



The VMware Reference Architecture for Cisco UCS and EMC CLARiiON with VMware View™ 4

REFERENCE ARCHITECTURE BRIEF



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Executive Summary

Introduction

This reference architecture brief provides a summary of a validated virtual desktop solution with a total datacenter infrastructure cost under \$750 per seat which includes hardware, storage and software licenses . This virtual desktop solution consists of VMware View (which includes VMware vSphere for desktops), Cisco's Unified Computing System, and EMC's CLARiiON storage. This validation was performed at scale in a lab environment simulating a 2,048 concurrent user virtual desktop environment, executing a realistic desktop workload. Included in this brief is a description of the test environment and equipment, samples of actual test results and the user profile description. With validated architectures, customers can have confidence that a virtual desktop environment can be efficiently implemented and that it will perform as expected.

Desktop Challenges

The challenges of traditional desktop administration, especially at scale, range from lost laptops with corporate data, security issues related to viruses or hackers, or simply ensuring that IT resources can maintain a service level agreement (SLA) appropriate for specific end-users. In addition to the challenges of operational management, IT must also consider implications of broader system wide issues—such as compliance, corporate governance, and of course, business continuity strategies to address potential pandemic issues.

Increasingly, organizations are turning to virtual desktop technologies to address the operational, as well as strategic, issues related to traditional corporate desktop environments. IDC estimates that by using VMware View, organizations can save over \$610 per user, per year, over an unmanaged PC². VMware View provides a virtual desktop environment that is secure, cost effective, and easy to deploy. To meet the demanding needs of various user profiles, VMware View also provides best-in-class user experience, whether on the corporate LAN or on the WAN.

Virtual Computing Environment Coalition

Virtual Computing Environment (VCE) coalition is an unprecedented collaboration of three information technology (IT) industry leaders (VMware, Cisco, and EMC) focused on helping customers build a Private Cloud through a shared vision using aligned products and technologies. The coalition has been created to accelerate the customers' ability to increase business agility through greater IT infrastructure flexibility, and lower IT, energy, and real estate costs through pervasive [datacenter virtualization](#) and a transition to private cloud infrastructures.

With the VCE strategic alliance providing reference architectures, solutions, and services, market adoption of virtual datacenter architectures can be increased with less risk and greater reward to enterprises and IT organizations. VCE also offers a joint vision, technology development roadmaps, integrated transformation services, and solutions that will reduce the time needed for a customer to realize business value. Over the last six years VMware, Cisco, and EMC have been developing this alliance through partnerships to lead the effort in the virtualization of datacenter architectures. VCE solutions, consumption types, and technology development work streams have been created specifically for this initiative, as well as reference architectures that have been defined and tested.

¹ Microsoft VECD license included at \$23 / seat, actual cost may vary

² IDC White Paper sponsored by VMware, Quantifying the Business Value of VMware View, Doc # 21970, September 2009

VMware View

VMware View Value Proposition and Benefits

Purpose-built for delivering desktops as a managed service, VMware View provides the best end-user experience and transforms IT by simplifying and automating desktop management. Centrally maintaining desktops, applications, and data reduces costs and improves security while at the same time increases availability and flexibility for end users. Unlike other desktop virtualization products, VMware View is a tightly integrated end-to-end solution built on the industry leading virtualization platform. It allows customers to extend powerful business continuity and disaster recovery features to their desktops, and standardize on a common platform from the desktop through the datacenter to the cloud.

The VMware View solution provides a wide range of benefits:

- **Simplify and automate desktop management.**
VMware View lets you manage all desktops centrally in the datacenter and provision desktops instantly to new users, departments, or offices. It also enables the creation of instant clones from a standard image, dynamic pools, or groups of desktops.
- **Optimize end-user experience.**
VMware View PCoIP display protocol provides a superior end-user experience over any network. Adaptive technology ensures an optimized virtual desktop delivery on both the LAN and the WAN. It also enables users to address the broadest list of use cases and deployment options with a single protocol. Access to personalized virtual desktops complete with applications and end-user data and settings are available anywhere and anytime with VMware View.
- **Lower costs.**
VMware View reduces overall costs of desktop computing by up to 50 percent by centralizing management, administration and resources, and removing IT infrastructure from remote offices.
- **Enhance security.**
Since all data is maintained within the corporate firewall, VMware View minimizes risk and data loss. Built-in SSL encryption provides secure tunneling to virtual desktops from unmanaged devices or un-trusted networks.
- **Increase business agility and user flexibility.**
VMware View accommodates changing business needs—such as adding new desktop users or groups of users—while providing a consistent experience to every user from any network point.
- **Built in business continuity and disaster recovery.**
VMware View is built on industry-leading VMware vSphere™—allowing you to easily extend features such as High Availability and Fault Tolerance to your desktops without the need to purchase expensive clustering solutions. It also provides a method to automate desktop back-up and recovery as a business process in the datacenter.
- **Standardize on a common platform.**
VMware View includes VMware vSphere™ and brings all the benefits and enterprise features of the datacenter to the desktop. Extend features such as VMware VMotion™, VMware High Availability (HA), VMware Distributed Resources Scheduler (DRS), and VMware Fault Tolerance to your desktops to create a built-in disaster recovery and business continuity solution. Optimized specifically for desktop workloads, VMware vSphere is able to handle the high loads associated with desktop operations such as boot up and suspend operations. Standardize your virtualization platform and use a single solution to manage both servers and desktops from the datacenter through to the cloud.

VMware View Architecture

VMware View provides Unified Access to virtual desktops and applications running in a central secure datacenter and that are accessible from a wide variety of devices. VMware View Composer streamlines image management, while reducing storage needs through the use of VMware Linked Clone technology.

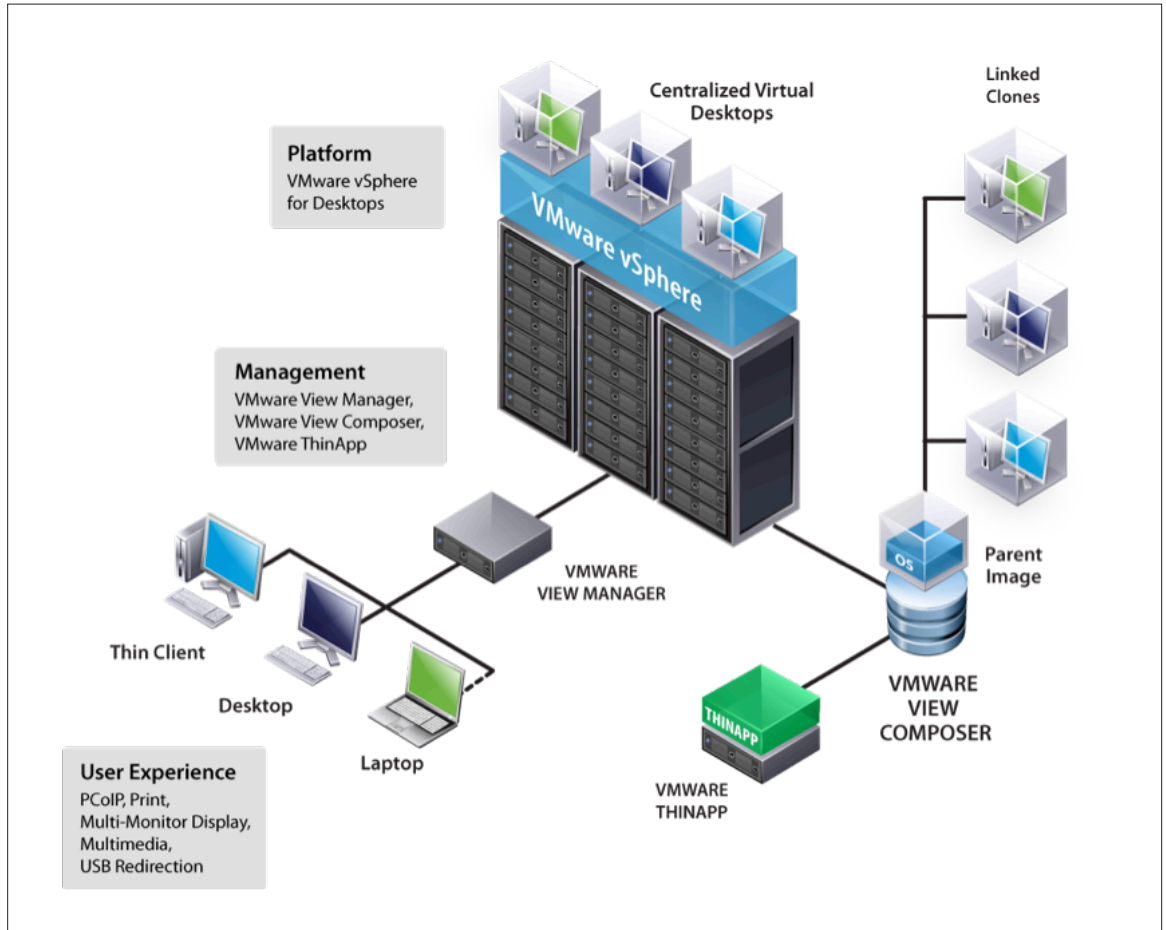


Figure 1. VMware View Architecture

Virtual Computing Environment – Vblock

VMware, Cisco and EMC have partnered to create an integrated, validated infrastructure package built from best-of-class components for compute, network, storage and virtualization called a Vblock. Vblock 0, Vblock 1 and Vblock 2 are the three sizes in which these integrated packages are available and they each allow for massive consolidation and rapid provisioning of compute, network and storage resources on an on demand basis. The VMware View 4 project was done on a Vblock 1 and the following sections briefly describe the key technologies that were used.

Cisco Unified Computing System

The Cisco Unified Computing System (UCS) is a next-generation data center platform that unites compute, network, and storage access. The platform, optimized for virtual environments, is designed within open industry standard technologies and aims to reduce TCO and increase business agility. 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.

EMC CLARiiON CX4 Model 480

EMC CLARiiON CX4 Model 480 provides high-capacity networked storage that meets the needs of demanding OLTP workloads and large-scale e-mail environments. With the CX4-480, you can scale seamlessly up to 471TB of storage capacity and consolidate twice the workloads in one array as you can with other storage providers. Users of the CX4-480 will benefit from proven CLARiiON 99.999 percent availability and innovative technologies like Flash drives, virtual provisioning, 64-bit operating system, and multi-core processors. UltraFlex™ technology provides dual-protocol, online-expandable connectivity options, and the ability to integrate future technologies—all while leveraging advanced CX4 functionality to protect your data from unexpected events and decreasing energy use.

Reference Architecture Overview

In many of today's enterprises, individual laptops and desktops are managed as standalone entities—residing outside of the datacenter environment and not subject to an organization's information security, backup and recovery, and application usage policies. With enterprises and IT organizations requiring more secure and efficient means for managing corporate resources, the need to bring all of these resources under the control of a centralized datacenter managed by IT becomes of paramount importance. The Reference Architecture has been designed as a low-impact, cost-effective approach to bring all of these resources under the control of the data center using VMware, Cisco, and EMC technologies, while providing a rich, single view of an end-user's applications and data.

Using VMware View's virtual desktop infrastructure technologies, including VMware View Manager's administrative interface, desktops can be provisioned quickly and easily using templates, providing the ability to rapidly create virtual desktop images from one master image. Administrative policies can be set, and patches and updates can be applied to virtual desktops in minutes without affecting user settings, data or preferences.

Cisco's Unified Computing System and Fiber Channel over Ethernet (FCoE) technologies are the backbone of the virtual infrastructure, providing a data center architecture for administrators that is easy to use and manage.

EMC's technology and applications provides administrators with the tools to manage and maintain an end-user's data and applications in the VDI infrastructure. Using the CLARiiON storage array and a host of best-of-breed software applications administrators have a comprehensive set of solutions to ensure administrative and security policies are maintained.

Building Blocks

The following diagram shows the VCE Vblock 1 infrastructure for VMware View 4 Reference Architecture topology:

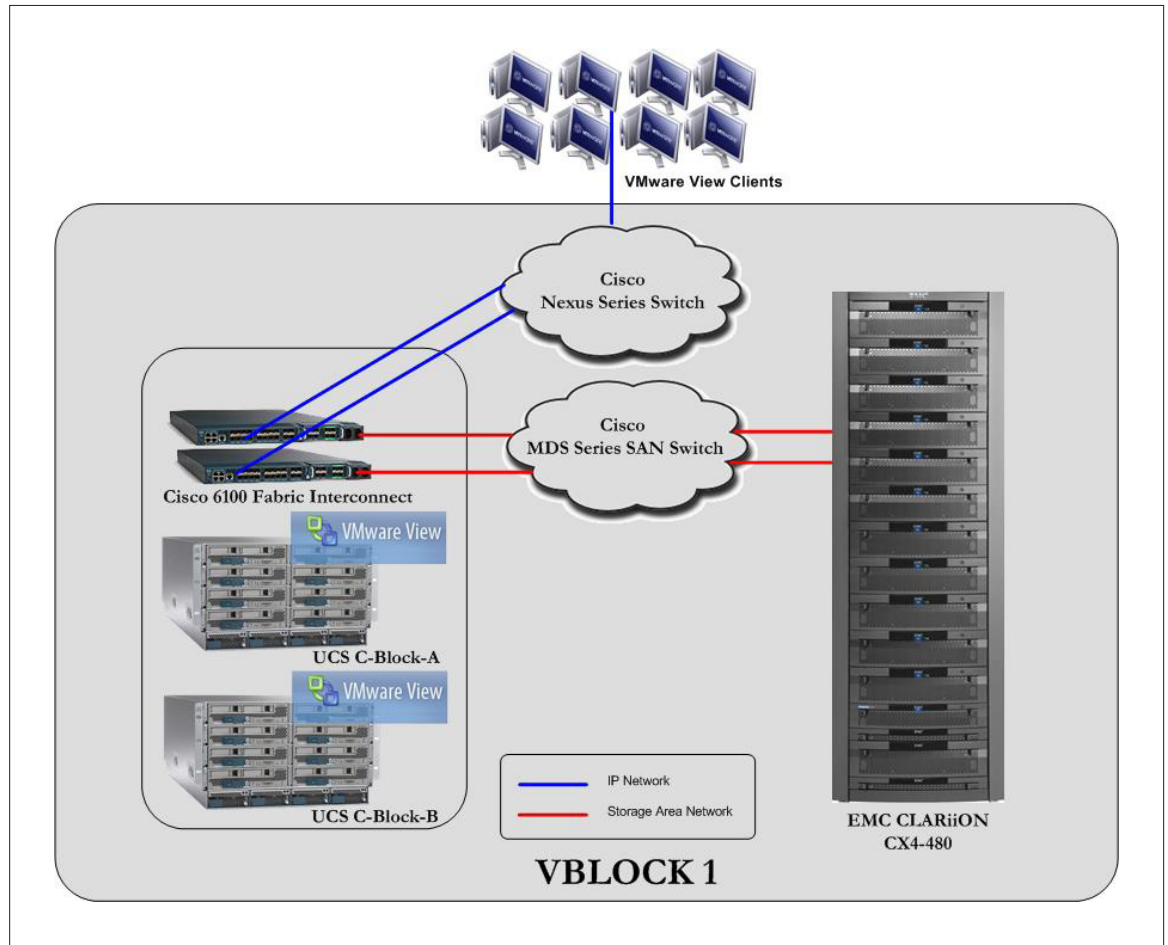


Figure 2. VCE Vblock 1 Infrastructure for VMware View 4 Reference Architecture

Using template-based virtualization to allocate and provision resources, an enterprise can:

- Reduce performance bottlenecks and configuration errors through automation of resource configuration tasks.
- Enable the rapid deployment of resources using templates, reducing operational expenses and costs.

Four core technologies are used to perform template-based provisioning and configuration:

- **VMware View 4** to provision, manage and monitor users and desktops.
- **VMware vSphere 4** to enable multiple virtual servers to be deployed to handle increased demands placed upon the network while existing server templates are being used.
- **Cisco Unified Computing System** to provide administrators the ability to scale out computational power while limiting the impact on the network infrastructure.
- **EMC CLARiiON storage array** to provide administrators the ability to not only expand existing storage, but also specify size, meta members, protection type and disk type in advance so they can be used to create reusable templates.

The Reference Architecture includes the following components:

Hardware

- Cisco UCS
- Cisco MDS SAN Switches
- EMC CX4 CLARiiON Storage Array

Software

- VMware View 4
- VMware vSphere 4
- Cisco Nexus 1000V VSM Virtual Appliance Software On UCS
- EMC PowerPath/VE

User Workload Profiles

Each virtual machine is equipped to run a workload that simulates typical user behavior—using an application set commonly found and used across a broad array of desktop environments. The workload has a set of randomly executed functions that perform operations on a variety of applications. Several other factors can be implemented to increase the load or adjust the user behavior—such as the number of words per minute that are typed and the delay between applications being launched. The workload configuration used for this validation included Microsoft Outlook, Microsoft Word, Excel, PowerPoint and Internet Explorer, Adobe Acrobat, McAfee Virus Scan, and Pkzip. During the execution of the workload, multiple applications were opened at the same time and windows were minimized and maximized as the workload progressed—randomly switching between each application. Individual application operations that were randomly performed included:

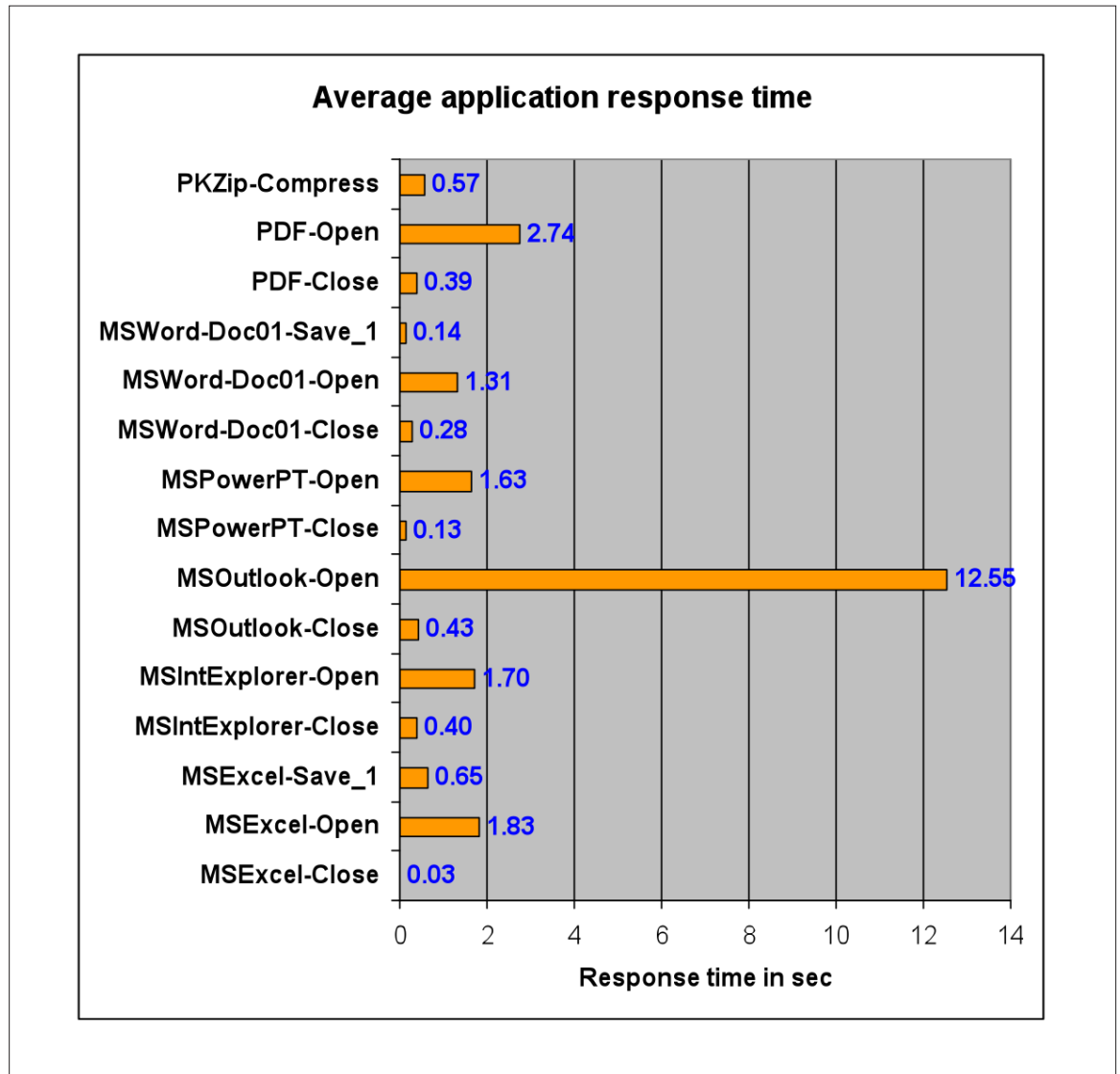
- Microsoft Outlook - Open, minimize, maximize, and close the application, send email messages.
- Microsoft Word - Open, minimize, close, write random words/numbers, save modifications.
- Microsoft Excel - Open, minimize, close, write random numbers, insert and delete columns/rows, copy and paste formulas, save modifications.
- Microsoft PowerPoint - Open, minimize, close, conduct a slide show presentation.
- Adobe Acrobat Reader - Open, minimize, close, browse pages in PDF document.
- Internet Explorer - Open, minimize, close, browse page.
- McAfee Anti-virus - Real time scanning.
- Pkzip - Open, close, compress a large file.

Based on the think time and words per minute used for this validation, this workload could be compared to that of a high-end task worker or lower-end knowledge worker.

Performance Charts

Application response times

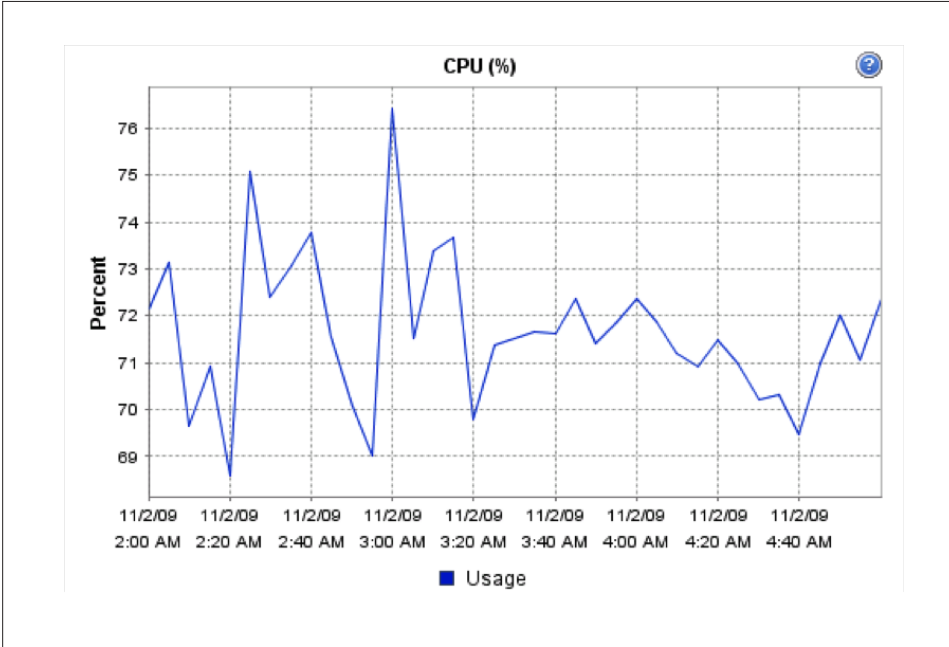
A test run consisting of 2,048 concurrent “knowledge worker” users was conducted. The overall application response times appeared reasonable as shown in the chart below:



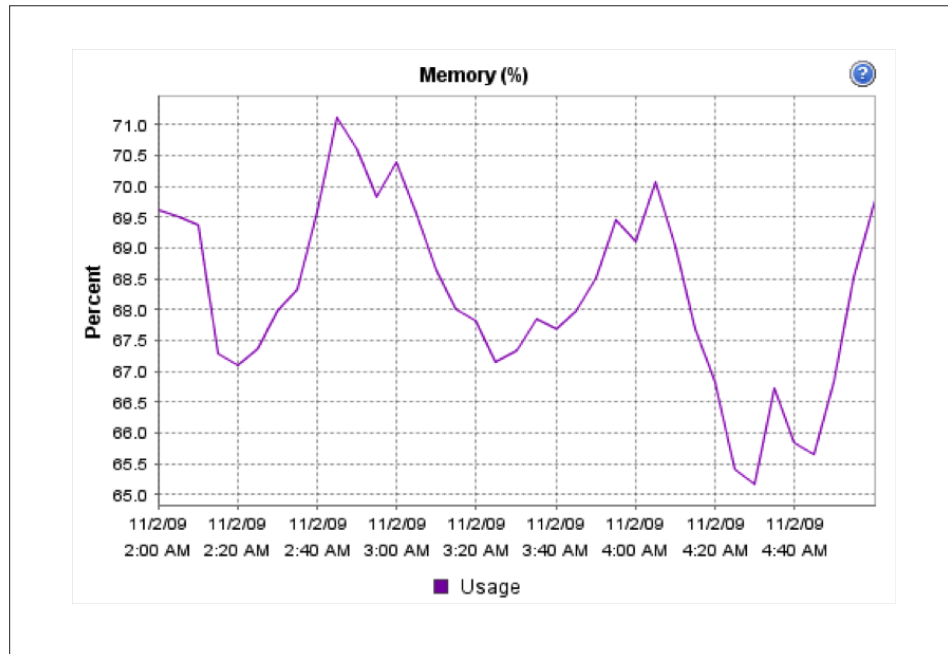
The Outlook open operation, was as expected as it reads the .PST file during startup. As can be seen, the regular operation of Outlook is within acceptable boundaries for response time.

VSphere Server Utilization

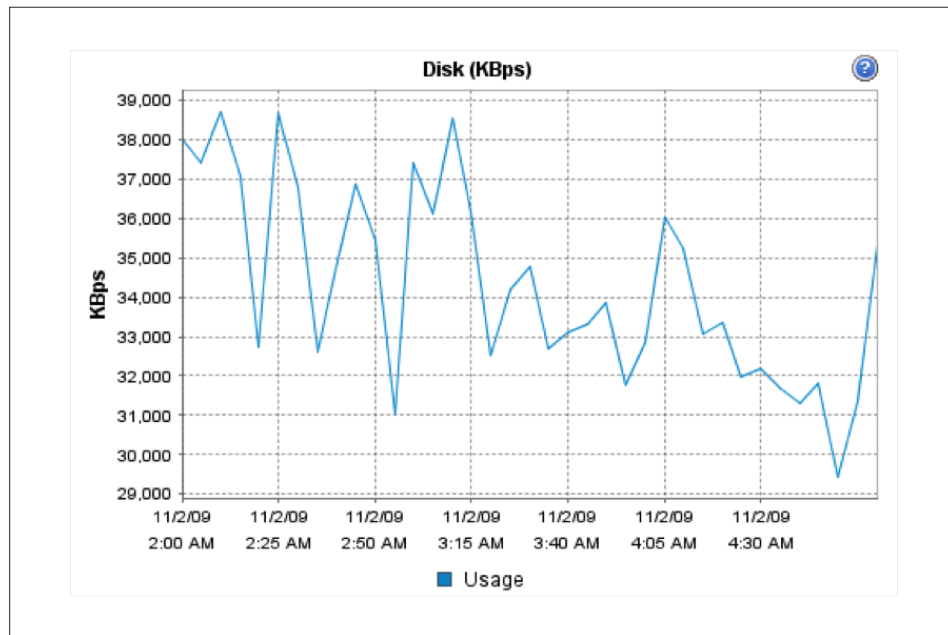
The chart below shows the resource utilization of one blade server during the steady state. The performance profile of the remaining 15 blades should be identical.



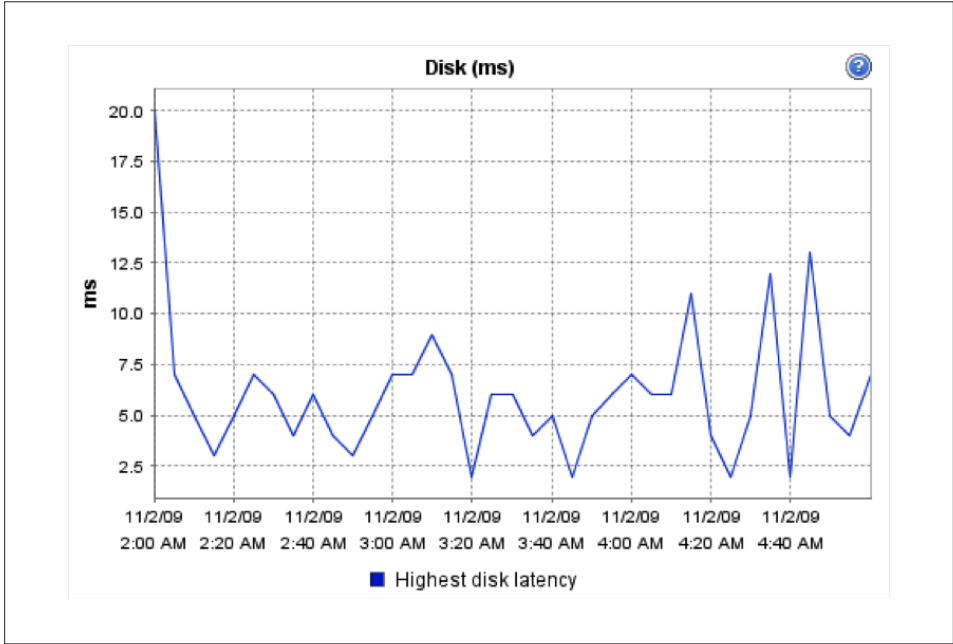
Please note that the system still has 25 percent of CPU idle. This implies that it can either accept some more users provided the other resources are not oversubscribed or have enough head room to handle unexpected peaks. The memory plot below indicates that the memory system was never stressed. There is still 25-30 percent free memory available in the system that can be allocated to newer virtual machines or added to existing virtual machines.



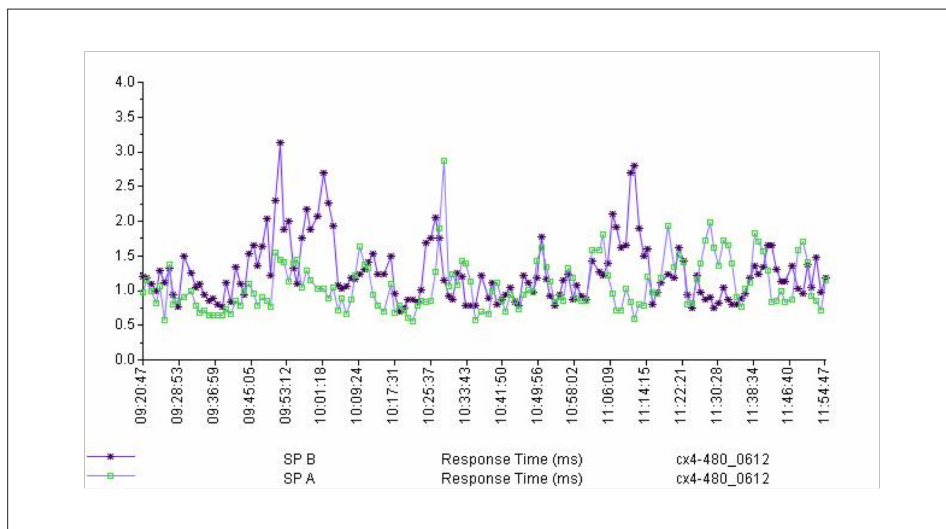
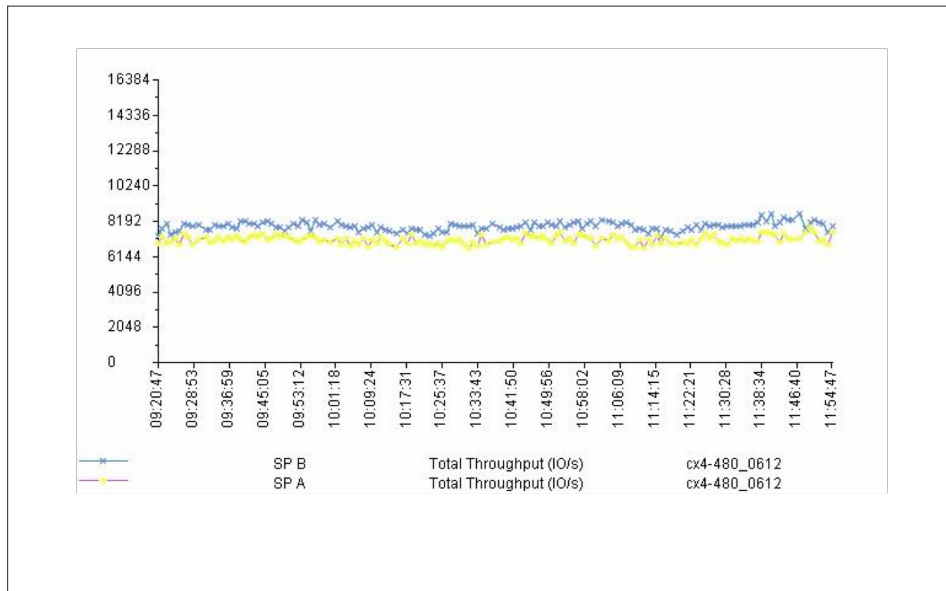
The disk subsystem is not stressed as indicated by the chart below.



The highest latency experienced by vSphere server was in the order of 7.5ms during the steady state that resulted in a very good user experience.



The charts below show the corresponding statistics from the storage array.



The steady state IOPs are around 15,000 from 2,048 concurrent users. This is somewhere in the order of 7-8 IOPs per user. This is expected given the knowledge worker profile used that includes Microsoft Outlook. The storage level latencies are well below 2.5ms during the steady state resulting in a very good user experience. The Linked Clone technology and its inherent de-duplication is reducing the disk seeks resulting in excellent disk latencies.

Conclusion

The VMware View 4 architecture discussed in this brief can significantly reduce both CAPEX and OPEX of virtual desktop environments. The technical validation of a VCE Vblock 1 clearly confirms that at scale, executing a realistic workload, it is capable of hosting 2,048 concurrent virtual desktop sessions. The performance data indicates that there is still some CPU head room in the system which can absorb occasional spikes in virtualized CPU resource requirements. Similarly the memory head room in the system indicates that the free memory can be allocated to existing virtual machines. The virtual machine density achieved is a function of vSphere 4 and Cisco UCS, and helps drive the datacenter infrastructure cost to below \$750 per seat. At this price point, virtual desktop deployments are near, or on par with acquisition costs typically associated with physical PCs. Low acquisition costs, combined with the incremental benefits of a virtual desktop environment (security, scalability, management) will serve to further accelerate the already rapid market adoption of hosted virtual desktop environments.

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VMware team: Matt Eccleston, Fred Schimscheimer, Mason Uyeda, John Kennedy and Mac Binesh

References

- Workload Considerations for Virtual Desktop Reference Architectures
<http://vmware.com/go/view4rawc>
- VMware View Reference Architecture
<http://www.vmware.com/resources/techresources/1084>
- VMware View
<http://www.vmware.com/products/view/>
- VMware vSphere 4
<http://www.vmware.com/products/vsphere/>
- Cisco UCS
<http://www.cisco.com/go/unifiedcomputing>
- Cisco Data Center Solutions
<http://www.cisco.com/go/datacenter>
- Cisco Validated Designs
<http://www.cisco.com/go/designzone>
- EMC CLARiiON Family
<http://www.emc.com/products/family/clariion-family.htm>
- EMC PowerPath/VE
<http://www.emc.com/products/detail/software/powerpath-ve.htm>

