



HP App Map for Database Consolidation for Microsoft SQL Server on ConvergedSystem 700x

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Executive summary

One of today's larger problems facing IT organizations is reducing data center sprawl and complexity. In particular, Microsoft® SQL Server Database Servers pose one of the more complex problems, as departments, groups or business units deploy new servers as a new application or workflow process comes online. Over time, IT staff becomes overburdened with the rising management challenges of administering many under-utilized database servers, with various ages and capabilities.

HP ConvergedSystem 700x addresses this problem by providing a balanced, flexible virtualized infrastructure with integrated software, hardware and support, complete with best-in-class management. This provides a solid platform for developing a SQL server consolidation strategy to reduce server counts and streamline management. The HP ConvergedSystem 700x can also provide a foundation for developing or transitioning into a virtualized SQL Server private cloud for partner, client or in-house applications. The fault tolerance, scalability, and flexibility ensure that the SQL private cloud can easily adapt as client and customer needs change.

This document provides a tested solution for consolidating Microsoft SQL Server Database servers performing transaction processing onto an HP ConvergedSystem 700x. Using the HP ConvergedSystem 700x as a virtualized consolidation platform features some of the following benefits:

- Optimized and validated to support OLTP specific workloads
- Designed to support and scale to several hundred virtual machines (VMs)
- Decreased time to value

Migrating physical SQL servers to virtual servers running on HP ProLiant servers, provides a “Many to 1” consolidation opportunity. With the HP ConvergedSystem 700x platform, your solution can scale by simply adding more blade servers, blade enclosures, disks or disk arrays. Cost savings and a reduction in management complexity are the most immediate results of a consolidation effort with the HP ConvergedSystem 700x.

Two sized and configured Online Transaction Processing (OLTP) SQL server configurations are described in this document, along with a third fully tested configuration. These configurations provide storage performance of over 90,000 IOPS (Input/Output operations per second) and capacities nearing 73TB of raw storage space. Using our Transaction Processing workload, featuring multiple sizes of virtual machines, we were able to support over 250 SQL OLTP DB virtual machines during our testing.

Settings, best practices, and test results for deploying SQL Server based workloads on the HP ConvergedSystem 700x platform are detailed throughout this document as well as guidelines for ordering and configuring an HP ConvergedSystem 700x.

Target audience: The intended audience for this white paper is technical decision makers, data architects, database architects and solution architects.

Document purpose: The purpose of this document is to describe a tested App Map and describe the best practices and design considerations for implementation.

This white paper describes testing performed by HP in December 2013.

Introduction

HP ConvergedSystem 700x addresses one of today's top priorities for IT organizations – reducing data center complexity. Pre-configured to meet a range of business needs, HP ConvergedSystem 700x offerings can be easily and rapidly deployed to support a variety of virtualized application environments.

HP ConvergedSystem 700x delivers a best-in-class virtualized infrastructure, with integrated software, hardware, services, and support – all delivered as a single, proven solution that can support multiple hypervisors and is enabled for cloud management. Transparent scalability allows the solution to grow as your business needs change, from entry-level to the enterprise.

The HP ConvergedSystem 700x is pre-built with HP Converged Infrastructure consisting of HP ProLiant Gen8 servers, HP Networking and HP StoreServ 3PAR Storage arrays. For virtualization, the HP ConvergedSystem 700x is available in three flavors, the “HP ConvergedSystem 700x” model that doesn't use a specific model of hypervisor, the “HP ConvergedSystem 700x for VMware” model which is tailored for use on the VMware platform, and finally, the “ConvergedSystem 700x for Microsoft Solutions” model which leverages Microsoft Windows® 2012 Hyper-V, managed by Microsoft System Center 2012 SP1. The tested and recommended solutions in this document all use the Microsoft Solutions model. Further detail on each of the solutions can be found in the next section.

Overview

The ConvergedSystem 700x for Microsoft Solutions is available in two sizes, single rack and multi-rack. Table 1 details the specifications of each.

Table 1. ConvergedSystem 700x technical overview

| | # of Blades | Est. VMs | Memory/Server | Storage | Storage Controllers | Drive Cages | Drive Count |
|-------------|-------------|----------|---------------|-------------------------|---------------------|----------------------|-------------------------|
| Single rack | Up to 16 | 512 | 128/256/384GB | 3PAR 7200 3PAR 7400 | 2 or 4 | Up to 6 | Up to 240 |
| Multi-rack | 16-64 | 2048 | 128/256/384GB | 3PAR 7400 3PAR 10000 | 2 or 4 2, 4 or 6 | Up to 16 Up to 42 | Up to 480 Up to 1920 |

The single rack configuration supports up to 16 blades in a single enclosure along with HP 3PAR StoreServ 7200 (3PAR 7200) or HP 3PAR StoreServ 7400 (3PAR 7400) storage with up to six additional drive cages (10 total). For each configuration, the HP ProLiant BL460c Gen8 blades support a maximum of 384GB of memory per host.

The multi-rack configuration provides scale up capacity for larger environments and future growth. It features support for up to four blade enclosures and 64 blades. For storage capacity, both the 3PAR 7400 and 10000 series storage arrays are supported. Using the 4-node 7400 storage array, up to 16 additional drive cages are supported for a total of 480 drives. Scaling even further, the HP 3PAR StoreServ 10000 array features up to 1920 disk drives serviced by two, four or six storage controllers

The flexibility in the HP ConvergedSystem 700x platform allows customers to purchase the correct hardware, software, and installation/configuration services to tailor to their needs. To that end, HP offers three different solution configurations for a customer’s platform needs:

HP ConvergedSystem 700x – This base solution allows customers to develop a hardware platform for their needs. The base platform does not offer any operating system integration, or any enhancements for a particular virtual environment; and software licensing is also not included. This solution is best for customers that simply want to purchase the HP ConvergedSystem 700x platform, and are willing to build and configure their solution themselves.

HP ConvergedSystem 700x for VMware – This solution is tailored toward customers seeking to run their workloads using VMware’s vSphere 5.1 virtualization solution. In addition to the hardware components offered in the base HP ConvergedSystem 700x, the ConvergedSystem 700x for VMware comes with HP Insight Control version 7.2, the HP Insight Control plug-in for vCenter, VMware vSphere 5.1 Enterprise Plus, and VMware vCenter Server standard. An onsite installation of HP Insight Control is also included. This solution is a joint-engineered solution between HP and VMware and the VMware software is factory installed for convenience. VMware software licenses are also factory installed if they are purchased with the solution. For direct cloud management, the VMware vCloud Suite is offered.

HP ConvergedSystem 700x for Microsoft – This Microsoft-based solution is the solution that is used for the basis of the SQL Consolidation App Map that is described in this white paper. This solution is targeted toward customers virtualizing their Microsoft applications using Microsoft Windows Server 2012 Hyper-V and managing their solution using Microsoft System Center 2012 SP1 management stack. This comes standard with HP Insight Control v 7.2, HP ProLiant Server and BladeSystem Management Packs for Microsoft System Center Operations Manager. Software licenses for Microsoft Windows Server 2012 Datacenter and Microsoft System Center 2012 Datacenter SP1 can also be purchased as part of this solution. Working jointly with Microsoft, HP has tested and validated this solution with the Microsoft Private Cloud Fast Track 3.0 program. The Fast Track program is designed for ease of deployment, scalability, and high availability for private cloud solutions.

All Microsoft software components are licensed and sold separately. The HP ConvergedSystem 700x platform can be custom tailored to a customer’s workload or environment. A wide range of configuration options are available from single rack configurations to multi-rack configurations allowing for future growth and scalability.

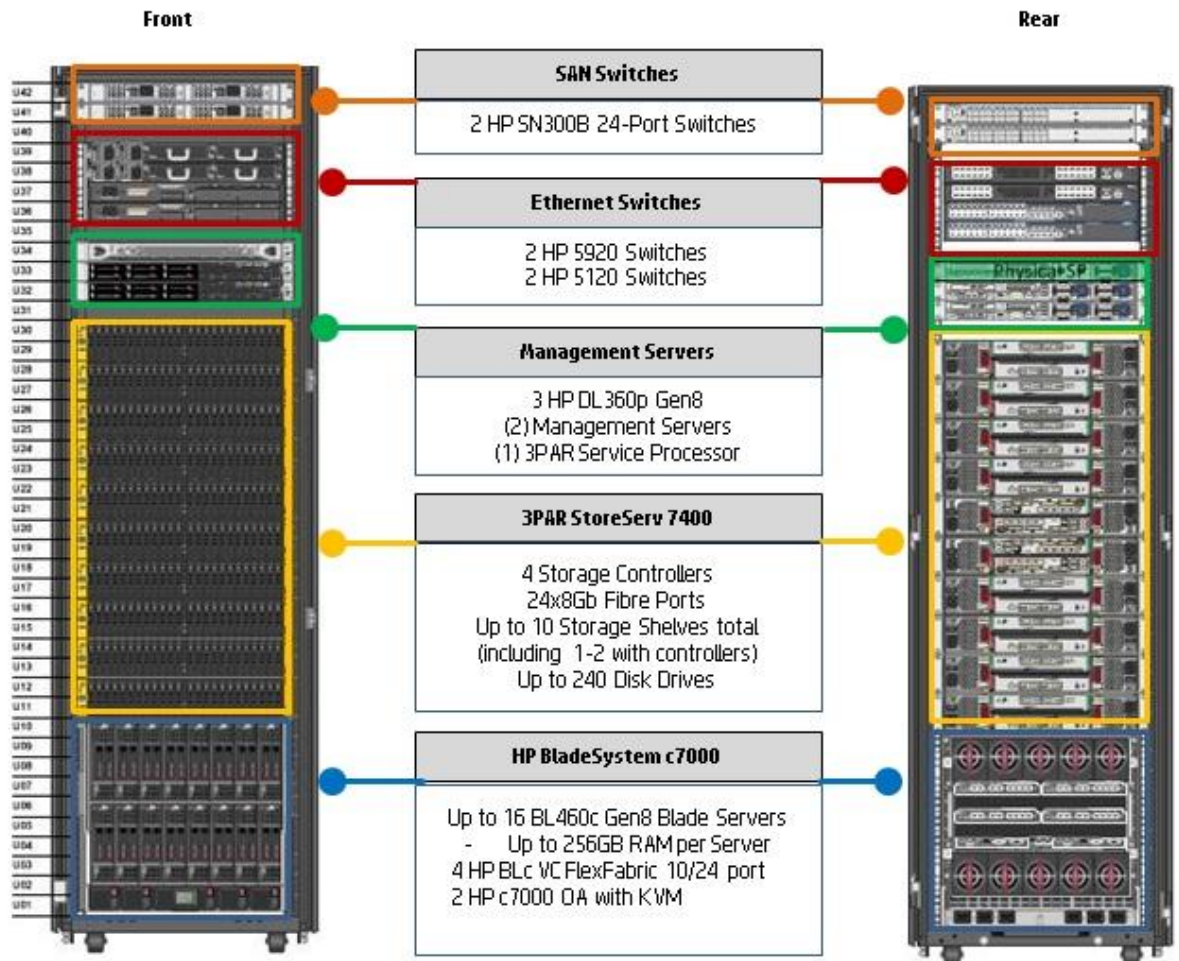
The solution used for this App Map, the HP ConvergedSystem 700x for Microsoft, includes HP Factory Express racking, set up and configuration, along with onsite startup and installation. Once setup is complete, the HP ConvergedSystem 700x is delivered as a fully functional unit with all virtualization and management components set up and ready for customization or solution setup.

HP ConvergedSystem 700x hardware configurations for the SQL Consolidation App Map

The single rack HP ConvergedSystem 700x was used for the small and medium recommended configurations in this document, while the multi- rack HP ConvergedSystem 700x platform is used for the large, tested configuration depicted in this white paper.

Figure 1 shows an example single rack configuration.

Figure 1. HP ConvergedSystem 700x single rack architecture



Single rack configurations can be customized for blades, storage, and management servers. The blade servers featured for the HP ConvergedSystem 700x consists of the HP BL460c Gen8 blades with the following:

- Two Intel® Xeon® E5-2690 v2¹ (3.0GHz/10-Core/25MB/130W) CPUs
- 256 RAM (PC3L-12800R)
- One HP FlexFabric 10Gb 2-port 554FLB Adapter
- One HP FlexFabric 10Gb 2-port 554M Adapter
- One 300GB 15K SFF SAS hard disk drives

¹ The HP ConvergedSystem 700x configuration tested for this white paper featured the E5-2690 V1 processors in the HP BL460c Gen8 servers. The V2 processors were not available when the test environment was built.

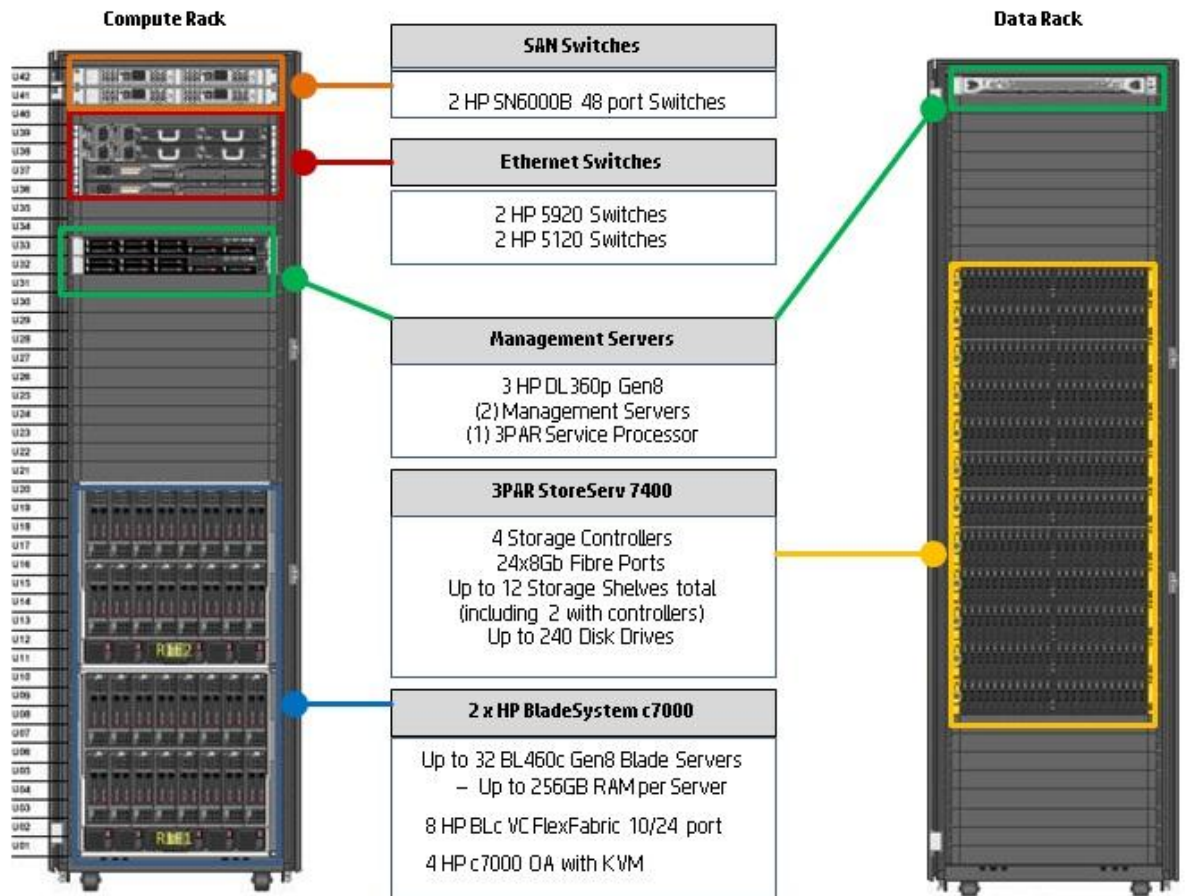
For storage, all single rack configurations utilize either the 3PAR 7200, or the 3PAR 7400 storage arrays. These arrays support three tiers of storage:

- SSD – 100/200GB SLC SSDs and 400/480/920GB MLC SSDs. These SSDs are available in both large and small form factors
- SAS – 300GB (15K), and 450/600/900GB (10K) drives are available in small form factor only
- NL – Consists of 1/2/3/4TB drives. The 1TB drives are available in SFF size only, while the other drives are available as LFF models only.

These three tiers of storage can be combined to provide flexibility for any workload or environment.

Scaling beyond a single rack configuration requires a multi-rack configuration as shown in Figure 2. The multi-rack configuration utilizes separate compute and storage racks for ease of scalability.

Figure 2. HP ConvergedSystem 700x multi-rack architecture



The multi-rack HP ConvergedSystem 700x configuration utilizes the same components as the single rack, but offers additional scalability and storage options. The 3PAR 10000 series storage arrays are also available with the multi-rack configuration and are available with up to six storage controllers for additional performance beyond the 7000 series storage arrays. Additionally, for ease of storage scalability, the multi-rack configuration features a separate “Data Rack” which houses only the storage array and storage controller. The additional “Compute Rack” houses the rest of the blade enclosures, management servers and network gear.

In order to satisfy the demand for IOPS (Input/Output Operations Per Second) brought on by a SQL Transaction Based workload, the recommended and tested configurations in this white paper, utilize a dual-tier storage scheme combining both SAS and SSD media.

HP ConvergedSystem 700x network connectivity overview

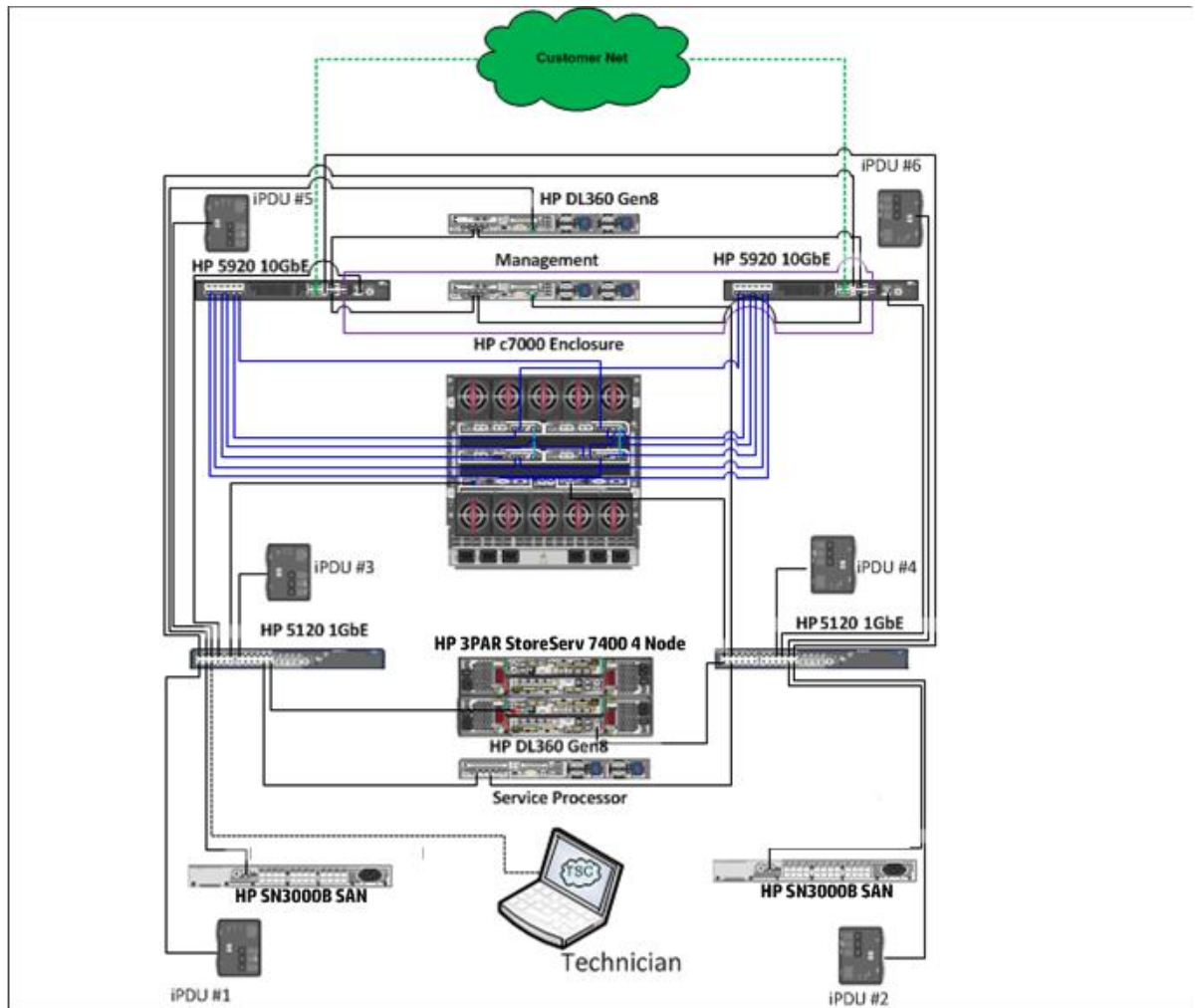
As part of the installation and setup service that is included with the HP ConvergedSystem 700x for Microsoft, a number of networks are partitioned and allocated using the HP Virtual Connect FlexFabric 10/24-Port modules. These modules provide both Ethernet and Fibre Channel connectivity for the Hyper-V blade servers residing in the BladeSystem c7000 enclosures. The following networks are configured as part of the setup process:

- Production Network (Ethernet/Teamed Connections)
 - Used for connecting to Virtual Servers from production network. These connections are teamed for redundancy.
- Management Network (Ethernet/Teamed Connections)
 - These are used by the Management Servers to manage the HP ConvergedSystem 700x using tools such as Microsoft System Center. These connections are also teamed for redundancy.
- VM Live Migration Network (Ethernet)
 - Used for moving virtual servers from one host to another transparently.
- Cluster Shared Volume Network (Ethernet)
 - This network is used for communications within each cluster for the Cluster Shared Volumes.
- Multipath I/O Storage Network (Fibre Channel/Redundant)

The HP ConvergedSystem 700x utilizes HP Virtual Connect technology to simplify the network connections coming into the c7000 blade enclosures. With Virtual Connect, server profiles can be set up and network resources allocated to individual blades easily and efficiently. Once the server profiles are set up, the virtual NICs appear in the operating systems of the blade hosts and can then be allocated through Hyper-V virtual switches to the VM servers.

Figure 3 shows the default physical network connections within the HP ConvergedSystem 700x.

Figure 3. Network connections



The HP 5920 10GbE switches shown above carry the majority of Ethernet traffic within the infrastructure. These two switches are transparently linked together and appear as a single device to the FlexFabric modules. In our tested configuration with two enclosures, the connections above are duplicated for the second enclosure.

Management software components

Components

The HP ConvergedSystem 700x for Microsoft provides the underlying infrastructure for running multiple workloads requiring high levels of performance and availability. To complete the solution, a software stack that can deliver the management, monitoring, operational control and lifecycle requirements is needed for a virtualized environment. To deliver these capabilities, System Center 2012 with HP Insight Control for System Center software is considered as part of the HP ConvergedSystem 700x for Microsoft solution. However the required licensing for System Center 2012 and Windows Server 2012 Datacenter SP1 is not included as a component part of HP ConvergedSystem 700x for Microsoft. HP customers that have already purchased Enterprise License Agreements (ELA) are covered and do not need to purchase any additional licenses. HP customers requiring licenses may purchase them as an addendum to their HP ConvergedSystem 700x product order.

Microsoft System Center 2012

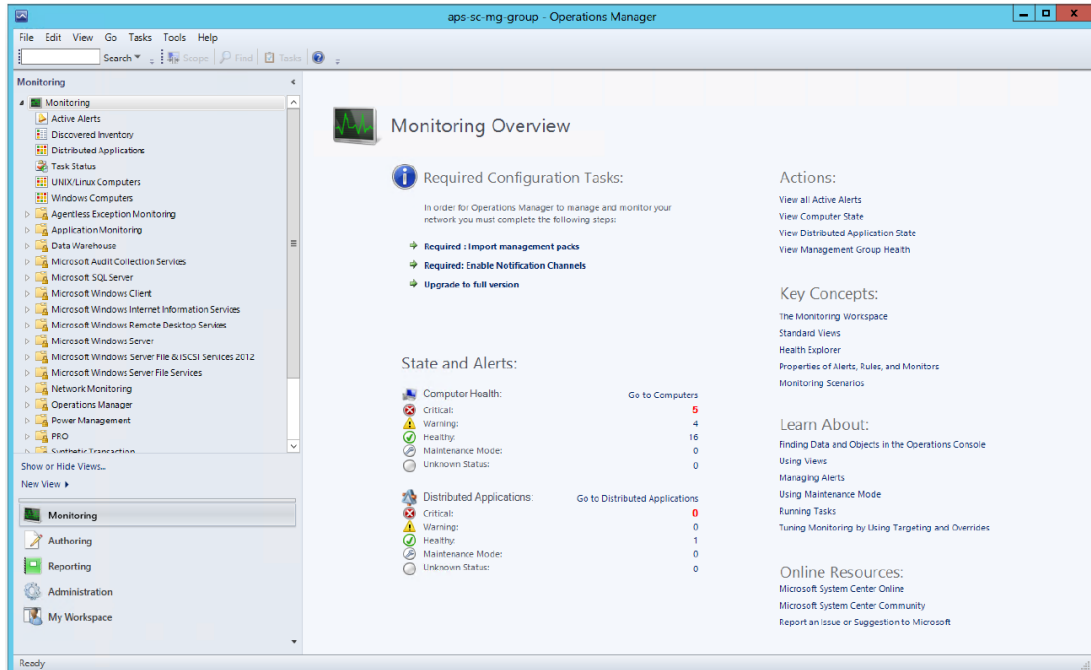
System Center 2012 is a comprehensive management platform consisting of capabilities for infrastructure management, service delivery and automation, and application management and control. The System Center 2012 management stack can be installed on a core set of VMs running on the HP ConvergedSystem 700x management servers (HP ProLiant DL360p Gen8 servers), through which the services are delivered to the business users. The System Center 2012 product includes a number of core components that can be installed including the following.

Microsoft System Center Operations Manager (SCOM)

Microsoft System Center Operations Manager (SCOM) with Service Pack 1 (SP1) provides a single point of management for servers, devices, operating systems, services and applications to ensure the data center infrastructure is running and to notify administrators in the event a monitored component fails as shown in Figure 4.

The basic functionality of SCOM is expandable using Management Packs. The Management Packs are available from Microsoft or other vendors, including HP. The Management Packs provide application or device awareness that integrates into the SCOM product and offers a single point of management to provide increased value for an organization to ensure that applications remain available and are running at the agreed upon service levels.

Figure 4. SCOM

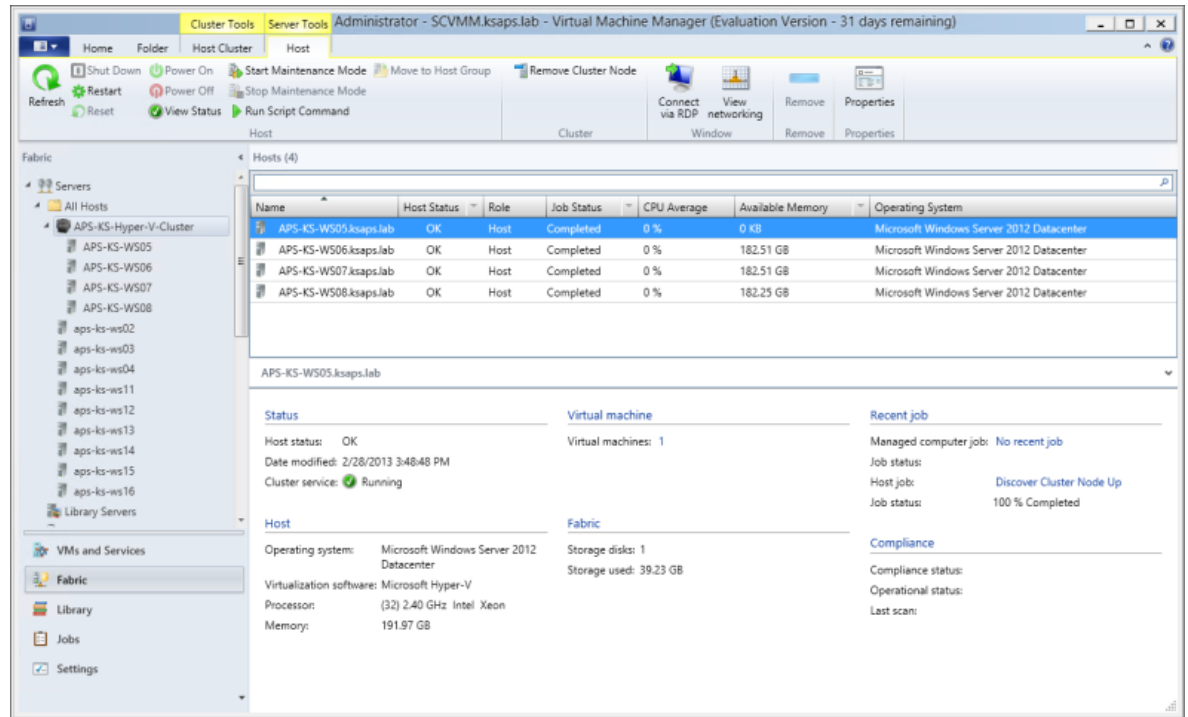


Additional information on Microsoft System Center Operations Manager (SCOM) is available from [Microsoft System Center Operations Manager](#).

Microsoft System Center Virtual Machine Manager (SCVMM)

Microsoft System Center Virtual Machine Manager (SCVMM) with Service Pack 1 (SP1) provides a single point of management for virtualized infrastructure including Hyper-V host and guest servers, network and storage devices, operating systems, services and applications to assist in deploying and managing the virtual infrastructure. SCVMM integrates with SCOM to ensure that the virtual infrastructure is running properly and to notify administrators in the event of a VM component failure.

Figure 5. Microsoft System Center Virtual Machine Manager (SCVMM)



Additional information on Microsoft System Center Virtual Machine Manager (SCVMM) is available from [Microsoft System Center Virtual Machine Manager](#).

HP Insight Control for Microsoft System Center

HP Insight Control for Microsoft System Center provides essential infrastructure management, making it easy to deploy, migrate, monitor, control and optimize an IT infrastructure, using a single, simple management console. Within the HP ConvergedSystem 700x, HP Insight Control for Microsoft System Center seamlessly integrates unique HP ProLiant and HP BladeSystem manageability features into System Center Operations Manager, exposing the native capabilities of servers and enclosures to System Center. This increased visibility makes it easier to perform root-cause analysis to the subsystem and component level.

For the HP ConvergedSystem 700x, Gen8 servers and the integration of Insight Control with System Center provide the following capabilities:

- Proactive hardware monitoring, managing and alerting of hardware health and intelligently responding to hardware events on servers running Windows.
- The HP ProLiant Agentless Management Pack manages the health of ProLiant Gen8 servers without the need for loading OS-based SNMP agents or WBEM providers.
- The HP SCVMM 2012 Integration Kit provides HP WinPE and production drivers for ProLiant servers to assist with OS deployment via SCVMM 2012.

The HP ProLiant Updates Catalog can be used by SCVMM 2012 to provide simplified Windows driver and firmware updates via a rotating, automated workflow for Hyper-V clusters.

HP Storage Management Pack for Microsoft System Center

HP Storage Management Pack for Microsoft System Center provides seamless integration with SCOM 2012 by integrating predefined discovery and state monitoring policies, event processing rules and tasks. This comprehensive integration solution complements HP Insight Control for Microsoft System Center, and allows administrators to proactively streamline IT operations and increase systems availability by monitoring ProLiant server environments and HP Storage products through a common console.

HP 3PAR Policy Manager Software

HP 3PAR Policy Manager Software works to implement customer-configurable remote service access policies. Installed on a customer-provided host, Policy Manager Software provides the customer with ultimate flexibility and control to allow or deny outbound communication or remote service connections to and from an HP 3PAR StoreServ Storage system. Policy Manager also serves as the centralized point for collecting and storing audit logs of all diagnostic data transfers and authorized remote service connections to and from all configured HP 3PAR StoreServ Storage systems. HP 3PAR Policy Manager provides the following benefits:

- The customer has complete control over policy administration.
- A centralized policy administration for all HP 3PAR StoreServ Storage systems is provided.
- A centralized audit log to facilitate security audits is provided.

More information, including QuickSpecs, solution briefs, etc., is available for the HP ConvergedSystem 700x at: hp.com/go/convergedsystem/CS700X

Solution components

SQL Consolidation App Map

Today's private cloud model of shared computing resources demands a flexible, scalable platform for application services such as Microsoft SQL Server. For IT services residing in the cloud, several key features are required for successful application service:

- **Flexibility** – Hardware and software services can quickly be added, removed or reassigned for use within the cloud.
- **Ease of provisioning** – With many users, business units, or groups competing for compute resources across the cloud, self-provisioning or ease of provisioning is required to offload demands on IT staff and resources.
- **Comprehensive management** – Central management of the cloud enables IT to quickly respond to the demands of business users, enable chargeback for resources, and to provide pro-active management reducing downtime and expense.

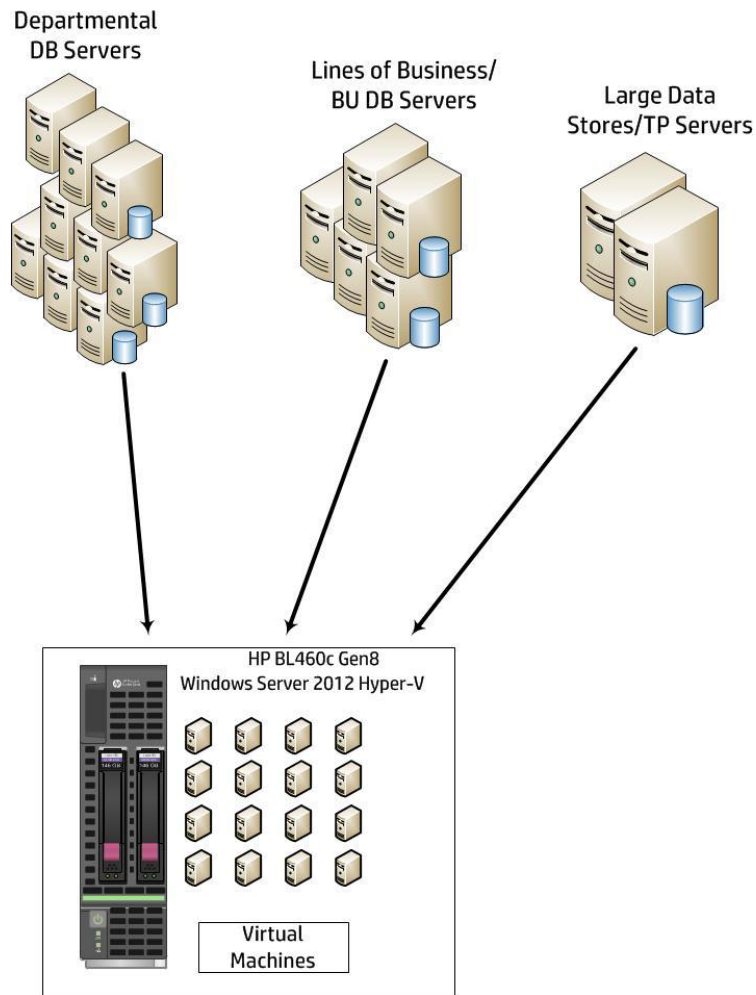
The new HP ConvergedSystem 700x cloud computing platform addresses all these needs while providing best in class ProLiant Gen8 hardware and fault tolerance.

In order to address the growing need of IT organizations reducing costs and server sprawl by consolidating database resources to the private cloud, HP has developed a SQL Consolidation App Map to demonstrate the capabilities for the HP ConvergedSystem 700x as a consolidation platform. The SQL Consolidation App Map is optimized for SQL Server 2012 consolidation and Online Transaction Processing (OLTP) by providing the following:

- **Optimized and validated to support OLTP specific workloads** – The tested workloads for this App Map simulate various OLTP transaction loads, ensuring scalability as transaction loads increase.
- **Designed to support and scale to several hundred VMs** – The tested workload scales up to over 200 VMs of varying database sizes and transaction rates.
- **Cost savings through Central Management** – By coupling Microsoft System Center with HP Insight Control, centralized management of the entire solution is accomplished easily and efficiently, thereby reducing management and provisioning cost.

The SQL Consolidation App Map leverages Microsoft Windows 2012 Hyper-V to provide robust virtual Database Servers that can be easily provisioned and deployed. This provides the ability to consolidate many types of SQL servers into a single HP BL460c Gen8 server blade as shown in Figure 6.

Figure 6. Database Consolidation overview



For this App Map, three different configurations were developed:

Small – Designed for customers looking to consolidate SQL Servers into less than 100 Virtual Machines.

Medium – Designed for customers consolidating between 100–200 servers, or those that are scaling up from the small configuration

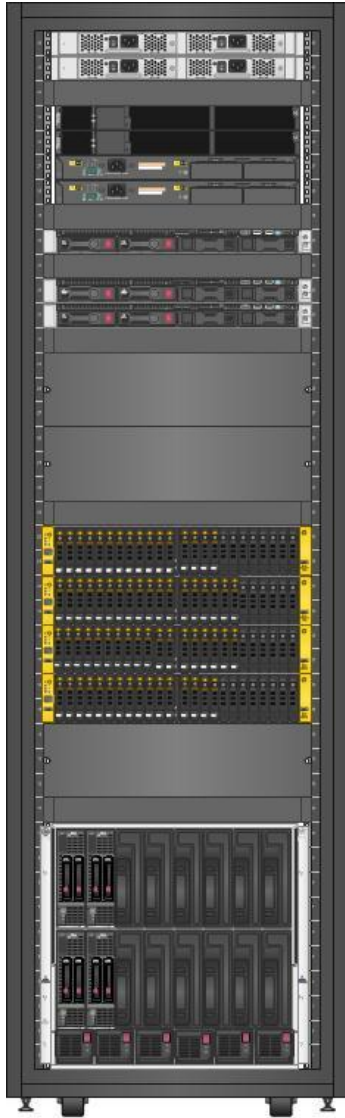
Large – Designed to support more than 200 VMs and can support customers scaling up from either the small or medium configurations by purchasing an additional rack and hardware.

Small SQL Consolidation App Map overview

The Small SQL Consolidation App Map is based on the single rack version of the HP ConvergedSystem 700x. It uses a single blade enclosure featuring four BL460c blades configured as two 2-node Windows failover clusters. Storage consists of the 3PAR 7400 2-Node storage array with 3 additional storage shelves (4 total) and 64 300GB SAS disks and 8 200GB SSDs. With a wealth of open Host bays, the Small App Map can easily be upgraded to the Medium SQL Consolidation App Map, by simply adding more blades, drive shelves and drives.

Figure 7 depicts the Small SQL Consolidation App Map.

Figure 7. Small SQL Consolidation App Map



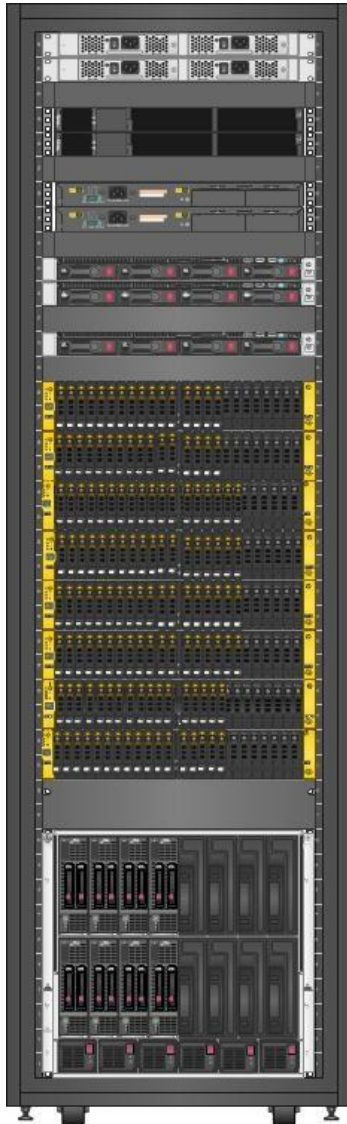
Medium SQL Consolidation App Map overview

The Medium SQL Consolidation App Map expands upon the HP ConvergedSystem 700x single rack architecture by featuring more host blades, more storage controllers, drives and shelves.

It features eight host blades configured across two 4-node Windows Failover Clusters. The 3PAR 7400 4-Node storage array is employed, along with 6 additional storage shelves (8 total) with 128 300GB SAS disks, and 16 200GB SSDs. This single rack configuration is expanded by adding additional host blades, drive shelves and drives.

The Medium SQL Consolidation App Map is shown below in Figure 8.

Figure 8. Medium SQL Consolidation App Map



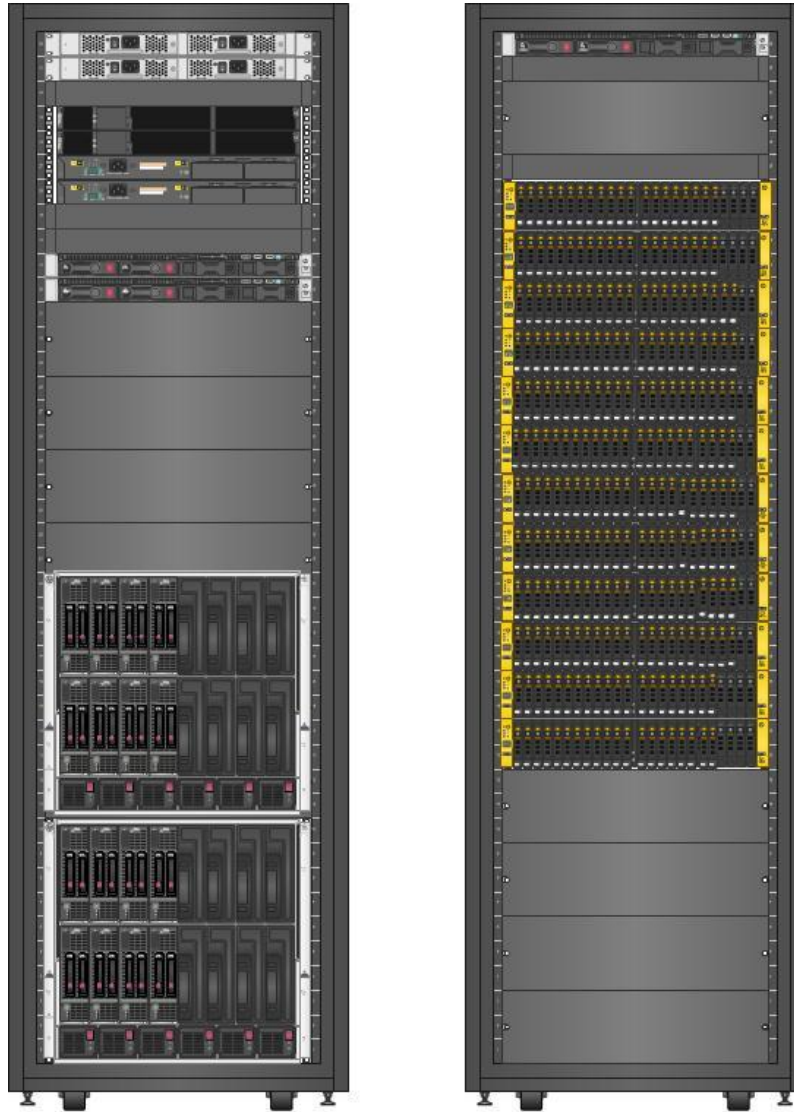
Large SQL Consolidation App Map overview

The Large SQL Consolidation App Map is based upon the HP ConvergedSystem 700x multi rack architecture. With 16 free blade slots and room for several more drive enclosures in the dedicated storage rack, the Large App Map is ready for future expansion.

With 16 blades across 2 Windows Failover Clusters, and a 3PAR 7400 4-Node Storage array with 10 additional storage shelves (12 total) configured with 240 300GB SAS and 32 200GB SSD, it has a total capacity of 73TB of RAW storage.

Figure 9 shows the large configuration.

Figure 9. Large SQL Consolidation App Map



Capacity and sizing

The three SQL Consolidation App Maps presented here all used the HP ConvergedSystem 700x platform as a base. All of the infrastructure, cabling, power, network, etc. were set up according to the specifications laid out in the HP ConvergedSystem 700x architecture. The configuration guidance for the SQL Consolidation App Map involves the specific deployment details for the VMs, the storage configuration and the resource allocation. This section details the configuration settings used to test our large multi-rack configuration. Unless otherwise noted, configuration details pertain to the tested configuration only.

More detailed information on the HP ConvergedSystem 700x architecture can be found in the “[Overview](#)” section of this document.

VM overview

For our SQL Consolidation App Map, our workload testing consisted of a mix of three different virtual machine sizes. The sizing of the three virtual machines was accomplished by researching industry statistics for average database sizes and resource requirements. Then, in order to optimize the virtual resource allotment on each blade server, three different sizes were developed, that span the range of typical database server sizes:

Small – For database servers with smaller or less frequently used databases

Medium – For database servers featuring databases with larger resource requirements or larger user loads

Large – For the largest databases or the heaviest user loads

Once the sizes were determined, a workload mix was developed to match the VM requirements to the specific Transaction Processing workload that we tested. The “VM workload mix” section below details the mix that was used for the larger tested SQL Consolidation App Map.

Table 2 shows the parameters used for each of the VM sizes.

Table 2. VM overview

| Size | CPU Cores | Memory | Storage Size | IOPS | VMs/Server |
|--------|-----------|--------|--------------|------|------------|
| Small | 1 | 4GB | 150GB | 150 | 9 |
| Medium | 2 | 8GB | 400GB | 500 | 5 |
| Large | 8 | 16GB | 800GB | 1500 | 2 |

For the SQL Consolidation App Map, a workload mix of 64-256 VMs is used across the three configurations. This workload mix can be customized for any given workload. For customer workloads requiring a larger number of smaller VMs, for example, the large configuration can support well over 300 VMs; whereas a customer deploying a Small SQL Consolidation App Map configuration with a requirement for mostly large VMs, may only support less than 50 VMs total. When designing workload mixes for this App Map, it is prudent to keep several factors in mind:

Growth – It is best to ensure that there is adequate resource headroom as databases expand and compute resource requirements increase.

Failover – The high availability provided by the Hyper-V Host clusters in this environment allows for the failover of one or several blades. As the blades failover, VMs are moved to the remaining blades during the outage. System resources must be available to take on the load of the additional VMs.

Table 3 below depicts the total resources assigned within each App Map, and the increase in VM workload in the case of single or multiple host failovers.

Table 3. SQL Consolidation App Map variants

| Feature | Small App Map | Medium App Map | Large App Map |
|---|----------------|------------------|-------------------|
| Total # of VMs (s/m/l) | 64 (36, 20, 8) | 128 (72, 40, 16) | 256 (144, 80, 32) |
| Total # of VMs per server (Normal Runtime) | 16 | 16 | 16 |
| Total # of VMs per server (Single Host Failure) | 32 | 21/22 | 18/19 |
| Total # of VMs per server (Dual Host Failure, Diff Cluster) | 32 | 21/22 | 18/19 |
| Total # of VMs per server (Dual Host Failure, Same Cluster) | 1 Cluster down | 32 | 21/22 |
| # of physical cores | 64 cores | 128 cores | 256 cores |
| RAM | 1 TB | 2 TB | 4 TB |
| IOPS | 25K | 50K | >90K |
| Raw Capacity | 19 TB | 38 TB | 73 TB |

Note

Capacity shown is RAW capacity of the storage array. Usable capacity will be less, depending on the RAID level chosen, etc.

VM workload mix

The three SQL Consolidation App Map configurations, based on the HP ConvergedSystem 700x architecture, use four, eight or 16 blades deployed with a mix of small, medium and large VMs on each blade.

For our tested and recommended architectures, we used a ratio of:

60% Small

30% Medium

10% Large

This mix provided a typical mix of VMs for many SQL Server workloads including our tested workload, though it's not typical of ALL workloads. Before implementing a SQL Consolidation App Map, careful research should be completed to define the correct mix for the workload that will reside on the App Map. Tools, such as the Microsoft Assessment and Planning (MAP) toolkit can be used to help define workload mixes and consolidation parameters. More information on the MAP toolkit can be found in the Appendix of this document.

Each blade has a total of 16 VMs, with the resource capacity to add more VMs in case of a failover situation within each of the clusters. When developing our virtual machine architecture, we developed a spreadsheet detailing the physical and virtual resources available on each blade server, then modeled that against the resource requirements for each type of virtual machine. This helped us develop the best virtual machine mix for our workload, while also ensuring that we have extra resources available in case of virtual machine failover. Figure 10 shows the spreadsheet that was used to determine virtual machine loads for each of the 16 blade servers in our tested configuration:

Figure 10. Virtual Server configuration spreadsheet

| # of VMS | 256 | Size | CPU cores* | Memory(GB) | IOPS | Storage(GB) |
|-----------------------------|-----------|--------------|------------|------------|-------|-------------|
| vCPU to CPU Ratio (x to 1) | 2 | | | | | |
| Workload Ratio (%) | Small 60 | Small | 1 | 4 | 150 | 100 |
| | Medium 30 | Medium | 2 | 8 | 500 | 400 |
| | Large 10 | Large | 8 | 16 | 1500 | 800 |
| DISK IOP Ratio (%) | SAS 50 | | | | | |
| | SSD 50 | | | | | |
| | | Total | 512 | 1638 | 99840 | 66560 |
| Server Capacity (BL460c G8) | | | 16 | 256 | | |
| Servers Needed | | | 16 | | | |
| Storage 7200 | | | 0 | | | |
| Storage 7400 | | | 1 | | | |
| SAS Disks Needed | | | 250 | | | |
| SSD Needed | | | 16 | | | |
| vCores/Server | | | 16 | | | |
| Memory/Server | | | | 102 | | |
| IOPS/Server | | | | | 6240 | |
| Storage/Server | | | | | | 4160 |
| VMs/Server | | | 16 | | | |

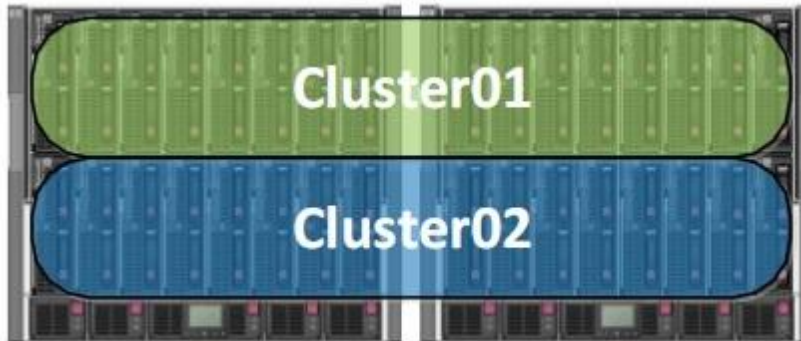
This spreadsheet allowed us to model different workload ratios, as well as the number of VMs/server and number of total VMs. For our workload, a conservative Virtual CPU/Physical CPU ratio of 2:1 was used. Based on published specifications for typical IOPS/disk, this spreadsheet also helped us determine the number of disks that were needed to support our total IOPS targets.

The SQL Consolidation App Map provides one example of a deployed VM configuration for SQL consolidation. The architecture can be customized for a wide range of workloads and production environments, featuring different mixes of VM sizes as well as different VM resource allocations.

Hyper-V host configuration

Each of the SQL Consolidation App Maps utilizes standard “Active-Active” Microsoft Windows Server 2012 Failover Clusters for Fault tolerance. In an “Active-Active” configuration, all Hyper-V host members are all always accessible. In the case of host failure, the cluster would stay up, while the resources in the failed host would be moved to other cluster nodes. While there are many HA options that can be implemented using Windows Failover Clusters, including guest clustering, the SQL Consolidation App Maps use Highly Available Virtual Machines. Once a VM is set as “Highly Available,” it will be moved to another cluster node upon host failover. For additional hardware fault tolerance at the blade enclosure level, 2 clusters are created for each enclosure as shown in Figure 11 below.

Figure 11. Windows Server Failover Cluster overview



For a configuration such as the Large SQL Consolidation App Map, which features two enclosures, clusters are set up by rows, where the top row of each enclosure comprises cluster 1, and the bottom rows of the enclosures are part of cluster 2.

The clusters are set up as Windows 2012 Node and Disk majority clusters, with a small disk witness volume that is used for Quorum.

Each Hyper-V host server within the cluster was sized with extra Memory and CPU capacity in case of hardware failure at the host or enclosure level. When a problem is detected and a failover is initiated, the VMs contained in the problem host will be spread across the remaining nodes in the cluster. Having this extra resource capacity ensures that the failed over virtual machines will be able to start on the new node. With the use of Clustered Shared Volumes (discussed later in this white paper), a failed over VM will have access to its VHDx files on any node in the cluster.

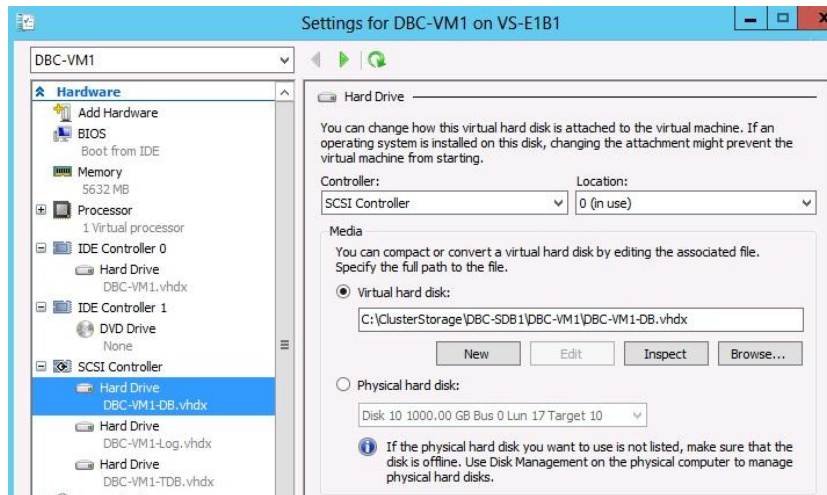
Figure 12 shows a typical Hyper-V host server running with a mix of small, medium and large VMs.

Figure 12. Hyper-V host VMs

| Virtual Machines | | | | |
|------------------|---------|-----------|-----------------|------------|
| Name | State | CPU Usage | Assigned Memory | Uptime |
| DBC-VM1 | Running | 0 % | 5632 MB | 2:03:52:52 |
| DBC-VM2 | Running | 0 % | 5632 MB | 2:03:10:28 |
| DBC-VM3 | Running | 0 % | 5632 MB | 2:03:10:27 |
| DBC-VM4 | Running | 0 % | 5632 MB | 2:03:10:18 |
| DBC-VM5 | Running | 0 % | 5632 MB | 2:03:10:25 |
| DBC-VM6 | Running | 0 % | 5632 MB | 2:03:10:17 |
| DBC-VM7 | Running | 0 % | 5632 MB | 2:03:10:20 |
| DBC-VM8 | Running | 0 % | 5632 MB | 2:03:10:23 |
| DBC-VM9 | Running | 0 % | 5632 MB | 2:03:10:21 |
| DBC-VM10 | Running | 0 % | 9728 MB | 1:20:08:58 |
| DBC-VM11 | Running | 0 % | 9728 MB | 1:20:08:55 |
| DBC-VM12 | Running | 0 % | 9728 MB | 1:20:08:53 |
| DBC-VM13 | Running | 0 % | 9728 MB | 1:20:08:47 |
| DBC-VM14 | Running | 0 % | 9728 MB | 1:20:08:02 |
| DBC-VM15 | Running | 0 % | 17920 MB | 1:21:53:29 |
| DBC-VM16 | Running | 0 % | 17920 MB | 1:21:53:23 |

The VMs configured for the SQL Consolidation App Map, utilize fixed sized memory capacities and are allocated memory and CPU resources depending on the size of the VM. Table 2 in the “VM overview” section of this document details the resource settings for each type of VM. Additionally all storage volumes are mounted as VHDx files, contained within cluster-wide CSVs. Figure 13 shows the settings for one of the small sized VMs.

Figure 13. Hyper-V Host VM settings



SQL Consolidation App Map technical storage summary

The SQL Consolidation App Map utilizes the 3PAR 7400 storage array for all three configurations. The array is available in both 2-controller and 4-controller variants. The 2-controller version of the 7400 array can easily scale to the 4-controller version by simply adding two more controllers. This also provides additional Fibre Channel ports. The storage configuration for each configuration is shown below.

Small SQL Consolidation App Map configuration

The Small SQL Consolidation App Map configuration features a 3PAR 7400 2-Node storage array with up to 19.3TB of raw storage space and up to 25,000 IOPS. The summary is shown in Table 4.

Table 4. Small SQL Consolidation App Map storage summary

| | |
|--------------------------------|---|
| Model | HP 3PAR 7400 2-Node Storage Array |
| Drive shelves | (4) Including the Controller Node Pair |
| Drives | (64) 300GB 15K SAS disks (8) 200GB SSD |
| Drive layout | (16) SAS drives per enclosure (2) SSD drives per enclosure |
| Raw space (user data) | 19.3TB |
| Estimated IOPS capacity | 25,000 |

Medium SQL Consolidation App Map configuration

The Medium SQL Consolidation App Map configuration features a 3PAR 7400 4-Node storage array with up to 38.7TB of raw storage space and up to 50,000 IOPS. The storage summary is shown in Table 5.

Table 5. Medium SQL Consolidation App Map storage summary

| | |
|--------------------------------|---|
| Model | HP 3PAR 7400 4-Node Storage Array |
| Drive shelves | (8) Including the 2 Controller Node Pairs |
| Drives | (128) 300GB 6G 15K SFF SAS disks (16) 200GB SSD |
| Drive layout | (16) SAS drives per enclosure (2) SSD drives per enclosure |
| Raw space (user data) | 38.7TB |
| Estimated IOPS capacity | 50,000 |

Large multi-rack SQL Consolidation App Map configuration

The Large SQL Consolidation App Map configuration features a 3PAR 7400 4-Node storage array with up to 73TB of raw storage space and over 90,000 IOPS. The storage summary is shown in Table 6.

Table 6. Large SQL Consolidation App Map storage summary

| | |
|--------------------------------|---|
| Model | HP 3PAR 7400 4-Node Storage Array |
| Drive shelves | (12) Including the 2 Controller Node Pairs |
| Drives | (240) 300GB 6G 15K SFF SAS disks (32) 200GB SSD |
| Drive layout | (20) SAS drives per enclosure (4) SSD drives in 4 enclosures (8 drives connected to each node pair) (2) SSD drives in 8 enclosures (8 drives connected to each node pair) |
| Raw space (user data) | 73TB |
| Estimated IOPS capacity | >90,000 |

3PAR Common Provisioning Groups (CPGs)

The 3PAR 7000 storage arrays use the concept of Common Provisioning Groups (CPGs) for the provisioning and allocation of storage within the array. CPGs are basically a virtual pool of disks, from which Virtual Volumes (VVs) are allocated. CPGs enable multiple VVs to share a pool of disks. When a VV is created, it draws space from a particular CPG. The VV can either be fully provisioned (space is pre-allocated) or Thin Provisioned. The CPG is defined at creation time as to what RAID type will be allocated to the VVs. As space is allocated to the VVs from the CPG pool, “chunk lets” or small units of data are striped onto the disks according to RAID type. One of the great features of the 3PAR 7000 arrays is their ability to stripe chunklets of different RAID types across the same physical disks. In this way, a single physical disk may be a part of a RAID1 CPG, RAID5 CPG, etc.

The 3PAR arrays also have a feature called “Adaptive Optimization” or AO. With AO turned on for a multi-tiered storage array, the array will analyze data access patterns and move data between configured tiers to optimize performance. Multiple AO configurations can be implemented and scheduled on an array to provide a fine tuned optimization plan and also to separate workloads with different data access patterns. Tiers are defined at the CPG level; for example an SSD tier would be a CPG that uses SSDs, while a SAS tier uses SAS disks.

For the SQL Consolidation App Map, it was decided to implement separate AO configurations for Small, Medium, and Large SQL Server VMs. These separate configurations allow us to place more emphasis on a particular VM subset and control which of those gets moved to the higher performing SSD tier.

To that end, several CPGs were created for the SQL Consolidation App Map as shown in Table 7.

Table 7. SQL Consolidation App Map CPGs

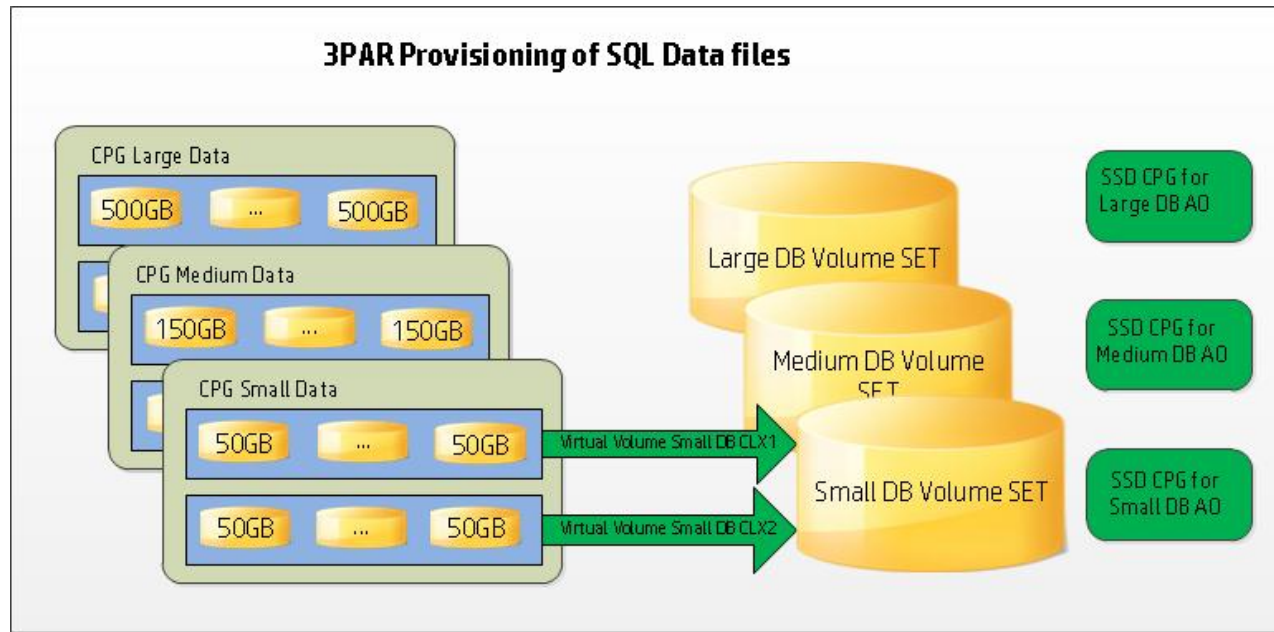
| CPG | RAID Type | Media | Content |
|---------------------------|-----------|-------|----------------------------------|
| CPG_OS | 5 | SAS | Operating System VHDs |
| CPG_Compute_Data_Small | 5 | SAS | SQL Database VHDs for Small VMs |
| CPG_Compute_Data_Medium | 2 | SAS | SQL Database VHDs for Medium VMs |
| CPG_Compute_Data_Large | 5 | SAS | SQL Database VHDs for Large VMs |
| CPG_Compute_Log_Small | 1 | SAS | SQL Log VHDs for Small VMs |
| CPG_Compute_Log_Medium | 1 | SAS | SQL Log VHDs for Medium VMs |
| CPG_Compute_Log_Large | 1 | SAS | SQL Log VHDs for Large VMs |
| CPG_Compute_TempDB_Small | 1 | SAS | SQL TempDB VHDs for Small VMs |
| CPG_Compute_TempDB_Medium | 1 | SAS | SQL TempDB VHDs for Medium VMs |
| CPG_Compute_TempDB_Large | 1 | SAS | SQL TempDB VHDs for Large VMs |
| CPG_AO_Data_Small | 5 | SSD | AO Policy CPG for Small VMs |
| CPG_AO_Data_Medium | 5 | SSD | AO Policy CPG for Medium VMs |
| CPG_AO_Data_Large | 5 | SSD | AO Policy CPG for Large VMs |

As AO runs for a given configuration, it will move data into and out of the CPG_AO_* CPGs, which reside on SSD.

All of the above CPGs are thin provisioned, and will only show actual data as it is consumed within the physical disks.

Figure 14 shows the provisioning within the 3PAR array. VVs and CPGs are created separately for each type of VM, and also for each type of VHDx file that it will contain. These volumes are all grouped together using Volume Sets, which can then be easily presented to each of the blade servers.

Figure 14. SQL Consolidation App Map storage provisioning



Once the volumes are presented to the server blades, they are set up as Clustered Shared Volumes for access throughout each cluster.

Clustered Shared Volumes

Cluster Shared Volumes (CSV) is a feature of Windows Failover Clustering that enables simultaneous read and write operations to a volume by all nodes within the cluster. For architectures such as the SQL Consolidation App Map, which uses many different volumes for the various VMs, this greatly simplifies storage management. 3PAR Virtual Volumes are simply exported to all Hyper-V hosts in the cluster. These volumes are then mounted, formatted and then converted to CSVs, making them instantly accessible to all Hyper-V hosts.

For fault tolerance purposes, this greatly enhances the resiliency of the cluster, as failed over VMs have instant access to the volumes they need to operate.

The SQL Consolidation App Map employs several CSVs which tightly map back to the CPGs and VVs on the 3PAR storage array.

Separate CSVs are created for small, medium and large VMs. Each VM utilizes the following type of CSV:

- DB – These CSVs store the Database VHDx files for each type of server (S, M, L)
- LOG – For storage of SQL Transaction Log VHDx files (S, M, L)
- TDB – TempDB VHDx files (S, M, L)

Additionally, a single operating system CSV is created within each cluster to house the VHDx files for each VMs operating system volume (all sizes). Figure 15 shows the CSVs mounted throughout a failover cluster.

Note

CSVs ending in the number 1, are used within cluster 1, those ending in the number 2 would be used in cluster 2.

Figure 15. CSV Layout

| Name | Status | Assigned To | Owner Node | Disk Number | Capacity | Information |
|---------------|--------|------------------------|------------|-------------|----------|-------------|
| DBC-LDB1 | Online | Cluster Shared Volume | Vs-E2B1 | 3 | 9.8 TB | |
| DBC-LLOG1 | Online | Cluster Shared Volume | Vs-E1B4 | 10 | 1,000 GB | |
| DBC-LTDB1 | Online | Cluster Shared Volume | Vs-E1B1 | 9 | 1,000 GB | |
| DBC-MDB1 | Online | Cluster Shared Volume | Vs-E2B4 | 2 | 7.8 TB | |
| DBC-MLOG1 | Online | Cluster Shared Volume | Vs-E1B2 | 11 | 1,000 GB | |
| DBC-MTDB1 | Online | Cluster Shared Volume | Vs-E2B3 | 6 | 1,000 GB | |
| DBC-OS1 | Online | Cluster Shared Volume | Vs-E1B3 | 4 | 3.9 TB | |
| DBC-SDB1 | Online | Cluster Shared Volume | Vs-E2B3 | 13 | 5.9 TB | |
| DBC-SLOG1 | Online | Cluster Shared Volume | Vs-E1B4 | 8 | 1,000 GB | |
| DBC-STDB1 | Online | Cluster Shared Volume | Vs-E2B2 | 1 | 1,000 GB | |
| VS-CC1-Quorum | Online | Disk Witness in Quorum | Vs-E2B4 | 5 | 1 GB | |

SQL licensing considerations

SQL Server 2012 licensing depends on the edition used. There are three editions available with SQL Server 2012, and two licensing modalities: Per core, and per Server+CAL. The considerations outlined here are focused solely on the per core licensing model, as the Server+CAL model is being phased out.

- Standard edition (licensed Per core, or per Server+CAL)
- Enterprise edition (licensed Per core, or per Server+CAL [Grandfathered via software assurance])
- Business Intelligence edition (licensed per Server +CAL only)

Standard and Enterprise (per core licensing) editions require a 4 physical or virtual core minimum license. The edition's licensing differences are:

- Standard edition requires each VM used for SQL databases to be licensed by the virtual core count supporting the virtual machine and each VM is subject to a 4 core license minimum.
- Enterprise edition allows unlimited virtual machine SQL deployments when all physical cores are licensed, and under software assurance (SA). Without software assurance, each core licensed above the 4 core minimum provides 1 additional VM right.

Enterprise edition provides all the features of Standard edition plus additional enterprise level features such as Always On high availability and advanced table features such as compression, and column store indexing.

The choice of edition and licensing model is therefore driven by the features and the licensing core requirements needed to support the number of VMs that will be used in your environment. It is important to note that enabling Hyper-Threading on the blades doubles the number of cores from a licensing perspective, effectively increasing the per core licensing costs.

Once the edition is established there are three main approaches regarding licensing SQL Server 2012 on the HP ConvergedSystem 700x environment:

1. New licensing: New licenses are purchased for all VMs.
2. Upgrading and consolidating from SQL 2008 R2: Existing customer licenses can be upgraded and moved to the HP ConvergedSystem 700x platform. For the purpose of upgrading and consolidating licenses the following rules apply:
 - A. One SQL Server 2012 Enterprise license is migrated for every two SQL Server 2008 R2 Datacenter licenses.
 - B. Two SQL Server 2012 Standard licenses are migrated for one SQL Server 2008 R2 Enterprise license.
 - C. One SQL Server 2012 Standard license is migrated with one SQL Server 2008 R2 Standard edition.
3. Consolidating 2012 licenses

Key Points

OEM licenses purchased through resellers cannot move from original host.

Grandfathering 2008 R2 Enterprise CAL based licenses to 2012 Enterprise core based licenses is limited to 20 logical processors (threads), so VMs cannot be deployed over more than 20 cores when grandfathering CAL based Enterprise licenses on a single server.

When licensing individual VMs under per core licensing model, all virtual cores supporting the VM must be licensed, with a minimum of four core licenses required. For licensing purposes, a virtual core equates to a physical core when Hyper-Threading is OFF, or a hardware thread when Hyper-Threading is ON.

Configuration guidance

Overview

Tests were performed to evaluate OLTP workload response times and validate the virtual machine availability and database performance of the sized configuration. The system was tested using the largest configuration of 256 virtual machines.

The high availability tests consisted of the performance evaluation of the workload when fewer servers were hosting the virtual machines simulating failover scenarios.

The performance tests consisted of baseline transactional tests grouped by virtual machine sizes, followed by a fully concurrent workload on all 256 virtual machines. The concurrent workload leveraged HP 3PAR Adaptive Optimization (AO) to perform autonomic sub-LUN data tiering onto SSD media and an evaluation of HP 3PAR Priority Optimization was performed to demonstrate the use of these technologies in a SQL Server 2012 database storage environment.

Test harness configuration

The HP ConvergedSystem 700x platform was tested using OLTP workload transactions driven in a three tier environment keeping the application and transaction generators in a test harness and performing network database calls to virtualize OLTP databases residing in the HP ConvergedSystem 700x platform. Each virtual machine hosts a single SQL Server 2012 instance, and these instances host a single OLTP database. The mix of small, medium, and large virtual machines was paired with databases of 50GB, 250GB, and 400GB sizes.

SQL server configuration

Table 8. SQL server parameters

| Parameter | Setting | Comment |
|------------------------------------|----------------|--|
| Max Degree of Parallelism (MAXDOP) | 0 | |
| SQL Startup Parameters | None | |
| Optional SQL Trace Flags | T834 | Large page memory support |
| SQL Server MAX Memory | 4GB, 8GB, 16GB | Small, Medium, Large DB Servers respectively |

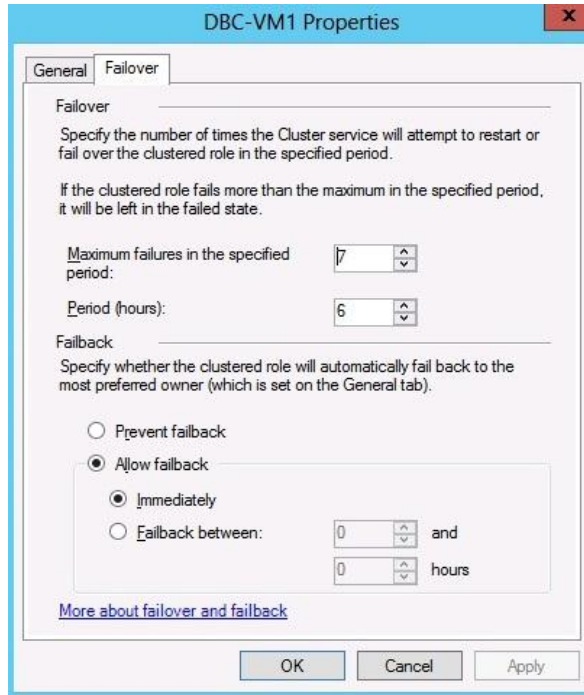
HA testing

The HP ConvergedSystem 700x platform features a Windows 2012 Failover Cluster for High Availability (HA). This provides resiliency in case of hardware or software failure in the blade host servers. To ensure that the SQL Server virtual machines remain available throughout the failover process, host clustering was implemented by making the virtual machines “Highly Available” within Windows Failover Clustering.

During the failover process, the VMs residing on a failed host blade are moved to an available host blade to continue processing. This places additional burden on other host servers as they must carry the load of the additional VMs. For our solution, the VMs deployed on a particular host blade have that blade as their preferred host. The preferred host is used in a failback situation, when the original host comes back online. The VMs will failback to their preferred hosts, instead of staying on the host blade that they reside on during the failover. VMs are not set to failback automatically by default, so this was configured during the setup process. It is also possible to set priorities on VMs so that they failover before other VMs, but this feature was not implemented. All other virtual machine HA settings were kept at their default settings.

Figure 16 below shows an example of the HA settings for the VMs in the SQL Consolidation App Map.

Figure 16. VM failover setting



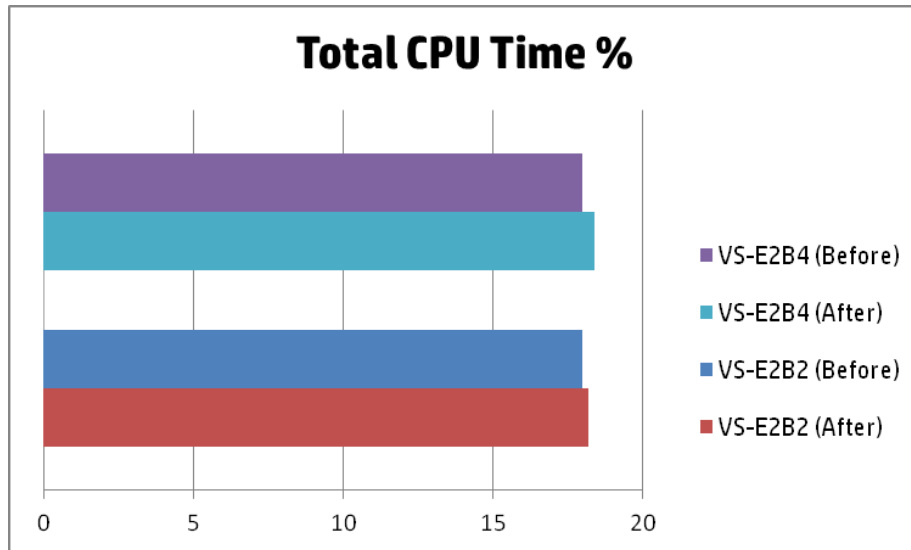
Part of the testing for the Large SQL Consolidation App Map included the performance differential between a blade host running normally and a blade host running with additional VMs from a failed host blade. Additionally, it is of importance to test performance of the failed-over VMs to see if there was an impact by moving them to a blade host with a larger than normal VM load.

Single host failure test

For the single host failure test, we shut down one of the blade hosts to let Windows Failover Cluster fail the VMs over to other blades. After the failover was complete, most blade hosts had an additional 2 or 3 VMs. We measured CPU and Memory metrics on a few of the blade hosts to see if there was an impact. As expected, available memory on the hosts, dropped to accommodate the fixed size memory load of the new VMs. CPU load on the other hand remained essentially unchanged

Figure 17 below depicts the change in CPU% before and after the failover.

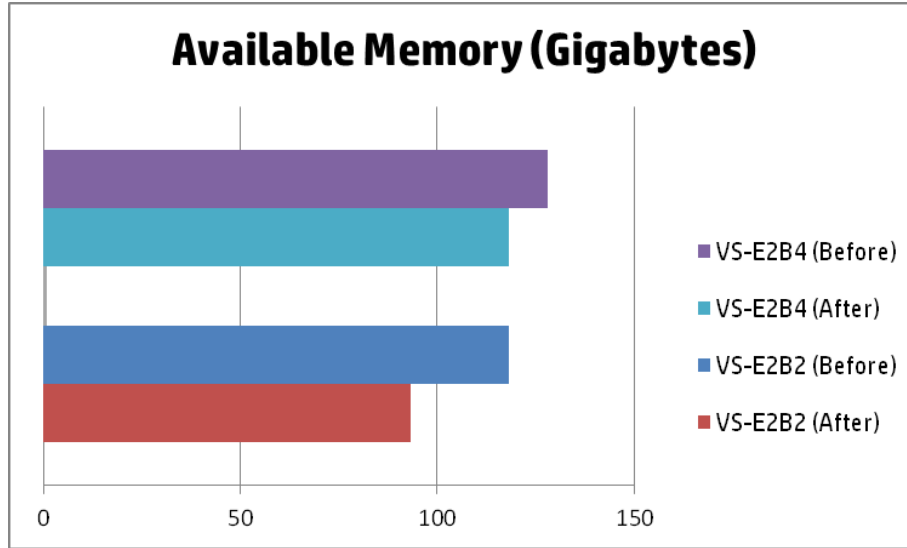
Figure 17. CPU utilization on blade hosts



Our transaction processing based workload is more I/O centric, and does not generate high CPU usage, so we expected CPU processing time to grow slightly or not at all. These results confirm this, showing essentially unchanged CPU time with the addition of 2-3 more VMs after the failover had completed.

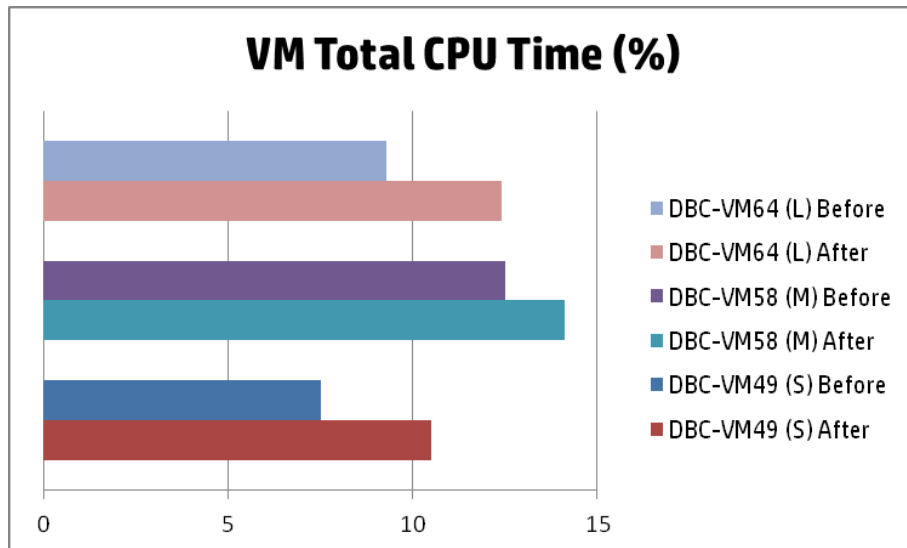
In addition to CPU time, available memory was also measured on the blade hosts. After the failover was complete, memory dropped on the blade hosts as they allocated the required memory for the 2-3 VMs that were moved as part of the failover. Figure 18 shows the available memory in Gigabytes before and after the failover.

Figure 18. Available memory



CPU percentage was also measured on the VMs that were failed over. On these VMs we observed a slight increase in CPU usage (around 3-4%) as a higher number of VMs competed for the same amount of CPU resources on the blade host. Figure 19 shows the before and after CPU usage for a sampling of each type (S, M, L) of VM server before and after the failover.

Figure 19. CPU utilization on VMs



Additional performance metrics were measured on the VM servers, including SQL server buffer counts and disk latencies. We found that these parameters were essentially unchanged after the failover, likely since the VMs are still using the same backend storage regardless of the Hyper-V host in which they reside.

SQL Server 2012 performance test results

Overview

The following section describes the testing performed to characterize the performance of OLTP databases deployed using SQL Server 2012 on the ConvergedSystem 700x. In this deployment Adaptive Optimization (AO) is leveraged to increase the performance of the system over the baseline it would provide when deployed on a single SAS drive tier. Measurements were done individually to characterize and properly size each workload on a single SAS tier, and subsequently measurements were done with all workloads running concurrently, after AO adaptation took place.

It's important to note that while absolute IOPS is a good metric to characterize a storage system, it is not necessarily the best metric to evaluate overall system performance, due to effects RAM and SSD have in buffering reads. This is why we also measure SQL batch requests per second to effectively measure the amount of transactional work being performed by the system. For example, a system could be running a small database entirely in memory and there would be nearly zero reads of the storage system. This small IOPS figure does not mean the system is slow, especially if it were processing thousands of SQL batch requests per second.

In addition, the SQL Server 2012 performance characterization does not represent maximum performance nor is it intended as a benchmark. The objective of this characterization is to show the performance of the system under a mix of OLTP workloads of various sizes deployed on a high density virtual platform, and establish a performance point of reference for sizing purposes.

SQL Server takes advantage of the Adaptive Optimization feature of 3PAR StoreServ, which is an autonomic sub-LUN performance management license that allows regions of data within a LUN to migrate to the most appropriate speed based on I/O demands. We test this adaptation using SSD drives, but it is important to note the adaptation and amount of performance improvement directly depends on workload characteristics and every database is different in terms of I/O.

Single size database baseline tests

The baseline performance test was used to establish user and transaction rate drive points for each of the workloads, and also to validate the IOPS performance of the SAS tier. In these baseline tests for Small, Medium, and Large sized OLTP databases, we measured SQL Batch requests per second, IOPS, and VM CPU among other counters. Table 9 shows the values obtained when running only identically sized databases (small, medium or large).

Table 9. SQL server baseline (average performance for each database size segment)

| Database segment | Avg. Batch Request/s | Buffer Cache Hit Ratio | Avg. VM IOPS | Avg. VM CPU% |
|------------------|----------------------|------------------------|--------------|--------------|
| Small (144 VMs) | 55 | 99.3 | 313 | 10 |
| Medium (80 VMs) | 162 | 99.4 | 629 | 10 |
| Large (32 VMs) | 342 | 99.7 | 1,368 | 10 |

When the results for each database size segment are aggregated, the data shows that the SAS tier is capable of servicing each segment, and the workloads driven are roughly equivalent across each database size segment in terms of I/O and CPU load. The VM server RAM allocation is also balanced as reflected in similar SQL buffer cache hit ratios for each segment. When extrapolated as if all workloads were running simultaneously, it is clear that these three segments could not be run concurrently in the SAS tier alone as the combined IOPS load of 140K IOPS would exceed the design limit of 50K for the 240-drive SAS tier in this test bed.

Table 10. SQL server baseline (total extrapolated performance for all database size segments)

| Database segment | Total Batch Request/s | Total VM IOPS |
|------------------|-----------------------|---------------|
| Small (144 VMs) | 7920 | 45K |
| Medium (80 VMs) | 4960 | 50K |
| Large (32 VMs) | 10942 | 44K |

Figure 20 shows the baseline run for a large sized database. The average batch requests per second is seen as 342.

Figure 20. Large database baseline Test with SAS disks



These measurements confirm the SAS tier is capable of the originally estimates under each of the different workloads and the performance is sustainable at reasonable response times.

Adaptive Optimization (AO)

The 3PAR 7000 StoreServ storage array provides an Adaptive Optimization (AO) feature that enables the automatic sub-LUN data tiering between drives of different speeds. This means 1MB regions of highly active data are moved to faster media and 1MB regions of inactive data are migrated to slower media. When Adaptive Optimization is initially enabled, there is an initial adaption period during which all the data resides in the SAS tier, and some data is gradually migrated to SSD up to the point when the SSD space allocated for AO is full. At that point, a scheduled AO job runs to maintain the data across all tiers migrating some out and some in to the SSD, SAS, and NL (if present, and enabled) tiers.

The following chart shows the initial adaption process and demonstrates how the service times improve over the adaption process. The SAS tier must experience some amount of pressure in order to trigger adaptation. (If SAS performance is reasonable, the system doesn't need to migrate data to faster media.)

Figure 21 shows the improvement in service times (lower service time) as AO transitions data to the faster SSD tier. As service times decrease, the system is capable of servicing higher amounts of I/O and this corresponding increase in IOPS is observed in Figure 22.

Figure 21. Baseline AO test service times

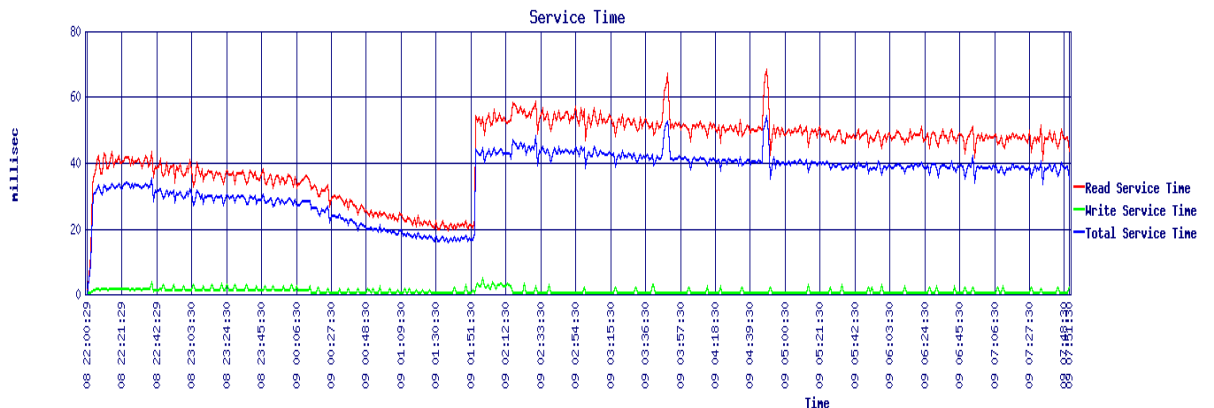


Figure 22. Measures IOPS with AO ramp up

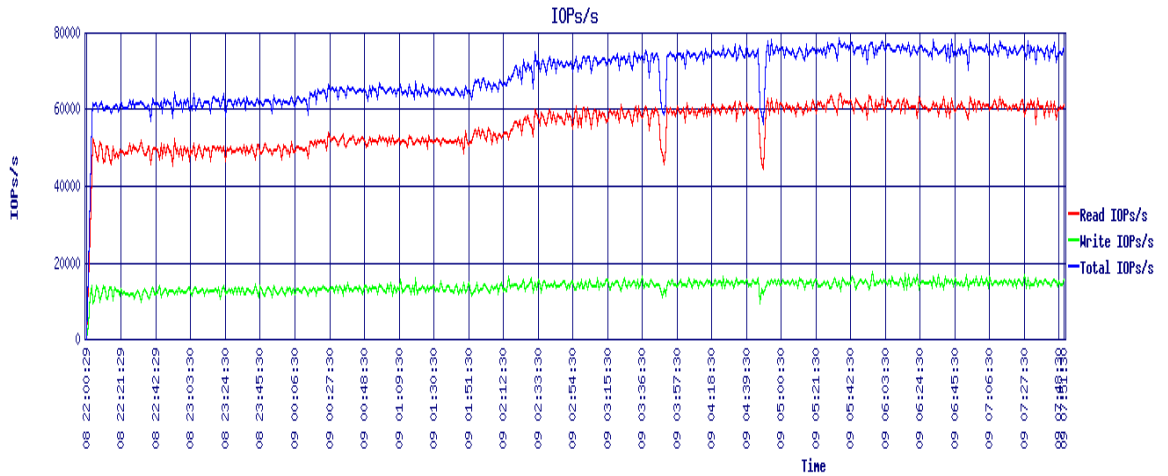
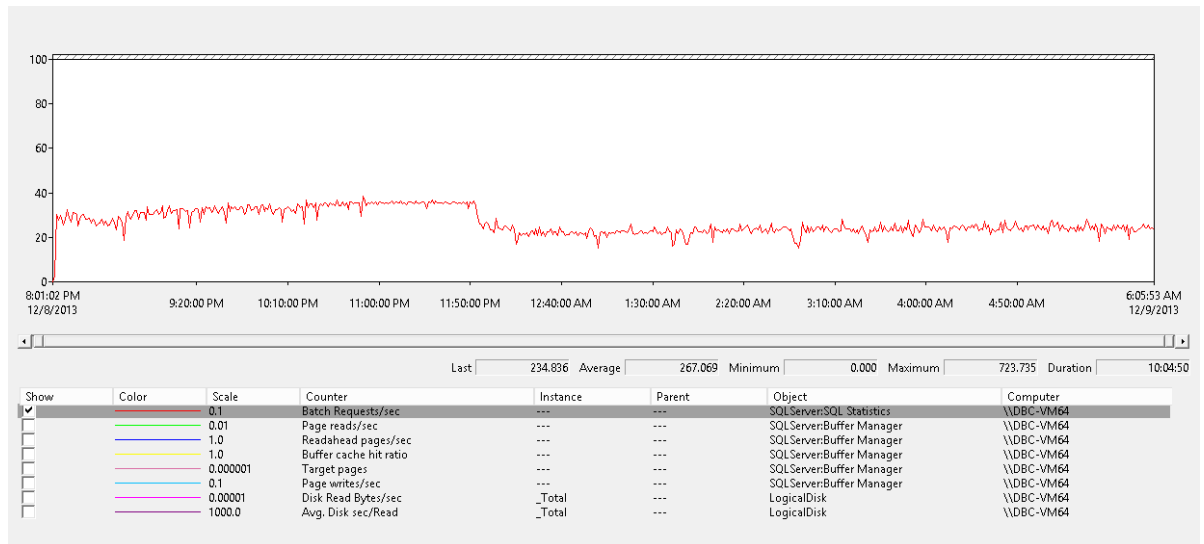


Figure 23. Transactional increase with AO



Combined database workload performance

The following test results show the achieved performance after AO was enabled and sufficient AO iterations populated the SSD tier with sub-LUN data regions. The data shows higher transactional rates and IOPS than the SAS tier limits.

Table 11. SQL server baseline (average performance for each database size segment)

| Database segment | Avg. Batch Request/s | Buffer Cache Hit Ratio | Avg. VM IOPS | Avg. VM CPU% |
|------------------|----------------------|------------------------|--------------|--------------|
| Small (144 VMs) | 55 | 99.3 | 313 | 10 |
| Medium (80 VMs) | 162 | 99.4 | 629 | 10 |
| Large (32 VMs) | 342 | 99.7 | 1,368 | 10 |

When the results are aggregated, the totals are shown in Table 12. Note that these numbers reflect ALL three database size segments running concurrently with AO as opposed to the baseline tests which were run in isolation. The workload user drive rates are also higher here as the system is capable of higher performance with AO enabled.

Table 12. SQL server baseline (total extrapolated performance for all database size segments)

| Database segment | Total Batch Request/s | Total VM IOPS | Latency |
|------------------|-----------------------|---------------|---------------------|
| Small (144 VMs) | 5,328 | 17K | 22ms |
| Medium (80 VMs) | 8,720 | 26K | 20ms |
| Large (32 VMs) | 9,136 | 24K | 20ms |
| Total | 23,184 | 67K | <21ms> |

Looking at the best performing of the three individual baselines, and comparing it with the concurrent and adaptive optimized run, we see the system being driven 80% more (transactions per second), and IOPS 33% higher. The SSD tier was used to its maximum capacity maximizing the use of resources.

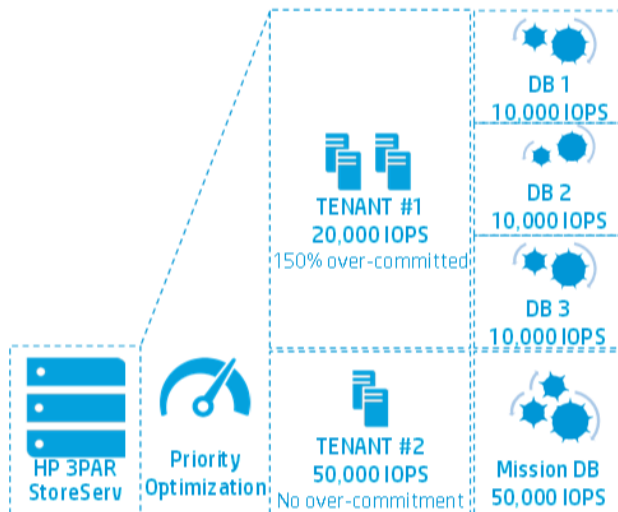
This result highlights the significant performance gains the system can achieve without expert tuning; rather, by efficiently leveraging all of the hardware resources. These gains were achieved under the sized configuration. Higher gains can be achieved by allocating higher memory to SQL instances, and increasing the capacity of the SSD drivers in tier 0.

Priority Optimization (QoS)

Priority Optimization is a licensable feature of the HP 3PAR StoreServ storage platform that allows setting limits on I/O operations and bandwidth. The use of QoS in a consolidated multi-host environment allows higher priority applications that are business critical maintain a level of performance even when lower priority applications experience storage resource surges.

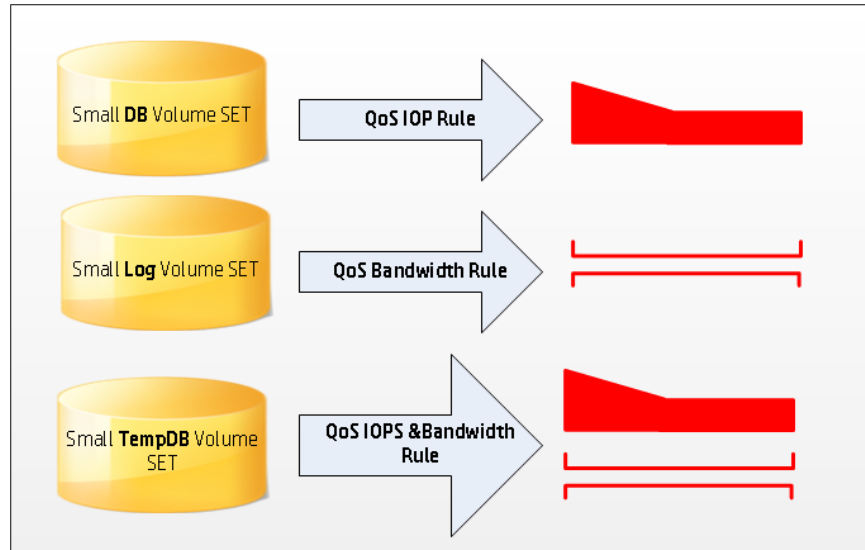
Priority Optimization provides the flexibility to define multiple rules that can result in I/O and bandwidth resource oversubscription without the risk of exceeding system limits. Figure 24 shows the flexibility that Priority Optimization can provide without exceeding system limits.

Figure 24. Priority Optimization overprovisioning through nested rules



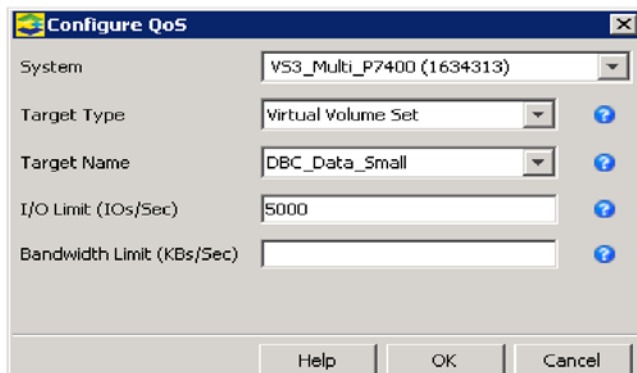
From a Microsoft SQL Server 2012 database perspective, we can see the benefit of establishing such limits on a volume set that hosts SQL data files, where an ad-hoc query can cause a large table scan. I/O bandwidth limits could also help minimize the impact of sequential I/O such as portions of SQL index maintenance jobs.

Figure 25. Uses of Priority Optimization with SQL Server 2012



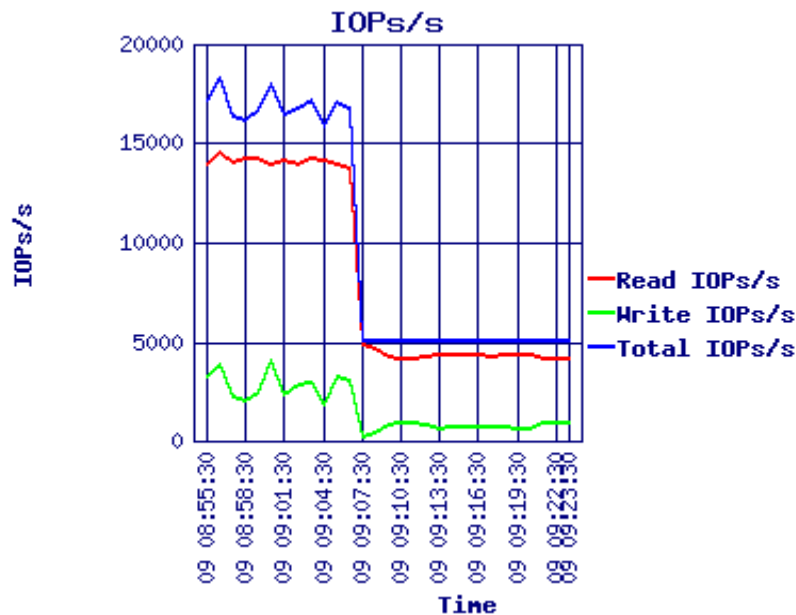
In this test we verified the ability of the HP ConvergedSystem 700x to limit I/O to 5K IOPS in a specific SAS tier volume set hosting SQL OLTP data files. A simple policy definition was enabled as shown in Figure 26.

Figure 26. Priority Optimization configuration



The immediate I/O limitation was observed on the running SQL workload as shown in Figure 27.

Figure 27. QoS IOPS



Testing summary

Tests show that the HP ConvergedSystem 700x platform is capable of performing well in a multi-host, multi-database environment. Response times were reasonable, and all workloads running AO adaptation worked well for database files as well as log files.

The data layout used is recommended for maximum flexibility. It allows for specific and granular AO and QoS rules, which maximizes performance and the use of storage resources with minimal administrative effort.

Sizing the storage subsystem depends on the I/O requirements and capacity requirements. I/O requirements will drive the number of SAS and SSD drives, while capacity requirements will drive the size of the drives. Choice of SSD size plays an important role in obtaining the most benefit from AO, so it is recommended to size that tier somewhere within 10-20 percent of the data file size, while keeping the number of drives such that the I/O capability of the SSD tier does not exceed 50% of the SAS tier capability.

Priority Optimization can be very effectively utilized to limit and prevent lower priority or secondary workloads from saturating the SAS tier (or SSD tier), during ad-hoc surges or maintenance jobs, etc. This guarantees a set number of IOPS and uniform response times for higher priority workloads, regardless of lower priority workload shifts.

Best practices for SQL consolidation

During the development and testing of the SQL Consolidation App Map, several best practices were developed and documented. These best practices should be used as guidelines when developing SQL based configurations or workloads for the HP ConvergedSystem 700x platform.

Reserve extra resources on each host blade – Some level of fault tolerance/HA should be built into any configuration to guard against unforeseen hardware or software problems. In order for blade hosts to absorb new VMs that were failed over from a failed host, adequate resources (CPU, memory etc.) must be available for those VMs to start and run. Depending on the level of HA required, up to 50% of total system resources may need to be available in case of single or multiple failures resulting in VM failover.

Create VVs large enough to hold all VHDx files – In the SQL Consolidation App Map, all operating system, database, and TempDB volumes are stored as VHDx files within the Windows 2012 operating system running on each host blade. A VHDx file is simply a container in which to put and grow files. A 200GB VHDx file, for example, could possibly contain only 500MB of data. While the 3PAR array will see that as 500MB of data, the Windows 2012 operating system will see the space taken up by the container file, the full 200GB. Windows 2012 Hyper-V **does not support** Dynamic disks for use in Cluster Shared Volumes, so the Windows Volumes holding the VHDx files **MUST** be sized properly to hold the full sizes of the VHDx files. If the volume runs out of space, the 3PAR Virtual Volume must be resized and the Windows Volume would need to be

extended. Since we use Thin Provisioning for all Virtual Volumes, create volumes that are larger than needed and monitor space on the array to ensure adequate space remains over time.

Size workloads for up to a 50/50 SAS/SSD I/O mix – When developing the workload for SQL consolidation, the rule of thumb is to keep the ratio of total IOPS to 50% or under for SSD media. When an array controller's microprocessors reach 100% of processing capability, they become bottlenecked, so as a best practice, customers should consult with their HP representative and have the array and solution sized for their workload. The solution will work best if the storage processors are not run to 100% of their capability, which may be different for each array configuration. SSD devices, with their higher IOPS capability, might cause array controllers to reach limitations sooner than SAS devices, as expected.

If, for example, the SQL consolidation workload has a target of 100,000 IOPS, it's best to ensure that during run time, your SSD drives are only generating up to 50K IOPS (50% of total). This brings into light the importance of modeling and testing any workload before placing into production.

Use separate storage resources for each type of VM – For our tested workload on the SQL Consolidation App Map, we employed 3PAR Adaptive Optimization (AO) technology to optimize data between the SAS and SSD tiers within the storage array. AO essentially moves data from one CPG on the SAS tier to another CPG sitting on the SSD tier. If we had set up single CPGs, we would not be able to dictate whether the data that AO moves belongs to small, medium, or large VMs. If we create separate CPGs for Small Compute Data, Large Compute Data, Medium Logs, etc., it allows us to control the type of data that will be moved by AO. Additional CPGs could also be created for servers that require a higher number of IOPS. These CPGs could then be assigned AO policies for optimization on higher performing SSD drives.

Use 3PAR Priority Optimization – In a consolidated SQL Server solution environment, use the HP 3PAR Priority Optimization (QoS) product to manage performance capabilities from the array. With HP 3PAR Priority Optimization, HP 3PAR StoreServ customers can protect their tenants and environments from unpredictable bursts of I/O and maintain predictable SLAs for multiple tenants. HP 3PAR Priority Optimization enables maximum performance thresholds for front-end IOPS or Bandwidth or both to be configured for application workloads via HP 3PAR Autonomic Groups. HP 3PAR Priority Optimization also allows customers to set latency goals for their tenants and workloads.

Test and profile all workloads before entering into production – One of the goals of this white paper was to present a tested solution that could be easily set up and deployed for SQL consolidation on the HP ConvergedSystem 700x platform. The workload presented here is an example of a single type of workload. Since there is a large diversity in the type and scope of workloads that could be deployed on this platform, there are no guarantees that a similar workload may perform at the same level or in the same fashion as this one. To that end, it's imperative that any new workload be modeled and profiled before being put into production. Many things can be uncovered during the testing:

- Too many IOPS being serviced by SSD
- Storage volumes for the database VHDs are too small
- VMs do not have enough memory for the workload

During our testing of the SQL Consolidation App Map, several things were adjusted as a result of running a simulated workload against it.

Order and build process

Overview

The SQL Consolidation App Map is an App Map that allows some leeway in the customization (disk drive quantities, additional management servers, additional hosts, etc.) of an ordered HP ConvergedSystem 700x configuration. The part numbers for the HP ConvergedSystem 700x in the BOMs below, include a number of configuration and integration services:

- **Factory Express Level 5 Integration** – Includes an assigned project manager to help lay out power, cooling and space requirements. Additionally all racking, cabling, and hardware integration is performed at the factory.
- **Onsite Startup and Integration** – This includes validation of the HP ConvergedSystem 700x for Microsoft as well as configuration of the 3PAR storage array (basic setup only)
- **HP ConvergedSystem 700x for Microsoft Deployment Accelerator Service** – This includes a number of integration services:
 - Connection of the HP ConvergedSystem 700x into the customer environment
 - Setup and Configuration of the Compute Clusters
 - Configuration of the System Center 2012 Datacenter SP1 components
 - Basic Validation of the Microsoft Private Cloud Environment
 - Delivery of an as-built document to the customer

For more information on the Factory Express Service, please visit:
hp.com/go/factoryexpress

Additional services

Additional custom services are available for the HP ConvergedSystem 700x, from workload modeling, configuration, consolidation assistance, to full scale SQL Server consolidation. More information is available on the HP services website:
<http://www8.hp.com/us/en/business-services/index.html>

Bill of materials

The tables below represent the bill of materials for the server, storage, and switching components of the SQL Consolidation App Maps, including the Large SQL Consolidation App Map that was tested for this white paper. Keep in mind that the performance represented in this white paper is valid only for the large configuration below.

Note

Part numbers are at time of publication and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your HP Reseller or HP Sales Representative for more details. hp.com/large/contact/enterprise/index.html

Note

The HP ConvergedSystem 700x for Microsoft solution SKU does *not* contain the necessary licenses for Windows Server 2012 Datacenter and System Center 2012 Datacenter SP1. Customers that have ELAs (Enterprise License Agreements) covering Windows Server 2012 Datacenter and System Center 2012 Datacenter SP1 are not required to purchase these licenses from HP. For customers that do not have these licenses they can be purchased from HP as an addendum to the order.

HP ConvergedSystem 700x for Microsoft is an orderable SKU which may reflect additional parts if needed based on the HP customer operational environment. The configurations used for these App Maps are:

Small SQL Consolidation App Map bill of materials

- HP ConvergedSystem 700x for Microsoft 727177-B21
- One (1) HP 42U 1075mm i-Series Shock Rack
 - Six (6) HP Intelligent Mod PDU
 - Six (6) HP 5xC13 Intelligent PDU Ext Bars G2 Kit (pair)
 - HP Intelligent Mod PDU 24a Na/Jpn Core
 - HP Custom Rack Door Branding Kit
 - HP 42U Location Discovery Kit
 - HP Rack Grounding Kit
 - HP Air Flow Optimization Kit
- One (1) HP BLc7000 3 IN LCD ROHS Enclosure (virtualization host)
 - HP BLc7000 10K Rack Ship Brkt Opt Kit
 - One (1) HP 6X 2400W Platinum Efficiency FIO Power Supply bundle
 - One (1) 6x HP Active Cool 2000 Fan Bundle
 - Two (2) HP c7000 Onboard Administrator with KVM Option
 - Four (4) HP Virtual Connect FlexFabric 10Gb/24-Port Module
- Four (4) HP ProLiant BL460c Gen8 Server, each with:
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - Sixteen (16) HP 16GB 2Rx4 PC3L-12800R-11 Kit (256 GB of memory)
 - Two (2) 300GB 6G SAS 15K rpm SFF SC Enterprise Hard Drive
 - One (1) HP FlexFabric 10Gb 2P 554FLB FIO Adapter
 - One (1) HP FlexFabric 10Gb 2P 554M Adptr

- Two (2) HP ProLiant DL360p Gen8 Server (Management Station), each with:
 - Eight (8) HP 32GB 4Rx4 PC3-14900R-13 (256GB memory)
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - One (1) HP 2GB Flash Backed Write Cache for P-Series Smart Array
 - Eight (8) HP 300GB 15K 6G SAS SFF
 - Two (2) HP 750W CS Platinum Power Supply Kit
 - One (1) HP 82Q 8Gb Dual Port PCI-e FC HBA
 - One (1) HP FlexFabric 10Gb 554FLR-SFP+ FIO Adapter
 - One (1) HP 9.5mm SATA DVD ROM Jb Kit
- HP StoreServ 3PAR 7400 2 Node
 - HP 3PAR 7000 Service Processor
 - HP 3PAR StoreServ 7400 2-N Storage Base
 - Two (2) HP 3PAR 7000 4-pt 8Gb/s FC Adapter
 - Sixty Four (64) HP M6710 300GB 6G SAS 15K 2.5in HDD
 - Eight (8) HP M6720 200GB 6G 2.5in SSD
 - One (1) HP 3PAR 7400 Reporting Suite LTU
 - One (1) HP 3PAR 7400 OS Suite Base LTU
 - (72) HP 3PAR 7400 OS Suite Drive LTU
 - (72) HP 3PAR 7400 Virtual Copy Drive LTU
 - Three (3) M6710 2.5in 2U SAS Drive Enclosures
 - One (1) HP 3PAR 7400 Reporting Suite LTU Supp
- Two (2) HP 5920AF-24XG Switch
- Two (2) HP 5120-24G EI Switch with 2 Slots
- Two (2) HP SN3000B 24-port FC switches
- Two (2) Integrate Lights-Out 4 Standard Edition
- HP Proactive Care 6hr CTR HP, plus Proactive Select 30 Service Credits
- HP Factory Express Integration Services plus Installation and Startup
- One (1) HP Insight Control v7.2 Enc FIO Bundle 16 License (per enclosure)
- Two (2) Insight Control v7 ML/DL/BL FIO Bundle License
- HP Proactive Care provides a single source support for the complete HP ConvergedSystem 700x, including the Microsoft OS and application software.
- HP ConvergedSystem 700x for Microsoft Deployment Accelerator Service to integrate and install the Microsoft Private Cloud management software and deliver a certified and compliant Microsoft Fast Track Private Cloud solution.

Medium SQL Consolidation App Map bill of materials

- HP ConvergedSystem 700x for Microsoft 727177-B21
- One (1) HP 42U 1075mm i-Series Shock Rack
 - Six (6) HP Intelligent Mod PDU
 - Six (6) HP 5xC13 Intelligent PDU Ext Bars G2 Kit (pair)
 - HP Intelligent Mod PDU 24a Na/Jpn Core
 - HP Custom Rack Door Branding Kit
 - HP 42U Location Discovery Kit
 - HP Rack Grounding Kit
 - HP Air Flow Optimization Kit
- One (1) HP BLc7000 3 IN LCD ROHS Enclosure (virtualization host)
 - HP BLc7000 10K Rack Ship Brkt Opt Kit
 - One (1) HP 6X 2400W Platinum Efficiency FIO Power Supply bundle
 - One (1) 6x HP Active Cool 2000 Fan Bundle

- Two (2) HP c7000 Onboard Administrator with KVM Option
- Four (4) HP Virtual Connect FlexFabric 10Gb/24-Port Module
- Eight (8) HP ProLiant BL460c Gen8 Server, each with:
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - Sixteen (16) HP 16GB 2Rx4 PC3L-12800R-11 Kit (256 GB of memory)
 - Two (2) 300GB 6G SAS 15K rpm SFF SC Enterprise Hard Drive
 - One (1) HP FlexFabric 10Gb 2P 554FLB FIO Adapter
 - One (1) HP FlexFabric 10Gb 2P 554M Adptr
- Two (2) HP ProLiant DL360p Gen8 Server (Management Station), each with:
 - Eight (8) HP 32GB 4Rx4 PC3-14900R-13 (256GB memory)
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - One (1) HP 2GB Flash Backed Write Cache for P-Series Smart Array
 - Eight (8) HP 300GB 15K 6G SAS SFF
 - Two (2) HP 750W CS Platinum Power Supply Kit
 - One (1) HP 82Q 8Gb Dual Port PCI-e FC HBA
 - One (1) HP FlexFabric 10Gb 554FLR-SFP+ FIO Adapter
 - One (1) HP 9.5mm SATA DVD ROM Jb Kit
- HP StoreServ 3PAR 7400 4 Node
 - HP 3PAR 7000 Service Processor
 - HP 3PAR StoreServ 7400 4-N Storage Base
 - Four (4) HP 3PAR 7000 4-pt 8Gb/s FC Adapter
 - One Hundred Twenty Eight (128) HP M6710 300GB 6G SAS 15K 2.5in HDD
 - Sixteen (16) HP M6720 200GB 6G 2.5in SSD
 - One (1) HP 3PAR 7400 Reporting Suite LTU
 - One (1) HP 3PAR 7400 OS Suite Base LTU
 - (144) HP 3PAR 7400 OS Suite Drive LTU
 - (144) HP 3PAR 7400 Virtual Copy Drive LTU
 - Six (6) M6710 2.5in 2U SAS Drive Enclosures
 - One (1) HP 3PAR 7400 Reporting Suite LTU Supp
- Two (2) HP 5920AF-24XG Switch
- Two (2) HP 5120-24G EI Switch with 2 Slots
- Two (2) HP SN3000B 24-port FC switches
- Two (2) Integrate Lights-Out 4 Standard Edition
- HP Proactive Care 6hr CTR HP, plus Proactive Select 30 Service Credits
- HP Factory Express Integration Services plus Installation and Startup
- One (1) HP Insight Control v7.2 Enc FIO Bundle 16 License (per enclosure)
- Two (2) Insight Control v7 ML/DL/BL FIO Bundle License
- HP Proactive Care provides a single source support for the complete HP ConvergedSystem 700x, including the Microsoft OS and application software.
- HP ConvergedSystem 700x for Microsoft Deployment Accelerator Service to integrate and install the Microsoft Private Cloud management software and deliver a certified and compliant Microsoft Fast Track Private Cloud solution.

Large SQL Consolidation App Map bill of materials

- HP ConvergedSystem 700x for Microsoft 727177-B21
- Two (2) HP 42U 1075mm i-Series Shock Rack, each with:
 - Six (6) HP Intelligent Mod PDU
 - Six (6) HP 5xC13 Intelligent PDU Ext Bars G2 Kit (pair)
 - HP Intelligent Mod PDU 24a Na/Jpn Core
 - HP Custom Rack Door Branding Kit
 - HP 42U Location Discovery Kit

- HP Rack Grounding Kit
- HP Air Flow Optimization Kit
- Two (2) HP BLc7000 3 IN LCD ROHS Enclosures (virtualization host), each with:
 - HP BLc7000 10K Rack Ship Brkt Opt Kit
 - One (1) HP 6X 2400W Platinum Efficiency FIO Power Supply bundle
 - One (1) 6x HP Active Cool 2000 Fan Bundle
 - Two (2) HP c7000 Onboard Administrator with KVM Option
 - Four (4) HP Virtual Connect FlexFabric 10Gb/24-Port Module
- Sixteen (16) HP ProLiant BL460c Gen8 Server, each with:
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - Sixteen (16) HP 16GB 2Rx4 PC3L-12800R-11 Kit (256 GB of memory)
 - Two (2) 300GB 6G SAS 15K rpm SFF SC Enterprise Hard Drive
 - One (1) HP FlexFabric 10Gb 2P 554FLB FIO Adapter
 - One (1) HP FlexFabric 10Gb 2P 554M Adptr
- Two (2) HP ProLiant DL360p Gen8 Server (Management Station), each with:
 - Eight (8) HP 32GB 4Rx4 PC3-14900R-13 (256GB memory)
 - Two (2) Intel Xeon E5-2690 v2 (3.0GHz/10-core/25MB /130W)
 - One (1) HP 2GB Flash Backed Write Cache for P-Series Smart Array
 - Eight (8) HP 300GB 15K 6G SAS SFF
 - Two (2) HP 750W CS Platinum Power Supply Kit
 - One (1) HP 82Q 8Gb Dual Port PCI-e FC HBA
 - One (1) HP FlexFabric 10Gb 554FLR-SFP+ FIO Adapter
 - One (1) HP 9.5mm SATA DVD ROM Jb Kit
- HP StoreServ 3PAR 7400 4 Node
 - HP 3PAR 7000 Service Processor
 - HP 3PAR StoreServ 7400 4-N Storage Base
 - Four (4) HP 3PAR 7000 4-pt 8Gb/s FC Adapter
 - Two Hundred Forty (240) HP M6710 300GB 6G SAS 15K 2.5in HDD
 - Thirty Two (32) HP M6720 200GB 6G 2.5in SSD
 - One (1) HP 3PAR 7400 Reporting Suite LTU
 - One (1) HP 3PAR 7400 OS Suite Base LTU
 - (168) HP 3PAR 7400 OS Suite Drive LTU
 - (168) HP 3PAR 7400 Virtual Copy Drive LTU
 - Ten (10) P M6710 2.5in 2U SAS Drive Enclosures
 - One (1) HP 3PAR 7400 Reporting Suite LTU Supp
- Two (2) HP 5920AF-24XG Switch
- Two (2) HP 5120-24G EI Switch with 2 Slots
- Two (2) HP SN6000B 48-port FC switches
- Two (2) Integrate Lights-Out 4 Standard Edition
- HP Proactive Care 6hr CTR HP, plus Proactive Select 30 Service Credits
- HP Factory Express Integration Services plus Installation and Startup
- One (1) HP Insight Control v7.2 Enc FIO Bundle 16 License (per enclosure)
- Two (2) Insight Control v7 ML/DL/BL FIO Bundle License
- HP Proactive Care provides a single source support for the complete HP ConvergedSystem 700x, including the Microsoft OS and application software.
- HP ConvergedSystem 700x for Microsoft Deployment Accelerator Service to integrate and install the Microsoft Private Cloud management software and deliver a certified and compliant Microsoft Fast Track Private Cloud solution. Deployment process

Deployment process

After the onsite setup of the HP ConvergedSystem 700x is complete, there are a number of steps that have to be undertaken to complete the configuration of the SQL Consolidation App Map. Below is a high level outline of the necessary planning and configuration tasks to configure the App Map on the HP ConvergedSystem 700x platform.

1. **Perform an assessment of servers to be consolidated** – The first step in developing any consolidation architecture is to assess your current environment, identify servers for consolidation, and then determine how many virtual servers would be needed. The “Microsoft Assessment and Planning” (MAP) tool is free and can be very useful in performing an initial assessment. More information on the MAP tool can be found in the Appendix of this document.
2. **Develop VM configurations** – After performing an initial assessment of the SQL database servers that will be consolidated or deployed onto the HP ConvergedSystem 700x, the next step is to determine the sizing of the SQL server virtual machines and the workload mix. The “Configuration guidance” section of this document provides information on determining these parameters.
3. **Develop storage layout** – Once the VM storage requirements are determined, the next step is to develop the storage architecture. This involves determining the CPGs and Virtual Volumes required for each cluster, as well as a strategy for using Clustered Shared Volumes to store operating system and database related VHDs. More details on the storage architecture used for our tested configuration can be found in the “Configuration guidance” section of this document.
4. **VM image development** – Once the VM and storage architectures are complete, the final step before deployment is to develop a “Gold Image” for the virtual machines. A Gold Image is basically a virtual machine template image that is used to provision new virtual servers. The image contains all the necessary operating system files, along with additional software such as Microsoft SQL Server 2012.
5. **VM deployment** – There are several methods used to deploy the virtual machine gold image across the HP ConvergedSystem 700x. An overview of the process that was used for our tested configuration is given below.

VM deployment

Virtual machines were deployed on each Host server using a virtual machine operating system template. The template is comprised of a VHDx file containing a Microsoft Sysprep-ed install of Windows Server 2012. Using an unattended .ini file, the operating system is automatically customized during initial virtual machine startup. Additionally, a sysprep-ed version of SQL Server 2012 is installed in the OS image. The SQL server installation was built using the “/PrepareImage” parameter which dictates the use of the “/CompleteImage” parameter during the VMs unattended install of the operating system. Below is a summary overview of the steps that were used to deploy the VMs for each blade server:

1. Copy Template VHDx files for OS, SQL Database, TempDB, etc. to the location on the CSVs where they will reside.
2. Create the new VM, and assign resources based on the VM sizes (S, M, L), and attach the Template VHDx files that were copied in Step 1. Ensure that the VMs core files and snapshot location is set to a CSV for failover.
3. Set up a network adapter for the VM and connect to the Hyper-V guest switch for network connectivity.
4. Start the VM to initiate the unattended install process.
5. The unattended process configures unique settings for each server, such as IP address, hostname, etc., then joins the Windows domain and completes the SQL server installation, setting it up as a unique SQL server within the environment

These steps can be automated and performed by the use of Windows PowerShell scripts, or one could use a more robust, full featured tool such as Microsoft System Center Virtual Machine Manager.

More information on Microsoft System Center can be found at:
microsoft.com/systemcenter

Summary

Addressing common IT problems such as data management and sprawl requires a robust, flexible and scalable platform such as the HP ConvergedSystem 700x. The SQL Consolidation App Map depicted in this white paper provides an example of an easily deployable solution for consolidation of database servers running line of business applications, departmental data stores and other database servers across the enterprise.

Using Microsoft SQL Server 2012 virtual machines within a Microsoft Windows 2012 Hyper-V virtualization framework provides unpatrolled capability for consolidating physical servers into easily deployed and managed virtual machines. Coupled with robust management tools such as HP Insight Control and Microsoft System Center 2012, the HP ConvergedSystem 700x provides not only a best in class data consolidation platform, but a robust foundation for all cloud computing needs within the enterprise.

Implementing a proof-of-concept

As a matter of best practice for all deployments, HP recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an HP Services representative hp.com/large/contact/enterprise/index.html or your HP partner.

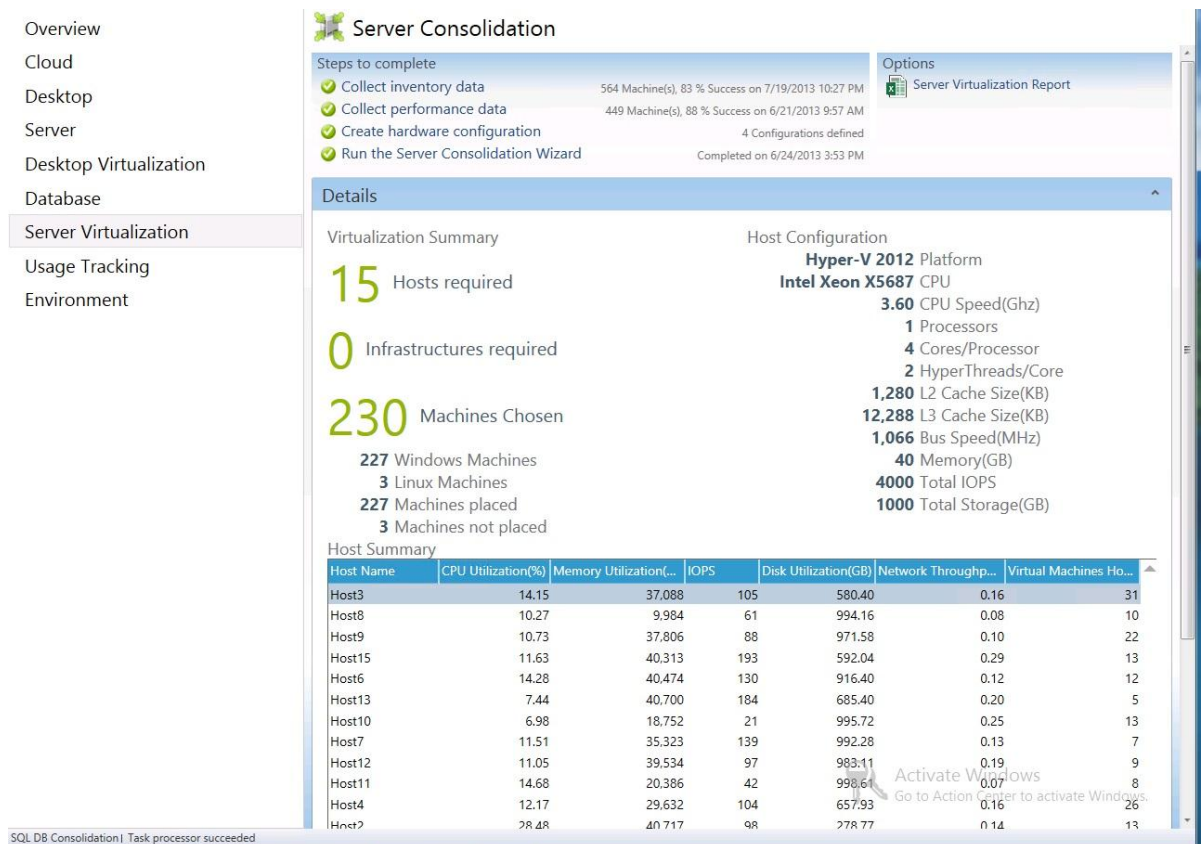
Appendix: Assessment and planning

Before embarking on any SQL consolidation effort, an assessment and planning phase is undertaken. The goal of the assessment phase is to identify the servers that are candidates for consolidation, the resource requirements for those servers, how many Virtual Host servers are required to host them, etc. For environments with a large or even moderate amount of SQL servers to survey, this can be a daunting task. There are many tools that provide this capability, but one of the best freely available tools is the Microsoft Assessment and Planning (MAP) toolkit. The toolkit, which is designed to detect and survey database servers running many different versions of SQL Server and others, is an agentless tool, that searches the network for SQL servers, and reports the following:

- Which database instances are suitable candidates for consolidation and into which SQL Consolidation App Map category do they fit (S, M, L)?
- How many host servers would be required to host them?
- Which host servers would be the best one to host a particular database (based on resource algorithms, etc.)?
- How many racks, hosts, etc. are required?
- What are the storage requirements?

Figure A-1 below shows a summary of an inventory assessment report generated by the map tool.

Figure A-1. Microsoft MAP tool assessment summary



The assessment tool also generates reports of suggested consolidation architectures, detailing the layout of the virtual host servers based on the performance parameters acquired during the inventory. The report also details the required hardware specifications for the host servers based on the VMs that it will host. Figure A-2 shows an example server consolidation report generated by the tool.

Figure A-2. Microsoft MAP tool SQL categorization report

| Server Consolidation Report | | | | | | | |
|---|------------------------------------|---|---------------------|-------------------------|-----------------------------|-----------------------------|----------------------------|
| This report provides recommendations for consolidation of the specified set of machines onto Hosts (configuration details available in the Host Machine Details Report) along with the projected utilization details after consolidation. | | | | | | | |
| Host | Virtual Machine Name | Guest Operating System | CPU Utilization (%) | Memory Utilization (MB) | Disk I/O Utilization (IOPS) | Disk Space Utilization (GB) | Network Utilization (MB/s) |
| Host1 | --Total-- | N/A | 11.7 | 40522.08 | 107.32 | 719.67 | 1.09 |
| Host1 | POM-3SP07SM5S-1.WA.USA.CONTOSO.COM | Microsoft(R) Windows(R) Server 2003, Standard Edition | 1.07 | 1098.13 | 5.28 | 8.3 | 0 |
| Host1 | POM-3SQL08EM-01.WA.USA.CONTOSO.COM | Microsoft(R) Windows(R) Server 2003, Enterprise Edition | 0.31 | 634.94 | 5.43 | 18.1 | 0 |
| Host1 | pom-3v3w-sp1-01.WA.USA.CONTOSO.COM | Microsoft(R) Windows(R) Server 2003, Web Edition | 0.02 | 269.18 | 0.66 | 2.89 | 0 |
| Host1 | POM-3V8E-01.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.06 | 642.12 | 0.84 | 11.13 | 0 |
| Host1 | POM-3V8E-02.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.07 | 534.31 | 0.98 | 11.21 | 0 |
| Host1 | POM-3V8E-DCMT-1.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.13 | 547.38 | 2.12 | 14.97 | 0.01 |
| Host1 | POM-3V8E-DCWA-1.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.16 | 745.83 | 2.46 | 15.23 | 0.01 |
| Host1 | POM-3V8E-SP1-1.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.05 | 506.55 | 0.88 | 8.06 | 0 |
| Host1 | POM-3V8E-DCBM-1.CONTOSO.COM | Microsoft® Windows Server® 2008 Standard | 0.09 | 646.05 | 2.21 | 13.18 | 0.01 |
| Host1 | POM-3V8E-SP1-01.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Standard | 0.03 | 413.56 | 0.31 | 10.13 | 0 |
| Host1 | POM-3V8E-SP1-02.WA.USA.CONTOSO.COM | Microsoft® Windows Server® 2008 Standard | 0.04 | 414 | 0.81 | 10.05 | 0 |
| Host1 | POM-3V8E-F011-1 | Fedora release 11 (Leonidas) | 0.02 | 489.37 | 0.29 | 12.8 | 0 |
| Host1 | POM-6H8C-HV8-1.CONTOSO.COM | Microsoft® Windows Server® 2008 Enterprise | 0.52 | 11580.6 | 5.91 | 103.75 | 0.17 |
| Host1 | POM-6H8D-HVR-03.CONTOSO.COM | Microsoft Windows Server 2008 R2 Datacenter | 0.27 | 2926.09 | 2.79 | 190.06 | 0.06 |
| Host1 | POM-6H8D-HVR-04.CONTOSO.COM | Microsoft Windows Server 2008 R2 Datacenter | 0.55 | 3373.42 | 4.74 | 63.36 | 0.33 |
| Host1 | POM-6SCV-12IN- | Microsoft Windows Server 2012 | 1.45 | 3305.32 | 16.45 | 34.58 | 0.23 |

One of the more challenging tasks of database consolidation is determining the optimal host for running various databases. Using these reports can help you better size your host blades and determine database placement to ensure a balanced platform.

More detailed information on the Microsoft Assessment and Planning tool and the free software download is available at: <http://technet.microsoft.com/en-us/solutionaccelerators/dd537566.aspx>

For more information

HP ConvergedSystem 700x for Virtualization, hp.com/go/convergedsystem/cs700x

HP ConvergedSystem 700, hp.com/go/convergedsystem/cs700virt

HP ActiveAnswers, hp.com/solutions/activeanswers

HP ActiveAnswers for Microsoft SQL Server solutions, hp.com/solutions/activeanswers/microsoft/sql

HP and Microsoft, hp.com/go/microsoft

HP ProLiant DL360p Gen8 server, hp.com/servers/dl360

HP 3PAR StoreServ storage, hp.com/go/3par

HP Networking, hp.com/go/networking

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