

White paper

Fujitsu Virtual Desktop Infrastructure (VDI) using DX200F AFA with VMware in a Full Clone Configuration

This flexible and scalable VDI VMware® solution combines all aspects of a virtual desktop environment, based on reliable technologies and best practice solutions, with simple implementation and operation. This document is provided for those interested in understanding the performance characteristics of smaller SSD based VDI solutions.



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1 Introduction

A Virtual Desktop Infrastructure (VDI) provides an effective and economical solution to a general business issue of providing staff with suitable, supported computer applications for them to be successful in their various roles within the organization. In the business operations environment today, with the expanding use of various mobile devices and staff usage requirements, equipping all staff with fully capable devices and with access to the data they need, puts a severe strain on all IT departments. Through VDI, the different devices, from a notebook to a tablet to a thin client, can be provided to each of the staff members enabling efficient access to the applications and data that they need. At the same time, resources within the data center and the IT center staff can be much more effectively deployed.

VMware provides one of the most widely used VDI environments through their VMware Horizon View family of products. It includes a number of components to support operational environments on a wide variety of end user devices, also known as client devices or clients. Provisions are made to ensure the security of each client, and to provide each client with a unique customizable desktop interface, with the services the client needs for their responsibilities. VMware environments often support large complements of clients ranging from 1,000 to 20,000, but they can also be configured for smaller environments as well.

The responsiveness of the storage supporting the client data is important for supporting the users. In this paper we provide a summary of tests conducted with the Fujitsu ETERNUS® DX200F AFA storage array to meet the demands of the VMware VDI environment.

2 Executive Summary

This paper provides test results for 250 VMware VDI users with the storage supported on SSDs attached through an 8Gbps Fibre Channel SAN. The testing indicates that for this level of traffic, the 8Gbps FC SAN provides more than adequate capability to support the load. In this test configuration, the number of VDI users was limited by the amount of storage required. With the use of larger capacity SSDs at least 500 users can easily be accommodated. The industry standard tool "Login VSI" is used to provide measured realistic VDI loads on the tested configurations. In the Login VSI test workloads that are similar, the ETERNUS DX200F AFA shows a 4:1 improvement in VSI_{max} v4 Response over the ETERNUS DX200 S3 configuration using Flexible Tiering and a combination of HDDs and SSDs. (see section 6.2)

3 Fujitsu PRIMERGY® and ETERNUS® for VMware®

The PRIMERGY RX servers used in this configuration are the convincing choice for the server pool of the Fujitsu architectures. These servers are the solution for cutting data center infrastructure costs through the use of tried-and-tested data center technology. Investments in the modular PRIMECENTER® racks supports seamless integration of PRIMERGY servers and SAN storage subsystems plus the infrastructure components including the SAN and LAN switches as well as the KVM switches necessary for operational control.

The ETERNUS DX200F All Flash Array provides a very high performance SAN storage array for supporting a VDI environment that requires nearly instant response from the storage for effective application operation. Many VDI environments can operate effectively without ultra-storage performance, but for those situations where near instant response from storage is needed; the DX200F provides just what the application requires.

In a virtualized environment, storage operations traditionally have been expensive from a resource perspective. Functions such as cloning and snapshots can be performed more efficiently by the storage device than by the host. VMware vSphere® Storage APIs – Array Integration (VAAI), also referred to as hardware acceleration or hardware offload APIs, are a set of APIs to enable communication between VMware vSphere ESXi hosts and storage devices. The APIs define a set of "storage primitives" that enable the ESXi host to offload certain storage operations to the array, which reduces resource overhead on the ESXi hosts and can significantly improve performance for storage-intensive operations such as storage cloning, zeroing, and so on. ETERNUS DX disk storage systems support the following functions of VAAI: Full Copy - Replication of virtual machine/Copy for migration, Block Zeroing - Zero out when allocating storage area in new virtual machine, Hardware Assisted Locking - Improved exclusion control and Thin Provisioning Space Reclamation - Release of unallocated areas.

Creating virtual machines (VMs) today requires considerable effort from both VMware administrators and storage specialists. Close coordination is required even with the best operational processes; deploying VMs can take more time than desired. VMware vSphere Virtual Volumes (VVOL) have been designed to help streamline deployment, make ongoing administration of VMs more straightforward, and to allow each VM to be managed individually. ETERNUS DX200F and ETERNUS DX S3 are certified for VVOL by VMware.

4 Desktop Virtualization with VMware products

4.1 VMware Horizon® View™

Simplify desktop and application management while increasing security and control with VMware Horizon View (formerly known as VMware View). VMware Horizon View enables delivery of a personalized high fidelity experience for end users across sessions and devices. It enables higher availability and agility of desktop services unmatched by traditional PCs while reducing the total cost of desktop ownership up to 50%. With VMware Horizon View end users can enjoy new levels of productivity and the freedom to access desktops from more devices and locations while giving IT greater policy control. VMware Horizon View version 5.5 was used in the testing included in this report.

4.2 VMware vSphere® Desktop

Designed specifically for virtual desktops, this VMware vSphere edition provides a highly scalable, reliable and robust platform for running virtual desktops and applications, with built-in business continuity and disaster recovery capabilities to protect desktop data and availability without the cost and complexity of traditional solutions.

4.3 VMware vCenter® Server Desktop

The VMware vCenter Server, which is the central management hub for vSphere, provides complete control over and visibility into clusters, hosts, virtual machines, storage, networking and other critical elements of the virtual infrastructure. The operating system used is Windows Server® 2008 R2. With every VMware vCenter license a Microsoft SQL Server® Express license is included. VMware supports up to 5 nodes with SQL Server 2008 Express. If the installation requires more than 5 nodes within one VMware vCenter an additional database or separate instance of an existing VMware vCenter supported database is required.

4.4 VMware Horizon View Manager

VMware Horizon View Manager streamlines the management, provisioning and deployment of virtual desktops. IT administrators can centrally manage hundreds of desktops from a single console. End users connect through VMware Horizon View Manager to securely and easily access Horizon View virtual desktops.

4.5 VMware Horizon View Composer

VMware Horizon View Composer lets customers easily manage pools of “like” desktops by creating master images that share a common virtual disk. By updating a master image with VMware Horizon View Manager, all the cloned desktops linked to the master image can be patched or updated without affecting the users’ settings, data or applications. In addition VMware Horizon View Composer saves up to 80% of storage capacity.

4.6 VMware Horizon View Client

VMware Horizon View Client enables access to centrally hosted virtual desktops from Windows® PCs, Macs, thin clients, zero clients and iOS and Android™-based mobile devices. VMware Horizon View Client with Local Mode enables access to virtual desktops running on a local Windows-based endpoint, regardless of network availability.

4.7 VMware vShield® Endpoint

VMware vShield Endpoint offloads and centralizes anti-virus and anti-malware (AV) solutions, eliminating agent sprawl and AV storm issues while minimizing the risk of malware infection and simplifying AV administration in virtualized environment.

5 Tested VDI Environment

5.1 General

The test environment included the following elements:

- **Datacenter infrastructure:** Active Directory, DNS and DHCP on Windows Server 2008 R2
- **VDI infrastructure:** VMware Horizon View 5.5 with VMware vCenter Server, vComposer Server and vConnection Server on Windows Server 2008 R2
- **Virtualization Host nodes for VDI Desktops:** VMware ESXi 5.5.0 hypervisor running on PRIMERGY RX600 S5 and RX300 S7 servers. Eleven of the servers were each configured with four Intel® Xeon® E7542 CPUs @ 2.659GHz (24 cores, 48 threads) and 64GB of memory. One server was configured with two Intel Xeon X7542 CPUs @ 1.8GHz (8 cores) and 64GB of memory. The servers used SAN storage only (ETERNUS DX200F via 4x 8Gbps Fibre Channel links). Twelve host node servers were used for this set of tests to measure the area of interest – SAN connected ETERNUS AFA storage array.
- **ETERNUS DX200F All Flash storage array:** configured with 4x RAID5(4+1) 800GB SSDs. The storage array was connected to the ESXi servers with 4 x 8Gbps Fibre Channel host ports.
- **Desktop VM:** Windows 8 64-bit English virtual desktops with 2vCPU and 2GB vRAM. All desktops were created using Full Clone technology with 43GB of provisioned, non-shared storage.
- **Login VSI:** Load generation for VDI benchmark testing, release 4.1.0RC2

5.2 Testing Objective and Methodology

The objective of this testing was to illustrate the effectiveness of an All Flash Array in providing the primary storage for a small VDI environment. This type of solution can be very effective for application environments that require very fast response from the storage for the desktop users. To ensure that the ESXi server nodes did not limit the number of users, more were included in the configuration than necessary. This is reflected in the relatively low loading seen on the CPUs during these tests. This was done to ensure that the focus of measurements met the objective without limitations within the upper levels of the environment. It is recognized that this is not a normal configuration, where the number of server nodes required is not nearly as many as were used in this set of tests. Users need to consider the number of server nodes necessary to support the types of applications that the environment requires.

5.3 Tested Configuration Detail

Datacenter & VDI Infrastructure	VMware vSphere Client	v5.5.0	PRIMERGY RX300 S7 Intel® Xeon® E5-2630@1.8GHz; 2x CPU (8 cores); 64GB Ram
	VMware Horizon View Composer	v6.0.1	
	ETERNUS SF Manager	v16.2	
	ETERNUS SF Storage Cruiser	v16.2	
	VMware vConnection Server	v5.5.0	PRIMERGY RX300 S6 Intel® Xeon® L5630@2.13GHz; 2x CPU; 48GB Ram
	VMware Horizon View Administrator	v6.0.1	
	VMware vCenter Server	v5.5.0	
	VMware vSphere Client	v5.5.0	PRIMERGY RX300 S6 Intel® Xeon® L5630@2.13GHz; 2x CPU; 48GB Ram
	VMware Web Client		
	DHCP Server	Microsoft Windows Server 2008 R2 Enterprise; Service Pack 1	PRIMERGY RX300 S3 Intel® Xeon® 3.00GHz; 8GB Ram
	AD Server		
	DNS Server		
	Login VSI Benchmark Infrastructure	Login VSI Control	v4.1
Launchers 1-5, 11		v4.1	
Launchers 12		v4.1	PRIMERGY RX600 S5 24 x Intel® Xeon® X7542@2.67GHz
Launchers 6-10		v4.1	PRIMERGY RX300 S7 8 x Intel® Xeon® E5-2603@1.8GHz
Virtualization Host Nodes:	VMware ESXi hypervisor	v5.5.0	11 x PRIMERGY RX600 S5 24 x Intel® Xeon® X7542@2.67GHz; 64GB; 2 x 8Gbps FC SAN Ports
	vCenter Pool [j14y_001] Options	Manual Pool, Dedicated User Assignment with Automatic Assignment Enabled, vCenter virtual machines, No Connection Server restrictions, No power action, do not auto logoff nor allow users to reset desktops, PCoIP Default display protocol & allow users to select protocol, Number of Monitors 2 (1920x1200)	
SAN Switches			2x Brocade® 5100 8Gbps Fibre Channel Switches
VDI Client Environment	Clone Type	Full Clone	250 VDI Users
	Client VDI Package	Microsoft Windows® 8 Professional Microsoft Office 2013	2vCPU; 2GB Memory; 43GB Disk per VDI User
Login VSI Workloads	Task Worker	v4.1	
	Knowledge Worker	v4.1	
	Power Worker	v4.1	
SAN Storage Array	ETERNUS DX200F with 4x 8Gbps FC Host Ports	Thin Provisioned Pool 12.5TB	4x RAID5 (4+1) Groups; 20x 800GB SSDs

5.4 Test Configuration Diagram

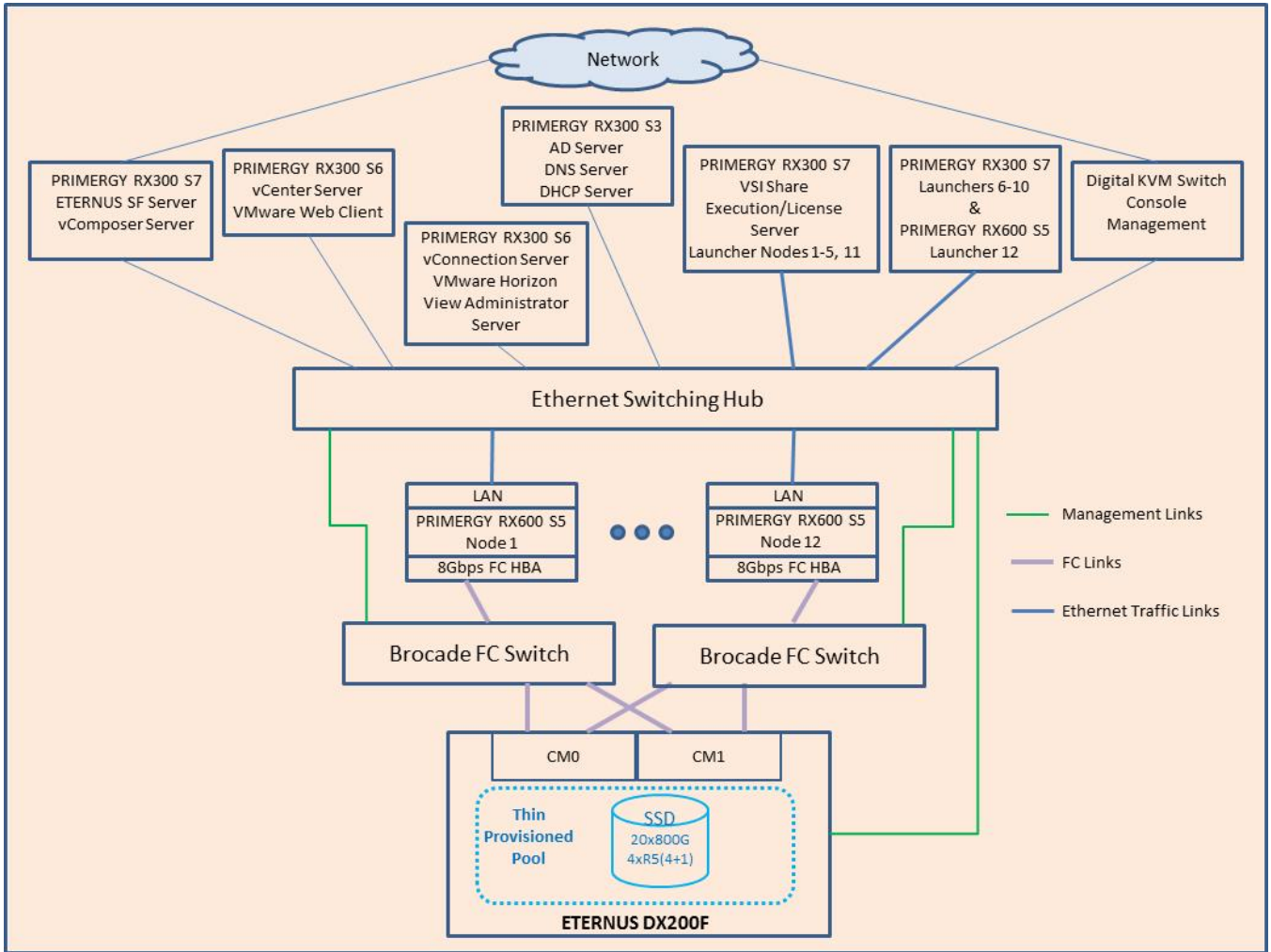


Figure 1 – VMware 250 Users DX200F AFA Test Environment

6 Login VSI Testing

6.1 Login VSI

Login VSI (www.loginvsi.com) is an industry accepted benchmarking tool for establishing the operating capabilities of a VDI configuration. It has been used to provide the performance information within the tested environment. Three test profiles were used and results reported herein:

- **Task Worker Workload** – includes segments with Microsoft Outlook®, Excel®, and Internet Explorer; Adobe Acrobat® and PDF Writer. The Task Worker workload does not place a very severe demand on the environment and represents a number of users that are not accessing the system very heavily.
- **Knowledge Worker Workload** – includes segments with Microsoft Outlook, Word, PowerPoint®, and Excel®; Adobe Acrobat, FreeMind®, PhotoViewer, Doro PDF Writer; and includes viewing several 360p movies. The Knowledge Worker workload places a more severe demand on the environment and represents a number of users that are accessing the system more heavily.
- **Power Worker Workload** – includes segments with Microsoft Outlook, Word, PowerPoint, and Excel; Adobe Acrobat, FreeMind, PhotoViewer, Doro PDF Writer; and includes viewing several 720p movies and many file copy and delete operations. The Power Worker workload places an even more severe demand on the environment and the storage than the Knowledge Worker workload, with more intense operations within Excel and PowerPoint.

These tests are executed from a separate set of servers that run the Login VSI Launchers to provide the test load for the environment. They record the performance seen from their position within the environment, which is the position from which normal VDI users see the behavior of the system. Login VSI reports several measures of the operations within the system under test:

- **Active Sessions** records the maximum number of sessions that successfully completed their test sequences.
- **VSI base** provides a measure of the basic response level within the system.
- **VSI_{max} v4 Average** provides a measure of the average response time for all the active user sessions throughout the test sequence.
- **VSI_{max} v4 Threshold** establishes a measure of the maximum acceptable response time for the active user sessions in the test sequence.
- **VSI_{max} Result** indicates if the VSI_{max} v4 Threshold was reached during the test, and if so, the number of active user sessions at which it was reached.

These reported results are provided for each of the sets of Login VSI tests that were conducted, and are reported in the following sections.

6.2 Login VSI Test Results

The three Login VSI test Scenarios provide data on the performance seen by the benchmark tool kit launchers.

Login VSI Workload	Number of Users	Successful Sessions	Stuck Sessions	VSI Baseline	VSI _{max} v4 Average	VSI _{max} v4 Threshold	VSI _{max} Result
Task Worker	250	250	0	1026	1119	2026	not reached
Knowledge Worker		249	0	994	1140	1995	not reached
Power Worker		248	0	963	1171	1964	not reached

Figure 2 – Login VSI Results for 250 User Tests

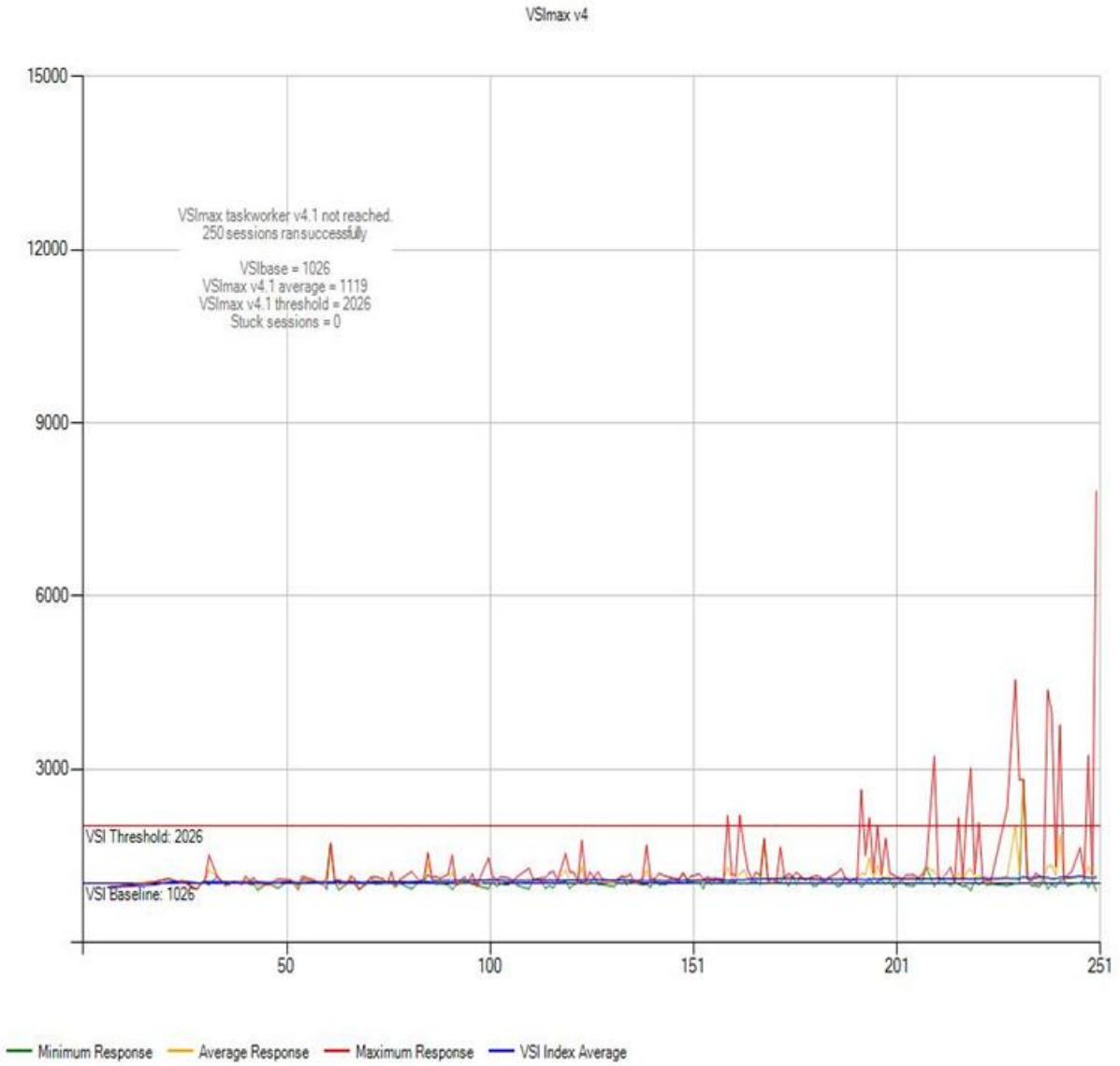


Figure 3 – Login VSI Response – Task Worker Workload

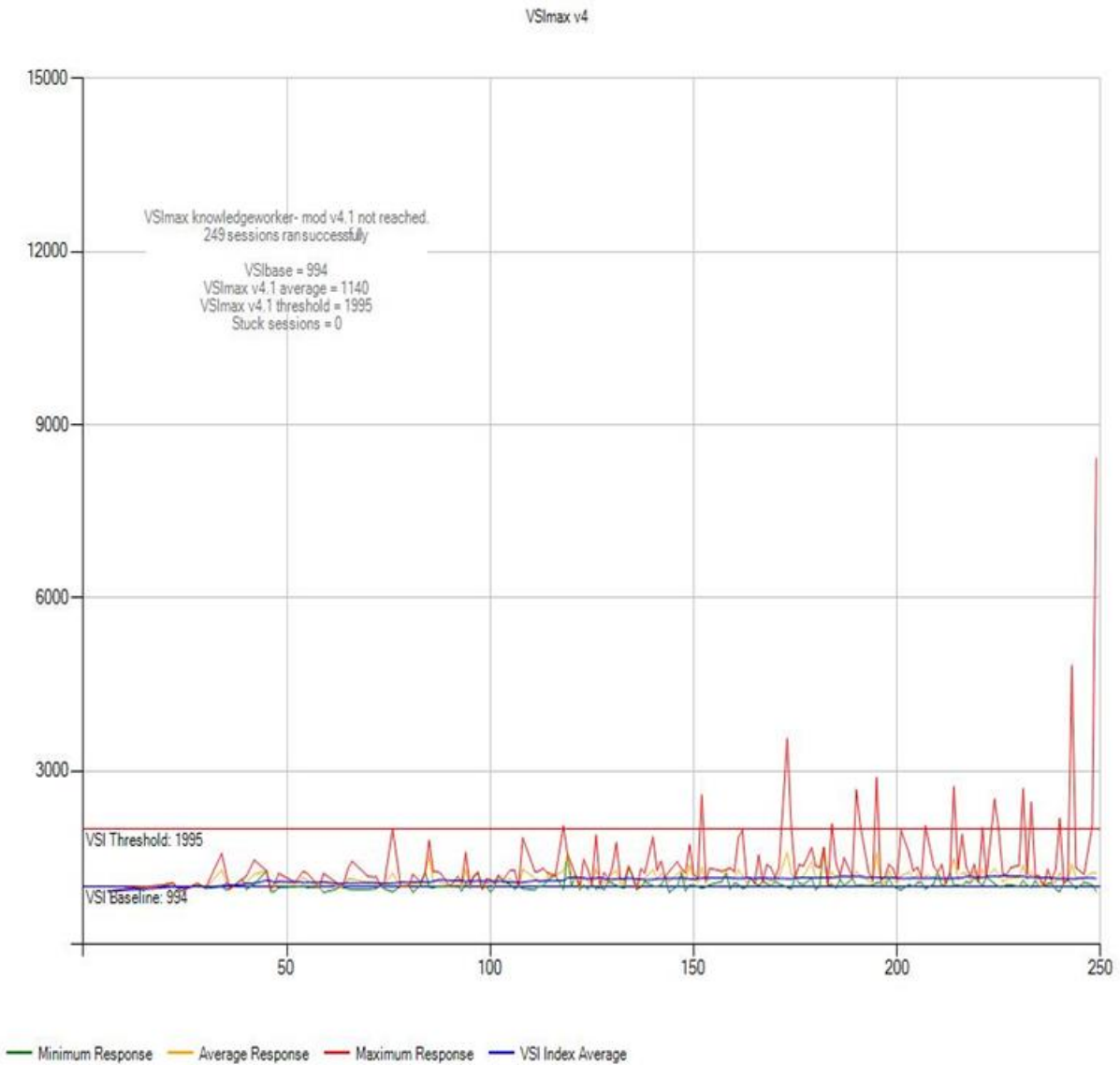


Figure 4 – Login VSI Response – Knowledge Worker Workload

In the published white paper “Fujitsu vShape Virtual Desktop Infrastructure (VDI) with Fibre Channel and VMware” a similar set of Login VSI tests were run with an ETERNUS DX200 S3 storage configuration using Flexible Tiering and a combination of Hard Disk Drives and SSDs. It used the Login VSI Medium Workload, which is an earlier version of the Knowledge Worker Workload, and with 250 users. In that test run the VSImax v4 Average response was 4,638, while with the DX200F All Flash Array, the VSImax v4 Average response was only 1,140. This is a reduction in Response Time with the AFA of 4:1. This shows that when the VDI environment application response time is important, the DX200F AFA using SSDs provides a significant advantage over the DX200 S3 with a combination of Hard Disk Drives and SSDs. In both sets of tests, the VSImax v4 Threshold was not reached during the test run with the 250 user sessions.

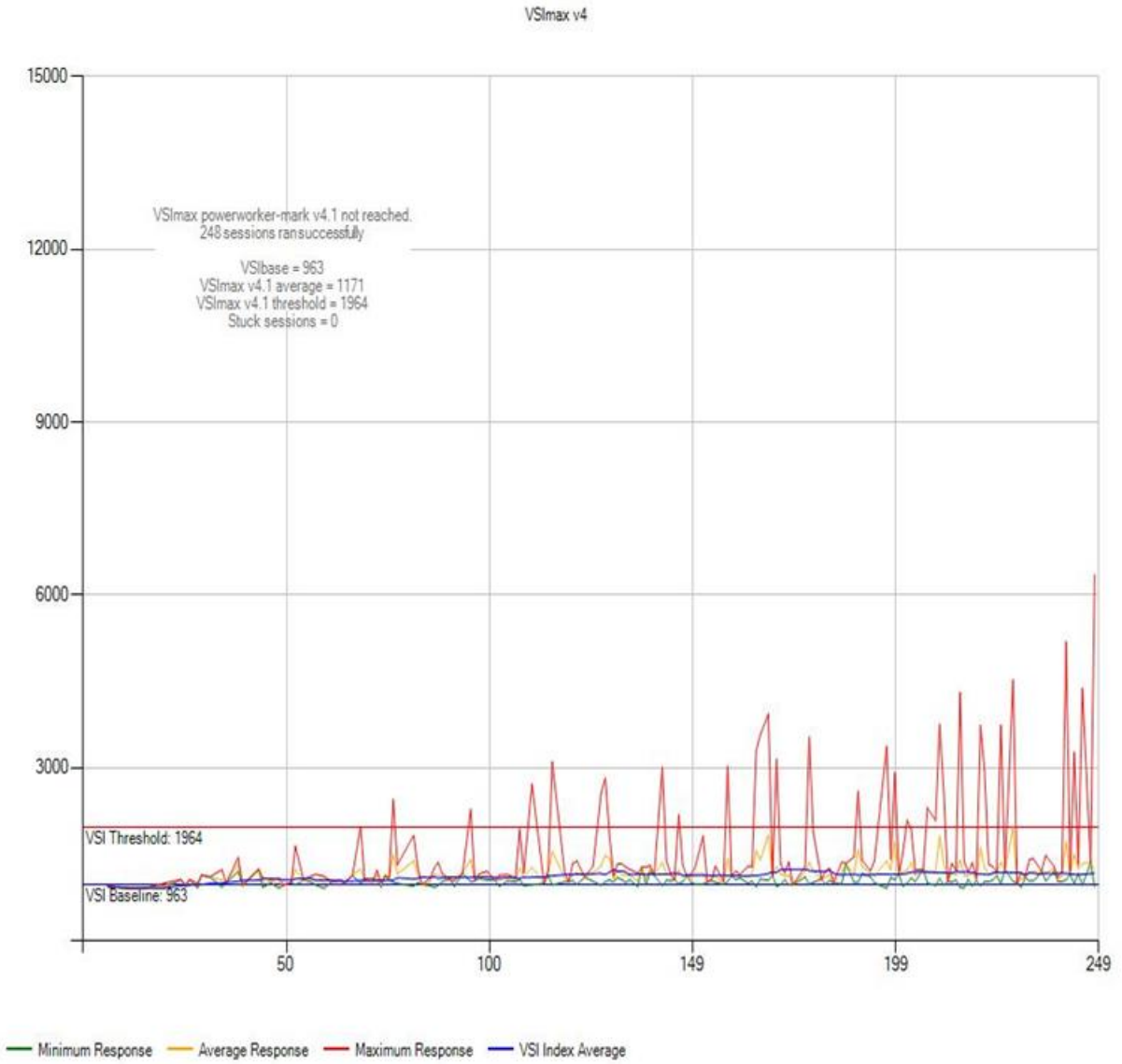


Figure 5 – Login VSI Response – Power Worker Workload

7 VMware ESXi Server Loading

The performance factors within the twelve ESXi servers provide a view of the loading within this test environment as seen in the following charts. These charts are based on the data provided by the vCenter server from the aggregated performance data for each of the ESXi servers, rolled up to 5 minute intervals. The specific time during which the respective benchmarks were run is reviewed in each of the charts.

7.1 ESXi CPU Loading

With the overprovisioning of the ESXi servers, it is not expected that the loading on the CPUs will be very high. This is seen in these charts.

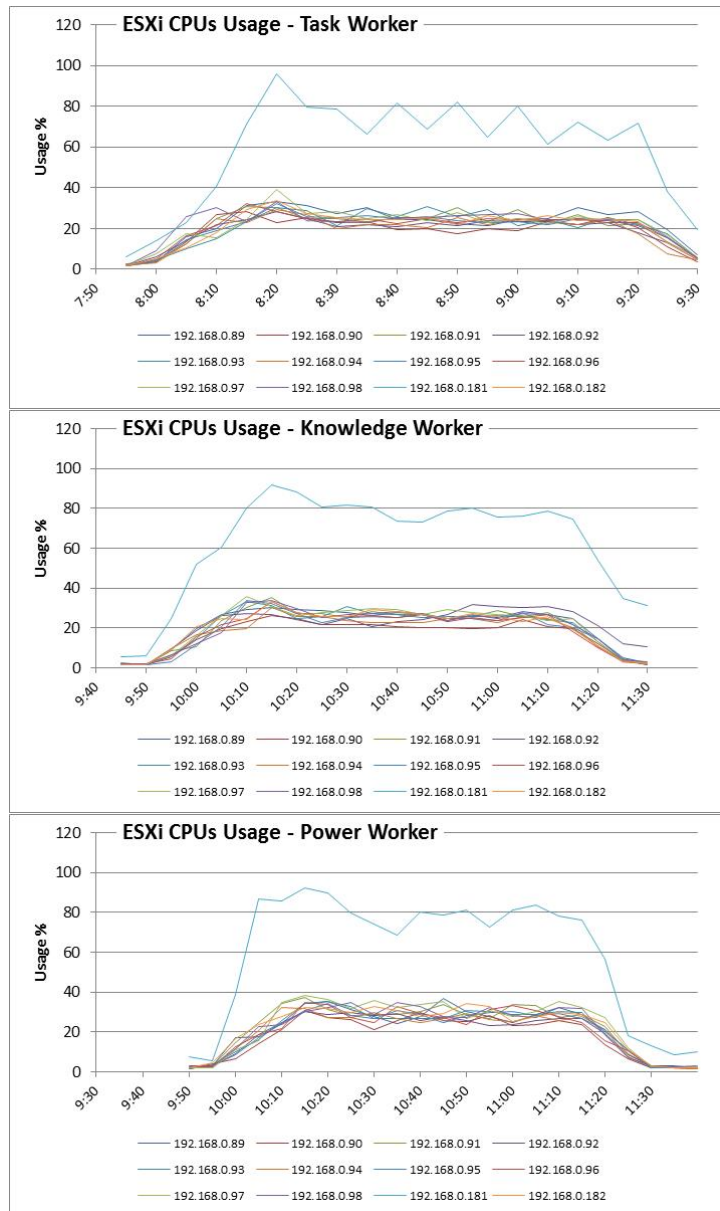


Figure 6 – ESXi CPU Loading Charts

It is clear from these CPU loading charts that the ESXi servers are not being stressed in this configuration, with the exception of 192.168.0.181. This server is of lesser capability than the others, having only 8 cores, versus 24 cores on the others. It is not the normal case to have extra servers, but these were included purposely to ensure that there would not be a limitation on the VDI performance imposed by the servers. This is because of the focus of this work on the ETERNUS DX200F AFA storage array performance.

7.2 ESXi Disk Traffic (Usage)

As all of the ESXi servers are running similar workloads, it is expected that the traffic each is demanding of the storage will be very much the same. These charts provide insight into the traffic between the servers and the storage, as viewed from the servers.

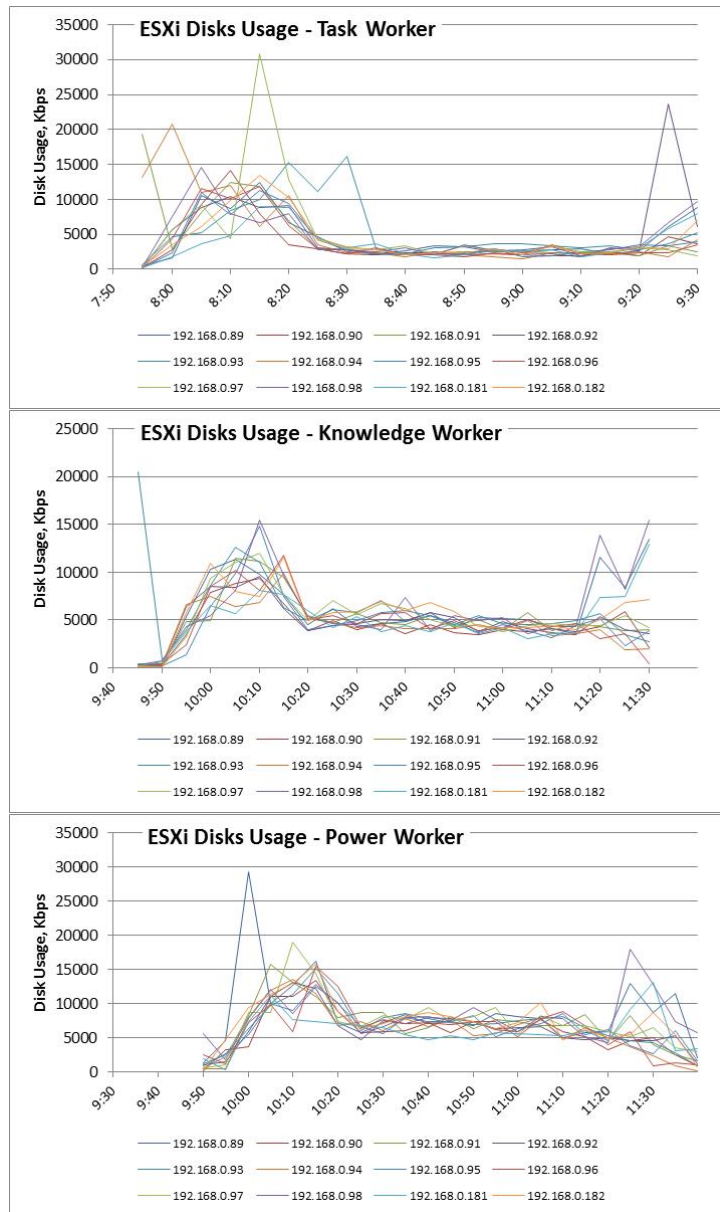


Figure 7 – ESXi Disk Traffic (Usage)

Notice that there is a burst of traffic as the VDI desktops are launched at the beginning of the test run. All 250 are launched within the first 30 minutes and all are then running the respective workload indicated throughout the test duration. At the end, all go through the logoff phase, and again this has varying amounts of disk traffic to complete the Login VSI test sequence.

7.3 ESXi Network Traffic

This represents the traffic between the ESXi servers and the Login VSI Launchers and other service functions within the environment usually seen between the VDI servers and the desktop users. Note that the traffic levels are very much the same, and none are very high. However, the usage from 192.168.0.181 is noticeably lower than the others - this is the lesser capable server that cannot support as great a load as the others.

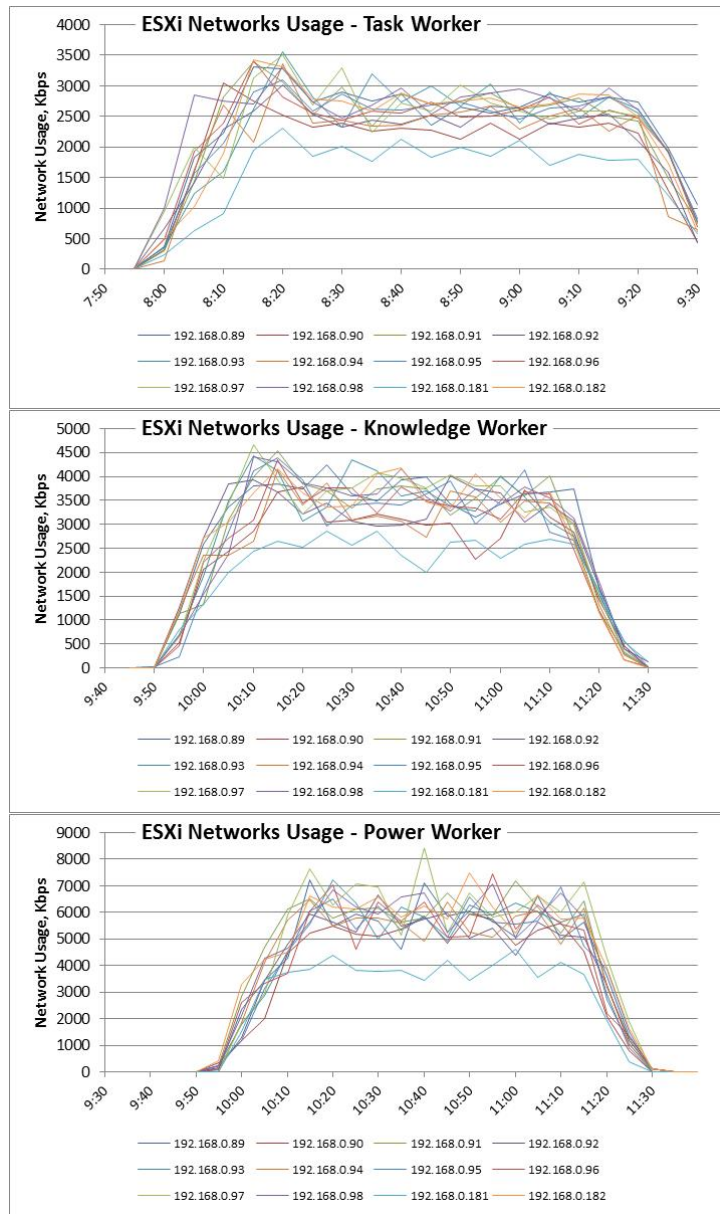


Figure 8 – ESXi Network Traffic

8 ETERNUS Performance

The aspect of performance that was the primary objective of these tests is the performance measured within the ETERNUS storage array. This performance view provides insight into the loading on the DX200F AFA storage array. It is clear that the three different test profiles (Task Worker, Knowledge Worker, and Power Worker) require different levels of service from the storage as they run. The burst in traffic within the first 30 minutes of the test run is in support of the 250 VDI desktops getting launched and logged in to their respective working sessions.

8.1 ETERNUS System Throughput

This throughput measurement represents the total load demanded by all twelve of the ESXi servers shown in the previous charts, and is separated into the Read Traffic and the Write Traffic for clarity in the nature of the workload demand on the storage.

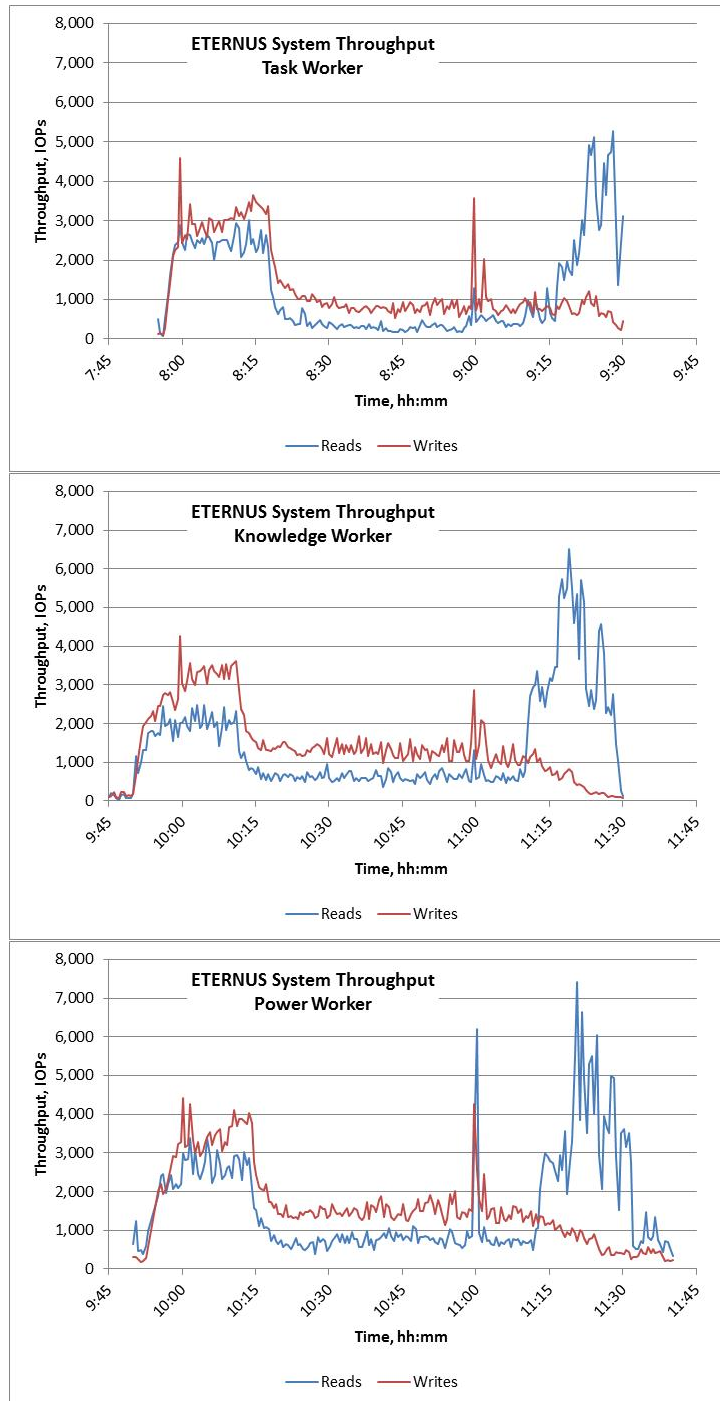


Figure 9 – ETERNUS System Throughput

The peak throughput reached <8000 IOPs in these test runs, which with four 8Gbps Fibre Channel host connections active, results in a peak of less than 2000 IOPs per host channel on the ETERNUS storage array, well within the capability of the FC host connection capabilities.

Clearly visible in these charts is the half hour time interval when the requested numbers of VDI users are becoming active. Each session is started by the Login VSI Launchers during this first half hour period, and then all run at their prescribed load level until their operations are complete, at which point they shut down. This operational profile is established by the Login VSI method of testing and provides a clear indication of the ability of the system to support the requested number of users.

8.2 ETERNUS Response Time

These charts provide a view of the response times provided by the ETERNUS storage array in support of the throughput shown on the previous charts.

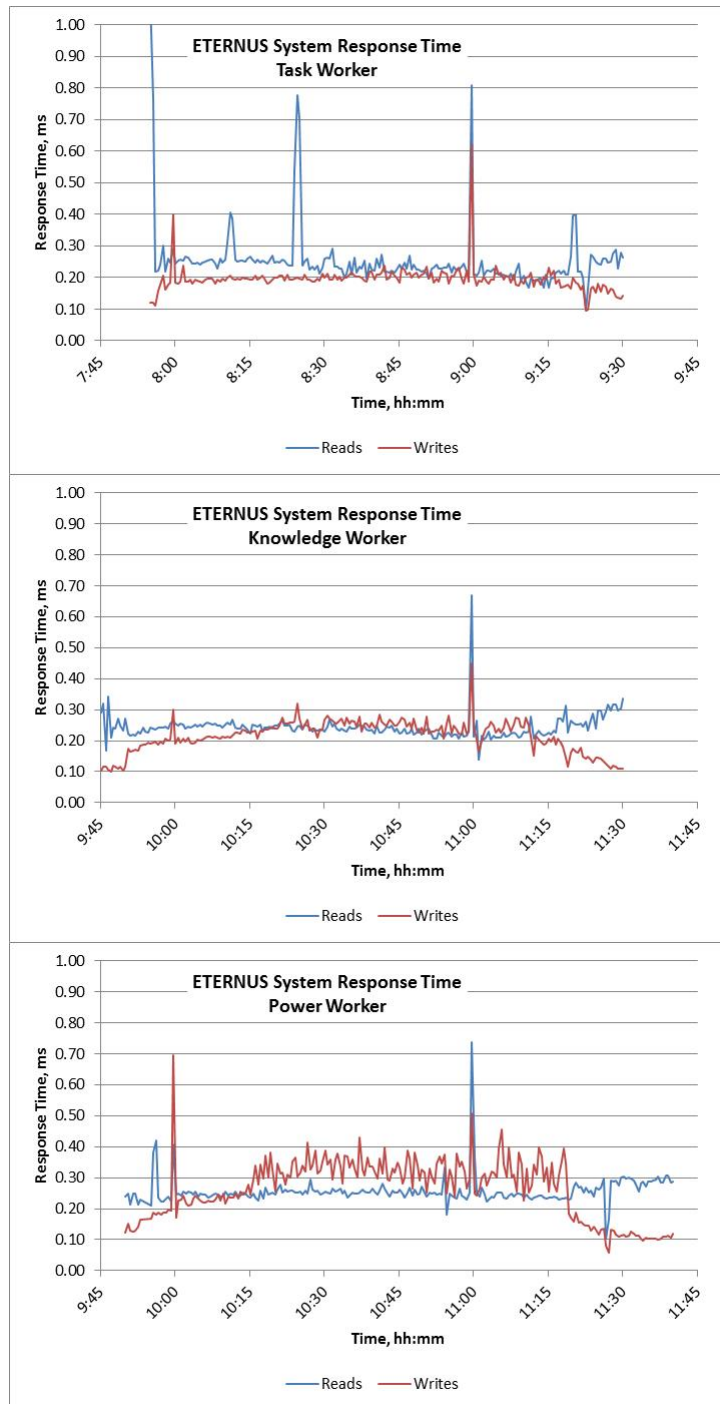


Figure 10 – ETERNUS System Response Time

Even though the ESXi servers are showing response times greater than 1ms, it is quite clear that the DX200F storage array is providing sub millisecond responses nearly all the time.

8.3 ETERNUS Host Channel Throughput

One of the objects of the testing is to evaluate the effectiveness of the 8Gbps Fibre Channel host connection channels. These charts provide the traffic carried by each of the four FC host channels in use during these tests.

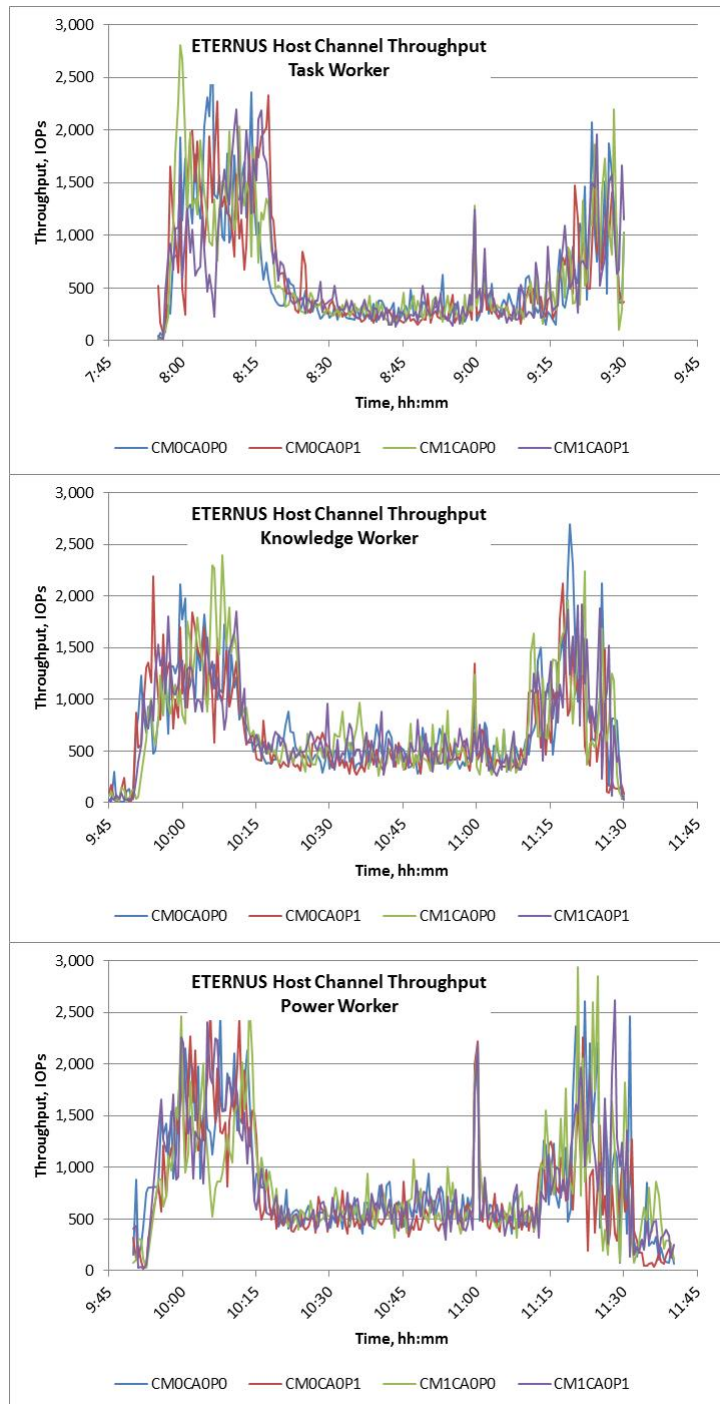


Figure 11 – ETERNUS Host Channel Throughput

These charts illustrate two aspects of the host interface traffic during these test runs. First, the traffic is well balanced across all four of the channels, which is important for effective use of the storage. Second, the level of traffic is well below the maximum traffic that 8Gbps FC links can be expected to support, indicating that this is a good match for smaller VDI requirements.

8.4 ETERNUS CM Busy

The Control Module (CM) in the ETERNUS provides the processing power within the storage array and can limit throughput under some workload demands. These charts show that the two CMs in the ETERNUS DX200F are not stressed by the workloads presented in this environment.

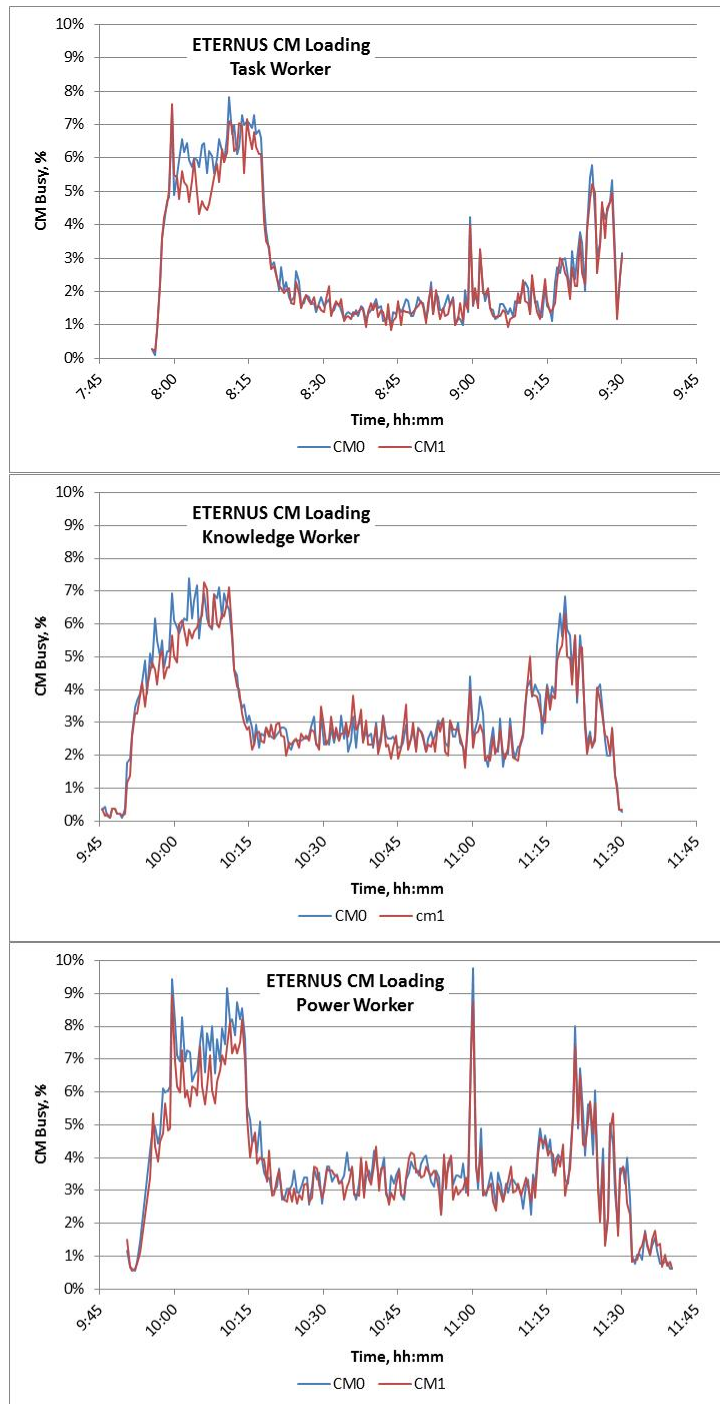


Figure 12 – ETERNUS CM Busy

The heavier demands of the Knowledge Worker and Power Worker workloads are clearly evident in these charts.

9 Test Analysis

As noted in section 5.2, the primary objective of this testing effort is to show that the ETERNUS DX200F can be a very effective storage array for support of small VDI environments. The ultra-fast response times shown Figure 10 illustrate the ability of the DX200F to support the most demanding response time sensitive VDI applications very effectively. Note that on all of the charts, there is a burst of activity at the beginning of each test run. With Login VSI, all of the applications that are going to be used within a test run are loaded as soon as the VDI User logs on. All of the 250 desktop users in these tests are logged on by Login VSI over a period of time at the beginning of the test run, and after each is logged on, it begins to run the test sequence. Once all of the users are active, the load drops to that representative of the specific test run demands until the test runs begin to complete. At test run completion, each user logs off and again there is a burst of activity as things wrap up for all of the users at the end of the test run.

In this set of test runs, the desktops were defined as Full Clone Persistent Desktops. These are very much like a laptop or physical PC, as the same user logs into the same desktop each time the user logs in. This type of desktop permits each user to store data locally, including custom changes within their desktop, their active documents, and any specially installed applications. Maintenance of Full Clone desktops requires use of traditional patching, virus scan support and application delivery. The storage used by each desktop is prepared at the time that the Virtual Machine (VM) for the desktop is created and remains as long as that VM exists.

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About Login VSI

Login VSI provides proactive performance management solutions for virtualized desktop and server environments. Enterprise IT departments use Login VSI products in all phases of their virtual desktop deployment—from planning to deployment to change management—for more predictable performance, higher availability and a more consistent end user experience. The world's leading virtualization vendors use the flagship product, Login VSI, to benchmark performance. With minimal configuration, Login VSI products works in VMware Horizon View, Citrix XenDesktop and XenApp, Microsoft Remote Desktop Services (Terminal Services) and any other Windows-based virtual desktop solution. For more information, download a trial at www.loginvsi.com.

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