

**Accelerating
VMware
vSphere®
Replication™
with Silver Peak**

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Overview

VMware vSphere Replication is a hypervisor-based virtual machine replication solution for disaster recovery. Disaster recovery becomes more important with every natural disaster and crashed system. Using VMware vSphere Replication, organizations can quickly and easily deploy a data protection solution that frees them from storage lock-in and provides flexibility.

VMware vSphere Replication can easily provide replication for thousands of virtual machines using a simple right-click methodology in vCenter Server. Volume Shadow Copy Service (VSS) is used for Microsoft virtual machines to help with consistent recovery. Recovery Point Objectives (RPOs) are configurable between 15 minutes and 24 hours, with multiple recovery points available for recovery to a previous known good state.

While vSphere Replication provides an efficient replication method for virtual machines running in a VMware vSphere environment, the Wide Area Network (WAN) can artificially limit replication throughput. When the WAN connecting the two data centers has latency, limited bandwidth, out-of-order or dropped packets, replication throughput can be adversely affected resulting in RPO violations and failed replication. Either of these expose the business to additional risk in the event of a disaster requiring recovery.

Silver Peak develops data center class replication acceleration software that fixes the problems that exist on the WAN, enabling more data to be replicated, in less time, and over longer distances. Silver Peak software can be deployed as a virtual machine or as a hardware appliance. Silver Peak software solves WAN problems by de-duplicating and compressing WAN traffic, repairing dropped and out-of-order packets, and overcoming the effects of latency.

When the problems on the WAN have been repaired, it is easy to meet, maintain, and even shrink RPOs. Silver Peak and VMware have performed extensive testing on the joint solution and share many customers. This white paper details the benefits that Silver Peak Replication Acceleration provides for VMware vSphere Replication.

The Challenge of Replicating Over Distance

Most replication tools use the Transmission Control Protocol, TCP, to move data across the WAN. While TCP is a ubiquitous protocol, it does have limitations that can cause disruption to replication, resulting in missed RPOs or failed jobs. Typical disruptions are caused by latency, packet loss, out-of-order delivery of packets, and bandwidth quantity.

Latency across the WAN is caused by the geographic distance between data centers, along with the switching and routing equipment in use. Throughput is also affected by the amount, and quality, of the bandwidth used for replication. When the WAN suffers from dropped or out-of-order packets, it will have a detrimental effect on replication throughput. When latency is combined with dropped and/or out-of-order packets, throughput can drop low enough that RPO targets are missed.

For example, when data is transmitted across a 622 megabit-per-second (Mbps) WAN with 80ms of latency and 1% packet loss (typical of an Internet VPN), throughput is limited to 22 Mbps, compared to 424 Mbps when no latency is present. The reduction in throughput is due to the combination of latency and packet loss, and is commonly seen in data transfers across similar WAN connections.

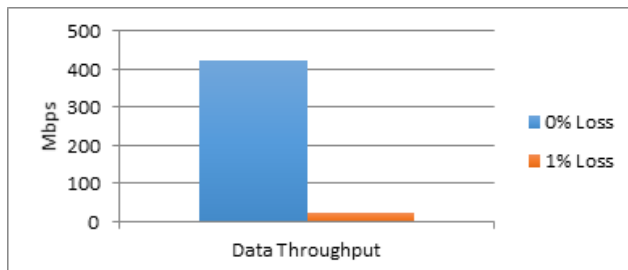


Figure 1: Throughput with 1% Packet Loss (Internet VPN)

Finally, the amount of bandwidth available for replication is a frequent problem in replication environments. Most businesses can't afford dedicated networks for data replication and backup, which means replication throughput must contend with all of the other traffic using the WAN. Some network-based solutions exist to manage the allocation of bandwidth, typically performed with Quality of Service (QoS) policies in a router or switch. While QoS can help provide a minimum amount of bandwidth for an application, it can't increase the overall available bandwidth for that same application. This problem is exacerbated when the total available bandwidth can't meet the requirements of a single application before replication is added to the WAN. When bandwidth is limited, replication throughput will also be limited, causing missed RPOs and failed backups.

Silver Peak's replication acceleration features can remove the impact of latency on throughput, while repairing dropped and out-of-order packets in real time, allowing all of the available bandwidth to be used. Silver Peak will also perform deduplication and compression, resulting in a much higher effective throughput across the WAN. All of these features combine to solve network problems that limit replication effectiveness and cause missed RPOs putting the business at risk of data loss.

VMware vSphere Replication and Silver Peak

VMware vSphere Replication Architecture

VMware vSphere Replication is a component of the VMware vSphere hypervisor. It has been designed to integrate seamlessly with vSphere to provide disaster recovery services by replicating virtual machines to a remote location. vSphere Replication provides a copy of each protected virtual machine that can be used to quickly restore services in the event of a disaster or data loss.

vSphere Replication has the following benefits:

- Integration with vCenter Server and vSphere Web Client
- Replication between different storage types, e.g., VMware Virtual SAN to NAS
- Per-VM recovery point objectives of 15 minutes to 24 hours and as low as 5 minutes when replicating between Virtual SAN data stores
- Native support for vCloud Air Disaster Recovery and Site Recovery Manager Air

vSphere Replication is a fully integrated, replication engine that is deployed as one or more virtual appliances. An agent resides in vSphere and is used to track changes for each protected virtual machine's disk(s). Changes are sent to a vSphere Replication virtual appliance at the secondary site, which writes them to an on-disk redo log. When all changes have been received, the data is written to the protected virtual machine's replica disks at the recovery site. The use of a redo log protects against corruption due to partial replication completion.

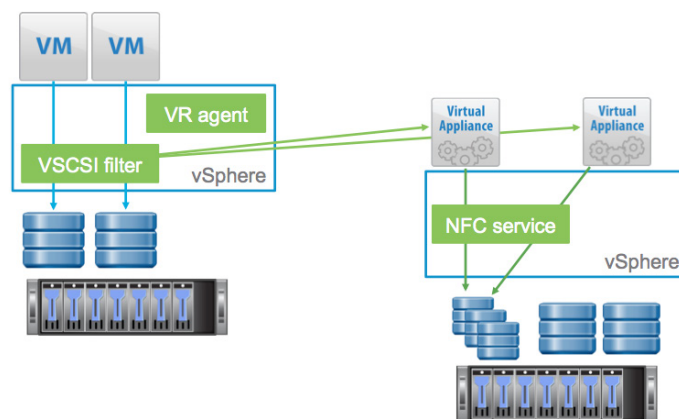


Figure 2: VMware vSphere Replication Architecture

Since vSphere Replication is host-based replication, it is independent of the underlying storage and works with a variety of storage types including Virtual SAN, traditional SAN, NAS, and locally attached disks. This flexibility enables vSphere Replication to work with a wide variety of configurations. Unlike many array replication solutions, vSphere Replication enables virtual machine replication between heterogeneous storage types. For example, Virtual SAN to local storage, SAN to NAS, and SAN to Virtual SAN. vSphere Replication can, of course, be configured between the same types of storage, e.g., Virtual SAN to Virtual SAN.

All vSphere Replication management is performed in vSphere Web Client. Virtual machines are protected by completing just a few wizard-driven steps in the vSphere Web Client such as configuring the RPO and selecting a destination for the replica copy.

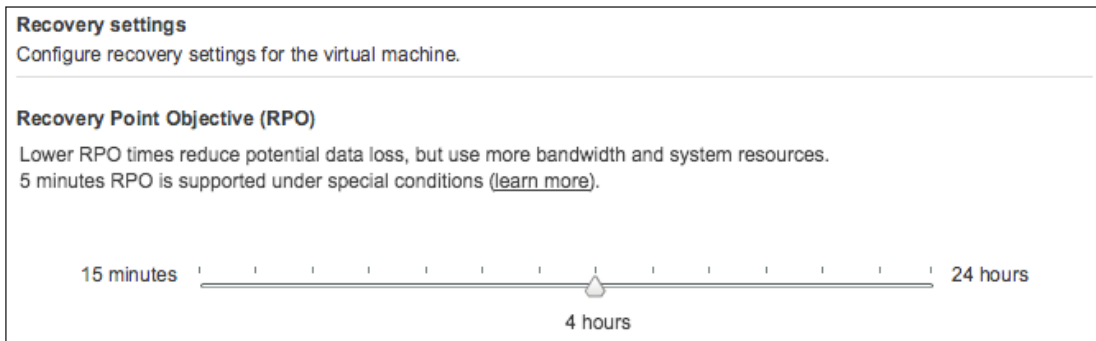


Figure 3: VMware vSphere Replication RPO Configuration

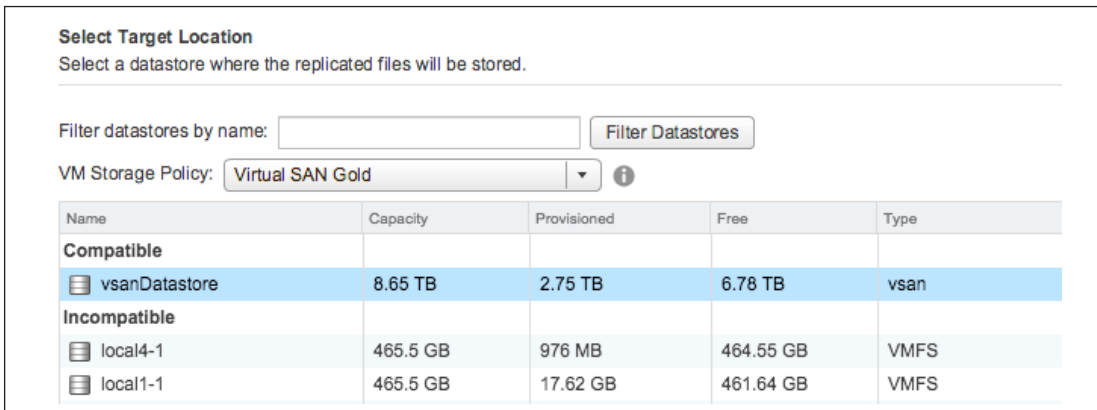


Figure 4: VMware vSphere Replication Target Datastore Configuration

Once replication is configured for a virtual machine, vSphere Replication performs an initial full synchronization. “Seed” copies of a virtual machine’s disk(s) can be used at the target location to reduce the amount of data transmitted during the initial full synchronization.

Silver Peak Replication Acceleration Software

Silver Peak VRX replication acceleration software solutions address the bandwidth, latency, and packet loss issues that are common to many distributed enterprise environments. Silver Peak’s optimization techniques are all performed in real-time and primarily at the network (IP) layer to ensure maximum performance across the widest range of applications and WAN environments.

Silver Peak VRX replication acceleration software is a specially packaged offering designed specifically for storage professionals leverages the following Silver Peak WAN technology components accelerate all replication over the WAN:

- **Latency Mitigation:** TCP and other protocol acceleration techniques minimize the effects of latency on application performance and significantly improve application response time across the WAN.
- **Data Reduction:** WAN compression and deduplication is applied to all traffic, eliminating repetitive transmission of duplicate data. Silver Peak software inspects WAN traffic at the byte level and stores content in local data stores. Advanced finger-printing techniques recognize repetitive patterns for local delivery. Data Reduction can be applied to all IP-based protocols, including TCP and UDP.
- **Path Conditioning:** Techniques to improve performance overcome the adverse effects of dropped and out-of-order packets that are common with broadband Internet and MPLS connections. Path Conditioning provides private-line-like performance over the public Internet.
- **Dynamic Path Control (DPC):** Real-time traffic steering can be applied over any broadband or MPLS link based on company defined business intent policies. In the event of an outage or brownout, DPC automatically fails-over to the secondary connection in about one second.
- **Encryption & WAN Hardening:** For customers replicating over the Internet, replication data can be secured edge-to-edge via 256-bit AES encrypted tunnels. Any traffic sent between Silver Peak software instances can be accelerated and encrypted at wire speed.
- **Virtual Deployment Options:** Silver Peak can be deployed as a physical appliance or a virtual instance. Silver Peak’s virtual products can be deployed on any hypervisor (VMware, Microsoft Hyper-V, Xen, and KVM) and on any server hardware that meets the minimum requirements.

Sizing

Silver Peak VRX replication acceleration software is typically sized based on the available WAN bandwidth for data protection traffic, including replication, backup, and data migration. Each VRX model has a limit on the amount of WAN bandwidth that it will support. The Silver Peak software that powers VRX can also be limited in the amount of bandwidth that will be used on the WAN.

For example, if you have 100 Mbps of WAN bandwidth, but only 40 Mbps is available for replication traffic, a VRX-4 will be used with a configured system rate limit of 40 Mbps. This allows the VRX-4 to take in as much data as possible, optimize the data, and then transmit up to the rate limit across the WAN.

Silver Peak Model	VRX-2	VRX-4	VRX-6	VRX-8
WAN Throughput	20 Mbps	100 Mbps	300 Mbps	1 Gbps
Average Accelerated Data Throughput	50 GBph	250 GBph	750 GBph	2 TBph

Silver Peak also offers a full range of WAN optimization options that can be deployed as virtual or physical appliances. More information about Silver Peak’s WAN optimization products is available at www.silver-peak.com.

VMware vSphere Replication Testing and Validation with Silver Peak

Test Methodology

A dedicated test environment was deployed to test compatibility and performance. The test environment is shown in Figure 5.

VMware vSphere Replication Test Suite Overview

The following components were used for vSphere Replication testing with Silver Peak. For each test, all nine protected VMs were replicated to the remote site. Subsequent replications were performed by writing new data into the protected VMs.

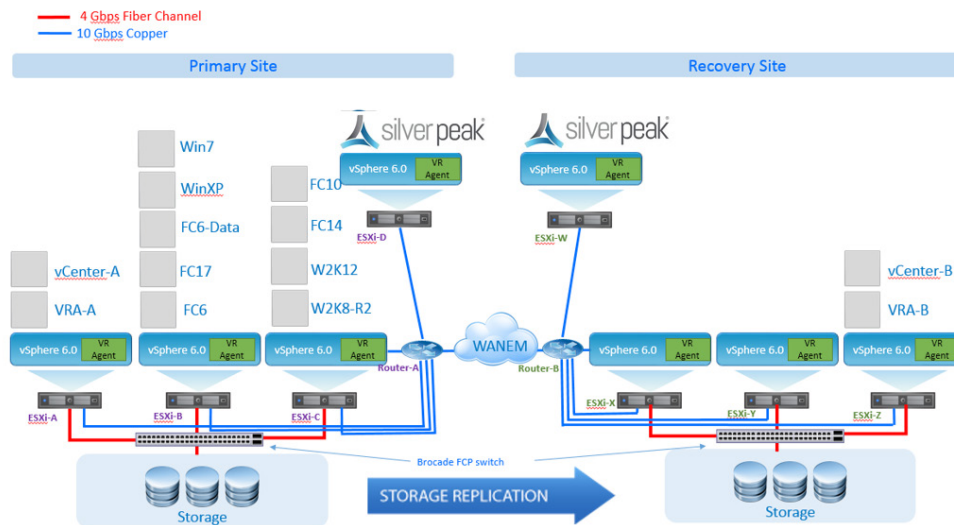


Figure 5: vSphere Replication/VRX-8 Test Bed

Device/Tool	Name	Version
vSphere	N/A	6.0
vSphere Replication	N/A	6.0
Silver Peak Virtual Appliances	VRX-8	VXOA 6.23.0_49572
WAN Emulator	KWANEM	52909
Replication VMs	Fedora	2xFC6, FC10, FC14, FC17
	Windows	XP, 2008R2, 2012, 7

The tables below represent the common loss and latency characteristics for WAN connections. These values are averages as actual WAN conditions vary based on many factors, including over subscription and actual cable miles between sites.

WAN Type	Average Packet Loss
Private Line	0%
MPLS	.1%
Internet VPN	1%
Satellite	5%

Table 3: Average WAN Packet Loss

Distance	Average Latency
Metro	5ms
Regional US	25ms
Coast to Coast US	80ms
US to Europe	150ms
US to Asia	300ms

Table 4: Average WAN Latency

Test Results

Performance across latencies, with packet loss of 0.1% and 1%, is consistent when Silver Peak is used to accelerate the replication traffic. Without Silver Peak, vSphere Replication throughput is reduced by the combination of packet loss and latency. Figure 6 shows throughput for vSphere Replication with 0.1% packet loss, while Figure 7 shows throughput with 1% packet loss. In both charts, Silver Peak is able to increase the effective throughput of vSphere Replication, even when the WAN has packet loss and latency.

Note that for these examples, vSphere Replication compression has been disabled, allowing the Silver Peak appliances to get the highest reduction possible. Silver Peak’s deduplication and compression technology is compatible with vSphere Replication Compression. Figure 8 shows the performance difference on a 20 Mbps WAN with 1% packet loss with and without vSphere Replication Compression. The throughput when compression is enabled displays as lower due to where the measurements were taken. Throughput is measured at the ingress and egress points of the Silver Peak appliance. Measuring this way allows a consistent standard, and also more detail on the value of Silver Peak’s deduplication and compression. vSphere Replication Compression reduces the amount of data sent across the network, before the Silver Peak appliance, so the throughput appears to be lower. In reality more data is sent than it appears due to the compression.

Use Case Examples

The following use cases are based on data that was collected during joint Silver Peak and VMware testing, as well as an average of data collected from installed customers.

Regional Replication across an Internet VPN

Replicating across an Internet VPN is becoming more common as a method to reduce the cost of disaster recovery. Utilizing an Internet VPN for replication traffic can be a cost-effective solution for most businesses.

Without Silver Peak software accelerating the WAN, throughput would be limited due to the amount of lost and out-of-order packets that are present on Internet connections.

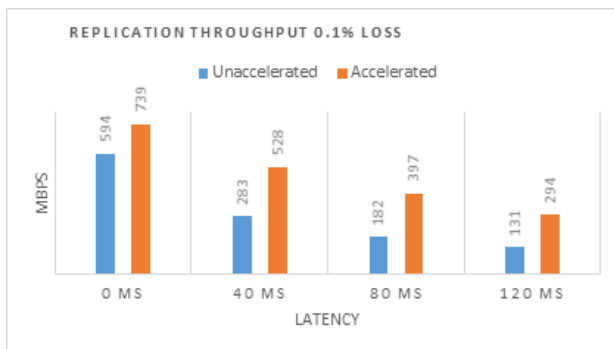


Figure 6: Test Results with 0.1% Loss

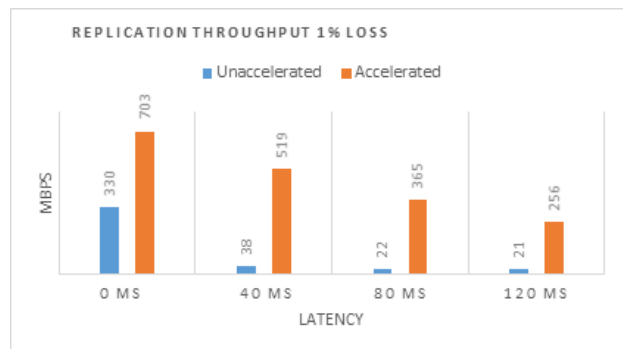


Figure 7: Test Results with 1% Loss

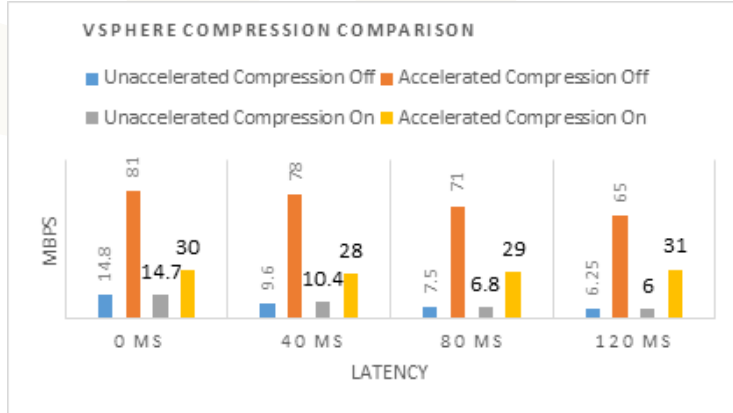


Figure 8: VMware vSphere Compression Comparison

For this use case we will use the following assumptions:

- WAN:
 - 45 Mbps of bandwidth available for replication
 - 80ms of latency – the equivalent of Boston, MA to Santa Clara, CA
 - 1% packet loss – the average amount of loss across an Internet VPN connection
- Data Set:
 - 5 TB mix of virtual machines with user data, email, databases, and other applications
 - 10% daily change rate during business hours (8am to 5pm)
 - 2 hour RPO

A 5 TB data set with a 10% change rate will have an average of 512 GB per day that needs to be replicated. In most scenarios, the change rate will vary during the day, creating periods when more data must be replicated to maintain the desired RPO. For simplicity, we will assume a uniform change rate across 8 hours resulting in 64 GB of data per hour that needs to be replicated.

- Without Silver Peak, the average throughput will be 22 Mbps
 - The 64 GB of data per hour will take approximately 6.6 hours to replicate
 - The 2 hour RPO will be missed by over 4 hours
- With Silver Peak the average throughput will 365 Mbps – a 16.5X increase in throughput
 - The 64 GB of data per hour will take approximately 24 minutes
 - The 2 hour RPO will be maintained, and reduced to just under half an hour

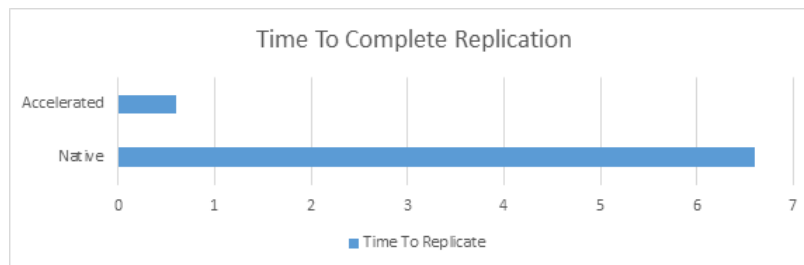


Figure 9: vSphere Replication time to complete – 45Mbps/80ms latency/1% packet loss (Internet VPN)

International Replication across an MPLS WAN

Multiprotocol Label Switching (MPLS) connections provide good value for money when compared to private or leased lines. However, MPLS WANs have approximately .1% packet loss on average, and can have a high number of out-of-order packets. When replication traffic is dropped, or consistently delivered out-of-order, it must be retransmitted across the WAN. Retransmits increase the latency, reduce usable bandwidth, and decrease the throughput of vSphere Replication. Even with the potential for loss and out-of-order, MPLS connections can still provide consistent performance when Silver Peak software is used.

For this use case we will use the following assumptions:

- WAN
 - 350 Mbps of available bandwidth for replication
 - 120ms of latency – the equivalent of Boston, MA to London, UK
 - .1% packet loss – the average loss on an MPLS connection
- Data Set
 - 20 TB mix of virtual machines including user data, several databases, application data, and an email server
 - 10% daily change rate during business hours (8am to 5pm)
 - 2 hour RPO

Our 20 TB data set will have an average of 2 TB per day that needs to be replicated. In most scenarios the change rate will vary during the day, creating periods when more data must be sent across the WAN to maintain the specified RPO. To make the math simple we will assume a uniform change rate across 8 hours resulting in 250 GB of data per hour that needs to be replicated. When we take our 2 hour RPO into account the amount of data that must be sent every RPO cycle is 250 GB.

- Without Silver Peak the average throughput will be 57.5 GB per hour
 - The 250 GB of changed data will take approximately 4.3 hours to replicate
 - The 2 hour RPO will be missed by 2.3 hours
- With Silver Peak the average throughput will be 129 GB per hour – a 2.2X increase in throughput
 - The 250 GB of changed data will take approximately 1.9 hours to replicate
 - The 2 hour RPO will be maintained

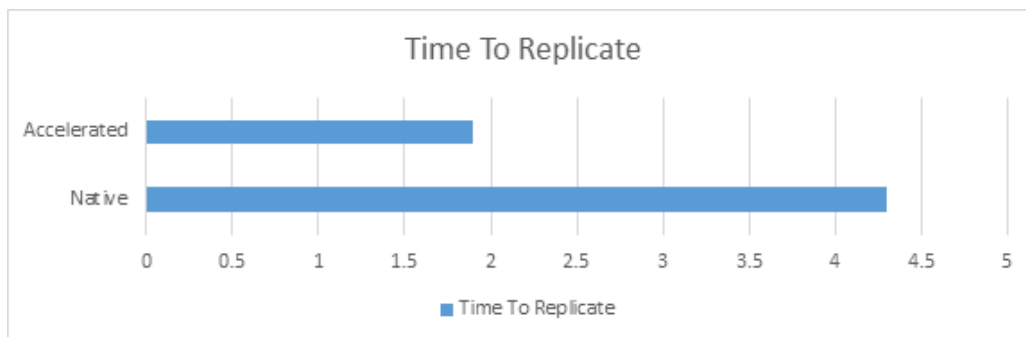


Figure 10: VMware vSphere Replication time to complete

When Should Silver Peak be Deployed with VMware vSphere Replication

Based on testing and customer deployments, we recommend that Silver Peak be deployed in the following scenarios:

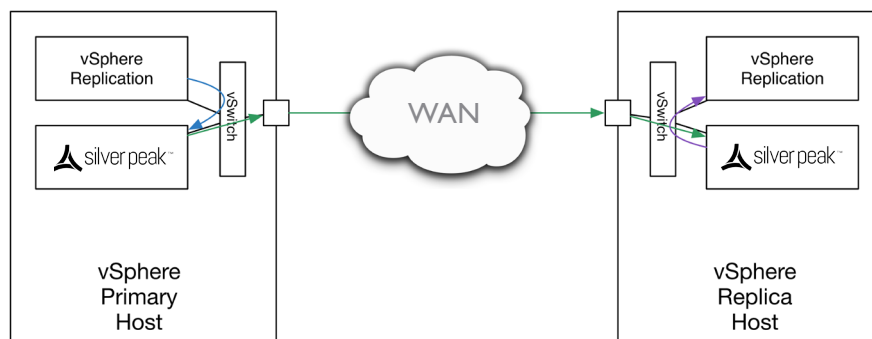
- The WAN has packet loss, or the potential for packet loss (typically Internet, MPLS, or Satellite connections)
- Available replication bandwidth is not high enough to meet recovery point objectives
- The WAN is shared between vSphere Replication and other applications

Example Architecture

Silver Peak VRX Replication Acceleration Software Deployed as a Virtual Machine

Silver Peak's VRX replication acceleration software is deployed as a virtual machine in the same environment that is being replicated with vSphere Replication. Using this deployment method, the only changes that need to be made in the environment are a static route on the vSphere host and the default gateway on the vSphere Replication virtual machine.

Setup and Configuration Best Practices



Traffic Flow:

1. vSphere Replication sends traffic to Silver Peak.
2. Silver Peak software sends traffic to the remote Silver Peak instance.
3. Silver Peak software sends traffic to the remote vSphere Replication.

Figure 11: vSphere Replication and the Silver Peak Architecture

While in most cases Silver Peak can provide adequate optimization out-of-the-box, there are several settings that should be configured to ensure the best performance when Silver Peak software is deployed with VMware vSphere replication. The following configuration options assume that vSphere replication has been configured and is operational.

VMware vSphere Replication Configuration

The following items must be configured on all vSphere hosts and vSphere Replication virtual appliances, which are being accelerated by Silver Peak software.

- Create a static route on each vSphere host using the Silver Peak software as the next hop - see <http://kb.vmware.com/kb/2001426>
- Do not enable vSphere Replication compression (it is disabled by default)

Silver Peak Configuration

The Silver Peak software should initially be configured using the relevant Quick Start Guide: <http://silver-peak.com/support/user-documentation>.

After initial configuration, the following settings should be used. Note that default settings have been specified to aid in troubleshooting.

To make the following changes to the tunnel select Configuration>Tunnels from the Silver Peak appliance manager. Click on the name of the tunnel that will be used for vSphere replication traffic and make the changes listed below. Note that it is possible to encrypt all traffic between Silver Peak software instances. To encrypt all traffic sent across the tunnel select Mode: IPSec, and enter an IPSec Pre-shared Key. The remote Silver Peak software must be configured to support IPSec and have the same Pre-shared Key.

Tunnel Configuration

Option	Value	Default Setting
Admin	Up	Yes
Auto Discover MTU	Checked	Yes
Auto Max BW	Checked	Yes
Mode	UDP	Yes
Reorder Wait	100	Yes
FEC with <.1% WAN packet loss	Auto 1:5	No
FEC with >.1% WAN packet loss	Enable 1:5	No

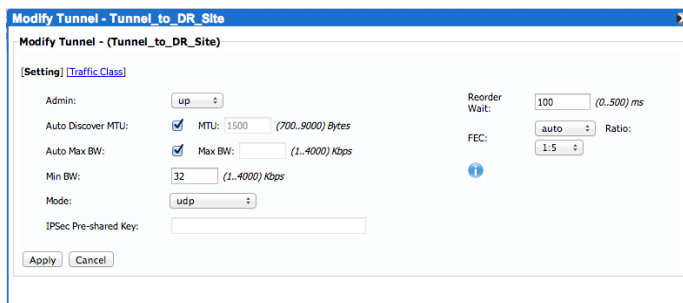


Figure 12: Tunnel Configuration

Forward Error Correction (FEC)

Forward Error Correction, or FEC, is a tunnel option that is used to recover lost packets on the WAN in real-time without requiring the data to be resent. Real-time packet loss can be measured in the Silver Peak appliance manager.

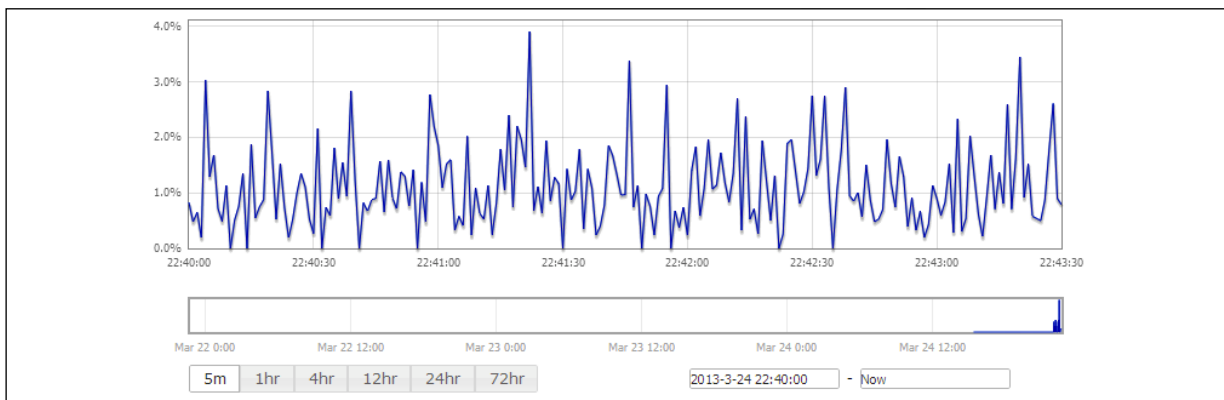


Figure 13: Monitoring Loss with Silver Peak Software

When there is evidence of consistent packet loss on, in or across the WAN, a FEC setting of enable with a ratio of 1:5 is recommended. By using a FEC setting of enable with a ratio of 1:5, packet loss across the WAN will be corrected, increasing overall replication throughput. When packet loss is rare or intermittent, FEC should be set to auto with a ratio of 1:5. Auto will allow Silver Peak to dynamically control the amount of parity packets that are injected into the data stream, with the upper limit capped by the chosen ratio value (1:5). For WANs that have zero packet loss, FEC can be set to auto or off. Off should only be used when there is no chance for bandwidth contention or dropped packets. When a setting of off is used, packet loss should be carefully monitored in the Silver Peak GUI.

Conclusion and Recommendations

Silver Peak software provides acceleration and optimization for VMware vSphere Replication across any WAN. With Silver Peak, replication can be performed over a longer distance using WAN connections like the Internet. In addition to saving money on the WAN connection, critical business data can be better protected with a smaller RPO, enabling better disaster recovery. Typical results for a Silver Peak and vSphere Replication deployment are between a 2X and 20X performance improvement for replication throughput. In some instances performance has been shown to be even higher. Extensive testing has been performed by Silver Peak and VMware to verify compatibility, and characterize the performance of Silver Peak software with vSphere Replication. All Silver Peak models are supported with vSphere Replication, providing flexibility in deployment options that will suit any environment.