Microsoft SQL Server on VMware
Availability and Recovery Options
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## 1. Introduction

Running Microsoft SQL Server on VMware vSphere® offers many options for database availability and disaster recovery utilizing the best features from both VMware and Microsoft. For example, VMware vSphere® vMotion® and DRS can help to reduce planned downtime and balance workloads dynamically and vSphere HA can help to recover SQL Servers in the case of host failure.

At the application level, all SQL Server features and techniques are supported on vSphere, including: database mirroring, failover clustering, and log shipping. SQL Server high availability features can be combined with vSphere features to create flexible availability and recovery scenarios, applying the most efficient and appropriate tools for each use case.

The following table lists SQL Server availability options and their ability to meet various recovery time objectives (RTO) and recovery point objectives (RPO). Before choosing any one option, evaluate your business requirements to determine which scenario best meets your specific needs.

### Table 1. SQL Server 2008 High Availability Options

<table>
<thead>
<tr>
<th>Technology</th>
<th>Granularity</th>
<th>RPO – Data Loss</th>
<th>RTO – Downtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Mirroring (High Safety Mode with Automatic Failover)</td>
<td>Database</td>
<td>None</td>
<td>&lt; 3 seconds</td>
</tr>
<tr>
<td>Database Mirroring (High Safety Mode without Automatic Failover)</td>
<td>Database</td>
<td>None</td>
<td>Administrator Recovery</td>
</tr>
<tr>
<td>Database Mirroring (High Performance Configuration)</td>
<td>Database</td>
<td>Some</td>
<td>Administrator Recovery</td>
</tr>
<tr>
<td>Failover Clustering</td>
<td>Server</td>
<td>None</td>
<td>~30sec + recovery</td>
</tr>
<tr>
<td>Log Shipping</td>
<td>Database</td>
<td>Possible transaction log</td>
<td>Administrator Recovery</td>
</tr>
</tbody>
</table>

This document provides a description of the various options available. Topics include:

- VMware vSphere Platform Advantages.
- Increase Availability across the SQL Server Lifecycle.
- Local Site Availability Options.
- Remote Site Availability Options.
- Backup and Restore Options.
2. VMware vSphere Platform Advantages

Although application-level clustering has been the prevalent solution for most SQL Server implementations, features of the vSphere platform can enhance the overall availability of SQL Server by providing options that help to limit both planned and unplanned downtime. In fact, for many organizations, the features provided by vSphere may satisfy the availability requirements of their business without needing to follow traditional clustering approaches. For other organizations that require a greater degree of availability, application-level clustering can be combined with the vSphere features to create an extremely flexible environment, with options for failover and recovery at both the hardware and application levels. Some of the advantages of the vSphere platform include:

- **Virtual machines are portable** – This means that your SQL Server is no longer bound to a particular piece of hardware, which can enhance availability in a couple of ways.
  - Design decisions are no longer permanent – You can adjust your CPU and memory requirements on a running virtual machine (VM) with VMware Hot-Add (SQL 2008 on Windows 2008) or through a quick configuration change and reboot of the virtual machine (earlier versions of SQL).
  - Easily upgrade to newer hardware – As your application requirements change, simply move the SQL Server virtual machine to newer hardware to accommodate increased workloads.

- **Virtual machines are hardware independent** – Hardware independence means increased flexibility when designing both production and disaster recovery components. Cluster nodes and recovery servers can be virtualized, eliminating the need for identical hardware.

- **vSphere High Availability (HA) protects your server from hardware failure** – If your physical server or any critical component within the server fails for any reason, vSphere HA will automatically reboot the SQL Server virtual machine on another physical server, acting as a first line of defence against service outage. By combining vSphere HA with traditional clustering approaches, you can mitigate both hardware and software failures for maximum availability.

**Note** As of vSphere v4.1, using vSphere HA with Microsoft failover clustering is supported. See details of support at [http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1037959](http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1037959). Database mirroring is not subject to any support restrictions and offers the best combination of SQL Server and VMware availability features.

- **VMware vSphere Distributed Resource Scheduler (DRS) can balance workloads and speed recovery** – vSphere DRS is vSphere vMotion with intelligence. As application workloads increase, vSphere DRS can move a bottlenecked virtual machine to another host with more available resources automatically and without downtime. vSphere DRS can also help to recover more quickly after server hardware failure. For example, if a physical server fails, vSphere HA reboots the virtual machine on another physical server. When the failed server is replaced, vSphere DRS migrates the virtual machine back to its original location with no downtime and no interruption to the end-user.

- **VMware offers consolidation opportunities** – Underutilized application and SQL Server components can be consolidated onto fewer physical servers for maximum hardware utilization and lower costs.
3. Increase Availability across the SQL Server Lifecycle

3.1 Simplify Upgrades and Reduce or Eliminate Downtime

- Traditional, physical environment upgrades and scale-up activities require a great deal of resources, including:
  - Planning and implementation time from engineering resources, including application administration, server administration, and SAN administration.
  - Sizing and acquisition of new hardware.
  - Downtime required to perform an upgrade, which results in higher costs and risks.

- In comparison, scaling your environment using vSphere means simply adding more SQL Server virtual machines as the workload increases.

- Physical SQL Server environments are tightly bound to a storage technology and are extremely difficult to scale. Adding more storage capacity to SQL Server virtual machines is less complex because vSphere emulates storage to a simple SCSI device. The end result is that the SQL Server environment can be upgraded regardless of the underlying storage technologies (iSCSI or Fibre Channel).

- With the VMware Virtual Machine File System (VMFS), the storage capacity serving SQL Server environments can be reduced or increased on the fly with the hot add/remove storage functionality in vSphere.

- Virtualized SQL Server environments can be serviced (for example, adding more memory or upgrading CPU) without interruptions due to the shared storage functionality from VMware VMFS and vSphere vMotion technology.

3.2 Performance and Recovery Advantages

- Virtualized SQL Server environments can recover from:
  - Planned and/or unplanned hardware outages using vSphere HA.
  - Hardware degradation by using vSphere DRS capability to automatically balance workloads.
  - Application failure using database mirroring (High-Safety with Automatic Failover) or Microsoft Failover Clusters within a VM on shared storage.

- With built-in multipathing capability and advanced queuing techniques available in virtual machine architectures, virtualized SQL Server environments can leverage advanced configuration options to:
  - Increase the IOPS/transactions to service more clients.
  - Balance the workloads of multiple SQL Servers sharing the same physical server to use multiple SAN paths and storage processor ports.

- High I/O, memory- and CPU-intensive applications such as SQL Server can better recover from SAN errors because the applications reside on VMFS, which hides SAN errors from guest operating systems.
4. Local Site Availability Options

When deploying SQL Server, the high-availability options available in physical environment continue to be available in a virtual environment. Additionally, vSphere features that provide high-availability and load distribution are also available to allow the highest level of performance and recovery in the case of a host failure.

4.1 vSphere HA, DRS, and vMotion for High-availability

4.1.1 vSphere HA

vSphere HA provides easy-to-use, cost-effective, high availability for applications running in virtual machines. In the event of physical server failure, affected virtual machines are automatically restarted on other production servers that have spare capacity. Additionally, if there is an OS-related failure within a virtual machine, the failure is detected by vSphere HA and the affected virtual machine is restarted on the same physical server.

4.1.2 vSphere Distributed Resource Scheduler (DRS)

vSphere DRS collects resource usage information for all hosts and virtual machines, and generates recommendations for virtual machine placement. These recommendations can be applied manually or automatically. vSphere DRS can dynamically load balance all virtual machines in the environment by shifting workloads across the entire pool of VMware ESX®/VMware ESXi™ hosts. This makes sure that critical SQL Server virtual machines in the environment always have the CPU and RAM resources needed to maintain optimal performance.

4.1.3 VMware vSphere vMotion

VMware vSphere vMotion leverages the complete virtualization of servers, storage, and networking to move a running virtual machine from one physical server to another. This migration is performed with no impact to running workloads or connected users. During a vMotion migration, the active memory and execution state of the virtual machine is rapidly transmitted over the network to the new physical server, all while maintaining its network identity and connections.

Example: Standalone SQL Server Virtual Machine with vSphere HA, DRS, and vMotion

Out of the box, vSphere features can help to protect your standalone SQL Server virtual machine from server host failure. vSphere HA automatically reboots your SQL Server virtual machine on another server if the current one fails, so your virtual machine can be restored to normal operation in the time that it takes to reboot the operating system and start the SQL Server services. After the original server hardware is fixed or replaced, vSphere DRS and vSphere vMotion can be used to quickly move the virtual machine back to its original ESX/ESXi host, with no additional downtime.
4.2 vMotion Considerations for Windows and SQL Clustering

The use of the VMware resource balancing feature (vSphere, vMotion), along with the Windows Server Failover Clustering (WSFC) Service, is a configuration supported by both Microsoft and VMware, however, additional configuration options are required to provide seamless and non-disruptive interactions with the two features.

SQL Server clustering (whether AAG, FCI, or the traditional MSCS for earlier versions of SQL Server) relies on Windows Server Failover Clustering Service (WSFC) for its functionalities. By default, each clustered SQL node exchanges heartbeat packets with its partners every second. If the node does not receive a response from any partner after 5 consecutive probes, the probing node considers the partner to be non-responsive (unavailable). The WSFC service on the probing node then initiates corrective actions, including taking ownership of clustered resources previously owned by the non-responsive partner.

To recap – a clustered node considers its partner unavailable if it is unable to exchange heartbeat packets with that partner after five attempts (five seconds), which triggers actions necessary to provide continued availability of the resources located on that partner. This is what happens when there is an unintended and unplanned cluster resource failover.

An aggressive cluster failover threshold can be problematic and disruptive. For example, a failover may not have been required because the non-responsiveness was a transient issue that went away after six seconds.

During a vMotion operation, a virtual machine’s memory pages are gradually copied from its current parent host to its target parent host and the virtual machine is subsequently switched over to the target host. During this copy-and-transition procedure, the virtual machine is quiesced (VMware refers to this as stunning). Under normal operating condition, the stun period is very brief and not noticeable. However, the quiescing period might last longer than the five-second threshold under the some operating conditions, including the following:

- Size of the VM (CPU and RAM).
- Current outstanding operations, threads, and processes on the VM.
• Total CPU subscription ratio in the vSphere cluster.
• Network bandwidth or congestion state.

The net effect of a stun operation is that the stunned VM is unable to exchange heartbeat for the duration of the stun operation. If that lasts longer than five seconds, and the VM is in a cluster relationship, then its cluster partners consider it unavailable.

This behavior is not peculiar to vMotion, or even virtualization in general. If your backup solution takes VSS-based snapshots of your server, it is also likely quiescing the server.

This is known behavior, and avoiding the unintended cluster failover incident (and its associated disruptive effects) when performing a vMotion operation on a clustered SQL Server node is an exact science for VMware. There are several configuration options described in the following sections that you can use to overcome these disruptive effects.

### 4.2.1 Cluster Heartbeat Settings

Two Windows Server Failover Cluster settings control the behavior of the cluster service to missed heartbeat probes. These are:

- **SameSubnetDelay** – Controls how often a node sends heartbeat probe packets.
- **SameSubnetThreshold** – Controls how many probe misses the node must tolerate before taking actions.

If the clustered nodes are in different subnets, the corresponding settings are:

- **CrossSubnetDelay**
- **CrossSubnetThreshold**

The following are the default values for these settings:

```powershell
PS C:\Windows\system32> get-cluster | fl *subnet*

<table>
<thead>
<tr>
<th>SubnetDelay</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SubnetThreshold</td>
<td>5</td>
</tr>
<tr>
<td>PlumbAllCrossSubnetRoutes</td>
<td>0</td>
</tr>
<tr>
<td>SameSubnetDelay</td>
<td>1000</td>
</tr>
<tr>
<td>SameSubnetThreshold</td>
<td>5</td>
</tr>
</tbody>
</table>
```

A `SubnetDelay` value of 1000ms and a `SubnetThreshold` of 5 denotes that heartbeat probes are sent every second with a tolerance for a maximum of 5 missed heartbeats. These are the settings that enabled the unexpected failover described in the preceding section.

Adjusting either of these parameters to 10 seconds (for cluster nodes in the same subnet) and 20 seconds (for cluster nodes in different subnets) is the simplest and most effective way to prevent the unintended cluster failover issue described in the preceding section. The following are the settings to accomplish each of the recommendations:

```powershell
(get-cluster).SameSubnetThreshold = 10
(get-cluster).CrossSubnetThreshold = 20
```
Windows Server 2012 includes an additional cluster service logging component that tracks dropped heartbeat packets. The RouteHistoryLength setting and its default value (10) must also be modified so that it remains useful when investigating heartbeat-related issues. According to Microsoft, the recommended value for this setting must be double that of the SubnetThreshold setting. If the value SameSubnetThreshold and CrossSubnetThreshold follow the VMware recommendations, the value of RouteHistoryLength must be double the value of the CrossSubnetThreshold value. The VMware recommended value for RouteHistoryLength setting is, therefore, 40.

There is no need to restart the cluster service for these changes to take effect.

The following commands accomplish the same goals in previous versions of Windows and SQL clustering:

```
Cluster.exe /cluster:<clustername> /prop SameSubnetThreshold=10:DWORD
Cluster.exe /cluster:<clustername> /prop CrossSubnetThreshold=20:DWORD
```

### 4.2.2 Multiple vSphere vMotion Interfaces

Database failover due to vSphere vMotion operations can be mitigated by using multiple dedicated vSphere vMotion network interfaces. In most cases, these interfaces are also used for management traffic. Because management traffic is relatively light, this does not add significant overhead.

vSphere provides the ability to use multiple VMNIC interfaces for vSphere vMotion traffic to effectively load balance the vSphere vMotion traffic. Testing has shown up to a 25% increase in throughput achieved when multiple vSphere vMotion interfaces are used. In the test case with two 2Gbps interfaces configured for vSphere vMotion and no cluster heartbeat modifications, vSphere vMotion operations succeeded with no database failover.

Enabling multiple interfaces for vSphere vMotion requires configuring multiple VMkernel ports on different port groups. Each port group is assigned multiple VMNIC interfaces as either active or standby. See Multiple-NIC vMotion in vSphere 5 at [http://kb.vmware.com/kb/2007467](http://kb.vmware.com/kb/2007467) for detailed configuration procedures.
4.2.3 Enable Jumbo Frames for vSphere vMotion Interfaces

Standard Ethernet frames are limited to a length of approximately 1500 bytes. Jumbo frames can contain a payload of up to 9000 bytes. Support for jumbo frames on VMkernel ports was added to vSphere 4.0 for both ESX and ESXi. This added feature means that large frames can be used for all VMkernel traffic, including vSphere vMotion.

Using jumbo frames reduces the processing overhead to provide the best possible performance by reducing the number of frames that must be generated and transmitted by the system. During testing, VMware tested vSphere vMotion migration of clustered SQL Server nodes with and without jumbo frames enabled. Results showed that with jumbo frames enabled for all VMkernel ports and on the VMware vSphere Distributed Switch™, vSphere vMotion migrations of cluster member virtual machines completed successfully. During these migrations, no database failovers occurred, and there was no need to modify the cluster heartbeat setting.

The use of jumbo frames requires that all network hops between the vSphere hosts support the larger frame size. This includes the systems and all network equipment in between. Switches that do not support, or are not configured to accept, large frames will drop them. Routers and Layer 3 switches might fragment the large frames into smaller frames that must then be reassembled, which can degrade performance.

4.3 Application Aware vSphere HA

As of vSphere 4.1 an application programming interface (API) was introduced to provide third-party vendors with the ability to integrate with vSphere HA. Symantec was the first partner to develop an agent for providing application awareness within a vSphere cluster. The capability to allow application monitoring agents to interact with vSphere HA is enabled per vSphere cluster with additional configuration options available per virtual machine. When enabled, this feature allows application monitoring agents to send application heartbeats to vSphere HA. In the event of an application-level failure the application monitoring agent can take action to either bring the application back online, or stop the application heartbeat, causing vSphere HA to initiate a restart of the virtual machine. Prior to vSphere 4.1, only VMware tools heartbeats could trigger VMware HA restarts.

Example: Standalone SQL Server with Symantec ApplicationHA

The Symantec ApplicationHA agent runs inside an SQL Server virtual machine to monitor the health of SQL Server resources. If a configured SQL Server instance or associated services become unavailable, the agent automatically detects it and tries to start the SQL Server services for a configurable number of attempts. If the SQL Server services do not start, the agent considers this to be an application failure and reports the status to vSphere HA. vSphere HA can then restart the virtual machine. After the virtual machine restarts, the agent starts the application services and brings the configured resources online on the system.

Symantec ApplicationHA fully integrates with VMware HA and vCenter for monitoring and recovering an SQL Server service.
4.4 SQL Server Database Mirroring

The database mirroring option provides complete protection against data loss and fast recovery through automatic failover. Database mirroring maintains a redundant database by shipping log streams to a mirror server.

Use database mirroring when you need to maintain multiple copies of your data and to create a warm standby of your SQL Server database environment. You should note that SQL Server database mirroring is performed at the database level. Only user databases can be mirrored. This can give you flexibility over SQL Server failover clustering in that you don’t need to include all of your databases in the instance. You can pick and choose which database(s) to mirror. There is also no single point of failure, as in SQL Server failover clustering where storage can become unavailable or corrupted. Database mirroring operates in the following modes:

- High Safety Mode with Automatic Failover
- High Safety Mode without Automatic Failover
- High Performance Mode

4.4.1 High Safety Mode with Automatic Failover

A principal server, mirror server, and witness server are required. This mode sets the transaction safety to FULL, thereby using synchronous I/O between the principal and mirror servers. The principal server waits for an acknowledgement from the mirror server that the shipped transaction has been applied on the mirror server. In the event of failure at the principal server, the witness server forms a quorum and failover to the mirror server. You do not lose any data as a result of the transaction safety mode being configured as FULL.

4.4.2 High Safety Mode without Automatic Failover

A principal server and mirror server are required. Transaction safety mode is set to FULL. This uses synchronous I/O between the principal and mirror servers. In the event of a failure of the principal server, you need to manually fail over to the mirror server as there is no witness server to perform quorum and automate failover.

4.4.3 High Performance Mode

A principal server and a mirror server are required. Transaction safety is set to OFF, and as a result, asynchronous I/O is used between the principal and mirror servers. In this mode, the principal server does not wait for an acknowledgement from the mirror server that all transactions have been recorded on the mirror server. The client application gets a confirmation that a transaction has been committed as soon as the principal server writes the transaction to the log. In the event of failure or unavailability of the principal server, you need to manually fail over to the mirror server. There is the possibility of data loss as some transactions might be “in flight” during the failure of the principal server.
Figure 2. SQL Server Database Mirroring

VMware availability features such as vMotion, HA, and DRS are fully supported in combination with database mirroring, offering the greatest level of protection for your SQL Server virtual machines. With database mirroring, you can eliminate a single point of failure in storage by locating the mirrored data on another physical array.

Example: vSphere HA with SQL Server Database Mirroring for Faster Recovery

Database Mirroring can be combined with vSphere HA to provide the maximum in SQL Server protection and flexibility. If configured in High-Safety Mode, log streams are replicated synchronously from the active database to one or more passive database copies which are kept in real-time lockstep with the active database. Upon SQL Server or OS failure the environment can be failed over to the mirrored database copy. If configured with Automatic Failover, failover to a mirrored database copy is automatic, facilitated by a server role known as the Witness.

During the time between loss of a node and its restoration, your SQL Server environment is vulnerable to further failures. Resynchronizing the mirrored nodes could take substantial time after the failed node is restored. vSphere HA helps to alleviate this issue by restarting the failed primary node on another available host in the vSphere cluster. This quickly restores the database to full protection and reduces the amount of time spent in the failover state.

Database mirroring can also be safely used in combination with vSphere vMotion, HA, and DRS.
4.5 Microsoft Failover Clustering

The failover clustering option is a more expensive solution for providing SQL Server availability. It provides very good protection in the case of hardware and software failure. Failover to a passive node is fairly quick (anywhere between 1-5 minutes depending upon the state of the cluster and database). Failover clustering provides service availability but does not provide data redundancy like database mirroring and log shipping. Data protection has to be provided at the storage level or by combining failover clustering with other solutions.

Failover clustering provides instance-level protection built on Windows failover clustering. Nodes of the cluster are typically co-located within the same site or datacenter to provide local availability, but can also be deployed regionally. Disaster recovery (DR) and Business Continuity (BC) are possible using geographically dispersed clustering solutions. These solutions can be difficult to design, implement, and maintain from a cost and operational standpoint.
**Example: vSphere HA/Administrator Recovery with Microsoft Failover Clustering**

Microsoft failover clustering protects the SQL Server at the instance level rather than the database level. One SQL Server instance serves as the primary or active node, while the other serves as a passive node. Both nodes are connected to a shared disk architecture, whereby only one node is accessing/updating the data at any given time.

vMotion cannot be used for Microsoft failover cluster nodes running on host Fibre Channel storage network; however, a cold migration is possible when executed manually by an administrator. This quickly restores the database to full protection and reduces the amount of time spent in the failover state. As of vSphere v4.1, using vSphere HA with Microsoft failover clustering is a supported configuration.
4.6 Log Shipping

The log shipping availability option typically provides lower cost automated transaction log backup and restore functionality, which provides redundancy at the database level. SQL Server provides the underlying framework for doing automated backup, copy and restore of transaction log files. SQL Server 2008 provides a sub-minute scheduling interval that enables quick backup and restores. Backups are performed on the primary SQL Server instance and restore is performed on secondary SQL Server instances. Scheduling is done through SQL Server Agent jobs.

As an availability strategy, the log shipping option does not provide any automatic failover capability and may allow some data loss, but the time synchronization interval is configurable, which gives users some level of control. (This data loss can occur due to corrupted, missing and possibly transaction log data that was not sent to the backup log file on the secondary server.) Log shipping can be used in conjunction with failover clustering to provide a good site failure redundancy with a low-cost solution.

You can use SQL Server log shipping to create multiple copies of your databases that can be used as a warm standby for recovery purposes, or to provide a database that can be used for reporting and to offload reporting and query functions off of the primary server, thereby improving overall performance and providing a better end user experience of the production SQL Server.
5. Remote Site Availability Options

Incorporating disaster recovery has become a leading business objective for new deployments and upgrades. Leveraging built-in solutions is ideal for protecting a single business critical application from disaster. Some environments require application and hardware-agnostic methods for protecting their mission critical applications and data. Deploying on vSphere provides the flexibility to meet all of these requirements.

5.1 VMware vCenter Site Recovery Manager

VMware vCenter Site Recovery Manager™ (SRM) makes disaster recovery rapid, reliable, manageable, and affordable. SRM leverages VMware vSphere and leading partners’ storage replication software to deliver centralized management of recovery plans, automate the recovery process, and enable dramatically improved testing of recovery plans. It transforms the complex hardcopy run books associated with traditional disaster recovery into an integrated element of virtual infrastructure management. SRM enables organizations to take risk and worry out of disaster recovery—yet another reason the VMware virtualization platform is the safest platform for datacenter applications.

Figure 6. VMware vCenter Site Recovery Manager
Example: VMware vCenter Site Recovery Manager with SQL Server Database Mirroring

Using SQL Server database mirroring within the datacenter to provide high availability will meet the requirements of most organizations. With database mirroring, a failover can occur automatically at the database level and can take place within a few seconds of a detected failure. When designing a disaster recovery solution automated failover is usually not a desirable feature. In many cases, a DR facility is designed with a lower SLA and has a slightly delayed version of data than the production facility. Making the choice to activate the DR facility should be a conscious decision that follows an organization’s change process. With SRM and a VMware partner’s storage replication solution, disaster recovery can easily be implemented to protect the entire virtual datacenter, including SQL Server. Failover testing can be accomplished with no production impact to confirm that the recovery-time and recovery-point objectives are being met. Additionally, customizable recovery plans allow for adding custom scripts, virtual machine power-on priority and breaks.

Figure 7. VMware vCenter Site Recovery Manager with SQL Server Database Mirroring
5.2 SQL Server Log Shipping with SQL Server Database Mirroring

For a description of Log Shipping, see Section 4.4, Microsoft Failover Clustering.

Example: SQL Server Log Shipping with SQL Server Database Mirroring

Log shipping can be used to provide off-site disaster recovery capabilities in addition to the local site high availability you get from database mirroring. In the production site, database mirroring is configured in High Safety Mode with Automatic Failover, allowing the system to recover from application failure. Log shipping is configured to replicate lagged copies of the databases to a standby SQL Server running at the DR site. Because the logs are sent asynchronously to the recovery server, there is some possibility of data loss in the case of site failure. VMware HA is used in both production and DR sites to protect virtual machines from host failure and facilitate rapid recovery.

Figure 8. SQL Server Log Shipping with SQL Server Database Mirroring
6. Backup and Restore Options

The feature set available to an application, when deployed in a virtual environment, is no different than what is available with a physical deployment. In fact, there are more options available for protecting entire virtual machines. This is especially useful for applications that require extensive configuration. For SQL Server the standard methods for backup are supported. These tend to be deployed using a third-party backup agent that uses a VSS requestor to coordinate with the VSS writer to prepare the database files for backup. Regardless of the backup solution required, VMware and VMware partners have provided solutions for most situations.

6.1 In-Guest Software Solutions

Many organizations have dedicated backup support teams or requirements that may not allow them to integrate the backup solution to the level that is available with vSphere. In these situations, traditional backup methods are used, and a virtualized environment allows that. Many of the leading backup software providers are VMware partners and provide full support for using their backup solutions within a virtualized guest operating system. Backup administrators can continue to deploy and manage the backup agents, jobs and restores as though they were running on physical systems.

6.1.1 Example: In-Guest SQL Server-Aware Backup Solution

Centralized backup management software controls the backup schedule, save set, and target location for all systems virtual and physical. Backup agent software loaded within the guest operating system allows the virtual machine guest OS to be managed just as all other systems. Additional plug-ins from backup software vendors provides application-aware support.

Figure 9. In-Guest SQL Server-Aware Backup Solution

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6.2 VMware Data Recovery

VMware Data Recovery (VDR) protects your data at the virtual machine level, capturing application and system data as a full virtual machine image. VDR runs at the ESX/ESXi host level as a virtual appliance to provide streamlined deployment and full integration with vCenter Server. VDR stores multiple restore points for each virtual machine using deduplication technology to not only provide point-in-time restore capabilities, but efficiently use available disk space.

As most SQL Server administrators know, the use of an SQL Server-aware backup agent provides database health checking and log truncation. Though VDR can use the VSS framework to back up Windows guest OS virtual machines it does not contain the required SQL Server VSS requestor to properly backup and restore a SQL Server database. Other application roles, such as Web servers, are relatively stateless and may benefit greatly from being protected using VDR.

Figure 10. VMware Data Recovery Backup Process

![Backup Process Diagram]

Figure 11. VMware Data Recovery Restore Process

![Restore Process Diagram]
6.3 Array-Based Backup Solutions

As is the case with the in-guest solutions, array-based solutions provided by many of the leading storage vendors continue to work with vSphere deployments of SQL Server. Array-based backup solutions for SQL Server use the Volume Shadow Copy Service (VSS) to produce near-instant, application-aware clones or snapshots of SQL Server databases. These local clones or snapshots can then be backed up to disk, tape or cloned off-site for disaster recovery purposes. Guidance on proper deployment methods and any additional considerations when running in a virtualized environment must be provided by the storage vendor. VMware can provide a comprehensive list of ISV partners that provide array-based replication of SQL Servers for backup and restore operations.

6.3.1 Example: Array-based SQL Server-Aware Backup Solution

Example: Array-based SQL Server-Aware Backup Solution

An array-based backup solution provides integration with the SQL Server application and the underlying storage solution. A software agent provided by your backup vendor coordinates with the SQL Server VSS writers to create a supported backup image of your SQL Server databases. These databases can later be streamed to tape as flat files for compliance or archive requirements with no IO impact to the production data.

Figure 12. Array-Based SQL Server-Aware Backup Solution
7. Additional Information

vSphere offers many tools and features to increase the availability of SQL Server. vSphere vMotion, vSphere HA, and DRS can help reduce downtime and improve flexibility in your application architecture while lowering costs. In some cases VMware and SQL Server features can be combined to improve overall availability. However, there are some things to keep in mind when architecting a solution:

- Database mirroring can be used in combinations with vSphere vMotion, vSphere HA, and DRS to maximize SQL Server availability.
- vMotion cannot be used for Microsoft failover cluster nodes running on host Fibre Channel storage network.
- As of vSphere v4.1, the use of vSphere HA with Microsoft failover cluster is supported. See detailed support information at http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1037959.