Best Practices for running Microsoft® SQL Server® and Microsoft® Hyper-V on Dell™ PowerEdge™ Servers and Storage

A Dell Technical White Paper

Database Solutions Engineering

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October 2009
Executive Summary

Dell Business Ready Configurations provide technical architecture guidance as a reference to help simplify complex solutions for customers. This white paper provides a reference architecture based on the Dell Business Ready Configurations for Virtualization targeted towards virtualizing Microsoft SQL Server 2008 with Microsoft Server 2008 R2 with Hyper-V in an iSCSI environment. The Business Ready Configuration for Virtualization is a configuration solution that provides architectural design to deploy and configure a robust virtualization infrastructure. Utilizing this configuration to build a virtual environment for SQL Server minimizes the design, deployment and configuration phases. We then ran a series of workload tests to validate the configuration and documented the system resource utilization to aid as a reference for sizing exercises.

The tests results described in this white paper will highlight some of the new features in Windows Server 2008 R2 and help reveal potential bottlenecks that may arise in a virtualized environment, providing best practice recommendations to mitigate the effects of these bottlenecks, including recommended server and virtual machine configurations as well as workload sizes supported by the server and storage configuration.

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Introduction
In order to simplify IT and assist customers in the pre-sales, sizing and evaluation stages, as well as in the post-sale stages of the solution, deployment and implementation, Dell offers Business Ready Configurations to help minimize the complexity of a solution by providing reference architectures that have undergone extensive engineering testing. These Business Ready Configurations allow for rapid deployment with optimal hardware configurations designed for scalability, high availability and performance.

This whitepaper describes the design, deployment and performance of a virtual environment utilizing the Business Ready Configuration for Virtualization to deploy Microsoft SQL Server 2008 in a Microsoft Server 2008 R2 with Hyper-V environment. It documents the architecture, server and storage configuration, virtual machine configuration and database workload tests and results. It also explores and implements a new feature in R2; Cluster Shared Volumes (CSV) and the benefits it provides to virtual databases in an iSCSI environment.

This white paper discusses the key points to consider when designing a virtualization strategy. The lessons learned in this white paper are the result of evaluating and implementing a Business Ready Configuration at the Dell Database Engineering Lab.

By demonstrating Small, and Medium Reference Architectures Configurations and the number of Virtual Machines each can support given an OLTP workload, this paper provides best practices for deployment and demonstrates that complimentary workloads can reside on a single server.

Audience and Scope
This white paper is intended for customers, partners, solution architects, storage administrators, and database administrators who are evaluating, sizing and planning a virtualization strategy. It provides an overview of various considerations and best practices as reference architecture for virtualized database OLTP workloads.

Overview
Dell Business Ready Configurations simplify the design and deployment phase of virtual environments minimizing potential challenges such as incompatibility issues that may arise during deployment to production, thus delaying time to market.

The Business Ready Configurations are offered in three variations:

Consolidation: Single-server configuration with internal storage. This solution is designed as an entry point to virtualized workloads for environments that do not require external storage capabilities. Also, it can be utilized as a test and development environment and as need arises can easily be expanded with external storage and high availability.

High Availability: Dual-server in cluster mode with external iSCSI storage. This configuration is designed to provide a cost-effective, highly available solution for
mission critical applications that can easily scale-out by adding servers to balance workloads.

**High Availability + Backup**: Three-server configuration with external iSCSI storage and Disk-to-Disk and optional Disk-to-Tape Backup. Designed for mission critical availability and integrated backup solution.

This white paper deploys a Consolidated and High Availability Business Ready Configuration for Virtualization in the Dell Development Lab to build a configuration for running SQL Server in a Hyper-V environment. The goal is to adjust the Business Ready Configuration for a SQL Server Database for a specific workload.

**Hardware Architecture**

The Business Ready Configuration for Virtualization is composed of the Dell PowerEdge™ R710, Dell PowerVault™ MD3000i iSCSI storage and Dell PowerConnect™ 6200 family of switches.

The Dell PowerEdge R710 is a high performance 2U server with Intel® Xeon® 5500 series processors providing a powerful and robust platform in which to consolidate virtualized database workloads. For more technical specifications on Dell Servers, please visit [www.dell.com/servers](http://www.dell.com/servers).

Dell PowerVault MD3000i is an iSCSI Storage Area Network (SAN). The MD3000i provides a cost-effective solution for shared storage requirements and provides the performance required to drive OLTP workloads. For a complete list of benefits and technical specifications, please visit [www.dell.com/md3000i](http://www.dell.com/md3000i).

Dell PowerConnect 6200 series of switches come in a 24 and 48-port layer 3 Gigabit Ethernet Switch with 10GE uplinks and stacking capabilities. The dual 48-port PowerConnect switches are used in this solution to provide enough ports for additional servers and storage and no single-point of failure.

The Business Ready Configuration is designed with redundancy at every level, complete with dual PowerConnect Ethernet switches, and dual PowerEdge servers in a cluster with virtual machines balanced across both nodes.

Figure 1 below shows the hardware components for this solution.
Table 1 through Table 3 describes the hardware and software components utilized in this white paper.

<table>
<thead>
<tr>
<th>Server Configuration</th>
<th>Consolidation</th>
<th>High Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dell PowerEdge Server</strong></td>
<td>One PowerEdge R710</td>
<td>Two PowerEdge R710</td>
</tr>
<tr>
<td><strong>Processors</strong></td>
<td>Two Quad-Intel® Xeon® X5550, 2.66Ghz, 8-M Cache, 6.40 GT/s QPI, Turbo, HT</td>
<td>Two Quad-Intel® Xeon® X5550, 2.66Ghz, 8-M Cache, 6.40 GT/s QPI, Turbo, HT</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>24-GB (6x4GB), 1333-MHz Dual Ranked RDIMMs for 2 Processors, Optimized</td>
<td>48-GB (6x8GB), 1333-MHz Dual Ranked RDIMMs for 2 Processors, Optimized</td>
</tr>
<tr>
<td><strong>Internal Hard Drives</strong></td>
<td>Two 2.5” 15K 146-GB RAID1 for the operating system</td>
<td>Two 2.5” 15K 146-GB RAID1 for the operating system</td>
</tr>
<tr>
<td></td>
<td>Six 2.5” 15K 146-GB RAID10 for Virtual Machine and Database files</td>
<td></td>
</tr>
<tr>
<td>Hard Drive Controller</td>
<td>PERC 6/I SAS RAID Controller 2x3 connectors, internal, PCIe 256-MB cache, x8 chassis.</td>
<td>PERC 6/I SAS RAID Controller 2x3 connectors, internal, PCIe 256-MB cache, x8 chassis.</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BIOS Settings</td>
<td>Performance BIOS Setting, VT enabled Execute Disable option enabled</td>
<td>Performance BIOS Setting, VT enabled Execute Disable option enabled</td>
</tr>
<tr>
<td>Remote Management Controller</td>
<td>iDRAC6 Enterprise</td>
<td>iDRAC6 Enterprise</td>
</tr>
<tr>
<td>Operating System Roles and Features</td>
<td>Hyper-V Hyper-V Microsoft Failover Clustering Cluster Share Volumes (CSV) Multi-Path I/O (MPIO)</td>
<td>Hyper-V Microsoft Failover Clustering Cluster Share Volumes (CSV) Multi-Path I/O (MPIO)</td>
</tr>
<tr>
<td>Additional Network Cards</td>
<td>Two Intel PRO 1000VT Quad Port 1GbE</td>
<td>Two Intel PRO 1000VT Quad Port 1GbE</td>
</tr>
</tbody>
</table>

**Table 1 Server Configurations**

<table>
<thead>
<tr>
<th>Network Configuration</th>
<th>High Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerConnect Switch</td>
<td>Two PowerConnect 6248 (Stacked)</td>
</tr>
<tr>
<td>Stacking Module</td>
<td>One stacking Module with 3 Meter Stacking Cable</td>
</tr>
<tr>
<td>VLAN Settings</td>
<td>Separate VLans used for iSCSI, Private, Public, Virtual Machine Traffic, Management networks were implemented. See Business Ready Configuration for details <a href="http://www.dell.com/virtualization">www.dell.com/virtualization</a>.</td>
</tr>
<tr>
<td>Settings</td>
<td>Jumbo Frames Enabled for iSCSI Traffic Link aggregation for Virtual Machine Traffic</td>
</tr>
</tbody>
</table>

**Table 2 Network Configuration**
Best Practices to Virtualize Microsoft® SQL Server® on Dell™ PowerEdge™ Servers and Dell Storage

### Storage Configuration

<table>
<thead>
<tr>
<th>Storage Configuration</th>
<th>System capabilities</th>
<th>Configuration as Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell PowerVault Storage</td>
<td>Dell PowerVault MD3000i (FW 07.35.31.60 or greater)</td>
<td>Dell PowerVault MD3000i (FW 07.35.31.60)</td>
</tr>
<tr>
<td>RAID Controller</td>
<td>Dual Active/Active RAID Controllers</td>
<td>Dual Active/Active RAID Controllers</td>
</tr>
<tr>
<td>RAID Types Supported</td>
<td>RAID 0, 1, 5, 6, 10</td>
<td>RAID 10 for VM and Databases</td>
</tr>
<tr>
<td>Physical Disks</td>
<td>15 3.5” SAS 15K 146GB Drives (also available 300GB, 450GB, 600GB 15K drives)</td>
<td>Two Disk Groups of 14 3.5” SAS 15K 146GB Drives for VM VHD’s and Database VHDs.</td>
</tr>
<tr>
<td>Enclosure Expansion</td>
<td>Up to two MD1000’s can be cascaded to an MD3000i (for a total of 45 physical disks).</td>
<td>One MD1000 for Database VHD’s.</td>
</tr>
<tr>
<td>LUN Size Support Greater than 2TB</td>
<td>RAID 0 = 45 Disks</td>
<td>RAID 10 = 44 Disks</td>
</tr>
<tr>
<td></td>
<td>RAID 5, 6 = 30 Disks</td>
<td>RAID 10 = 44 Disks</td>
</tr>
</tbody>
</table>

**Table 3 Storage Configuration**

For a complete details on hardware configuration and specifications, please refer to the Business Ready Configuration for Virtualization [www.dell.com/virtualization](http://www.dell.com/virtualization).

### Deployment Considerations

Depending on the type of databases that will be deployed on the system, various strategies can be implemented to provide fault tolerance and performance. The following sections describe some of the considerations to protect and configure an environment for SQL Server in a virtual environment.

### High Availability Clustering and SQL Mirroring

New in Windows 2008 R2 is the ability to share volumes across cluster nodes called Cluster Share Volume (CSV). This feature allows multiple cluster nodes to have concurrent access to the same underlying LUN/Virtual Disk. CSVs offer many benefits to a Hyper-V environment, such as simplified management of multiple virtual machine files (VHDs). VHDs within a single LUN/Virtual Disk can be controlled by distinct cluster nodes. In the event of failure, only VMs that are affected need be failed-over, not the entire cluster volume.

Using CSVs for Virtual Machines running SQL Server in a Cluster combined with SQL Server Mirroring provides a highly available solution. Figure 2 shows a two node cluster, with each
node hosting a SQL Server Virtual Machine. The VHDs hosting the operating system and database files for each VM are contained in a single CSV on the external storage array. The databases within each VM are configured with SQL Server mirroring, and the mirror relationships are bi-directional. In this configuration, the cluster provides physical redundancy and offers the opportunity to perform Live Migrations to facilitate planned maintenance. SQL Server Mirroring reduces the recovery time in the event of unplanned downtime.

Figure 3 shows how the combined solution can recover in the event that a single Hyper-V host fails. At the time of failure, VM2 will restart on a surviving cluster node. On the surviving virtual machine (VM1), BrokerDB is completely unaffected and MarketDB is promoted to the principal role. With a properly-configured application this transition can be transparent. After VM2 has restarted, mirroring can be reestablished allowing this VM to assume the mirror role for both

Figure 2 High Availability Clustering & Mirroring
Best Practices to Virtualize Microsoft® SQL Server® on Dell™ PowerEdge™ Servers and Dell Storage

databases. If a witness is configured for SQL Server mirroring, then the principal and mirror roles can be transitioned automatically. The witness instance can operate on another virtual machine and should, ideally, be hosted separately from the other SQL Server VMs. After the failed node has been restored, Live Migration can be used to transition VM2 back to its original host.

![Diagram of failover scenario]

**Figure 3 Failover Scenario**

**VHD Sizing Consideration:**
Guest Virtual Machines are created using Virtual Hard Drives (VHD) stored within the CSV. Each VM was configured with a maximum VHD size of 40GB. This size includes space allocated for

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1 For IO intensive workloads, configuring the storage as Pass through Disks is another option. For the purpose of this white paper only Fixed Size VHD’s are covered. For more information on Pass through Disk configuration please visit www.microsoft.com/hyper-v-server
Operating System, SQL Server Binaries, Snapshots and page file. After the Operating System and SQL Server were installed, the space utilized was 13.3GB of 39.8GB. This leaves 26.5GB free space for snapshots and logs.

**Note:** Depending on the space required for snapshots, reducing the VHD to 30GB would be ideal for space constrained environments.

Database Files are stored on a separate VHD within a different set of spindles. The sizing of the Database VHD depends on the size of the database and log file change rate. For high rate log file activity, it is recommended that you separate data and log files into separate Disk Groups. For the purpose of manageability in this white paper, we have a single VHD for data and log files.

**Note:** For better performance, VHD were created using Fixed Size configuration. Another option recommended for non disk intensive applications is dynamically Expanding VHDs.

![Figure 4 VHD Sizing](image)

**Storage Architecture Configurations**

After the appropriate VHD size has been determined, you must determine the actual storage location and space allocated in which to place the VM and Database VHD. The Disk Group is the overall container that defines the spindles and RAID type in which LUNs or Virtual Disks can be created. Deciding on RAID type and number of spindles depends on the type of workload, fault tolerance, space and performance that will be required. See Table 4 for some sample requirements.

<table>
<thead>
<tr>
<th>Workload?</th>
<th>OLTP</th>
<th>Transactional databases with bursts of small random IO’s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12
<table>
<thead>
<tr>
<th>Performance (R/W)</th>
<th>High/High</th>
<th>Required to satisfy random IO’s as fast as possible to avoid high query response times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space requirement</td>
<td>Low</td>
<td>Databases are typically less than 50GB. Total space requirement is 500GB.</td>
</tr>
<tr>
<td>Fault tolerance</td>
<td>High</td>
<td>RAID 10 offers faster rebuild times since there is no parity to compute.</td>
</tr>
<tr>
<td>RAID</td>
<td>10</td>
<td>RAID 10 offers the best performance for OLTP type workloads.</td>
</tr>
<tr>
<td># of Spindles</td>
<td>14</td>
<td>Spreading the data across multiple spindles allows for better performance.</td>
</tr>
<tr>
<td>Total Space</td>
<td>953GB</td>
<td>With 146GB drives, 450GB free to accommodate growth.</td>
</tr>
</tbody>
</table>

**Table 4 Workload Requirements**

In cases where space is the main requirement, utilizing RAID 5 or RAID 6 can be an option. It is recommended, however, that you create Disk Groups with fewer spindles (i.e. 6+1) to avoid performance degradation of the entire disk group during drive failure. The amount of time to rebuild depends on the amount and size of drives, the controller algorithm for parity calculations and the size of disk group. For more information on the tradeoffs between RAID10 and RAID5, refer to [Comprehending trade-offs between RAID 5 and RAID 10 for Database Workloads](http://www.dell.com/downloads/global/solutions/tradeoffs_RAID5_RAID10.pdf).

The following are sample storage configurations ranging from ease of management to maximum capacity:

**Simple Storage Configuration**: This configuration offers simple management and configuration with possible performance impact. The benefit of this configuration is data spread across the maximum number of spindles. VM VHD and Database + Logs VHD’s are contained within the

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same VD, however, and distinct IO patterns may cause excessive disk thrashing and cause performance impacts.

A Disk Group was created with 14 Spindles in a R1/0 configuration. The total usable capacity of this configuration is 953GB. Two Virtual Disks (VD) or LUNS were carved out of the Disk Group. The first one is a small 1GB Quorum Disk used for Clustering purposes. For simplicity, another VD was created with the remainder space, 952GB, which was configured as a CSV and can hold up to 9 VMs with the given configuration of 30GB VHDs and 75GB for Database and Log file VHDs.

**Balanced Storage Configuration:** This configuration offers a separation of Quorum, VM VHDs, and Database files. Smaller Disk Groups offer contained degradation in the event of a drive failure. This configuration provides a moderate complexity of management and balanced performance. The VM DG can hold up to 9 VMs each with a slightly reduced Database VHD size of 60GB including the Log file size.

**Maximum Separation Configuration:** This configuration offers the maximum separation of VM, database and logs IO traffic within the Virtual Disk. The drawback with this configuration is limited space and IO throughput by the number of spindles allocated per Disk Group. This configuration also holds 9 VMs, however the database VHD is now reduced to 30GB for data and 30GB for logs.
Best Practices to Virtualize Microsoft SQL Server on Dell PowerEdge Servers and Dell Storage

Maximum Capacity Configuration: Depending on the requirements, either more VM’s or increase Database space, every sample configuration described so far can be easily expanded by connecting up to two Dell PowerVault MD1000. In this example, we have created six Disk groups of 7 spindles each of type RAID5. Three of the Disk groups can be utilized for VM VHD’s and the remainder for Database files VHD’s. This configuration yields a maximum of 5.7 TB.
Disk Group and Virtual Disk Sizing

For workloads that require high storage performance, it is recommended that you assign the entire Disk Group and LUN or Virtual Disk to a single database workload. For workloads that are not highly dependent on storage response times, sharing Disk Groups provides the ability to run multiple Databases within the same container with reasonable performance. For test and development environments, aggregating these workloads provides a central location in which to run and manage.

When creating LUNs or Virtual Disks from a Disk Group, you can divide it in two strategies. One strategy is to create multiple LUNs/Virtual Disks from the Disk Group. This strategy provides a logical separation of data for each VHD within each VD. In addition to taking snapshots at the Hyper-V level, storage Administrators can take storage-level snapshots and clones of individual smaller Virtual Disks, thus providing another layer of protection. For example, from the pool of 19 VD’s of 50GB each only 3 may need to have a clone. Since each VHD is contained within each VD, the space requirement for 3 clones would be 150GB. These storage-level snapshots and clones can be taken at different time intervals.

From a Systems Administrators’ point of view, it can provide a challenge to maintain and keep track of a large set of Virtual Disks. Each Virtual Disk is converted into a CSV to allow all nodes in the cluster to access the data. Managing a large set of CSV can add additional overhead.

Another limitation with creating fixed sized Virtual Disks from a Disk Group is that the free space within each VD can not be shared or modified after it has been created. For example, if the VHD needs to expand to a size greater than 50GB, it is necessary to migrate the VHD to a new VD.

Figure 5 shows a logical representation of a Disk Group with multiple LUNs/Virtual Disks.

![Figure 5 Individual Virtual Disks](image_url)
Another strategy is to create a smaller number Virtual Disks from the Disk Group to form pools for multiple VHD files. In this case the same number of spindles is shared, but the grouping of VHD files provides added benefits. Each Virtual Disk is converted into a CSV which allows each VHD to failover independently of the other VHDs, this is a new feature included in Windows Server 2008 R2. In addition, if a VHD needs to be expanded, it can be easily accomplished by placing the VM in maintenance mode.

Figure 6 shows the logical representation of Disk Group with a few LUNs/Virtual Disks

![Figure 6 Multiple VHD per Virtual Disk](image)

This grouping provides ease of storage management, although careful consideration needs to be taken since creating a clone of a Virtual Disk at the storage level creates an exact copy of all the contents even if some of it does not require storage level backups. Grouping into categories will allow a tradeoff between manageability and space requirements for backups. In addition, potential performance impacts may arise during cloning of storage level virtual disks because VSS queues all database IO to the virtual disk.

**Test Methodology**

In order to understand the performance impact of running workloads within a virtual environment, the following tests were executed to validate the Business Ready Configurations.

**Test 1 – Consolidation Configuration:** Single Server with Hyper-V environment and internal storage.

**Test 2 – High Availability Configuration:** Dual Server with Hyper-V and Failover Clustering and external storage.

**Test 3 – Scalability Test:** Scale out of Virtual Machines on the High Availability Configuration.
An OLTP type workload was implemented using an online brokerage house model to simulate users placing online trades. Virtual machines were created and SQL Server 2008 SP1 installed on each VM. A 5,000 customer database was created and loaded on each VM. A scale of 10 connections was selected to run the workload against the database server. Scale of 10 was selected as a medium workload on a standard VM of 1vCPU and 4GB RAM.

Figure 7 shows the internal storage configuration for the Consolidation Configuration. The first two hard drives are 73GB 15K (RAID1) for the Operating System. The 6 remaining hard drives are 146GB 15K (RAID10) yielding a total of 408GB for VMs and Database VHDs.

Figure 8 shows the storage configuration for the High Availability Configuration. Dual R710 Servers clustered with external storage. The VM VHD files were stored in the first Disk Group located on the MD3000i. The Database VHD’s were created on the second Disk Group located on the MD1000 array.

Figure 8 shows the storage configuration for the High Availability Configuration.
Note that the overhead associated with running virtual machines depends on the workload and the number of virtual machines running on the same host. The cost of higher CPU utilization in a virtualized environment provides some of the benefits discussed in this paper such as high availability and separation of resources and workloads. Careful analysis is recommended when deciding to use virtualized servers.

**Test 1: SQL Server Performance Baseline**

Test 1 establishes the baseline for the Business Ready Configuration. It compares a single VM running within the Consolidation, High Availability Configurations against SQL Server running on the physical server with the Hyper-V role turned off.

Table 5 describes the standard VM configuration.

<table>
<thead>
<tr>
<th>Standard VM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtual Processors</strong></td>
</tr>
<tr>
<td><strong>Virtual Memory</strong></td>
</tr>
<tr>
<td><strong>Guest Operating System</strong></td>
</tr>
<tr>
<td><strong>Database</strong></td>
</tr>
</tbody>
</table>

**Figure 8 High Availability**
Table 5 Standard VM Configuration

Baseline Results

This test shows the transaction per second (TPS) and CPU of running the workload against SQL Server in a virtual machine versus the physical server for both Business Ready Configurations; Consolidation and High Availability.

Figure 9 shows the TPS and CPU utilization for the three configurations tested.

The Virtual SQL with Internal Storage represents the Reference Architecture for Consolidation configuration shown in Figure 7. We then compare it against the Reference Architecture for High Availability configuration labeled Virtual SQL External Storage. We can observe the improvement in TPS given the larger number of spindles configured on the MD3000i iSCSI SAN. The last column shows SQL Server running on the physical server with no Hyper-V role. The physical server was configured with limited resources by tuning SQL Server parameters to utilize 4GB RAM to match as closely as possible the standard VM configuration. For this particular workload, the physical server performed about 6% more TPS while sustaining a reduction in CPU utilization of about 25%.

![Virtual vs Physical](image)

Figure 9 Baseline VM vs. Physical
Test 2: SQL Server Performance in a Virtual Machine

This test evaluates the performance of a SQL Server running in a virtual machine. We divided this test from small to large VM configuration. Table 6 describes the test configuration for each VM.

<table>
<thead>
<tr>
<th></th>
<th>Small VM</th>
<th>Medium</th>
<th>Large VM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Processors</td>
<td>One vCPUs</td>
<td>Four vCPUs</td>
<td>Four vCPUs</td>
</tr>
<tr>
<td>Virtual Memory</td>
<td>4GB</td>
<td>4GB</td>
<td>8GB</td>
</tr>
<tr>
<td>Guest Operating System</td>
<td>Windows Server 2008 R2 EE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database</td>
<td>SQL Server 2008 EE SP1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User Load</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 VM CPU and RAM configuration

Virtualization Results

This test shows the TPS and CPU of running the workload against SQL Server in a virtual machine in various modes one at a time.

First we ran the workload on the standard VM configuration with 1vCPU and 4GB of RAM. The results show 55% CPU utilization and about 254 TPS on that configuration. We then increased the vCPU count to 4 and the effects were a reduction in CPU utilization by half and an increase in TPS to 312 TPS or 20% improvement. This shows that the baseline configuration was beginning to be constrained by CPU utilization. The last test performed was increasing the RAM to 8GB and maintaining the 4vCPU configuration. The result shows an alleviation of the memory bottleneck with an increase of TPS to 460 or 47% performance improvement. The CPU utilization increased as a result of more workload being performed from memory instead of waiting for storage IO’s.

Figure 10 shows the results of multiple mode single VM configurations.
Test 3: SQL Server Scalability Performance in a Virtual Machine
This test evaluates the impacts associated with running concurrent simultaneous workloads on each SQL Server Virtual Machine.

Table 7 describes the test. We selected the Small VM configuration from the previous test and scaled out the workload.

<table>
<thead>
<tr>
<th>VM Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Processors</td>
</tr>
<tr>
<td>Virtual Memory</td>
</tr>
<tr>
<td>Guest Operating System</td>
</tr>
<tr>
<td>Database</td>
</tr>
<tr>
<td>User Load</td>
</tr>
</tbody>
</table>

Table 7 Standard VM
Scalability Results

Figure 11 shows the performance impact of running database workloads in virtual machines. Each column represents a test from one VM to 9 concurrent VM’s. We can see that the transactions per second scale well from 1 to 3 VM’s. After 4 VMs the performance is impacted.

Figure 11 Scalability Results

Figure 12 shows the total number of transactions versus physical host CPU utilization (Hyper-V Hypervisor Logical Processor Perfmon counter) and Disk IO and response time (Transfers/sec). We observed almost linear behavior up to the 4th VM with respect to physical IOs; however, adding the 4th VM to the host resulted 15ms IO response time. The TPS follow the trend of the amount of IO’s the system can produce. However, from 4 to 9 VM’s we only see a 33% improvement in IOPS. In addition, the host CPU utilization is displayed. The Perfmon counter used was Hyper-V Hypervisor Logical Processor to show the total CPU resources consumed by the system. We observed that, since the amount of IO the VMs were producing, the CPU was lower than expected as it was in a state of IO Wait for a longer period of time.
Since each VM is running with 4GB a total of 36GB needs to be allocated to run this number of VM’s. Since the OLTP workload is IO intensive, you can mitigate this constraint by reducing the number of concurrent VM’s and increasing the RAM on each VM. Figure 13 shows the effects of running SQL VMs with 8GB RAM. The TPS doubled from 250 when running with 4GB to 500 when running with 8GB. Overall, we were able to process 23% more transactions due to more operations being run from memory rather than through IOs. The effect on storage was a reduction of 33% in IOPS.
The tests performed illustrate that database workloads can co-exists within the same storage Disk Group, but there is some performance impact. Depending on the memory configuration at the VM level, we were able to reduce the amount of IO requests to storage and increase transactions. For increased database IO and Virtual Machine requirements, a separate MD1000 can be added to expand space and IO requirements. Other configurations may yield better performance such as reducing the VM Disk Group to a smaller set of spindles and re-assigning the spindles for Database workloads.

For Test and Development environments this provides a starting point in which to consolidate hardware to maximize utilization and reduce server and storage sprawl.

**Conclusion**

To simplify the ordering, design and deployment of a virtualized infrastructure, Dell offers Business Ready Configurations that have been designed to meet a variety of customer needs. The goal of Business Ready Configurations is to provide configuration and best practices to achieve full redundancy—with no single point of failure, scalability, and ease of management.

This study provides a reference point based on the Dell Business Ready Configuration for Virtualization. Utilizing the Business Ready Configuration Reference Architecture to implement a virtual environment with Hyper-V and iSCSI storage configured for SQL Server Database workload. The goal of this white paper was to explore the effects of running database workloads in an iSCSI virtual environment.

Depending on the type of workload the databases will sustain, virtualizing workloads offers many benefits such as improved hardware utilization, separation of resources and high availability. Careful planning and design at the storage level will dictate the overall performance SQL Server is able to achieve. Utilizing a medium OLTP workload, we were able to run up to 4 Virtual Machines within the same physical storage Disk Group with reasonable performance adding the benefits in manageability and ease of administration. For mission critical database workloads, we recommend separating the VMs database files to individual Disk Group containers to avoid sharing of spindles with other workloads. We observed an average of 25% performance degradation for each VM added to the same Disk Group. One way to mitigate the IO requirements is to build VM’s with larger memory configurations to avoid excessive IO requests from the underlying storage array.

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