SAP® Sybase® Adaptive Server Enterprise on VMware vSphere®

Essential Deployment Tips

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White paper

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Introduction

With the trend towards large logical CPU and high memory systems at cost-effective prices, more and more SAP customers are looking to deploy their production databases on VMware vSphere®. However, there is a perception that mission-critical, high-performance online transaction processing databases suffer performance penalties when virtualized.

VMware, in cooperation with SAP, conducted several extensive tests to compare the performance of SAP® Sybase® Adaptive Server® Enterprise (SAP Sybase ASE), version 15.7 running on VMware vSphere 5.0®, versus directly on native hardware. The results showed that throughput on the high-transaction OLTP database SAP Sybase ASE, running in a virtual machine, often matched that of an identical physical system.

Once the performance myths are dispelled, the next questions are typically centered around support, such as "Is the database supported once it is virtualized?" and "Do I have to reproduce issues on physical hardware?" SAP fully supports and certifies SAP Sybase ASE running on VMware vSphere, and customers will not be required to reproduce issues on native hardware.

With the performance and support barriers removed, database administrators can focus on delivering ROI to the enterprise by leveraging the benefits of running SAP Sybase ASE on VMware vSphere.

This paper describes the advantages and technical considerations for running SAP Sybase ASE on the VMware vSphere platform. This document is written for architects and engineers who are responsible for SAP Sybase ASE and VMware virtualized environments. This paper assumes that the reader has basic knowledge of SAP database products and the VMware vSphere virtualization platform.

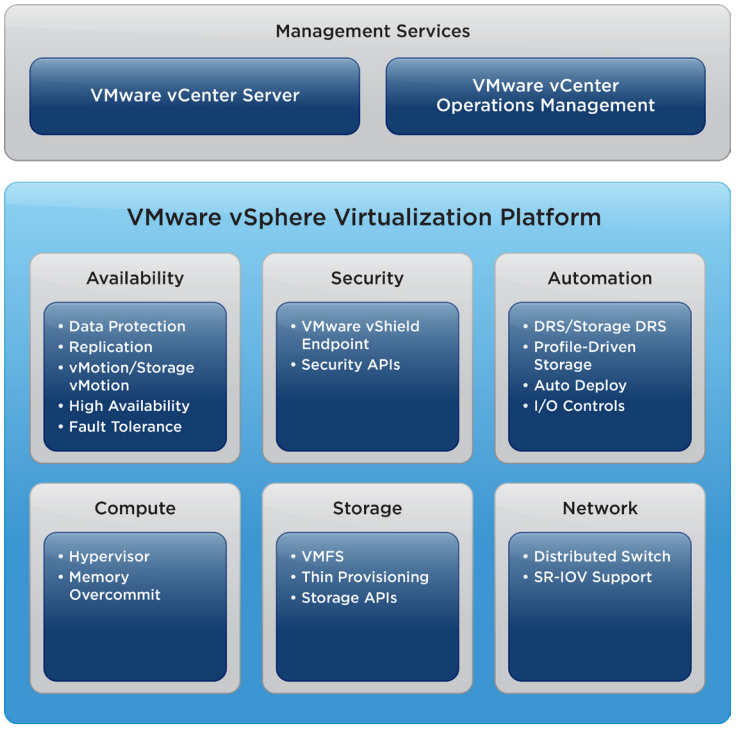
VMware vSphere

VMware vSphere is an optimal virtualization platform and enabler for cloud computing architectures. vSphere enables IT to meet service-level agreements (SLAs) for the most demanding business-critical applications at the lowest total cost of ownership (TCO). VMware vSphere delivers control over all IT resources with the highest efficiency and choice in the industry, as shown in Figure 1.

vSphere transforms industry-standard hardware into a shared, mainframe-like resilient environment with built-in service-level controls for all applications. vSphere virtualization and cloud computing solutions provide for:

- **Consolidation**. VMware virtualization allows multiple application servers to be consolidated onto one physical server, with little or no decrease in overall performance. This helps minimize or eliminate underutilized server hardware, software, and infrastructure.
- **Manageability**. The live migration of virtual machines from server to server and its associated storage is performed with no downtime using VMware vSphere® vMotion® and VMware vSphere® Storage vMotion®.

Figure 1. VMware vSphere



- **Automation**. VMware automated load balancing takes advantage of vMotion and Storage vMotion to migrate virtual machines among a set of VMware® ESXi™ hosts. VMware vSphere® Distributed Resource Scheduler™ (DRS) and VMware vSphere® Storage DRS™ enable automatic resource relocation and optimization decisions for virtual machines and storage.
- **Availability**. High availability can be enabled to reduce unplanned downtime and support higher service levels for applications. VMware vSphere® High Availability (HA) ensures that, in the event of an unplanned hardware failure, the affected virtual machines are automatically restarted on another host in a VMware cluster.

For more information about vSphere, see the "Resources" section later in this paper.

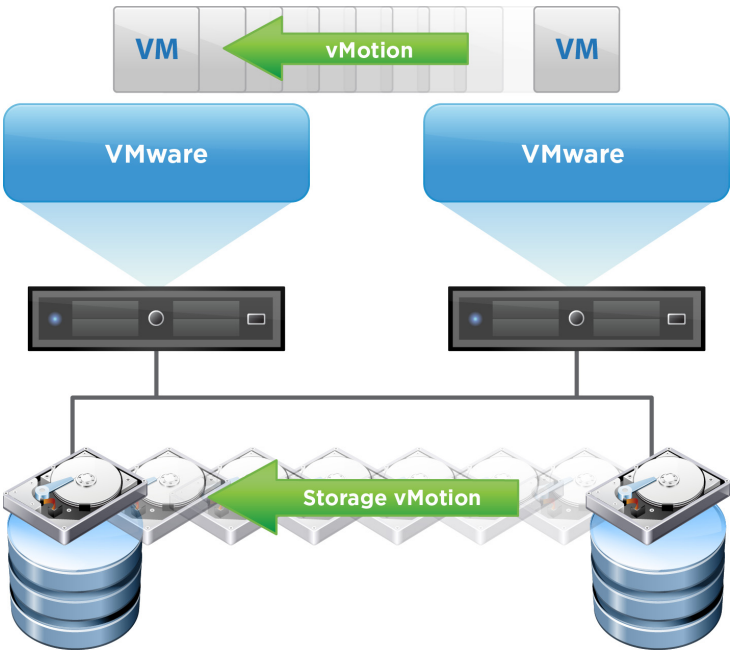
In addition, VMware vSphere advanced features increase availability and automation and improve the manageability of SAP Sybase ASE. The advanced features used in the SAP Sybase ASE solution described in this paper include VMware vMotion, Storage vMotion, Distributed Resource Scheduler (DRS), and Storage DRS. Each of these features is described in the sections below.

VMware vMotion and Storage vMotion

Together, VMware vMotion and Storage vMotion provide for the complete virtualization of servers, storage, and networking in order to move an entire virtual machine running SAP Sybase ASE instantaneously, from one physical server to another. The virtual machine retains its network identity and connections, ensuring a seamless migration process.

In addition, VMware vSphere 5.1 enables a virtual machine to change its datastore and host simultaneously, even when the hosts do not have a shared storage environment. It allows virtual machine migration between clusters in a larger datacenter that might not have a common set of datastores between them. vSphere also allows virtual machine migration in small environments without requiring access to expensive, shared storage equipment, as shown below.

Figure 2. VMware vMotion and Storage vMotion



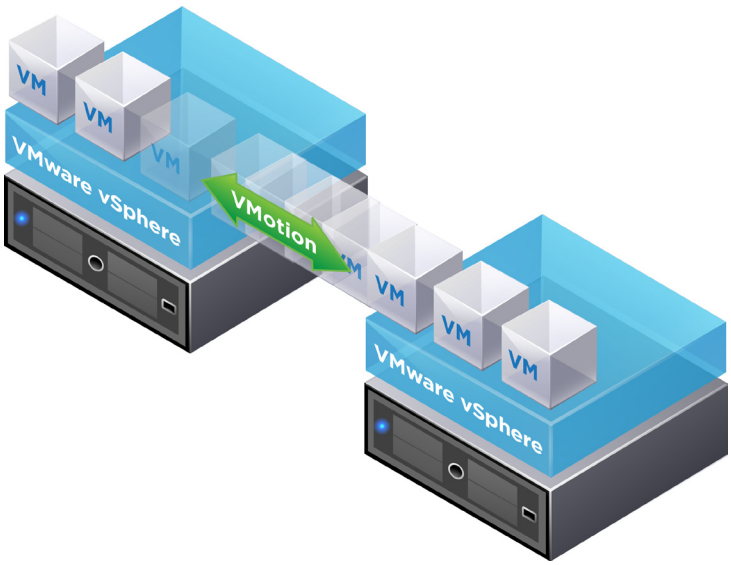
vSphere 5.1 allows vMotion and Storage vMotion to be combined into one process. This combined migration copies both the virtual machine memory and its disk over the network to the destination host. After the memory and disk data are sent over, the destination virtual machine resumes and the source virtual machine is powered off.

Each of these vSphere advanced features is described in the sections below.

VMware vMotion

VMware vMotion enables the live migration of virtual machines running SAP Sybase ASE from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. vMotion is a key enabling technology for creating the dynamic, automated, and self-optimizing data center. This capability makes hardware maintenance possible at any time, and vMotion does not require clustering or redundant servers, as shown below.

Figure 3. VMware vMotion



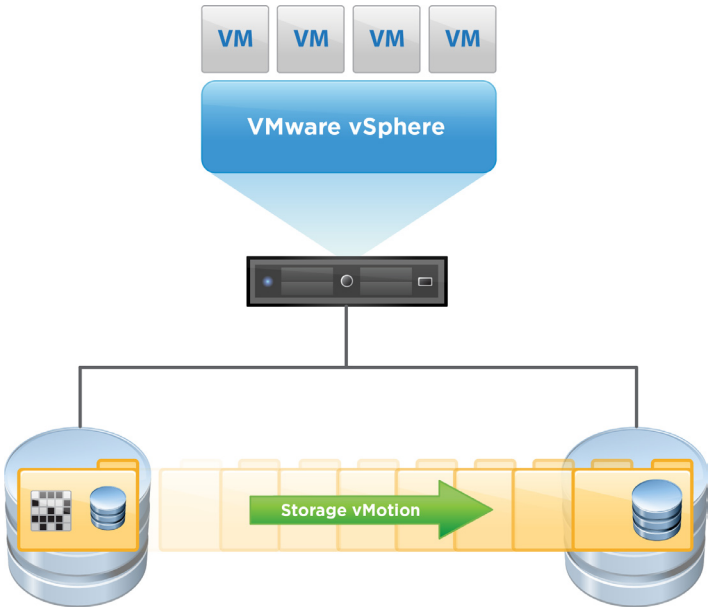
VMware vMotion:

- Moves entire running virtual machines instantly. Performs live migrations with zero downtime, undetectable to the user.
- Manages and schedules live migrations with ease at predefined times without an administrator's presence, with the reliability and manageability that is derived from a production-proven product.
- Performs multiple concurrent migrations of a virtual machine running any operating system, across any type of hardware and storage that is supported by vSphere, complete with an audit trail.
- Moves online workloads from one ESXi™ Server host machine to another in order to maintain service levels and performance goals.
- Continuously and automatically optimizes virtual machine placement within resource pools. Proactively moves virtual machines away from failing or underperforming servers.
- Performs hardware maintenance without the need to schedule downtime and disrupt business operations.

VMware Storage vMotion

Storage vMotion enables the live migration of virtual machine disk files within and across storage arrays, and it provides for automated storage management. Storage vMotion relocates disk files of virtual machines running on SAP Sybase ASE, while maintaining continuous service availability and complete transaction integrity, as shown below.

Figure 4. VMware Storage vMotion



vSphere Storage vMotion:

- Enables the live, automated migration of virtual machine disk files from existing storage to different classes of tiered storage with zero downtime.
- Migrates virtual machines running any supported operating system on any supported server hardware based on usage and priority policies for tiered storage.
- Performs live migration of virtual machine disk files across any Fibre Channel, Internet Small Computer System Interface (iSCSI), Fibre Channel over Ethernet (FCoE), and Network File System (NFS) storage system supported by vSphere.
- Dynamically optimizes storage I/O performance by moving virtual machine disk files to alternative LUNs that deliver the required performance without scheduled downtime.
- Eliminates over-allocation of storage resources in order to proactively deal with I/O bottlenecks.
- Efficiently manages storage capacity and utilization by reclaiming unused or "stranded" storage capacity and allocating it to other virtual machines.
- Moves virtual machines with higher performance needs or critical workloads to larger capacity storage LUNs as virtual machine disk files approach their total available LUN size limits.

VMware Distributed Resource Scheduler (DRS) and Storage DRS

VMware Distributed Resource Scheduler aligns resource usage with business priority by enabling automated load balancing across hosts, and optimizes power consumption by turning off hosts during lower load periods. Similarly, VMware Storage DRS enables ongoing load balancing between datastores to optimize the use of storage resources, and to avoid bottlenecks. Storage DRS provides smart virtual machine placement and load-balancing mechanisms based on I/O and space utilization.

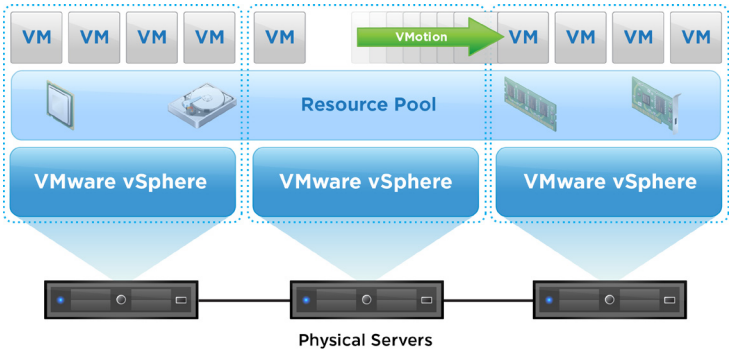
Each of these vSphere advanced features is described in the sections below.

VMware Distributed Resource Scheduler

DRS is an automated load-balancing technology that takes advantage of vMotion to migrate virtual machines among a set of ESXi™ hosts. DRS continuously monitors utilization across vSphere servers and intelligently allocates available resources among virtual machines according to business needs. DRS dynamically aligns resources with business priorities, balances computing capacity, and reduces power consumption in the datacenter, as shown below.

DRS enables automatic initial virtual machine placement on any of the hosts in the cluster. It also makes automatic resource relocation and optimization decisions as hosts and virtual machines are added or removed from the cluster. When DRS is configured for manual control, it makes recommendations for review and later implementation only; there is no automated activity.

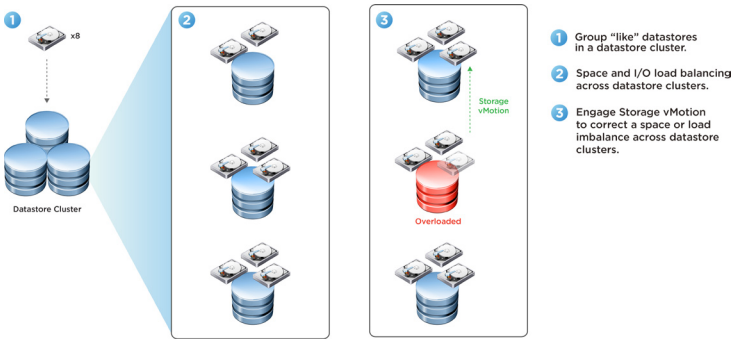
Figure 5. VMware Distributed Resource Scheduler



VMware Storage DRS

Storage DRS aggregates the resources of several datastores into a single datastore cluster to simplify storage management at scale. During virtual machine provisioning, Storage DRS ensures that virtual machine data is assigned the optimal storage location initially, and it provides intelligent virtual machine placement based on the I/O load and available storage capacity. Storage DRS performs ongoing load balancing between datastores to align the storage resources with predefined rules in order to meet business objectives, as shown below.

Figure 6. VMware Storage DRS



vSphere Storage DRS:

- Continuously monitors storage space and I/O utilization across a preassigned pool of datastores and intelligently aligns storage resources with business growth objectives.
- Specifies how storage resources are allocated to virtual machines with rules and policies.
- Assigns dedicated storage infrastructure to business units, while achieving higher storage utilization through pools of storage volumes.

- Empowers business units to build and manage virtual machines within their storage, while giving central IT control over storage resources.
- Balances storage space usage and storage I/O load, avoids resource bottlenecks to meet application service levels, and increases the manageability of storage at scale.
- Easily deploys additional storage capacity and seamlessly takes advantage of additional capacity when new storage is added to a pool of storage volumes.
- Maintains data stores and improves service levels for all applications.

SAP Sybase Adaptive Server Enterprise

SAP Sybase ASE has a long history of delivering industry-leading support for high-performance, high-throughput, high-concurrency systems. SAP Sybase ASE, version 15.7 represents the latest generation of the flagship database management system from Sybase, an SAP company. Its architecture is designed to perform and scale extremely well under varying workloads.

SAP Sybase ASE, version 15.7:

- Is the first version of SAP Sybase ASE to be certified with SAP Business Suite software.
- Implements a threaded, lightweight kernel that utilizes operating-system resources very efficiently – thereby improving performance, scalability, and reliability.

A major design principle of the SAP Sybase ASE threaded kernel is to take advantage of modern, multithreaded processor architectures. With the advent of cores and threads, the industry has reached a point to where it's no longer a "chip clock-speed" race, but a "core and thread" race.

Previously, SAP Sybase ASE was extremely efficient at utilizing faster processors, but it did not take full advantage of the additional cores and threads being implemented on Intel and RISC-based processors commonly in use today. With an increasing number of customers deploying virtualized Intel and RISC-based environments, this architectural limitation has become more apparent.

For this reason, VMware and SAP implemented the threaded-kernel option of SAP Sybase ASE while running an industry-standard online transaction processing (OLTP) benchmark on both bare metal and virtualized hardware. In each case, the transactional throughput was measured and reported within SAP Sybase ASE by calculating the number of begin/commit pairs over a given period of time. From the operating system perspective, the CPU load (user/system/idle) and I/O throughput was measured using industry-standard tools such as iostat.

In addition, the threaded-kernel model is the preferred kernel method going forward, especially for running SAP Business Suite on Sybase ASE.

General Purpose Computing Environment

When deployed on the vSphere platform, Sybase ASE can be used to create optimized, purpose-built computing environments. The first step in creating this type of environment requires a careful examination of the BIOS settings, disabling of unnecessary

processes and peripherals, and the compilation of a monolithic kernel to direct the critical compute resources (CPU, memory, network, and I/O) to the databases.

Each of these items is described in the sections below.

Virtual Machine BIOS Settings

Servers with Intel® micro-architecture (Nehalem class) including the Intel® Xeon® 5500 series and later CPUs, offers two other power management options: C-states and Intel Turbo Boost. Leaving C-states enabled can increase memory latency. This option is therefore not recommended for low-latency workloads.

Enable these settings	Disable these settings
• Virtualization technology • Turbo mode • Hardware based virtualization support • Hyperthreading (workload dependent) • Wake on LAN (required for VMware vSphere® Distributed Power Management™) • Execute Disable (required for vMotion and DRS) • Static high performance/ balanced	• Node interleaving • C1E Halt state • Power saving • Unused features: Video BIOS Shadowable, Video RAM Cacheable, on-board audio, on-board modem, on-board serial ports, on-board parallel ports, on-board game port, floppy drive, CD-ROM, USB

Table 1. Workload used

Virtual Machine Guest Operating System

In order to minimize the virtualization overhead, move the virtual machines to modern guest operating systems, such as SUSE® Linux Enterprise Server (SLES) 11 Service Pack 1, Red Hat® Enterprise Linux® (RHEL) 6, Windows Server® 2008 R2, or later releases. Plan the operating system installation to ensure that it takes advantage of virtualization and creates an optimized computing environment.

Simply disabling the peripheral components in the BIOS does not guarantee that these components are fully disabled. It is also important to ensure that the peripheral components are not re-enabled during the operating system installation. In addition, do not install office productivity suites, graphics, sound, video programs, and so on.

After the installation, disable unnecessary foreground and background processes.

For example, Linux processes include:

- anacron, apmd, atd, autofs, cups, cupsconfig, gpm, isdn, iptables, kudzu, netfs, and portmap

Examples of Windows® processes include:

- Alerter, Automatic Updates, Clipbook Viewer, Error Reporting, Help and Support, Indexing, Messenger, NetMeeting, Remote Desktop, and System Restore Services

The operating system settings and configurations below are recommended to run Sybase ASE in a virtualization environment:

- In the /etc/sysctl.conf file:
  kernel.shmmax = <database dependent size value>
  vm.swappiness = 10
  vm.nr_hugepages = <database dependent size value>

- Add the 'sybase' user to /etc/security/limits.conf in order to utilize HugePages on the system (by default only the 'root' user can use HugePages).

- For ease of management use filesystem-based devices (not raw partitions). For example, RedHat's High Performance Filesystem Option (XFS).
- Change the I/O scheduler:
  - To 'noop' from the default of 'cfq'. Sybase ASE performs better in a virtual environment.
  - Use a 4K page size, since the Linux operating system utilizes a 4k block size for I/O operations by default.

For additional operating system and version settings and dependencies, go to the Sybase ASE release notes at: http://www.sybase.com/support/techdocs

See the "Resources" section later in this paper for more information.

CPU Considerations

For the best performance of latency-sensitive applications in guest operating systems, schedule all virtual CPUs (vCPUs) on the same Non-Uniform Memory Access (NUMA) node. Fit and allocate all virtual machine memory from the local physical memory attached to the NUMA node. Set processor and memory affinity as described below.

When the processor affinity for vCPUs is scheduled on a specific NUMA node, set the processor affinity using the vSphere client as shown in the table below.

Processor Affinity	Memory Affinity
For the virtual machine settings, go to : • Resources tab • Advanced CPU • Check the Scheduling Affinity box	For the virtual machine settings, go to : • Resources tab • Advanced CPU • Check the NUMA Memory Affinity box

Table 2. Workload used

Virtual CPUs

When configuring the Sybase ASE database on virtual machines for production environments, ensure that the total vCPU resources for the virtual machines running on the system do not exceed the CPU capacity of the host. It is good practice to under-commit CPU resources on the host. If the host CPU capacity is overloaded, the performance of the virtual database might degrade.

Do not over commit CPU resources in a production environment. A reasonable ceiling should be 80 percent of consumption; set 90 percent consumption as the limit for generating an alert to the virtual infrastructure administrator.

A multithreaded application such as Sybase ASE can benefit from using multiple CPUs. However, for latency-sensitive applications, do not over commit virtual CPUs compared with the number of physical CPUs. In order to ensure that the physical CPUs are not oversubscribed, limit the total number of vCPUs to the total number of physical CPUs, minus 1.

Configuring virtual Sybase ASE database with excess vCPUs can impose a small resource requirement on vSphere because unused vCPUs continue to consume timer interrupts. vSphere co-schedules virtual machine vCPUs and attempts to run the vCPUs in parallel to the extent possible. Unused vCPUs impose scheduling constraints on the vCPU being used and can degrade its performance.

Workload CPU Optimization - CPU Scheduling

In some use cases, the application owner may want to ensure that the VMkernel does not de-schedule the virtual machine when the vCPU is idle. In order to determine that there is optimal database performance, add the configuration below:

- Go to Virtual Machine Settings in vCenter Server, Options tab, Advanced General, Configuration Parameters, and add:
  - monitor_control.halt_desched (with the value of False)

Performance is normally monitored through vSphere vCenter. However, it is a best practice to periodically collect additional statistical measures of the host CPU usage. This can be done through the vSphere Client, or by using esxtop or resxtop. CPU usage tips are listed below.

Work with your VMware administrator to interpret esxtop data:

- If the load average listed on the first line of the esxtop CPU Panel is equal to, or greater than, the number of physical processors in the system, this indicates that the system is overloaded.
- The usage percentage of physical CPUs on the PCPU line can be another indication of a possibly overloaded condition.

In general, 80 percent usage is a reasonable ceiling in production environments. 90 percent usage should be used as an alert to the VMware administrator that the CPUs are approaching an overloaded condition that needs to be addressed. However, decisions concerning usage levels are typically made based on the criticality of the Sybase database being virtualized, regarding the desired load percentage.

When using esxtop, three critical statistics to interpret are:

- **%RUN** – The percentage of total time the "world"[1] is running on the processor. If %RUN is high, it does not necessarily mean that the virtual machine is resource-constrained. (See description of %RDY below.)
- **%RDY** – The percentage of time the world was ready to run, but is not scheduled to a core. A world in a run queue is waiting for the CPU scheduler to let it run on a PCPU. When %RDY is greater than 10 percent, it could be an indication of resource contention.
- **%CSTP** – The percentage of time the world is stopped from running to allow other vCPUs in the virtual machine to catch up, co-deschedule state. If %CSTP is greater than 5 percent, this usually means the virtual machine workload is not using VCPUs in a balanced fashion.

By using esxtop, DBAs can gain additional performance insight with respect to CPU resource contention. DBAs should also work with their VMware administrator to fully understand and interpret esxtop statistics.

Memory Considerations

For memory, the best practice is to configure memory reservations equal to the size of the Sybase ASE max memory setting. Do not over commit memory in a production environment. When consolidating Sybase ASE database instances, vSphere presents the opportunity for sharing memory across all virtual machines that may be running the same operating systems, applications, or components. In this case, vSphere uses a proprietary, transparent page-sharing technique to reclaim memory that allows databases to run with less memory than physical. Transparent page sharing can also be used to over- commit memory, without any performance degradation.

Hardware-Assisted Memory Virtualization

Some recent processors include a feature that addresses overhead due to memory management unit (MMU) virtualization by providing hardware support to virtualize the MMU. Without

1 Esxtop uses "worlds" and "groups" as the entities to show CPU usage. A "world" is an ESX VMkernel schedulable entity, similar to a process or thread in other operating systems. A "group" contains multiple worlds.

hardware-assisted MMU virtualization, VMware ESXi™ maintains "shadow page tables" that directly map guest virtual memory to host physical memory addresses.

These shadow page tables are maintained for use by the processor and are kept consistent with the guest page tables. This allows ordinary memory references to execute without additional overhead, since the hardware translation lookaside buffer (TLB) caches direct guest virtual memory to host physical memory address translations that are read from the shadow page tables. However, extra work is required to maintain the shadow page tables.

Hardware assistance eliminates software memory virtualization overhead. In particular, hardware assistance eliminates the overhead required to keep shadow page tables in synchronization with guest page tables, although the TLB miss latency is significantly higher. This means that hardware assistance provides workload benefits depending primarily on the memory virtualization overhead that is caused when using software memory virtualization.

If a workload involves a small amount of page table activity, such as process creation, mapping the memory, or context switches, software virtualization does not cause significant overhead. However, workloads having a large amount of page table activity, such as workloads from a database, are likely to benefit from hardware assistance.

For these reasons, enable vSphere to Choose the Best Virtual Machine Monitor based on the CPU and Guest Operating System Combination.

Large (Huge) Memory Pages

Large (huge) pages can potentially increase TLB access efficiency, thereby improving database performance. The use of large pages can significantly improve the performance of SAP Sybase ASE databases on vSphere, compared to running the workload using small pages. Large-page support is enabled by default in VMware ESX versions 3.5 and later. The use of Large Pages is supported for SAP Sybase ASE version 15.0.3 and greater.

Using HugePages at the operating system level enables SAP Sybase ASE to achieve approximately a 10 percent performance improvement. It is recommended for any 64-bit production system. Furthermore, in larger memory configurations (that is, configurations where SAP Sybase ASE utilizes more than 256 GB of RAM, HugePages are required in order for SAP Sybase ASE to boot.

Resource Management

When using vSphere advanced workload management features such as VMware vMotion and VMware DRS, the database is freed from the resource limitations of a single host. With vMotion, virtual machines running SAP Sybase ASE can be moved from one physical vSphere to another to balance the available resources. DRS can dynamically allocate and balance computing resources by continually monitoring the utilization of resource pools associated with virtual machines in a VMware cluster.

Over-commitment is perfectly acceptable for SAP Sybase ASE in nonproduction environments such as Dev, Test, QA, and others, where predictable and consistent performance is not as critical.

Networking

For Sybase ASE, the networking configuration includes virtual distributed switch, VNXNET3, and network interface card (NIC) optimization. Each of these components is described in the sections below.

Virtual Distributed Switch

For a database-as-a-service with SAP Sybase ASE and complex infrastructure implementation, the best practice is to use a Virtual Distributed Switch (vDS). Prior to vSphere 4.0 virtual infrastructure administrators configured standard switches on each host. The vDS simplifies virtual machine networking and enables virtual machine networking that spans multiple vSphere hosts in a data center to be managed as a single virtual switch from a centralized VMware vCenter Server through vSphere Client.

When a host is added, networking for that host does not require configuration. Instead, the host is added to a defined port group that is dedicated to Sybase ASE traffic or other specific application traffic.

In addition to supporting Private VLANs (PVLANs), the vDS also provides the ability to shape both inbound and outbound network traffic. VMware Standard Switches can be easily migrated to vDS in a nondisruptive manner with the vCenter Server management user interface.

VNXNET 3

The best practice is to use VMWare VMXNET 3 virtual NICs for virtual machines running the SAP Sybase ASE database. VMXNET 3 is the latest generation of paravirtualized NICs that are designed from the ground up for performance.

VMXNET 3 by default also supports an adaptive interrupt coalescing algorithm for the same reason that physical NICs implement interrupt coalescing. Virtual interrupt coalescing helps drive high throughput to the virtual machines with multiple vCPUs with parallelized workloads such as multiple threads.

NIC Optimization

Most NICs also provide a mechanism, usually via the ethtool command and/or module parameters, to disable interrupt coalescing. In order to determine if disabling the physical NIC interrupt moderation on the VMware® ESXi™ host is needed, perform the following command:

```
# esxcli system module parameters set -m ixgbe -p “InterruptThrottleRate=0”
```

This example applies to the Intel®10 GbE driver called ixgbe. In order to find the appropriate module parameter for the NIC, first find the driver using the ESXi command:

```
# esxcli network nic list
```

Then find the list of module parameters for the driver used:

```
# esxcli system module parameters list -m <driver>
```

Large Receive Offload (LRO) is another feature of VMXNET 3 that helps deliver high throughput with lower CPU utilization. LRO aggregates multiple received TCP segments into a larger TCP segment before delivering it to the guest TCP stack. However, for latency-sensitive applications that rely on TCP, the time spent aggregating smaller TCP segments into a larger one adds to the latency. It can affect TCP algorithms such as TCP delayed acknowledgment (ACK) that cause the TCP stack to delay an ACK until the two larger TCP segments are received. This also adds to the end-to-end latency of the application.

In order to determine if disabling LRO benefits application stack requirements, reload the vmxnet3 driver in the Linux guest:

```
# modprobe -r vmxnet3
```

Add the following line in /etc/modprobe.conf (Linux-version dependent):

```
options vmxnet3 disable_lro=1
```

Then reload the driver using:

```
# modprobe vmxnet3
```

Storage

For Sybase ASE, the storage configuration includes datastores, Virtual Machine File System (VMFS), Paravirtualized SCSI Adapters, and VMware Storage DRS. Each of these components is described in the sections below.

Data Stores

vSphere uses data stores to store virtual disks. Data stores provide an abstraction of the storage layer that hides the physical attributes of the storage devices to the virtual machines. VMware administrators can create data stores that can be used as a single consolidated pool of storage, or many data stores that can be used to isolate various application workloads.

In traditional Storage Area Network (SAN) deployments, it is a generally accepted best practice to create a dedicated data store if the application has a demanding I/O profile, and databases fall into this category. The creation of dedicated data stores allows DBAs to define individual service-level guarantees for different applications and is analogous to provisioning dedicated LUNs in the physical world. However virtualized customers can use vSphere features such as VMware vSphere® Storage I/O Control, Storage vMotion, and Storage DRS to prioritize and manage data store workloads. For production SAP Sybase ASE databases, use dedicated data stores. For nonproduction or less demanding environments, use consolidated data stores.

VMFS

VMware vSphere® VMFS provides high-performance, clustered storage virtualization that is optimized for virtual machines. With VMFS, each virtual machine is encapsulated into a small set of files. VMFS is the default storage management interface used to access those files on physical SCSI disks and partitions. VMFS allows multiple ESXi™ instances to access shared virtual machine storage concurrently. It also enables virtualization based, distributed infrastructure services such as vMotion, VMware DRS, and VMware High Availability to operate across a cluster of ESXi™ hosts.

In order to balance performance and manageability in a virtual environment, it is an accepted best practice to deploy databases using VMFS. Raw Device Mappings (RDMs) are sometimes erroneously selected to provide increased performance. In contrast, the two dominant workloads associated with databases, random read/write and sequential writes, have nearly identical performance throughput characteristics when deployed on VMFS or using RDM.

Paravirtual SCSI Adapters

It is a best practice to create a primary adapter for use with a disk that hosts the system software and Sybase ASE binaries, and separate paravirtual SCSI (PVSCSI) adapters for the Sybase ASE

data and log devices. PVSCSI adapters are high performance storage adapters that can result in greater throughput and lower CPU utilization. PVSCSI adapters are best suited for high performance storage environments[2].

Multiple Virtual SCSI Controllers

VMware recommends creating multiple virtual SCSI controllers to distribute the I/O associated with database workloads. When creating multiple SCSI controllers, map these controllers to the database or operating system workload profile. Ensure that the operating system and Sybase ASE binaries reside on one SCSI controller, and the Sybase ASE data files and log files reside on separate SCSI controllers. In analytic or decision support database systems, ensure that the temporary database files reside on a separate SCSI controller.

The primary purpose for using multiple virtual SCSI controllers is to parallelize the units of work in a database transaction. In this case, consider the implications when using multiple SCSI controllers to parallelize a single unit of work within a transaction. For instance, creating several SCSI controllers for data files increases throughput, but it may also increase the latency.

Virtual SCSI Driver	Virtual Device	Type	Virtual Pool
LSI Logic	0:0	ASE binaries and operating system	RAID 5, Fibre Chanel
Paravirtual	1:0	ASE data files	RAID 5, Fibre Chanel
Paravirtual	1:1	ASE data files	RAID 5, Fibre Chanel
Paravirtual	2:0	ASE log files	RAID 1, Fibre Chanel

Table 3 Workload used

2 To configure PVSCSI adapters for use with the SAP Sybase ASE database, go to the VMware Knowledge Base Article: Configuring disks to use VMware Paravirtual SCSI (PVSCSI) adapters.

SAP Sybase ASE – Direct I/O Parameter

In Sybase ASE version 15, the directI/O parameter is used to configure Sybase ASE to transfer data directly to disk, bypassing the operating system buffer cache. This directI/O parameter acts similar to a "raw device" in legacy UNIX. In fact, raw partitions in Linux are simply direct I/O to a file. Direct I/O performs I/O in the same manner as raw devices and provides the same performance benefit as raw devices (significantly better than dsync), but it has the ease of use and manageability of file system devices.

The default settings for any filesystem-based device in Linux is to use DirectI/O, although it requires a filesystem that supports it, such as ext4 or xfs, as described in the test scenario. Do not use Direct I/O or dsync options for tempdb devices, as recovery is not important for tempdb. The directio and dsync parameters are mutually exclusive. If a device has dsync set to true, you cannot set DirectI/O to true for this device. In order to enable DirectI/O for a device, first reset dsync to false.

File System Alignment

As in the physical world, file system misalignment can severely impact performance. File system misalignment not only manifests itself in databases, but with any high I/O workload. VMware makes the following recommendations for VMware VMFS partitions:

- Similar to other disk-based file systems, VMFS suffers a penalty when the partition is unaligned. Use VMware vCenter to create VMFS partitions, since it automatically aligns the partitions along the 64 KB boundary.
- In order to manually align your VMware VMFS partitions, check your storage vendor's recommendations for the partition starting block (for example, EMC VNX uses 128k offsets).

VMware Storage DRS

Historically, virtual machine storage provisioning has imposed operational challenges. Monitoring datastore capacity and I/O load has proven to be very difficult, and as a result it is often neglected. The Storage DRS is a feature introduced in VMware vSphere® 5.0 provides smart virtual machine placement and load balancing mechanisms based on I/O and space capacity. It helps decrease the operational effort associated with the provisioning of virtual machines and the monitoring of the storage environment.

EMC VMAX FAST VP

EMC® Fully Automated Storage Tiering for Virtual Pools (FAST VP) challenges the conventional wisdom associated with data placement and layout. In the past, the database architect needed to work closely with storage administrators to make sure data and log files were placed on the highest-performing drives, and to closely monitor the tracks on which data was placed.

With FAST VP data placement is not static. FAST VP provides support for sub-LUN data movement in thin provisioning environments. FAST VP continuously analyzes devices at the sub-LUN level. This enables it to identify and relocate the specific parts of a LUN that are the most active and would benefit the most from being moved to higher-performing storage such as EFD. It also identifies the least active parts of a LUN and relocates that data to higher-capacity, more cost-effective storage such as SATA, without altering performance.

In doing so, it combines the advantages of virtual provisioning with automatic storage tiering at the sub-LUN level to optimize performance and cost, while radically simplifying storage management and increasing storage efficiency. Data movement between tiers is based on performance measurement and user-defined policies, and it is executed automatically and nondisruptively using FAST VP.

FAST VP Performance Measurement and Data Movement

With FAST VP, entire devices are promoted or demoted between tiers based on overall device performance. FAST VP works at the sub-LUN level, introducing finer granularities of both performance measurement and data movement, and can spread the data from a single thin device across multiple tiers.

The metrics collected at the sub-LUN level for thin devices under FAST VP control contain measurements that enable FAST VP to make separate data movement requests for every 7,680 KB unit of storage that makes up the thin device. This unit of storage is called an extent group and it consists of 10 contiguous thin device extents.

FASTVP and VMware Storage DRS

Auto-tiering technologies such as FAST VP migrate LUN segments (chunks) to different disk types, based on the use pattern. Hot (frequently accessed) segments typically move to faster disks, whereas cold segments move to slower disks. Depending on the array type and vendor, there are different policies and thresholds for these migrations.

Storage DRS generates migration recommendations that prevent out-of-space situations or resolve imbalances in performance. In order to prevent hot spots in the datastore cluster and decrease the overall latency imbalance, Storage DRS I/O load balancing uses device modeling and virtual machine workload modeling:

- Device modeling helps Storage DRS analyze the performance characteristics of the devices backing the datastores.
- Virtual machine workload modeling analyzes workloads of virtual machines running inside the datastore cluster.

Both device and workload modeling help Storage DRS assess improvement in I/O latency achieved after a virtual machine migration.

In order to characterize the datastore, device modeling opens and reads random blocks. Storage DRS does not detect active FAST VP structures and might open blocks located on disks of similar speed, either slow or fast. The datastore can be distributed throughout multiple tiers of disk types, thereby leading to an incorrect performance characterization. Therefore, the assessment of migrating the workload can be incorrect. This can generate a recommendation to move into an underperforming datastore. It also can cause a recommendation to be withheld while there is sufficient performance available in other datastores.

By aggregating datastores backed by FAST VP technology into a datastore cluster, Storage DRS provides simplified storage management on the datastore cluster level, rather than on the datastore level. Initial placement speeds up the process for the user by automating the selection of an individual datastore, leaving the user with the much smaller scale decision of selecting a datastore cluster.

By default, Storage DRS is invoked every eight hours and requires performance data over more than 16 hours to generate I/O load balancing decisions. FAST VP uses different time cycles to collect and analyze the workload before moving LUN segments than Storage DRS. The misalignment of Storage DRS invocation and FAST VP algorithm cycles makes it unpredictable when LUN segments might be moved, potentially conflicting with Storage DRS recommendations.

For these reasons, the best practice is either to turn off Storage DRS or configure Storage DRS in manual mode with I/O Metric disabled.

Storage DRS Manual Mode and I/O Metric Inclusion

In manual mode, Storage DRS makes recommendations when the configured thresholds for latency or space utilization have been exceeded. It also provides recommendations for placement during the provisioning process of a virtual machine or a virtual disk. In other words, when Storage DRS is set to manual mode, it monitors the environment and makes recommendations on destinations for virtual disk migrations. Manual mode is the default setting when configuring a Storage DRS datastore cluster.

In order to disable I/O Metric inclusion, go to Advanced Options, and uncheck the I/O Metric box in the Storage DRS Runtime Rules configuration window.

Deployment Tips/Guidelines Summary

Component	Settings
Operating system	• XFS file system • NOOP I/O Scheduler • Hyperthreading enabled – workload dependent

Server BIOS	• Enable:
	  • Virtualization Technology
	  • Turbo mode
	  • Hardware based virtualization support
	  • Hyperthreading
	  • Wake on LAN (Required for DPS)
	  • Execute Disable (Required for vMotion/DRS
	  • Static high performance/balanced
	• Disable:
	  • Node interleaving
	  • C1E Halt state
	  • Power saving
	  • Unused features: Video BIOS Shadowable, Video RAM Cacheable, on-board audio, on-board modem, on-board serial ports, on-board parallel ports, on-board game port, floppy drive, CD-ROM, USB

Sybase ASE	• Use large (huge)pages (supported for 15.0.3 and greater).
	• Use direct I/O = true for data devices, set to false for temp devices:
	  • DSYNC turned off
	  • AIO Lib loaded
	• Tabular Data Stream (TDS) packet size 16K (LOBs)
	• Page Size 4K typical – 16K for SAP

vSphere	• Scale vCPUs for each ASE engine (Example: 4 ASE engines = 4 vCPUs).
	• Allow vSphere to Choose the Best Virtual Machine Monitor based on the CPU and Guest Operating System Combination.
	• Set memory reservations to equal to the size of the Sybase ASE max memory setting.
	• Use VMXNET 3 virtual NICs.
	• Hardware Assisted Memory Virtualization - CPU/MMU Virtualization Option = Automatic
	• Use Virtual Distributed Switch for ease of management and to isolate database, application, vMotion traffic on separate VLANS.
	• Determine if disabling interrupt coalescing is optimal.
	• Determine if disabling LRO is optimal.
	• VMFS 5.0:
	  • Paravirtualized SCSI driver for SAP Sybase ASE devices.
	  • LSI Logic SCSI driver for operating system – SAP Sybase ASE binaries.
	  • Align file system offset – Ex: VNX 128K offset.
	  • Use dedicated datastores for SAP Sybase ASE production databases.
	  • Use multiple Virtual SCSI Controllers.
	• Leverage New Storage Architectures (EX: EMC FASY VP).

Table 4. Sybase ASE on vSphere: General Guidelines for Settings

Conclusion

As shown by our joint testing, even the most demanding SAP Sybase ASE database workloads can be virtualized using VMware vSphere. This is an important data point for customers who are considering running not only their existing SAP Sybase ASE database on VMware vSphere, but SAP Business Suite on SAP Sybase ASE as well. These results were achieved for the most part out-of-the-box. There is minimal tuning or specialized configurations needed to run SAP Sybase ASE on VMware vSphere. This paper is a guideline database administrators can use to easily virtualize their environments, without having to learn or relearn their duties.

Appendix A: Test Results – ASE Native versus vSphere

Appendix A provides summarized, sample validation test results for Sybase ASE running on native physical hardware versus running on the VMware vSphere virtualization platform. These tests were run on standard x86 hardware using an OLTP transactional benchmark. The results below show consistently less than 5 percent transactional overhead as the number of users are increased.

(The graphs below are part of a presentation delivered by Chris Brown at SAP TechEd in Las Vegas in 2012.)

Figure A-1 results show an average of less than 5 percent overhead.

Figure A-1. 11 Sybase ASE engine threads and 12 vCPUs

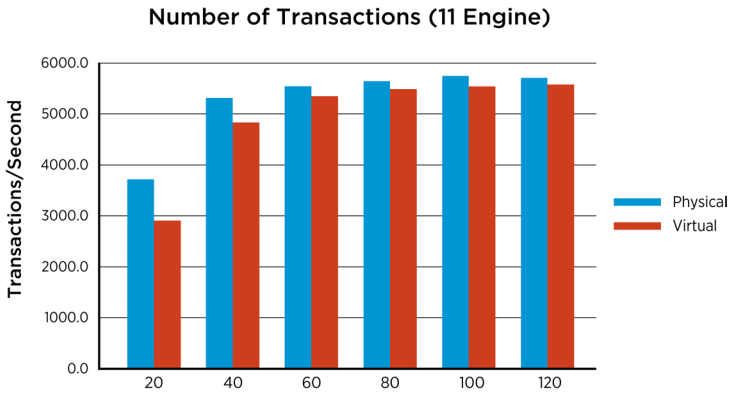


Figure A-2 results show that this configuration exceeded physical performance.

Figure A-2. 4 SAP-Sybase ASE engine threads 6 vCPUs

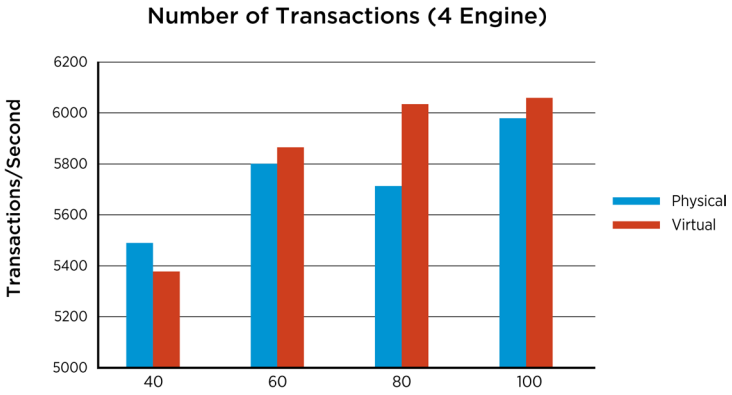
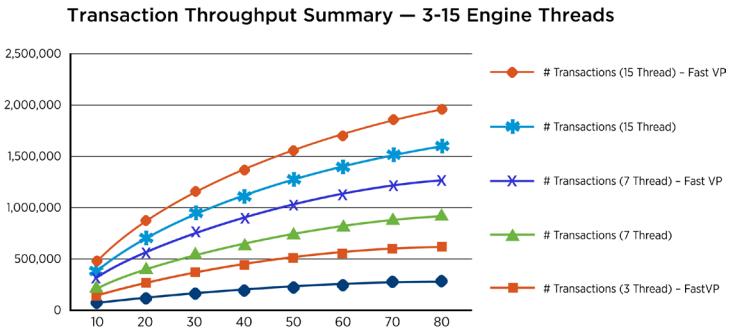


Figure A-3 results show a significant increase in transactional throughput with EMC FAST VP enabled.

Figure A-3. Sybase ASE on vSphere with EMC FAST VP



Resources

Customers can find more information about the products and technologies described in this paper using the links listed below.

VMware

Deployment References

- Press Release: *VMware Cloud Infrastructure Validated by SAP for Virtualization of SAP's Database Portfolio*: http://www.vmware.com/company/news/releases/vmw-sap-database-05-14-12.html
- VMware Global Alliances Blog: *SAP-Sybase Makes Running Business Critical Databases on vSphere Hassle Free*: http://blogs.vmware.com/alliances/2012/06/vmware_sybase_sap.html
- Performance Characterization of VMFS and RDM Using a SAN: http://www.vmware.com/files/pdf/performance_char_vmfs_rdm.pdf
- Configuring Disks to Use VMware Paravirtual SCSI (PVSCSI) Adapters: http://kb.vmware.com/kb/1010398
- VMware vSphere® Distributed Switch Best Practices: http://www.vmware.com/files/pdf/techpaper/vsphere-distributed-switch-best-practices.pdf
- VMware vSphere: http://www.vmware.com/products/datacenter-virtualization/vsphere/overview.html
- VMware Support and Downloads web site: http://www.vmware.com/support/product-support/vsphere/index.html
- Performance Best Practices for VMware vSphere 5.0: http://www.vmware.com/pdf/Perf_Best_Practices_vSphere5.0.pdf

General Information

- VMware web site: http://www.vmware.com/
- Featured VMware Documentation Sets: http://www.vmware.com/support/pubs/
- VMware Licensing Help Center: http://www.vmware.com/support/licensing/
- VMware Product Podcasts: http://www.vmware.com/technical-resources/podcasts/
- VMware Technology Network (Community) web site: http://communities.vmware.com/community/vmtn
- Community, VMware Knowledge Base: http://communities.vmware.com/community/vmtn/resources/knowledgebase
- VMware Support Insider: http://blogs.vmware.com/kbtv/
- VMware TV: http://www.youtube.com/user/vmwaretv
- VMworld TV: http://www.youtube.com/user/VMworldTV
- VMware KB TV (external): http://www.youtube.com/user/VMwareKB

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