Reference architecture:
SAP on IBM eX5 enterprise systems, IBM SAN Volume Controller, and IBM Storwize V7000 storage systems and VMware

IBM SAP International Competence Center – Walldorf, Germany

Authors:
Paul Henter – IBM
Maik Gasterstaedt – IBM
Version 1.0
November 2011
Table of Content

1. Abstract ................................................................................................................................. 4
2. Executive overview .................................................................................................................... 5
   2.1 Use of virtualization in SAP landscapes ............................................................................. 5
3. Product introduction ................................................................................................................ 6
   3.1 IBM eX5 Systems .................................................................................................................. 6
   3.1.1 IBM System x3690 X5 ..................................................................................................... 7
   3.1.2 IBM System x3850 X5 ..................................................................................................... 8
   3.2 VMware Virtualization Solution on IBM System eX5 ....................................................... 10
      3.2.1 VMware vSphere ......................................................................................................... 10
4. SAP virtualization on System x servers with eX5 technology .............................................. 11
   4.1 Setup of IBM System x3850 X5 ......................................................................................... 11
   4.2 Management of VMware vSphere environment .................................................................... 13
5. Storage configuration for SAP applications using VMware vSphere and IBM storage systems ................................................................................................................................. 15
   5.1 Storage virtualization in VMware vSphere ........................................................................ 15
   5.2 IBM SAN Volume Controller and Storwize V7000 storage: Innovative storage with built-in virtualization .................................................................................................................... 15
      5.2.1 Easy to implement ....................................................................................................... 15
      5.2.2 Common features ....................................................................................................... 15
   5.3 Storage setup for SAP applications .................................................................................... 16
   5.4 Storage management in VMware vSphere environments using the IBM Storage Management Console for VMware vSphere ............................................................... 17
      5.4.1 Introduction ............................................................................................................... 17
      5.4.2 Main features and benefits ....................................................................................... 17
   5.5 Storage setup using the IBM Storage Management Console for VMware vCenter .......... 18
   5.6 Enhanced storage support through VMware VAAI ........................................................... 22
      5.6.1 Main features ........................................................................................................... 22
      5.6.2 Testing the IBM Storage Device Driver for VMware VAAI ............................................ 23
6. SAP landscape setup ............................................................................................................... 28
   6.1 Virtual machine setup ......................................................................................................... 28
      6.1.1 SAP ERP .................................................................................................................... 28
      6.1.2 Enhanced monitoring ............................................................................................... 30
7. Sample configurations for SAP ............................................................................................... 33
   7.1 Small configuration ............................................................................................................ 33
   7.2 Medium configuration ....................................................................................................... 33
   7.3 Large configuration in two locations ............................................................................... 34
8. Conclusion ............................................................................................................................... 35
1. Abstract

This white paper describes infrastructure aspects of running SAP applications on IBM System x servers, IBM SAN Volume Controller and/or IBM Storwize V7000 storage systems, and VMware vSphere. This includes a brief description of the hardware and software components, a sample how-to install and setup the components, and three sample reference architectures for small, medium and large installations.

The concepts and methods described in this paper are derived from proof of concepts done in the IBM SAP International Competence Center (ISICC) in Walldorf in Germany.

The reader should bring some knowledge of IBM System x servers, IBM storage and related concepts, and VMware vSphere virtualization concepts.
2. Executive overview

What is the motivation in running SAP in virtualized environments? Since the last decade, SAP landscapes are growing and becoming more complex. When you compare a SAP landscape in 2001 with today’s SAP landscapes, you can see a growing number of applications that run on a dedicated server. Managing this multiple system landscape requires tremendous administrative effort. Systems management is often the largest- and fastest-growing IT cost component when landscapes and infrastructure become more complex. Virtualization is playing a major role in driving improvements in these SAP landscapes. Servers and storage systems that can integrate features enhancing virtualization capabilities can offer significant benefits to customers.

While SAP landscapes are getting more complex, computing energy, reliability, and management capabilities of the latest servers, such as IBM® System x3850 x5 and storage systems such as the IBM System Storage® SAN Volume Controller and IBM Storwize® V7000 storage system are also improving. In addition to the rock-solid and flexible-virtualization capabilities of the x86 and storage hardware, IBM also provides:

- Virtualization skills and services (IBM has a very long experience in virtualization technologies, going as far back as the 1960s and the origin of virtualization itself)
- Deep SAP understanding and many years experience with virtualization of SAP environments on many platforms
- The right tools to manage different virtualization solutions and support consolidation for all IBM platforms

Virtualized SAP landscapes bring the benefit of:

- Higher server and storage utilization
- Reduced maintenance costs
- Easier administration of the complete SAP landscape
- Faster responsiveness to changing business demands.

In addition, virtualization technology helps to improve the reliability, availability, and serviceability (RAS) features of a server.

2.1 Use of virtualization in SAP landscapes

Virtualization can offer significant benefits to customers with SAP landscapes, where they are planning to:

- Consolidate multiple SAP instances or application server and DBMS of three-tier landscapes in one server
- Enable higher levels of business continuity and disaster recovery
  - High availability (HA)
  - Minimized downtime
  - Hardware maintenance
- Establish a dynamic data center environment
  - Repurpose a server or Virtual Machine (VM) quickly and easily

This paper explains why and how to virtualize SAP implementations on an IBM System x3850 X5 server and IBM XIV storage systems.

The solutions contained in this paper are valid for both IBM SAN Volume Controller (SVC) and IBM Storwize V7000 storage systems.
3. Product introduction

3.1 IBM eX5 Systems

IBM eX5 product portfolio represents the fifth generation of servers built upon IBM X-Architecture®. Servers with IBM eX5 technology are a major component in a dynamic infrastructure and offer significant new capabilities and features that can address the key requirements for customers with SAP landscapes. The IBM System x server portfolio provides an ideal platform for SAP applications running virtualized in a private cloud environment. With multiple workloads running on the same server, performance remains important but reliability and availability become more critical than ever.

Features and benefits

- Maximum memory with unique expansion capabilities
- Fast, integrated data storage options
- Extreme flexibility with FlexNode partitioning
- IBM Chipkill memory to effectively recover from a failed DRAM (dynamic random access memory) module
- IBM Memory ProteXion to enable a higher degree of data integrity
- Memory mirroring and DIMM (dual inline memory module) rack sparing
- Advanced light path diagnostics that offer proactive problem solving and faster time to repair
- Integrated management module (IMM), which allows remote control access to manage, and monitor
- Automatic node failover
- QPI fail down

Embedded hypervisor

IBM delivers the System x3850 X5 model with VMware ESXi 4 installed as an embedded hypervisor. ESXi is a thin hypervisor integrated into the server hardware. The ESXi server offers basic partitioning of server resources. However, it also acts as the foundation for virtual infrastructure software, enabling VMware VMotion, Distributed Resource Scheduling (DRS), and so on, which are the keys to the dynamic, automated data center.

![Embedded hypervisor](image)

Figure 1: Embedded hypervisor

The embedded hypervisor allows customers to easily deploy a virtualized environment as soon as they boot their system. It brings virtualization to customers who might not have all the resources or the knowledge and skill to deploy a virtualized solution. The solution is based on a USB interface that comes with a protective interposer card that locks the mechanism into place, securing it in transport.
Memory Access for eX5 (MAX5) is the name given to the memory scalability subsystems that can be added to eX5 servers. MAX5 is a memory expansion system that can be added to eX5 servers. MAX5 for the rack-mounted systems (x3690 X5, x3850 X5, and x3950 X5) is in the form of a 1U device that attaches below the server.

For the IBM BladeCenter® HX5, MAX5 is implemented in the form of an expansion blade. For memory scaling, the MAX5 memory expansion system offers 32 DIMMs of extra memory capacity and extra memory channels. MAX5 memory expansion offers:

- Memory scaling that is independent of processors, adding 32 DIMMs of extra memory capacity and 16 extra memory channels for no compromises
- Fifty percent more virtual machines and leading database performance over competitor 4-socket systems
- Lower cost and high performance configurations reaching the desired memory capacity, using less-expensive DIMMs

With the new Samsung Green DDR3 Memory 32 GB DIMM support, IBM can offer 1 TB in a 2-socket server. The x3690 X5 and MAX5 systems support memory configuration up to 2 TB with 32 GB DIMMs in a 3-socket system.

IBM System x enterprise servers are the ideal platform for business-critical and complex SAP applications, (such as database processing, customer relationship management, and enterprise resource planning) and highly consolidated, virtual server environments. With multiple workloads running on the same server, performance remains important but reliability and availability become more critical than ever. Servers with IBM eX5 technology are a major component in a dynamic infrastructure and offer significant new capabilities and features that can address the key requirements for customers with SAP landscapes.

3.1.1 IBM System x3690 X5

IBM System x3690 X5 is a scalable 2U two-socket system rack optimized server. It is a system with the same benefits known from the flagship system x3850 X5.
IBM SAP International Competence Center

IBM System x3690 X5 has the following features:

- 2 x Intel® Xeon® E7 2800/4800/8800 series (up to 10 core) or 2 x Intel Xeon 7500 or 6500 families (up to 8 cores)
- 32 to 64 DDR3 DIMMs
- 16 DIMMs on the system planar / maximum 256 GB
- 32 DIMMs with optional memory mezzanine / maximum 512 GB
- 64 DIMMs with optional MAX5 and memory mezzanine / maximum 1024 GB
- 2.5-inch HDDs or eXFlash with 1.8-inch solid-state drives (SSDs) with M5015 Controller
- RAID 0/1 (Standard, Option) RAID 5
- 2 x 1 Gb Ethernet
- 2 x 10 Gb Ethernet ports (standard on some models)
- Integrated virtualization on internal USB socket
- IMM, uEFI, and IBM Systems Director Active Energy Manager™

With a two-socket system with MAX5, it is possible to host memory intensive SAP virtual machines with 40 virtual processors and 2 TB of memory. With this system, IBM has a unique configuration for SAP Private Cloud and Virtualization solutions with an unbeatable price performance ratio.

IBM and Samsung deliver energy-efficient virtualization platforms with IBM eX5 servers and Samsung ultra low power green DDR3 1.35V memory. With the ability to extend the x3690 X5 system to a very large memory configuration with MAX5 in only 3U, you can use this system as the base of SAP in memory computing engines (for example, HANA).

You can find more information for IBM System x3690 X5 on the IBM System x at-a-glance guide at: http://www.redbooks.ibm.com/redbooks/technotes/tips0818.pdf and in the x3690 X5 data sheet at: ftp://public.dhe.ibm.com/common/ssi/pm/sp/n/xsd03061usen/XSD03061USEN.PDF

You can position the x3690 X5 for SAP Large Application Servers and SAP Distributed Application servers. Often, processors are not the limitation for virtualized SAP systems. SAP virtualization solutions depend on the memory capacity of its host systems. Memory over commitment leads to a dramatic performance loss for a virtualized SAP system. In a productive environment, this over commitment is not allowed. With MAX5 memory expansion, the overall systems can scale up without adding additional servers or licenses.

### 3.1.2 IBM System x3850 X5

IBM System x enterprise servers are the ideal platform for business-critical and complex SAP applications—such as database processing, customer relationship management and enterprise resource planning—and highly consolidated, virtual server environments. With multiple workloads running on the same server, performance remains important but reliability and availability become more critical than ever. Servers with IBM’s eX5 Technology are a major component in a dynamic infrastructure and offer significant new capabilities and features which address key requirements for customers with SAP landscapes.
System x3850 X5 is a leadership high-end scalable system that offers:

- Up to three times SAP application performance
- 3.3 times greater database performance and 3.6 times more virtual machines than industry leading 2-socket x86 (Intel Xeon 5500 Series processor) systems
- Scaling through QPI from 4-socket, 64 DIMMs to 8-socket, 80 cores, 128 DIMM performance (192 DIMMs with MAX5)

The IBM System x3850 X5 has the following features:

- Four Xeon E7 2800/4800/8800 series (6 core/8 core/10 core) or Xeon 6500/7500 series
- Scalable to eight sockets by connecting two x3850 X5 servers together
- 64 to 96 DDR3 DIMMs
  - Up to eight memory cards can be installed, each with eight DIMM slots (64 in total)
  - MAX5 adds 32 DIMM sockets
- Seven PCI Express (PCIe) 2.0 slots and PCIe 2.0 slot for supported RAID card
- Up to eight 2.5-inch HDDs or 16 1.8-inch SSDs
- RAID 0/1 Std, Opt RAID 5
- Two 1 GB Ethernet
- Two 10 GB Ethernet (opt.)
- integrated virtualization on internal USB socket
- One Emulex 10 Gb Ethernet dual-port adapter (except ARx models)
- IMM and uEFI

Two x3850 X5 servers can be connected together to form a single-system image with up to eight processors and up to 2 TB of RAM with cheaper 16 GB DIMMs (compared to a 32 GB option).

With these features, the System x3850 X5 high-end servers are the optimal platform for large-scale server consolidation projects and virtualization of multiple processor-intensive SAP instances. They enable larger system resource pools to support more simultaneously peaking virtual machine applications, using the load-balancing features of virtualization solutions.

New levels of innovation include superior energy management tools. IBM Systems Director Active Energy Manager is designed to take advantage of new processor features, enabling balanced system performance according to the available energy input. With Active Energy Manager, you can plan, predict, and cap energy consumption based on the hardware configuration, reducing infrastructure requirements for redundancy and potentially lowering the support costs of multiple application services as required by complex SAP solution landscapes.
3.2 VMware Virtualization Solution on IBM System eX5

3.2.1 VMware vSphere

ESX Server is the product name of a thin virtualization layer that runs directly on x86 hardware without any operating system being involved. ESX Server provides the environment for multiple virtual machines to run on a single x86 server. The main task of this server is to create the illusion for each virtual machine that it runs on its own set of hardware and maps those virtual hardware interactions to the physical hardware.

VMware vCenter is the key management component. It groups several ESX servers together into a pool, called a cluster. vCenter provides a single management interface to all the participating ESX servers and represents a uniform view of its resources. It is also instrumental in providing Virtual Infrastructure Services, such as VMotion, high availability (failover protection). Refer to Figure 5 for further details of Virtual Infrastructure Services.

- VMotion enables the administrator to move a running virtual machine from one ESX server to another without causing any interruption to the user. VMotion provides the basis for two more services, a load balancing service, called DRS (Distributed Resource Scheduling) and an energy-saving service called Distributed Power Management (DPM). DRS uses VMotion as a mechanism to do load balancing across the available ESX servers. DRS dynamically determines the load condition (not only for initial placement of a VM) and, depending on the configuration of DRS, it either lists recommendations or actually performs the relocation of VMs to other ESX servers, using VMotion.
- HA is a failover protection service for the entire virtual machine. In case a physical server (the ESX server) fails, all the VMs that had been running on this ESX server are restarted (rebooted) on the remaining ESX servers.

VMware vSphere ESX Server facts

Host
- 64-bit VMkernel
- 1 TB host memory
- 64 logical processor
- 320 virtual machines per host

Virtual machines
- 8-core virtual SMP
- 255 GB RAM
- Virtual Machine Hardware Version 7
  - New virtual devices
  - VMDirectPath I/O

Networking
- Distributed switch
  - Simplify datacenter administration
  - Enable networking statistics and policies to migrate with virtual machines (Network VMotion)
- VMDirectPath I/O
4. SAP virtualization on System x servers with eX5 technology

You can use the scale up approach of virtualization with the servers that allow you to consolidate and optimize workload for environments with different systems on one big server. The benefit comes from better hardware utilization and easier management of a centralized infrastructure.

Instead of using many small servers, you can choose System x3850 X5 for virtualized SAP landscapes. The System x servers with eX5 technology provide a rock-solid and flexible virtualization infrastructure.

The test team used the following hardware for this proof of concept.

IBM System x3850 X5 - (7145-AC1):
- Four 8-core Xeon 7560 series 2.27 GHz processors
- 160 GB memory
- One host bus adapter (HBA) and two Network interface cards
- Eight internal 146 GB SAS HDDs

![Figure 7: IBM System x3850 X5](image)

Network

Each node is connected to the lab network using two Gigabit Ethernet adapters. The advanced systems management card (Remote Supervisor Adapter II) is connected to the same network for management access.

4.1 Setup of IBM System x3850 X5

The first step of the hardware setup is the update of the firmware to the latest level. You can use the IBM UpdateXpress bootable CD to update all firmware in a single step. At this time, this option is available for x3950 M2 and x3650 M2.

4.1.1 Integrated management module

The web-based interface to the IMM allows a complete remote management of the server and gives a comprehensive overview of the system status. It helps to provide:

- Easy usage for system administrators to manage large group of diverse systems
- Lower IT cost
- Diagnostics, virtual presence, and remote control to manage, monitor, troubleshoot, and repair from any corner of the world (LightPath)
  - Manage servers remotely, in a secure environment independent from Operating System state
  - A single administrator can configure and deploy server from bare metal to operating system boot
- Secure alerts and status, ensuring maximum uptime when used with IBM Systems Director Active Entergy Manager.
• Standards-based alerting, enabling upward integration into a wide variety of enterprise management environments
• Dedicated 10/100 Mb Ethernet

With the remote control, the test team was able to access the service console to insert the initial values for the ESXi Server after the first reboot. The team used that interface to set up the two-node configuration. The event log shows whether there are any error conditions on the servers.

All the systems that are used in this proof of concept are equipped with an embedded hypervisor, and therefore, installation on a local disk was not required. For this proof of concept, the team tested the embedded hypervisor and the full ESX4 server on a RAID1 on two internal SAS disks.

The team inserted the hypervisor in the x3850 X5 and chose x3650 M2 and x3950 M2 with the preinstalled hypervisor option.

Figure 8: embedded hypervisor

The embedded hypervisor can be selected as a permanent boot device in the BIOS setup. Start the system and select the setup option when prompted. Select Embedded Hypervisor as the first boot device. Also, check the BIOS to ensure that the Intel Virtualization Technology option is enabled.
The ESXi server needs a basic configuration to get a connection through the network. The test team provided the IP address and root password in the ESXi configuration panel at the server console. The team used the remote console of the System x3850 X5 IMM for access to the server.

Then, we started the server and used it as a standalone ESXi server. To install the virtual infrastructure client on an administrator workstation we connect to the web interface of ESXi server.

### 4.2 Management of VMware vSphere environment

The test team used the VMware vCenter Server for a centralized management of all host systems. To connect to that management server, they used the vSphere Client on an administration workstation with Microsoft® Windows®. Then they added all the hosts to the vCenter server. After successful setup, you can see the system information on the summary page of the ESXi server.
Figure 11: vSphere client summary page

With this initial setup, the environment is ready for the proof of concept.


Make sure to follow the VMware ESX Server configuration guidelines (SAP Note 1056052). The IBM System x3850 M2 and System x3950 M2 Installation Guide can be found at: ibm.com/systems/x/index.html
5. Storage configuration for SAP applications using VMware vSphere and IBM storage systems

5.1 Storage virtualization in VMware vSphere

The VMware ESX Server File System, called Virtual Machine File System (VMFS) is a file system designed specifically for the storage of virtual machines. It is a cluster-capable shared file system, designed to format very large disk drives (LUNs, maximum 2 TB) and store the virtual machine .dsk files, which can also be very large. These volumes store the following key data:

- Virtual drives of virtual machines: the .vmdk files
- VM description file: *.vmx
- The memory images from virtual machines that have been suspended
- Delta files, in case snapshots of entire virtual machines are used

5.2 IBM SAN Volume Controller and Storwize V7000 storage: Innovative storage with built-in virtualization

IBM SAN Volume Controller is designed to deliver the benefits of storage virtualization in environments from large enterprises to small businesses and midmarket companies.

5.2.1 Easy to implement

IBM System Storage SAN Volume Controller software is delivered preinstalled on SAN Volume Controller storage engines, so it is quickly available for implementation as soon as the engines are attached to your storage area network (SAN). SAN Volume Controller storage engines are based on proven IBM System x server technology and are always deployed in redundant pairs, which are designed to deliver very high availability.

SAN Volume Controller is designed to take control of existing storage, retaining all your existing information. This ability helps to speedup and simplify implementation, while helping to minimize the need for additional storage. After implementing SAN Volume Controller, you can make changes to the configuration quickly and easily as needed.

SAN Volume Controller uses a completely new graphical user interface modeled on the IBM XIV® Storage System, which has been very well received by customers. The user interface is designed to be very easy to use and includes many built-in IBM recommendations to help simplify storage provisioning and enable new users to get started quickly.

5.2.2 Common features

The following list of features applies to both SAN Volume Controller and Storwize V7000 storage systems:

- Combines storage capacity from multiple vendors for centralized management
- Increases storage utilization by providing more flexible access to storage assets
- Improves administrator productivity by enabling management of pooled storage from a single interface
- Insulates host applications from changes to the physical storage infrastructure
- Enables a tiered storage environment to match the cost of storage to the value of data
- Applies common network-based copy services across storage systems from multiple vendors
- Supports data migration among storage systems without interruption to applications
- First storage virtualization system with tightly integrated support for solid-state drives (SSDs)
• Supports consolidated disaster recovery site servicing more than one production location
• Enables almost instant recovery from disk backups

In addition to SAN Volume Controller’s functionality, IBM Storwize V7000 offers disks included within the system, including SSDs.

You can find more detailed information on the IBM XIV storage system at:
• ibm.com/systems/storage/software/virtualization/svc
• ibm.com/systems/storage/disk/storwize_v7000

5.3 Storage setup for SAP applications

The IBM SAN Volume Controller storage system contains the volumes for the proof of concept landscape in a separate pool. Storage pools control the storage resources of volumes and snapshots. They provide a logical separation similar to a folder. Within this pool, following volumes are created for each virtual machine:

• An operating system volume for the operating system
• A database volume for the SAP application, database, and log files (for the test systems)
• A data volume for the SAP application and database files (for the production systems)
• A log volume for the log files (for the production systems)
• A swap volume for the operating system’s swap partition

The volumes are mapped to each of the virtual machines as raw devices.

In addition, the proof of concept uses a shared file system (here vmfs_shared, which uses VMFS version 3.33) accessed by all IBM System x hosts and all virtual machines in order to use VMware VMotion. IBM recommends setting the block size of all volumes to 2048 GB.

To ensure that all volumes are automatically visible to the host when a new host is added to the cluster, create a cluster on the IBM SAN Volume Controller storage system and assign all IBM System x hosts to this cluster.
5.4 Storage management in VMware vSphere environments using the IBM Storage Management Console for VMware vSphere

5.4.1 Introduction

The IBM Storage Management Console for VMware vCenter is a software plug-in that integrates into the VMware vCenter server platform and enables VMware administrators to connect to and fully utilize IBM storage systems. After establishing a connection, administrators can create volumes (LUNs) in selected predefined storage pools. These volumes are mapped (as logical drives) to ESX hosts or clusters, and can be populated by user-defined VMware datastores that can be used by virtual machines.

5.4.2 Main features and benefits

The IBM Storage Management Console for VMware vCenter runs as a Windows Server service on the vCenter server. Any vSphere client that connects to the vCenter server detects the service on the server, and automatically enables the IBM storage management features on the vSphere client.

The IBM Storage Management Console for VMware vCenter is available for IBM SAN Volume Controller (as used in this proof of concept), IBM Storwize V7000, and IBM XIV Storage Systems including Gen 2 and Gen 3.

As soon as the plug-in is installed and configured, the IBM Storage Management Console enables:

- Full integration with the VMware vSphere GUI, in the form of an IBM Storage resource management tool and a dedicated IBM Storage management tab.
- Full control over SAN Volume Controller and XIV-based storage volumes, including volume creation, resizing, renaming, migration to a different storage pool, mapping, unmapping, and deletion.
- Easy and integrated allocation of volumes to VMware datastores, used by virtual machines that run on ESX hosts or clusters.
5.5 Storage setup using the IBM Storage Management Console for VMware vCenter

This section depicts the procedure to set up the IBM Storage Management Console for VMware vCenter, and also the procedure to create volumes on the SAN Volume Controller and to map them to a VMware vSphere host using the VMware vSphere GUI.

1. **Add a storage system:**

   After the plug-in is installed, the you can access the storage management functionality by clicking **Home → Management → Storage Management → <host name>**

   To add a new storage system, click **Add** in the **Storage Systems** section and provide the IP address and login credentials of the storage system. Then the machine will be displayed.
Figure 14: Storage Management view in VMware vCenter

2. **Attach a storage pool:**

   In the **Storage Pools** section, click **Attach**, and then select the pool on the SAN Volume Controller and provide the login credentials.
After the pool is added, it is shown in the Storage Pools section.

Reference architecture:
SAP on IBM eX5 enterprise systems, IBM SAN Volume Controller, and IBM Storwize V7000 storage systems and VMware
3. **Create and attach a new LUN:**

In the **Storage Pools** section, select the required pool, click **New LUN**, and provide the volume size and name.

![Figure 17: Volume details](image)

Then, attach the volume to the desired host.

![Figure 18: Attaching the new volume to a host](image)
When completed, the volume is created and mapped to the host. It is shown in the **Unused LUNs** section in the IBM Storage tab.

![Image](image_url)

**Figure 19: New volume(s) shown in the Unused LUNs section**

Now, the volume can be used to host a datastore or to be mapped to a virtual machine as a RAW device.

### 5.6 Enhanced storage support through VMware VAAI

The IBM Storage Device Driver for VMware vStorage APIs for Array Integration (VAAI) is a software plug-in that integrates with the VMware ESX and ESXi environments, as part of VMware VAAI. The IBM software plug-in consists of a kernel module that reports to the VMware VAAI driver and allows offloading extended VMware operations to the IBM SAN Volume Controller, Storwize V7000, and XIV Storage Systems.

#### 5.6.1 Main features

The IBM Storage Device Driver for VMware VAAI supports the offloading of the following VMware extended operations to the IBM SAN Volume Controller, Storwize V7000, and XIV Storage System:

- Full copy (clone) – Copies data from one logical unit (LUN based) to another without writing to the ESX server. Rather than issuing read and write requests from the host, the data
copying operation is initiated on the storage system. This speeds up the virtual machine cloning operation and reduces the processor load on the host.

- Block zeroing – Assigns zeroes to large storage areas without actually sending the zeros to the storage system. This speeds up the VM initiation operation, and reduces the I/O and processor load on the host.

- Hardware assisted locking – Locks a particular range of blocks in a shared logical unit, providing exclusive access to these blocks. Instead of using SCSI reservation that locks the entire logical unit, locking specific blocks is a more efficient alternative that greatly improves scalability in large server arrays. The locking is performed using Atomic Test and Set (ATS) commands.

You can find more information regarding IBM SAN Volume Controller and IBM Storwize V7000 Storage Device Driver for VMware VAAI and installation instructions at:

ibm.com/sar/CMA/SDA/02l6n/1/IBM_Storage_DD_for_VMware_VAAI_1.2.0_IG.pdf

5.6.2 Testing the IBM Storage Device Driver for VMware VAAI

In order to test the IBM Storage Device Driver for VMware VAAI, the test team cloned a virtual machine consisting of one virtual machine disk (VMDK). The template and target datastores resided on separate volumes on the IBM SAN Volume Controller. The template contained an SAP system with about 30 GB of used space. The clone was created one time with VAAI enabled and one more time with VAAI disabled.

To enabled or disabled VAAI:

1. In the vSphere client, select the vSphere host.
2. In the Configuration tab, in the Software section, click Advanced Settings.
3. In the Advanced Setting dialog box, click Data Mover.
4. Set the values to 0 or 1 to disable or enable VAAI respectively.

![Advanced Settings](image)

Figure 20: Enabling and disabling of VMware VAAI
After activating VMware VAAI, the volumes or datastores are flagged with **Hardware Acceleration: Supported**.

The cloning process of the SAP system with VAAI disabled took about 5 minutes, while the cloning of the same virtual machine with VAAI enabled took only less than 4 minutes, which is less than 80% of the original amount of time:

![Figure 22: Amount of time for cloning the same SAP system with VAAI disabled and VAAI enabled](image)

**Note:**
As the SAN Volume Controller is used, the copying of the data cannot be achieved inside the storage system itself as the SAN Volume Controller is triggering the process. While the copying is done inside the SAN Volume Controller, the date still needs to be transferred through the SAN Volume Controller and processed through the SAN Volume Controller.

Therefore, an even better performance increase through VAAI can be achieved by using direct-attached storage.
The following figures show the throughput between the ESX host and the SAN Volume Controller. The first half of the timeframe relates to the test case with VAAI disabled and the second half of the timeframe relates to the test case with VAAI enabled.

The figures show that data is being transmitted between the ESX host and the SAN Volume Controller with VAAI disabled, and nearly no data is being transmitted with VAAI enabled – indicating that the copying process is completely handled inside the SAN Volume Controller and the storage system.

Figure 23 shows the traffic on the source disk, which is only read traffic, while Figure 24 shows the traffic on the target disk which is only write traffic.

Figure 23: VDisk throughput source disk with VAAI enabled and disabled
Figure 24: VDisk throughput target disk with VAAI enabled and disabled
Also the throughput between the SAN Volume Controller and the actual storage system is optimized with VAAI enabled, as shown in Figure 25. Again, the first half of the timeframe relates to the test case with VAAI disabled while the second half of the timeframe relates to the test case with VAAI enabled.

With VAAI disabled, there is a constant data transfer between the SAN Volume Controller and the actual storage system.

With VAAI enabled, most of the traffic can be covered inside SAN Volume Controller’s cache and only at the end of the test copying process, data needs to be transferred between the SAN Volume Controller and the storage system. This helps to keep the load off the SAN.

**Figure 25: MDisk throughput with VAAI enabled and disabled**
6. SAP landscape setup

In this proof of concept, the test team set up an environment with an SAP ERP ECC system. The first step is the creation of a virtual machine and the installation of an operating system.

6.1 Virtual machine setup

The first step to run a SAP system in a virtual environment is the setup of a virtual machine that runs a supported operating system. VMware ESX Version 4 (vSphere) adds some new features, especially for virtualizing SAP application servers. You can now use up to eight processors and up to 256 GB of memory per virtual machine.

![Figure 26: Virtual machine properties](image)

With those values for virtual processors and memory, a virtual machine is now better positioned to host SAP workloads. A virtualized Windows server now has enough processing energy and memory for most SAP workloads. You can use different versions of the Windows Server operating system. The installation process does not differ from the standard setup process and is not described in this paper.

6.1.1 SAP ERP

The installation process inside a VM differs slightly from an installation on a physical host (for example, enhanced monitoring). You can follow the installation and tuning guidelines from SAP.

To install SAP ERP 6.0 central system, the team followed the instructions from the following SAP installation guides:

- Java™ installation
- IBM DB2® database installation
- SAP installation master

The team selected DB2 for Windows and installed a central system with central services, a database instance, and a central instance (Figure 42):
After the successful installation, the team tested the system processes. Refer to Figure 28.

Then they checked the installation with the SAP GUI log on.

The team logged in with SAP at the SAP system.
6.1.2 Enhanced monitoring

Refer to SAP Notes SAP Note 1409604 Virtualization on Windows: Enhanced monitoring when you plan to use the SAP system for productive use.

Modify the ESX server with vSphere Client - Configuration. In the Advanced Settings dialog box, click Misc and set the value of Misc.GuestLibAllowHostInfo to 1.

Modify the ESX server with vSphere Client - Configuration. In the Advanced Settings dialog box, click Misc and set the value of Misc.GuestLibAllowHostInfo to 1.

![Image](image1.png)

Figure 30: ??

Add parameter in the virtual machine setting – ‘Options’ - ‘Advanced’ - ‘General’ – . In the Configuration Parameters dialog box, set the value of the tools.guestlib.enableHostInfo parameter to TRUE.

![Image](image2.png)

Figure 31: ??

Install VMware Tools inside the virtual machine and this step is mandatory to use the modified SAPOSCOL and the enhanced monitoring in the transactions os07n. Add the library directory C:\Program Files\VMware\VMware Tools\Guest SDK\lib\win64 to the PATH variable in this virtual machine.
Install C-runtime 8.0 from Microsoft for the 64-bit Windows platform in the virtual machine that runs the SAP server. Refer to the following URL:

Stop the SAPOSCOL service, download and replace SAPOSCOL from SAP Service Marketplace: Support Packages and Patches - Entry by Application Group" Additional Components" - SAP Kernel" SAP KERNEL 64-BIT UNICODE" - SAP KERNEL 7.01 64-BIT UNICODE - #Database independent

Restart the SAPOSCOL service after replacement.

The new SAPOSCOL service can retrieve data only if the VMware Tools are installed in the virtual machine.

Refer to the SAP Note 1260719 for detailed description of the specific virtualization counters in this view.
Figure 33: Eight virtual processors

After successful installation, you can check the system configuration. The fastest way to check this and get an overview of the performance is by using the task manager. You can see eight processors in these virtual machines. You can then clone this virtual machine to a template for the next steps,
7. Sample configurations for SAP

7.1 Small configuration

Figure 34: Small configuration

7.2 Medium configuration

Figure 35: Medium configuration
7.3 Large configuration in two locations

![Diagram of large configuration in two locations](image)

**Figure 36: Large configuration in two locations**
8. Conclusion

Based on fifth-generation IBM X-Architecture technology, the IBM System x3850 X5 is a highly scalable x86 server, designed to deliver innovation with features that enable optimal performance for consolidation and virtualized SAP environments.

IBM System x servers and the VMware vSphere portfolio are high performance platforms for server consolidation of SAP enterprise applications. IBM offers a broad range of systems combined with IBM storage systems and services for creating a virtualized environment for SAP applications.

IBM SAN Volume Controller and Storwize V7000 system can offer exceptional business values to VMware users through compelling strategic solutions for complex and dynamic virtualized environments. IBM SAN Volume Controller and Storwize V7000 systems, with its inherent design and partnership-fortified tight end-to-end VMware interoperability, provide the perfect virtualized storage complement to VMware platforms.

Users of both the solutions gain server-storage virtualization primed for whatever business endeavor that comes next, while reducing the risk, cost, and complexity of storing and managing their most important asset, which is data.
9. Resources

These websites provide useful references to supplement the information contained in this paper:

- IBM Systems on PartnerWorld
  ibm.com/partnerworld/systems

- IBM Power Systems Information Center
  http://publib.boulder.ibm.com/infocenter/powersys/v3r1m5/index.jsp

- IBM Redbooks
  ibm.com/redbooks

- IBM Publications Center
10. About the authors

Text about the author goes here. If there are multiple authors, change heading to authors. Highlight the author name in bold, use lowercase for the job title and show the area within IBM. Giving readers an e-mail address for the authors is acceptable.

If there are appendices, this section becomes one of the appendices sections.

**John Smith** is a consultant in IBM Systems and Technology Group ISV Enablement Organization. He has more than 10 years’ experience working with the IBM System xyz platform. As part of … You can reach John at johnsmith@us.ibm.com.

**Maik Gasterstaedt** is an IBM storage and cloud computing specialist within IBM Germany. Working in the IBM SAP International Competence Center in Walldorf in Germany, he is responsible to develop and proof architectures, concepts and storage related solutions for SAP environments.

You can reach Paul and Maik at ISICC@de.ibm.com
11. Trademarks and special notices

© Copyright IBM Corporation 2011. All rights Reserved.

References in this document to IBM products or services do not imply that IBM intends to make them available in every country.

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. If these and other IBM trademarked terms are marked on their first occurrence in this information with a trademark symbol (® or ™), these symbols indicate U.S. registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at www.ibm.com/legal/copytrade.shtml.

Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

Intel, Intel Inside (logos), MMX, and Pentium are trademarks of Intel Corporation in the United States, other countries, or both.

UNIX is a registered trademark of The Open Group in the United States and other countries.

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

SET and the SET Logo are trademarks owned by SET Secure Electronic Transaction LLC.

Other company, product, or service names may be trademarks or service marks of others.

Information is provided "AS IS" without warranty of any kind.

All customer examples described are presented as illustrations of how those customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics may vary by customer.

Information concerning non-IBM products was obtained from a supplier of these products, published announcement material, or other publicly available sources and does not constitute an endorsement of such products by IBM. Sources for non-IBM list prices and performance numbers are taken from publicly available information, including vendor announcements and vendor worldwide homepages. IBM has not tested these products and cannot confirm the accuracy of performance, capability, or any other claims related to non-IBM products. Questions on the capability of non-IBM products should be addressed to the supplier of those products.

All statements regarding IBM future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only. Contact your local IBM office or IBM authorized reseller for the full text of the specific Statement of Direction.

Some information addresses anticipated future capabilities. Such information is not intended as a definitive statement of a commitment to specific levels of performance, function or delivery schedules with respect to any future products. Such commitments are only made in IBM product announcements. The information is presented here to communicate IBM’s current investment and development activities as a good faith effort to help with our customers’ future planning.

Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user’s job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput or performance improvements equivalent to the ratios stated here.

Photographs shown are of engineering prototypes. Changes may be incorporated in production models.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.