



**EMC Virtual Infrastructure for
Microsoft and Oracle Applications**

Enabled by EMC CLARiiON and VMware
vSphere 4

Blueprint

EMC Global Solutions



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Overview

Purpose

This Blueprint documents the results of the design and interoperability testing of an EMC® CLARiiON® environment that features FLARE® 29, VMware vSphere 4™, PowerPath®/VE, and Navisphere® Management Suite with virtualization-aware functionality.

Upon reading this document, companies will have clear direction on how to most effectively leverage the virtualization-aware features of EMC CLARiiON with Navisphere.

Blueprint definition

An EMC Global Solutions Blueprint documents the interoperability, functionality, and performance test results of a combination of EMC and third-party products chosen to meet a specific customer requirement.

In contrast to Proven Solution validation, a Blueprint does not include scalability testing results. While individually a Blueprint provides important customer value, it may also be used to feed into the development of a Proven Solution. Blueprint results are used to create Work Package deliverables for EMC KB.Wiki, Powerlink®, and EMC.com.

The business challenge

Companies are under increasing pressure to maximize resources and reduce costs. Many companies look to consolidate their IT infrastructures through virtualization to leverage under-utilized server and storage assets. However, there are concerns when combining several applications with unpredictable workload profiles, especially applications that support core business processes. It is imperative to verify that performance, information, and application availability are not compromised when there is a simultaneous increase in demand for all the applications within the consolidated, virtual infrastructure. This ensures there is no interruption in information availability or impact to revenue generation.

Additionally, many customers face management challenges in a virtual environment. Often, the storage administrator and VMware administrator are unable to communicate productively with each other, as each has their own tool set for managing system resources. Determining the intersection point of the tools is time consuming. Varying workloads cause variation in information access, further impacting application performance. In a virtual environment, determining the best way to balance the load across access paths traditionally adds another layer of complexity to the environment.

Companies need to find ways to access and manage information among the multiple content repositories.

**Blueprint
solution**

EMC has the experience for designing successful solutions within VMware environments to help maximize the value of your data center environment while reducing operational and management costs with a virtualized, consolidated environment.

A standardized infrastructure simplifies implementation and management of applications and enables you to provide common support for backup and high availability.

This Blueprint demonstrates how your company can:

- Use VMware vSphere 4 to manage multiple content repositories on different application platforms
 - Use CLARiiON CX4 to consolidate mixed workloads on a single, scalable storage platform
 - Reduce the costs of storage, power, and space by using a combination of hardware, software, and virtual machines
 - Reduce management costs with virtualization-aware capabilities, reducing the number of necessary management tools
 - Reduce the amount of physical servers: maintaining the same cumulative number of CPU cores and memory ensures similar performance levels. In addition, the solution promotes a more eco-friendly environment through the use of virtualization technology
 - Effectively manage a virtual environment, enabling communication between the storage and virtual machines
-

Key components

Introduction The following extracts identify and briefly describe the major components of the Blueprint.

EMC CLARiiON CX4-480 CLARiiON CX4 Model 480 provides high-capacity networked storage, in both Fibre Channel and iSCSI environments, that meets the needs of demanding OLTP workloads and large-scale email environments. With the CX4-480, customers can scale seamlessly up to 471 TB of storage capacity and consolidate twice the workloads in one array as is possible with other storage providers.

EMC is the only vendor to deliver virtualization-aware storage management functionality at the device manager level with the CLARiiON CX4.

EMC CLARiiON FLARE 29 FLARE is the name given to the operating environment that controls the operation of the CLARiiON CX4 disk-array storage systems. FLARE manages all functions of the storage system. Additional layered applications, such as Storage Groups, Virtual Provisioning™, SnapView™, MirrorView™, SAN Copy™, Navisphere QoS Manager, and Navisphere Analyzer, can be enabled within FLARE.

Some of the main benefits of CLARiiON FLARE 29 include:

- Virtualization-aware Navisphere, which automates resource discovery and reporting in VMware environments to help users maximize the value of their storage infrastructure in virtual environments
 - CLARiiON disk-drive Spin Down, which improves energy and cost efficiencies in virtual and physical environments
 - 10 Gigabit Ethernet connectivity for CLARiiON and Celerra®, which allows users to realize virtual server consolidation on a large scale
-

EMC PowerPath/VE PowerPath/VE delivers PowerPath Multipathing features to optimize VMware vSphere and Microsoft Server 2008 Hyper-V virtual environments. With PowerPath/VE, you can standardize path management across heterogeneous physical and virtual environments. PowerPath/VE enables you to automate optimal server, storage, and path utilization in a dynamic virtual environment. This eliminates the need to manually load-balance hundreds or thousands of virtual machines and I/O-intensive applications in hyper-consolidated environments.

The ability to make full use of the aggregate bandwidth available from a modern server has traditionally been a challenge in virtualized environments, constraining the degree to which workloads could be consolidated and yet still deliver the desired I/O performance. PowerPath allows enhanced cost savings as greater ESX host consolidation can be achieved because PowerPath enables an individual ESX host to fully utilize all the available performance of multiple I/O cards.

Key components

VMware vSphere 4

Building on the power of VMware Infrastructure, VMware® vSphere, the industry's first cloud operating system, dramatically reduces capital and operating costs and maximizes IT efficiency - with the freedom to choose any application, operating system, or hardware. Benefits include:

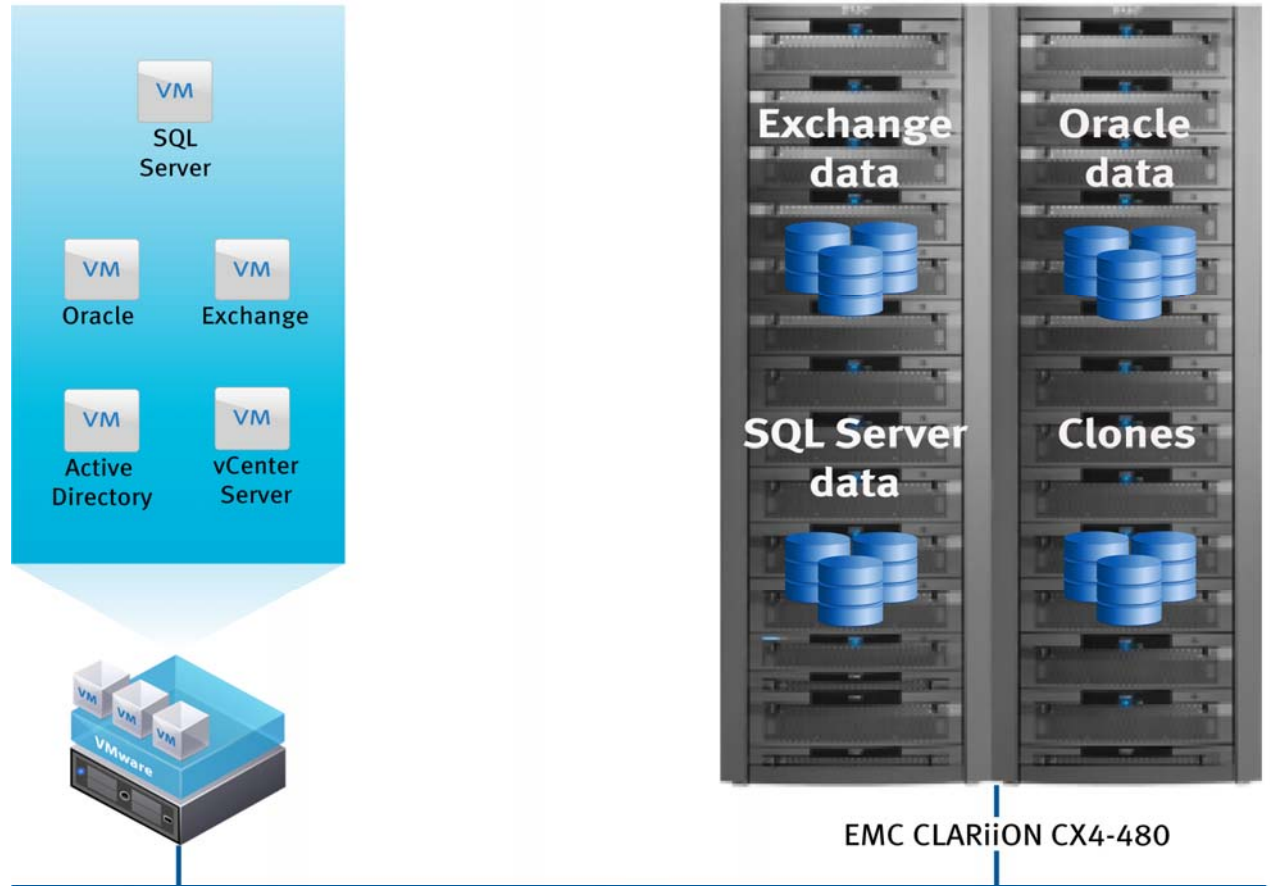
- Optimizing the IT infrastructure through server consolidation, automation, and high availability
- Decreasing downtime and improving reliability with business continuity and disaster recovery
- Increasing energy efficiency by running fewer servers and dynamically powering down unused servers with green IT solutions

Available in several different editions, VMware vSphere delivers targeted benefits to small, mid-size, and enterprise business customers.

Physical architecture

Architecture diagram

The following illustration depicts the overall physical architecture of the Blueprint.



— 1 Gigabit Ethernet
VM: VMware virtual machine

EMC PowerPath/VE
VMware vSphere 4
EMC FLARE 29 for CLARiiON CX4

- New features include:
- Disk-drive Spin Down
 - Virtualization-aware Navisphere
 - 10 Gb/s iSCSI

CL4360

Environment profile

Hardware resources

The hardware used in the Blueprint is listed below.

Equipment	Quantity	Configuration
Storage array	1	CLARiiON CX4-480 75 Fibre Channel disks
Network	1	Standard 1 Gb Ethernet switch
Server	1	<ul style="list-style-type: none"> • Mem: 132 GB RAM • CPU: 6 x Quad 2.66 GHz • NIC: 2 x Intel Dual 1 Gb Ethernet

Virtual machines

The virtual allocation of hardware resources is listed below.

Equipment	Quantity	Configuration
Windows 2008 (x64)	1	Exchange Server load with Jetstress
	1	SQL Server load with SQLIOSim
	1	Oracle load with ORION
	1	Domain Controller
	1	VMware vCenter

Software resources

The software used in the Blueprint is listed below.

Software	Version
EMC CLARiiON	FLARE 29 (4.29)
EMC Navisphere Management Suite	FLARE 29 (4.29)
EMC PowerPath/VE	5.4
Microsoft Exchange Server Jetstress Tool (x64)	2007 (08.02.0060)
Microsoft SQLIOSim	6.02
Oracle ORION	10.3
VMware vCenter	4.0.0 (b153581)
VMware vSphere ESX	4.0.0 (b 164009)

Design and validation

Introduction

This Blueprint is intended not only to meet the basic functionality requirements when deploying a mixture of mission-critical applications in a VMware vSphere environment, but to also provide solid foundations for future growth and development of the environment.

The following information will demonstrate how EMC can very simply and dynamically build, implement, manage, and monitor your virtualized environment while producing the performance that critical applications require.

This Blueprint shows the ease of use in implementing a 1 Gb iSCSI or 10 Gb iSCSI infrastructure while providing storage administrators with brand new ability to visualize and map their storage back-end to the virtual machine layer with the new virtualization-aware Navisphere features.

Interoperability

Before any applications are built out, the underlying infrastructure needs to be in place.

The primary platforms for this solution are:

- VMware vSphere ESX 4
- EMC CLARiiON CX4

In this Blueprint, the ESX server accesses data from the CLARiiON CX4 storage array over 1 Gb iSCSI, which is native to the CX4 series.

The first component of this attachment is the ESX software iSCSI initiator, which has its underlying physical NICs bound to it. In order to maximize high availability, load balancing, and performance, EMC PowerPath/VE is used to manage and optimize iSCSI connections to the CX4 storage array, as shown in the following screenshot.

The screenshot shows the VMware ESX Storage Adapters configuration page. It displays a list of storage adapters and their details. The 'Storage Adapters' section includes:

- ISCSI Software Adapter:** vmhba33 (iSCSI), vmhba5 (Block SCSI), vmhba32 (Block SCSI)
- LPe11000 4Gb Fibre Channel Host Adapter:** vmhba1 (Fibre Channel)

The 'Details' section for the 'vmhba33' iSCSI Software Adapter shows:

- Model: ISCSI Software Adapter
- ISCSI Name: iqn.1998-01.com.vmware:tce-rx600-01-598987bf
- ISCSI Alias:
- Connected Targets: 4, Devices: 4, Paths: 16

The 'View' section shows a table of disks:

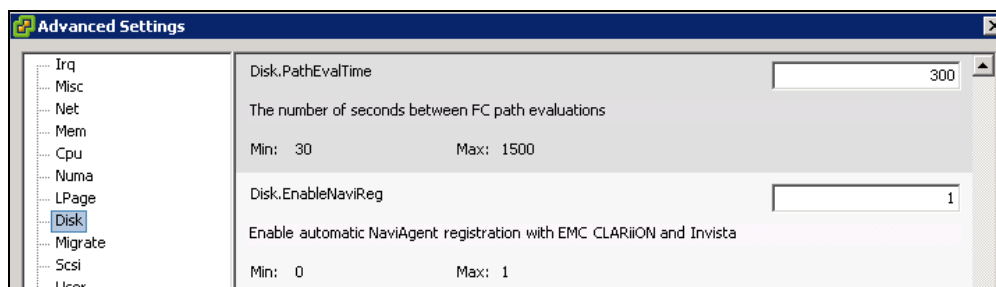
Name	Runtime Name	LUN	Type	Transport	Capacity	Owner
DGC ISCSIDisk (naa.600601602e2024000cef40aa7465de11)	vmhba33:C0:T0:L0	0	disk	iSCSI	5.00 GB	PowerPath
DGC ISCSIDisk (naa.600601602e2024000def40aa7465de11)	vmhba33:C0:T0:L1	1	disk	iSCSI	5.00 GB	PowerPath
DGC ISCSIDisk (naa.600601602e2024000e6a3c47765de11)	vmhba33:C0:T0:L2	2	disk	iSCSI	100.00 G	PowerPath
DGC ISCSIDisk (naa.600601602e2024000e6a3c47765de11)	vmhba33:C0:T0:L3	3	disk	iSCSI	500.00 G	PowerPath

The 1 Gb iSCSI ports on the CLARiiON CX4 are easily configured by adding IP addresses to each relevant SP port. VLAN tagging is also supported.

Once the server-to-array bindings have been successfully completed, and the ESX storage adapter rescan has been completed, Navisphere will then automatically register the connections from the ESX server to the host so that storage can be masked out immediately, as shown in the following screenshot of Navisphere Host Connectivity Status.

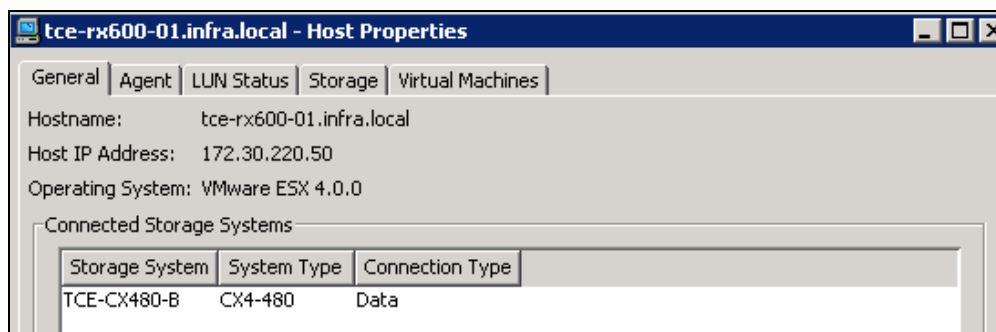


Manual registration of host/server initiators within Navisphere is no longer required due to the vSphere 4 “Disk.EnableNaviReg” setting for EMC CLARiiON and EMC Invista®, which is enabled by default as shown in the following diagram.

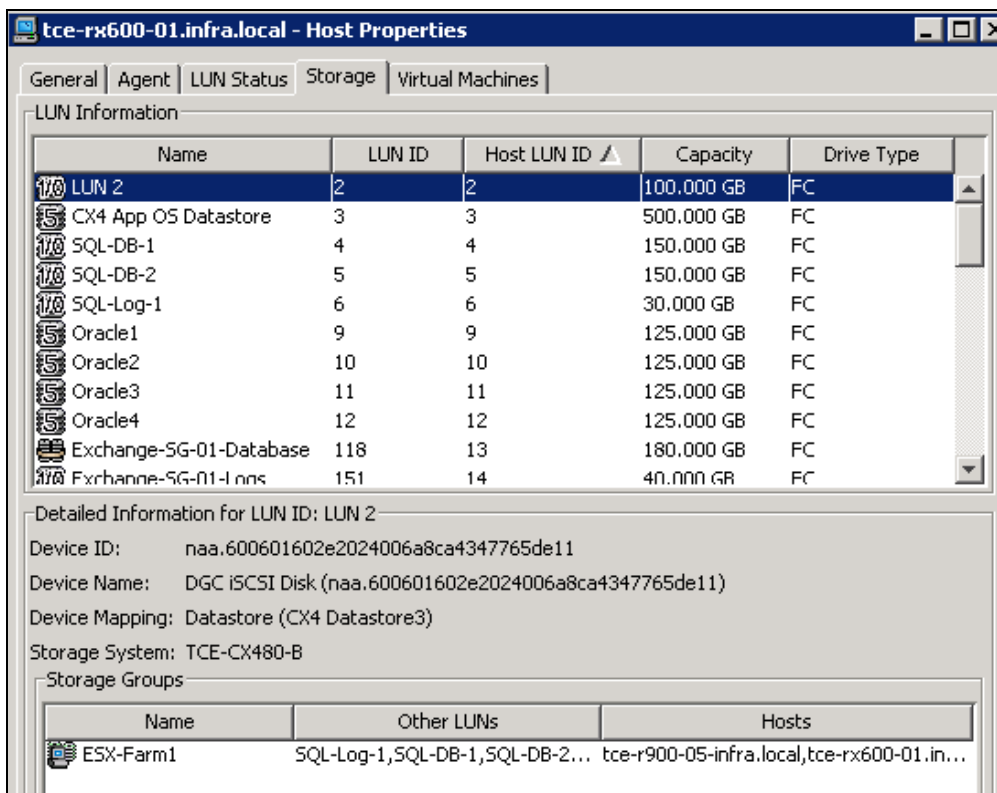


As a result of this automatic registration of the attached ESX server, the CLARiiON storage administrator can automatically take advantage of the new virtualization-aware functionality of Navisphere. The following views demonstrate the depth and detail of ESX and virtual machine information now available within Navisphere.

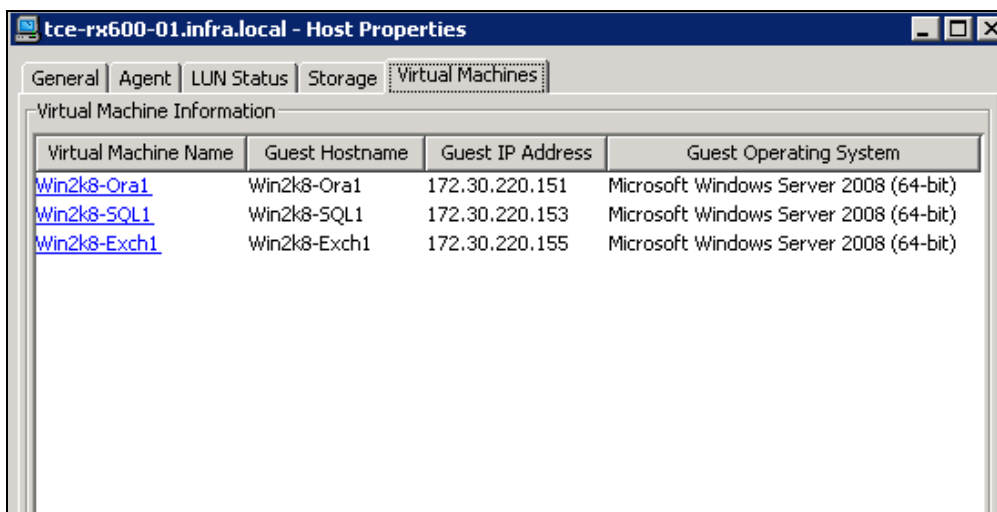
This first view provides a brief overview of the attached ESX properties.



By selecting the Storage tab, it is possible to get a full view of the end-to-end mappings between the ESX server and the back-end storage LUNs that have been assigned.



Further to the ESX mapping information, it is also possible to view properties of the virtual machines residing on the attached ESX server, as shown in the following screenshot.



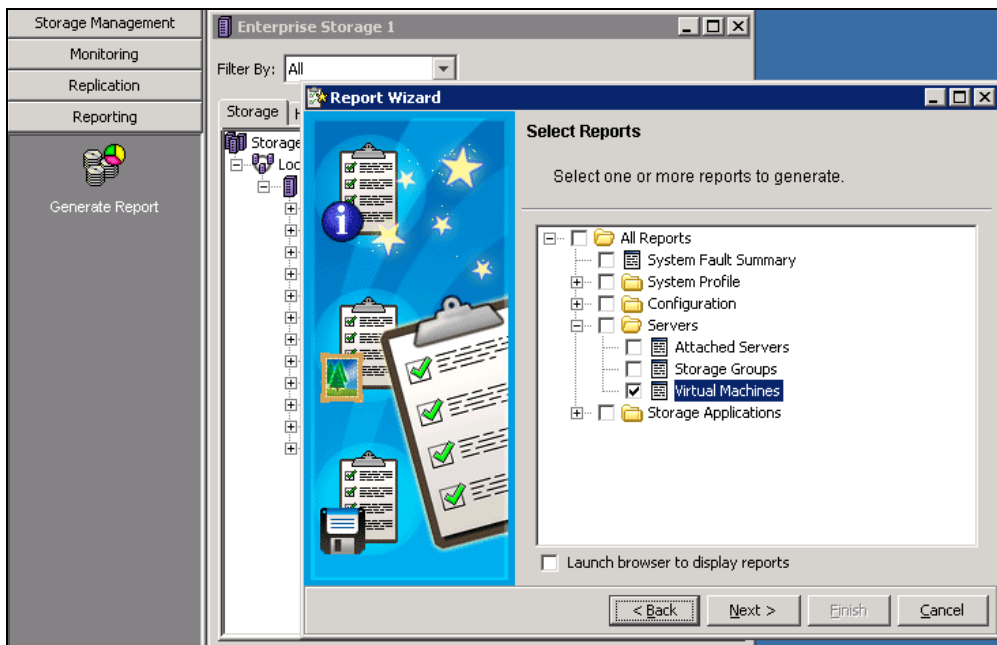
In the following screenshot, through this single view of a virtual machine, it is possible to see:

- RDMs and VMFS datastores
- File locations
- Thin versus thick disk attributes
- Disk capacity and utilization

Name	Device Mapping	Device Name	Storage System
CX4 App OS Datastore	Datastore (CX4 App OS Datastore)	naa.600601602e202400e6a3c47ef75de11	TCE-CX480-B
Oracle1	Mapped Raw LUN	naa.600601602d402300ba6ee92e167dde11	TCE-CX480-B
Oracle2	Mapped Raw LUN	naa.600601602d40230012d5eb3e167dde11	TCE-CX480-B
Oracle3	Mapped Raw LUN	naa.600601602d4023005add9e3e167dde11	TCE-CX480-B
Oracle4	Mapped Raw LUN	naa.600601602d402300c0ff5251167dde11	TCE-CX480-B

Name	Type	LUN Names ^	Disk Mode	Disk Capacity	File Path
Win2k8-Ora1	VM Configuration	CX4 App OS Datastore	N/A	N/A	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1.vmx
Hard disk 1	Virtual Disk - Thin	CX4 App OS Datastore	Persistent	45.00G (11.96G)	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1_1.vmdk
Hard disk 2 Mapping File	Datastore Mapping File	CX4 App OS Datastore	N/A	N/A	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1_10.vmdk
Hard disk 3 Mapping File	Datastore Mapping File	CX4 App OS Datastore	N/A	N/A	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1_11.vmdk
Hard disk 4 Mapping File	Datastore Mapping File	CX4 App OS Datastore	N/A	N/A	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1_14.vmdk
Hard disk 5 Mapping File	Datastore Mapping File	CX4 App OS Datastore	N/A	N/A	[CX4 App OS Datastore] Win2k8-Ora1/Win2k8-Ora1_15.vmdk
Hard disk 2	Mapped Raw LUN - Physical	Oracle1	Independent Persistent	125.00G	N/A
Hard disk 3	Mapped Raw LUN - Physical	Oracle2	Independent Persistent	125.00G	N/A
Hard disk 4	Mapped Raw LUN - Physical	Oracle3	Independent Persistent	125.00G	N/A
Hard disk 5	Mapped Raw LUN - Physical	Oracle4	Independent Persistent	125.00G	N/A

The EMC Storage Viewer* provides end-to-end storage mapping information to VMware vCenter users. Virtualization-aware Navisphere provides virtual machine information and configuration details to Navisphere Manager users as well as VMware-assigned storage capacity reporting as shown in the following screenshot.

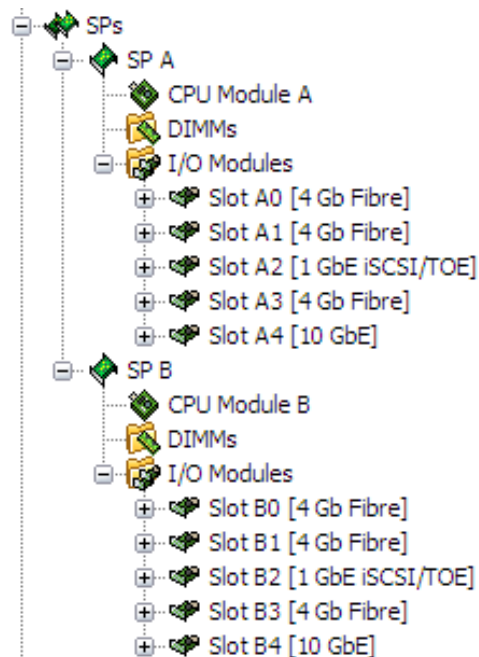


Once the underlying connectivity and infrastructure are in place, it is then possible to proceed with assigning the appropriate storage and deploying the relevant virtual machines before configuring the applications.

* EMC Storage Viewer is a plug-in to VMware vCenter Server ESX 3.5 and vSphere 4 environments. It provides significant added value to VMware system administrators. Storage Viewer discovers EMC storage devices in VMware vCenter and displays virtual-to-physical mapping for both Symmetrix® and CLARiiON.

Functionality

CLARiiON CX4 users can take advantage of using multiple protocols when connecting to their storage array. One, 2, 4, or 8 Gb Fibre Channel as well as 1 Gb or 10 Gb iSCSI are available within the same array.



* 8 Gb Fibre Channel ports are not included in above system

Users can also use PowerPath/VE to manage, maintain, and optimize those data paths for any of the previously mentioned protocols, providing maximum high availability and performance for their environment.

```
Pseudo name=emcpower9
CLARiiON ID=CKM00090700010 [ESX-Farm1]
Standard UID=naa.600601602d4023008d11329e167dde11 [Exchange-SG-09-Database]
state=alive; policy=CLAROpt; priority=0; queued-I/Os=0
Owner: default=SP B, current=SP B      Array failover mode: 4
=====
--- Host ---
### HW Path          I/O Paths          - Stor -  -- I/O Path -  -- Stats ---
          I/O Paths          Interf.   Mode      State  Q-I/Os  Errors
=====
1 vmhba33            C0:T0:L29 SP A4      active  alive    0        4
1 vmhba33            C1:T3:L29 SP B5      active  alive    0        5
1 vmhba33            C1:T2:L29 SP A5      active  alive    0        4
1 vmhba33            C0:T1:L29 SP B4      active  alive    0        5
```

The above display demonstrates how PowerPath/VE, having claimed the available paths to a device/LUN, provides multiple active paths to each device. The default load balancing policy for CLARiiON attach is “CLAROpt”.

Of the four paths available in the above example, also displayed is:

- The name of the CLARiiON storage group to which the LUN belongs
- The owning storage processor
- The LUN “nice” name (Exchange-SG-15-Database) that can be set within Navisphere
- The ESX Controller ID, CLARiiON iSCSI Target ID and Device ID for the LUN

Performance

Once I/O load is active and operational from the host through to the storage array, it is possible to view performance details at multiple points along its journey.

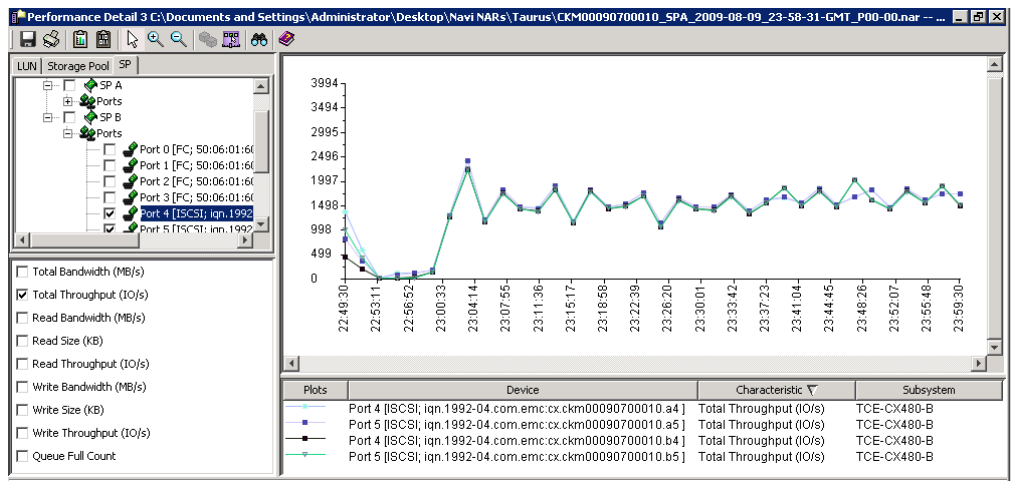
The following screenshot displays from esxtop on the ESX Service Console how many reads and writes are being driven from the ESX server at any one time. Note also, the path management and load-balancing capabilities of PowerPath/VE.

```

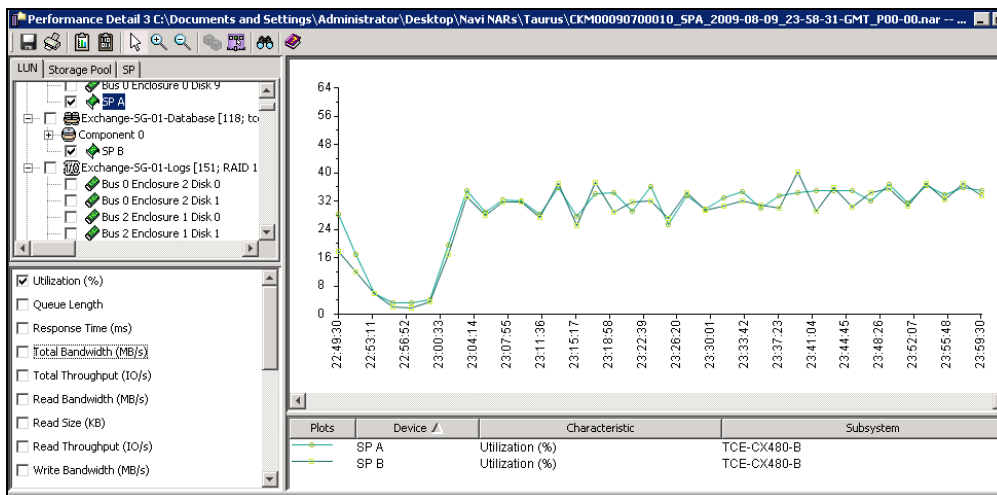
8:32:40pm up 2:07, 213 worlds; CPU load average: 0.04, 0.03, 0.04
ADAPTR  CID  TID  LID  NCHNS  NTGTS  NLUNS  CMDS/s  READS/s  WRITES/s  MBREAD/s  MBWR
vmhba0  -   -   -    1     0     0     0.00    0.00    0.00    0.00    0.00
vmhba1  -   -   -    1     0     0     0.00    0.00    0.00    0.00    0.00
vmhba2  -   -   -    1     1     1     2.17    0.00    2.17    0.00    0.00
vmhba3  -   -   -    2     1     1     0.00    0.00    0.00    0.00    0.00
vmhba32 -   -   -    2     0     0     0.00    0.00    0.00    0.00    0.00
vmhba33 0   -   -    1     1    43    1856.09 1119.15  734.97    8.71    8.71
vmhba33 1   -   -    1     1    43    1832.57 1089.51  743.07    8.48    8.48
vmhba33 2   -   -    1     1    43    1868.34 1121.92  744.85    8.74    8.74
vmhba33 3   -   -    1     1    43    1844.04 1105.91  738.13    8.61    8.61
vmhba33 4   -   -    1     0     0     0.00    0.00    0.00    0.00    0.00
    
```

In the above screenshot, vmhba33 is the ESX Software iSCSI Initiator using four perfectly balanced data paths. PowerPath/VE is managing these paths, thereby providing perfectly balanced data operations to the CLARiiON CX4 storage array's 1 Gb iSCSI ports.

As well as being able to view the performance through a 1 Gb Ethernet switch in between, it is possible to see exactly how the I/O load is hitting the storage array. And just as important to see is that PowerPath/VE is balancing the load consistently across the four available CX4 1 Gb iSCSI ports.



Navisphere Analyzer also provides the ability to view just how busy the CX4 storage processors are during the mixed load run, as shown in the following screenshot.



The individual requirements of each application are taken into account when considering the resources for each virtual machine. These requirements involve the performance of each application and what CPU, RAM, and disk resources are required. Future growth and development must also be taken into consideration.

VMware vSphere now provides the ability to assign up to eight CPUs and up to 255 GB of memory to each virtual machine. This is crucial when considering deploying mission-critical applications in a virtualized environment. Availability of disk performance for the virtual machine is just as important as the availability of CPU and memory.

Microsoft Exchange

As part of the overall mixed workload for this solution, storage was configured for 4,000 very heavy Exchange 2007 users each with 350 MB mailboxes. Microsoft Jetstress was used to validate the storage arrays capacity to handle the I/O requirements.

Sizing and configuring storage for use with Microsoft Exchange Server is a complicated process, driven by many variables and factors, which vary from organization to organization. The goal is to ensure that the primary storage system meets the I/O requirements of the Exchange users in a reliable and scalable fashion.

A proven unit of measure called a “building block” is used. The building block accommodates 4,000 users, consists of 20 storage spindles (16 for databases and 4 for logs), and is scalable for future growth. Each unit, properly configured, will match the Microsoft Exchange Server recommendations for a healthy-performing system - from both a disk and an end-user perspective.

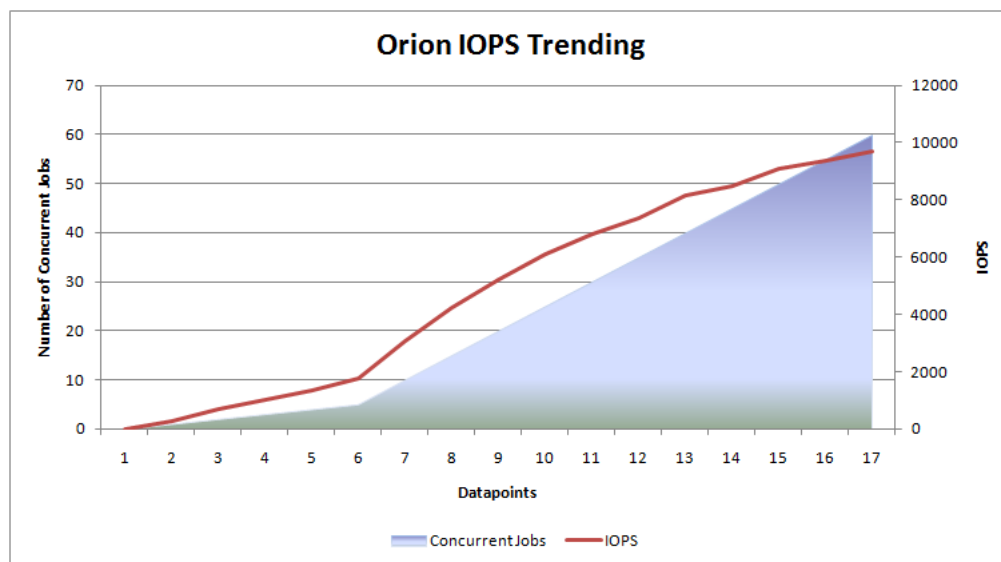
Results of Jetstress testing are as follows.

Test criteria	Results
Database disks transfers/sec	2118
Database disks reads/sec	1072
Database disks writes/sec	1046
Average database disk read latency (ms)	14
Average database disk write latency (ms)	4
Average log disk write latency (ms)	1
Log disks writes/sec	1,170

Oracle

The Oracle I/O Calibration Tool (ORION) tool was used to validate the storage back-end. ORION is a standalone tool for calibrating the I/O performance for storage systems that are intended to be used for Oracle databases and can be configured to generate a wide range of I/O workloads, including ones that simulate OLTP and data warehouse workloads.

The priority is to provide enough disk spindles to satisfy read and write latencies for database I/O operations. Once met, additional disks can be added for capacity. The CLARiiON storage is configured to house a 500 GB production Oracle database. To satisfy the performance requirements of this OLTP environment, with a 60:40 Read:Write ratio, 20 Fibre Channel drives were configured for the back-end storage. For the purpose of this solution, RAID 5 was used throughout the configuration.



SQL

The goals of SQL server design are sustained performance and reliability for an OLTP workload on a 300 GB database. As with the Oracle design, the priority is to provide enough disk spindles to satisfy read and write latencies for database I/O operations. Once met, this can be derived as a building block for the deployment of additional databases with the same characteristics.

Design and validation

Microsoft's SQL I/O Simulator tool was used to generate a SQL-type workload. The test results from the SQL I/O SIM tool were used to validate the back-end disk configuration.

CLARiiON storage is configured to house a 300 GB production SQL database. To satisfy the performance requirements of this OLTP environment, 30 Fibre Channel drives were configured for the back-end storage. For the purpose of this solution, RAID 1/0 was used throughout the configuration.

Operation type		DataFile	Logfile
SQL operations	Reads	9705	0
	Scatter Reads	74920	0
	Writes	475	4964
	Gather Writes	111861	0
Array operations	Avg Array Read Size	98 KB	0 KB
	Avg Array Write Size	118 KB	53 KB
Host operations	Avg Latency	5 ms	3 ms
	Read MB/s	28.3	0
	Write MB/s	12.5	0.9

Conclusion

Summary	<p>This Blueprint showcases the EMC CLARiiON CX4 platform in combination with VMware vSphere and 1 Gb iSCSI components, which allows for efficient and effective consolidation of Microsoft and Oracle applications, therefore reducing costs. New Navisphere virtualization-aware functionality greatly enhances the usability and manageability of CLARiiON storage in the context of a virtual data center and increases management efficiencies.</p>
Findings	<p>The documented configuration was shown to adequately meet the requirements of virtualization, consolidation, and management of Microsoft Exchange 2007, Microsoft SQL, and Oracle. Combining all three workloads on a single storage platform proved to have no impact on the observed performance. It was also very interesting and important to see how PowerPath/VE successfully managed the I/O paths between server and array by providing maximum load balancing and performance capabilities.</p>
Usability	<p>Virtualization-aware Navisphere Manager automatically discovered all virtual machines and provided end-to-end virtual to physical mapping information.</p> <p>Virtualization-aware Navisphere is the single-most important feature in the FLARE 29 release. Using tighter integration with VMware, Navisphere automatically discovers all virtual machines managed under VMware vCenter Server and provides storage administrators with end-to-end, virtual-to-physical mapping information. This enhancement eliminates the painstaking task of manually mapping out the virtual infrastructure and simplifies common administrative activities such as troubleshooting and capacity planning in virtualized environments.</p>
Benefits	<ul style="list-style-type: none">• Virtualization-aware Navisphere automates resource discovery and reporting in VMware environments to help users maximize the value of their storage infrastructure in virtual environments.• CLARiiON disk-drive Spin Down improves energy and cost efficiencies in virtual and physical environments.• Implementation of both 1 Gb and 10 Gb Ethernet connectivity for CLARiiON and Celerra allows users to realize virtual server consolidation on a large scale.• PowerPath/VE realizes the potential of the underlying infrastructure by providing maximum load balancing, high availability, and performance capabilities.
Next steps	<p>EMC can help accelerate assessment, design, implementation, and management while lowering the implementation risks and cost of creating a VMware environment with CLARiiON technologies, allowing a greater return on investment on their assets.</p> <p>To learn more about this and other solutions contact an EMC representative or visit http://www.emc.com.</p>
