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Unified Storage Computing – The Future of Data Centers

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EMC Proven Professional Knowledge Sharing 2010

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Abstract

Data centers are the core of IT and are a crucial aspect of most organizational operations. The main concerns are cost and management; companies rely on their information systems to run their operations. Almost all of the IT costs in an Enterprise are allocated to data center development and maintenance. Company operations may be impaired or stopped completely if a system becomes unavailable. We must provide a reliable infrastructure for IT operations to minimize any chance of disruption. This is only possible if a data center provides uninterrupted operations with a better value for the money.

A data center includes thousands of servers, network switches, and storage arrays for its operations. These components help organisations achieve an important goal – computing. Unified Computing promises to aggregate all the components that contribute to computing. This will help organisations to reduce hardware costs, management, and floor space, while increasing throughput, efficiency, performance, scalability, and agility. A Unified computer will enable the IT staff to easily manage the whole IT infrastructure.

Unified computing has been a topic of interest among data center architects recently. As with any other technological progress, it has gone through several phases. 2009 has been very important for data center technologies. Several companies have understood and accepted the flaws in their products. This led to a collaborative effort to deliver a single yet powerful product in the field of Enterprise computing.

Note: This document expresses the views of the author and does not endorse or support any vendor/company. The reference to words ‘Unified computer’, ‘Unified Computing’, ‘Unified Infrastructure’ in this article refers to the concept of Unified Computing and not any product.

Evolution that caused the rise of Unified Computing

The current data center has gone through a major evolution in the past forty years. The timespan from computers to data centers wasn't very long, but it didn't happen overnight. There are many computing systems that played vital roles in data center evolution, including: mainframe computers, mini computers, and distributed computing systems. IT architects chose computing systems affecting the overall design and performance.

Mainframes

Mainframes were the first commercially accepted computer. The mainframe's power makes it a powerful and valuable component. Large corporations who need to have massive, mission-critical applications rely on mainframes. Small and medium-sized businesses (SMB) generally find mainframes too costly.

Large scale data centers chose mainframe because of its power, high utilization rates, effective workload management, and well-defined processes and procedures. However, to enable such a powerful computer to work seamlessly comes with a price. The cost of purchase and set up is the major drawback of a mainframe. Although a single vendor started mainframe computing, several companies rapidly entered the market. This encouraged competition. However, because vendors used proprietary operating systems, once a customer started using and implementing business-critical applications, they were locked in.

Mini Computers

A new age of computers arrived in the 1970s and 1980s as mini computers became an alternative to mainframes. They were much smaller than mainframes and, most importantly, less expensive. They were primarily targeted to run business applications.

Companies started developing applications on mini computers due to their flexibility. Developers experienced freedom with the rules and processes in this environment. Developers also gained more flexibility when writing applications. Mini computers were the first step in revolutionizing the data center and offering freedom from mainframes.

Mini computers were welcomed by many but they suffered a few setbacks. As they were small and inexpensive, they were seen in labs and offices and not primarily in the traditional data center. This created data centers with no standards and policies as owners used them in their own way. Their lack of portability was another setback. A code written for an application on a mini computer wouldn't run on another mini computer from another vendor. The developer would have to re-write the code to enable it to work on that particular platform.

Distributed Computing

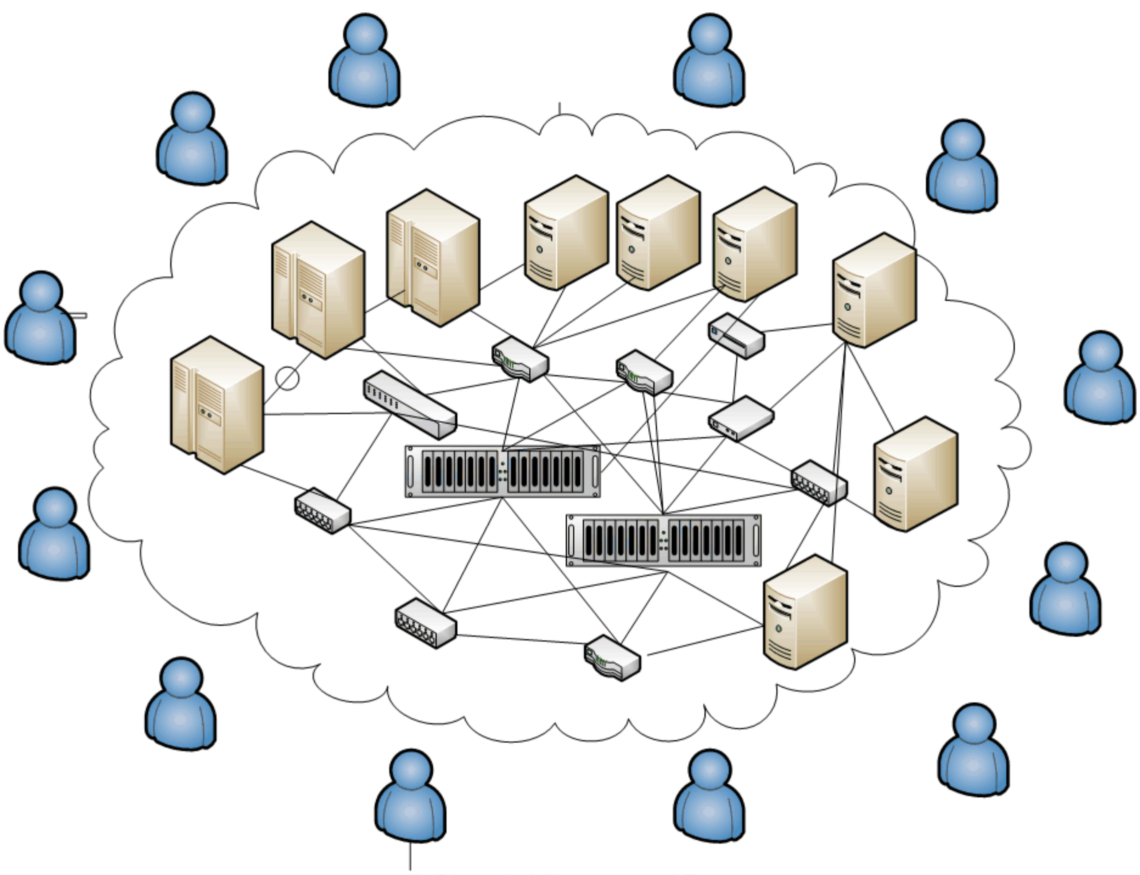
1980s marked the emergence of distributed systems consisting of multiple autonomous computers that communicate through a computer network. The computers interact with each other to achieve a common goal. It enabled major operating systems to be available on small, low-cost servers. As a result, developers wrote their mission-critical codes on their workstation and later deployed them on the main server. Ethernet was one of the first distributed systems. Distributed computing provided great freedom of computing. However, this caused the current complexity that has led to today's major trend towards consolidation.

The need for consolidation

We measured limited creative license and increased time to mainframe development queues in years as they tend to be less agile. The need for consolidation has existed for a long time. With the rapid growth of effective and powerful technologies, hardware has been reduced to a great extent. An evolution caused the use of Enterprise storage arrays and the use of storage area network (SAN) instead of SCSI disks. Servers played a major role in consolidation. Several servers were underutilized; the physical resources did less than they were capable of doing. This led to the need for a feature to enable existing resources to do more jobs than they were currently doing. Technology companies brought a new phase to the industry that is now a household word; 'virtualization.' With server virtualization, the number of logical servers outnumber the number of physical servers. Servers are now doing more work than they were doing before.

Problems in the current data center

Today's data centers house hundreds of servers, switches, network interfaces, storage arrays, power supplies, cables, cooling units, and more. The servers are manufactured and supplied by different vendors, as are the switches and the storage arrays. Each one has its own standards, protocols they support, features, advantages, and disadvantages. All of these components enable computing. Only 40%-60% of each component's features are utilized. The remaining feature is either not useful in the environment or it is too expensive to implement. When there are multiple components that need to communicate, there should be several mediums to transfer data. That is achieved using interconnecting connections, cables, and additional I/O slots. As each is a separate physical component, each requires its own rack, power supply units, and separate cooling.



A Chaotic Mismanaged Datacenter

Some of the challenges in High-Performance Computing:

- Insatiable demand for performance
- Storage consumption
- Must provide continuous operations
- Rapid recovery from disaster and errors
- Get the most from IT investment
- Reduce complexity

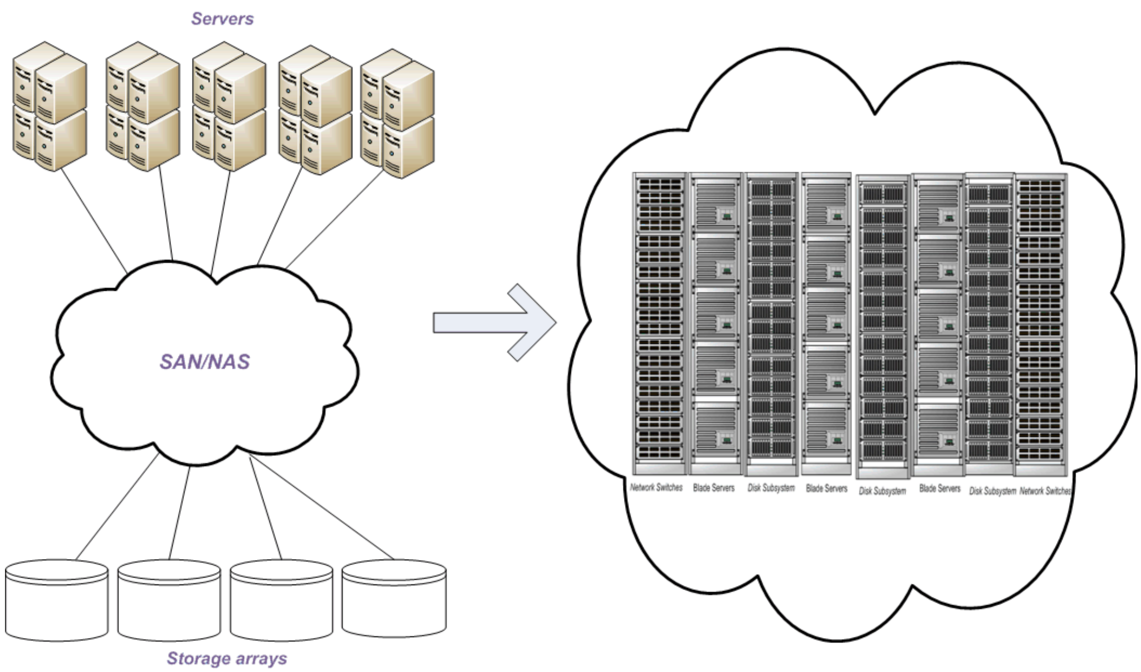
Virtualization has always been the option to share the available physical resources to create multiple logical entities. All these physical resources are a combination of several multiple components. Also, several market leaders are utilizing multiple physical server components and achieving several logical servers, similar to Logical Partitioned Servers. However, they still utilize the networking and the storage residing in physically separate locations. Manageability, degraded performance, scalability, cost of power and cooling, and less utilization of all the features in each component are the problems we face.

The nature of Unified computing

Unified computing reduces the cost to acquire, manage, support, and increase the performance, speed, and agility of the system. Unified computing incorporates virtualization, on-demand service, dynamic hardware movement of the resources, and network ports. It might be considered a 'data center in a rack' or 'stack in a rack.' A single utility can manage all the resources in the Unified Computer. The resources can either be divided into several chunks of multiple separate entities (for example, a group of memory, CPUs, and storage space) or you can group all these components in standard units that can be called a 'block' of a unified computer or 'one standard unit' of the Unified Computer.

Incorporating the best

Simply put, when a new product is launched, the priority is to develop the best. Unified computing replaces the inefficient, poor performing, existing hardware in the data center with an efficient, simplified, high performing infrastructure. Management overhead is reduced considerably with Unified computing.



Current Datacenter with multiple components

Datacenter having Unified Infrastructure/Computer

These are the salient features of a Unified Computer:

Dynamic Hardware

Inspired by the concept of Dynamic Logical Partitions (DLPAR), Dynamic Hardware will be one of the main features in Unified Computing. A DLPAR allows users to configure the hardware components dynamically without having to shut down the operating system that runs on the logical partition (LPAR). DLPAR enables memory, CPUs, and I/O interfaces to be moved non-disruptively between LPARs within the same server.

A unified computer allows the CPUs and memory to be dynamically added to a logical partition. This LPAR is one of the smallest logical entities in the unified computer. An LPAR may be considered a subset of a computer's hardware resources, virtualized as a separate computer. In effect, a physical unified computer can be partitioned into multiple LPARs, each housing a separate operating system.

With Dynamic Hardware, a unified computer allows combining multiple test, development, quality assurance, and production work on the same system. This provides LPAR isolation. Although all the LPARs are working as individual computers, they are managed using a common management console. When you require a number of CPUs or memory boards, the management console allows CPUs to be added to an existing LPAR.

Dynamic Software

Unlike rack-mount or blade servers that have separate channels of communication for power, Local Area Network (LAN) connection, and Storage Area Network (SAN) connection, a Unified computer wouldn’t have multiple communication channels for different types of protocols. Data center traffic can be consolidated onto a single network medium using Fibre Channel over Ethernet (FCoE), or 10 Gigabit Ethernet or Infiniband communication links.

With I/O being consolidated, there will be only one (or two) communication channel(s) to the LPAR. LAN and SAN traffic has to be addressed using certain unique identifiers commonly called Media Access Control (MAC) address for LAN traffic and World Wide Port Number (WWPN or just WWN) for SAN traffic. A unified computer wouldn’t have separate Network Interface Cards (NIC) or Host Bus Adapter (HBA) to have a unique MAC or HBA. To provide a MAC and WWPN address to an LPAR, Unified Computer incorporates a feature allowing administrators to assign MAC and WWN addresses to an LPAR from a ‘pool of addresses.’ The range of the addresses depends on the vendor selling the unified computer hardware. This WWN of the LPAR is now said to belong to a Virtual Host Bust adapter (vHBA). The management console will provide the capability to upgrade the firmware and BIOS with minimal downtime.

Virtualization

With multiple CPUs aggregated to form LPARs, you might notice that the allocated resources to the LPAR aren't being effectively utilized. Virtualization has been enabled in a Unified Computing environment to overcome this. Virtualization dramatically improves the efficiency and availability of resources and applications. Internal resources are underutilized under the old "one server, one application" model and IT administrators spend too much time managing the servers.

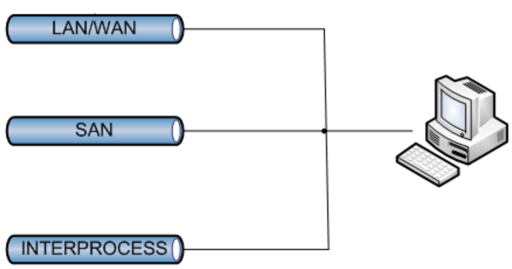
Virtualization is the best solution for applications that require less CPU cycles or that require less memory. As explained about Dynamic Hardware that allows CPUs to be aggregated, the virtualization feature allows creating multiple instances of an operating system in the same physical hardware.

Unified Fabric

Server I/O architecture is one major architectural component that can be shared in this manner. Typically, a conventional server is deployed with multiple network adapters that serve three basic I/O requirements: LAN/WAN, SAN, and interprocess communications. You can deploy servers with multiple Ethernet network interface cards (NICs), Fibre Channel host bus adapters (HBAs), and sometimes dedicated clustering interconnects. Servers can require many expansion slots for mission-critical applications, such as databases. In a large data center, managing these servers and their cables can be difficult and costly, hampering the agility to quickly meet business demands.

Aggregating the server's I/O resources saves significant capital expense. Consolidating resources over the unified fabric eliminates the cost of underutilized Fibre Channel HBAs and NICs as well as associated cabling complexity. Instead of being designed to accommodate bandwidth peaks using a dedicated switch port for each host, a data center can share remote Fibre Channel and Gigabit Ethernet ports, enabling network designs based on average load across multiple servers. This can save up to 50% of the cost of the I/O associated with a server. Also, by eliminating multiple adapters and local storage by introducing a single high-bandwidth, low-latency connection, the size of the server is driven only by CPU and memory requirements. This often results in a reduction in the size and cost of the server as well as in its space, power, and cooling needs. This results in a 50% return on investment.

Virtualizing I/O on the server also makes it possible to aggregate multiple servers by changing server identities rapidly based on time of day. Physical machines can switch rapidly between different operating systems and applications by simply changing the server-to-storage mappings stored in the server switch. Everything unique about a server is stored in the fabric; the physical server is simply another resource to be assigned. This creates a new level of flexibility, because servers are no longer tied to physical locations.



Existing environment using separate I/O channels

Unified Fabric using single I/O channel for all the traffic

The diagram shows the major advantage of a unified fabric environment. The number of channels has been reduced considerably using the unified fabric environment. There are fewer cables coming out or going to the system, reducing the complexity of the environment. Using the example of a rack-mount server with connectivity to LAN and SAN, it would require at least 4 cables out of the server. Two cables will be used for SAN connectivity and the remaining two for LAN/WAN connectivity.

In a high availability clustered environment, requiring high throughput for SAN traffic and separate back-up traffic through LAN, the LAN traffic would demand 6 cables (two for primary data traffic for LAN, two for backup data traffic, and two for heartbeat), and another 4 cables for the 4 HBAs connecting the SAN. Unified fabric uses the same physical link to transport all of the above traffic using a single medium. This link is usually a 10 Gbps line with the capability to transport multi-protocols.

FCoE, 10 GigE, and Infiniband are some of the switched fabric communications links that dominate unified fabric architecture. In a unified computing environment, unified fabric plays a major role in aggregating and simplifying the system.

Storage Networking

The storage infrastructure is the last component that plays a vital role in the formation of a Unified computer. Today, there are several enterprise storage vendors offering multiple features and proprietary standards. Each has its own advantages and disadvantages that distinguish it from the other. However, while architecting a unified computing environment, we must ensure that the cost per GB is not too high without compromising performance.

The characteristics of a storage infrastructure inside a Unified Computer are different from those of the usual Enterprise intelligent disk array. It would continue to have disk bays with protection and spares. It would continue to include processors, cooling fans, and power supply with no single point of failure components. However, the front end ports (the ports that communicate with the hosts that seek storage) will now be hard-coded within the hardware to communicate with the LPARs. The communication protocol will remain Fibre Channel (FC), but the medium of communication will no longer be via FC cables or interfaces. FC interfaces and cables, although reliable and high performing, have the drawback of being more expensive than any other means of communication link.

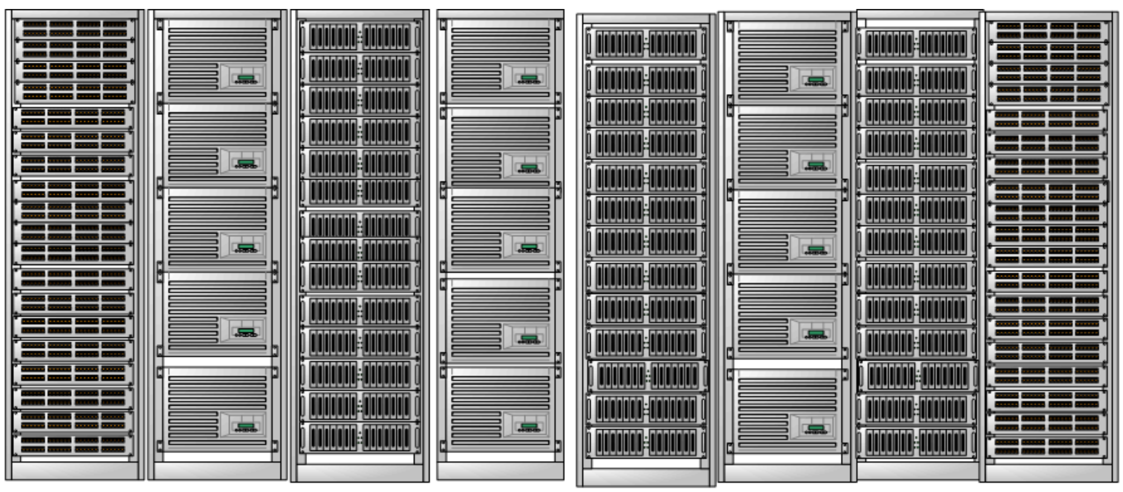
FCoE will be used to overcome this since it has better performance and is less expensive than traditional FC. The disk shelves will continue to communicate with copper cables (similar to high speed serial data link (HSSDC) cables with the usual Small Computer System Interface (SCSI) protocol. The concept of redundant array of independent disks (RAID) will have to undergo a massive change to satisfy the objectives of a unified computer. RAID 6 (striped data with dual parity) might be the best solution for massive data storage and very high redundancy. Redundancy is important here because we are now dealing with a large number of physical disks. When the number of disks is high, the mean time between failure (MTBF) is also high. RAID 6, having dual parity, shouldn't continue to be a performance bottleneck for the writes and calculation of the dual-parity.

The data that hits the cache of the array will start calculating the parity and then hits the disk to avoid this. This has to be done using a separate integrated circuit to prevent high utilization of the storage processors. The re-build operation has to be modified to ensure faster data recovery from failed disks. This can be achieved by copying the contents of a 'failing disk' to a spare disk and when the disk is actually failed, the data that couldn't be copied will be calculated using the parity and the other normal disks.

Managing the storage array would no longer be the task of a storage administrator. As with any other management in the unified computer, the storage components will be managed by the management console that has been used to create and manage the LPARs.

A closer look at the Unified Computing Architecture

Now that we know what components constitute the unified computer, let us see how it actually might look. There doesn't seem to be much difference from the outside with a couple of racks attached to it. A sample representation is shown below:



An example representation of Unified Computer

The biggest USP of the unified computer is that the above racks have no additional components from a 'data center.' Logically, no other components are required to solve the biggest problem called 'High Performance Computing.' The switches on the right and left bays are used for connectivity for LAN, WAN, tape libraries, remote replication of the storage, etc. All other networking infrastructure is used for communication of the server. Storage has now been unified and it is 'hidden' inside the other racks. The racks communicate with each other using the unified fabric infrastructure.

The server bays do not contain any rack-mount type servers. Instead, a series of blade enclosures are piled on the rack. A blade enclosure that can hold multiple blade servers provides services such as power, cooling, networking, various interconnects, and management—though different blade providers have differing principles around what to include in the blade itself (and sometimes in the enclosure altogether). The blade chassis now communicates to other racks using the unified fabric infrastructure – 10Gigabit Ethernet, FCoE, or Infiniband. There are no separate Ethernet, SAN, or other cables that come out of these chassis except the unified link.

Storage bays will continue to look and act similarly to enterprise storage arrays. The disk shelves will contain a fixed number of physical disks similar to any other storage array. The first disk enclosure is connected to the disk controller card that manages the addressing and data distribution for the disk shelf and the subsequent shelves. They are connected with each other in a daisy-chain loop. The storage controller processor is connected to one of the network switches that allow administrators to manage it.

Server Architecture

The system integrates a low-latency, lossless 10 Gigabit Ethernet unified network fabric with enterprise-class, x86-architecture servers. The system is an integrated, scalable, multi-chassis platform in which all resources participate in a unified management domain. The chassis will have fewer physical components, no independent management, and will be more energy efficient than traditional blade server chassis. This simplicity eliminates the need for dedicated chassis management and blade switches, reducing cabling.

Features and Benefits of a leading Unified computing server product:

Feature	Benefit
Unified fabric	Decreases TCO by reducing the number of network interface cards (NICs), host bus adapters (HBAs), switches, and cables
Auto discovery	Requires no configuration; like all components in the Cisco Unified Computing System, chassis are automatically recognized and configured by Cisco UCS Manager
High-performance midplane	• Provides investment protection • Supports up to 2x 40 Gigabit Ethernet for every blade server slot when available • Provides 8 blades with 1.2 terabits (Tb) of available Ethernet throughput for future I/O requirements • Provides reconfigurable chassis to accommodate a variety of form factors and functions
Redundant hot-swappable power supplies and fans	• Provides high availability in multiple configurations • Increases serviceability • Provides uninterrupted service during maintenance
Hot-pluggable blade servers and fabric extenders	Provides uninterrupted service during maintenance and server deployment
Comprehensive monitoring	• Provides extensive environmental monitoring on each chassis • Allows use of user thresholds to optimize environmental management of the chassis
Efficient front-to-back airflow	Helps reduce power consumption and increase component reliability
Tool -free installation	• Requires no specialized tools for chassis installation • Provides mounting rails for easy installation and servicing
Mixed blade configurations	Allows up to 8 half-width or 4 full-width blade servers, or any combination thereof, for maximum flexibility

Source: http://www.cisco.com/en/US/prod/collateral/ps10265/ps10279/data_sheet_c78-526830_ps10276_Products_Data_Sheet.html

The industry standard x86-based processor architecture is the best possible alternative to the proprietary architecture that locks in the vendor to the customer environment. The open standard-based architecture is easier to manage, has greater flexibility, and is easier to consolidate. It is flexible and offers greater computing performance. In addition, it is the ideal infrastructure for virtualization. Ultimately, all these advantages lead to a much lower total cost of ownership (TCO).

The next component in a server is the amount of memory the processor can support for operation. Of course, you should always have a large amount of memory for resource consuming applications to overcome problems related to memory, including memory leaks/bound issues. The operating system (OS) should be smart enough to prevent these problems. However, have a large memory pool for high performance computing. With 64-bit processors, the amount of addressable memory can be increased drastically. Now you can have more memory for applications (The CPUs usually use 40-bit of memory addressing, even though it's a 64-bit CPU. It can address a maximum of half a terabyte of memory, i.e., 512GB. But in practical scenarios the amount of memory is much less).

Some of the specifications of a Unified computing server product are mentioned below:

Item	Specification
Processors	1 or 2 Intel Xeon Series 5500 processors
Memory	• Up to 12 DIMM slots per Cisco UCS B200 M1 • Up to 48 DIMM slots per Cisco UCS B250 M1 • Support for DDR3 registered DIMMs
Hard drives	Up to 2 front-accessible, hot-swappable, 2.5-inch SAS drives per blade
Hard drive options	• 73-GB SAS; 15,000 rpm • 146-GB SAS; 10,000 rpm
Temperature: Operating	50° to 95°F (10° to 35°C)
Temperature: Nonoperating	-40° to 149°F (-40° to 65°C)

Item	Specification
Humidity: Operating	5% to 93% noncondensing
Humidity: Non-operating	5% to 93% noncondensing
Altitude: Operating	0 to 10,000 ft (0 to 3,000 m) Maximum ambient temperature decreases by 1°C per 300m)
Altitude: Nonoperating	40,000 ft. (12,000m)

source:http://www.cisco.com/en/US/prod/collateral/ps10265/ps10280/data_sheet_c78-524797_ps10280_Products_Data_Sheet.html

Switches

A switch is the nervous system of the Unified computing architecture. Without switches, all the components would surely be working; but not for a 'unified' goal. By definition, a network switch is a computer networking device that connects network segments. In a unified computer, the switch does more than just connect network segments. It integrates all the components of unified computing, unified fabric, and storage to make the whole infrastructure that is a Unified computer.

The switch in a Unified computer is usually a multi-layer, multi-protocol switch. Now the big question arises. "If they are mere Ethernet or Fibre Channel switches, how would they have the intelligence to manage the whole subsystem?" These switches have features and benefits like Unified Fabric with line-rate, low-latency, lossless 10 Gigabit Ethernet, and FCoE. It should have an expansion module option providing capability for 10 Gigabit Ethernet/FCoE connections. The switches are the only gateway to communicate with the Unified Computing infrastructure. All configuration changes must go through these switches in a Unified Infrastructure. These also connect to the LAN for management of the system and other public data traffic as well.

Some of the qualities of switches that have these features are shown below:

Feature	Benefit
Autoconfiguration	Simplifies operations by automatically synchronizing firmware levels between the fabric extenders and the interconnects
Unified fabric	• Decreases TCO by reducing the number of network interface cards (NICs), host bus adapters (HBAs), switches, and cables • Transparently encapsulates Fibre Channel packets into Ethernet
Automatic failover	Increases availability with an active-active data plane
Scalable bandwidth	Reduces TCO by optimizing overall system capacity to match actual workload demands
Environmental monitoring	Removes the need for chassis management modules
Lossless fabric	Provides a reliable, robust foundation for unifying LAN and SAN traffic on a single transport
Priority flow control (PFC)	• Simplifies management of multiple traffic flows over a single network link • Supports different classes of service, enabling both lossless and classic Ethernet on the same fabric
System-wide bandwidth management	Enables consistent and coherent quality of service (QoS) management throughout the system
SFP+ ports	• Increases flexibility with a range of interconnect solutions, including copper Twinax cable for short runs and fiber for long runs. • Consumes less power per port than traditional solutions

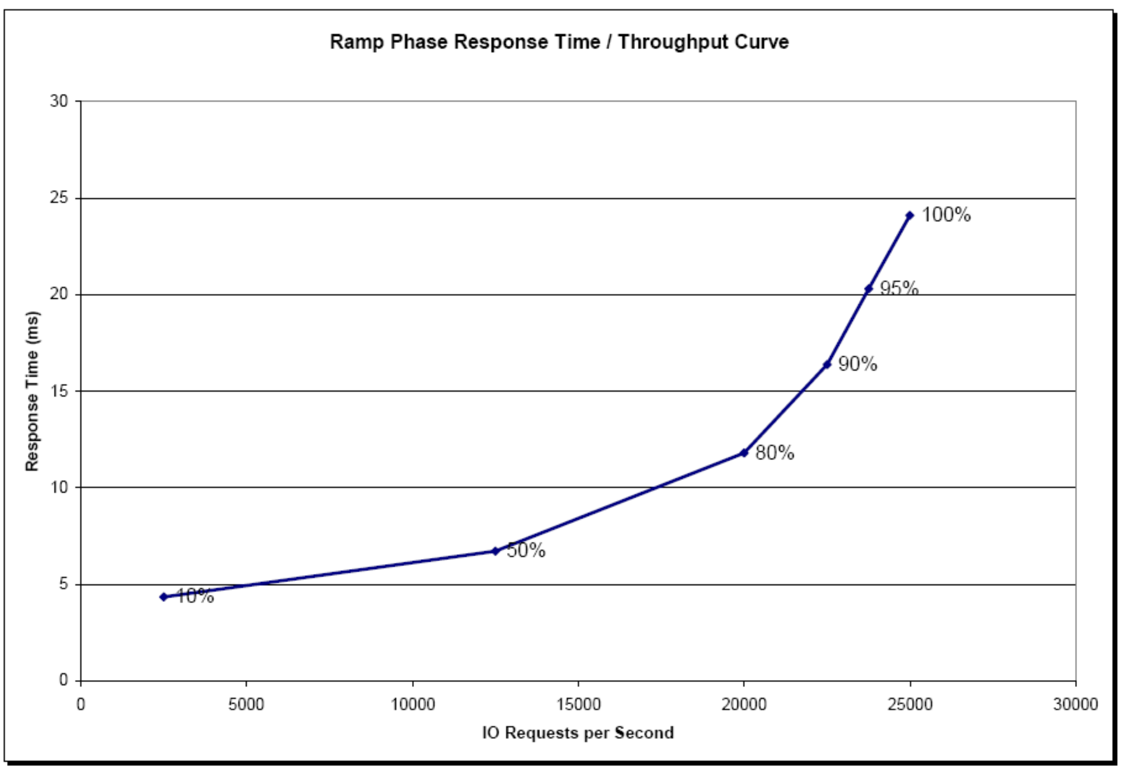
source:http://www.cisco.com/en/US/prod/collateral/ps10265/ps10278/data_sheet_c78-524729_ps10276_Products_Data_Sheet.html

Storage

We must have best-of-breed technologies to overcome the disadvantages of the previous situation. Storage is one of the most important aspects in the data center as it is always in the news for poor performance, poor capacity management, un-utilized storage disks, etc. So what is the real problem? Several vendors came up with solutions that they think is the best. But when the Storage Administrator starts using it, he comes to recognize the storage arrays' problems. Data center managers do not always conduct complete research of the available storage options in the market. An independent body would help the end user to understand the facts and numbers that are involved with storage system performance.

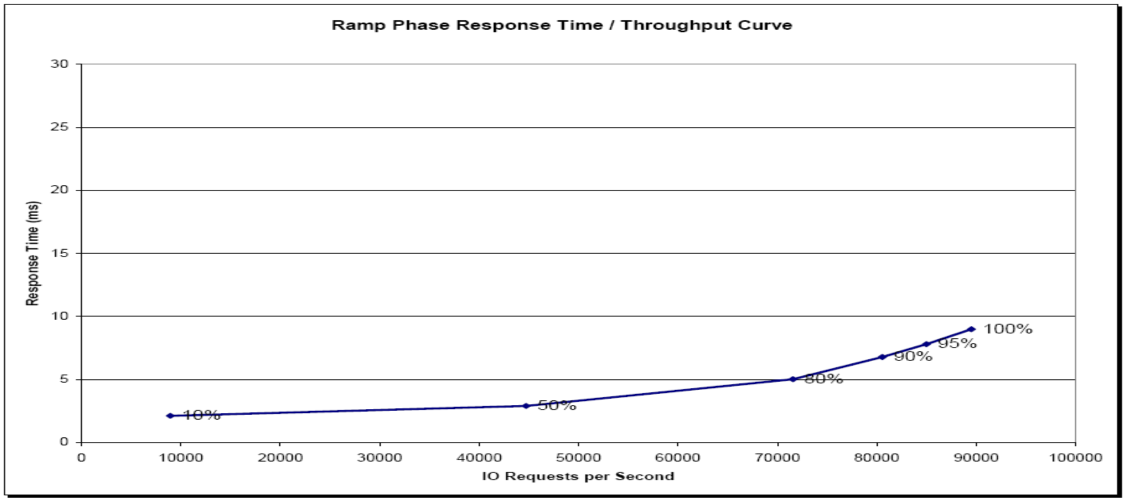
The following are the graphs of Input/Output (I/O) response time versus Input/Output per second (IOPS) of a finite amount of data:

EMC CLARiiON CX3-40:



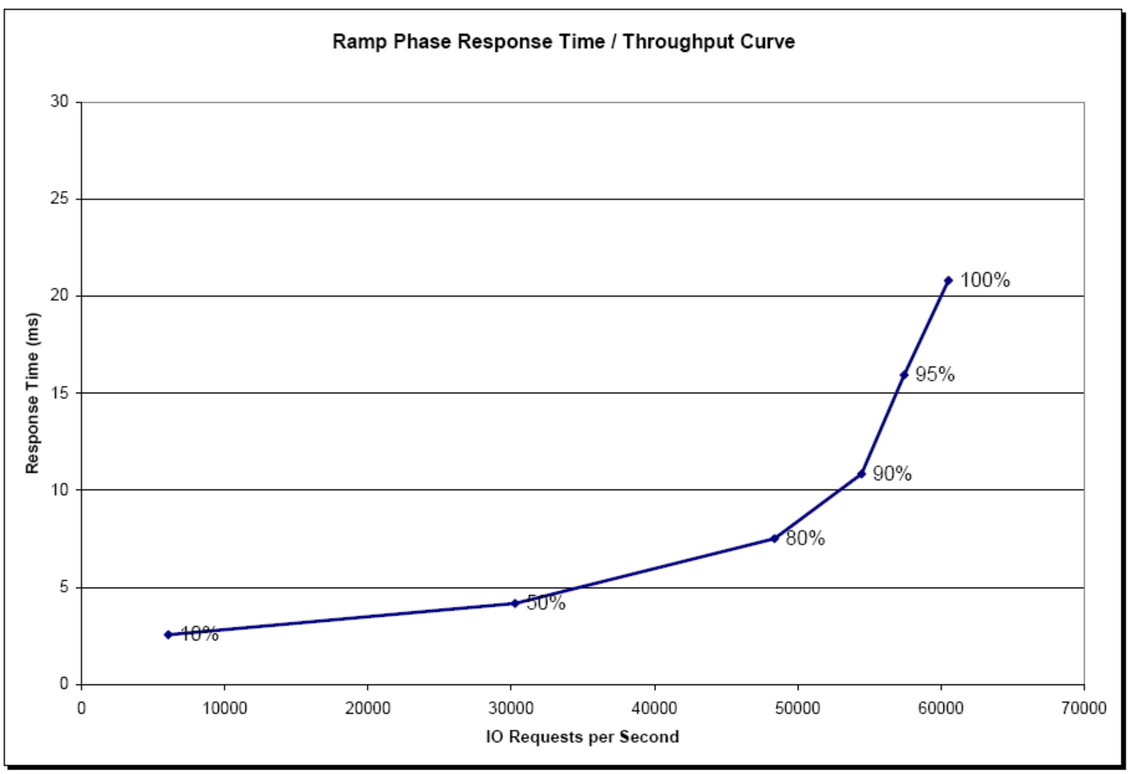
http://www.storageperformance.org/results/a00059_NetApp_EMC-CX3-M40_executive-summary-r1.pdf

Hitachi AMS 2500:



http://www.storageperformance.org/benchmark_results_files/SPC-1/HDS/A00078_Hitachi-AMS2500/a00078_HDS_AMS2500_SPC1_executive-summary.pdf

NETAPP FAS3170:



http://www.storageperformance.org/results/a00066_NetApp_FAS3170_executive-summary.pdf

The Response Time-Throughput Curve illustrates the Average Response Time (in milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level to generate the metric.

It is difficult to select a storage system based on factors like price, vendor support, and reputation. Ignoring all factors except performance, you might be very impressed by Hitachi AMS 2500 because even at 100% workload for 90000 IOPS, the response time is very much less than 10ms. Also, another question arises, “Are we comparing the right storage products?”

An EMC Symmetrix® storage array might provide even better performance. However, if the data center requires a storage array with file sharing capability, no matter how well the AMS box performs you wouldn’t need it. The obvious choice would be the NetApp FAS3170, which is the best choice here for a NAS solution. Eventually, when the data center grows and the need for high performance storage increases, the NetApp box wouldn’t be able to satisfy the needs.

The option is to find a NAS-capable array with high performance storage that exceeds AMS performance. Practically, by this time, there would be another vendor with another product that would provide much better performance than any of the above three. This is natural as technology advances daily; newer products with enhanced features will be available in the market. The important thing is to find a way to keep the existing storage infrastructure capable of expanding, and ensure its ability to boost performance without making major changes to the environment.

Storage is no longer just hardware with a set of disks with the ability to store data. Storage has evolved in the last ten years. Data centers that used SCSI disks are now using Ultra-High performance solid-state drives (SSD). The reason for this drastic change is the growth and demand of information – data. Paper records are becoming less reliable due to recent manmade and natural disasters. This has increased data digitization. All data is also being copied for disaster recovery. It is estimated that unstructured data is now about 80% of the data being managed, often with infrastructures that were originally designed for corporate transactional data.

A unified computer will not be the answer to today's data center solution unless storage is unified and its problems are addressed correctly. Storage competition has increased proportionally with data growth but not with performance. Insatiable demand for performance, hard to predict storage consumption, providing continuous operations, recovering rapidly from disasters, reducing complexity of high performance applications, etc. are some of the problems seen in high performance storage computing.

Storage vendors now have to focus on realistic problems and resolve them. They need to ensure that the goal is performance and effective utilization of the storage space. Storage arrays in a unified computing environment should have the following features:

- Efficient implementation of RAID or other means of protecting data and improving throughput
- Use redirect-on-write methodology for snapshots instead of copy-on-first-write
- Serial Attached SCSI (SAS) disks against Fibre Channel to optimise cost but not compromise performance
- Automated thin-provisioning
- LUN-level data deduplication
- Unified SAN/NAS and archiving appliance
- Multiprotocol appliance
- Host-level storage management tools
- Greater cache memory
- Powerful processors
- High throughput and multiple front-end and back-end channels
- Easily scalable and simple management

Business Continuity in Unified Computing

We have discussed a possible solution for a unified computer's hardware. It is important to keep the business running even when there is a disaster in the primary data center. A unified computer installed in a location may be considered the primary system. An identical unified computer with the same configuration will be installed in another geographically separated location. The remote unified computer will be in-synch with the primary. In case of a disaster at the primary location, the unified computer in the remote location will take over and act as primary. Once the primary resumes operations, the data that was managed by the secondary unified computer during the outage will be copied to the primary.

Interaction with Cloud computing

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). The name 'cloud computing' was inspired by the cloud symbol that's often used to represent the Internet in flow charts and diagrams. Cloud computing is a flexible and economical model for delivering IT services. Based on virtualization technology and web-based delivery, cloud computing provides the agility needed to respond to ever-changing market opportunities and business requirements. It brings together business strategy, architecture, and operations to increase IT's contribution to business value.

Cloud computing has a profound effect on business by helping to manage information, lower business risk, and reduce expenses. In the software-as-a-service cloud model, the vendor supplies the hardware infrastructure, the software product, and interacts with the user through a front-end portal. SaaS is a very broad market. Services can be anything from Web-based e-mail, to inventory control and database processing. Because the service provider hosts the application and the data, the end user is free to use the service from anywhere.

Cloud computing will be able to deliver the best solutions by harnessing itself in a Unified Computing environment. From the above statements about cloud, it might well be understood that cloud computing is all about services. Cloud computing services achieves its goal only if it is sits on top of strong, robust, agile, scalable, high-performance hardware. Traditional data center components cannot be used to transform itself into a cloud; they need to be modified accordingly.

Private clouds

Private cloud (also called internal cloud or corporate cloud) is a marketing term for a proprietary computing architecture that provides hosted services to a limited number of people behind a firewall. Advances in virtualization and distributed computing have allowed corporate network and data center administrators to effectively become service providers that meet the needs of their "customers" within the corporation. Private clouds will be the biggest customer of a unified computing environment. Apart from regular data centers that need to reduce power consumption, management, space, and increase efficiency, companies who are looking forward to host-based cloud services will ensure that they have infrastructures capable of optimizing the service.

Companies are working collaboratively to accelerate adoption of massive virtualization and private cloud infrastructures. This is a very good sign for data center managers as they can now rely on a single vendor window for resolving any problem.

Will unified computing indeed make a difference?

Yes. Unified computing is the future of data centers. We have seen that it has the potential to simplify, integrate, and reduce cost, power, cooling, and space requirements. Data centers are undergoing a complete transformation with efficient cooling and 'green' initiatives. Now, let us see how it will help.

Power and Cooling Savings

Per Rack	W/Sq. Foot	Energy Cost
2kW	67	$3,218
4kW	133	$6,437
6kW	200	$12,546
24kW	800	$50,184
40kW	1,333	$102,912

Source : Gartner

One of the main objectives of unified computing is to reduce data center power consumption. The unified computing system contributes to resolve the problem. It is predicted that energy cost will be much higher in coming years. To make matters worse for technologists, regulations now require a reduction in our carbon footprint and the use of clean-fuel. For example, a customer with a highly available data center needs to have uninterrupted power supplies all the time. To do this, he would purchase diesel generators as back-up. But due to government regulations, he cannot use them as they do not use clean fuel.

The only way to reduce the carbon footprint is to reduce the data center's power consumption. This can only be achieved by using low power consuming hardware and proper management of cooling. One of the leading research companies has predicted the cost of energy will be very expensive in the coming years. This will be a serious cause of concern for CFOs.

Savings using Unified Fabric

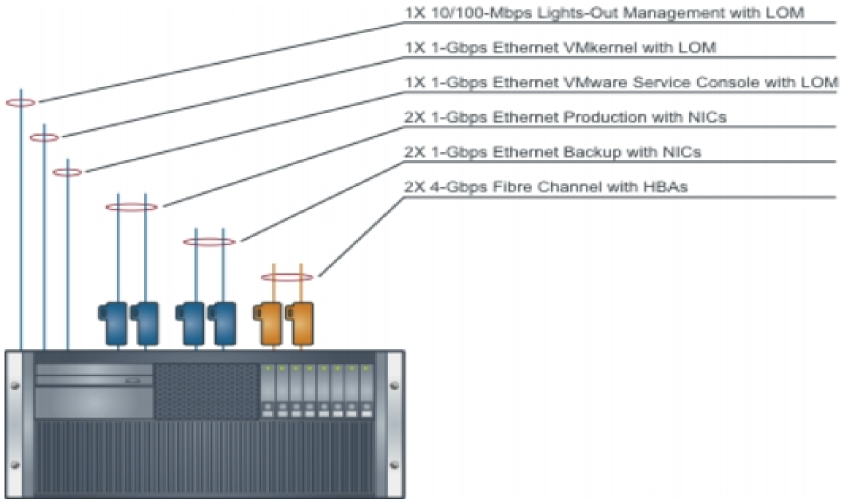
The unified network fabric is now a reality, giving customers a greater range of choices for their data center networks. In the past, separate physical networks were required to handle each type of traffic using technologies including LAN and SAN, and interprocess communication (IPC) mechanisms. The following illustrates how unified fabric can transform the existing IT infrastructure and save money.

A customer was involved in a data center expansion to incorporate 1,650 new servers. The original design equipped each server with interfaces and cabling for multiple LAN and SAN connections. A leading networking company presented a Unified Fabric as an alternative to a discrete LAN and SAN design. The customer calculated the power and cooling savings that it would realize through I/O consolidation at the rack level. The results made a compelling case for adopting Unified Fabric.

- The customer achieved a 41% savings in power and cooling costs for the consolidated network’s access layer and SAN aggregation layer compared to the costs for a discrete LAN and SAN design. This savings amounts to US $75,114 per year for the 1,650 servers and supporting infrastructure.

- The Unified Fabric required only one-third the number of network adapters, saving capital and operating expenses and eliminating multiple potential points of failure.

- The Unified Fabric required only one-third the amount of rack-level cabling and access ports, reducing the number of interconnects from nine per server to three.



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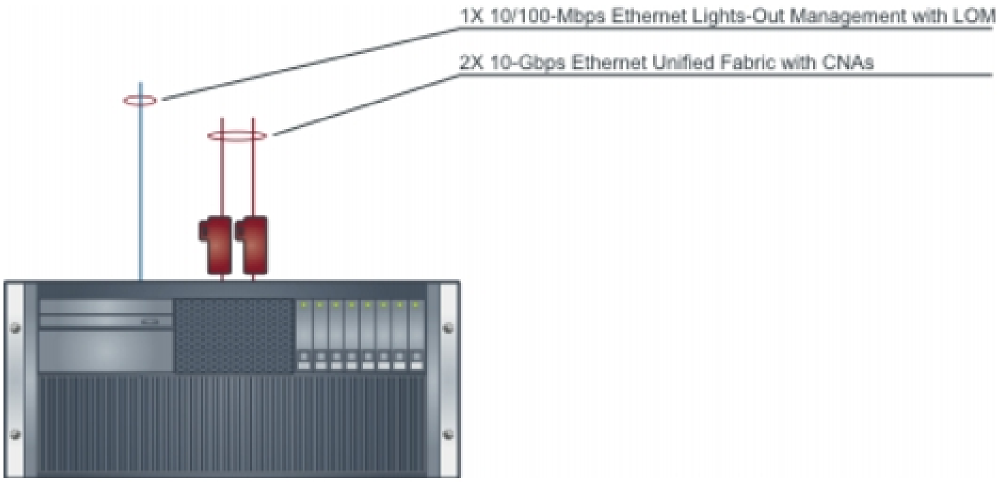
Using a Traditional LAN and SAN Architecture, Each Server Would Require Nine Data Cables Supported by Six Discrete Interfaces

With the customer's servers requiring 500W each, the savings are enough to power an additional 120 servers. More organizations prefer to deploy more computing resources rather than more network equipment. The move to a Unified Fabric delivers more than energy savings; it brings all the benefits of Gigabit Ethernet networking, including the following:

- The move from Gigabit Ethernet to 10 Gigabit Ethernet networking provides a 10X increase in bandwidth. Even when a single 10 Gigabit Ethernet link is used to replace several Gigabit Ethernet connections, the unified network leaves room for future growth. The capability to grow and adapt to rapidly changing business conditions is a strategic benefit that can help maintain a company's competitive edge.

- Unified Fabric supports a “wire once, use later” model in which every server is deployed with standard 10 Gigabit Ethernet and is enabled for LAN, SAN, and IPC protocols as needed through the Cisco Nexus 5000 Series switch configuration. Servers equipped for the unified network can be repurposed later without the need to re-cable racks or install new I/O adapters.

- A Unified Fabric has fewer points of failure, fewer elements requiring maintenance, and fewer chances for human error. All these factors contribute to increased reliability and availability.



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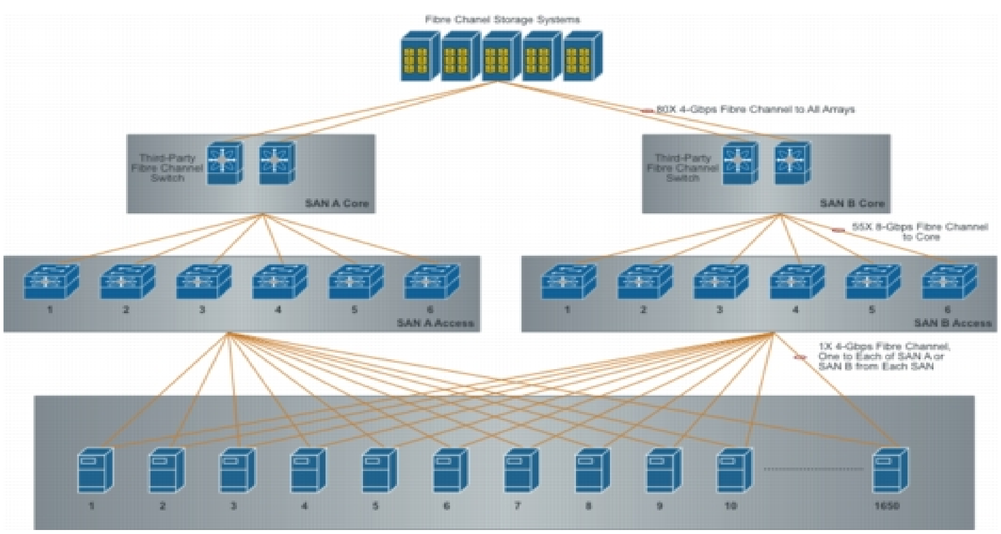
Using a Unified Fabric (Instead of a Discrete LAN and SAN Design) Requires Only Three Cables and Two CNAs per Server

Discrete LAN and SAN Architecture

The traditional approach to supporting each server's I/O and networking requirements is to create separate, parallel LANs and SANs. Each network has its own access, aggregation, and core layers with a sufficient number of ports and upstream bandwidth to handle each server's multiple LAN and SAN cables.

SAN Architecture

The customer's proposed SAN architecture provides connectivity between each server and five dual-ported Fibre Channel storage arrays through two independent SANs:



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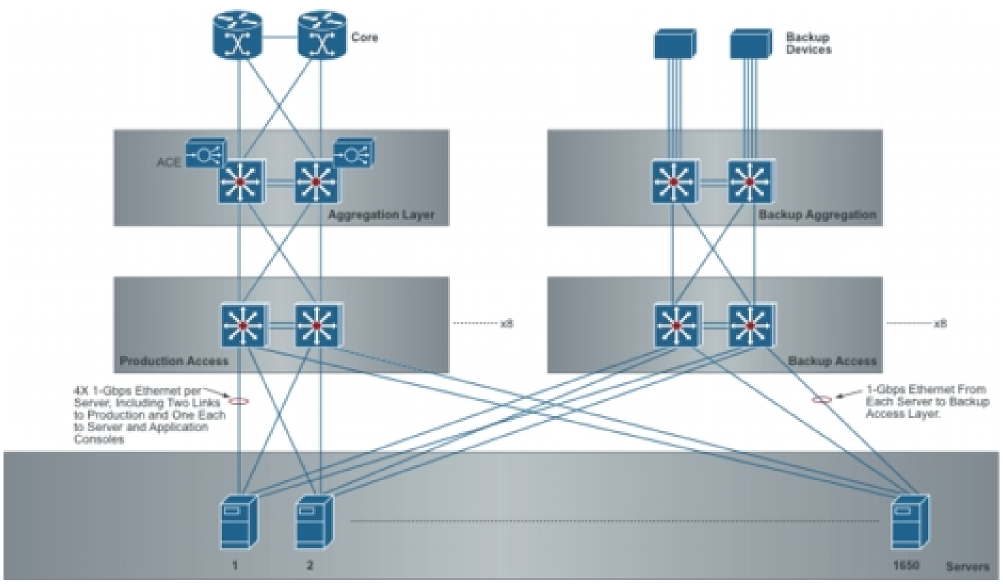
- Each server is equipped with a pair of 4-Gbps Fibre Channel HBAs. Each port uses a fiber connection to reach one of six third-party Fibre Channel switches in each SAN's access layer. One port connects to one of the six SAN access-layer switches; the other connects to one of six SAN B access-layer switches.

- Each of the 12 access-layer switches connects to the SAN core through 55 8-Gbps Fibre Channel links.

- The SAN core consists of four switches, two supporting each SAN. Each core switch connects to the customer's set of five Fibre Channel storage arrays through 80 4-Gbps Fibre Channel connections each.

- The storage network supports an average of 1.55 Gbps sustained throughput per server port. It requires 16 Fibre Channel switches and a total of 4,280 fiber cables.

LAN Architecture



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Discrete LAN Architecture Is Structured as Two Parallel Networks: One for Production and One for Backups

The proposed LAN architecture uses Cisco Catalyst 6500 Series Switches to deliver Gigabit Ethernet connectivity throughout. Each server is configured with two NICs for the production network and two for the backup network. LOM connections are used for server VMkernel and VMware Service Console connections. The supporting LAN is built to support independent storage and backup networks:

• Each server's two production LAN NICs connect to one of two access-layer Cisco Catalyst 6500 Series Switches in a pair.

• Each server's VMkernel and VMware Service Console ports connect to the access layer.

• Each server's two backup LAN NICs are connected to each of a pair of backup network access-layer switches.

• The production and backup network access layers each consist of eight pairs of interconnected Cisco Catalyst 6500 Series Switches.

• The production LAN aggregation layer is supported by a single pair of Cisco Catalyst 6500 Series Switches that are interconnected as peers. These switches are equipped with a Cisco ACE Application Control Engine Module. These switches connect directly to the LAN core.

• The backup LAN aggregation layer is supported by a single pair of Cisco Catalyst 6500 Series Switches that connect to backup devices.

• The server lights-out management ports are connected to Cisco Catalyst 3750 Series Switches (not shown).

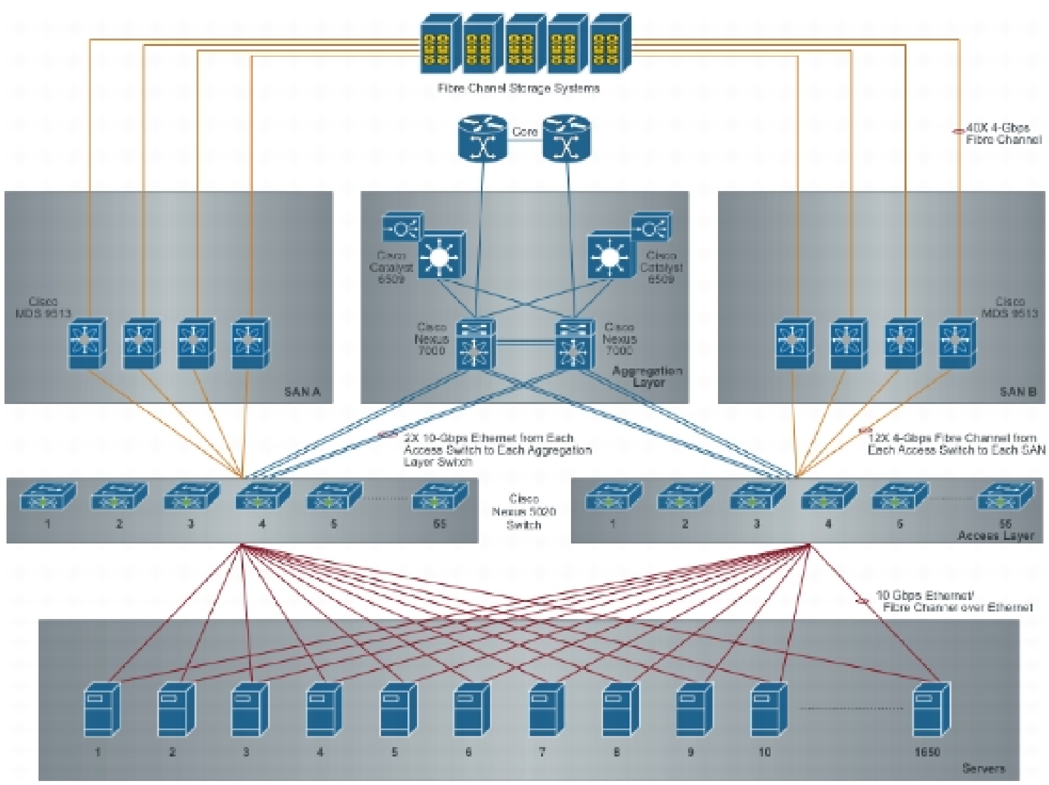
The access and aggregation layer, excluding lights-out-management, uses a total of 34 Cisco Catalyst 6500 Series Switches.

Unified Fabric Architecture

Cisco proposed an alternative architecture that uses a Unified Fabric to carry all LAN and SAN traffic from servers to Cisco Nexus 5020 Switches in the access layer (Figure 5). The Unified Fabric carries Fibre Channel traffic through Fibre Channel over Ethernet (FCoE), a straightforward, standards-based encapsulation of Fibre Channel into Ethernet. Both LAN and SAN traffic are carried over a common, Ethernet standards-based, Unified Fabric. These standards include IEEE Data Center Bridging that defines a set of extensions to the Ethernet to enhance the network's ability to carry multiple traffic streams over the same physical link.

Simplified Server Configuration

The Unified Fabric simplifies each server's I/O configuration. The six NICs and HBAs are replaced by two single-port CNAs that support 10-Gigabit Ethernet and FCoE to the access-layer switches. What previously required a total of nine cables per server now needs only three. All I/O (except lights-out management) is carried over 10 Gigabit Ethernet links, boosting speed and leaving room for future growth in traffic.



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Savings

- Examining the power and cooling savings of the Unified Fabric, the Cisco customer calculated a 41% savings when comparing the access layer and SAN aggregation layer equipment. The total amounted to US $75,115 per year, or US $375,575 over a 5-year period. These amounts were calculated using estimated power draws using vendor power calculators combined with the customer's power cost of US $0.0712 per kilowatt-hour (kWH). The customer calculated the difference between the discrete and the unified networks. The results, summarized in Table 1, are as follows:

    - The Unified Fabric eliminates all four NICs from each server. At 3W per NIC, this amounts to a savings of 19,800W.

    - The Unified Fabric uses single-port, single-application-specific integrated circuit (ASIC), second-generation converged network adapters in place of Fibre Channel HBAs. A power estimate of 5W each (provided by the manufacturer) makes this an even exchange.

    - For each server, six upstream network ports are no longer required, saving 9W per port. Four ports that used discrete NICs and two ports that formerly used built-in ports were eliminated. The power savings is based on use of Cisco Catalyst 6500 Series Switches for Gigabit Ethernet connectivity in the access layer. This change saves a total of 89,100W.

    - The 10 Gigabit upstream ports, two for each server, are accounted for by the Cisco Nexus 5020 server's calculated power consumption of 480W. These switches add 52,800W to the network's power consumption.

    - The Cisco Nexus 5020 Switches serving as both the LAN and SAN access layer allow 12 SAN edge switches to be eliminated. This, plus the change in power consumption between the third-party's SAN core design and the Cisco design using Cisco MDS 9513 Multilayer Directors, adds 4,116W to the savings.

Components Saved in United Fabric	Power Savings (Watts)
4 NICs per server rated at 3W per NIC	19,800
6 Gigabit Ethernet access-layer ports per server at 9W per switch port (4 NIC and 2 LOM network connections)	89,100
Add power for 110 Cisco Nexus 5020 Switches calculated at 480W each	-52,800
Eliminate 12 third-party SAN edge switches and replace SAN aggregation layer with Cisco MDS 9513 Multilayer Directors (net power savings shown)	4,116
Total direct power savings	60,216
Power and cooling savings based on power usage effectiveness (PUE) of 2.0	120,432
kWH per year	1,054,984 kWH
Annual customer savings based on US$0.712 per kWH	US $75,114

The above is an example illustration of the advantages using Unified Fabric.

Source:/www.cisco.com/en/US/prod/collateral/switches/ps9441/ps9670/white_paper_c11-497077.html

Savings beyond Power and Cooling

While the customer's focus was on the power and cooling savings achieved by implementing Unified Fabric at the access layer, a number of other savings became obvious when comparing the two models:

- Although the overall capital cost savings were not evaluated, the customer noted that avoiding the purchase of four Gigabit Ethernet adapters per server alone would save the company US $1,254,000.

- Co-locating the Cisco Nexus 5020 switches in the server racks saved 480RUs, and 210RUs were saved by eliminating the SAN edge switches. This total of 690RUs is the space equivalent of 172 servers, opening up space for potential future expansion.

- The direct power savings leaves capacity for an additional 120 servers using 500W each, leaving room for a 7.2% expansion in server capacity.

Simplified Management

Unified Computing infrastructure promises to simplify data center management. As the whole data center infrastructure is unified from a hardware and logical perspective, management is also simplified. There would be an 'intelligent' switch that is the brain of the system; this would act as a gateway for the system. The whole subsystem could be easily managed by a graphical user interface (GUI) tool. Some of the options that the GUI would offer include:

- Display the list of powered and unpowered servers
- Manage, access, and administer the servers
- Check for faults in power supplies, fans
- Options to log on and restart the machine remotely
- Details about inventory
- Configuration
- Firmware details and upgrades
- Monitoring
- Auditing
- Statistics collection

Reduction in Data center Space

Real estate costs have dramatically increased. Data centers tend to be located in areas where there is uninterrupted electricity and other feasibilities. CFOs now watch the space utilized by the infrastructure inside the data center. The 'Data center in a box' solution has emerged lately but hasn't proven to be effective as it focuses on the server platform.

On the other hand, a Unified computer will not only reduce the power requirement and management overhead but also save data center space. As seen in the example above, reducing the number of ports required for discrete LAN and SAN architecture helped to eliminate the physical switches which in turn reduced data center space requirements. We saw a great reduction of power consumption as well. The server count will also be reduced as we are now integrating a set of servers.

Summary

The Data center is transforming. The server market is undergoing a major paradigm shift. Logical and physical architecture consolidation is driving the market. There has been a transformation from workstation-based servers, to rack-mount, to blade chassis, and now to Unified computing. The evolution that started with mainframes will continue to evolve. Modeling and measuring data centers will become one of the most important elements of data center management during the next years, because data center changes are increasingly expensive and will occur more frequently, causing modeling and "what if" scenarios to persist.

How do we get there? Companies have to understand the components that contribute to computing, fix the flaws, and consolidate the components by utilizing new technologies like Unified Fabric, virtualization, and Unified Storage networking. Virtualization will continue its trend to effective utilization of the physical resources. Unified Computing will allow data centers to get more than they need. Cloud Computing will be the next big thing in the world of IT and it will drastically change the activities we perform day to day. Unified Computing integrating cloud computing services will offer a powerhouse of high performance, next-generation information technology.

We need this! With the growing costs of power and real estate, and regulations requiring energy-efficient data centers, the demand for high performance, easy scalability to Petabytes of storage and thousands of CPUs will become the new standard. Companies must realize the importance of their IT transformation plans quickly to prevent the perception that IT is the problem and not the solution.

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