

Building the Virtual Information Infrastructure

Technology Concepts and Business Considerations

EMC Global Solutions

Abstract

A virtual information infrastructure allows organizations to make the most of their data center environment by sharing computing, network, and storage resources across the data center or across the world. EMC's virtual information infrastructure solution provides virtualized computing, unified switching fabric, and a FAST tiered storage architecture.

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Table of Contents

Executive summary 4
Introduction..... 6
Virtual information infrastructure data center environment 7
Planning a virtual information infrastructure..... 8
Physical architecture 9
Network resources 10
Computing resources 13
Storage resources 16
Visibility in the virtual information infrastructure..... 21
Multipathing 23
Conclusion..... 25

Executive summary

Business case As more organizations find widespread success with server virtualization in their computing environments, virtualization has spread into other areas of the infrastructure and given rise to the concept of the *virtual information infrastructure*.

The virtual information infrastructure is a computing architecture that provides shared resources including:

- servers,
- networks, and
- storage.

The virtual information infrastructure enables shared access to these resources by applications across a data center or organization, or across the world.

Business environment Organizations require that their business application infrastructure:

- support strict SLAs,
- maximize flexibility,
- minimize cost, and
- minimize complexity.

An organization's critical applications must be available 24/7. This demand for higher uptime and performance requirements is reflected in stricter service-level agreements (SLAs) for the computing infrastructure.

Today's computing environment must be able to service applications in the most flexible and effective manner – which may mean moving the environment to a data center in another geography in order to meet the performance needs. As these stricter requirements become more common, organizations will need to implement the infrastructure to support these needs while also minimizing cost and complexity.

The virtual information infrastructure employs technologies that enable essential characteristics such as elasticity and on-demand service. These technologies include:

- virtualization,
- unified computing, and
- flexible, tiered storage

Technical solution

A multi-site virtual information infrastructure architecture that supports active/active and data recovery capabilities includes the following elements:

- content-switched secure virtual desktops,
- business continuity and disaster recovery for remote and local users,
- unified computing,
- resource pooling,
- distributed networking, and
- tiered storage.

A virtual information infrastructure must be able to provide high availability across all components – networking (through the use of director-class switches), computing, and storage. EMC's virtual information infrastructure solution provides components that enable high availability and sustainability over all layers of the infrastructure.

EMC's hardware and software products integrate tightly with the virtualization technologies needed to support the virtual information infrastructure and provide visibility to the storage platform as well as multi-tenancy and other resource sharing.

Introduction

Purpose

This white paper explores the elements and features of a virtual information infrastructure data center environment.

The elements of the virtual information infrastructure in this white paper include:

- EMC[®] storage platforms
- EMC FAST tiered storage technology
- Virtualization hypervisor
- 10 Gb multiprotocol switching infrastructure
- x86 computing platform

The features and advantages of a virtual information infrastructure include:

- Content-switched secure virtual desktops
 - Business continuity and disaster recovery
 - Unified computing, resource pooling, distributed networking, and tiered storage
 - Flexible, cost-effective deployment and configuration
-

Audience

This white paper is intended for EMC employees, partners, and customers including IT planners, virtualization architects and administrators, and any others involved in evaluating, acquiring, managing, operating, or designing a virtual information infrastructure environment leveraging EMC technologies.

Virtual information infrastructure data center environment

Introduction

The *virtual information infrastructure* is an environment in which infrastructure resources are:

- managed as an aggregate pool, regardless of physical location,
- deployed as needed to meet dynamic demand requirements,
- able to meet and manage SLAs within the environment, and
- able to maintain security compliance.

In a virtual information infrastructure the entire environment, whether a single site or multiple sites, performs as one large computing resource. This allows for the ability to migrate workloads as needed to maintain SLA requirements:

- from one section of the data center to another section in the same data center, or
- from a data center in one geographical region to a completely separate data center in another part of the world.

In a traditional tiered data center, administrators provision server resources based on the *peak* needs, even if the servers will be largely underutilized most of the time. In a virtual information infrastructure servers are instead assigned from a pool based on immediate *actual* need, and then reclaimed into the pool when those resources are no longer required. In this way resources are available for other uses the rest of the time, or can be powered down if not needed.

A computing resource pool can use host resources more efficiently, especially where virtualization utilizes each server as fully as possible. Using automated provisioning of virtual machines out of a pool lets administrators bring a new system online in minutes rather than days or weeks. The addition of resources to the pool is decoupled from the needs of quick systems provisioning.

Elements of a virtual information infrastructure

A virtual information infrastructure is a fully virtualized data center composed of shared resource pools for:

- computing resources including desktops and servers,
- network resources including switching and transmission, and
- storage resources including tiered storage and business continuity (recovery).

Virtual information infrastructure management and security are implemented as appropriate and where needed, and are tailored toward virtualized environments. In addition, automation of provisioning and management is a critical component of the virtual information infrastructure, as is seamless mobility between locations within the cloud. The result is a dynamic data center environment that is independent of physical hardware constraints and can move, potentially around the globe, as required to achieve application SLAs.

Planning a virtual information infrastructure

Design considerations

When planning to implement a virtual information infrastructure data center environment, there are many considerations that need to be taken into account. In many cases, these considerations are a shift from traditional data center design.

A virtual information infrastructure is based on the technologies that allow for resources to be shared more easily across the data center environment, such as:

- Virtualization technologies from vendors such as VMware and Microsoft
- Networking technologies from Cisco, HP, and others
- Unified computing technologies such as those from Cisco on the UCS platform
- Storage technologies from EMC

All of these technologies must be integrated to provide a seamless platform for deploying applications anywhere the resources are best able to meet application SLAs. This integrated platform must:

- Be able to provide for managed downtime, including both planned downtime and unplanned downtime.
 - Provide no single point of failure.
 - Include director-class products with online upgrade capability.
-

Legacy vs. new technology

If a virtual information infrastructure is deployed in a green field environment, or brand new installation, it is much simpler to design it for the best possible use of all of the virtual information infrastructure resources. Designing a virtual information infrastructure to allow for migration from a legacy data center environment is more of a challenge, although the same principles apply. In some cases, even a green field deployment must accommodate legacy technologies because the newer technology is not yet widely available.

Fibre Channel over Ethernet (FCoE) is an example of a new technology that promises to completely change the way networks and SANs are deployed. FCoE connectivity is not yet available on all storage platform arrays, but its continued growth— even on the access layer — means that a forward-looking virtual information infrastructure must be ready to incorporate it when it is fully available.

Management and security

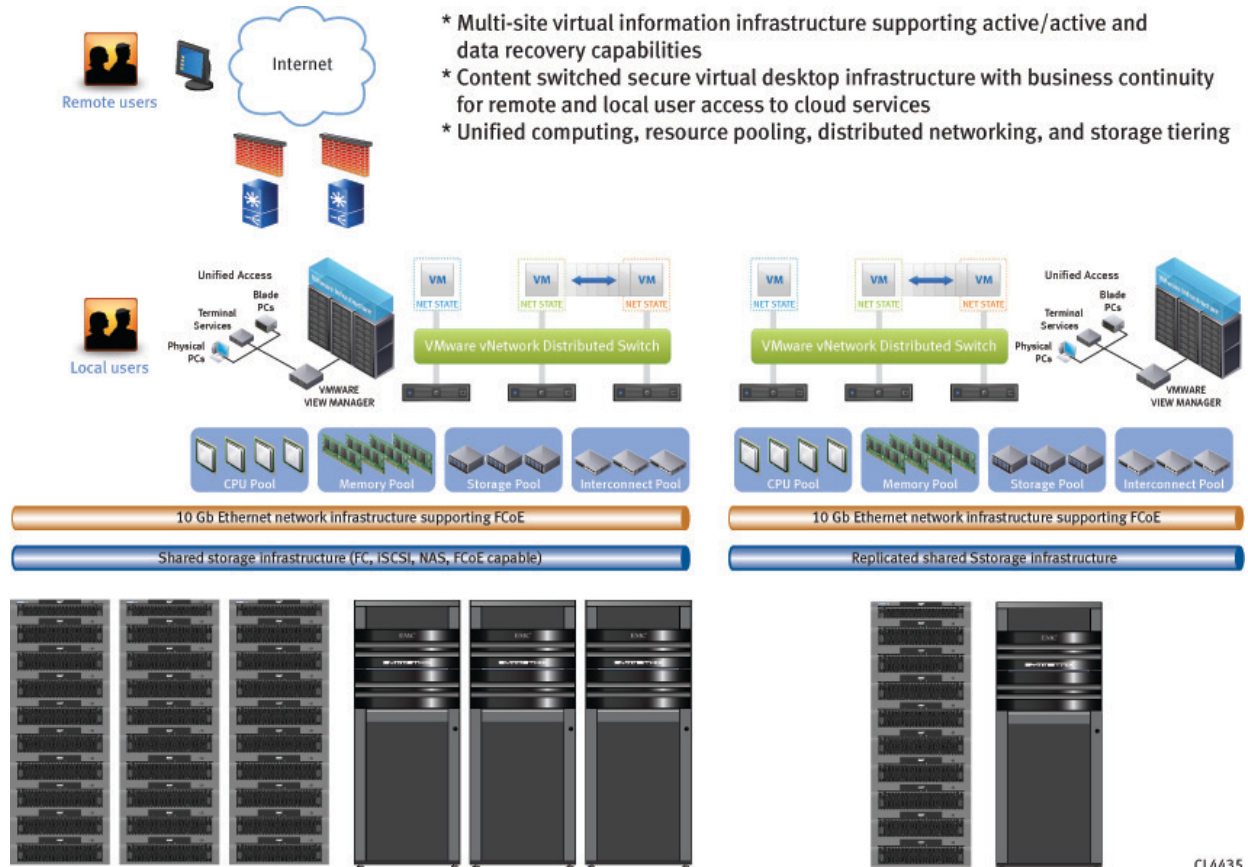
Although organizations can realize great benefits through the shared resource model of a virtual information infrastructure, many of the same challenges from traditional networks still must be met. Managing and securing the virtual information infrastructure is critical to ensuring that resources are used in the most efficient and scalable manner, and that applications and resources are no less secure than in a traditional environment.

In fact, applications can be made even more secure in a virtual information infrastructure data center than in a traditional environment. Using EMC products such as those from EMC Ionix™ and RSA, data center management and security can be easily implemented in a holistic way that allows for easy and secure deployment of all application environments.

Physical architecture

Architecture diagram

The following illustration depicts the overall physical architecture of the virtual information infrastructure environment.



Infrastructure environment

As the architecture diagram illustrates, a virtual information infrastructure includes:

- Network resources, featuring a unified fabric of 10 Gb Ethernet and FCoE.
- Computing resources, featuring virtual machines and VMware vNetwork Distributed switches to interface with the CPU, memory, storage, and interconnect pools.
- Storage resources, featuring tiered storage solutions from EMC such as Symmetrix® V-Max™ and Celerra®.

Network resources

Unified switching fabric

The virtual information infrastructure benefits from deploying a unified switching fabric that uses:

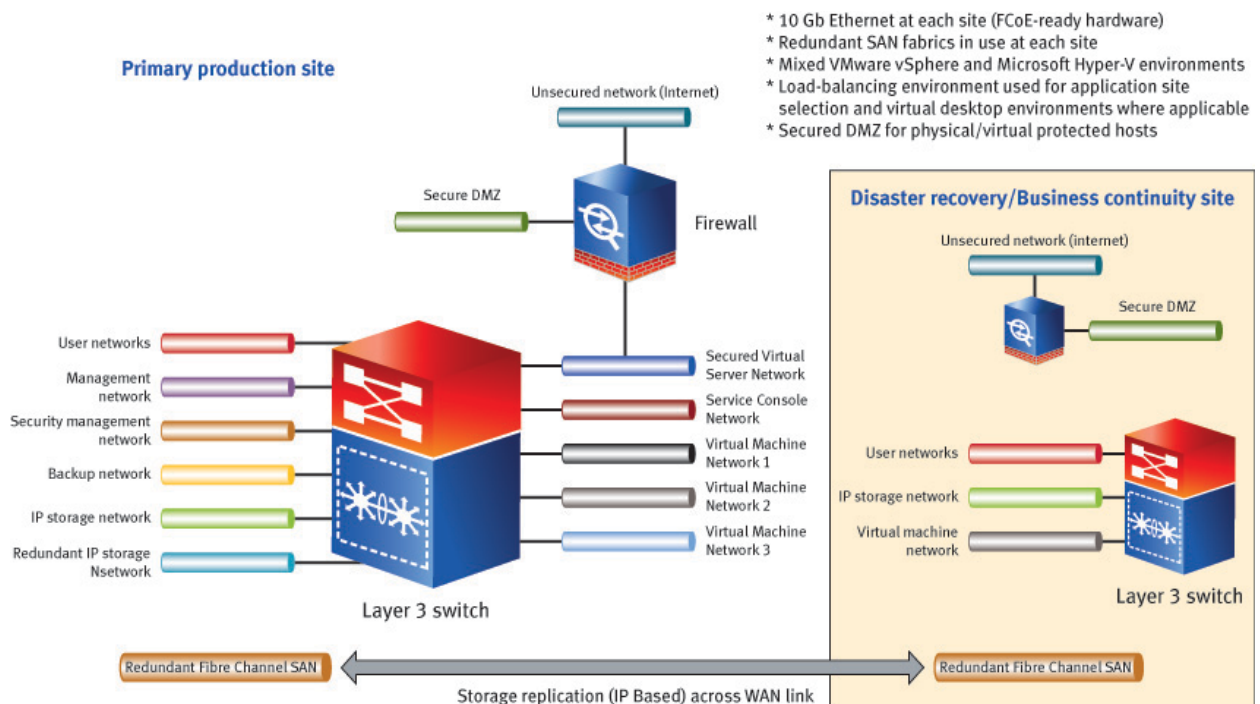
- 10 Gb Ethernet, and
- Fibre Channel over Ethernet (FCoE).

Using a single Ethernet network for all connectivity needs brings benefits in both cost and manageability. Additional advantages of a unified fabric include:

- savings on system power and cooling use,
- less networking hardware required, and
- reduction in complexity.

Network logical diagram

The following illustration shows a logical diagram of the networking infrastructure deployed in our virtual information infrastructure.



CL4436

10 Gb converged network adapters

Deploying a network based on 10 Gb Ethernet follows the same principles of redundancy and fault tolerance as in a traditional network, but allows for a more efficient deployment by utilizing converged network adapters (CNAs).

Using two CNAs per server, each connected to a separate switch, provides:

- redundancy,
- fault tolerance, and
- bandwidth aggregation.

To the network operating system the CNA appears as a separate network interface card (NIC) and host bus adapter (HBA). Future CNA releases will allow the adapter to be virtually split into multiple virtual NICs and HBAs.

The advantages of 10 Gb CNAs include:

- Consolidation of multiple 1 Gb NICs for greater throughput and redundancy.
- Fewer Ethernet switch ports are required.
- Allows for greater throughput using fewer network ports.
- Also handles the Fibre Channel traffic that had previously required a separate HBA(s) and required its own SAN switch port(s).

Network topology

In the virtual information infrastructure environment discussed in this white paper, the converged network topology was deployed on Cisco Nexus 5000 and 7000 switches.

Nexus 7010 switches were used:

- for the combined Layer 3 core and aggregation layer switches, and
- in a redundant configuration to protect against loss of individual components or an entire switch.

Nexus 5000 switches were used:

- As access layer switches, in a mixture of Nexus 5010s and Nexus 5020s used in a Top Of Rack deployment.
- Where additional 1 Gb port capacity was needed, Nexus 2148 Fabric Extenders were employed.
- The Nexus 5000s were deployed in the server racks in pairs and had redundant trunk links back to the 7010s.
- Servers each had two CNAs, one per Nexus 5000.

The logical network topology utilized VLANs for traffic segregation and isolation:

- In most cases the VLANs were routed on the Nexus 7010.
- Firewalls were used to route to secured networks, for example those with inbound access from the Internet such as e-commerce and virtual desktop infrastructure.

In most cases, the server uplinks were configured as 802.1q trunks and VLAN tagging was configured in the hypervisor. In addition, distributed virtual switches were used to enhance management of the VM networking to allow for seamless failover from host to host without the risk of losing a VM's networking profile.

Network isolation

With the use of high-bandwidth CNAs there is less need for multiple networks each serving specific purposes. However in the virtual information infrastructure environment discussed in this white paper some networks were isolated for various purposes, such as:

- a separate backup network, and
- a separate storage network.

Valid reasons for keeping these types of traffic include broadcast isolation and performance tuning. VMware best practices recommend separate networks for iSCSI traffic and for VMotion, a critical tool for virtual machine mobility in a virtual information infrastructure environment. These networks were deployed separately in our virtual information infrastructure. In addition, Jumbo Frames were enabled within the networking hardware where desired.

Primary and secondary sites

In any live data center servers may be segregated on different networks as follows:

- by function,
- by service requirements such as content switching and load balancing, or
- by application.

The virtual information infrastructure must accommodate these needs and still be able to pool and share resources. This is accomplished by making individual VLANs available throughout the network to allow for VM mobility without losing the association it had to a particular network.

Because a virtual information infrastructure uses resources independent of geography, the virtual information infrastructure configuration we deployed in our environment consisted of a primary site and a secondary/disaster recover site.

The secondary site was configured as a Virtual Device Context (VDC) on the 7010 switch, using an Empirix WAN Emulator to simulate distance. This second site allowed us to configure active/active clusters if needed, as well as a standard disaster recovery scenario.

The tools used included VMware Site Recovery Manager in conjunction with EMC's data replication tools such as SRDF[®], RecoverPoint, Celerra Replicator[™], and so on. Data replication was IP-based, using a simulated 1 Gb Ethernet WAN link. Where required in testing, lower-bandwidth routed links were deployed using Cisco routers and the WAN emulator.

Computing resources

Maximizing return on investment

Virtualization helps to maximize the return on investment of your computing resources. Traditional data center servers frequently use only a fraction of their computing capacity. With virtualization, data center administrators can share the resources of a single physical server with multiple virtual machines. This allows administrators to realize a much higher utilization of their resources, which lead to savings in:

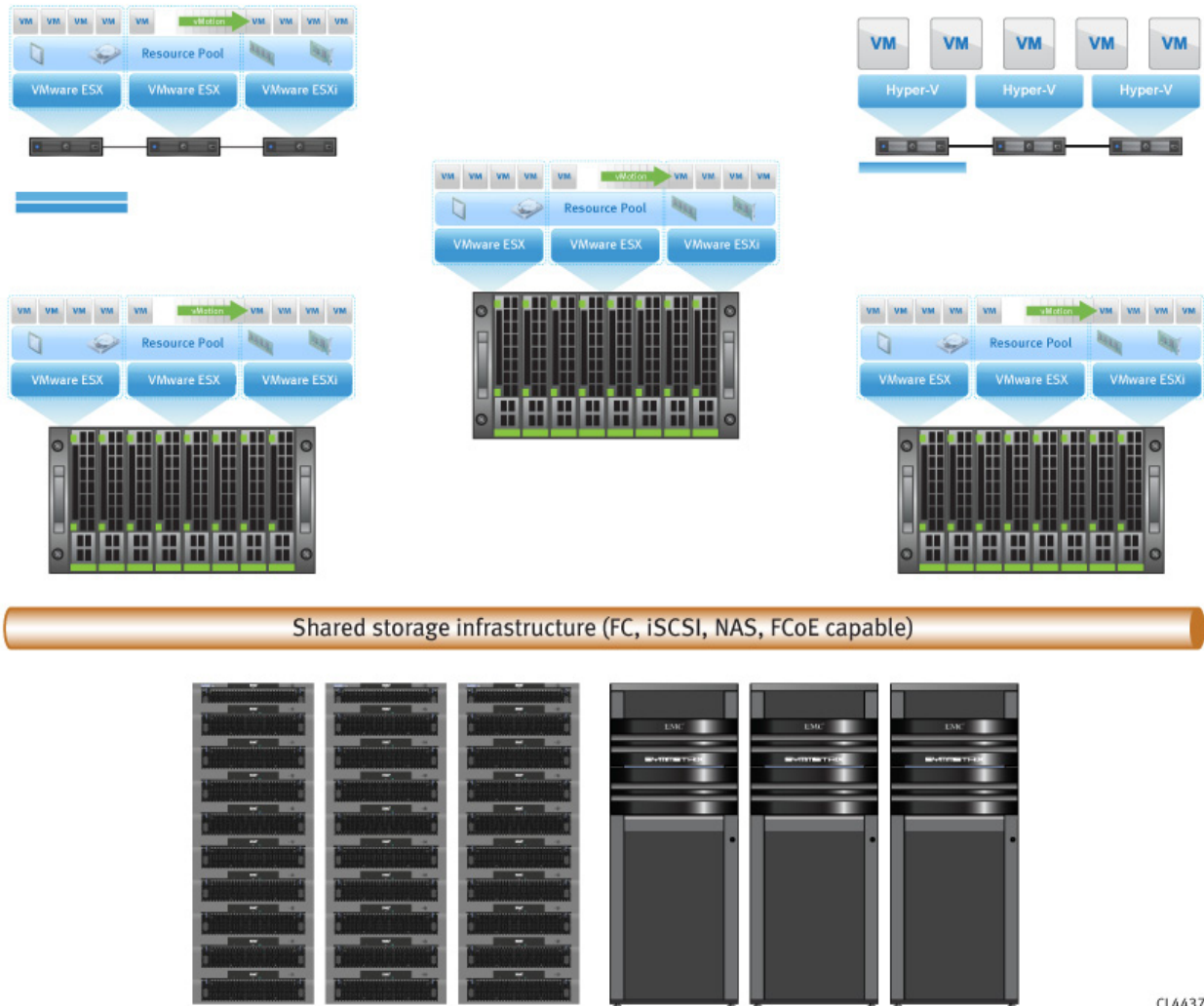
- hardware costs,
- power and cooling costs, and
- administrative costs.

With the virtual information infrastructure this concept is taken even further, allowing computing resources to be shared across the entire infrastructure.

Computing environment

The following diagram illustrates the computing environment deployed in our virtual information infrastructure.

- * Multi-Hypervisor environment on standalone and unified compute platforms
- * Multi-protocol shared storage for access from anywhere
- * Multiple virtual datacenters with multiple clusters within each, unique by resources and/or applications
- * Distributed networking, resource pool allocation, storage tiering



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Unified computing

One of the key enablers of the virtual information infrastructure is *unified computing* such as that used with Cisco's Unified Computing System (UCS) platform. Unified computing allows administrators to provision servers faster and more efficiently and move them as needed to achieve the greatest performance.

Through a UCS single portal, administrators are able to provision hardware resources and deploy an operating system with a few clicks, and move that server to another physical piece of hardware if there is ever a need, whether based on an outage or a maintenance window.

Server virtualization hypervisor

The virtual information infrastructure environment discussed in this white paper contains a combination of standalone servers and Cisco UCS blade servers. But regardless of the server platform the key to maximizing use of the hardware is a server virtualization hypervisor.

This virtual information infrastructure utilized VMware vSphere 4.0 and Microsoft Hyper-V. In all cases, clustering virtual servers allowed us to make the most cost-efficient use of the hardware resources while providing the ability to migrate virtual machines, either manually or automatically depending on configuration, as needed. In addition, through the use of resource pools we are able to allocate server resources to individual virtual machines based on the need of the application running on the VM.

Shared storage

Shared storage and common networks are essential to the use of a server virtualization technology. If a VM on one server must be moved to a second server, then that second server must be able to access the same networks and storage as the original server.

Our environment was built with this shared model in mind. Storage access, whether over Fibre Channel, iSCSI, or NAS, was open to all servers that were potential hosts for a given VM. In addition, 10 Gb Ethernet networks were common between the hosts to allow for VMotion and Storage VMotion migrations when necessary.

Virtual desktops

Another key benefit to virtualization is the ability to deploy a virtual desktop infrastructure that allows users to connect to a desktop that exists in the virtual information infrastructure data center. Consolidating and centrally managing user desktops in the data center provides benefits beyond cost savings. With the desktops contained within the data center, security is easier and stronger. There is no longer the risk of a laptop hard drive containing sensitive data ending up in the wrong hands. In addition, patching and software deployment is greatly simplified in a template-based VDI environment.

Storage resources

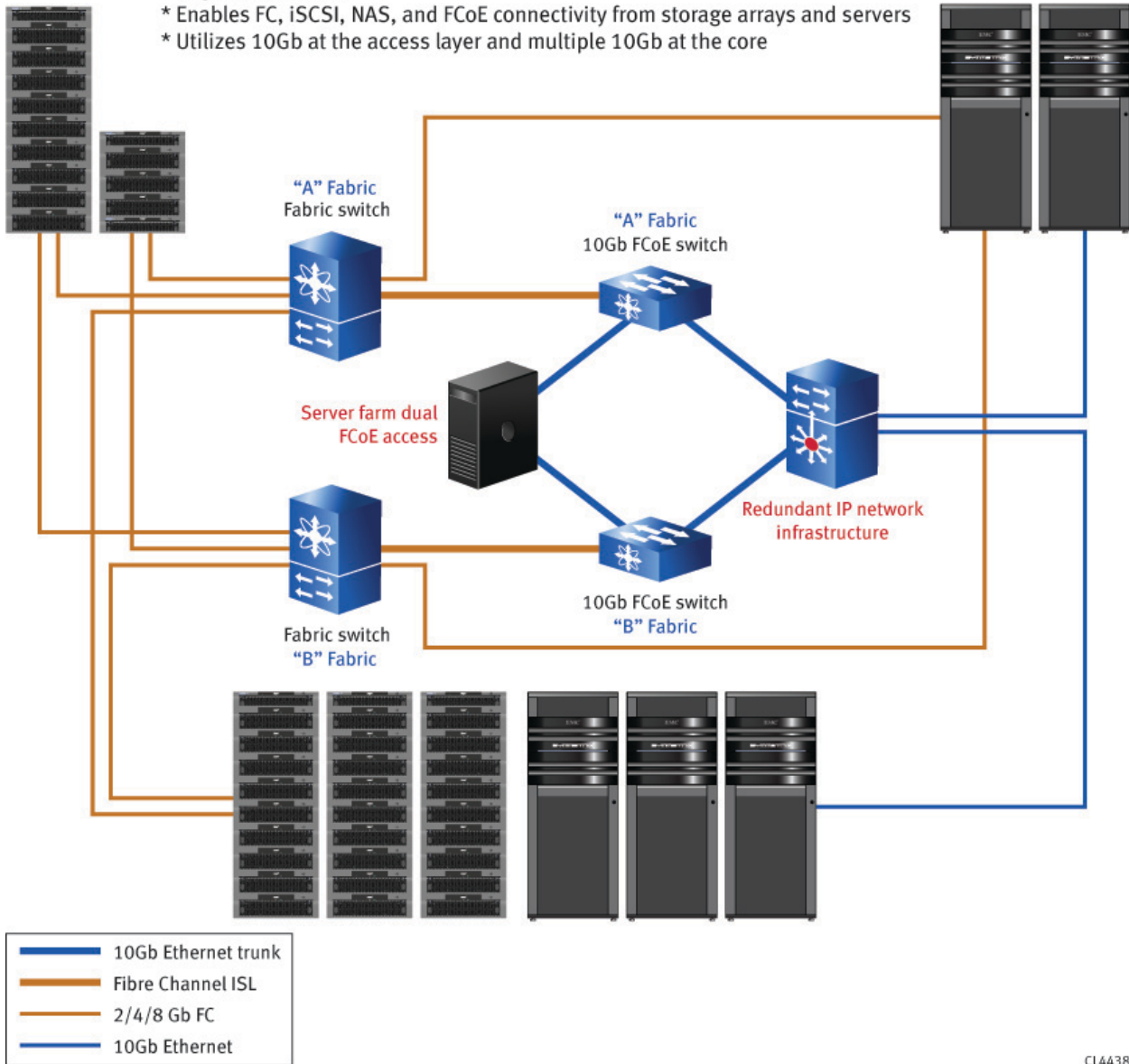
Shared storage Storage is a critical component of the virtual information infrastructure. *Shared storage* provides mobility to a virtual machine. Without shared storage, a VM is tied to the server where its storage resides. Whether the storage is accessed over Fibre Channel or over an IP network is up to the administrator, and to an extent the application using the disk. A truly dynamic and scalable virtual information infrastructure will allow for all technologies to be used from anywhere.

As storage vendors, including EMC, make Fibre Channel over Ethernet (FCoE) more available, it will become the preferred choice for SAN infrastructures. Converged networks decrease costs, increase efficiencies, and are much more manageable than separate Ethernet and Fibre Channel networks.

Storage area network diagram

The following diagram shows the storage area network (SAN) environment deployed in our virtual information infrastructure.

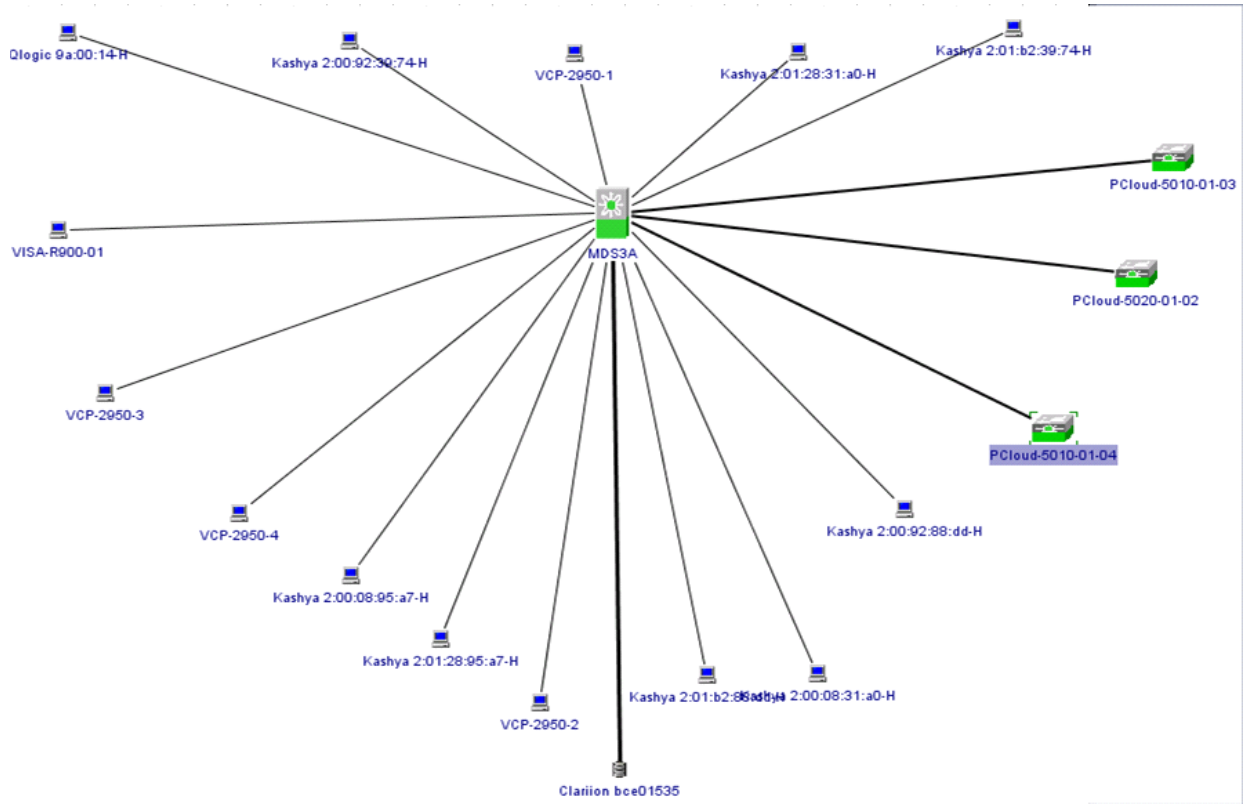
- * Incorporates legacy Fibre Channel and IP networks for easy migration to FCoE
- * Enables FC, iSCSI, NAS, and FCoE connectivity from storage arrays and servers
- * Utilizes 10Gb at the access layer and multiple 10Gb at the core



CL4438

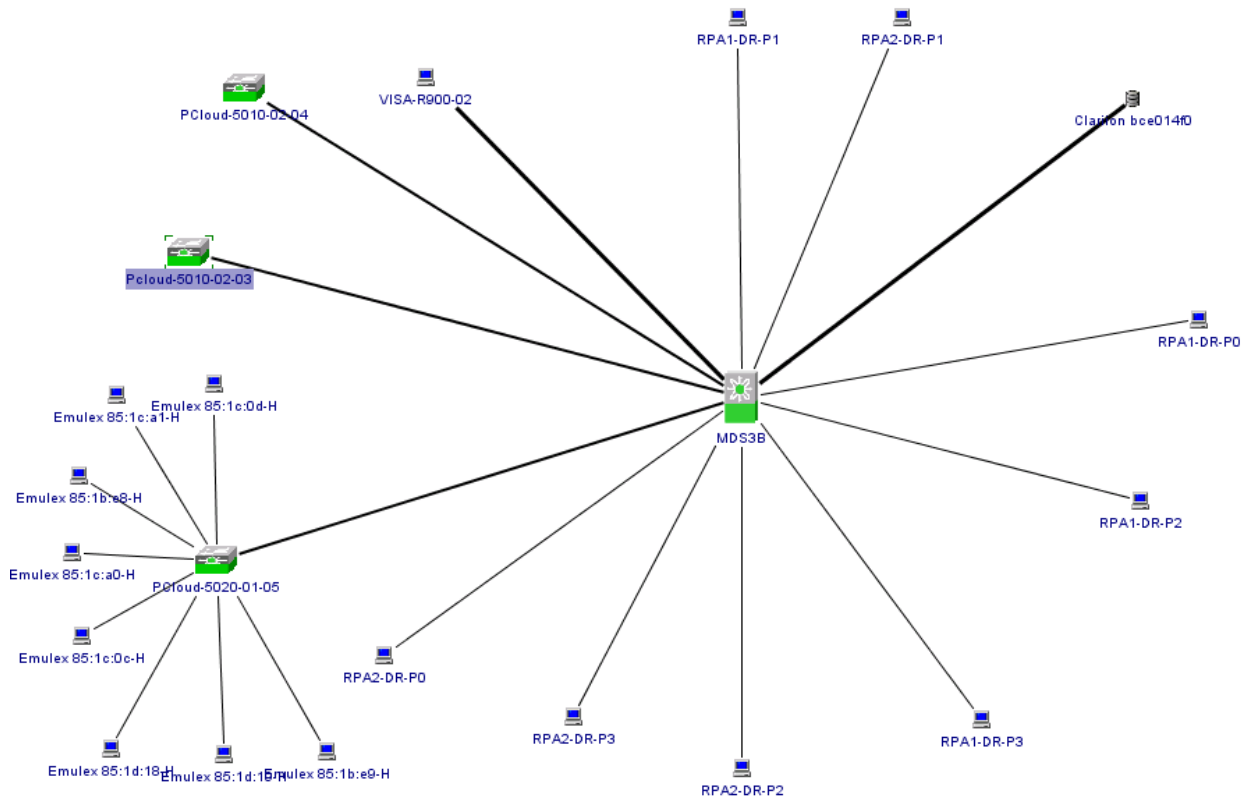
**Storage
Fabric A**

The following illustration shows a Cisco fabric representation of Fabric A.



**Storage
Fabric B**

The following illustration shows a Cisco fabric representation of Fabric B.



Storage access EMC storage arrays are accessible using:

- Fibre Channel,
- 1 Gb and 10 Gb iSCSI,
- Unified platforms such as Celerra, and NFS, and
- FCoE (in the near future).

These options make it easy to find an access model for any environment.

In the virtual information infrastructure environment discussed in this white paper, the SAN network topology was deployed on Cisco MDS 9509 director-class SAN switches. Connectivity between the Fibre Channel SAN and the converged network was through E_Port connectivity between the MDS switches and the Fibre Channel ports of the Nexus 5000 switches.

The design deployed here allowed for the migration from the existing Fibre Channel SAN to an FCoE model, while also being ready to deploy 10 Gb iSCSI where required.

Tiered storage In addition to storage access from anywhere, the virtual information infrastructure requires the ability to move data according to changing demands. Storing data on different media types according to usage requirements is called *tiered storage*.

Tiered storage is available from EMC as Fully Automated Tiered Storage (FAST). FAST automates the placement and movement of data on an array based on changing needs.

Where a server's data is stored depends on the performance requirements of the application and how often the data is accessed. Storage media is available in a variety of types, from fast and expensive to slow and cheap:

- Enterprise Flash Drives (EFDs) are extremely fast and efficient, but relatively expensive compared to traditional drives.
- SATA drives are cheap but relatively slow.

The goal is to put the data with the fastest requirements on EFDs and the data that is infrequently used on SATA. Moving this data is normally a time-consuming manual process. EMC FAST automates this process by examining an application's data and moving it to the most appropriate and cost-effective storage media. By making these changes automatically, FAST results in better performance for lower cost.

The virtual information infrastructure environment in this white paper employs EMC Celerra unified storage, CLARiiON, and Symmetrix. Within each array, varied disk configurations such as FC, SATA, and EFD are employed.

Visibility in the virtual information infrastructure

Stack management

With the flexibility of movement in the virtual information infrastructure comes an increased need for visibility into all layers of the stack:

- application,
- server,
- network, and
- storage.

Virtualization makes it easy to migrate a virtual machine (VM) to achieve the best resource performance possible. But that easier movement expands the need to be able to see where a storage array and a VM are in relation to each other.

EMC has developed many software tools that allow administrators to gain access into an environment:

- The EMC Storage Viewer plug-in for vSphere allows an administrator to drill down on a datastore and get information on the array and LUN where the datastore sits. This visibility into the storage layer makes it very easy for a server administrator to provide needed LUN information to a storage administrator if changes are required or a problem exists.
 - The new virtualization-aware Navisphere[®] software for CLARiiON allows the storage administrator to drill down on a server and/or LUN and see the VMs that exist on that LUN.
-

Virtualization-aware Navisphere

Below is a diagram of the virtualization-aware Navisphere deployed in our virtual information infrastructure.

LUN Mapping for Win2k8-Ora1 on VMware ESX Server tce-r900-05-infra.local (172.30.220.151)

Name	Device Mapping	Device Name	Storage System
CX4 App OS Datastore	Datastore (CX4 App OS Datastore)	naa.600601602e2024000e6a3c47ef75de11	TCE-CX480-B
Oracle1	Mapped Raw LUN	naa.600601602d402300ba6ee92e167dde11	TCE-CX480-B
Oracle2	Mapped Raw LUN	naa.600601602d40230012d5eb36167dde11	TCE-CX480-B
Oracle3	Mapped Raw LUN	naa.600601602d4023005add8e3e167dde11	TCE-CX480-B
Oracle4	Mapped Raw LUN	naa.600601602d402300c0ff5251167dde11	TCE-CX480-B

Virtual Machine Information

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.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

**VMware
vSphere
Storage Viewer**

The figure below shows a VMware vSphere server with EMC PowerPath® installed and in control of the data devices:

The screenshot displays the VMware vSphere Storage Viewer interface. The top navigation bar includes tabs for Getting Started, Summary, Virtual Machines, Performance, Configuration, Tasks & Events, Alarms, Permissions, Maps, and Storage Views. The left sidebar shows Hardware and Software sections with various configuration options. The main content area is titled 'Storage Adapters' and shows a list of adapters: 02801EB/ER (ICH5/ICH5R) IDE Controller, LP10000 2Gb Fibre Channel Host Adapter, and 53c1030 PCI-X Fusion-MPT Dual Ultra320 SCSI. The 'Details' section for the selected 'vmhba4' adapter shows its model, WWN, and target information. Below this is a table of storage devices, where the 'Owner' column for all entries is 'PowerPath'.

Identifier	Runtime Name	LUN	Type	Transport	Capacity	Owner
(naa.... naa.60060160571022004e4...	vmhba1:C0:T0:L0	0	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.60060160571022004f4c...	vmhba1:C0:T0:L1	1	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200504...	vmhba1:C0:T0:L2	2	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220054d...	vmhba1:C0:T0:L3	3	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220055d...	vmhba1:C0:T0:L4	4	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220056d...	vmhba1:C0:T0:L5	5	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220057d...	vmhba1:C0:T0:L6	6	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200514...	vmhba1:C0:T0:L7	7	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200524...	vmhba1:C0:T0:L8	8	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200534...	vmhba1:C0:T0:L9	9	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220058d...	vmhba1:C0:T0:L10	10	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200544...	vmhba1:C0:T0:L11	11	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200554...	vmhba1:C0:T0:L12	12	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.6006016057102200564...	vmhba1:C0:T0:L13	13	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.60060160571022001c5...	vmhba1:C0:T0:L15	15	disk	Fibre Channel	50.00 GB	PowerPath
(naa.... naa.600601605710220050d...	vmhba1:C0:T0:L20	20	disk	Fibre Channel	1.05 TB	PowerPath

Multipathing

PowerPath/VE

One of the key enablers in a virtual information infrastructure is fast and open access to resources. EMC's PowerPath/VE is a multipath plug-in that provides path management to ESX hosts. PowerPath/VE not only provides the ability to utilize multiple paths to a datastore or RDM but it provides seamless failover capabilities that allow a host to continue accessing data even after a path fails.

PowerPath/VE is designed to use all paths at all times. PowerPath/VE distributes I/O requests to logical devices across all available paths, rather than requiring a single path to bear the entire I/O requests. In addition, PowerPath/VE is automatically applied as new logical devices are added, and its dynamic I/O distribution adjusts to changing workloads.

Path status

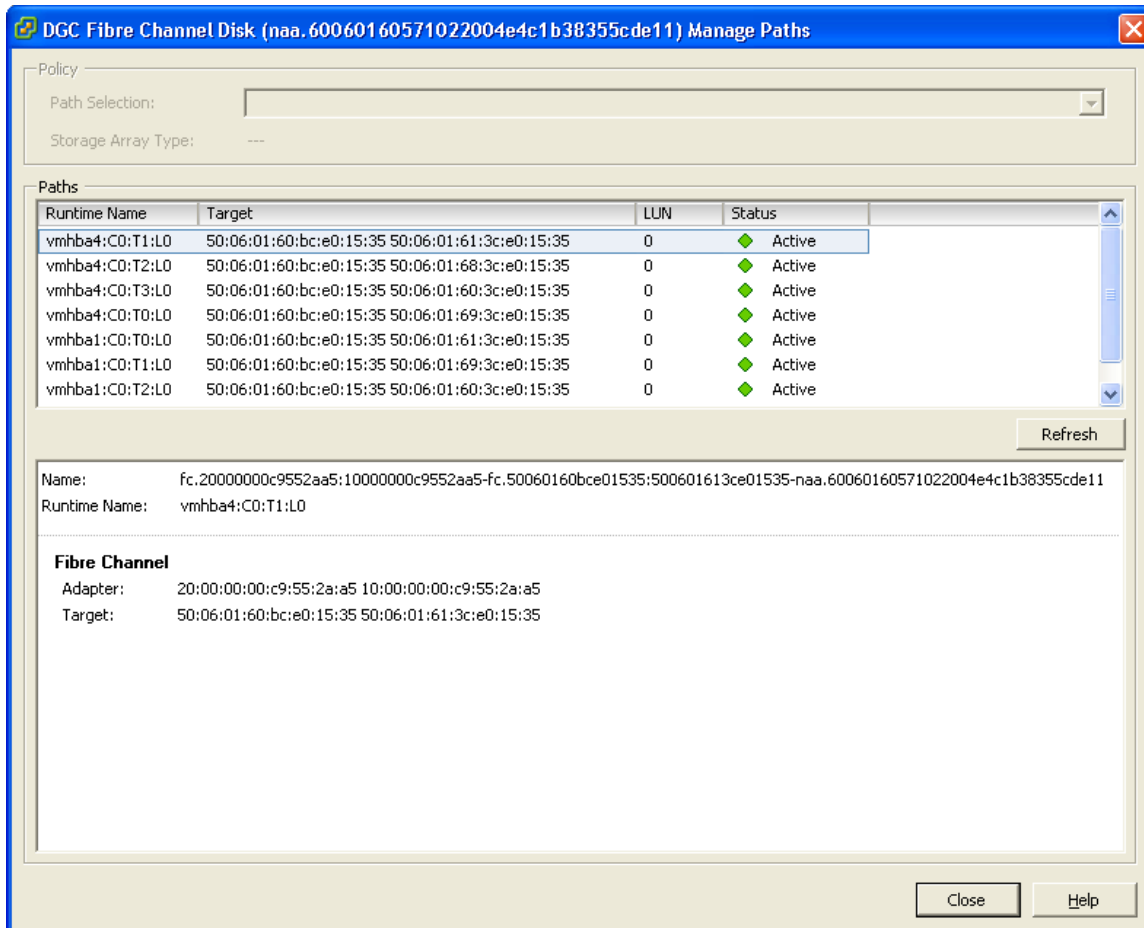
The following figure shows the status of the path.

The screenshot shows the VMware ESX Configuration console for host 10.241.15.111. The 'Storage Adapters' section is expanded, showing the 'LP10000 2Gb Fibre Channel Host Adapter' (vmhba1). The 'Details' section for vmhba1 shows 4 targets, 11 devices, and 44 paths. The 'Paths' view is selected, displaying a table of active paths.

Runtime Name	Target	LUN	Status
vmhba1:C0:T0:L1	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	1	Active
vmhba1:C0:T3:L2	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	2	Active
vmhba1:C0:T2:L2	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	2	Active
vmhba1:C0:T1:L2	50:06:01:60:bc:e0:15:35 50:06:01:69:3c:e0:15:35	2	Active
vmhba1:C0:T0:L2	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	2	Active
vmhba1:C0:T3:L7	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	7	Active
vmhba1:C0:T2:L7	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	7	Active
vmhba1:C0:T1:L7	50:06:01:60:bc:e0:15:35 50:06:01:69:3c:e0:15:35	7	Active
vmhba1:C0:T0:L7	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	7	Active
vmhba1:C0:T3:L8	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	8	Active
vmhba1:C0:T2:L8	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	8	Active
vmhba1:C0:T1:L8	50:06:01:60:bc:e0:15:35 50:06:01:69:3c:e0:15:35	8	Active
vmhba1:C0:T0:L8	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	8	Active
vmhba1:C0:T3:L9	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	9	Active
vmhba1:C0:T2:L9	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	9	Active
vmhba1:C0:T1:L9	50:06:01:60:bc:e0:15:35 50:06:01:69:3c:e0:15:35	9	Active
vmhba1:C0:T0:L9	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	9	Active
vmhba1:C0:T2:L11	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	11	Active
vmhba1:C0:T3:L11	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	11	Active
vmhba1:C0:T0:L11	50:06:01:60:bc:e0:15:35 50:06:01:61:3c:e0:15:35	11	Active
vmhba1:C0:T1:L11	50:06:01:60:bc:e0:15:35 50:06:01:69:3c:e0:15:35	11	Active
vmhba1:C0:T2:L12	50:06:01:60:bc:e0:15:35 50:06:01:60:3c:e0:15:35	12	Active
vmhba1:C0:T3:L12	50:06:01:60:bc:e0:15:35 50:06:01:68:3c:e0:15:35	12	Active

LUN status

The following figure shows the status of the LUNs.



Conclusion

Summary

Designing and building a virtual information infrastructure is a process that must be comprehensive and detailed, and take into account both current and future technologies. The design must be such that future changes won't require a complete redesign of the environment but can simply be assimilated without disruption.

As detailed in this white paper, a virtual information infrastructure must encourage cost-effective, easily managed and secure shared resources, including:

- computing resources,
- storage resources, and
- networking resources.

The virtual information infrastructure must allow for transport between locations without affecting application performance SLAs. In addition, taking advantage of emerging technologies around server virtualization, higher bandwidth connectivity, multi-protocol storage, and unified computing are critical to building a data center infrastructure that can meet the virtual information infrastructure needs of the organization now and in the future.

Key points

The table below summarizes the key points that this solution addresses.

Key Point	Solution objective
A virtual information infrastructure includes secure shared resources including computing, networking, and storage.	EMC's virtual information infrastructure solution provides a cost-effective, easily managed infrastructure.
Virtual information infrastructure network resources should accommodate advanced high-speed technologies.	EMC's virtual information infrastructure provides a unified fabric using 10 Gb Ethernet and Fibre Channel over Ethernet.
Virtual information infrastructure computing resources leverage virtualization and unified computing for easy management and flexible deployment.	EMC's virtual information infrastructure solution uses a multi-hypervisor environment on standalone and unified computing platforms.
Data in the virtual information infrastructure should take advantage of tiered storage so that applications can use the most appropriate storage media.	EMC's FAST (Fully Automated Tiered Storage) automates the movement of data based on changing system needs.
