SteelFusion™ with Citrix® XenDesktop

Solution Guide

August 2014

NOTICE:
New Product Names
The contents of this asset do not reflect our recent product name changes. Here are the new Riverbed® names:

<table>
<thead>
<tr>
<th>Old Names</th>
<th>New Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steelhead</td>
<td>SteelHead™</td>
</tr>
<tr>
<td>RPM, OPNET, Cascade</td>
<td>SteelCentral™</td>
</tr>
<tr>
<td>Stingray</td>
<td>SteelApp™</td>
</tr>
<tr>
<td>Granite</td>
<td>SteelFusion™</td>
</tr>
<tr>
<td>Flyscript</td>
<td>SteelScript™</td>
</tr>
<tr>
<td>Whitewater</td>
<td>SteelStone™</td>
</tr>
</tbody>
</table>
PREFACE (REQUIRED) .............................................................................................................. 4
  About This Guide ................................................................................................................. 4
  Audience ............................................................................................................................ 4
  Contacting Riverbed .......................................................................................................... 4
  Internet ............................................................................................................................... 4
  Technical Support .............................................................................................................. 4
  Professional Services ......................................................................................................... 4

Chapter 1 Solution Overview ........................................................................................... 5
  SteelFusion Overview ....................................................................................................... 5
  Citrix XenDesktop Overview ............................................................................................ 6
  Branch Office Desktop Design with SteelHead and SteelFusion Appliances ..................... 6

Chapter 2 Deploying SteelFusion Appliances with Citrix XenDesktop ............................. 8
  Deployment Prerequisites ................................................................................................. 8
    Citrix Infrastructure ......................................................................................................... 8
    VMware Infrastructure .................................................................................................... 8
    Microsoft Windows Infrastructure .................................................................................. 8
    Riverbed appliances ....................................................................................................... 8
  Storage requirements ........................................................................................................ 8

  Branch Office Desktop Configuration ............................................................................... 9
    Task 1: Preparing for Initial Deployment ........................................................................ 9
      Map vSphere Host at Data Center to Storage .............................................................. 10
      Populate LUN with master VM image ........................................................................ 11
      Un-mount the datastore from the vSphere host ......................................................... 13
      Prepopulate SteelFusion Edge with the Master Image ............................................... 15
    Task 2: Initial branch setup ............................................................................................ 19
      Reference Architecture for Task 2 ............................................................................... 19
      Bringing up SteelHead EX at the Branch .................................................................... 19
      Connect the vSphere Host at the Branch to the LUN via SteelFusion Edge ............... 20
    Task 3: Deploying initial desktops at the branch............................................................ 26
      Add the vSphere Host and Storage at the Branch to XenDesktop Controller ............ 26
      Creating Desktops at the Branch Office ..................................................................... 30
      Create a Delivery Group and Add VMs ..................................................................... 34
    Task 4: Patching VMs at the Branch .............................................................................. 37

Chapter 3 Solution Recommendations and Best Practices ............................................ 38
  Citrix XenDesktop vSphere Best Practices .................................................................... 38
    Desktop Management ..................................................................................................... 38
    vSphere Hosts ................................................................................................................ 38
  Riverbed SteelFusion Best Practices .............................................................................. 38
    Pinned LUNs at the Branch ............................................................................................ 38
    Sizing SteelFusion Edge for BOD ................................................................................ 39
    Microsoft Windows Server at the Branch Office .......................................................... 40
    QoS for SteelFusion Traffic ......................................................................................... 41
    SteelFusion Protocol Overview ................................................................................... 41
PREFACE (REQUIRED)

Welcome to the SteelFusion solution guide for Citrix XenDesktop. Read this preface for an overview of the information provided in this guide and contact information. This preface includes the following sections:

- About This Guide
- Contacting Riverbed

About This Guide

The SteelFusion solution guide for Citrix XenDesktop outlines the required steps needed to deploy Riverbed® SteelFusion appliances with Citrix XenDesktop to provide a remote virtual desktop infrastructure (VDI) that separates compute and storage requirements. It centralizes storage infrastructure to simplify IT administration while delivering localized performance required of branch or remote office users.

Audience

This paper is written for storage and network administrators familiar with administering and managing distributed office environments using common network and storage protocols such as iSCSI, SCSI, TCP, CIFS, HTTP, FTP, and NFS.

You must also be familiar with:
- Citrix XenDesktop Studio and related components
- VMware vSphere and related components
- Riverbed SteelHead management interface
- Riverbed SteelHead appliance installation and configuration process

This guide assumes that you are familiar with virtualization technology.

Contacting Riverbed

This section describes how to contact departments within Riverbed.

Internet

You can learn about Riverbed products through the company Web site: http://www.riverbed.com.

Technical Support

If you have problems installing, using, or replacing Riverbed products, contact Riverbed Support or your channel partner who provides support. To contact Riverbed Support, open a trouble ticket by calling 1-888-RVBD-TAC (1-888-782-3822) in the United States and Canada or +1 415 247 7381 outside the United States. You can also go to https://support.riverbed.com.

Professional Services

Riverbed has a staff of professionals who can help you with installation, provisioning, network redesign, project management, custom designs, consolidation project design, and custom coded solutions. To contact Riverbed Professional Services, email proserve@riverbed.com or go to http://www.riverbed.com/us/products/professional_services/.
Chapter 1 Solution Overview

Riverbed SteelFusion appliances can help consolidate distributed data, improve security, and reduce administration for managing remote / branch office environments. When utilized with an existing storage system, SteelFusion can expose one or more iSCSI LUNs to a remote / branch office. Citrix XenDesktop can then leverage this infrastructure to remotely deliver high performing remote desktops to users at a branch or remote office, without requiring islands of storage, security, and management to administer it.

This chapter includes the following sections:
- SteelFusion Overview
- Citrix XenDesktop Overview
- Branch Office Desktop Design with SteelHead and SteelFusion Appliances

SteelFusion Overview

SteelFusion products enable users and applications in branch office locations to write to and access centrally managed storage while maintaining local disk performance. By accelerating branch access to data center deployed Storage Area Networks (SANs), IT organizations no longer need to provision and maintain dedicated storage resources in branch offices.

The SteelFusion solution is deployed in conjunction with SteelHead appliances and consists of two components:

- **SteelFusion Core** – a physical or virtual appliance that resides in the data center alongside centralized storage
- **SteelFusion Edge** – a module that runs on a SteelHead EX appliance in the branch office

SteelFusion Core mounts iSCSI LUNs provisioned in the data center and shares the storage resources with branch offices running the SteelFusion Edge module. SteelFusion Edge virtually presents one or more iSCSI targets in the branch which can be utilized by services and systems running both within the Riverbed Virtual Services Platform (VSP) as well as externally to the SteelHead EX appliance. SteelFusion Core inspects mounted file systems and is able to proactively stream data to the branch locations utilizing innovative block-level prediction algorithms. This industry-first capability allows data from centralized storage to be available wherever and whenever it is needed. Through asynchronous block-based write acceleration, SteelFusion Edge ensures that data created in branch office locations is securely stored in the data center.

![Figure 1 SteelFusion Core and SteelFusion Edge high level network topology](image)
Citrix XenDesktop Overview

Citrix XenDesktop is a suite of desktop virtualization products that provides among other things a solution for VDI. VDI delivers desktop virtualization that decouples the applications, data and operating system from the end point, and moves these components into the data center where they can be centrally managed. VDI allows IT to simplify and automate the management of thousands of desktops and to securely deliver desktop as a service to users from a central location with levels of availability and reliability unmatched by traditional PCs. XenDesktop uses the Independent Computing Architecture protocol (ICA) protocol for communication between the VDI clients and the virtualized desktops. Citrix XenDesktop can be deployed with different hypervisor platforms. This solution guide applies to XenDesktop deployed with VMware vSphere hypervisor.

Branch Office Desktop Design with SteelHead and SteelFusion Appliances

A growing number of organizations are adopting virtual desktop infrastructure (VDI) to simplify global end-point management, reduce costs and achieve better levels of security and compliance. Desktop virtualization with Citrix XenDesktop allows IT to simplify and automate the management of thousands of desktops and to securely deliver desktop as a service to users from a central location with levels of availability and reliability unmatched by traditional PCs. When accessed over the wide area network (WAN) in branch office deployments, customers encounter several challenges that are potential show-stoppers when deploying and using Citrix XenDesktop. These challenges include:

- **WAN Connectivity**
  - Low bandwidth at remote locations
  - High latency between branches and the data center hosting the VDI infrastructure
  - Loss of desktop connectivity during WAN outages

- **Cost of Centralized Storage**
  - Needs to be sized for peak IOPS for VDI to account for “boot-storms” generated during login process.
  - Expensive tiered storage to eliminate slowness experienced by users for read/write intensive applications

- **Other Design Considerations**
  - Latency and bandwidth concerns around peripheral performance (e.g. printing).
  - Consolidating services at the branch locations and eliminating infrastructure around services (DHCP, Print servers, Active directory) and backup.

To address these challenges, Riverbed Technology optimizes desktop performance for local branch users with a new Branch Office Desktop (BOD) solution that combines the SteelHead WAN optimization and SteelFusion Edge virtual server infrastructure with Citrix XenDesktop and VMware at the branch office. SteelHead and SteelFusion technologies integrated with creates a perfect balance of centralized management and security while providing fast access to the desktops at remote locations while overcoming the limits of the WAN.

The BOD solution utilizes both SteelHead and SteelFusion appliances to optimize the virtual desktop experience for branch users. SteelHead accelerates any data transfer required across the WAN, and SteelFusion enables a completely localized experience with the virtual desktops, including operation in the event of a WAN failure. In this solution, the desktops for users at the branch are stored on a LUN in the central location. The SteelFusion Core appliance at the data center projects this storage to the branch office to the SteelFusion Edge appliance. SteelFusion Edge presents the projected storage target containing the virtual desktops to a local vSphere host at the branch office which enables the desktops to run locally at the branch office.
Figure 2 Branch Office VDI using SteelHead and SteelFusion Appliances

Figure 2 illustrates the deployment architecture with Riverbed SteelHead and SteelFusion appliances in a traditional XenDesktop environment. In a typical deployment, the desktops for users at the branch office location are stored and executed from a central location. This leads to the challenges described earlier, primarily around bandwidth and latency.

SteelFusion technology enables XenDesktop desktops to be provisioned and managed centrally, but to be utilized with local connectivity in the remote location. The BOD solution does not require any of the XenDesktop management components to run outside the data center. Users connect to the XenDesktop controller as they normally would but establish a session with the local “projected” desktop so all ICA traffic stays within the branch. The only XenDesktop traffic crossing the WAN is agent communication that is optimized via the SteelHead appliance. All applications accessed inside the virtual desktops that require resources centrally or outside of the local branch are also optimized over the SteelHead appliance for optimal performance. The BOD solution removes the heavy dependency on the WAN and also the fear of a network outage as desktop users remain connected and able to work on any application that does not require resources outside of the branch. The solution also provides benefits by lowering central storage requirements and costs. Because the desktops at the branch office are fronted by the SteelFusion appliance, users accessing heavy read/write workloads (boot-storms) hit the SteelFusion Edge appliance first. For any necessary writes, SteelFusion Edge subsequently trickles IOPS in a steady-state fashion back to the data center storage. The central storage no longer needs to be sized for peak desktop operations and can be scaled down for such deployments.

The benefits of the BOD the solution include:

- **WAN connectivity**
  - LAN performance while accessing the desktops
  - Bandwidth savings by completely eliminating ICA over the WAN
  - Disconnected operations during WAN outages
  - SteelHead appliances accelerate all application traffic from the branch

- **Reduced cost of Centralized Storage**
  - Lower SAN IOPs requirements – read/write bursts absorbed locally
  - Centralized storage can be tiered down

- **Other benefits**
  - Branch consolidation and disaster recovery are built in
    - Data stores are replicated to centralized storage where they can be protected with local array snapshots or other backup technologies
    - No backups required at the remote location
    - Consolidated branch services (DHCP, print services) delivered locally by SteelHeads appliances using the Virtual Services Platform (VSP)
  - Peripherals are supported on the LAN
    - Desktops are executed at the branch location and have local access to printers or USB drives
    - Peripheral devices no longer consume WAN bandwidth during operation.
Chapter 2 Deploying SteelFusion Appliances with Citrix XenDesktop

This chapter describes the process and procedures for deploying SteelFusion appliances with NetApp storage systems. It includes the following sections:

- Deployment Prerequisites
- Branch Office Desktop Configuration
  - Task 1: Preparing for Initial Deployment
  - Task 2: Initial Branch Setup
  - Task 3: Deploying Initial Desktops at the Branch
  - Task 4: Patching VMs at the Branch

Deployment Prerequisites

For a BOD deployment, the following components are needed:

**Citrix Infrastructure**

- Citrix XenDesktop infrastructure at the data center
  - XenDesktop controller
  - XenDesktop director
  - No dependency on versions (Solution tested with XenDesktop 7.1)
- Citrix XenDesktop infrastructure at the branch office
  - XenDesktop virtual desktop agent (VDA) installed on virtual desktops
  - VDA version must be compatible with XenDesktop controller version at the data center

**VMware Infrastructure**

- VMware vSphere infrastructure at the data center
  - vCenter
  - No dependency on vSphere version unless virtual desktops are running on VSP (5.X is required if desktops are to run on VSP)
- vSphere host at the branch
  - Can be hosted on SteelFusion
  - No dependency on versions unless desktops are to run on VSP (5.X required if desktops are to run on VSP)

**Microsoft Windows Infrastructure**

- Microsoft Windows infrastructure at data center
  - Active directory
- Microsoft Windows infrastructure at the branch
  - Windows 2k8 R2 server running on top of VSP
    - Providing Read only domain controller, DHCP, DNS, Print services

**Riverbed appliances**

- SteelFusion Core at the data center
  - Physical or virtual SteelFusion Core
  - Software version 1.0.1 or later.
- SteelHead appliance at the data center
  - Any SteelHead appliance sized appropriately for the specific deployment
  - No dependency on version (7.x or later recommended)
- SteelHead EX at the branch
  - Requires SteelFusion license
  - No dependency on software version

**Storage requirements**

Any SteelFusion supported storage.
Branch Office Desktop Configuration

The configuration for the BOD deployment is divided into four tasks. Each task is described below and highlights steps required at each stage of the deployment cycle.

- Task 1: Preparing for Initial Deployment – This task includes populating the storage LUN at the data center with the VM image that will be used as the master image to create the desktops at the branch followed by the prepopulation of the SteelHead EX + SteelFusion appliance with this image and shipping of the unit to the branch office.

- Task 2: Initial branch setup – This task includes setting up the SteelHead EX + SteelFusion unit at the branch, configuring the vSphere host at the branch office to connect to the storage at the data center via SteelFusion.

- Task 3: Deploying initial desktops at the branch – This task utilizes desktop studio to create desktops at the branch office on top of the SteelFusion LUN. Once complete, start the VM from the delivery group using Citrix Studio. Confirm that the VM comes up as registered. If needed, adjust networking on the VM such that it can access Citrix Studio to complete registration.

- Task 4: Patching VMs at the Branch – Once the BOD solution has been deployed the VMs at the branch might need to be patched. This step describes the patching process for desktops when using the BOD solution.

Task 1: Preparing for Initial Deployment

This step is performed at the data center to prepare the SteelHead EX unit for the deployment of desktops at the branch office. In this step, the SteelHead EX unit is prepopulated with the master VM image that will be used for the deployment of the desktops. This step is not a requirement, but prepopulating the SteelHead EX with the VM image will speed up the deployment process by not having to copy the VM image across the WAN, which for sites with limited bandwidth can be a time consuming process. Once the VM image is populated on the SteelHead EX, the SteelHead EX appliance can be shipped to the remote location brought online and ready for deploying the desktops.

In this first task the following 4 steps will be performed:

- Map local vSphere host to storage at the data center
- Populate SteelFusion LUN with master VM image
- Prepopulate SteelFusion Edge with the master image
- Ship SteelHead EX to branch office for initial desktop deployment

Reference Architecture for task 1

![Figure 3 Reference Architecture for Task 1](image-url)
Map vSphere Host at Data Center to Storage
The first step is to create a LUN which will serve as the storage for the master VM image that will be used for creating desktop VMs in the branch, and map it to the data center.

1. Create the LUN on the data center storage subsystem and map it to local vSphere host with access to the master VM image.

2. Within vSphere client map the newly created LUN to a vSphere host at the data center. From the vCenter GUI navigate to the hostname of vSphere host, select **Configuration > Storage Adapters > Properties** as shown in Figure 4.

![Figure 4 vSphere Host iSCSI Configuration](image)

3. In the iSCSI Initiator Properties window click **Dynamic Discovery**, then click **Add...** button to enter the IP address of the storage array into the **iSCSI Server** field, as shown in Figure 5.

![Figure 5 Adding an iSCSI Portal](image)
4. Close the window, and answer Yes to the request from the vSphere host to rescan the host bus adapter, as shown in Figure 6.

![Figure 6 Host bus adapter rescan](image)

5. Navigate to the Storage menu of the vSphere host and then click Add Storage to open the Add Storage wizard, as shown in Figure 7.

![Figure 7 Add Storage](image)

6. Follow the wizard. For Storage Type select Disk/LUN and for File System Version select VMFS-5. Click the Finish button to complete the operation as shown in Figure 8. The datastore will appear as shown in Figure 9.

![Figure 8 Choose Disk/LUN](image)

![Figure 9 Datastore Added](image)

**Populate LUN with master VM image**

Now that the empty LUN is available at the data center, copy the master VM image onto the LUN that will be used in the SteelHead EX.
1. On vCenter navigate to the hostname of the vSphere host where the datastore of the master VM image resides. Right click on the master image virtual machine and click **Clone** as shown in Figure 10.

![Figure 10 Cloning the Master Image](image)

2. Follow the wizard and point to the vSphere host where the newly created datastore resides and click **Next**. Select **Do not customize** and click **Next**, as shown in Figure 11.

![Figure 11 Select the New Datastore](image)
Un-mount the datastore from the vSphere host

Once the master VM image cloning process is complete, the datastore must be un-mounted from the vSphere host. Before that can be done the newly created cloned VM must also be removed from inventory.

1. On vCenter, navigate to the hostname of vSphere host. Right click the newly created virtual machine and click Remove from Inventory as shown in Figure 12.

![Figure 12 Removing VM from Inventory](image)

2. Once the VM is removed from inventory, un-mount the datastore. On the vCenter GUI navigate to the hostname of the vSphere host. Click the Configuration tab for the host. Select Storage from the list on the left panel. Right click the datastore and click Unmount, as shown in Figure 13.

![Figure 13 Un-mounting the Datastore](image)

3. Detach the LUN from the vSphere host by selecting the Devices view button (not Datastore view as in the previous step), right click the LUN, and select Detach. Perform a refresh and verify the datastore is gone by selecting Refresh.

Note: If in a VMware cluster, repeat steps 2-3 for each host of the cluster. This prevents corruption of the LUN.

4. If the vSphere host no longer needs to connect to the storage system, remove the iSCSI connection. In the vCenter GUI, navigate to the hostname of vSphere host. Click the Configuration tab for the host. Select Storage adapters from the left menu and click Properties, as shown in Figure 14.
5. Navigate to the **Dynamic Discovery** tab. Select the IP address of the storage adapter to remove, on the **iSCSI Initiator Properties** window, click the **Remove** button as shown in Figure 15.

**Figure 14 Removing iSCSI Connections**

**Figure 15 Removing iSCSI Connections Continued**
Prepopulate SteelFusion Edge with the Master Image

Once the vSphere host is detached from the LUN, prepopulate the SteelFusion Edge on the branch SteelHead EX with the LUN that contains the master image VM.

1. On the storage system, map the LUN with the master image to the SteelFusion iSCSI Qualified Name (IQN). The IQN name can be found from SteelFusion Core GUI. Navigate to the UI for the SteelFusion Core appliance. Choose Configure followed by iSCSI configuration. Look for the IQN name next to Initiator Name as shown in Figure 16.

   ![Figure 16 IQN Name of SteelFusion Core](image)

2. In this step SteelFusion Core will connect to the storage system. In the SteelFusion Core GUI, navigate to Configure. Click Add an iSCSI Portal. Enter the IP address of storage system and click the Add iSCSI Portal tab as shown in Figure 17.

   ![Figure 17 Adding iSCSI Portal](image)
3. Once the iSCSI target is discovered from the iSCSI portal, map the iSCSI target learned from the portal. Click the Add Target button. SteelFusion Core will then discover iSCSI targets that have been mapped from the storage system. The newly discovered targets are displayed under Target Name, as shown in Figure 18.

![Figure 18 Adding iSCSI Target](Image)

4. Once the target is mapped, the LUN where the master VM image resides must be mapped on the SteelFusion Core. Go to Configure > Storage > LUNS. Under LUN Serial number select the LUN with the master VM image and provide an alias. An alias is a name assigned to the LUN that is meaningful or descriptive to the purpose of the LUN, as shown in Figure 19.

![Figure 19 Add the iSCSI LUN](Image)
5. From SteelFusion Core assign the LUN to SteelFusion Edge on the SteelHead EX appliance. First, map the SteelFusion Edge to the SteelFusion Core. On the SteelFusion Core GUI choose Configure > Storage > Granite Edges. Click Add Granite Edge and enter an identifier for SteelFusion Edge. An identifier is a name assigned to the SteelFusion Edge that is meaningful to the administrator, as shown in Figure 20.

![Figure 20 Mapping SteelHead EX on SteelFusion Core](image)

6. Assign the LUN to the specific SteelFusion Edge. On the SteelFusion Core GUI, navigate to Configure > Storage > SteelFusion Edges. Click on the identifier for the SteelHead EX appliance hosting SteelFusion Edge. Assign the LUN with the master VM image to the appropriate SteelFusion Edge and click Map These LUNS, as shown in Figure 21.

![Figure 21 Mapping LUN to SteelHead EX](image)
7. Connect the SteelFusion Edge to the SteelFusion Core. On the GUI of the SteelHead EX navigate to Configure > Granite > Granite Storage. Enter the IP address or the hostname of the SteelFusion Core. Enter the SteelFusion Edge identifier that was previously configured on the SteelFusion Core. Leave the interface as primary for simplicity, as shown in Figure 22 and click Add Core.

8. Once the SteelFusion Edge has successfully connected to the SteelFusion Core, prepopulate the LUN contents to the SteelFusion Edge. In the GUI of SteelFusion Core, navigate to Configure > Storage > LUNS. Select the LUN where master VM image resides. Select Pinned and click Update. Next, click Enable and then click Enable Immediate Repopulation to prepopulate the contents of the LUN onto the SteelFusion Edge, as shown in Figure 23.

9. Once the previous step is complete save the configuration on both the SteelFusion Core and SteelFusion Edge, and power down the SteelHead EX appliance. It is ready to be shipped to the branch office.
Task 2: Initial Branch Setup

Once the SteelHead EX is shipped to branch office, the vSphere host at the branch can connect to the LUN back at the data center through the use of SteelFusion Core. In this task the following steps are performed:

- Bring up SteelHead EX at the Branch
- Connect the vSphere host at the branch to LUN at data center via SteelFusion

Reference Architecture for Task 2

![Reference Architecture for Task 2](Figure 24)

**Figure 24 Reference Architecture for Task 2**

**Bringing up SteelHead EX at the Branch**

1. Power up the SteelHead EX at the branch and configure it with the appropriate IP addresses. Additional configuration may be needed for SteelHead WAN optimization. Refer to the SteelHead deployment guide for the configuration steps.

2. Once networked, ensure the SteelHead EX can connect back to the data center. In the GUI of the SteelHead EX, navigate to **Configure > Granite > Granite Storage**. The green check box indicates that the SteelHead Edge is connected to the SteelFusion Core.

![SteelFusion Edge to SteelFusion Core Connection](Figure 25)

**Figure 25 SteelFusion Edge to SteelFusion Core Connection**
Connect the vSphere Host at the Branch to the LUN via SteelFusion Edge

Next you will connect the branch vSphere host to the LUN in the data center that is being delivered by SteelFusion Core and SteelFusion Edge.

1. Once the SteelFusion Edge connects to SteelFusion Core, connect the vSphere host at the branch to the LUN target made available via SteelFusion Edge. First get the IQN name of the vSphere host at the branch to use when mapping the LUN. To get the IQN name of the vSphere host, connect to vCenter and navigate to the vSphere host at the branch. Click on the Configuration tab then click on Storage adapters. The IQN name can be found under Properties as shown in Figure 26.

![Figure 26 vSphere Host IQN name](image)

2. Add the vSphere host IQN name above as an initiator on SteelFusion Core. In the SteelFusion Core GUI click on Configure then navigate to Storage and SteelFusion Edges. Click on the appropriate SteelFusion Edge, then click on Initiators and finally click Add Initiator. Enter the IQN name of vSphere host. Click Add initiator as shown in Figure 27.

![Figure 27 Adding vSphere host as an initiator in SteelFusion Core](image)
3. Next map the LUN with the master VM image to the vSphere host. Navigate to Configure > Storage > Granite Edges. Click the identifier of the SteelFusion Edge to expand it. Click on the LUNs tab and select the LUN alias to be mapped. Highlight the IQN name of the vSphere host to be mapped and click Add as shown in Figure 28.

![Figure 28 Mapping the Branch vSphere Host to the LUN](image)

4. Connect the branch vSphere host to LUN with the master VM Image. On vCenter, navigate to the name of the branch vSphere host. Select Configuration > Storage Adapters > Properties as shown in Figure 29.

![Figure 29 Connect the Branch vSphere host to SteelFusion Edge](image)
5. Navigate to the **Dynamic Discovery** tab of the **iSCSI Initiator Properties** window. Click the **Add** button. Enter the IP address of the primary interface of the SteelHead EX into the **iSCSI Server** field, as shown in Figure 30.

![Figure 30 Connect the Branch vSphere host to SteelFusion Edge Continued](image)

6. Close the window and answer **Yes** to the rescan request from the vSphere host. When the rescan is complete, you will see the volume as shown in Figure 31.

![Figure 31 New LUN on vSphere host Delivered by SteelFusion](image)
7. Now that the branch vSphere host sees the LUN the next step is to add it to the datastore. From the vCenter GUI navigate to the IP or hostname of the branch vSphere host. Click Configuration > Storage > Add Storage as shown in Figure 32.

![Figure 32 Adding New Storage](image)

8. Follow the Pop up window and select Disk/LUN and click Next as shown in Figure 33.

![Figure 33 Select Disk/LUN](image)

9. On the pop up window select the SteelFusion projected LUN and click Next as shown in Figure 34.

![Figure 34 Select the SteelFusion LUN](image)
10. On the pop up window select **Keep the existing signature** and click **Next** as shown in Figure 35. Then click **Finish** to complete the wizard as shown in Figure 36.

![Figure 35 Select Existing Signature](image)

![Figure 36 New LUN added](image)
11. Next add the master VM image from the added datastore into the branch vSphere host inventory. Click on the name of the newly added datastore. Right click on Browse Datastore as shown in Figure 37.

![Browse Datastore](image1.png)

**Figure 37** Browse the Newly Added Datastore

12. Navigate to the folder that contains the master VM image. Right Click the *.VMX file and click Add to Inventory as shown in Figure 38.

![Adding VM to the Branch vSphere Host Inventory](image2.png)

**Figure 38** Adding VM to the Branch vSphere Host Inventory
Task 3: Deploying Initial Desktops at the Branch

With the vSphere host at the branch connected to the LUN at the data center through SteelFusion, the next step is to deploy the initial desktops at the Branch Office. The initial desktop deployment differs from what is typical with a XenDesktop deployment at the data center. Typically in the data center, the master VM image for the deployment can exist on any vSphere host that is managed by the same vCenter server. For the BOD deployment, the master VM image for the desktops needs to be in a data store that is connected to the vSphere host at the branch. In this task the following operations will be performed.

- Add the vSphere Host and Storage at the Branch to XenDesktop Controller
- Creating Desktops at the Branch Office
- Creating new desktop group and adding desktops to the group

Add the vSphere Host and Storage at the Branch to XenDesktop Controller

This step will add the vSphere host at the branch to XenDesktop controller so that it may provision and allocate desktops on the host. XenDesktop creates and allocates desktops by communicating with a vCenter server, so an account with administrative rights on the vCenter is required for this step, and the vCenter server must already have added the branch vSphere host.

1. On the XenDesktop controller launch the Citrix studio application, as shown in Figure 39.

![Citrix Studio](image-url)
2. In the Citrix Studio GUI expand Configuration > Hosting on the left hand pane. In the right hand pane window click Add Connection and Resources, as shown in Figure 40.

![Figure 40 Add Connection and Resources](image)

3. Follow the wizard steps to fill in the required connection information to the vCenter server that is managing the branch vSphere host, as shown in Figure 41. Click Next.

   a. **Connection name**
      Create a name to associate with the connection
   b. **Host Type**
      Select VMware vSphere
   c. **Address**
      http://hostname-of-your-vCenter-server/sdk
   d. **Username/Password**
      Account credentials needed to access vCenter server

![Figure 41 Connection Information](image)
4. Click on **Browse** and select the host name or IP of the branch vSphere host, as shown in Figure 42. Click **OK**.

![Figure 42 Select Branch vSphere Host](image)

5. Select the network on the vSphere host to use for communication with XenDesktop controller. For most users, select **rvbdpri_vm_network**, as shown in Figure 43. Click **Next**.

![Figure 43 Selecting the Network](image)
6. Select the storage LUN that was projected by SteelFusion to the branch vSphere host, as shown in Figure 44. Click Next.

![Figure 44 Select SteelFusion Storage](image)

7. Provide a resource name and click Finish. When complete, the connection will appear as shown in Figure 45.

![Figure 45 Created vCenter Connection](image)
Creating Desksops at the Branch Office

Next, desktops will be created on the SteelFusion projected LUN using the master VM image that was previously pre-populated onto this LUN from Task 1: Preparing for Initial Deployment. You will need to create a machine catalog in Citrix Studio, which is a container for the desktops.

1. On the Citrix Studio GUI right click **Machine Catalogs**, and select **Create Machine Catalog**, as shown in Figure 46.

![Figure 46 Create a new Machine Catalog](image)

2. Select the type of desktop deployment that the master VM image is based upon, as shown in Figure 47. For more information on the different types of deployment refer to XenDesktop reference guide. The BOD solution can support all deployment types. Click **Next**.

![Figure 47 Desktop VM Operating System Type](image)
3. Select the appropriate infrastructure choice based on the environment you are deploying, and the deployment type (MCS or PVS), as shown in Figure 48. Click **Next**.

![Figure 48 Infrastructure and Deployment Type](image1)

4. Select the type of desktop (static or random), and the location for storing user changes, as shown in Figure 49. Click **Next**.

![Figure 49 VM Desktop Type and User Changes Selection](image2)
5. Select the resource created in the first section of Task 3 and the VM which serves as the master VM image from which additional desktops will be created, as shown in Figure 50. Click Next.

![Figure 50 Select Master VM Image](image)

6. Select the number of desktop to create and assign resources to the desktops, as shown in Figure 51.

![Figure 51 Desktop VM Creation Options](image)
7. Specify if new computer accounts needs to be created in Active Directory, and select the location where computer accounts will reside in Active Directory. Also specify the naming convention for the new desktops, as shown in Figure 52.

![Figure 52 AD Computer Account Names and VM Naming](image)

8. Name the new Machine Catalog and click **Finish** to create the desktop VMs, as shown in Figure 53.

![Figure 53 Catalog Name and Completion](image)
Create a Delivery Group and Add VMs
The delivery group provides assignments of VMs created and added to the machine catalog in the previous step.

1. On the Citrix Studio GUI right click Delivery Groups and select Create Desktop Group, as shown in Figure 54.

![Figure 54 Create a New Delivery Group](image)

2. Select the machine catalog that was created in previous step, as shown in Figure 55. Click Next.

![Figure 55 Machine Catalog Selection](image)
3. Identify that you are delivering remote desktops, as shown in Figure 56. Click **Next**.

![Figure 56 Delivery Type](image)

**Figure 56 Delivery Type**

4. Select the users or groups within Windows Active Directory which will have access to the remote desktops, as shown in Figure 57. Click **Next**.

![Figure 57 User Assignment to a Delivery Group](image)

**Figure 57 User Assignment to a Delivery Group**
5. Select the StoreFront server that the above assigned users will access the remote desktops in this delivery group, as shown in Figure 58.

![Figure 58 StoreFront Server Selection](image)

6. Provide a delivery group name, display name, and optionally a description. Click Finish to create the delivery group, as shown in Figure 59.

![Figure 59 Display Name for Delivery Group](image)

7. Once complete, start the VM from the delivery group using Citrix Studio. Confirm that the VM comes up as registered. If needed, adjust networking on the VM such that it can access Citrix Studio to complete registration.
Task 4: Patching VMs at the Branch

Just like deploying initial desktops at the branch office, the process of patching VMs with the BOD solution differs from that of the typical Citrix XenDesktop patching process at the data center. With the BOD solution, the master image is first patched at the data center and then re-cloned to a datastore on the vSphere host at the branch. The desktops can then be re-created with the new master image by rerunning Task 3.

1. Patch the master VM image in the data center as needed. When complete, use vCenter GUI to navigate to the hostname of the vSphere host where the master VM image is hosted. Right click on master VM image and click Clone, as shown in Figure 60.

![Figure 60 Cloning of the Patched Master VM Image](image)

2. Follow the wizard and point to the vSphere host at the branch office. Select the SteelFusion datastore and click Next. Follow the wizard. Select Do not Customize and Click Next, as shown in Figure 61.

![Figure 61 Clone VM to SteelFusion Datastore](image)

When this step completes use the new master image to re-create the desktops according to the steps in Task 3: Deploying Initial Desktops at the Branch.
Chapter 3 Solution Recommendations and Best Practices

The BOD solution is designed to maintain a centralized VDI model for provisioning, re-composition, security and yet providing end users local desktop performance. To ensure optimal performance and management for production environments, several key deployment best practices are highlighted in the following sections.

Citrix XenDesktop vSphere Best Practices

The first set of recommendations is focused specifically on the best practice when configuring Citrix XenDesktop with VMware vSphere in the BOD solution.

Desktop Management

The BOD solution is designed to provide granular control over each location and associated dependencies. The recommended approach is to create a desktop group per branch location or at least a desktop group that manages branches of similar sizes. The desktop group would be linked to vSphere host with SteelFusion storage at branch.

While this adds some management overhead, it provides better branch management for the provision and re-composition processes.

vSphere Hosts

In a typical VDI deployment a farm of high-end vSphere hosts provide compute resources for virtual desktops. In the BOD deployment, user desktops at branch locations require local compute which can be provided either directly on the SteelHead EX Virtual Services Platform (see below) or by a separate ESXi host. There is little to no management overhead for the hosts at the branch location. SteelFusion Edge presents vSphere VM images directly at the branch where one or more external compute hosts can be configured to mount SteelFusion-projected storage to use for booting and local desktop execution.

Riverbed SteelFusion Best Practices

This section covers XenDesktop best practices configuration on the SteelFusion appliance for the BOD deployment.

Pinned LUNs at the Branch

A storage LUN provisioned via SteelFusion can be deployed in two different modes, pinned and unpinned. Pinned mode caches 100% of the data blocks on the SteelHead EX at the branch. This allows users at the branch to access all data even in the case of a WAN outage. Unpinned mode maintains only a working set of the most frequently accessed blocks at the branch locally host the most recently used files at the branch location and intelligently pre-fetch blocks of storage of new files as needed.

For BOD deployments it is recommended that the LUNs containing the data stores for the virtual desktops host OS user data, and VMFS and host OS swap files are separated out into different LUNS. The OS LUN should be pinned to have it always available whereas the LUN containing the user data can leverage the advantages of unpinned mode. The swap files should be on a data store that is not replicated back to the datacenter. This can be in the form of local disk on the vSphere host or it can use a portion
of the SteelFusion disks that is designated as not replicated.

If disconnected operations are a requirement than the LUN containing user data should be pinned as well.

The following figure depicts the recommended storage layout for the BOD solution.

![Recommended Storage Layout for BOD](image)

**Figure 63 Recommended Storage Layout for BOD**

**Sizing SteelFusion Edge for BOD**

When deploying the BOD solution it is important to size the SteelFusion Edge appropriately for the branch office. When sizing the SteelFusion Edge for XenDesktop it is important to take into account the expected number of IOPS that will be used by virtual desktop operations at the branch. A typical medium office workload typically generates 5 to 15 IOPS during steady state. Using Table 1, size the SteelFusion Edge based on the number of XenDesktop desktops that the SteelFusion Edge will be supporting and the expected number of IOPS per desktop. It is also recommended to enable host caching when creating the XenDesktop pool as this minimizes the number of IOPS generated by the pool.

<table>
<thead>
<tr>
<th>Series</th>
<th>Granite IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX560/EX760</td>
<td>85</td>
</tr>
<tr>
<td>EX1160</td>
<td>170</td>
</tr>
<tr>
<td>EX1260-2TB</td>
<td>350</td>
</tr>
<tr>
<td>EX1260-4TB</td>
<td>700</td>
</tr>
<tr>
<td>EX1360</td>
<td>1700</td>
</tr>
<tr>
<td>EX1360P</td>
<td>10000</td>
</tr>
</tbody>
</table>

*Table 1 Sizing SteelHead EX IOPS for SteelFusion Edge Operations*
The SteelHead EX solution natively features an ESXi hypervisor known as the Riverbed Virtual Service Platform (VSP) that provides the ability to run XenDesktop desktop VMs directly on the WAN optimization appliance. For some deployments the compute resources on the SteelHead EX may be sufficient to support the number of XenDesktop desktops running at the branch. When sizing the SteelHead EX appliance for XenDesktop desktops it is important to consider the compute resource and memory available to VSP. This will determine the number of XenDesktop desktops that can run on a single appliance. Table 2 shows the specs that are available for each SteelHead EX model.

<table>
<thead>
<tr>
<th>Model</th>
<th>1160 Series (with BlockStream)</th>
<th>1260 Series (2 TB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configurations</td>
<td>G</td>
<td>L</td>
</tr>
<tr>
<td>Upgradable To</td>
<td>1160-L/M/H</td>
<td>1160-M/H</td>
</tr>
<tr>
<td>Block Store (SSD)</td>
<td>768 GB</td>
<td>1580 GB</td>
</tr>
<tr>
<td>Advanced Tiering Cache</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Storage Fault Tolerance</td>
<td>RAID1</td>
<td>RAID10</td>
</tr>
<tr>
<td>Hot Swappable Drives</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total RAM</td>
<td>48 GB</td>
<td>48 GB</td>
</tr>
<tr>
<td>Available for VSP (GB)</td>
<td>32 GB</td>
<td>48 GB</td>
</tr>
<tr>
<td>Optimized WAN Capacity (10 Mbps)</td>
<td>10 Mbps</td>
<td>20 Mbps</td>
</tr>
<tr>
<td>Optimized TCP &amp; UDP Flows</td>
<td>N/A</td>
<td>900</td>
</tr>
<tr>
<td>Data Store Capacity (SSD)</td>
<td>1.8 GB</td>
<td>7.8 GB</td>
</tr>
<tr>
<td>QoS Bandwidth (Mbps)</td>
<td>100 Mbps</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>QoS Rules/Caches (Mbps)</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Expansion Slots (PCI-e)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Included Bypass Ports (Copper)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Max. # of Bypass Ports</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Model</th>
<th>1260 Series (4 TB)</th>
<th>1360 Series (10 TB)</th>
<th>1360P Series (10 TB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configurations</td>
<td>G</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>Upgradable To</td>
<td>1260-L/M/H</td>
<td>1260-M/H</td>
<td>1260-H</td>
</tr>
<tr>
<td>Block Store (SSD)</td>
<td>3574 GB</td>
<td>9400 GB</td>
<td>9400 GB</td>
</tr>
<tr>
<td>Advanced Tiering Cache</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Storage Fault Tolerance</td>
<td>RAID10</td>
<td>RAID10</td>
<td>RAID10</td>
</tr>
<tr>
<td>Hot Swappable Drives</td>
<td>10</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Total RAM</td>
<td>64 GB</td>
<td>128 GB</td>
<td>128 GB</td>
</tr>
<tr>
<td>Available for VSP (GB)</td>
<td>64 GB</td>
<td>64 GB</td>
<td>64 GB</td>
</tr>
<tr>
<td>Optimized WAN Capacity (10 Mbps)</td>
<td>10 Mbps</td>
<td>20 Mbps</td>
<td>50 Mbps</td>
</tr>
<tr>
<td>Optimized TCP &amp; UDP Flows</td>
<td>N/A</td>
<td>900</td>
<td>1500</td>
</tr>
<tr>
<td>Data Store Capacity (SSD)</td>
<td>1.4 GB</td>
<td>2.8 GB</td>
<td>1.4 GB</td>
</tr>
<tr>
<td>QoS Bandwidth (Mbps)</td>
<td>100 Mbps</td>
<td>100 Mbps</td>
<td>100 Mbps</td>
</tr>
<tr>
<td>QoS Rules/Caches (Mbps)</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Expansion Slots (PCI-e)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Included Bypass Ports (Copper)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Max. # of Bypass Ports</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2 SteelFusion Edge Specifications

**Microsoft Windows Server at the Branch Office**

A Windows server can be deployed at the branch office running on top of VSP on the SteelHead EX appliance. It is recommended that a read only domain controller is configured on the windows server as this will speed up authentication to desktops at the branch as well as providing other services such as DHCP, DNS and print services. In environments where there is high latency between the branch office and data center this can dramatically improve login times to desktops by providing local authentication. XenDesktop VMs should be able to acquire IP addresses which provide connectivity to the Citrix Studio server for registration.
QoS for SteelFusion Traffic

During production hours, writes from SteelFusion edge back to the data center might affect other higher priority WAN production traffic such as VOIP or other application data. To limit the impact of SteelFusion traffic on other production traffic, it is highly recommended that QoS be enabled on the SteelHead appliance. QoS can be adjusted to free SteelFusion traffic from restriction during non-production hours as there typically will not be any traffic contention during these periods.

SteelFusion Protocol Overview

The following description of the SteelFusion protocol and utilized ports provides information that is useful in determining quality of service configuration requirements. The protocol defines how the SteelFusion Edge and SteelFusion Core appliances communicate and how data blocks are transferred over the WAN. SteelFusion uses five TCP ports for data transfers and one TCP port for management. The following table lists the TCP ports used by the protocol and maps the different operations to each TCP port:

<table>
<thead>
<tr>
<th>TCP Port</th>
<th>Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7970</td>
<td>Management</td>
<td>Used for management information exchange between Edge and Core appliances</td>
</tr>
<tr>
<td>7950</td>
<td>Read</td>
<td>Used to transfer data requests for data blocks absent in Edge from the data center</td>
</tr>
<tr>
<td>7951</td>
<td>Write</td>
<td>Used to transfer new data created at the Edge to the data center</td>
</tr>
<tr>
<td>7952</td>
<td>Prefetch0</td>
<td>Pre-fetch data for which SteelFusion has highest confidence (example: file read ahead)</td>
</tr>
<tr>
<td>7953</td>
<td>Prefetch1</td>
<td>Pre-fetch data for which SteelFusion has medium confidence (example: boot)</td>
</tr>
<tr>
<td>7954</td>
<td>Prefetch2</td>
<td>Pre-fetch data for which SteelFusion has lowest confidence (example: prepopulation)</td>
</tr>
</tbody>
</table>

Table 3 SteelFusion Protocol TCP Ports

Note: The SteelFusion protocol creates five TCP connections per exported LUN.

SteelFusion QoS Requirements

The following table lists SteelFusion QoS requirements for each operation and relative TCP port:

<table>
<thead>
<tr>
<th>TCP Port</th>
<th>Operation</th>
<th>Outgoing Branch Bandwidth</th>
<th>Outgoing Branch Priority</th>
<th>Outgoing Data center Bandwidth</th>
<th>Outgoing Data center Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>7970</td>
<td>Management</td>
<td>Low</td>
<td>Normal</td>
<td>Low</td>
<td>Normal</td>
</tr>
<tr>
<td>7950</td>
<td>Read</td>
<td>Low</td>
<td>Business-Critical</td>
<td>High</td>
<td>Business-Critical</td>
</tr>
<tr>
<td>7951</td>
<td>Write</td>
<td>High (off-peak hours)</td>
<td>Low-Priority</td>
<td>Low</td>
<td>Normal</td>
</tr>
<tr>
<td>7952</td>
<td>Prefetch0</td>
<td>Low</td>
<td>Business-Critical</td>
<td>High</td>
<td>Business-Critical</td>
</tr>
<tr>
<td>7953</td>
<td>Prefetch1</td>
<td>Low</td>
<td>Business-Critical</td>
<td>Medium</td>
<td>Normal</td>
</tr>
<tr>
<td>7954</td>
<td>Prefetch2</td>
<td>Low</td>
<td>Business-Critical</td>
<td>Low</td>
<td>Best-Effort</td>
</tr>
</tbody>
</table>

Table 4 SteelFusion Protocol QoS Requirements

QoS for SteelFusion Write Traffic

To prevent SteelFusion traffic between the branch and the data center from consuming bandwidth required for other applications during business hours, it is recommended to allow more bandwidth for Write traffic (port 7951) during off-peak hours and a less bandwidth during peak hours. It is important to consider required RPO and RTO objectives when configuring QoS for SteelFusion replication traffic.

QoS for non-pinned LUNs

In a non-pinned LUNs scenario, Riverbed recommends to prioritize traffic on port 7950 so that the SCSI Read requests for data blocks not present on the SteelFusion Edge block-store cache can arrive from the data center LUN in timely manner. It is also recommended to prioritize traffic on ports 7952, 7953 and 7954 so that the pre-fetch data can arrive at the branch block-store when needed.

QoS for Pinned LUNs

In a pinned LUN scenario because all the data will be present at the edge, it is recommended to only prioritize port 7951 so that the protocol can transfer newly written data blocks from the SteelFusion Edge block-store to the data center LUN via the SteelFusion Core appliance.
Time-based QoS
SteelFusion can also completely disable SteelFusion write flushes during peak hours and limit this action to occur only during off-peak hours. By using time based QoS rules, SteelFusion write traffic can be limited so that no writes occur and therefore do not consume any WAN bandwidth during working hours. The example below illustrates how to configure time-based QoS rules on a SteelHead appliance. The goal is to create two recurring jobs, each undoing the other, using the standard 'job' cli command. One sets the daytime cap on throughput or a low minimum guarantee and the other removes that cap or sets a higher minimum guarantee.

SteelHead (config) # job 1 date-time hh:mm:ss year/month/day "Start time"
SteelHead (config) # job 1 recurring 864000 "Occurs once a day"
SteelHead (config) # job 1 command 1 <command>
SteelHead (config) # job 1 command 2 <command2>
SteelHead (config) # job 1 enable

SteelHead (config) # job 2 date-time hh:mm:ss year/month/day "Start time"
SteelHead (config) # job 2 recurring 864000 "Occurs once a day"
SteelHead (config) # job 2 command 1 <command>
SteelHead (config) # job 2 command 2 <command2>> "Commands to set daytime cap"
SteelHead (config) # job 2 enable

SteelHead (config) # job 3 date-time hh:mm:ss year/month/day "Start time"
SteelHead (config) # job 3 recurring 864000 "Occurs once a day"
SteelHead (config) # job 3 command 1 <command>
SteelHead (config) # job 3 command 2 <command2>
SteelHead (config) # job 3 enable

SteelHead (config) # job 4 date-time hh:mm:ss year/month/day "Start time"
SteelHead (config) # job 4 recurring 864000 "Occurs once a day"
SteelHead (config) # job 4 command 1 <command>
SteelHead (config) # job 4 command 2 <command2>> "Commands to remove daytime cap"

About Riverbed
Riverbed delivers performance for the globally connected enterprise. With Riverbed, enterprises can successfully and intelligently implement strategic initiatives such as virtualization, consolidation, cloud computing, and disaster recovery without fear of compromising performance. By giving enterprises the platform they need to understand, optimize and consolidate their IT, Riverbed helps enterprises to build a fast, fluid and dynamic IT architecture that aligns with the business needs of the organization. Additional information about Riverbed (NASDAQ: RVBD) is available at www.riverbed.com.