number of advantages, it also comes with some performance limitations and disadvantages such as limited bandwidth, application contention, high latency, and packet loss. As the distance between source and destination of WAN connections and packet loss increase, there is substantial WAN throughput degradation. As mentioned in [1], "given a commonly used maximum window size of 64 KB in the original TCP protocol and 45 Mbps bandwidth, the effective TCP throughput of one flow over a source-to-destination distance of 1000 miles is only around 30% of the total bandwidth. With the source-to-destination distance of 100 miles, the effective TCP throughput degrades from 97% to 32% and 18% of the whole 45 Mbps bandwidth when the packet loss rate increases from 0.1% to 3% and 5%, respectively".

As discussed in the paper "On Wide Area Network Optimization", there are some barriers not normally encountered in LANs that can lead to performance degradation of applications that run across WAN connections. These are network and transport barriers, application and protocol barriers, operating system barriers, and hardware barriers which are briefly discussed below.

1) Network and Transport Barriers

WAN connections are characterized by limited bandwidth, high latency, high congestion and packet loss compared to LANs.

- 1.1) Limited Bandwidth: Although there have been considerable improvements in terms of speed in LANs, there have not been similar improvements in WANs. For instance, 1000 Mbps connection in modern LANs is common and application deployed in these environments are provided enough throughput for optimal performance, but WANs are still bound by old bandwidth limitations. At the same time, trends toward data center consolidation, cloud computing, and mobile users have caused WAN oversubscription, which further impacts applications' performance.
- 1.2) High Latency: The two main sources of latency in WAN environments are distance and routers. As the distance between source and destination of the WAN end points increases, the round-trip time of the packets transmitted between source and destination end points increases,

which further translates into higher latency. Routers are used to route packets from source to destination. In order to route a packet, a router needs to copy the packet from an incoming interface to the appropriate outgoing interface. This action introduces a slight delay in transmission of the packet and as the number of routers between the source and destination increases the total latency increases. Finally, other factors such as saturated routers and protocol translation can also increase the overall latency. Latency is the main source of slow application response time over WAN connections.

1.3) High Congestion and Packet Loss: Congestion happens when there is excessively large number of network packets accumulated at a router or link and it may deteriorate network service quality resulting in queuing delays and packets loss. Excessively large and full buffer on a router also results in a culprit called bufferbloat, which results in higher latency and poor system performance in WAN environments.

2) Application and Protocol Barriers

Some applications use protocols that are designed to run smoothly in LAN environments, but the same protocols perform poorly in WAN environments simply because they are not considered to run over WAN. Microsoft CIFS infamous for being a chatty application performs quite well in LAN environment. However, it does not perform as expected over WAN because CIFS client and server exchange large number of control and status messages to transfer a relatively small file. "As an example, accessing a 1.5-MB file over the network that resides on a Windows file server requires well over 1000 messages to be exchanged between the client and the server." [2] Once implemented over WAN, performance of chatty protocols/applications such as CIFS decreases as the amount of latency on WAN increases.

3) Operating System and Hardware Barriers

Other factors that are commonly ignored once checking the performance of an application are the operating system hosting the application and the server platform hosting the operating system. Proper planning, selection and configuration of server's hardware and operating system components such as CPU, memory, disks and disk controllers, cache size, and correct operating system and processor combination (32-bit or 64-bit) improves the overall performance of the application. At the same time, various operating system vendors provide software based functionalities aimed to improve application performance. For example, Microsoft provides TCP Chimney Offload, Receive-side Scaling (RSS), and Network Direct Memory Access (NetDMA) to accelerate the Windows network stack.

The need for WAN Optimization

Transferring information and application delivery are among the most important goals of using networks. Continuous performance and speed improvements in components making up computers and LANs have made it easy to efficiently transfer information and deliver applications in LANs. However, performance improvements in WAN speed and technology have not been able to keep pace with LANs. Furthermore, recent trends toward virtualization and cloud computing, data center consolidation, and increased demand for data backup and recovery have placed huge demand on WAN connections and changed the way applications are delivered. Taking into considerations the limitations of WAN connections and massive demand on these connections, enterprise IT organizations have felt the need to optimize their WAN environments to improve network availability, reliability, and performance. WAN optimization is defined as a collection of techniques used for increasing/improving data transfer efficiencies across wide area networks [3]. It uses various techniques such as de-duplication, compression, caching, latency optimization, forward error correction, traffic shaping and other techniques to address applications.

Project Purpose

The purpose of this implementation is to evaluate the efficiency of WOCs or similar WAN optimization appliances in acceleration of file data transfers for Branch-to-Headquarter scenario. As it is demonstrated at the end of this document, Riverbed Virtual Steelhead appliance uses deduplication, LZ compression, and caching techniques to optimize Microsoft Server Message Block (SMB) files transferred across the WAN link.

Market Analysis of Solution

WAN Optimization Techniques

Some of the most common WAN optimization techniques used across the WAN optimization industry are discussed below.

Deduplication: Eliminates redundant data transfer across WAN connections by sending references of data rather than the actual data. "By having this WAN Optimization technique work at the byte level, benefits are achieved across multiple IP applications." [4] Deduplication also reduces storage utilization by eliminating duplicate copies of redundant data. Redundant data are simply replaced by pointers pointing to the unique copy of data.

Compression: Is used to save bandwidth by reducing the size of data as it is transferred over the WAN. Compression works in symmetric fashion in that two appliances are required on each WAN end points. The sending device uses compression techniques such as ZIP and RAR to compress the traffic as it is being transferred to the destination. At the receiver side, the same compression technique is used to decompress the traffic. Compression works well with various kind of traffic, but it is not recommended for real-time multimedia such as voice over IP and video conferencing. However, Compressed Real Time Traffic Protocol(CRTP) is an emerging protocol that can compress real time traffic over reliable point to point links with short delay.

Caching: Is one of the most common methods used in WAN optimization. It reduces bandwidth consumption by maintaining a local copy of frequently/recently requested data at the remote site. If the same file is requested a second time within the cache aging timer, WAN accelerator intervenes and provides the file from its cache. If the same file at the headquarter is changed, only changes to the file is transferred to the remote site. Caching is a very useful technique in scenarios where file server or e-mail server such as Microsoft Exchange is hosted in the headquarter (main office) and users in the branch office (remote site) need to use the services of these applications.

Latency Optimization: "Can include TCP refinements such as window-size scaling, selective acknowledgements, Layer 3 congestion control algorithms, and even co-location strategies in which the application is placed in near proximity to the endpoint to reduce latency. In some implementations, the local WAN optimizer will answer the requests of the client locally instead of forwarding the request to the remote server in order to leverage write-behind and read-ahead

mechanisms to reduce WAN latency." [5] For example, in case of a chatty application like CIFS, when the WAN accelerator at the headquarter understands that a file transfer is running, it presends some or parts of the file to the WAN accelerator at the branch office. On the other hand, the WAN accelerator at the branch office intercepts messages destined for the server at the headquarter and generates the appropriate response. In this case, although WAN accelerator prevents CIFS from congesting the WAN link, the actual file transfer takes place over the WAN.

Forward Error Correction: Uses redundant data at the source to enable the destination to detect and correct limited number of errors that might occur in packets while transiting the WAN and avoid retransmissions caused by errors in packets. Since Forward Error Correction consumes more bandwidth to transfer the packets, it only applies to scenarios where retransmission is either costly or impossible.

Traffic Shaping: Also known as packet shaping refers to manipulation and prioritization of network traffic so that some applications take precedence over other applications in WAN environments. Voice over IP and video conferencing traffic are some of the candidates for traffic prioritization.

Common WAN Topologies

Two common forms of using WAN connections are Branch-to-Headquarter and Datacenter-to-Datacenter. Branch-to-Headquarter WAN connections are generally characterized by limited bandwidth, and latency issues, and are mainly used to connect users to business applications such as mail, database, and web. Datacenter-to-Datacenter connections are often characterized by high bandwidth, lower latency compared to Branch-to-Headquarter connections, and are primarily used for bulk data transfers such as backup, replication, virtualization, and traffic migration.

Why WAN Optimization from Riverbed

WAN optimization is relatively new in IT industry, but there have emerged big number of companies that provide WAN optimization solutions for various purposes. According to a study done by Research and Markets [7], WAN optimization market is estimated to be \$5.2 in 2014 and is estimated to reach \$12.1 billion in 2019. Although there are many documents related to the

features and capabilities of the available solutions from various WAN optimization vendors, most of the documents are commercial and biased in contents. In order to select a vendor and appropriate solution for the purpose of the project, an article titled "Magic Quadrant for WAN Optimization" by Gartner was used. In this article, the authors use a set of criteria to select the WAN optimization industry vendors for evaluation. They then evaluate the vendors in terms of product/service, maturity, viability, sales execution, marketing execution, and customer experience and then provides ranking for each one of the vendors. There are four ranks, which are Leaders, Challengers, Visionaries, and Niche Players. Leaders are the companies, which have the ability to shape the market by introducing additional capabilities in their products. Challengers are market followers in terms of products or innovation and might have less-complete feature sets compared to the leaders. Visionaries are the vendors who exhibit strong market understanding, but currently lack the ability to influence a large portion of the market [7]. And, finally, Niche Players have a limited set of features and capabilities and do not have a demonstrated vision. The ranking, advantages, and disadvantages of the products provided by each vendor enable companies planning to optimize their WAN environments to make the right choice for their environments. Comparing the same article "Magic Quadrant for WAN Optimization" via graphs depicted in figure 1, 2, 3 for the years of 2014, 2015, and 2016, it is evident that Riverbed is the leader of WAN optimization industry. The authors provide a relatively comprehensive overview of WAN optimization industry vendors in terms of vision, sales strategy, products, and features. By explaining the advantages and disadvantages of the vendors' products and the various forms (physical appliance, virtual appliance, etc) that the products are provided to the market, the paper provides WAN optimization industry customers with insight regarding the vendors and their products. Furthermore, recommendations are provided in terms of the scenarios that the products by different vendors should be used for. For example, it is recommended to consider Circadence when mobile application performance is critical to the business. Riverbed is selected for the purpose of this project as it has been the industry top leader for Branch-to-Headquarter and Datacenter-to-Datacenter scenarios for several years. At the same time, Riverbed provides trail virtual appliances, which serves the purpose of this project.



Figure 1. Magic Quadrant for WAN Optimization 2014



Figure 2. Magic Quadrant for WAN Optimization 2015



Figure 3. Magic Quadrant for WAN Optimization 2016

Following are the strengths and cautions for Riverbed products mentioned in "Magic Quadrant for WAN Optimization 2016".

STRENGTHS

- Riverbed offers broadest set of capabilities in terms of features for large branch office networks, data center replication, storage networking protocols, single remote user, and cloud services optimization.
- Riverbed offers a good direct internet solution with IP VPN and single-ended HTTP caching, advanced SSL proxy for public SaaS connectivity, and internet- and SaaS-specific visibility.
- The combination of SteelHead and SteelCentral AppResponse provides very good visibility and reporting capabilities for drill-down reporting across networks, servers, applications, web apps, pages, objects, sites and users (including end-user experience).
- The new Secure Transport feature supports an IPsec-encrypted overlay mesh network, and a partnership with Zscaler provides the ability to scan optimized traffic for security purposes before going to the cloud.

CAUTIONS

- Riverbed's price can be significantly higher than its leading competitors, and although it does respond when competitively challenged, its discount policies can be inflexible and inconsistent.
- Riverbed's portfolio is extensive and has a broad solution scope, with six product ranges and multiple options within each range. However, this can make it difficult to understand how to meet functional needs.
- Riverbed has innovated less in the past 12 months than previously, and has been slow to embrace hybrid and SD-WAN. Its WAN path selection capabilities are more basic than segment-leading vendors.
- Gartner clients have reported that the solution can be difficult to manage in complex application environments, which can lead to misconfiguration and degraded application performance. However, Riverbed is adding autoconfiguration capabilities, and support is very responsive and highly rated by Gartner clients.

Real-Time Traffic Optimization

Although there exists a UDP optimization module in Riverbed optimization operating system, it is designed to deal with what is known as Bulk UDP Traffic. UDP optimization module is used for backup, data replication, and other purposes that use UDP as their transport mechanism to deduplicate redundant data and ultimately reduce the amount of data transferred over WAN. On the other hand, Real-time UDP/TCP traffic such as video and VOIP is very latency sensitive and do not have large amount of redundant and repeated data payload. To efficiently transport real-time traffic such as video and VOIP, Riverbed recommends traffic prioritization based on bandwidth and latency to protect the traffic against congestion and latency. At the same time, dynamic path control enables real time traffic to be routed via the fastest and least congested route to achieve better quality of service and experience.

Solution Setup

In order to set up and implement the project, solutions from various leading industry vendors were used, which are further discussed below.

HP Proliant DL380 G5

HP Proiant DL380 series servers are commercial servers that provide performance, availability and expandability for small to medium range workloads. A single HP Proliant DL380 G5 server platform with following specification was used to implement the solution using industry leading virtualization solution VMware vSphere 6.

Manufacturer	HP
Model	Proliant DL380 G5
CPU Cores	8 CPUs * 2.499 GHz
Processor Type	Intel(R) Xeon(R) CPU E5420 @ 2.50GHz
Processor Sockets	2
Core per Socket	4
Logical Processors	8
Memory	32 GB

Number of NICs	4
Storage	2.09 TB SAN Storage Space

VMware vSphere Hypervisor 6

VMware vSphere hypervisor 6 also known as VMware ESXi version 6 is the slimmest hypervisor in the industry with less than 150 MB of install footprint. At the very core of ESXi, there exists the VMKernel (the operating system) and a number of processes running atop VMkernel. VMkernel, shown in figure 20, is the foundation of the virtualization process in ESXi and manages the virtual machine's access to the underlying hardware resources by providing CPU scheduling, memory management, I/O management, file system and other related functions [8]. There is a fundamental difference between VMware ESXi and most other hypervisors such as Microsoft Hyper-V and Citrix XenServer in that VMware ESXi handles I/O within the hypervisor itself. Since ESXi handles I/O within the hypervisor and does not depend on any general-purpose operating systems, it has greater throughput and lower overhead in terms of I/O management compared to other hypervisors. At the same time, since the I/O stack and device drivers are within the hypervisor itself [8], it has stricter hardware compatibility compared to Microsoft Hyper-V and other similar solutions. VMware ESXi6 is currently the latest version of bare-metal hypervisor from VMware and is used for the purpose of this project to implement either side of the WAN link (headquarter and branch office).





Windows Server 2012 R2

Windows Server 2012 R2 is the latest production release of server operating system from Microsoft currently. It has been one of the most famous server operating systems in data centers and is used for various roles such as file server, Web server, LDAP server and others. For the purpose of this project, Windows Server 2012 R2 is used to implement Microsoft file service so that clients in branch office are able to share and transfer files through headquarter. WAN optimization is used to accelerate file transfers between the clients and server.

Active Directory

Active Directory is the most popular LDAP server in data centers throughout the world. Windows Server 2012 R2 is also used to implement Active Directory directory service. Although Active Directory is not to the core of the project, it used for the sake of authentication and authorization between the clients and file server.

Windows 10

Windows 10 is the latest workstation operating system from Microsoft and is used to share and transfer files to and from the file server. The main purpose of this project to accelerate and facilitate Windows 10 clients access to file server through the WAN connection.

Cisco 1000v Router

Cisco 1000v is a software based router, which comes in virtual form factor and provides routing, firewalling and VPN functionality for single or multi-tenant, private, public or provider-hosted clouds. It is used in this project in either side of the WAN connection to connect headquarter and branch office to one another using a 2 Mbps emulated WAN connection.

WAN Emulator

Dummy Cloud is a comprehensive WAN emulator solution that is cable of emulating WAN characteristics such as bandwidth restrictions, latency, packet loss, queue depth, asymmetric link

environment and some other characteristics. Dummy Cloud is used in this project to emulate WAN environment with 2 Mbps bandwidth and latency of 20ms. At the same time, as per recommendation in WAN Optimization Test Plan 8.0 by riverbed [9], simulated packet loss was not configured in the WAN emulator machine.

Riverbed Steelhead-v CX755

Steelhead-v CX755 is a virtual WAN optimization controller from Riverbed that optimizes performance of various applications including on-premises, cloud and SaaS across WAN connections. In this project, two Steelhead-v CX755 are imported into the VMware vSphere environment using an OVA file format. Then each of the appliances sits between virtual switch implemented in VMware vSphere environment and Cisco 1000v in either side of the WAN connection to perform the actual optimization. Figure 5 demonstrates the project topology along with all the components involved in the project implementation.



Figure 5. Project Topology

Lab Implementation

This section explains a step by step procedure that was used to implement the project.

VMware ESXi6

- 1. Start the HP Server machine and make sure it is configured to boot from the DVD-ROM.
- 2. Place the bootable DVD in the DVD-ROM.
- 3. On the following screen, leave the default and hit Enter.

Figure 6. ESXi Boot Menu



4. On the welcome screen, hit Enter.

Figure 7. ESXi Welcome Screen



5. On the End User License Agreement page, hit F11 to accept the EULA and continue.

Figure 8. ESXi License Agreement



6. Select an appropriate disk to install ESXi hypervisor.

Figure 9. ESXi Disk Selection

Select a Disk to Install or Upgrade * Contains a VMFS partition # Claimed by VMware Virtual SAN (VSAN)									
Storage Devic	e								Capacity
Local: (none) Remote: Viluare	/irtual	disk	;	Copx . s	mhba() : CO : TO :	LO)		16.00 GiB
(Esc) Cano	el	(F1)	Detai	ls	(F5)	Refresh		(Enter)	Cont inue

7. Select a keyboard layout.

Figure 10. ESXi Keyboard Selection

Please select a keyboard layout
Swiss French Swiss German Turkish US Default US Dvorak Ukrainian United Kingdom
Use the arrow keys to scroll.
(Esc) Cancel (F9) Back (Enter) Continue

8. Enter your desired password.

Figure 11. ESXi Password Selection



9. Hit F11 to perform the installation.

Figure 12. ESXi Installation Confirmation



10. Upon successful installation of ESXi, remove the DVD from DVD-ROM and hit Enter to reboot.

Figure 13. ESXi Installation Completion



11. Once the server is rebooted, hit F2 and enter your password to customize ESXi host settings.

Figure 14. ESXi Authentication Page



12. Navigate to Configure Management Network and configure the appropriate settings such as IPv4 address, DNS server, VLAN and other relevant settings.

IPv4 Configuration	
This host can obtain network settings automatincludes a DHCP server. If it does not, the f specified:	tically if your network following settings must be
() Disable IPv4 configuration for management () Use dynamic IPv4 address and network conf (o) Set static IPv4 address and network conf	t network Figuration iguration:
IPv4 Address	[172.20.199.12]
Subnet Mask	[255.255.255.0]
Default Gateway	[172.20.199.1]
<pre>KUp/Down> Select (Space> Mark Selected)</pre>	<pre><enter> OK <esc> Cancel</esc></enter></pre>

13. Once network related configuration is done, we need to connect to ESXi host using VMware vSphere Client, which is a Windows based software. Open vSphere Client and enter appropriate information to connect to the ESXi host.

	~	-	~			
Liguro	16	nhora	(liont	Authont	antion	Dogo
riguie	10. VO	DIELE	Ullent	Aument	Ication	rage

Ø VN	Iware vSphere Client 🛛 😽
vmware VMware vSphere Client	
All vSphere features available only throug vSphere Client will or feature set as vSphere To directly manage a sing To manage multiple hosts vCenter Server.	introduced in vSphere 5.5 and beyond are the vSphere Web Client. The traditional ontinue to operate, supporting the same are 5.0. le host, enter the IP address or host name. , enter the IP address or name of a
IP address / Name: User name: Password:	172.20.199.12 root ******** Use Windows session credentials Login Close

Figure 15. ESXi IPv4 Settings

VMware ESXi Network Implementation

This project extensively depends on the network and network configuration.

In order to simulate LAN and WAN environments in a single ESXi machine, we need specific network configuration so that the solution will work as required. Followings are required for the lab.

- Two internal only switches, which are not connected to any uplink interfaces on the physical host. These switches are required to simulate LAN switches on headquarter and branch office sites. The server in the headquarter and client in the branch office are connected to these switches. At the same time, each Riverbed WAN Optimizer in each site must also have a connection to the switch on its site to forward and optimize the traffic.
- 2. Two external switches for connection between Cisco virtual routers and Riverbed WAN Optimizers.
- 3. An external switch for connection between WAN emulator and Cisco virtual routers.

Once all the virtual switches are configured, networking in ESXi will resemble the following figure.

Standard Switch: vSwitch0	Remove Properties
VMkemel Port Management Network vmk0 : 172.20.199.12 VLAN ID: 199 Virtual Machine Port Group WAN-200 3 virtual machine(s) VLAN ID: 200 Dummy_Cloud	Physical Adapters
CSR2 CSR1	Remove Properties
Virtual Machine Port Group VLAN-197 2 virtual machine(s) VLAN ID: 197 CSR1 WOC1	Physical Adapters
Standard Switch: vSwitch2	Remove Properties
VLAN-198 2 virtual machine(s) VLAN ID: 198 CSR2 WOC2	• Winici 1000 Full
Standard Switch: vSwitch3	Remove Properties
Virtual Machine Port Group Branch-Office 2 virtual machine(s) VLAN ID: 198 WOC2 Client	- Physical Adapters No adapters
Standard Switch: vSwitch4	Remove Properties
 Virtual Machine Port Group HeadQuarter 2 virtual machine(s) VLAN ID: 197 WOC1 FS 	- Physical Adapters - No adapters

Figure 17. ESXi Networking Configuration

Figure above implements the following logical network topology required for the project.



Note: Internal switches attached to Riverbed WAN optimizers in both sites need to have promiscuous mode enabled as per the following figure.

Figure 19. vSwitch Promiscuous Mode Configuration

Ports	Network Adapters	1		
Conf	iguration	Summary	vSphere Standard Switch Properties	
卸	vSwitch	120 Ports	Number of Ports:	1
	Branch-Office	Virtual Machine		
🍠 vSwi	tch3 Properties			\times
Genera Polic	tch3 Properties	Shaping NIC Teaming		×
Genera Polic	tch3 Properties	Shaping NIC Teaming		×
Genera Polic	tch3 Properties	Shaping NIC Teaming	-	×

Internal Switch Configuration

In order to implement the internal switch, we need to take the following steps.

1. From the inventory list, select the ESXi host and then click Configuration tab.

Figure 20. Navigating to ESXi Networking Page

File	Edit V	ïew	nvento	ory Admin	istration Plug-ins Help			
	-		Home	🕨 🚮 Inv	ventory 🕨 🗊 Inventory			
E.	6							
± [172.20	D.199.	12		ESXiTest2 VMware ESXi,	, 6.0.0, 3029758		
1					Getting Started Summar	ry Virtual Machines Re	source Allocation Performance	Configuration
					Hardware	View	vSphere Standard Switch	2
					Health Status Processors Memory Storage	Netw	rorking CSR2 CSR1	

2. From the upper right corner of vSphere Client console, click Add Networking, leave Virtual Machine selected and click Next.

Ø	Add Network Wizard – 🗖 🗙
Connection Type Networking hardware ca	an be partitioned to accommodate each service that requires connectivity.
Connection Type Network Access Connection Settings Summary	Connection Types Virtual Machine Add a labeled network to handle virtual machine network traffic. VMkernel The VMkernel TCP/IP stack handles traffic for the following ESXI services: vSphere vMotion, ISCSI, NFS, and host management.
	Back Next ≥ Cancel

Figure 21. vSwitch Connection Type

3. Make sure no uplink interface is selected and click Next.

Figure 22. vSwitch Virtual Machine – Network Access

Ø	Add Network	Wizard	-		×
Virtual Machines - Netw Virtual machines reach	ork Access networks through uplink adapters attached to vSphe	ere standard sv	witches.		
Connection Type Network Access Connection Settings Summary	Select which vSphere standard switch will handle vSphere standard switch using the unclaimed ne Create a vSphere standard switch Intel Corporation 82571EB Gigabit I Use vSwitch0 Intel Corporation 82571EB Gigabit I Use vSwitch1 QLogic Corporation NC373i Integrat Wmnic0 Preview:	the network t twork adapter Speed Ethernet Con Down Speed Ethernet Con 1000 Full Speed ted Multifund 1000 Full Physical Adapters	raffic for this connection. You may also create s listed below. Networks troller None Networks troller ⊡-172.20.22.32-172.20.22.47 (VLAN 22) Networks tion Gigabit Server Adapter ⊡-172.20.1.1-172.20.1.127 (VLAN 10)	a new	*
<u> </u>			< Back Next >	Cancel	_
				cancor	

4. Enter appropriate Network Label and VLAN ID and click Next.

Figure 23. vSwitch Virtual Machine – Connection Settings

Ø	Add Network Wizard	- 🗆 🗙
Virtual Machines - Conne Use network labels to ic	ection Settings lentify migration compatible connections common to two or more hosts.	
Connection Type Network Access Connection Settings Summary	Port Group Properties Network Label: VLAN-197 VLAN ID (Optional): Image: Constraint of the second	
<u> </u>	≤Back Next ≥	Cancel

5. On the Ready to Complete page, click Finish.

Figure 24. vSwitch Ready to Complete Page

Ø	Add Network Wizard 🛛 🚽 📉 🗙			
Ready to Complete Verify that all new and m	Ready to Complete Verify that all new and modified vSphere standard switches are configured appropriately.			
Connection Type Network Access Connection Settings Summary	Host networking will include the following new and modified standard switches: Preview: Vitual Machine Port Group VLAN_197 VLAN ID: 197			
< Back Finish Cancel				

External Switch Configuration

In order to implement the external switch, we need to take the same steps as the internal switch except we need to select a network interface card on Virtual Machine-Network Access page.

Server and Client Implementation

Virtual Machine Creation

The ultimate purpose of this project is to optimize the communication between the client and the server. The server and the client are the end points at either side the of LAN and are implemented through virtual machines. Following are the steps taken to create the virtual machines. This section needs to be done once for the client and once for the server.

1. Right click ESXi host name/IP address and select New Virtual Machine.

Figure 25. New Virtual Machine Wizard

File	e Edi	t View Inventory Administration Plug	-ins Help
		📓 🛛 🔄 Home 🕨 🚮 Inventory 🕨 🇊	Inventory
- 191		3	
	1 17	72.20.199.12 ESXITest2 V	Mware ESXi, 6.0.0, 3029758
	192	New Virtual Machine Ctrl+N	N. Summany Mirtual Machi
		New Resource Pool Ctrl+O	J Janmary Virtual Mach
		Enter Maintenance Mode	
		Rescan for Datastores	tus
		Add Permission Ctrl+P	
		Shut Down	
		Reboot	P
		Report Summary	depters
		Report Performance	Settings
		Open in New Window Ctrl+Alt+N	nagement

2. Select Custom and Click Next.



Ø	Create New Virtual Machine -	
Configuration Select the configuration fo	r the virtual machine	
Configuration Name and Location State a Within Version Guest Operating System CPUS Memory Network SCSI Controller Select a Disk Ready to Complete	Configuration Typical Create a new virtual machine with the most common devices and configuration options. Custom Create a virtual machine with additional devices or specific configuration options.	
	< Back Next >	Cancel

3. Select a Name and click Next.

Figure 27	Virtual	Machina	Nomo
$r_{1}guic 27$.	v muai	waching	

Ø	Create New Virtual Machine – 🗖 🗙
Name and Location Specify a name and locati	ion for this virtual machine
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Ready to Complete	Name: FSS Virtual machine (VM) names may contain up to 80 characters and they must be unique within each vCenter Server VM folder. VM folders are not viewable when connected directly to a host. To view VM folders and specify a location for this VM, connect to the vCenter Server.
	< Back Next > Cancel

4. Select a data store to place the virtual machine and click Next.

Figure 28. Virtual Machine Datastore

Ø	Crea	ate New Virtu	al Machine		- 🗆 🗙
Storage Select a destination storage for the virtual machine files					
Configuration	Select a destination sto	rage for the virtua	al machine files:		
Name and Location Storage	Name	Drive Type	Capacity Provis	ioned Free T	ype Thin Prov
Virtual Machine Version	datastore1(1)	Non-SSD	676.00 GB 503.5	9 GB 596.82 GB V	MFS5 Supporte
Guest Operating System	Test-Pool	Non-SSD	728.25 GB 81.12	GB 647.13 GB V	MFS5 Supporte
CPUs	Test-Storage	. Non-SSD	2.09 TB 404.5	7 GB 1.79 TB V	MFS5 Supporte
Network SCSI Controller Select a Disk Ready to Complete					
	<				>
	Disable Storage D	RS for this virtual	machine		
	Name	Drive Type	Capacity Provision	ed Free Typ	be Thin Provis
	<				>
				< Back Next >	Cancel

5. Select a Virtual Machine Version and click Next.

Figure 29. Virtual Machine Version

Ø	Create New Virtual Machine 🛛 – 🗖 🗙				
Virtual Machine Version					
<u>Configuration</u>	Virtual Machine Version				
Storage Virtual Machine Version	This host or cluster supports more than one VMware virtual machine version. Specify the virtual machine version to use.				
Guest Operating System	 Virtual Machine Version: 4 				
CPUs Memory Network	This version will run on VMware ESX 3.0 and later, and VMware Server 1.0 and later. This version is recommended when sharing storage or virtual machines with ESX up to 3.5.				
SCSI Controller	C Virtual Machine Version: 7				
Ready to Complete	This version will run on VMware ESX/ESXI 4.0 and later. This version is recommended when sharing storage or virtual machines with ESX/ESXI up to 4.1.				
	C Virtual Machine Version: 8				
	This version will run on VMware ESXi 5.0 and later. Choose this version if you need the latest virtual machine features and do not need to migrate to ESX/ESXi 4.				
	🔿 Virtual Machine Version: 9 / 🔔				
	This version will run on VMware ESXi 5.1 and later.				
	O Virtual Machine Version: 10 🛕				
	This version will run on VMware ESXi 5.5 and later.				
	• Virtual Machine Version: 11 A				
	This version will run on VMware ESXi 6 and later.				
	▲ If you use this client to create a VM with this version, the VM will not have the new features and controllers in this hardware version. If you want this VM to have the full hardware features of this version, use the vSphere Web Client to create it.				
	< Back Next > Cancel				

6. Select an appropriate operating system and click Next. For the server, select Windows Server 2012 R2 and for the client select Windows 10 (64-bit).

Figure 30. Virtual Machine Guest Operating System

Ø	Create New Virtual Machine	- 🗆 🗙
Guest Operating System Specify the guest operating	ng system to use with this virtual machine	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUS Memory Network SCSI Controller Select a Disk Ready to Complete	Guest Operating System:	ppropriate defaults for
	< Back N	ext > Cancel

7. Select the required number of CPUs and click Next.

Figure 31. Virtual Machine CPUs

Ø	Create New Virtua	l Machine		- 🗆 🗙
CPUs Select the number of virtu	al CPUs for the virtual machine.		Virtu	al Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Ready to Complete	Number of virtual sockets: Number of cores per virtual socket: Total number of cores: The number of virtual CPUs that you of depends on the number of CPUs on the number of CPUs supported by the gue The virtual CPU configuration specified might violate the license of the guest of Click Help for information on the numb processors supported for various gues systems.	2 an add to a VM ie host and the est OS. d on this page OS. er of st operating		
			< Back Next >	Cancel

8. Select the appropriate amount of RAM and click Next.

Figure 32. Virtual Machine Memory

Ø	Create New Virtual Machine	- 🗆 🗙
Memory Configure the virtual machine	's memory size.	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Ready to Complete	Memory Configuration 2 TB Memory Size: 4 4 3 GB • 1 TB guest OS: 4080 GB. 512 GB Maximum recommended for this 256 GB Default recommended for this 32 GB Minimum recommended for this 32 MB Minimum recommended for this 16 MB Minimum recommended for this 32 MB Minimum recommended for this 16 MB Minimum recommended for this 32 MB Minimum recommended for this 4 MB Minimum recommended for this	в.
	< Back	Next > Cancel

9. Select an appropriate port-group and click Next.

Figure 33. Virtual Machine Network

Ø	Create New Virtual Machine	- 🗆 🗙
Network Which network connectior	ns will be used by the virtual machine?	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Ready to Complete	Create Network Connections How many NICs do you want to connect? I I Network Adapter NIC 1: Branch-Office If E1000E If supported by this virtual machine version, more than 4 NICs can be a virtual machine is created, via its Edit Settings dialog. Adapter choice can affect both networking performance and migration co the VMware KnowledgeBase for more information on choosing among the supported for various guest operating systems and hosts.	Connect at Power On added after the added after the
	< Back	Next > Cancel

10. Leave the default for the SCSI controller and click Next.

Figure 34. Virtual Machine Disk Controller

Ø	Create New Virtual Machine	- 🗆 🗙
SCSI Controller Which SCSI controller type	would you like to use?	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Ready to Complete	SCSI controller BusLogic Parallel (not recommended for this guest OS) LSI Logic SAS VMware Paravirtual	
	< Back	Next > Cancel

11. Select create a new virtual disk and click Next.

Figure 35. Virtual Machine Disk Selection

Ø	Create New Virtual Machine 🛛 – 🗖 🗙
Select a Disk	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Create a Disk Advanced Options Ready to Complete	A virtual disk is composed of one or more files on the host file system. Together these files appear as a single hard disk to the guest operating system. Select the type of disk to use. Disk C Create a new virtual disk Reuse a previously configured virtual disk. Reuse a previously configured virtual disk. C Raw Device Mappings Give your virtual machine direct access to SAN. This option allows you to use existing SAN commands to manage the storage and continue to access it using a datastore. C Do not create disk
	<pre> < Back Next > Cancel</pre>

12. Select Thin Provision and click Next.

Figure 36. Virtual Machine Disk Size and Type

Ø	Create New Virtual Machine	- 🗆 🗙
Create a Disk Specify the virtual disk size	and provisioning policy	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUS Memory Network SCSI Controller Select a Disk Create a Disk Advanced Options Ready to Complete	Capacity Disk Size: 40 GB Disk Provisioning C Thick Provision Lazy Zeroed C Thick Provision Eager Zeroed C Thin Provision Location C Store with the virtual machine C Specify a datastore or datastore cluster: Browse	
	< Back No	ext > Cancel

13. Leave the default selected and click Next.

	Figure 37. Virtual Machine Disk Advanced Options
	Create New Virtual Machine
15	Virtual M

C C C C C C C C C C C C C C C C C C C	Create New Virtual Machine	~
Advanced Options These advanced options d	lo not usually need to be changed.	ual Machine Version: 11
Configuration Name and Location Storage Witual Machine Version Guest Operating System CPUs Memory Network SCSI Controller Select a Disk Create a Disk Advanced Options Ready to Complete	Specify the advanced options for this virtual disk. These options do not normally nee to be changed. Virtual Device Node SCSI (0:0) IDE (0:0) Mode Independent Independent disks are not affected by snapshots. C Persistent Changes are immediately and permanently written to the disk. C Nonpersistent Changes to this disk are discarded when you power off or revert to the snapshot.	d
	< Back Next >	Cancel

14. On the final page, select edit virtual machine settings before completion and click Finish.

Now move to the next section, which is operating system installation.

Figure 38. Virtual Machine Read to Complete

Ø	Create New Virt	ual Machine 🛛 🗕 🗖 📉 🗙
Ready to Complete Click Finish to start a task	that will create the new virtual machine	Virtual Machine Version: 11
Configuration Name and Location Storage Virtual Machine Version Guest Operating System CPUs Memorx Network SCSI Controller Select a Disk Create a Disk Create a Disk Advanced Options Ready to Complete	Settings for the new virtual machine: Name: Host/Cluster: Datastore: Guest OS: CPUs: Memory: NIC: NIC 1 Network: NIC 1 Network: NIC 1 Network: Out 1 Network: Out 2 Network: Out 2 Network: Disk capacity: Disk provisioning: Datastore: Virtual Device Node: Disk mode: ▲ Creation of the virtual machine settings between system. Install a guest OS on the	FSS ESXITest2. Test-Storage-Pool-Safe-To-Remove Microsoft Windows Server 2012 (64-bit) 2 4096 MB 1 Branch-Office E1000E LSIL ogic SAS New virtual disk 40 GB Thin Provision Test-Storage-Pool-Safe-To-Remove SCSI (0:0) Persistent
		< Back Continue Cancel

Server and Client Installation

Taking into consideration Windows Server 2012 R2 and Windows 10 installation involves similar steps, this section only goes through the installation of Windows Server 2012 R2.

 Picking up from previous section, click CD\DVD drive, select Datastore ISO File, browse to the location of Windows Server 2012 R2 ISO file, click OK two times and then click Finish.

Note: You should have already uploaded the Windows Server 2012 R2 ISO file to ESXi host datastore.

e e	FSS - Virtual Mac	chine Properties
Hardware Options Resources		
Show All Devices	Add Remove	Device Status
Hardware Hardware CPUs (adding) CPUs (adding) Video card (adding) VMCI device (adding) New CD/DVD (adding) New Floppy (adding) New SCSI Controller (add New NIC (adding) New Hard Disk (adding)	Add Remove Summary 4096 MB 2 Video card Deprecated [Test-Storage-Pool Client Device LSI Logic SAS Branch-Office Virtual Disk	 Connected Connect at power on Device Type Client Device Note: To connect this device, you must power on the virtual machine and then click the Connect CD/DVD button in the toolbar. Host Device Host Device Test-Storage-Pool-Safe-To-Remove Browse Mode Passthrough IDE (recommended) Emulate IDE Virtual Device Node IDE (1:0)
		Finish Cancel

Figure 39. Virtual Machine Properties
2. Right click the virtual machine and click Open Console.

Figure 40. Virtual Machine Menu Options

□ □ 172.20.199.12 □ Client □ CS1	ESXiTest2 VMware ESXi, 6.0.0, 3029758 Getting Started Summary Virtual Machin
CSR1	Hardware
FS FS	Processors
Guest	
Open Console	ters
Edit Settings Add Permission	Ctrl+P
Report Performance	
Open in New Window	. Ctrl+Alt+N
Remove from Inventory Delete from Disk	I Services Startup/Shutdown

3. Click the Power On button.

Figure 41. Virtual Machine Console



4. Let the Windows boot up and then click Next on Windows Set Up page.

Figure 42. Windows Server 2012 R2 Setup Page

Windows Setup	
Windows Server 2012 R2	
anguage to install: [English (United States)	
Time and currency formation (United States)	
Keyboard or input method: US	-
Enter your language and other preferences and click "Next" to continue.	
© 2013 Microsoft Corporation. All rights reserved.	Next

5. On the next screen click Install now.



🛥 Windows Setup				
Windows Server 2012 R2				
<u>I</u> nstall now				
Repair your computer © 2013 Microsoft Corporation. All rights reserved.				

6. Select an appropriate edition of Windows and click Next.

Figure 44. Windows Server 2012 R2 Edition Selection

Operating system	Architecture	Date modified
Windows Server 2012 R2 Standard (Server Core In:	stallation) x64	3/18/2014
Windows Server 2012 R2 Standard (Server with a 0	GUI) x64	3/18/2014
Windows Server 2012 R2 Datacenter (Sether Core I	Installation) x64	3/18/2014
Windows Server 2012 R2 Datacenter (Server with a	a GUI) x64	3/18/2014
his option is useful when a GUI is required—for ex pplication that cannot be run on a Server Core ins upported. You can switch to a different installation	xample, to provide backware stallation. All server roles and n option later. See "Window	d compatibility for an d features are s Server Installation
apporten rou constituite a anterent instantatio	- option laten bee minutes	
ptions.		

7. Accept the license terms and click Next.

Figure 45. Windows Server 2012 R2 License Terms

Your use of agreement customer, use may not use software fro	this software is subject to the terms and conditions of the license by which you acquired this software. If you are a volume license se of this software is subject to your volume license agreement. You this software if you have not validly acquired a license for the m Microsoft or its licensed distributors.
EULAID:WSB_	<pre>KVSID_V_en-us</pre>

8. Select Custom: Install Windows only (advanced).

Figure 46. Windows Server 2012 R2 Upgrade/Custom Installation

Windows Setup	
Which type of installation do you want?	
<u>Upgrade: Install Windows and keep files, settings, and applications</u> The files, settings, and applications are moved to Windows with this option. This option is only available when a supported version of Windows is already running on the computer.	
<u>Custom: Install Windows only (advanced)</u> The files, settings, and applications aren't moved to Windows with this option. If you want to make changes to partitions and drives, start the computer using the installation disc. We recommend backing up your files before you continue.	
Help me decide	

9. Select an appropriate drive to install Windows and click Next.

Figure 47. Windows Server 2012 R2 Dat	astore
---------------------------------------	--------

Name		Total size	Free space	Туре
🛹 Drive 0 Un	allocated Space	40.0 GB	40.0 GB	
≁ <u>R</u> efresh	Delete	■ Eormat	<mark>₩</mark> N <u>e</u> w	

10. Wait for the installation to finish.

Figure 48. Windows Server 2012 R2 Installation Progress



11. On the final page, enter a password and click Finish.

Figure 49. Windows Server 2012 R2 Settings

Setting	S	
Type a password for the	built-in administrator account that you can use to sign in to this computer.	
<u>U</u> ser name	Administrator	
<u>P</u> assword	••••••	
Reenter password	······	
		PT 1.1
		Finish

Network Share Set up

In order to test the implementation, a network share was set up on the Server with the following share and NTFS permission.

Fig	ure 50. Windows	File Share/Shar	e Permission
鷆 Share		8/21/	2016 9:46 AM
1.	Share Pi	roperties	×
.	Permissio	ons for Share	×
Share Per	missions		
Group or	user names:		
Sec. Eve	ryone		
		Add	Remove
Permissio	ons for Everyone	Allow	Deny
Full Co	ntrol		
Chang	e	✓	
Read			
	ОК	Cancel	Apply

Figure 51. Windows File Share NTFS Permission

📙 Share	8/21/2016 9:46 AM
👃 Share Prope	erties ×
General Sharing Security Previous	Versions Customize
Object name: C:\Share	
Group or user names:	
& CREATOR OWNER	
SYSTEM Administrators (XYZ)Administrators	6
Lisers (XYZ\Users)	-7
To change permissions, click Edit.	Edit
Permissions for Users	Allow Deny
Full control	_
Modify	~
Read & execute	✓ =
List folder contents	~
Read	~
Write	✓ ✓
For special permissions or advanced se click Advanced.	ttings. Advanced
Close	Cancel Apply

Cisco CSR1000v Cloud Services Router Implementation

Two Cisco CSR1000v Cloud Services Routers appliances are implemented in this project and they will be connected to the Dummy Cloud WAN Emulator from one side and to the Riverbed Virtual Steelhead appliances on the other side. Below is the step by step procedure to implement a Cisco CSR1000v appliance. Configurations for each one of the appliances are provided in the appendices section.

1. From file menu in the vSphere Client, click Deploy OVF Template.



Figure 52. Deploying an OVF Template

2. Browse to the location of Cisco virtual router OVA file and click Next.

Figure 53. OVF Template Source

Ø	Deploy OVF Template			×
Source Select the source location.				
Source OVF Template Details Name and Location Storage Disk Format Ready to Complete	Deploy from a file or URL Intverselk9.03.11.02.5.154-1.52-std-C1-M2560-N3-D58.ova ▼ Browse Enter a URL to download and install the OVF package from the Internet, or specify a location accessible from your computer, such as a local hard drive, a network share, or a CD/DVD drive.			
	≤Back Next ≥	C	Cancel	

3. On the next page, click Next.

Figure 54. OVF Template Details							
Ø		Deploy OVF Template		- 🗆 🗙			
OVF Template Details Verify OVF template detail	5.						
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Product: Version: Vendor: Publisher: Download size: Size on disk: Description:	Cisco CSR 1000V Cloud Services Router 03.11.02.S.154-1.S2-std Cisco Systems, Inc. No certificate present 267.5 MB 546.9 MB (thin provisioned) 8.3 GB (thick provisioned)					
		< Ba	ock Next >	Cancel			

4. Pick up a Name and click Next.

Figure 55. OVF Name

Ø	Deploy OVF Template -			×
Name and Location Specify a name and location	on for the deployed template			
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Name: <u>Cisco CSR_1000V Cloud Services Router</u> The name can contain up to 80 characters and it must be unique within the inventory folder.			
	< Back Next >	C	ance	=

5. Select a data store and click Next.

Figure 56. OVF Datastore

Ø	C	Deploy OVF Te	emplate	-	
Storage Where do you want to sto	re the virtual machine file:	s?			
Source	Select a destination sto	rage for the virtua	I machine files:		
OVF Template Details	Name	Drive Type	Capacity Provisioned	Free Type	Thin Prov
Storage	datastore1(1)	Non-SSD	676.00 GB 503.59 GB	596.82 GB VMFS5	Supporte
Disk Format	Test-Pool	Non-SSD	728.25 GB 81.12 GB	647.13 GB VMFS5	Supporte
Network Mapping	Test-Storage	. Non-SSD	2.09 TB 327.75 GB	1.86 TB VMFS5	Supporte
	Disable Storage Di Select a datastore:	RS for this virtual r	machine Capacity Provisioned	Free Type	> Thin Provis
	<				>
			< Back	Next >	Cancel

6. Select Thin Provision and click Next. (For production environment. It is recommended to use thick disks)

Figure 57. OVF Disk Format
Deploy OVF Template

Ø	Deploy OVF Template	_ 🗆 🗙
Disk Format In which format do you wa	ant to store the virtual disks?	
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Datastore: Test-Storage-Pool-Safe-To-R Available space (GB): 1907.5 C Thick Provision Lazy Zeroed C Thick Provision Eager Zeroed C Thin Provision	
	<u>≤</u> Back Next ≥	Cancel

7. Select an appropriate VLAN for each interface and click Next.

Figure 58. OVF Network Mapping							
0	Deploy O\	/F Template	- 🗆 🗙				
Network Mapping What networks should the	deployed template use?						
Source OVF Template Details Name and Location	Map the networks used in this OV	F template to networks in your inventory					
Storage	Source Networks	Destination Networks					
Disk Format	GigabitEthemet1	VLAN-197					
Network Mapping	GigabitEthemet2	VLAN-198					
Ready to Complete	GigabitEthemet3	WAN-200					
		< Back Next >	Cancel				

8. Select Power on after deployment and click Finish.

Figure 59. OVF Ready to Complete							
Ø	Deploy OV	F Template – 🗖 🗙					
Ready to Complete Are these the options yo	pu want to use?						
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	When you dick Finish, the deployment settings: Deployment settings: OVF file: Download size: Size on disk: Name: Host/Cluster: Disk provisioning: Network Mapping: Network Mapping:	eent task will be started. E:\Project\csr1000v-universalk9.03.11.02.S.154-1.S2-std 267.5 MB 546.9 MB Cisco CSR 1000V Cloud Services Router ESXITest2. Test-Storage-Pool-Safe-To-Remove Thin Provision "GigabitEthernet1" to "VLAN-197" "GigabitEthernet2" to "VLAN-198" "GigabitEthernet3" to "WAN-200"					
1		< Back Finish Cancel					

Riverbed Virtual Steelhead CX 755V Implementation

Two Riverbed Virtual Steelhead appliances are implemented in this project and they will be connected to two Cisco CSR1000V cloud services routers and LAN switches on each side of the WAN connection. Below is the step by step procedure to implement a Riverbed Virtual Steelhead appliance. Initial configurations for each one of the appliances are provided in the appendices section.

1. From file menu in the vSphere Client, click Deploy OVF Template.



Figure 60. Deploying an OVF Template

2. Browse to the location of Riverbed Virtual Steelhead CX 755V OVA file and click Next. Figure 61. OVF Template Source

Ø	Deploy OVF Template	-		×
Source Select the source location.				
Source OVF Template Details Name and Location Storage Disk Format Ready to Complete	Deploy from a file or URL E: ProjectVimage_rbt_vcx_9_1_2_n27_x86_64.ova ▼ Browse Enter a URL to download and install the OVF package from the Internet, or specify a location accessible from your computer, such as a local hard drive, a network share, or a CD/DVD drive.]		
	< Back Next >		Cance	

3. On the next page, click Next.

Figure 62. OVF Template Details						
Ø		Deploy OVF Template – 🗖 🗙				
OVF Template Details Verify OVF template detail	s.					
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Product: Version: Vendor: Publisher: Download size: Size on disk: Description:	Riverbed Steelhead 9.1.2 Riverbed Technology, Inc. No certificate present 902.6 MB 1.9 GB (thin provisioned) 88.0 GB (thick provisioned) Riverbed Steelhead 9.1.2 (steelhead/baffin/point/9.1.2/27/x86_64/)				
		< Back Next > Cancel				

4. Pick up a Name and click Next.

Figure 63. OVF Name

Ø	Deploy OVF Template -	
Name and Location Specify a name and location	on for the deployed template	
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Name: [Style=bed Steelhead] The name can contain up to 80 characters and it must be unique within the inventory folder.	
	< Back Next >	Cancel

5. Select a data store and click Next.

		1 12		I Dutubt	010			
1		D	eploy OVF T	emplate			—	
Storage Where do you want to s	store the vi	rtual machine files	5?					
Source	Select	a destination stor	age for the virtu	al machine files	:			
OVF Template Details	Nam	e	Drive Type	Capacity	Provisioned	Free	Туре	Thin Pr
Storage	8	datastore1(1)	Non-SSD	676.00 GE	3 503.59 GB	596.82 GB	VMFS5	Suppo
Disk Format		Test-Pool	Non-SSD	728.25 GE	81.12 GB	647.13 GB	VMFS5	Suppo
Network Mapping		Test-Storage	Non-SSD	2.09 TE	3 327.75 GB	1.86 TB	VMFS5	Suppo
	<	Disable Storage DR	RS for this virtual	machine				
	<	Disable Storage DF :t a datastore: e	S for this virtual	machine Capacity F	Provisioned	Free	Туре	Thin Pro
	< Selec	Disable Storage DF it a datastore: e	25 for this virtual	machine Capacity F	Provisioned	Free	Туре	Thin Pro

6. Select Thin Provision and click Next. (For production environment. It is recommended to use thick disks)

Figure 65. OVF Disk Format							
Ø	Deplo	oy OVF Template		- 🗆 ×			
Disk Format In which format do you w	ant to store the virtual disks?						
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Datastore: Available space (GB): C Thick Provision Lazy Zer C Thick Provision Eager Ze Thin Provision	Test-Storage-Pool-Safe-To-R 1907.5 oed roed					
		<	Back Next >	Cancel			

7. Select an appropriate VLAN for each interface and click Next.

	Figure 66. OV	F Network Mapping	
Ø	Deploy O	VF Template	- 🗆 ×
Network Mapping What networks should th	ne deployed template use?		
Source OVF Template Details Name and Location	Map the networks used in this O	/F template to networks in your inventory	
Storage	Source Networks	Destination Networks	
Disk Format	Primary	HeadQuarter	
Network Mapping	Aux	HeadQuarter	
Ready to Complete	LAN	Branch-Office	
	WAN	VLAN-197	
	Description:		Ŷ
	Warning: Multiple source networl	s are mapped to the host network: HeadQuarter	
		< Back Next >	Cancel

8. Select Power on after deployment and click Finish.

Figure 67. OVF Ready to Complete

0	Deploy O	VF Template – 🗖 🗙
Ready to Complete Are these the options yo	ou want to use?	
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	When you click Finish, the deploted Deployment settings: OVF File: Download size: Size on disk: Name: Host/Cluster: Datastore: Disk provisioning: Network Mapping: Network Mapping:	yment task will be started. E:\Project\image_rbt_vox_9_1_2_n27_x86_64.ova 902.6 MB 1.9 GB Riverbed Steelhead ESXITest2. Test-Storage-Pool-Safe-To-Remove Thin Provision "Primary" to "HeadQuarter" "Aux" to "HeadQuarter" "Aux" to "HeadQuarter" "LAN" to "Branch-Office" "WAN" to "VLAN-197"
		< Back Finish Cancel

Riverbed Virtual Steelhead CX 755V Optimization Configuration

Configuring Virtual Steelhead CX 755V in Branch Office

1. Enter the management IP address of the headquarter Virtual Steelhead that was configured during initial configuration in your browser. Then enter your username and password.

Figure 68. Riverbed Steelhead Authentication



 Once logged in, navigate to Administration →Licenses and enter your trial or production licenses. The optimization service will not start until the time the appliance is licensed.

Figure 69. Riverbed Steelhead Licenses

• 1	OC2 / SteelHead [™] VCX	ip 172.20.1	98.30 • VCX (VC	X555H) (x86_64) • 9	9.1.2 • uptime 3 we	eks, 6 days 🔸 S	at 08:26 GMT +0000	adm
	D/	ASHBOARD	NETWO	RKING OPT	IMIZATION	REPORTS	ADMINISTRATI	ION
		-		MAINTENANCE	SECURITY		SYSTEM SETTINGS	
LI	CENSES Maintenance > Licen	ses 🕐		Services	General Se	ttings	Announcements	
				Scheduled Jobs	Oser Perm Decovord	issions Policy	Alarms Date/Time	
O A	Add a New License 💿 Remove Select	ed		Software Upgrade	RADIUS	oncy	Monitored Ports	
	License	De	scription	Keboot/Shutdown		.1+		
	LK1-FIPS-428A-42E4-5-C2B2-D4E9	-8571 Fec Pro	deral Informa ocessing Stan		Manageme Web Settin REST API A	ant ACL gs cress	SNMP ACLs Email Logging	
	LK1-SH10BASE-0000-0000-5-E0C1 -A7B7	-6D8B Sca (SD	alable Data R)R)				My Account Configurations	
	LK1-MSPECVCX755H-428A-42E4-5 041D-8CF7	-6A66- Mo Spe	odel VCX755H ecification	Vi 20	alid through 016/11/19	Sun Aug 2 GMT (10 w	1 2016 12:12:39 reeks, 5 days ago)	М

3. Once the appliance is licensed, restart the optimization service by navigating to Administration→Services and then click the restart bottom.

	Figure /0. Riverbed Steelnead Services					
WUUZ / SteelHead [™] VCX	ip 172.20.198	3.30 • VCX (VCX555H) (x8	:6_64) • 9.1.2 • uptime 3 v	weeks, 6 days 🔸 Sa	at 08:28 GMT +00	00 admin Sigr
	DASHBOARD	NETWORKING	OPTIMIZATION	REPORTS	ADMINIST	RATION H
Services Maintenance > 5	iervices ⑦			E s	ave to Disk 🥤	Ə Restart Servi
Optimization Service						
Restarting the optimization service a seconds.	will disrupt existing	3 network connection	s being proxied throug	gh this appliand	te. Restarting r	may take a few
Clear Data Store (applies only to s	starting and restartiv	ng the service)				
Status: running				Stop	Start	Restart

4. In order to optimize a specific application or specific kind of traffic, we need to create optimization rules, which work very similar to firewall rules. Optimization service checks the rules from top to bottom and where there is a match to a rule, it will apply that rule. In-path rule is configured on the steelhead appliance where a new connection is being stablished by a client. It does this to determine the steelhead behavior with TCP sync packet being sent.

In order to create an In-Path rule, navigate to Optimization \rightarrow In-Path Rules and then click Add a New In-Path Rule. Select Auto Discover for the type, and then enter the source and destination subnet leaving all the other options to the default, and then click Apply.

Figure 71. Riverbed Steelhead In-Path Rule

Ac	ld a New I	in-Path Rule ₍₂₎ Rem	iove Selected Rule	es 👫 Move Selected Rules				
	Rule	Туре	Source	Destination	VLAN	Protocol	Preoptimization Poli	icy La
	▼ 1	Auto Discover	172.20.198.0/24	4:* 172.20.197.0/24:*	All		None	N
	Type:		Auto Dis	scover	-			
	Source	Subnet:	172.20.	198.0/24				
	Destina	tion Subnet:	172.20.	197.0/24		F	Port or Port Label: all	
	VLAN T	ag ID:	all					
	Preopti	mization Policy:	None	•				
	Latency	Optimization Policy	: Normal	-				
	Data Re	duction Policy:	Normal	-				
	Cloud A	cceleration:	Auto	•				
	Auto Ki	ckoff:						
	Neural	Framing Mode:	Always	-				
	WAN VI	sibility Mode:	Correct	Addressing 🔹				
	Descrip	tion:						
	Enable	Rule:	V					
	Ар	ply						

Note: Auto Discover type use TCP SYN packet to automatically discover if the remote Steelhead appliance is able to optimize the traffic being attempted.

Configuring Virtual Steelhead CX 755V in Headquarter

- 1. Follow the steps 1 to 3 from the previous section to login, license and start the Riverbed appliance service.
- 2. Configure a Peering rule by navigating to Optimization \rightarrow Peering Rules to accept connection attempts for In-Path rule created earlier in the previous section.

Figure 72. Riverbed Steelhead Peering Rule Peering rules allow you to define appliance peering relationships. Note that only the first matching rule will be applied.

T T	Sett En	ings able Enhance able Extende	ed Auto-Disc d Peer Table	overy : 🕰					
	Арр	bly							
	🔂 Ad	ld a New Peei	ring Rule 🙁	Remove Selected Rules	H Move Selected Rule	25			
		Number	Туре	Source	Destination	Port	Peer	SSL	Cloud /
			Accept	172.20.198.0/24	172.20.197.0/24	All	All-IPv4	No Check	Auto
Description: Peering rule from Branch-Office to Head			adQuarter						
		▶ 2	Pass	All-IP	All-IP	All	All-IPv4	Incapable	Auto

3. On the Peering Rules page click Add a New Peering Rule. For the Rule Type select Accept, enter source and destination subnet, leave all other options to the default and click Apply.

Figure 73. Riverbed Steelhead Peering Rule Settings

▼ 1	Accept	172.20.198.0/24	172.20.197.0/24
	, accept	172120115010724	T/ EIEOTTS/TO/ET

Rule Type:	Accept 🔹				
Source Subnet:	172.20.198.0/24				
Destination Subnet:	172.20.197.0/24			Port:	all
Peer IP Address:	All-IPv4	SSL Capability: N	o Check 💌		
Cloud Acceleration:	Auto 💌				
Description:	Peering rule from I	Branch-Office to Hea	idQuarter		

Description: Peering rule from Branch-Office to HeadQuarter

As per the rule configured between the two Steelhead appliances, all IPv4 traffic between the specified source and destination subnets will be optimized. For the purpose of this project, SMB3 traffic is optimized.

Dummy Cloud WAN Emulator Implementation

One Dummy Cloud virtual appliance is implemented in this project and it is connected to two Cisco CSR1000V cloud services routers from either side. Below is the step by step procedure to implement Dummy Cloud virtual appliance. Configuration for the appliance is provided in the appendices section.

1. From file menu in the vSphere Client, click Deploy OVF Template.

		~	
¢	2		
	File	Edit View Inventory Admin	nistration Plug-ins Help
		New •	entory 🕨 🗊 Inventory
		Deploy OVF Template	
_		Export •	
П		Report •	ESXITest2 VMware ESXI, 6.0.0, 3029758
		Print Maps 🕨	Getting Started Summary Virtual Machines
H		Exit	Hardware
L		Dummy_Cloud	Health Status
I.		👘 FS	Processors
I.		woci	Memory
I.		I WOLL	Storage

Figure 74. Deploying an OVF Template

2. Browse to the location of Dummy Cloud WAN Emulator OVA file and click Next.

	Figure 75. OVF Template Source	
Ø	Deploy OVF Template	- 🗆 🗙
Source Select the source location		
Source OVF Template Details Name and Location Storage Disk Format Ready to Complete	Deploy from a file or URL E:\Project\Dummy_Cloud-VM_3.1.4\Dummy_Cloud_VM_3.1.4 Enter a URL to download and install the OVF package from the Internet, or specify a location accessible from your computer, such as a local hard drive, a network share, or a CD/DVD drive.	
	< Back Next >	Cancel

3. On the next page, click Next.

	Fig	ure 76. OVF Template	Details	
Ø		Deploy OVF Template		- 🗆 ×
OVF Template Details Verify OVF template details	5.			
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Product: Version: Vendor: Publisher: Download size: Size on disk: Description:	Dummy_Cloud_VM_3.1.4 No certificate present 322.0 MB 772.8 MB (thin provisioned) 1.0 GB (thick provisioned) Dummy Cloud		
			< Back Next >	Cancel

4. Pick up a Name and click Next.

Figure 77. OVF Name

Ø	Deploy OVF Template – 🗖 🗙
Name and Location Specify a name and locat	ion for the deployed template
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Name: Dummy_Cloud_VM_3.1.4 The name can contain up to 80 characters and it must be unique within the inventory folder.
	< Back Next > Cancel

5. Select a data store and click Next.

		Figu	re 78. OVI	F Datastore	•			
Ø		D	eploy OVF T	emplate			-	
Storage Where do you want to store	e the v	irtual machine files	?					
Source OVE Template Details	Select	a destination stor	age for the virtu	al machine files:				
Name and Location	Nam	e	Drive Type	Capacity	Provisioned	Free	Туре	Thin Prov
Storage		datastore1 (1)	Non-SSD	676.00 GB	503.59 GB	596.82 GB	VMFS5	Supporte
Disk Format		Test-Pool	Non-SSD	728.25 GB	81.12 GB	647.13 GB	VMFS5	Supporte
		Disable Storage DR t a datastore:	1.5 for this virtual	machine				>
	< Nam	e	Drive Type	Capacity Pr	ovisioned	Free	Туре	Thin Provis
					< Back	Next	>	Cancel

Select Thin Provision and click Next. (For production environment. It is recommended to use thick disks)
 Figure 79, OVE Disk Format

	riguic / 9	. OVE DISK FOIMAL		
Ø	Deplo	oy OVF Template		- 🗆 ×
Disk Format In which format do you wa	ant to store the virtual disks?			
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	Datastore: Available space (GB): Thick Provision Lazy Zer Thick Provision Eager Zo Thin Provision	Test-Storage-Pool-Safe-To-R 1907.5 roed eroed		
			< Back Next >	Cancel

7. Select an appropriate VLAN for each interface and click Next.

	Figure 80. OVF	Network Mapping	
Ø	Deploy O	VF Template -	- 🗆 🗙
Network Mapping What networks should the o	deployed template use?		
Source OVF Template Details Name and Location	Map the networks used in this O	VF template to networks in your inventory	
Storage	Source Networks	Destination Networks	
Disk Format Network Mapping	bridged	WAN-200	
Ready to Complete	Description:		~ ~
	Warning: Multiple source networ	rks are mapped to the host network: WAN-200	Cancel
		< Back Next >	Cancel

8. Select Power on after deployment and click Finish.

Figure 81. OVF Ready to Complete

Ø	Deploy OV	F Template – 🗖	×
Ready to Complete Are these the options yo	pu want to use?		
Source OVF Template Details Name and Location Storage Disk Format Network Mapping Ready to Complete	When you dick Finish, the deploym Deployment settings: OVF file: Download size: Size on disk: Name: Host/Cluster: Disk provisioning: Network Mapping: Network Mapping: Network Mapping:	nent task will be started. E:\Project\Dummy_Cloud-VM_3.1.4\Dummy_Cloud_VM 322.0 MB 772.8 MB Dummy_Cloud_VM_3.14 ESXITest2. Test-Storage-Pool-Safe-To-Remove Thin Provision "bridged" to "WAN-200" "custom" to "WAN-200"	_3
		< Back Finish Canc	el

Test Procedure

WAN Optimization Test Plan 8.0 provided by Riverbed was used to set up and test the implementation set-up. Following steps were taken to set up the test procedure:

- A Windows file share that was part of Active Directory domain (xyz.local) was set up in the headquarter as the repository to download and upload files.
- A Windows client part of Active Directory domain (xyz.local) was set up in the branch office to download and upload files from and to the network share.
- Riverbed virtual steelhead appliance CX 755V was set up and configured in each site to optimize SMB traffic. (SMB traffic from the client to the server and vice versa was forced through Riverbed appliances)
- Typical test files were put on the file server to be downloaded by the client. (Riverbed recommends files of different types and sizes)
- Un-optimized operations: Files were downloaded by the client from the server bypassing Riverbed Virtual Steelhead appliances. Stop watch was used to estimate the amount of time that it took for the files to be copied.
- **Optimized operations:** Same files were downloaded by the client from the server with Riverbed Virtual Steelhead configured between the client and server and simultaneously stop watch was used to estimate the amount of time that it took for the files to be copied. There are performance improvements for the first few times that the files are copied.
 - Cold test: "Because most WAN optimizers include a data store and some type of compression, the first optimized test will often show very little performance improvement and a reduction in bandwidth use." [9]
 - Warm test: "The second time an operation is performed will often show more dramatic improvements." [9]
- Results from Un-optimized operations and Optimized operations were compared.

Results Analysis

Although there are performance improvements in terms of WAN bandwidth and time for files of different sizes, as the size of files gets larger, savings in terms of bandwidth and time are much more considerable. As a result, considering WAN optimizers for data transfers requires an

understating of the sizes of files to be transferred so that proper decisions could be made. For this project, two files were selected to be transferred in un-optimized, optimized (cold test), and optimized (warm test) fashion and the results are provided below.

The result for transfer of a file with the size of 8,594 KB is provided in the table below.

File Size	8,594 KB
un-optimized test	25.43 seconds
optimized (cold test)	21.61 seconds
optimized (warm test)	2 seconds

The following diagram taken from Riverbed appliance reporting section also demonstrates the cold and warm test transfer over LAN and WAN. For the first transfer (cold test), LAN throughput is very low and is taking longer time compared to the second transfer, which has a sharp spike in the LAN throughput and is taking over much less time. At the same time, in the WAN throughput diagram (graph at the bottom), it can be noted that the first transfer is taking longer time with less throughput compared to the second transfer.



File Size	280,418 KB
un-optimized test	16.21 minutes
optimized (cold test)	16.08 minutes
optimized (warm test)	7.67 seconds

The result for transfer of a file with the size of 280,418 KB is provided in the table below.

The following diagram also demonstrate LAN and WAN throughput over time for cold and warm test transfers. As it can be noticed in the diagram, bandwidth and time savings for this large file is much noticeable and considerable compared to the previous file transfer.

Figure 83. Riverbed Steelhead Optimized Throughput



Issue and Challenges

There were two main challenges in the implementation of this project. One challenge was to find a scenario to implement various components of the project in a test environment using limited lab resources. Another challenge was WAN emulation, which also affected the scenario that was used to implement different components of the project.

After working out through the project for some time, it was understood that emulating WAN is the main challenge of the project and it affected the scenario that was used to implement the whole project. Taking into consideration that most WAN emulators from known vendors come in form of physical appliances, which also come at a cost, a more cost efficient method had to be used, which was a virtual appliance. After some research, it was also noticed that virtual appliances that emulate WAN need to work in routed mode not bridge mode so that they can be implemented in the virtualization environment. After some research, Dummy Cloud was used to implement WAN emulation. At the same time, a single HP Proliant DL380 G6 server platform along with baremetal virtualization technology from VMware (VMware vSphere ESXi version 6) was used to implement all project components.

The network infrastructure implementation was an important part of the project and all the network infrastructure had to be implemented through a single hardware server platform. Implementation of the LANs in a way that the traffic from LAN connected machines only flows through WAN optimization appliances was also another challenge. Finally, taking into consideration that WAN optimization technology is relatively new compared to other technologies such as operating system from Microsoft, there were some difficulties on finding information on setting up and troubleshooting WAN optimizers from Riverbed.

Conclusion

In order to increase productivity, provide ubiquitous access, enhance collaboration, and reduce costs, companies of various sizes have deployed their applications over wide area network (WAN) connections. At the same time, recent trends toward virtualization and cloud computing, data center consolidation, and increased demand for data backup and recovery have placed huge demand on WAN connections and changed the way applications are delivered. Taking into considerations the limitations of WAN connections and massive demand on these connections, enterprise IT organizations have felt the need to optimize their WAN environments to improve network availability, reliability, and performance. The WAN optimizer from Riverbed used in this project accelerated file transfers between the two WAN end points by considerable amount. However, companies need to have a clear understanding of the type and size of the files if they plan to implement WAN optimization. WAN Optimization Controllers are useful in transferring files over WAN connections, but the real advantage comes when the sizes of files are large once compared to files of few Megabytes or Kilobytes.

Although WAN optimization industry is new compared to other industries such operation systems, the demand for WAN Optimization Controller has been very high in the past recent years and continue to grow. The fact that WAN optimization market is estimated to reach \$12.1 billion in 2019 proves the matter. [7] As a result, the industry will demand for more and more professionals with expertise in the field of WAN optimization.

Appendices and References

Cisco Virtual Router Configurations

CSR1#show run

Building configuration...

Current configuration : 1092 bytes ! Last configuration change at 20:03:26 UTC Sat Aug 20 2016 version 15.4 service timestamps debug datetime msec service timestamps log datetime msec no platform punt-keepalive disable-kernel-core platform console virtual hostname CSR1 1 boot-start-marker boot-end-marker 1 enable secret 5 \$1\$JXka\$jhMvy.pl5kvhwDt3xNb2S. no aaa new-model no ip domain lookup subscriber templating multilink bundle-name authenticated license udi pid CSR1000V sn 93UW7H831L0 redundancy mode none interface GigabitEthernet1 ip address 172.20.197.11 255.255.255.0 negotiation auto interface GigabitEthernet2 ip address 172.20.200.201 255.255.255.0 negotiation auto virtual-service csr mgmt

1 ip forward-protocol nd no ip http server no ip http secure-server ip route 172.20.198.0 255.255.255.0 172.20.200.211 1 control-plane line con 0stopbits 1 line aux 0 stopbits 1 line vty 0 password 123 login line vty 1 password 123 login length 0 line vty 2 4 password 123 login line vty 5 15 password 123 login End

CSR2#show run

Building configuration...

Current configuration : 1071 bytes ! ! Last configuration change at 16:45:44 UTC Mon Sep 5 2016 ! version 15.4 service timestamps debug datetime msec service timestamps log datetime msec no platform punt-keepalive disable-kernel-core platform console virtual ! hostname CSR2 ! boot-start-marker boot-end-marker

! enable secret 5 \$1\$KbAe\$I3qTIaQyRYIK13FGLCry91 1 no aaa new-model subscriber templating multilink bundle-name authenticated 1 license udi pid CSR1000V sn 94NSWC1TV55 redundancy mode none interface GigabitEthernet1 ip address 172.20.198.12 255.255.255.0 negotiation auto interface GigabitEthernet2 ip address 172.20.200.202 255.255.255.0 negotiation auto virtual-service csr mgmt ip forward-protocol nd no ip http server no ip http secure-server ip route 172.20.197.0 255.255.255.0 172.20.200.212 control-plane line con 0 stopbits 1 line aux 0 stopbits 1 line vty 0 password 123 login line vty 1 password 123 login length 0 line vty 2 4 password 123 login line vty 5 15

password 123 login ! end

Riverbed Configuration

WOC1- Headquarter Site





WOC2- Branch Site

File View VM Image: Image: WOC2 Image: Woc2
 Hostname: WOC2 Use DHCP on primary interface: no Primary IP address: 172.20.198.30 Netmask: 255.255.255.0 Default gateway: 172.20.198.12
1. Hostname: WOC2 2. Use DHCP on primary interface: no 3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
1. Hostname: WOC2 2. Use DHCP on primary interface: no 3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
1. Hostname: WOC2 2. Use DHCP on primary interface: no 3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
1. Hostname: WOC2 2. Use DHCP on primary interface: no 3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
1. Hostname: WOC2 2. Use DHCP on primary interface: no 3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
3. Primary IP address: 172.20.198.30 4. Netmask: 255.255.255.0 5. Default gateway: 172.20.198.12
5. Default gateway: 172.20.198.12
E Deturne DNS concert 172 20 107 20
7. Domain name: xyz.local
8. Admin password: Barez@Pass 9. SMTP server:
10. Notification email address: 11. Set the primary interface speed: auto
12. Set the primary interface duplex: auto
14. In-Path IP address: 172.20.198.32
15. In-Path Netmask: 255.255.25.0 16. In-Path Default gateway: 172.20.198.12
17. Set the in-path:LAN interface speed: auto 18. Set the in-path:LAN interface duplex: auto
19. Set the in-path:WAN interface speed: auto
To change an answer, enter the step number to return to. Otherwise hit <enter> to save changes and exit.</enter>
Choice: _

Figure 85. Riverbed Steelhead WOC2 Initial Configuration

Figure 86. Riverbed Steelhead Peering Rule

Add a New Peering Rule
 Remove Selected Rules
 Move Selected Rules...

Number	Туре	Source	Destination
	Accept	172.20.198.0/24	172.20.197.0/24
 Description: Peering ru	ile from Branch-Offic	e to HeadQuarter	
Edit Peering Rule 1:			
Rule Type:	Accept 💌		
Source Subnet:	172.20.198.0/24		
Destination Subnet:	172.20.197.0/24		Port: all
Peer IP Address:	All-IPv4	SSL Capability: No Check 💌	
Cloud Acceleration:	Auto 💌		

Apply

Description:

Figure 87. Riverbed Steelhead In-Path Rule

Peering rule from Branch-Office to HeadQuarter

Rule	Туре	Source	2	Destination	VLAN	Protocol	Preoptimization Policy
▼ 1	Auto Discover	172.20).198.0/24:*	172.20.197.0/24:*	All		None
Type:			Auto Discover		•		
Source Su	ibnet:		172.20.198.0/2	24			
Destinatio	on Subnet:		172.20.197.0/2	24			Port or Port Label: all
VLAN Tag	ID:		all				
Preoptimi	ization Policy:		None	•			
Latency C	ptimization Policy:		Normal	•			
Data Redu	uction Policy:		Normal	•			
Cloud Acc	eleration:		Auto	•			
Auto Kick	off:						
Neural Fr	aming Mode:		Always 💌				
WAN Visik	pility Mode:		Correct Addre	ssing 🔹			
Descriptio	on:						
Enable Ru	lle:		V				

Apply

WAN Emulator Configuration

Figure 88. Dummy Cloud Emulator WAN Emulation Configuration

💋 Dummy_Cloud on ESXiTest2 – 🗖 🗙
File View VM
Dummy Cloud -> Main Menu -> WAN Emulation
 Show status of Dummy Cloud Set NIC1 <-> NIC2 Link Bandwidth Set NIC1 <-> NIC2 Link Round Trip Time 4 Set NIC1 <-> NIC2 Link Round Trip Time 4 Set NIC1 <-> NIC2 Link Round Trip Time 5 Set NIC1 <-> NIC2 Link Bandwidth 5 Set NIC1 <-> NIC3 Link Bandwidth 6 Set NIC1 <-> NIC3 Link Round Trip Time 7 Set NIC1 <-> NIC3 Link Round Trip Time 7 Set NIC2 <-> NIC3 Link Bandwidth 8 Set NIC2 <-> NIC3 Link Bandwidth 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 9 Set NIC2 <-> NIC3 Link Round Trip Time 10ut=0.00%/In=0.00% Loss=0.00% 10ut=0.00%/In=0.00% Loss=0.00% 10ut=0.00%/In=0.00% Loss=0.00%
<mark>[]К_] Cancel</mark> [Copyright (с) ЛиммуСloud.Сом 2009-2012 All Rights Reserved]

Figure 89. Dummy Cloud Emulator Advanced Network Settings

C ²	Dummy_Cloud_VM_3.1.4 on ESXi0 - U
File View VM	
Di	MMy Cloud -> Main Menu -> Network Settings Select from the following options:
2 3 4 5 6 7 8 8 8 X	Show status of Dummy CloudSet IP Address on NIC1[172.20.200.211]Set IP Address on NIC2[172.20.200.212]Set IP Address on NIC3[192.168.30.1]Set Default Gateway[]Configure Routing[]Configure Bridge Mode[]Configure VRRPAdvanced Network SettingsReturn to previous Menu[]
[Copyright	Cancel (c) DummyCloud.Com 2009-2012 All Rights Reserved]



Figure 90. Dummy Cloud Emulator Static Routes

Figure 91. Dummy Cloud Emulator Advanced WAN Emulation Configuration

🕗 Dummy_Cloud on ESXiTest2 – 🗖 🔤
File View VM
Dummy Cloud -> Main Menu -> WAN Emulation
Show status of Dummy Cloud2 Set NIC1 <-> NIC2 Link Bandwidth3 Set NIC1 <-> NIC2 Link Round Trip Time4 Set NIC1 <-> NIC2 Link Packet Loss5 Set NIC1 <-> NIC3 Link Bandwidth6 Set NIC1 <-> NIC3 Link Round Trip Time7 Set NIC1 <-> NIC3 Link Round Trip Time8 Set NIC1 <-> NIC3 Link Bandwidth9 Set NIC2 <-> NIC3 Link Bandwidth9 Set NIC2 <-> NIC3 Link Round Trip Time9 Set NIC2 <-> NIC3 Link Packet Loss10 Link Round Trip Time10 Link Round Round Trip Time10 Link Round Round Round Round Round Round10 Link Round Round Round Round Round10 Link Round Round Round Round10 Link Round Round Round Round10 Link Round Round10 Link Round Round10 L
<mark>С DK] Cancel</mark> [Copyright (с) DummyCloud.Com 2009-2012 All Rights Reserved J—

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