The Mandate for Converged Infrastructure Management

Introduction

IT services have historically been criticized as being both too expensive and too inflexible. The reality is that over the last decade IT services have continually become incrementally more cost effective and incrementally more agile. However, the challenge facing both enterprise IT organizations as well as service providers is that the business pressure under which the typical company functions has increased in proportion to the improvement in the cost and agility of IT services over the last decade and that business pressure is likely to continue to increase for the foreseeable future. As a result, an ongoing series of small incremental improvements will not be sufficient to enable IT services to be viewed as sufficiently cost effective and agile by a company's business unit managers. What is needed is a fundamentally new approach to how IT services are provided - one that provides more than incremental improvements.

As will be explained in the next section of this white paper, cloud computing has the potential to provide a dramatic improvement in both the cost and agility of IT services. One of the techniques that is associated with the vast majority of cloud computing solutions is one or more forms of virtualization; e.g., server, storage, desktop. Another technique that is increasingly being associated with cloud computing is the implementation of an infrastructure that is based on the tight integration of networking, servers and storage.

The implementation of virtualization and the integration of IT resources enable an organization to realize many of the potential benefits of cloud computing. There is, however, a fundamental stumbling block that those two techniques don't address. That stumbling block is that the provisioning of IT services that cut across technology domains has traditionally been a manual process that is characterized by being slow, resource intensive and error prone. Given these characteristics, organizations will not be able to achieve the potential benefits of cloud computing if they continue to utilize a traditional approach to the provisioning of IT services.

One goal of this white paper is to describe a new approach to the provisioning of IT services - one that is based on unified infrastructure management. Another goal of this paper is to exemplify how EMC's products enable that new approach. In order to achieve those goals three IT professionals were interviewed. One of the IT professionals is a senior consultant for a European company that provides IT infrastructure consulting. The other two IT professionals were the CTO and the VP of IT operations for a US based healthcare organization. The three interviewees will be referred to respectively in this white paper as The Senior Consultant, The CTO and The VP of Operations.

Cloud Computing

Cloud computing has been a very hot topic for the last few years even though for most of that time there was considerable confusion and disagreement about the exact definition of cloud computing. For example, as recently as a year ago many industry leaders insisted that the phrase *cloud computing* only referred to services that were provided to an organization by a third party such as rackspace. Many other industry leaders also insisted that these services

had to be provided over the Internet. While the precise definition of cloud computing is still somewhat allusive, the goal of cloud computing is quite clear. That goal is to deliver a dramatic improvement in the cost effective, elastic provisioning of IT services.

There are several proof points that indicate that the goal of cloud computing as stated above is achievable. For example, an article in Network World identified some of the potential cost savings that are associated with cloud computing[1]. In that article, Geir Ramleth the CIO of Bechtel stated that he benchmarked his organization against some Internet-based companies. As a result of that activity, Ramleth determined that the price that Amazon charges for storage is roughly one fortieth of his internal cost for storage. Ramleth also estimated that YouTube spends between $10 and $15 per megabit/second for WAN bandwidth, while Bechtel is spending $500 per megabit/second for its Internet-based VPN.

Relative to the provisioning of IT services, historically it has taken IT organizations several weeks or months from the time when someone first makes a request for a new server to the time when that server is in production. In the last few years many IT organizations have somewhat streamlined the process of deploying new IT resources. However, in the traditional IT environment in which IT resources have not been virtualized, the time to deploy new resources is still measured in weeks if not longer. This is in sharp contrast to a public cloud computing environment in which the time it takes to acquire a virtual machine (VM) from a cloud computing service provider is typically measured in minutes.

Over the last year, a lot of the disagreement about the definition of cloud computing has disappeared. For example, today there is widespread agreement that there are three general classes of cloud computing: public, private and hybrid. The phrase *public cloud computing* refers to IT organizations obtaining services from a cloud computing service provider (CCSP) such as Google. There are three categories of public cloud computing solutions. They are:

- Software-as-a-Service (SaaS)

  In the typical SaaS offering, an independent software vendor (ISV) offers access to their applications on a subscription basis. An example of this type of service offering is SalesForce.com.

- Infrastructure-as-a-Service (IaaS)

  Infrastructure services are comprised of the basic compute, storage, and network services required to run applications. An example of this type of service is Amazon's Simple Storage Service (S3).

- Platform-as-a-Service (PaaS)

  Platform services provide software development environments, including application programming interfaces (APIs) and middleware that abstract the underlying IaaS

1 The Google-ization of Bechtel, Carolyn Duffy Marsan, Network World, October 28, 2008

infrastructure in order to support rapid application development and deployment. An example of this type of service is Force.com.

Referring back to Geir Ramleth the CIO of Bechtel, the decision that he reached was not that he was going to rely on third parties to supply all of his IT requirements. Rather, he decided that Bechtel would identify the techniques that enable some CCSPs to be dramatically more cost effective and agile than the typical IT organization and that Bechtel would implement these techniques within Bechtel's internal IT environment. These techniques are discussed in the next section of this white paper. The approach that Ramleth is taking is referred to as *Private Cloud* or *Private Cloud Computing*. The phrase *Hybrid Cloud* refers to those instances in which an enterprise IT department uses a mixture of services that it provides itself and services that it acquires from a CCSP.

The Primary Characteristics of Cloud Computing

In spite of the confusion as to the exact definition of cloud computing, the following set of characteristics are typically associated with cloud computing.

- **Centralization** of applications, servers and storage resources. This centralization reduces cost and enables IT organizations to have better control over the company's data.

- Extensive **virtualization** of every component of IT. This includes servers, desktops, storage, networks and appliances such as WAN optimization controllers, application delivery controllers and firewalls.

- **Standardization** of the IT infrastructure on a small set of products and technologies.

- **Technology convergence**. One example of this is the convergence of the data center's LAN and SAN. Another is the ongoing convergence of servers, networks and storage.

- **Automation** of as many tasks as possible; e.g., provisioning, troubleshooting, change and configuration management. Automation can enable IT organizations to reduce cost, improve quality and reduce the time associated with management processes.

- The **dynamic movement of resources** such as virtual machines and the associated storage. This capability also helps to streamline the provisioning of new applications, improve backup and restoration operations and enable zero-downtime maintenance.

A Converged IT Infrastructure

Most data centers have evolved over time by adding equipment and software from a wide range of vendors. The Senior Consultant stated that relative to outfitting their data center that the various organizational units within his company "did their own thing" and that it was common for the various units to "run around and buy what they needed from every vendor you can think of." His company has recently standardized on the Vblock Infrastructure

Platform that is described below. However, prior to that standardization, and as a result of everyone doing their own thing, his company had roughly two hundred management tools and didn't have a manager of managers. According to The Senior Consultant "Nobody in the IT organization had an overall view of what was happening" and that their complex approach to management "made achieving high availability very difficult."

In the traditional data center design, functionality such as servers, storage, LAN switches, firewalls and load balancers are typically dedicated to a single service or application. This approach to data center design has a number of negative side affects. For example, it results in stranded capacity and hence an increase in the overall cost of the data center. It also increases the time it takes to deploy a new service or application since new infrastructure must be designed, procured, installed and tested before a new service or application can go into production.

The inefficiencies that are associated with the traditional approach to data center design are one of the primary reasons why IT organizations acquire IaaS solutions from a CCSP. However, similar to the decision that Bechtel made, few IT organizations are going to decide to rely entirely on CCSPs to provide all of the infrastructure services that their company requires. As a result, many IT organizations have established initiatives the goal of which is to enable the IT organization itself to provide IaaS solutions that have cost and agility characteristics that are similar to those of the IaaS solutions that are provided by CCSPs.

The CTO stated that his organization now provides IaaS services internally based on their implementing Vblock Infrastructure Platforms (see below) throughout the company. He said that one of the factors that drove them to do this was that his organization recognized that in order to lead dramatic change in their segment of the healthcare industry in a post health care reform environment that the company would need to rely on a hybrid cloud computing model. His organization also recognized that before they could effectively operate in a hybrid cloud computing model that they needed to first operate an effective private cloud; e.g., be able to offer self provisioning and the ability to scale up and down capacity. Another factor that drove his organization to implement IaaS based on the Vblock Infrastructure Platform was that for the last five years the company has been experiencing hyper growth. One measure of that growth is that they started off 2006 with roughly one hundred employees and currently they have approximately fourteen hundred employees. He added that his IT organization was "constantly chasing growth" and that they had to "make a big bet [Vblock Infrastructure Platform] to leap frog chasing after our own growth."

As previously noted, the time that it takes to acquire a VM from a CCSP is typically measured in minutes. However, IT services as consumed by end users are comprised of more than just compute resources. They typically include additional IT resources such as networks and storage. In order to be successful with their private and public IaaS initiatives, IT organizations and service providers need to be able to provision complex IT services in the same time frame that a new VM can be provisioned; e.g., minutes.

As was also previously mentioned, two of the primary characteristics of a cloud computing solution such as IaaS are virtualization and automation. The Senior Consultant stated that

they have virtualized all of their servers and that their motivation was higher uptime, more automation of IT processes and the ability to move IT resources between servers. It is difficult to implement virtualization and automation and also support the dynamic movement of IT resources that The Senior Consultant referred to in a traditional data center that is comprised of many disparate technologies from a wide variety of companies. That is one of the reasons why another primary characteristic of a cloud computing solution is standardization on a small number of technologies and products.

Given the value that is associated with a converged IT infrastructure it is not surprising that IT organizations and service providers who want to implement a converged IT infrastructure have multiple options from which to choose. For example, these organizations could implement a solution from a single provider. Examples of this type of solution include IBM's CloudBurst[2] and HP's BladeSystem Matrix[3]. An alternative approach is to implement a converged IT infrastructure based on solutions from VCE[4]. VCE is unique in that multiple vendors (e.g., Cisco, EMC, VMware) formed the company with the goal of bringing together best of breed technologies from each.

One of the key concepts that VCE has brought to the market is the concept of Vblock™ Infrastructure Platforms. Each Vblock Infrastructure Platform is a standard, proven set of components from Cisco, EMC and VMware that are pre-integrated and tested. A Vblock Infrastructure Platform combines virtualization, networking, storage, security, and management and it is installed, configured and managed as a single entity with a single line of support. VCE handles all software release planning and configuration management, pre-testing upgrades and patch management in order to minimize any impact to system uptime.

The primary product components of a Vblock Infrastructure Platform include:

- Virtualization by VMware vSphere™ and VMware vCenter™ Server
- Networking by Cisco Nexus® switches
- Computing by Cisco Unified Computing System™ (UCS)
- Storage by EMC Symmetrix® VMAX™, CLARiiON®, or Celerra® Unified Storage
- Security by RSA enVision® (optional)
- Management by EMC Ionix™ Unified Infrastructure Manager
- Additional hardware required for racking, cabling, uninterruptible power supplies, etc.

There are currently 4 Vblock Infrastructure Platforms that have been defined based on the components listed above. These platforms are referred to as Vblock 0, Vblock 1u, Vblock 1

[2] http://www-03.ibm.com/systems/x/solutions/infrastructure/cloud/index.html
[3] http://h18000.www1.hp.com/products/blades/components/matrix/index.html
[4] http://www.vce.com/

and Vblock 2 and they scale from 96 cores to 2,048 cores and from 384 GB of RAM to 24,575 GB of RAM. More information on the four Vblock Infrastructure Platforms is contained in the appendix as well as in the document entitled *Vblock Infrastructure Platforms: A Technical Overview*[5].

The Challenges of Managing a Converged IT Infrastructure

As noted earlier, one of the primary motivations for adopting a converged IT infrastructure is to reduce the overall complexity that is associated with enabling a fully virtualized infrastructure. The reduction in complexity makes it feasible to fully capitalize on the virtualized infrastructure's inherent potential to serve as an agile, demand-driven platform that can deliver dynamic IT services with unprecedented levels of control, security, compliance, reliability, and cost efficiency. In order to realize the full potential of a converged IT infrastructure, IT organizations will have to address a number of management challenges. These challenges generally fall into the following categories:

- Implementing control of the infrastructure in a significantly more efficient manner than is possible with the traditional labor-intensive tool sets that are not well integrated or automated.

- Ensuring compliance with enterprise policies, as well as best-practice guidelines for service deployment in the converged infrastructure.

- Implementing granular, near real-time provisioning and change management for virtualized infrastructure services.

- Expediting resolution of any issues that could compromise the performance or availability of infrastructure services.

Meeting these challenges will involve a number of changes in the way the data center is managed. In particular, the converged infrastructure requires a management system and management processes that have the same level of integration and cross-domain convergence that the infrastructure has. For example, in order to support the requirement for the dynamic provisioning and re-allocation of resources to support a given IT service, the traditional manual processes for synchronizing the required server, network and storage resources will have to be replaced with integrated, automated processes. In order to enable this change, the provisioning and change management processes will need to be integrated and will need to feature the automatic configuration of network and storage resources when additional infrastructure services are deployed or when additional physical or virtual servers are brought on line or are moved. In a similar fashion, operations management needs to be consolidated and automated to keep service quality in line with user expectations.

IT departments can take a do-it-yourself (DIY) approach to implementing an integrated, cross-domain management system. They could, for example, leverage the available element

[5] www.vce.com/pdf/solutions/vce-vblock-infrastructure-technical-overview.pdf

manager plug-ins and APIs and piece together a management system that integrates at least some of the overall components of the infrastructure. However, this type of ad hoc automation and integration across the end-to-end, cross-domain infrastructure is quite time-consuming and involves considerable specialized programming expertise and detailed technical knowledge. It is also expensive and time consuming to support over time. There is an alternative to the DIY approach. IT departments that are evaluating converged infrastructure solutions can expect to see highly effective pre-packaged integrated management solutions that negate the need for a DIY approach. In addition, IT organizations can use the breadth, efficiency, and effectiveness of the converged management solutions as one of the key decision criteria to evaluate the converged infrastructure solutions that are offered by competing vendors.

While not a requirement, the cross-domain integrated management of a converged infrastructure will bring the greatest benefit in those instances in which a single administrator has the authority to initiate and complete cross-domain management tasks, such as provisioning and modifying infrastructure services. For example, the use of a single administrator can eliminate the considerable delays that typically occur in a traditional management environment where the originating administrator must request other administrators to synchronize the configuration of elements within their domains of responsibility. However, as discussed below, in many cases the evolution from the current approach of having separate administrators for each technology domain to an approach in which there is a single administrator will involve organizational challenges. As a result, many IT organizations will evolve to this new approach over time.

The EMC Ionix Solution for Managing Vblock Infrastructure Platforms

The EMC® Ionix™ Unified Infrastructure Manager (UIM) is an example of a pre-packaged integrated management solution. UIM provides integrated and automated provisioning, configuration, change and compliance management as well operations management across Vblock Infrastructure Platforms. UIM functions as a unified element management system for the Vblock Infrastructure Platform components, allowing a Vblock Infrastructure Platform to be managed as a single, converged infrastructure element controllable by a single administrator and via a single management tool and interface. UIM also supports roles-based management allowing multiple administrators to manage elements within their domains via a common tool. Roles-based management provides IT organizations flexibility in addressing the organizational challenges of managing a converged infrastructure while minimizing the need to rely on a multitude of non-integrated element management systems.

As previously discussed, The Senior Consultant stated that prior to standardizing on Vblock Infrastructure Platforms that his company had two hundred management tools. After standardizing on the Vblock Infrastructure Platform and UIM, that number was reduced to forty. One of his company's requirements relative to the adoption of UIM was that it supports roles-based management so that they could implement UIM without any significant organizational changes. He added that, "Organizational change is hard. People will fight it for years."

The VP of Operations said that in the past his organization "cobbled together management solutions". He described a situation in which if there was a problem, the appropriate people went to a war room with their isolated tools and tried to do event correlation and root cause analysis in a largely manual fashion. He stated that his organization might be a bit different than the norm in that they have implemented Vblock Infrastructure Platforms throughout the organization. The VP of Operations emphasized that in order to get the most benefit out of both a converged infrastructure and integrated management that "IT organizations need to take the time to think about how you are currently and what you want to accomplish at both a business and an IT level."

As shown in Figure 1, UIM V2.1 includes two high-level management utilities, UIM Provisioning Center 2.1 (UIM/PC) and UIM Operations Center 2.1 (UIM/O).

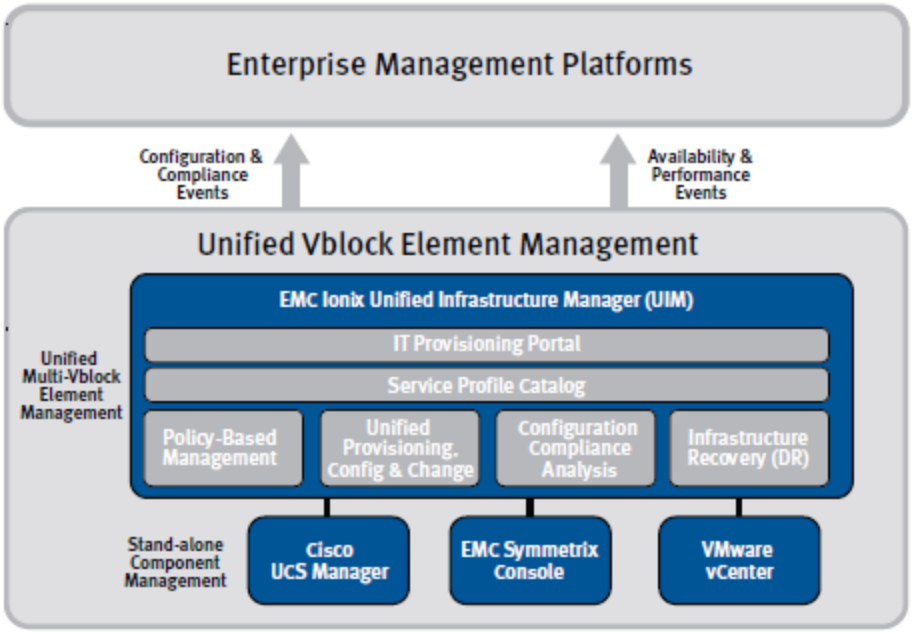

Figure 1: The EMC Ionix Unified Infrastructure Manager

Provisioning Center 2.1 allows an infrastructure service to be provisioned with a single mouse click. UIM/PC relies on a context-sensitive model of the dependencies among the software and hardware components of a Vblock Infrastructure Platform to ensure that configurations are automatically kept in synchronization across technology domains and that the configurations are fully consistent and compliant with corporate policies for security and service priorities.

When asked about the value of Provisioning Center 2.1 The Senior Consultant stated that, "When setting up a new Vblock Infrastructure Platform, the use of Provisioning Center 2.1 reduces the installation time drastically." He gave an example of an installation that took 240 hours of work without UIM and only 16 hours of work with UIM - a 93% reduction.

Operations Center 2.1 provides operational management of Vblock Infrastructure Platforms including in-depth operational analysis across all components of a Vblock Infrastructure Platform. UIM/O helps administrators maintain expected levels of service performance via rapid resolution of any issues within a Vblock Infrastructure Platform or associated infrastructure components. UIM/O also provides comprehensive views of infrastructure services, the cross-domain topology as well as alarms and events.

The Senior Director was also asked about the value of Operations Center 2.1. He said that, "Being able to monitor the entire hardware and hypervisor stack end-to-end with a solution that is really quick to set up is currently hard to do on a third party solution with mixed vendors in a non-standard setup. Operation Center 2.1 is a great addition to the UIM portfolio that helps IT administrators get a view of the entire solution quickly and without much hassle."

Both UIM/PC and UIM/O leverage views of infrastructure services provided by the Service Catalog and Service-level Dashboard. The latter utilities allow the administrator to see the range of tiered services (e.g., Gold, Silver, Bronze) that are ready for “single-click” provisioning from the Vblock Infrastructure Platform resource pool. These service views also allow administrators to rapidly assess the impact of infrastructure issues on service level performance. The Cross-domain Context utility captures both the configuration and operational interdependencies and relationships among Vblock Infrastructure Platform components to support the multi-element synchronization required by both UIM/PC and UIM/O.

As shown in Figure 1, UIM integrates with VMware's vCenter management to provide a cohesive management solution which synchronizes vCenter with UIM. In a similar fashion, UIM is also integrated with VMware's vCloud Director, which is the customer-facing portal for the self-service deployment of virtual machines, vApps, and the associated virtual resources. UIM integration with vCenter and the vCloud Director enables full end-to-end automation of infrastructure services, which is often referred to as *Zero-Touch Infrastructure*. Tighter integration, which will be available in the near future, will support full bi-directional information exchange between UIM and both vCenter and the vCloud Director.

The Senior Director stated that UIM's integration with vCenter and vCloud Director is extremely important as it removes a "missing link" in the process. He added that, "Without this feature the VMware administrator would have to do a lot of manual work and the infrastructure team would need to provide the administrator with a lot of information all of which adds significant time to the processes."

Additional APIs are available for integration of UIM with other management systems that IT departments have currently deployed to administer the end-to-end data center. For example, these APIs can provide integration with enterprise management systems, automated service provisioning systems, fault and performance management systems, and orchestration engines.

Summary

As highlighted by the CTO, enterprise IT organizations and service providers are adopting cloud computing in part to "leap frog" away from a never ending sequence of incremental improvements to the provisioning of IT services that typically fail to catch up to the business requirements. However, as pointed out by The Senior Director, it is difficult to realize the benefits of cloud computing in the traditional IT environment in which the infrastructure and the management of the infrastructure is based on disparate infrastructure products and management tools that were acquired from a wide range of companies and that were not designed to function in a highly integrated fashion.

Some of the larger IT vendors are attempting to offer integrated infrastructure solutions based largely or entirely on their own products. An alternative approach is to implement a converged IT infrastructure based on solutions from VCE. As opposed to having an infrastructure solution based on the products of a single company, Cisco, EMC and VMware formed VCE with the goal of providing integrated infrastructure solutions that are based on bringing together best of breed technologies from each vendor.

Both of the companies that were interviewed for this white paper have implemented VCE's Vblock Infrastructure Platforms. A Vblock Infrastructure Platform combines virtualization, networking, storage, security, and management. Some of the advantages of a Vblock Infrastructure Platform is that it is a standard, proven set of components that are pre-integrated and tested; it is installed, configured and managed as a single entity with a single line of support; and VCE handles all software release planning and configuration management, pre-testing upgrades and patch management.

In order to realize the full potential of a converged IT infrastructure, IT organizations must implement a management system and management processes that have the same level of integration and cross-domain convergence that the infrastructure has. For example, in order to support the requirement for the dynamic provisioning and re-allocation of resources to support a given IT service, the traditional manual processes for synchronizing the required server, network and storage resources will have to be replaced with integrated, automated processes.

EMC's UIM is an example of a pre-packaged integrated management solution that provides integrated and automated provisioning, configuration, change and compliance management as well operations management across Vblock Infrastructure Platforms. The Senior Director spoke to part of the value of UIM when he said that "Being able to monitor the entire hardware and hypervisor stack end-to-end with a solution that is really quick to set up is currently hard to do on a third party solution with mixed vendors in a non-standard setup." He elaborated on the value of UIM when he discussed how the use of UIM reduced the amount of time it takes to install a system by 93%.

The greatest value accrues to those companies that redo their management processes to fully leverage the value of UIM. The US based healthcare organization that was interviewed for this white paper is an example of such a company. However, as was the case with the

European company that provides IT infrastructure consulting, IT organizations often resist change. Recognizing this, UIM also supports roles-based management allowing multiple administrators to manage elements within their domains via a common tool. As noted by The Senior Director, implementing a roles-based approach to management resulted in acceptance from the IT organization which lead to the benefits mentioned in the preceding paragraph as well as the ability of the IT organization to go from having two hundred management tools to where is only has forty.

Appendix

Vblock Infrastructure Platforms include all of the layers of IT functionality needed to effectively support IaaS. This includes:

The Compute Layer: Cisco's Unified Computing System (UCS)

Cisco's UCS combines computing, networking and storage access and is optimized to support virtualization. UCS integrates a low-latency, lossless 10 Gb Ethernet unified network fabric with x86 based servers in such a way that all of its resources participate in a unified management domain. Some of the components of Cisco's UCS include the Cisco UCS:

- 6100 Series Fabric Interconnects
- 5100 Series Blade Server Chassis
- 2100 Series Fabric Extenders
- B-Series Blade Servvers

The Network Layer: Cisco Nexus 1000V

The Cisco Nexus 1000V is a software switch that delivers Cisco VN-Link[6] services to VMs hosted on that server. VN-Link services bridge the server, storage, and network management domains in Vblock Infrastructure Platforms to help ensure that changes in one environment are communicated to the others. The Nexus 1000V leverages the VMware vSphere framework to offer tight integration between server and network environments. It allows policies to move with a VM during live migration, which ensures persistent network, security, and storage compliance.

The Storage Layer: Products from EMC and Cisco

Table 1 shows the specific products that are included in the storage layer for each type of Vblock Infrastructure Platform.

	Vblock 0	Vblock 1	Vblock 1u	Vblock 2
EMC Symmetrix VMAX				Yes
EMC CLARiiON Cx4		Yes		
EMC Celerra Unified Storage	Yes		Yes	
EMC Celerra Gateways				Optional
Cisco MDS 9148		Yes		Yes

Table 1: Components of the Storage Layer

[6] http://www.cisco.com/en/US/solutions/collateral/ns340/ns517/ns224/ns892/ns894/solution_overview_c22-496213.html

- *EMC Symmetrix VMAX*
  Symmetrix VMAX is a high-end storage system that was purpose built to support wide scale virtualization. It uses specialized engines that provide for full redundancy hand high availability.

- *EMC CLARiiON Cx4*
  In Vblock 1 Infrastructure Platforms, the EMC CLARiiON CX4-480 can scale up to 375 disk drives for a maximum capacity of 481 TB. It supports enterprise flash drives for maximum performance and comes preconfigured with Fibre Channel and iSCSI connectivity.

- *EMC Celerra Unified Storage*
  The Vblock 0 Infrastructure Platform supports up to two EMC Celerra NS-120 systems and the Vblock 1U Infrastructure Platform supports the EMC Celerra NS-480 or NS-960 with multiple disk configurations. These systems come with capabilities such as as the Celerra Manager, file system deduplication, virtual provisioning, automated volume management, and EMC Celerra SnapSure™. They also feature flexible connectivity: NAS, MPFS, iSCSI, and Fibre Channel.

EMC Celerra Gateways

EMC Celerra Gateway products are dedicated network servers that are optimized for file access and advanced functionality. They are optional components of the Vblock 2 solution and when included in that solution they extend the value of the storage arrays by adding IP storage (NAS) in a centrally managed system.

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- *Cisco MDS 9148*
  The MDS 9148 is part of both the Vblock 1 and Vblock 2 solutions. It supports 48 ports of Fibre Channel connectivity running at speeds from 1Gbps to 8 Gbps as well as intelligent network services such as VSAN technology, access control lists for hardware-based intelligent frame processing, and advanced traffic management features.

The Virtualization Layer: VMware vSphere

This class of functionality is provided by VMware vSphere Enterprise which virtualizes all application servers and provides key functionality such as dynamic resource scheduling. VM management is provided by VMware vCenter Server which provides centralized control and visibility.