Increase Efficiency for SAP Landscapes with EMC Symmetrix FAST VP

An Architectural Overview

EMC GLOBAL SOLUTIONS

Abstract

This white paper describes how EMC® Symmetrix VMAX™ Fully Automated Storage Tiering for Virtual Pools (FAST VP) can provide SAP customers with a multi-tiered storage system that is automatically and efficiently managed. I/O is optimized automatically as the SAP data grows and changes over time, which eliminates the manual work and the costly downtime associated with manual I/O optimization.

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Table of Contents

Executive summary

Introduction to the new EMC Symmetrix VMAX and Enginuity 5875

EMC's latest Proven Solutions for both desktop and business-critical application environments make it easier and faster to manage infrastructure and clone applications for test and development through virtualization. These solutions document best practices that can drive significant cost savings and better performance for demanding application workloads, while accelerating the customer's journey to the private cloud.

Proven Solutions use new and enhanced features to validate storage efficiency and scale for organization growth:

- EMC® Symmetrix VMAX™ Fully Automated Storage Tiering for Virtual Pools (FAST VP)—providing better optimization of high-performance Flash drives, and better responsiveness to changes in data activity through sub-LUN automated storage tiering
- VMware® vStorage APIs for Array Integration (VAAI)—enabling storage administrators to maintain control of the infrastructure, while managing virtual server storage and other applications sharing the same storage array
- New duplicate TimeFinder®/Snaps—creating capacity-efficient replicas for application testing and development, and maximizing the use of existing storage

Business case

Traditional SAP storage management methods are costly and labor-intensive

Managing storage for SAP results in high storage costs over time and requires frequent manual intervention by database administrators in order to sustain dynamic performance requirements, especially as data grows.

Typical overallocation of expensive storage

Even though SAP business processes typically access recent data, which is a subset of the database, SAP customers often place their entire SAP multi-terabyte production systems on Tier 1 (highest performance, typically FC) storage. Customers do this to simplify management and ensure the performance required during cycles of peak processing such as "period end" or seasonal demand spikes. In addition, SAP customers typically provision the Tier 1 storage to accommodate future, not current, needs.

Pain point: Satisfying required performance SLAs without driving up costs

Large SAP production databases can cause degradation of system performance over time. Conventional methods of dealing with this issue include conducting complex projects to analyze the data and then using SAP archiving or database technologies to ensure adequate system performance.

What's needed

SAP customers need an automated solution that makes the most cost-effective use of storage while sustaining the dynamic performance requirements of an SAP system, putting the right data in the right place at the right time.

Solution overview

This solution demonstrates that EMC Symmetrix® VMAX Fully Automated Storage Tiering for Virtual Pools (FAST VP) provides SAP customers with a multi-tiered storage system that is automatically and efficiently managed. FAST VP analyzes the SAP workload and re-tiers frequently used data to a higher-performing tier, such as EFD, to offer optimal I/O performance.

FAST VP also analyzes SAP data activity and moves seldom used data to a lower-cost tier (such as from FC to SATA). I/O is optimized nondisruptively as the SAP data grows and changes over time. This reduces the need to perform manual data analysis and eliminates the downtime associated with complex disk layout changes.

Key results

Key results of the validation of the solution are as follows:

22% CAPEX reduction

A multi-tiered EFD/FC/SATA configuration with FAST VP results in a 22 percent cost reduction in storage capital expenditure (CAPEX) without compromising system performance or throughput.

37% OPEX reduction

A multi-tiered EFD/FC/SATA configuration with FAST VP results in a 37 percent savings in the operational expenditure (OPEX).

Automated and optimized storage management with sustained performance

FAST VP provides an automated solution to simplify optimization of storage resources while meeting the performance requirements of a realistic SAP workload. Storage is managed as pools instead of LUNs tracked with spreadsheets, and storage can be provisioned quickly with no downtime for data growth.

Additional feature support

The solution supports the following additional capabilities, which can be implemented at any time.

- Rapid cloning from thick LUNs to thin LUNs using EMC Replication Manager (part of the EMC Intelligent Cloning for SAP solution)
- Integration with performance analysis and tuning tools such as EMC Symmetrix Performance Analyzer

Introduction

Purpose

The purpose of this paper is to show that SAP customers can significantly reduce costs over time while maintaining required performance levels by deploying EMC Symmetrix VMAX with FAST VP.

Scope

This paper describes a solution that enables SAP customers to reduce costs over time while maintaining required performance using EMC Symmetrix VMAX with FAST VP. The solution demonstrates how FAST VP effectively manages a tiered storage configuration, maintaining performance service levels while reducing storage costs throughout the lifecycle of SAP applications.

Specifically, this paper describes:

- The functionality improvements with Symmetrix Enginuity™ 5875 microcode
- The migration experience of an SAP ERP 6.0 system installed on thick (traditional) LUNs to thin (virtually provisioned) LUNs
- The performance of the SAP ERP 6.0 system, under heavy workload, both before and after FAST VP-initiated data movement between storage tiers

Audience

The target audience for this white paper is business executives, IT directors, and infrastructure administrators who are responsible for their company's SAP landscape.

The target audience also includes professional services groups, system integration partners, and other EMC teams tasked with deploying SAP systems in a customer environment.

This paper is also intended for those who seek an introduction to the rationale or use cases for the tiering of storage using EMC Symmetrix VMAX in support of SAP landscapes.

A high-level understanding of SAP solutions, SAP landscapes, and the practice of storage tiering is beneficial. Familiarity with virtualization concepts is also beneficial.

Terminology

This section defines terms that may appear in this document.

Term	Description
Data device	Virtual Provisioning™ term for devices (not mapped to the host) that provide physical storage for thin devices. Data devices must be contained in a virtual pool before they can be used.
Disk group	Physical disk drives within the Symmetrix VMAX that are grouped by technology (Flash, FC, SATA), rotational speed, and size. A disk group may be part of multiple storage tiers.
Enginuity	The operating environment that provides the intelligence that controls all components in a Symmetrix VMAX array.
Enterprise Flash drive (EFD)	Also known as solid state or Flash drives. EFDs contain no moving parts and provide the best performance for applications sensitive to traditional magnetic disk drive latency.
FAST policies	FAST policies manage data placement and movement across storage types to achieve service levels for one or more storage groups. They contain a set of tier usage rules that defines how an application's disks will be distributed across storage tiers.
FAST VP	Fully Automated Storage Tiering for Virtual Pools (FAST VP) supports automatic storage tiering at the sub-LUN level. VP denotes virtual pools, which are Virtual Provisioning thin pools. FAST VP is a feature of EMC Enginuity 5875.
Fibre Channel (FC)	FC is a technology for transmitting data between computer devices. FC is especially suited for connecting computer systems to shared storage devices and for interconnecting storage controllers and drives.
Fully Automated Storage Tiering (FAST)	FAST is a feature of Symmetric VMAX that automates the identification of data volumes for the purpose of allocating or reallocating SAP or other business application data across different performance and capacity tiers within the storage array.
Logical unit number (LUN)	A unique identifier used to distinguish storage devices.
PowerPath®	EMC server-resident software that enhances performance and application availability by supporting multiple I/O paths to logical devices, and intelligently distributing I/O requests across all available paths. PowerPath also provides automatic failover in the event of a hardware failure by automatically detecting the path failure and redirecting I/O to another path.
I/O response time	The interval of time between submitting an I/O request and receiving a response.
Serial Advanced Technology Attachment (SATA)	A hard disk technology that focuses on greater data density, less power consumption, and less cost, but that has lower data transfer rates.
SMC	Symmetrix Management Console is a powerful and intuitive GUI that configures and manages multiple Symmetrix arrays. It presents the functionality of the SYMCLI in a browser interface and simplifies storage administration tasks though the use of built-in wizards. It includes the functionality for configuring FAST VP.

SPA	Symmetrix Performance Analyzer is a server-based application that provides a single tool to monitor the realtime workload activity for a number of Symmetrix arrays. It is integrated with SMC and shares SMC resources, while providing diagnostic, performance, and planning information with easy-to-use graphical data representations.
Storage group	A user-defined logical grouping of devices for common management by FAST. A storage group is associated with a FAST policy, which determines how the storage group's devices are allocated across tiers.
Storage tier	A user-defined set of one or more virtual pools containing data devices of the same technology and protection type.
Storage type	A shared storage resource with common technologies.
SYMCLI	Symmetrix Solutions Enabler command line interface.
Thin device (TDev)	A logical device that is configured and presented to the host but that allocates physical storage only as needed. The physical storage used to supply disk space to the thin devices comes from the virtual pool to which the thin device is bound. Thin devices can be created with an inflated capacity, because the actual storage space for data written to them is provided by data devices. To a host operating system, thin devices look like standard devices with their configured capacity, and the host interacts with them in the same way as standard devices.
Tiered storage	Tiered storage is the process of maintaining storage of varying performance characteristics, or protection requirements, within the same array or across multiple arrays. Tiered storage gives administrators the flexibility to utilize their resources effectively by aligning storage technology to the appropriate information value and access speed requirements.
VAAI	vStorage APIs for Array Integration.
Virtual LUN (VLUN)	Virtual LUN technology enables the migration of data between storage tiers within the same array. VLUN provides the ability to move data without disrupting SAP users or users of other business applications.
Virtual LUN VP Mobility	Virtual LUN VP Mobility enables administrators to manually move thin LUNs between pools. VP denotes virtual pools, which are Virtual Provisioning thin pools. This new feature of Enginuity 5875 includes the ability to regather a thin volume's many chunks from multiple virtual pools and move them all to a single pool, regardless of the underlying disk technology or RAID protection. Movements are completely transparent to the environment, having no host or application impact.
Virtual pool	A Virtual Provisioning thin pool consisting of a collection of data devices that provide storage capacity for the thin devices that are bound to the pool. All data devices in a given virtual pool share the same RAID protection level and are of the same drive technology. Virtual Provisioning automatically stripes data across all data devices in a virtual pool, balancing the workload across physical storage devices. To ensure even striping of data, it is recommended that all data devices in a virtual pool are the same size. Virtual pools provide the storage tiers used by FAST VP.
Virtual Provisioning	EMC's implementation of thin provisioning.
VSI	Virtual Storage Integrator. VMware vCenter™ Server plug-in.

Key components

Component list

This section identifies and briefly describes the major components of the validated solution environment. The components are:

- EMC Symmetrix VMAX storage array
- EMC Symmetrix Management Console (SMC)
- EMC FAST VP
- SAP ERP 6.0
- VMware vSphere™
- VMware vCenter Server

EMC Symmetrix VMAX storage array

EMC Symmetrix VMAX with Enginuity version 5875 provides the newest microcode edition to the Symmetrix family. The tiered storage configuration used in the test environment is based on the following VMAX features:

- Sub-LUN FAST VP
- VLUN 3 or Virtual LUN VP Mobility
- VAAI

Built on the strategy of simple, intelligent, modular storage, it incorporates a new, highly scalable Virtual Matrix Architecture™ that enables VMAX arrays to grow seamlessly and cost-effectively from an entry-level configuration into the world's largest storage system. VMAX supports EFDs, FC drives, and SATA drives within a single array, as well as an extensive range of RAID types.

The EMC Enginuity operating environment provides the intelligence that controls all components in the VMAX array. Enginuity 5875 for Symmetrix VMAX offers:

- More efficiency: New zero-downtime technology for migrations (technology refreshes) and lower costs with automated tiering
- More scalability: Up to two times more performance, with the ability to manage up to 10 times more capacity per storage administrator
- More security: Built-in encryption, RSA-integrated key management, increased value for virtual server and mainframe environments, replication enhancements, and a new e-licensing model

EMC Symmetrix Management Console (SMC)

The Symmetrix VMAX storage system provides a built-in web browser interface, Symmetrix Management Console (SMC). SMC provides centralized management to the entire VMAX storage infrastructure.

In the context of FAST, SMC integrates easy-to-use wizards to:

- Define storage groups
- Create storage tiers
- Create a thin pool
- Set FAST policies

EMC FAST VP

FAST VP is the sub-LUN version of Fully Automated Storage Tiering (FAST). It enables the storage administrator to set high-performance policies that utilize more Flash drive capacity for critical data, and cost-optimized policies that utilize more SATA drive capacity for less-critical data. With FAST VP, customers can achieve:

- Maximum utilization of Flash drives for high-performance workloads
- Lower overall total cost of storage by placing the inactive data on SATA drives
- Better or same performance than all-FC configurations, but at a lower cost, requiring fewer drives, less power and cooling, and a smaller footprint
- Radically simplified management in a tiered environment

FAST VP moves portions of a volume or LUN between tiers, based on the changing performance requirements of applications. It builds on the premise that only portions of a volume or LUN are active, and those are the portions that should be promoted to Flash drives. Since only the active portions of the volume or LUN are being moved to Flash drives, customers get the best utilization out of their limited Flash drive capacity. Additionally, FAST VP also moves inactive portions of a volume or LUN to SATA drives and enables customers to use both Flash and SATA together in Tier 1 environments.

More importantly, because FAST VP also moves inactive portions of a volume or LUN to SATA drives, customers can attain the optimal combination of the best cost per IOPS and the fastest response time benefits of Flash, offset by the best price per gigabyte afforded by SATA drives. It also enables customers to use different combinations of Flash, FC, and SATA to meet a broad range of application performance targets more efficiently.

SAP ERP 6.0

SAP Enterprise Resource Planning (ERP) 6.0 Enhancement Pack (EHP) 4 is a world-class, fully integrated solution that fulfills the core business needs of midsize and large organizations across all industries and market sectors. Powered by the SAP NetWeaver technology platform, SAP ERP 6.0 helps enterprises to perform financial analysis, human capital management, procurement and logistics, product development and manufacturing, and sales and service, supported by functionality for analysis, corporate services, and end-user service delivery. Together with SAP NetWeaver and a repository of enterprise services, SAP ERP 6.0 can serve as a solid business process platform that supports continued growth, innovation, and operational excellence.

VMware vSphere

VMware vSphere is the industry's most complete, scalable, and powerful virtualization platform, delivering the infrastructure and application services that organizations need to transform their information technology and deliver IT as a service. VMware vSphere provides agility, control, and efficiency while fully preserving customer choice.

VMware vCenter Server

VMware vCenter Server presents a universal hub for managing the VMware vSphere environment. It provides unified management of all hosts and virtual machines in a data center from a single console. VMware vCenter Server enables administrators to improve control, simplify day-to-day tasks, and reduce the complexity and cost of managing an IT environment.

Physical Architecture

Overview

The environment consists of VMware ESX® servers, which contain the entire infrastructure required to operate an SAP ERP 6.0 EhP4 testing bed, including a central instance, dialog instances, LoadRunner Controller, and LoadRunner load generators. SAP ERP 6.0 EhP4 is hosted on a Red Hat Linux/Oracle platform. EMC Symmetrix VMAX provides flexible, highly available storage while ensuring performance for the entire SAP system.

Physical architecture diagram

Figure 1 illustrates the physical architecture of the solution as validated.

Note: The validated environment required additional servers and software (HP LoadRunner) to generate a repetitive SAP-specific workload.

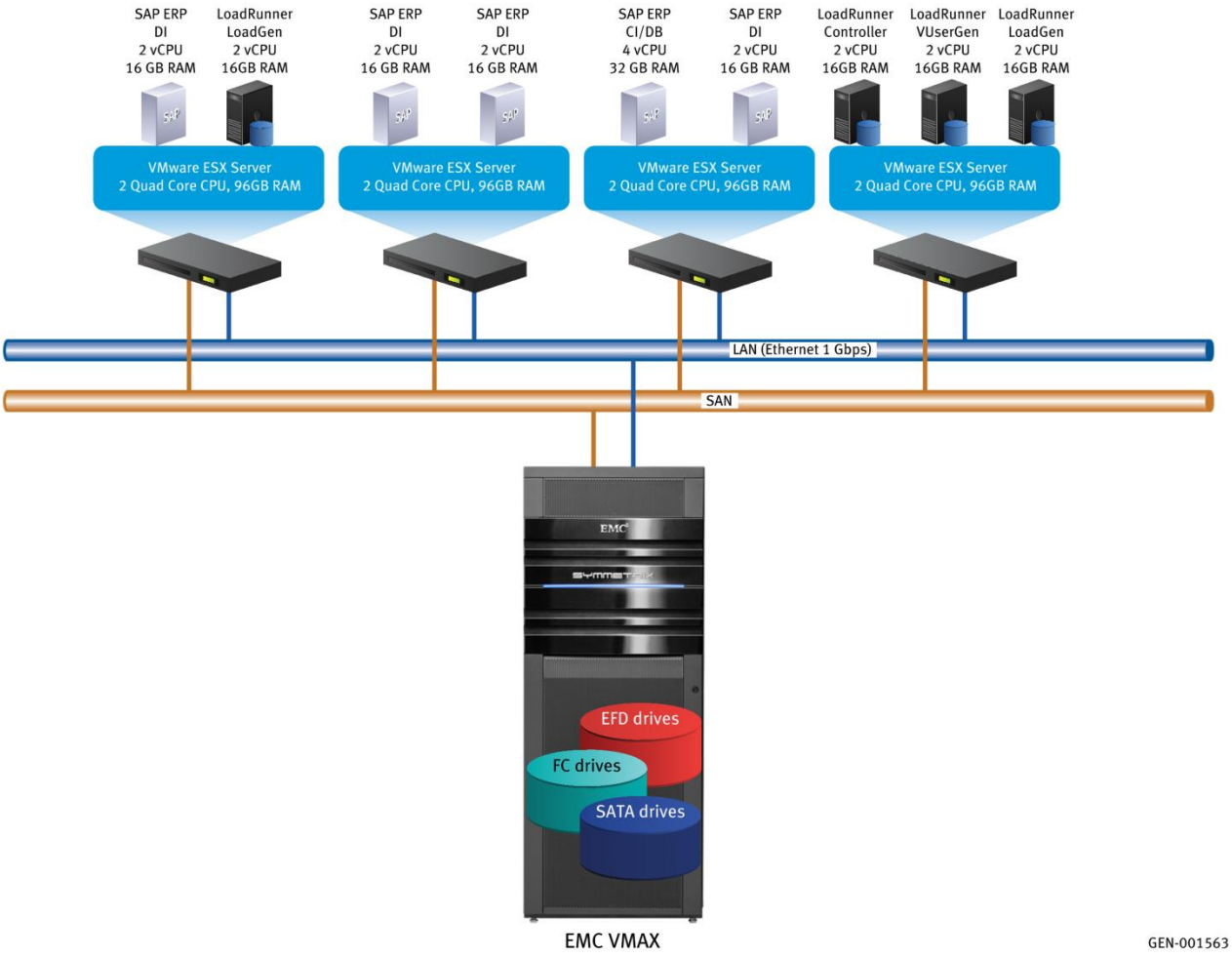


Figure 1 Physical architecture

Environment profile

Hardware resources

Table 1 lists the hardware used to validate the solution.

Table 1 Hardware resources

Equipment	Quantity	Configuration
EMC Symmetrix VMAX	1	Two-engine VMAX 56 GB cache 300 GB 15k FC disks 1 TB 7.2k SATA disks 200 GB Flash drives
Intel x86-based servers	4	Two quad-core Intel Nehalem CPUs with 96 GB RAM

Software resources

Table 2 lists the software used to validate the solution.

Table 2 Software resources

Software	Version
SAP ERP	6.0 Core EHP4 IDES
SAP NetWeaver	7.0 EHP 1 Unicode 64-bit
Oracle Database	10.2.0.4 64-bit
Red Hat Enterprise Linux	5.2 AS 64-bit
VMware vSphere	4.0 Update 2
VMware vCenter	4.0 Update 2
EMC VMAX Enginuity	5875
EMC Solutions Enabler	7.2.0.524
EMC Replication Manager	5.3.1
HP LoadRunner (used to simulate an SAP workload in the validation lab)	9.5.1
Precise (used for analysis)	8.8.1

Solution design and validation

Overview

Validating or proving a solution end to end is a complex endeavor. The validation of this solution can be represented by the following phases:

1. Design an enterprise-level SAP ERP system using EMC hardware and software.
2. Deploy an enterprise SAP ERP 6.0 system on the EMC VMAX platform.
3. Test and compare/contrast performance of the system on virtual machines running a sample SAP business workload (generated by HP LoadRunner) under a traditional thick LUN configuration, a thin LUN configuration, and a FAST VP configuration.

SAP ERP system configuration

SAP ERP system RE2 was installed as a central system with the IDES (International Demonstration and Education System) database on Oracle/Red Hat Linux.

IDES, in the ERP system, represents a model company. It consists of an international group with subsidiaries in several countries. IDES contains application data for various business scenarios that can be run in the SAP system. The business processes in the IDES system are designed to reflect real-life business requirements, and have access to many realistic characteristics.

RE2 consists of one central instance (CI/DB) and four dialog instances (DIs). All instances were installed on virtual machines (VMs) with the configuration shown in Table 3.

Table 3 RE2 instance VM configuration

Instances	CPU	Memory
CI/DB (1)	4 vCPUs	32 GB RAM
DI (4)	2 vCPUs	16 GB RAM

RE2 was configured as follows:

- Linux was configured according to SAP-specific notes (refer to SAP documentation in the Reference section on page 39 of this document).
- Database patches, parameters, and statistics were configured according to SAP installation guides, notes, and procedures provided with patches (refer to SAP documentation in the Reference section on page 39 of this document).
- SAP Basis settings (Housekeeping Batch Jobs, Support Add-ons, Early Watch Alert, SAP Buffer, Extended Memory, Heap Memory, Operation Mode, and so on) were configured according to SAP notes to accommodate the workload.
- The SAP load-balancing algorithm was modified according to SAP recommendations to give more weight to the number of logged-in users than to the average response time. This achieved evenly distributed users on all dialog instances.
- SAP Update processes (UPD/UP2) were configured on the central instance.

- VMware vSphere was configured according to SAP recommendations and VMware performance best practices.
- Some IDES functionality—for example, synchronization with the external GTS system—was deactivated to eliminate unnecessary external interfaces that might cause errors that could be disruptive to the focus of the validation testing. No such external interfaces were configured or customized outside the SAP standard IDES.
- The system was configured and customized to enable LoadRunner automated scripts to run business processes across functional areas including Sales and Distribution (SD), Material Management (MM), Finance and Controlling (FI/CO), and Basis.

Initial disk layout (before enabling FAST VP)

In the validation environment, one storage group contained the SAP IDES database.

Note: Redo logs and SAP and Oracle file systems were not included in this storage group.

Table 4 shows the initial mount point, file system, disk tier, protection type, and capacity information for both thick device configuration and thin device configuration.

Table 4 Initial disk layout (before enabling FAST VP)

Mount point	VG	Filesystem	Thick Device	Thin Device	Disk Tier	Protection Type	Size (GB)	Logical Disk
/oracle/RE2/mirrlogA	sapmirrlogvg	fslvmirrlogA	005B	005B	FC	RAID 1+0	32	/dev/sdc
/oracle/RE2/mirrlogB	sapmirrlogvg	fslvmirrlogB						
/oracle/RE2/origlogA	saporalogvg	fslvoriglogA	005A	005A	FC	RAID 1+0	32	/dev/sdb
/oracle/RE2/origlogB	saporalogvg	fslvoriglogB						
/oracle/RE2/sapdata1	sapdata1vg	fslvsapdata1	005C	015C	FC	RAID 5	64	/dev/sdd
			005D	015D	FC	RAID 5	64	/dev/sde
/oracle/RE2/sapdata2	sapdata2vg	fslvsapdata2	005E	015E	FC	RAID 5	**64**	/dev/sdf
			005F	015F	FC	RAID 5	64	/dev/sdg
/oracle/RE2/sapdata3	sapdata3vg	fslvsapdata3	0060	0160	FC	RAID 5	64	/dev/sdh
			0061	0161	FC	RAID 5	64	/dev/sdi
/oracle/RE2/sapdata4	sapdata4vg	fslvsapdata4	0062	0162	FC	RAID 5	64	/dev/sdj
			0063	0163	FC	RAID 5	64	/dev/sdk
/oracle/RE2/sapdata5	sapdata5vg	fslvsapdata5	0064	0164	FC	RAID 5	64	/dev/sdl
			0065	0165	FC	RAID 5	64	/dev/sdm
/oracle/RE2/sapdata6	sapdata6vg	fslvsapdata6	0066	0166	FC	RAID 5	64	/dev/sdn
			0067	0167	FC	RAID 5	64	/dev/sdo
/sapmnt/RE2	sapvg	fslvsapmnt	0088	012E	FC	RAID 5	32	/dev/sdp
/usr/sap/RE2	sapvg	fslvusrsap						
/usr/sap/trans	sapvg	fslvusrsaptrans						
/oracle/RE2/oraarch	saparchvg	fslvsaparch	0089	011F	FC	RAID 5	64	/dev/sdq
/oracle/RE2/saptrace	saparchvg	fslvsaptrace	008A	0120	FC	RAID 5	64	
/oracle/client	oraclevg	fslvoraclient	008B	012F	FC	RAID 5	32	/dev/sdr
/oracle/stage	oraclevg	fslvorastaging						
/oracle/RE2/102_64	oraclevg	fslv102_64						

Final disk layout (after enabling FAST VP)

Table 5 shows the final mount points, file systems, disk tiers, protection types, and capacity information for the thin device configuration resulting from the FAST VP data relocation.

Three virtual pools were created, one for each storage tier—Flash (EFD) drives, Fibre Channel (FC) drives, and SATA drives. Each storage tier was configured with an appropriate protection type.

The colors depict LUN utilization. Red is high, yellow is medium, and blue is low.

In the table, the percentage values specified in the FAST VP policy (2%, 38%, 60%) correspond to the allocation of the storage group to each of the three storage tiers.

After the FAST VP data relocation, portions of the LUNs were allocated to the new storage tiers. The values shown in green indicate the percentages of the LUNs that were moved nondisruptively by FAST VP to the new storage tiers.

Note: In some cases, an entire LUN might not be highly utilized but some of its sub-LUNs might be highly utilized. In the table, Thin Device 0164 is an example of this.

Table 5 Final disk layout (after enabling FAST VP)

										FAST VP Policy			
Mount point	VG	Filesystem	Thin Device	Disk Tier	Protection Type	Size (GB)	Before FAST VP	New Disk Tiers	Protection Type	2 % EFD	38 % FC	60 % SATA	After FAST VP
/oracle/RE2/mirrlogA	sapmirrlogvg	fslvmirrlogA	005B	FC	RAID 1+0	32							
/oracle/RE2/mirrlogB	sapmirrlogvg	fslvmirrlogB											
/oracle/RE2/origlogA	saporalogvg	fslvoriglogA	005A	FC	RAID 1+0	32							
/oracle/RE2/origlogB	saporalogvg	fslvoriglogB											
/oracle/RE2/sapdata1	sapdata1vg	fslvsapdata1	015C	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	4	44	52	
			015D	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	0	38	62	
/oracle/RE2/sapdata2	sapdata2vg	fslvsapdata2	015E	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	3	52	45	
			015F	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	0	46	54	
/oracle/RE2/sapdata3	sapdata3vg	fslvsapdata3	0160	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	0	37	63	
			0161	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	3	31	66	
/oracle/RE2/sapdata4	sapdata4vg	fslvsapdata4	0162	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	1	25	74	
			0163	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	2	43	55	
/oracle/RE2/sapdata5	sapdata5vg	fslvsapdata5	0164	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	6	40	54	
			0165	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	1	28	71	
/oracle/RE2/sapdata6	sapdata6vg	fslvsapdata6	0166	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	3	30	67	
			0167	FC	RAID 5	64		EFD / FC / SATA	RAID 5 / 5 / 6	0	42	58	
/sapmnt/RE2	sapvg	fslvsapmnt	012E	FC	RAID 5	32							
/usr/sap/RE2	sapvg	fslvusrsap											
/usr/sap/trans	sapvg	fslvusrsaptrans											
/oracle/RE2/oraarch	saparchvg	fslvsaparch	011F	FC	RAID 5	64							
/oracle/RE2/saptrace	saparchvg	fslvsaptrace	0120	FC	RAID 5	64							
/oracle/client	oraclevg	fslvoraclient	012F	FC	RAID 5	32							
/oracle/stage	oraclevg	fslvorastaging											
/oracle/RE2/102_64	oraclevg	fslv102_64											

HP LoadRunner system configuration

HP LoadRunner is software that emulates hundreds or thousands of concurrent users to apply production workloads to almost any application platform or environment. HP LoadRunner stresses an application from end to end—applying consistent, measurable, and repeatable loads—and then uses the data to identify scalability issues that can affect real users in production.

The LoadRunner system consists of one LoadRunner Controller and three Load Generators installed on virtual machines with the configuration shown in Table 6.

Table 6 HP LoadRunner instance VM configuration

Instances	CPU	Memory
Controller and Load Generator (1)	2 vCPUs	16 GB RAM
Load Generators (3)	2 vCPUs	16 GB RAM

The following configurations were applied to the LoadRunner Controller and Load Generators.

- The controller parameters were configured according to best practices, including enabling IP spoofing, running as process instead of thread, and setting think time to a limited value.
- SAP technical and functional transactions were recorded and customized using scripts and variables instead of fixed values. A set of recorded scripts was added to a customized scenario to simulate SAP business users performing routine tasks with high intensity. This resulted in a workload similar to a real-world enterprise workload with regard to business volume and complexity.

SAP ERP workload profile

The following business processes were run by a LoadRunner customized scenario to generate the application specific workload.

Order to Cash (OTC)

This process covers a sell-from-stock scenario, which includes the creation of a customer order with six line items and the corresponding delivery with subsequent goods movement and invoicing. The process consists of the following transactions:

1. Create an order with six line items (Transaction VA01).
2. Create a delivery for this order (VL01N).
3. Display the customer order (VA03).
4. Change the delivery (VL02N) and post a goods issue.
5. Create an invoice (VF01).
6. Create an accounting document.

Procure To Pay (P2P)

This process involves a series of steps to create a purchase requisition for material, a purchase order with a reference to the purchase requisition, changes to conditions, a goods receipt, and an invoice for the purchase order. The process consists of the following transactions:

1. Create a purchase requisition for a material (ME51N).
2. Create a purchase order with reference to the purchase requisition (ME21N).
3. Change the purchase order (ME22N).
4. Post a goods issue for purchase order (MB01).
5. Create an invoice (MIRO).

Material Master Data Maintenance

This process covers a material master data maintenance scenario, which includes the creation of a material with basic and extended information, a goods receipt, pricing condition configuration and 100 info records for this material. It consists of the following transactions:

1. Create a material (MM01).
2. Create a goods receipt for this material (MB1C).
3. Configure a material pricing condition (VK11).
4. Create an Info Record for the material (ME11).

COPA Report

This process runs the Execute Profitability Report (KE30) against a predefined operating concern with specific selection criteria.

Basis

Transaction SE16 (Data Browser) and DB05 (Analysis of a Table With Respect to Index Fields) are transactions used by limited authorized personnel for troubleshooting and system analysis purposes.

During validation testing, SE16 performed a query on a large database table and DB05 performed selectivity analysis on another large database table.

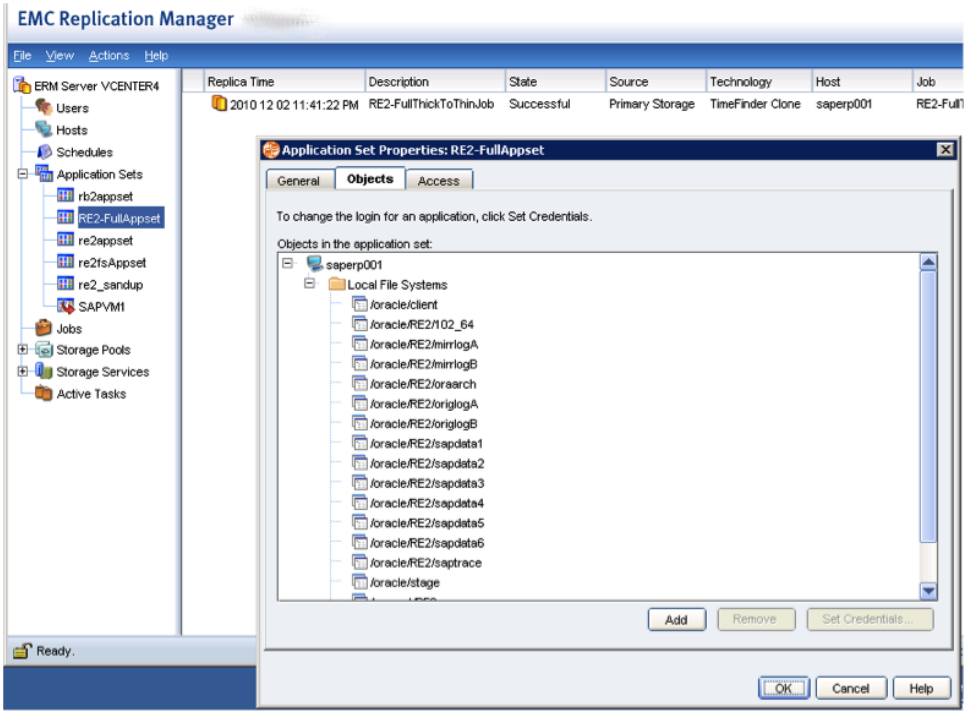
LUN conversion from thick to thin

The validation team used EMC Replication Manager (part of the EMC Intelligent Cloning for SAP solution) to convert a virtual machine running SAP ERP CI/DB from a thick-LUN to a thin-LUN configuration.

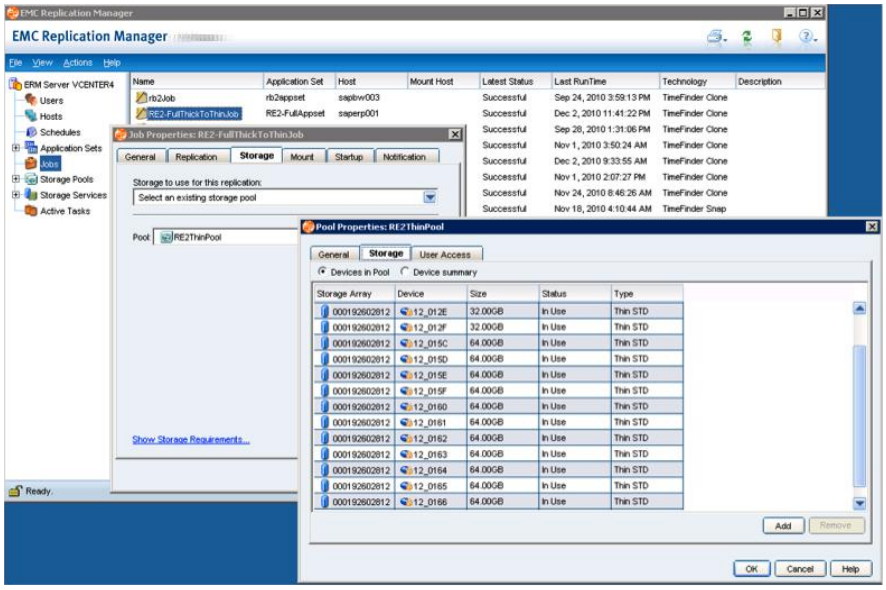
Note: This required shifting SAP from one virtual machine to another, which required the SAP system to be offline.

The high-level steps are as follows. (For detailed information, refer to EMC Intelligent Cloning for SAP documentation.)

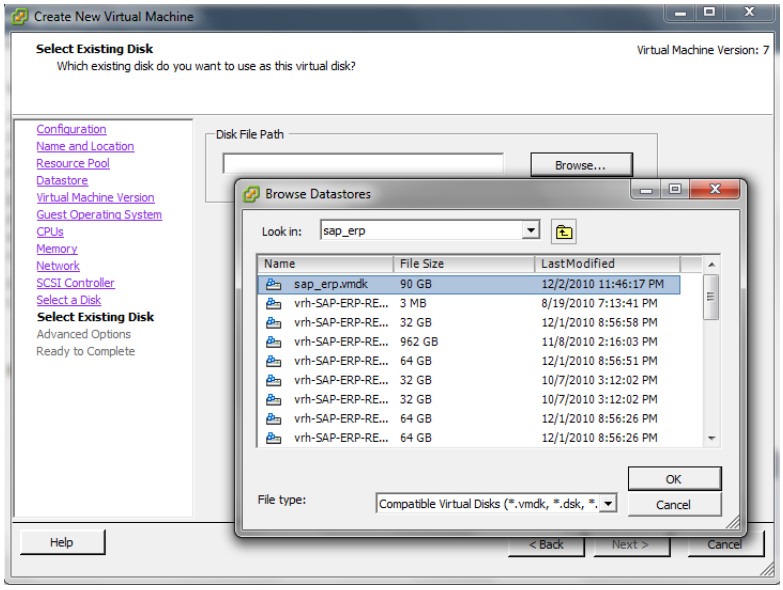
1. Create the target thin LUN clones for the SAP database and file systems.
2. Shut down the SAP ERP source system and the Oracle database on the CI/DB.
3. Create a Replication Manager job to clone the file systems from the source VM. The screenshots shown below illustrate an example of the job setup, starting with the Application Set.



In the screenshot below, the window in the background shows the file systems selected for replication. The window in the foreground shows the thin LUNs designated as clone LUNs.



4. Unmount and export all volumes from the source VM.
5. Shut down the source VM containing the CI/DB.
6. Use an existing disk to create a new VM for the OS. Using an existing disk eliminates the need to prepare a new OS to perform the conversion. This preserves the OS and IP configuration of the source VM. The screenshots shown below provide examples of this setup.



7. Assign to the new VM the thin LUNs that have been cloned.
8. Power up the new VM using thin LUNs.
9. Import the volume groups and mount the file systems.

FAST VP configuration

The validation team used the following management tools to configure FAST VP for the SAP environment:

- Solutions Enabler Command Line Interface (SYMCLI)
- Symmetrix Management Console (SMC)

The team performed the following configuration steps:

1. Set FAST VP working windows.
2. Create virtual pool tiers.
3. Create a FAST VP policy.
4. Create a storage group for FAST VP.
5. Associate a storage group with the FAST VP policy.
6. Enable FAST VP.

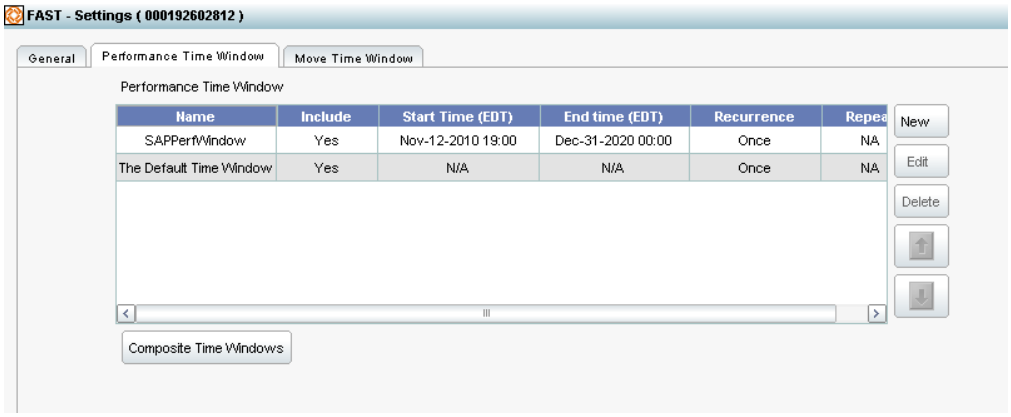
See also: For configuration details, considerations, and restrictions refer to EMC Symmetrix VMAX 5875 FAST VP configuration documentation.

Step 1: Set FAST VP working windows

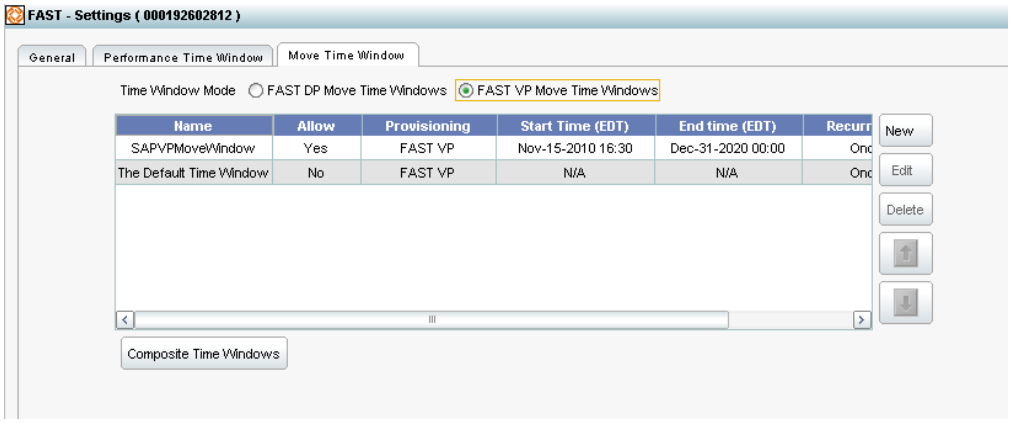
The FAST VP policy chosen to validate the solution (described in Step 3: Create a FAST VP policy) required two working windows to be set up:

- Performance Time Window
- Move Time Window

Performance was sampled as defined in the Performance Time Window (screenshot shown below).

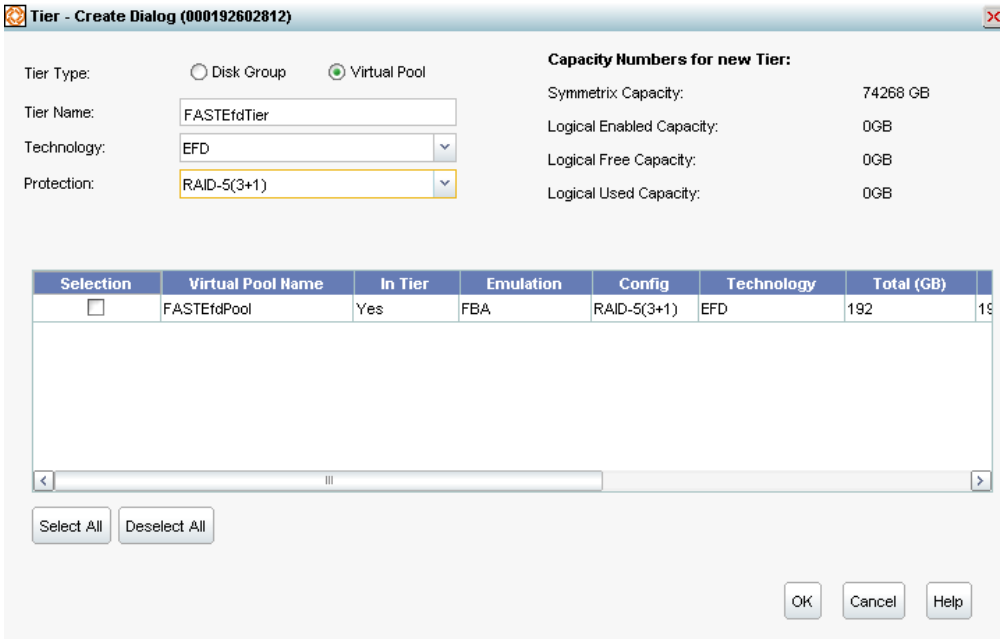


Data was promoted and demoted automatically, by the FAST VP policy, as defined in the Move Time Window (screenshot shown below).



Step 2: Create virtual pool tiers

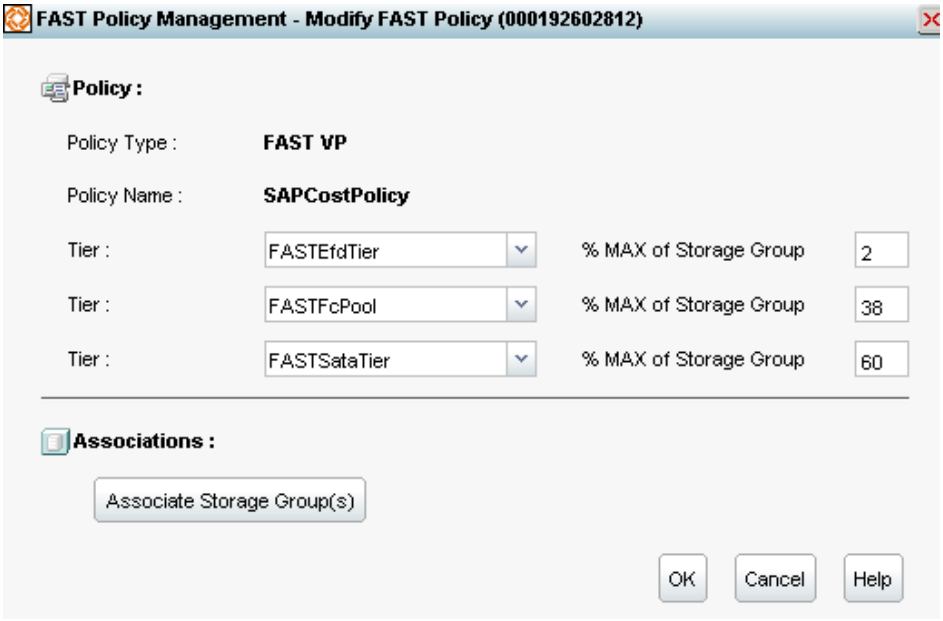
Virtual pools to be managed by FAST VP first need to be organized in tiers. To add virtual pools to a tier, under FAST, right-click on Thin Tiers, select Create Tier, and add the required virtual pools to the tier.



Step 3: Create a FAST VP policy

The FAST VP policy governs the usage of the virtual pool tiers. The FAST VP policy affects only the thin devices in a storage group. Each policy can govern up to three tiers. Administrators can set a storage group allocation percentage for each tier (from 1% to 100%). The total percentage (across all tiers) must be at least 100% but cannot exceed 300%.

The validation team created a policy to govern three tiers. The team then tested various combinations of storage group allocation percentages across the tiers. In the validation environment, the values 2% EFD / 38% FC / 60% SATA demonstrated the greatest cost savings without impacting performance.



Step 4: Create a storage group for FAST VP

The validation team created a new storage group containing only the thin LUNs to be managed by FAST VP. The team observed the following rules when creating the storage group:

- All devices in the storage group must be under the control of only one policy.
- The storage group must contain only the devices that will be under FAST VP control.

Note: In the validated environment, only the storage group containing the SAP ERP database was added to the FAST VP policy.

Step 5: Associate the storage group with the policy

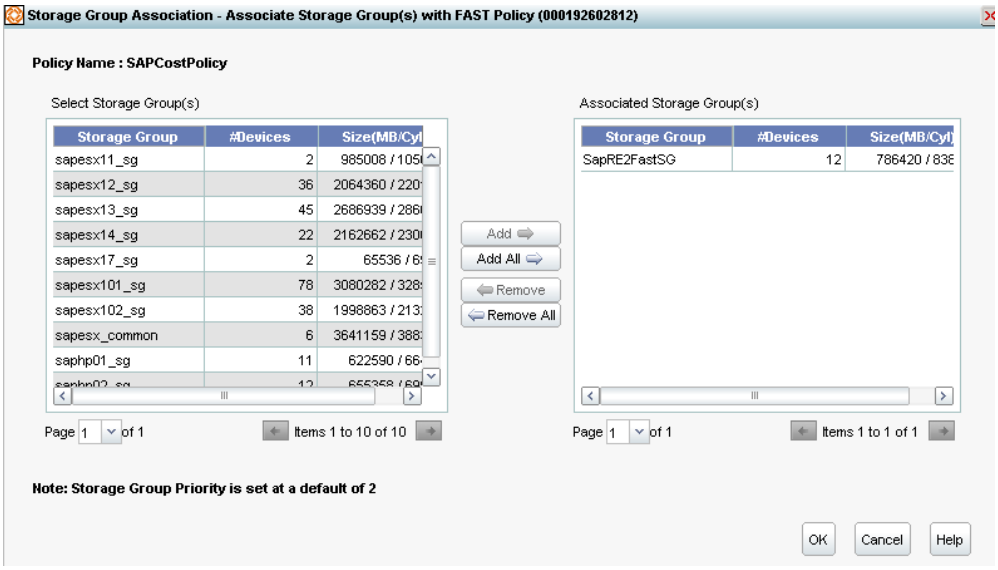
Administrators associate the storage group (containing the thin LUNs) with the FAST VP policy. The following rules apply:

- The storage group can be associated with only one policy.
- The maximum number of storage group-to-FAST VP policy associations cannot exceed 8,192.

Note: The validation team used only one storage group and one policy.

About the association priority

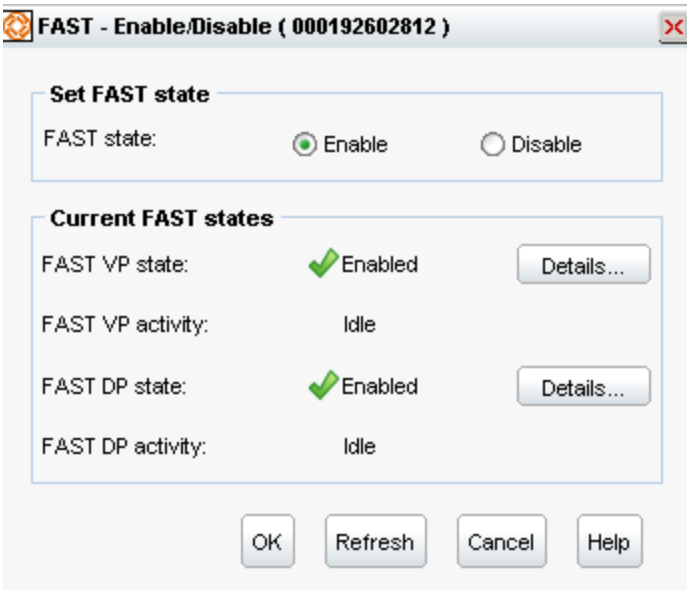
Storage groups associated with a policy are assigned a priority value that determines the order in which the tiers serve the storage group in the event of a conflict. For example, if two storage groups simultaneously require more capacity than is available in a storage tier, the storage group with the higher priority receives the storage first. Administrators can adjust the association priority value. Possible values range from 1 (the highest priority) to 3 (the lowest priority).



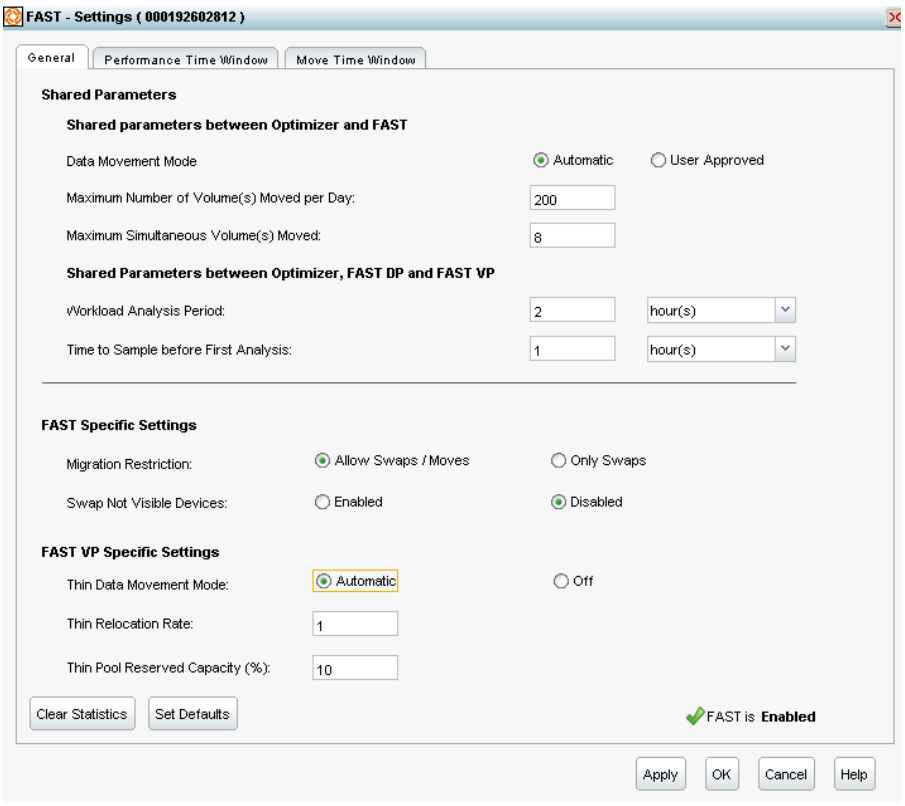
Step 6: Enable FAST VP

The validation team used this procedure to enable FAST VP on the Symmetrix VMAX storage array.

1. In SMC, navigate to FAST › FAST Control Parameters › Enable/Disable FAST. For FAST State, select Enable.

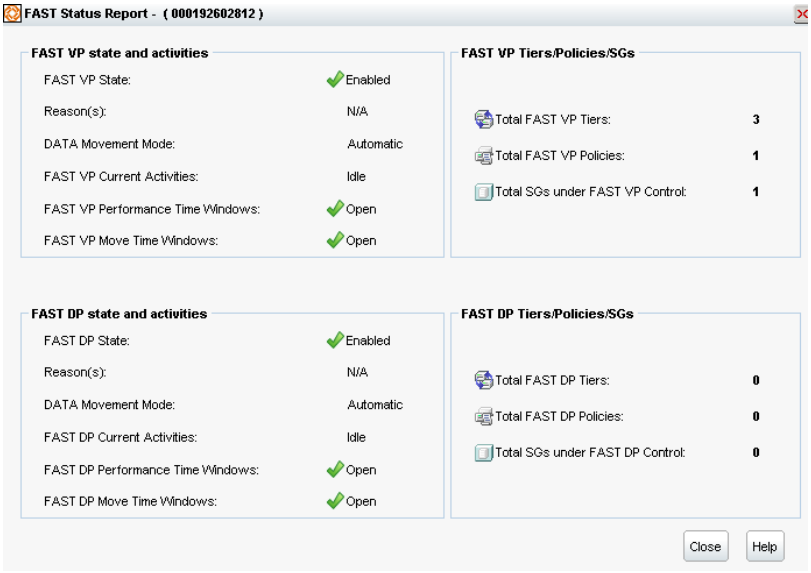


2. In SMC, navigate to FAST › FAST Control Parameters › Settings. For FAST VP Specific Settings Thin Data Movement Mode, select Automatic.



This activates the FAST VP Performance Time Window and Move Time Window, configured in Step 1: Set FAST VP working windows.

3. In SMC, navigate to FAST › FAST Status Report.



This screen shows that FAST VP is enabled and the Performance and Move Time Windows are active.

Testing methodology

Methodology overview

The validation team simulated a typical SAP production environment with storage back-end I/O. The team ran a series of tests to compare and contrast the performance and throughput of the following storage configurations:

- A traditional, single-tiered FC thick LUN configuration
- A multi-tiered, EFD/FC/SATA thin LUN configuration with EMC FAST VP

The validation team used the following key performance indicators (KPI) to evaluate system throughput and performance:

- Business volume (number of SAP business documents processed)
- SAP average response time for dialog workprocess

These KPIs were compared across multiple storage tier configurations.

Since FAST VP works at the storage level, performance metrics were collected from the VMAX storage system.

VMware vSphere ESX servers provided adequate CPU and memory resources during all of the testing to ensure that the systems were never resource-constrained.

Analysis tools list

The following tools were used to analyze the test results:

- EMC Tier Advisor
- EMC STP Analyzer
- EMC Symmetrix Performance Analyzer
- EMC Symmerge
- SAP system monitoring transactions (ST04, ST03N)
- Oracle Enterprise Manager
- Precise

EMC Tier Advisor

EMC Tier Advisor is an analytical performance modeling tool that helps to demonstrate the value of tiered storage. The validation team used this tool to estimate the initial performance and cost of different combinations of disk drive technologies. Tier Advisor estimated initial storage tiering benefits based on storage statistics collected following an SAP workload run on traditional Fibre Channel (FC) thick LUNs.

EMC STP Analyzer

EMC STP Analyzer is a software tool that collects, graphs, analyzes, and archives performance data for effectively monitoring and managing performance trends in an information infrastructure. The validation team used EMC STP Analyzer to analyze EMC Symmetrix VMAX storage performance statistics after an SAP workload was run on each of three different storage tier configurations.

EMC Symmetrix Performance Analyzer

EMC Symmetrix Performance Analyzer is software that collects and stores historical performance data for analysis and reporting on workload and resource usage trends for:

- High-frequency data collection
- Root cause analysis
- Alerts and events
- User-definable charts
- Service level management
- Capacity planning

The validation team used EMC Symmetrix Performance Analyzer to analyze realtime storage performance statistics during HP LoadRunner-generated SAP workload runs.

EMC Symmerge

EMC Symmerge is a software tool used by Symmetrix performance experts to help optimize system utilization and performance. The validation team used EMC Symmerge to analyze EMC Symmetrix VMAX storage performance statistics after an SAP workload was run on each of three different storage tier configurations. The team also used the tool to generate the utilization (heat) maps presented in the Test results section of this document, beginning on page 34.

Precise

Precise is application performance management software that monitors and analyzes critical business systems from the end user to the EMC storage array. Precise has developed an EMC edition of its Precise for SAP product that fully integrates with EMC Symmetrix and CLARiiON®. This product connects the SAP transaction activity with the database and storage resources being consumed. Precise for SAP OS agent, Oracle agent, listener agent, and EMC storage agent was installed in the test environment and used to correlate Oracle wait event information with underlying EMC storage device information.

Load generation

The SAP ERP 6.0 EHP4 system used to validate this solution was a standard IDES system with custom configuration and additional master data and transactional data. The database size was 511 GB and the SAP SID was RE2.

LoadRunner Controller ramped up six virtual users every 15 seconds until the number of virtual users reached 253 concurrent and active users. All users generated system workload activity during all testing periods for all storage tiering strategies.

The controller distributed the 253 virtual users across four vuser generators (including the controller itself) to execute several business process scripts.

All vuser generators connected to RE2 through the logon group "FAST-VP" in order to distribute the workload evenly across the dialog instances.

The peak load ran for two hours. The controller then ramped down five vusers every 30 seconds until the load was diminished.

The 253 virtual users were grouped as shown in Table 7.

Table 7 Distribution of users across business processes

SAP business processes	Number of concurrent, active users
Order to Cash (OTC)	110
Procure To Pay (P2P)	110
Material Master Data Maintenance	30
COPA Report	1
Basis SE16	1
Basis DB05	1

Test phases

The following test phases were designed to assess application and storage efficiency with different storage configurations:

Phase 1: Apply the workload to the SAP system with a thick LUN configuration and capture performance/throughput information to identify a baseline.

Phase 2: Apply the workload to the SAP system with a thin LUN configuration, capture performance/throughput information, and compare it with the baseline.

Phase 3: Apply the workload to the SAP system with a FAST VP configuration, capture performance/throughput information, and compare it with the baseline.

Test sequence

The following test sequence was followed:

1. Perform test phase 1.
2. Use Replication Manager with EMC TimeFinder cloning technology (part of the EMC Intelligent Cloning for SAP solution) to convert LUNs from a thick LUN to a thin LUN configuration.
3. Perform test phase 2.
4. Enable FAST VP.
5. Perform test phase 3.

Test procedure

The validation team performed the following steps for each of the three test phases:

1. Count existing SAP documents for the business.
4. Reset the SAP and LoadRunner environment.
5. Start OS performance collection daemons.
6. Run the LoadRunner scenario.
7. Stop OS performance collection daemons.
8. Count existing SAP documents for the business processes.
9. Collect performance metrics from SAP, Oracle, VMAX, and Precise.

Test results

Results overview

Test results were captured from the SAP ERP system, Oracle, and the VMAX array after each HP LoadRunner scenario completed. The results were then compared to the baseline.

The entire suite of tests was run multiple times and the average test results are presented.

FAST VP results were collected after the initial data movement completed.

SAP business throughput

Figure 2 depicts the SAP business volume throughput. The results pertain to the main documents for the OTC, P2P, and Material Master Data Maintenance business processes. The COPA Report and Basis transactions were run simultaneously. The Y axis represents the number of SAP business documents processed per minute.

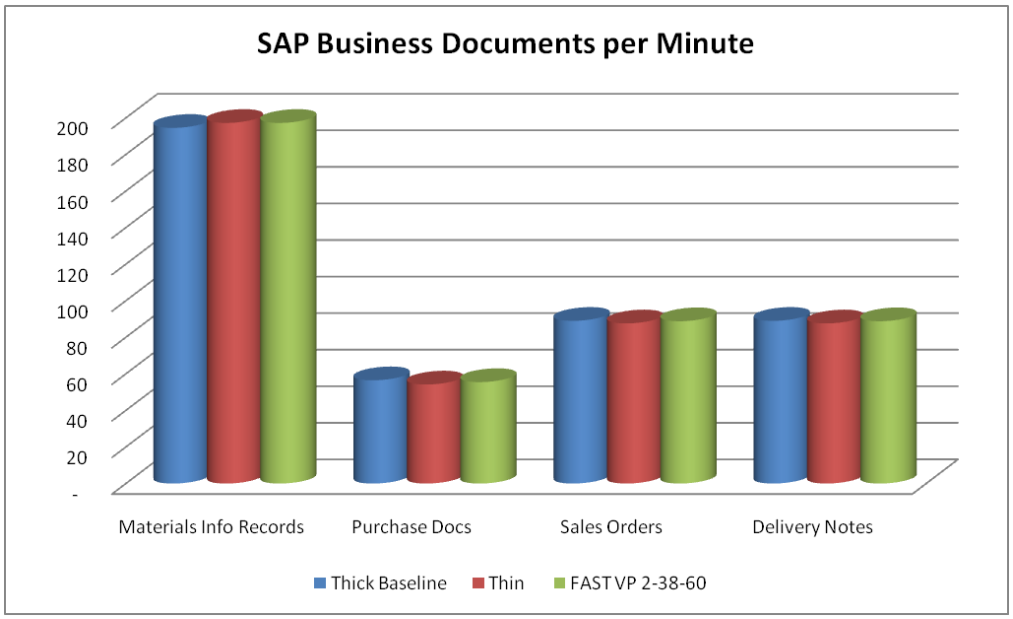


Figure 2 SAP business throughput

Table 8 presents the same data in a tabular format.

Table 8 SAP business throughput

Test runs	Materials info records/min	Purchase docs/min	Sales orders/min	Delivery notes/min
Thick baseline	194	56	89	89
Thin	197	54	87	87
FAST VP 2% EFD / 38% FC / 60% SATA	197	56	89	89

Characterization

After converting the storage LUNs from a thick LUN configuration to a thin LUN configuration with FAST VP enabled, the system maintained the performance and processed the same volume of business documents as with the baseline configuration.

SAP system performance

Figure 3 depicts the total number of SAP dialog steps and the average response time for each of the three configurations.

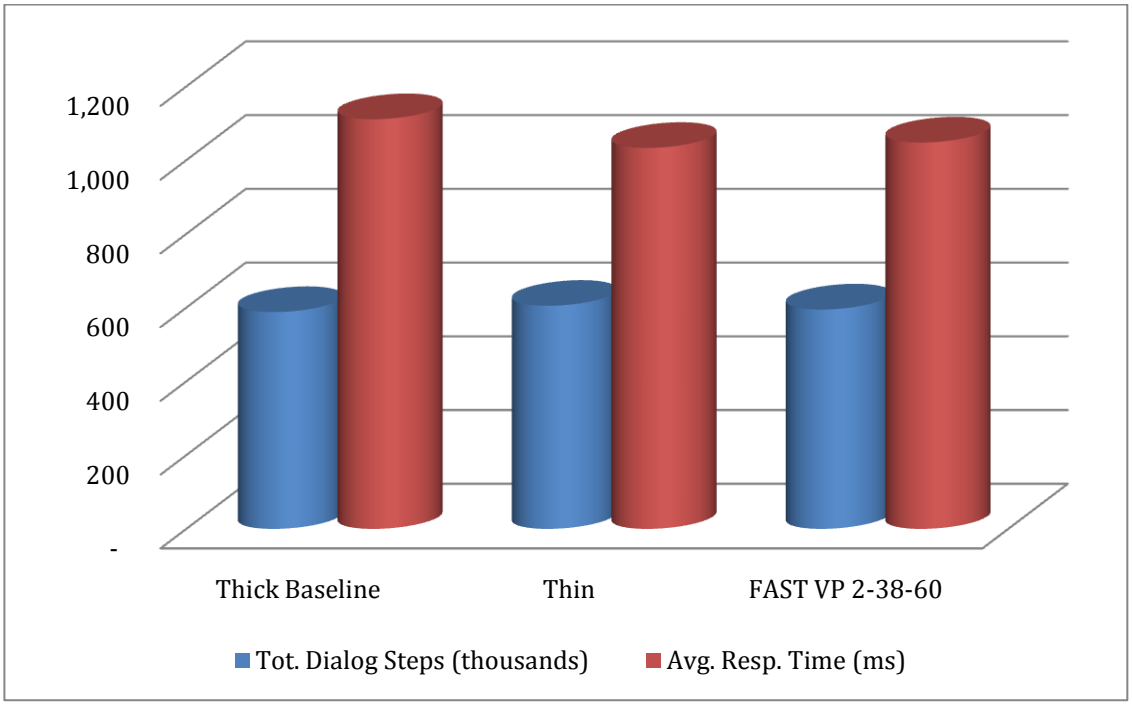


Figure 3 SAP system performance

Table 9 presents the same data in a tabular format.

Table 9 SAP system performance

Test Runs	Total dialog steps in thousands	Average response time in milliseconds
Thick baseline	588	1,111.1
Thin	605	1,033.3
FAST VP 2% EFD / 38% FC / 60% SATA	595	1,047.9

Characterization

Converting the storage LUNs from a thick LUN configuration to a thin LUN configuration resulted in the entire database being placed into a single, large virtual pool on FC disks. This, in turn, resulted in higher throughput and lower average response time than the baseline configuration.

With FAST VP enabled, the FAST controller analyzes the workload and generates data movement requests to move the data to EFD and SATA disks as specified by the FAST VP policy. Results with FAST VP enabled were also higher for throughput and lower for average response time than the baseline.

Oracle I/O performance

Figure 4 depicts the Oracle I/O wait (in percentages).

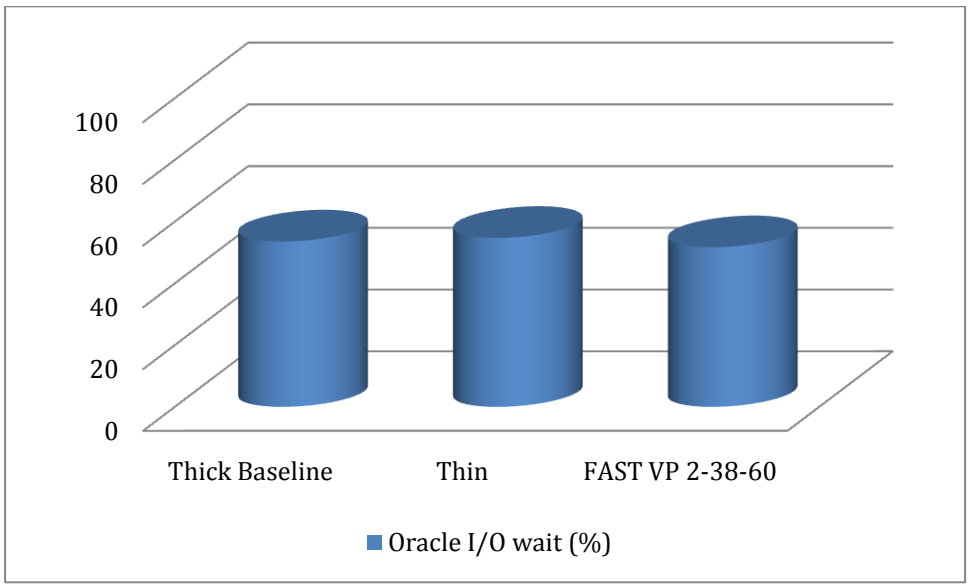


Figure 4 Oracle I/O performance

Table 10 presents the same data in a tabular format.

Table 10 Oracle I/O performance

Test runs	Oracle I/O wait
Thick baseline	53.58 %
Thin	54.74 %
FAST VP 2% EFD / 38% FC / 60% SATA	51.71 %

Characterization

With a 2% EFD / 38% FC / 60% SATA FAST VP tier strategy, the I/O wait was reduced compared with the baseline. In other words, the system spent less time waiting for I/O to/from the storage.

VMAX disk utilization

Symmetrix heat maps are an output of the EMC Symmerge Utility. This utility can be used to illustrate visually the disk usage during a workload period. Disks that are busier are shown in yellow and orange while less busy disks are shown in green and blue.

Baseline (thick LUN) configuration

The heat map of the original (baseline) disk layout is shown in Figure 5. This map indicates that only a few disks are busy but most are not.

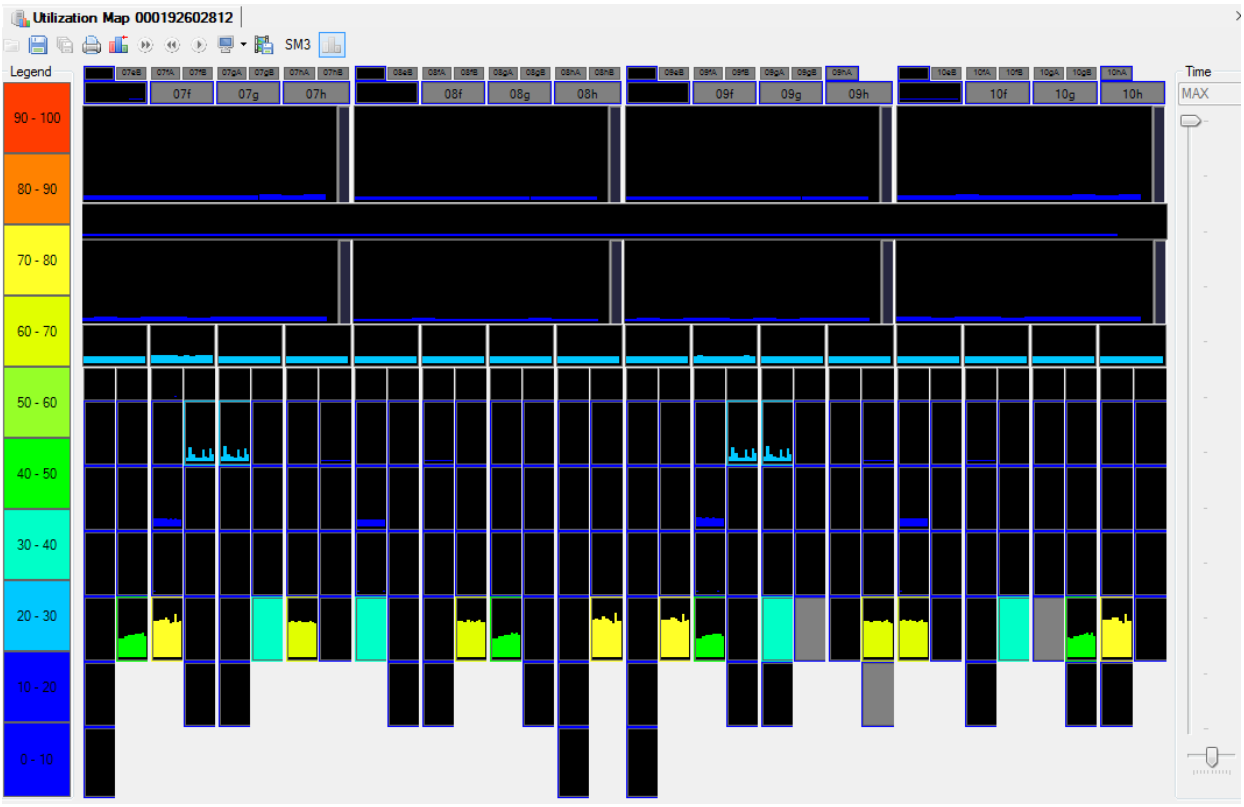


Figure 5 Heat map of the baseline (thick LUN) configuration

Thin LUN configuration

As shown in Figure 6, after converting from thick to thin LUNs, I/O utilization was more evenly spread across the disks, although some disks were still being utilized slightly more than others.

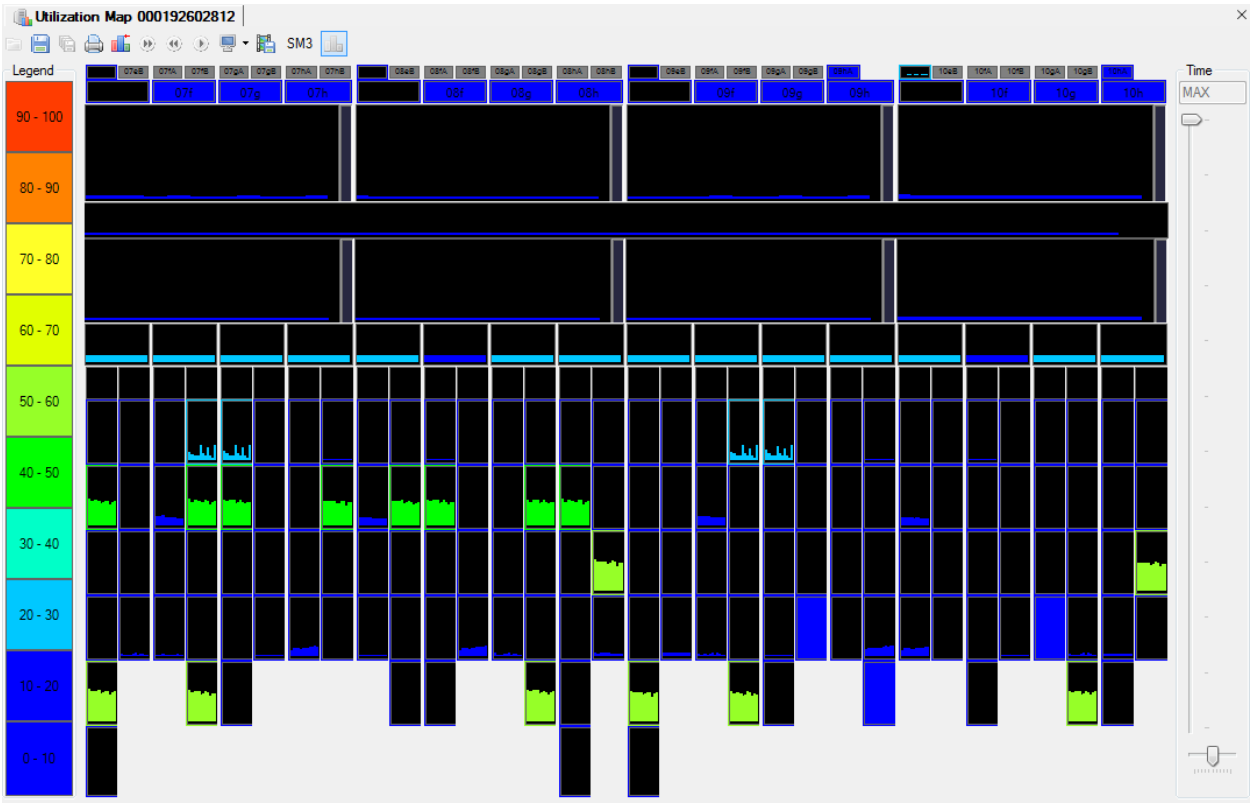


Figure 6 Heat map of the thin LUN configuration

FAST VP-enabled configuration

After enabling FAST VP, I/O utilization was spread evenly across the drives. The utilization of all drives was balanced, as shown in Figure 7.

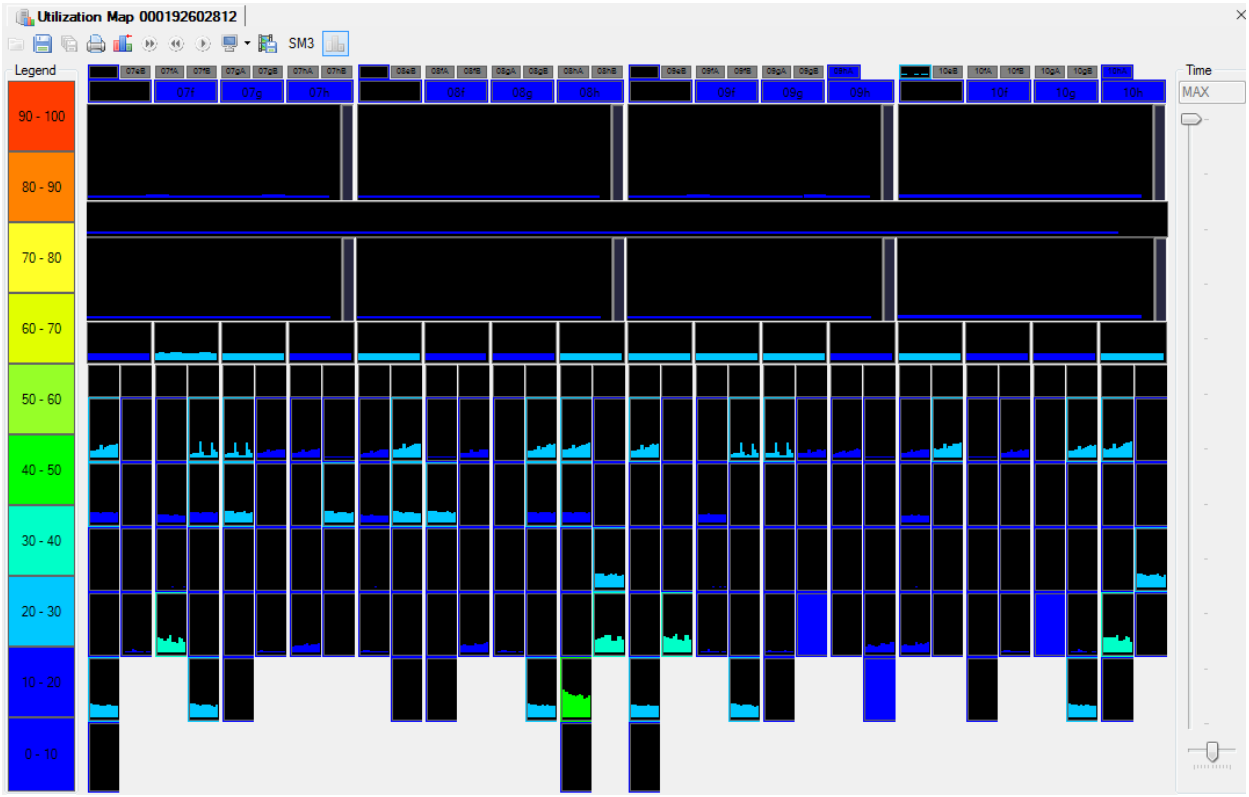


Figure 7 Heat map of the FAST VP-enabled configuration

Time required to convert from thick LUNs to thin LUNs

The entire SAP environment occupied 960 GB of disk space. Converting from thick to thin LUNs involves LUN cloning. The validation team used the EMC Replication Manager (part of the EMC Intelligent Cloning for SAP solution) and EMC TimeFinder replication technology.

The initial synchronization of the source and target LUNs required 53 minutes to complete.

Recommendation: Run the EMC Replication Manager job to perform initial synchronization before cutover to reduce the downtime associated with conversion.

Metrics for FAST VP-initiated data moves

The validation team measured the effects on storage during a FAST VP-initiated data move.

Specifically, the team evaluated the move resulting from enabling FAST VP (2% EFD / 38% FC / 60% SATA) on the thin LUN configuration. For database LUNs occupying 768 GB, the team captured the number of back-end IOPS, the time to achieve allocation policy compliance, and the time to optimize the location of the data.

Note: The data move that was measured (from Fibre Channel to a three-tier strategy) was the initial, one-time data move that occurred after FAST VP was enabled for the first time.

Note: No SAP downtime was required to execute the FAST VP-initiated data moves.

The results are presented in Table 11. As the table shows, IOPS returned to normal following the data move, and the cumulative time to achieve allocation policy compliance and optimize the location of the data was 100 minutes.

Table 11 Effects on storage during a FAST VP-initiated data move

Back-end IOPS before and after move	Back-end IOPS during initial, one-time move	Time to achieve allocation policy compliance (minutes)	Time to optimize the location of the data (minutes)
1,300	3,500	85	15

Note: More than half of the SAP database was relocated to another storage tier, which explained the high level of activity in the storage back end during the initial move performed non-disruptively by FAST VP. Subsequent, incremental moves performed by FAST VP generated minimal storage back-end load.

Conclusion

Summary

This solution illustrates the significant cost saving benefits of combining EMC Symmetrix VMAX Fully Automated Storage Tiering for Virtual Pools (FAST VP) with an SAP ERP application. FAST VP improves storage efficiency while reducing complexity through automation to meet the dynamic business-driven performance requirements of an SAP ERP instance. The solution also demonstrates the potential cost saving benefits of leveraging the server virtualization capabilities of VMware vSphere.

Key points / findings

Key results of the validation of the solution are as follows:

22% CAPEX reduction

A multi-tier EFD/FC/SATA configuration with FAST VP results in a 22 percent cost reduction per gigabyte in storage capital expenditure (CAPEX) without compromising system performance or throughput. This figure was derived by evaluating and comparing the costs of the storage tier configurations with and without the use of FAST VP.

37% OPEX reduction

A multi-tier EFD/FC/SATA configuration with FAST VP results in a 37 percent power consumption cost reduction per gigabyte in operational expenditure (OPEX). This figure was derived by using the EMC Power Calculator web-based tool to evaluate and compare the costs of the storage tier configurations with and without the use of FAST VP.

Automated and optimized storage management with sustained performance

FAST VP provides an automated solution to simplify optimization of storage resources while meeting the performance requirements of a realistic SAP workload. Storage is managed as pools instead of LUNs tracked with spreadsheets, and storage can be provisioned quickly with no downtime for data growth.

Additional benefits

Customers that have a single SAP production system that supports different functions at different business hours can also benefit from FAST VP continuous migration of hot data with minimal effects on the storage system back end.

For customers that have a consolidated data center that supports global SAP systems, user activity may vary from one time zone to another. With FAST VP automatic storage tiering, the most active business processes at any given time can receive optimal system performance.

A large number of development and quality assurance systems are typically consolidated on a single storage array in order to optimize cost efficiency. FAST VP virtual pools provide optimal disk utilization and also accommodate distributed peak loads resulting from multiple concurrent projects running on those systems.

Important considerations

All performance data contained in this report was obtained in a rigorously controlled environment. The complexity of the customer's SAP system landscape can produce different results. The following variables must be considered when determining a tiered storage FAST VP configuration:

- SAP system usage types and workloads
- SAP system interfaces with external SAP and non-SAP systems
- SAP system data volume, locality, and utilization intensity
- SAP system design, architecture, and implementation

Reference

Refer to the following documents for additional, related information.

EMC documentation

- *New Features in EMC Enginuity 5875 for Open System Environments* (EMC white paper)
- *EMC Implementing FAST VP and Storage Tiering for Oracle Database 11g and EMC Symmetrix VMAX* (EMC white paper)
- *Storage Tiering for VMware Environments Deployed on EMC Symmetrix VMAX with Enginuity 5875* (EMC white paper)
- *EMC Tiered Storage for SAP: A New Way to Optimize with Use Cases for EMC Symmetrix VMAX and Virtual LUN – Applied Technology* (EMC white paper)
- *New Features in EMC Enginuity 5875 for Mainframe Environments* (EMC white paper)
- *Enginuity—The EMC Symmetrix Storage Operating Environment – A Detailed Review* (EMC white paper)
- *Implementing EMC Symmetrix VMAX in a Cloud Service Provider Environment – Applied Technology* (EMC white paper)

VMware Documentation

- *SAP Solutions on VMware vSphere 4 Best Practice Guidelines* (SAP white paper)

SAP Documentation

- *Installation Guide: SAP ERP 6.0 – EHP4 Ready ABAP on Linux: Oracle Based on SAP NetWeaver 7.0 Including Enhancement Package 1*

SAP Notes

- 1122388 - Linux VMware ESX 3.x or vSphere Configuration Guidelines
- 0171356 - SAP software on Linux: Essential information
- 1048303 - Red Hat Enterprise Linux 5.x: Installation and upgrade

- 0941735 - SAP memory management for 64-bit Linux systems
- 0830576 - Parameter recommendations for Oracle 10g
- 0805934 - FAQ: Database time
- 0618868 - FAQ: Oracle Performance
- 0619188 - FAQ: Oracle wait events
- 0793113 - FAQ: Oracle I/O Configuration

HP LoadRunner Product Documentation