VMware vSphere Replication with Riverbed Steelhead WAN Optimization

A Joint Solution by VMware and Riverbed Technology
What You Will Learn

VMware vSphere Replication is a component of VMware Site Recovery Manager 5.0 that provides the ability to replicate Virtual Machines and their associated data within or between data centers. Replicating data over a wide area network (WAN) introduces performance challenges. Limited bandwidth, high latency, and packet loss can prevent replication objectives or service level agreements (SLAs) from being met. Riverbed® Steelhead® WAN optimization technology overcomes these performance challenges, providing the ability to protect more data at further distances and with lower cost.

In this paper you will learn about the benefits and best-practices associated with combining VMware vSphere Replication and Riverbed Steelhead WAN optimization technology. Results of collaborative testing performed by VMware and Riverbed are presented.

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Benefits of vSphere Replication

VMware vSphere Replication is a new component of VMware Site Recovery Manager (SRM) 5 that allows storage associated with Virtual Machines to be replicated from a local data store to a remote data store, independent of the replication capabilities of the underlying storage technology. Previously, Site Recovery Manager relied on storage array-based replication as the only way to move large amounts of data offsite, which inherits the legacy of additional equipment and licenses, making it cost-prohibitive for smaller- and medium-sized businesses. VMware vSphere Replication provides the same level of protection of storage-based replication without any of the associated costs, and alleviates the complexity of integrating storage arrays into an SRM environment.

Challenges of WAN Performance

When sending large amounts of data across a WAN, a number of challenges arise which can dramatically impair performance and prevent replication objectives from being met. These performance challenges are rooted in the following characteristics of wide area networks:

- Limited Bandwidth
- High Latency
- Packet Loss

**Limited Bandwidth**

The amount of network capacity available between geographically distributed locations is typically far less than that found within a given site or data center. When the amount of data to be replicated within a target replication time window exceeds the amount of raw capacity available, Recovery Point and Time Objectives (RPO/RTO) must be stretched, thereby increasing the risk of data loss and/or the speed of recovery in the event of a disaster.

**High Latency**

As the distance or latency between two locations increases, end-to-end throughput delivered by network protocols (TCP) and/or application protocols can decrease dramatically. For example, TCP uses a flow control mechanism that specifies the number of bytes that can be “in-flight” while waiting for acknowledgements. As latency in a network increases, the number of “in-flight” bytes must also increase in order to maximize end-to-end throughput. Most applications use the standard implementation of TCP with a maximum window size of 65,535 bytes. This becomes insufficient in networks with higher latencies.

**Packet Loss**

Packet loss dramatically reduces the performance of any application utilizing TCP as its underlying data transport protocol. Packet loss most commonly occurs at moments when network resources are over utilized. This can happen when a given application attempts to transmit data at a rate exceeding the network capacity. It can also occur when multiple applications are contending for the same network resource, which occurs when a WAN resource is shared by multiple applications (e.g. email, web, file, backups, replication, voice, video, etc.). Contention and packet loss can also occur within the WAN network itself, as is common when lower-cost WAN infrastructure options are leveraged (e.g. MPLS, VPN over Public Internet).

Individually or combined, the above characteristics of WAN infrastructure represent inherent performance challenges which can dramatically impair or prevent replication objectives from being met.
Benefits of Riverbed Steelhead WAN Optimization

Riverbed Steelhead appliances, powered by the Riverbed Optimization System (RiOS®), overcome the performance challenges inherent in sending data over wide area networks. The following capabilities provide the ability to replicate more data across further distances and at lower cost.

<table>
<thead>
<tr>
<th>Performance Challenge</th>
<th>Riverbed Solution</th>
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<tbody>
<tr>
<td>Limited Bandwidth</td>
<td>Data Streamlining</td>
</tr>
<tr>
<td>High Latency</td>
<td>Transport Streamlining</td>
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<tr>
<td>Packet Loss</td>
<td>Network Quality of Service (QoS) MX-TCP</td>
</tr>
</tbody>
</table>

**Data Streamlining**

Riverbed’s patented Data Streamlining technology overcomes the negative effects of limited WAN bandwidth. Through byte-level deduplication of WAN traffic, bandwidth consumption is commonly reduced by 60-95 percent. This leads to direct cost savings through a reduction in the monthly cost of WAN infrastructure and/or through deferral of WAN bandwidth upgrades.

Data Streamlining works at the network level by reducing the transmission of redundant bytes for TCP-based applications. As traffic flows through a Steelhead-optimized network, RiOS analyzes, indexes, and stores the data in the Steelhead appliances. When a Steelhead recognizes a repetitive data pattern being sent, it transmits a small “reference” which is interpreted and expanded into the original data sequence by its peer Steelhead across the WAN. One small reference can refer to megabytes of existing data that has been transferred over the WAN before, thereby dramatically reducing the amount of data that traverses the WAN.

**Transport Streamlining**

Transport Streamlining overcomes the negative impact of high-latency by automatically tuning and expanding the performance of TCP-based applications. By default, TCP-based flows will typically place up to 65,535 bytes of information onto the network, then wait for acknowledgements before additional bytes are transmitted. This number of “in flight” bytes may be insufficient to fully utilize networks with higher latencies, resulting in severely limited throughput. Steelhead appliances automatically and dynamically tune TCP performance relative to the bandwidth and latency characteristics of the WAN, ensuring that maximum throughput is maintained. Further, when combined with the benefits of Data Streamlining, Steelhead appliances virtually expand TCP performance, dramatically reducing the number of round trips that are needed to deliver large amounts of data, often by a factor of 100 times or more.

**Network Quality of Service (QoS)**

Network QoS, also known as “packet shaping” or “traffic shaping”, gives IT professionals the ability to manage the performance of applications which share the same WAN links. By prioritizing access across traffic types, IT professionals can guarantee that critical replication jobs will be given the WAN bandwidth they need in order to meet their replication objectives consistently. Unlike other QoS implementations, the Riverbed Optimization System (RiOS) provides advanced traffic shaping capabilities such as minimum bandwidth allocation, dynamic bandwidth expansion, latency-based prioritization, Hierarchical Fair Service Curves (HFSC), and deep-packet classification.

**MX-TCP**

While most terrestrial WANs have a very low natural packet loss rate, normally well under 0.1 percent, and often under 0.01 percent, such packet loss can result in inconsistent performance for TCP-based applications. This is due to the fact that TCP interprets any dropped packet as a sign of congestion and will slow down its transmission rate by half, then slowly increase its sending rate over time. RiOS MX-TCP overcomes the negative effects of packet-loss, guaranteeing that TCP will continue to perform at maximum speed even when a packet is dropped between Steelhead appliances. When combined with RiOS QoS, IT professionals can guarantee that replication traffic will operate at maximum speed while simultaneously carving room for other applications also contending for WAN capacity.
The Combined Solution and Benefits

VMware vSphere Replication provides a cost-effective and simple-to-manage solution for replicating Virtual Machines and their associated data between remote locations. When faced with the performance challenges inherent in moving large amounts of data over a WAN, Riverbed Steelhead WAN optimization solutions used in conjunction with vSphere Replication can be leveraged to ensure that data replication objectives can be met, while reducing the cost of WAN infrastructure.

This section provides additional technical detail and best-practices for the combined solution.

![Diagram of vSphere Replication and Steelhead appliance network topology]

Figure 1: vSphere Replication and Steelhead appliance network topology

Steelhead Appliance Best-practice Configuration

The following configuration guidelines represent a baseline for optimal integration with VMware vSphere Replication. For additional detail regarding best practices for using Steelhead appliances in replication scenarios, refer to the "Data Protection Deployments" chapter in the Steelhead Deployment Guide, and to the Steelhead Appliance Installation and Configuration Guide, both of which are available from http://support.riverbed.com.

**QoS / MXTCP**

Create a QoS class for vSphere Replication and set the queue type to "mxtcp". Create a QoS rule to match traffic for vSphere Replication, mapping it to the mxtcp class created.
TCP
Set WAN buffers to 2 times the Bandwidth Delay Product (BDP) for your network. For example, if latency is 40 ms RTT and bandwidth capacity is 10 Mbps: 2 x BDP = \[2 \times (10^5 \text{ kbps}) \times (40 \text{ ms}) / 8 \text{ bits per byte} \times 100,000 \text{ bytes}.\]

Set Neural Framing to never for vSphere Replication ports (default ports 31031 and 44046).

Data Streamlining
Enable SDR-Adaptive (Advanced).

Network Integration
Steelhead appliances can be deployed either physically in-path or virtually in-path via the Riverbed Interceptor, WCCP or PBR.

vSphere Replication Best-practice Configuration
VMware vSphere Replication establishes one TCP connection per Virtual Machine Disk (vDisk) to be replicated. For each vDisk, vSphere Replication will send up to 16 data blocks to the network at a time, then wait for acknowledgements before sending additional data blocks. This places an upper bound on end-to-end throughput, defined by the number of vDisks being replicated as well as the network latency between sites. For maximum performance, increase the number of vDisks to be replicated simultaneously.
Performance Analysis

The picture above illustrates the setup used to evaluate the combined benefits of vSphere Replication with Steelhead WAN optimization.

The vSphere Replication environment consists of a protected site on the left of the diagram and a DR site on the right. The protected site has a selection of Windows 2008 VMs, including:

- Windows 2008 Domain Controller
- Windows 2008 SQL Server
- Windows 2008 Sharepoint Server
- Windows 2008 vCenter Server
- Windows 2008 Exchange Server

To simulate WAN environments, a network simulator is deployed between the two "sites", configured for specific levels of bandwidth, latency, and packet loss. For this testing, the following WAN parameters were used:

**WAN Capacity:**
- 10 Mbps – Mid-size remote office or small data center

**Latency:**
- 40 ms RTT – Representative ½ distance between US East and West coasts.
- 100 ms RTT – Representative of US East to West (coast-to-coast)

**Packet-loss:**
- 0 percent - Representative of point-to-point WAN infrastructure
- 0.1 percent - Representative of packet loss using MPLS infrastructure
- 1.0 percent - Representative of packet loss in VPN over Public Internet
Test Results
The table below captures end-to-end throughput of vSphere Replication with and without Steelhead WAN optimization over a variety of real-world WAN conditions. Without Steelhead WAN optimization, performance is limited by available bandwidth. Furthermore, increased levels of latency and packet-loss prevent WAN capacity from being fully utilized. Steelhead appliances overcome these limitations, expanding the virtual capacity of the WAN and resulting in over 9 times improvement in end-to-end performance.

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Latency</th>
<th>Packet Loss</th>
<th>vSphere Replication (Not optimized)</th>
<th>vSphere Replication (With Steelheads)</th>
<th>Performance Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Mbps</td>
<td>40 ms RTT</td>
<td>0 %</td>
<td>10 Mbps</td>
<td>83 Mbps</td>
<td>8.3 X</td>
</tr>
<tr>
<td>10 Mbps</td>
<td>40 ms RTT</td>
<td>0.1%</td>
<td>10 Mbps</td>
<td>85 Mbps</td>
<td>8.5 X</td>
</tr>
<tr>
<td>10 Mbps</td>
<td>40 ms RTT</td>
<td>1%</td>
<td>10 Mbps</td>
<td>83 Mbps</td>
<td>8.3X</td>
</tr>
<tr>
<td>10 Mbps</td>
<td>100 ms RTT</td>
<td>0%</td>
<td>10 Mbps</td>
<td>76 Mbps</td>
<td>7.6X</td>
</tr>
<tr>
<td>10 Mbps</td>
<td>100 ms RTT</td>
<td>0.1%</td>
<td>8.2 Mbps</td>
<td>78 Mbps</td>
<td>9.2X</td>
</tr>
<tr>
<td>10 Mbps</td>
<td>100 ms RTT</td>
<td>1%</td>
<td>8.2 Mbps</td>
<td>76 Mbps</td>
<td>9.3X</td>
</tr>
</tbody>
</table>

Table 4: vSphere Replication with and without Steelhead WAN Optimization

Conclusion
VMware vSphere Replication reduces the cost and complexity of protecting Virtual Machines and their underlying data. Performance challenges inherent in sending data over wide area networks can prevent vSphere Replication objectives from being met. With Riverbed Steelhead WAN optimization appliances, IT professionals can overcome these challenges, boost vSphere Replication by over 10 times and significantly reduce the cost of WAN infrastructure.

For More Information