

# Dell EMC PowerVault ME4024 and VMware Horizon View with 1,300 Persistent VDI Users

## Abstract

This reference architecture document describes a virtual desktop infrastructure (VDI) storage solution based on the Dell EMC™ PowerVault™ ME4024 array.

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## Executive summary

This reference architecture document describes a virtual desktop infrastructure (VDI) storage solution based on the Dell EMC™ PowerVault™ ME4024 array. The ME4024 storage array is an excellent choice as a cost-effective platform for VDI users. It delivers very good performance at a low price point yet offers many expansion options to scale up to larger environments.

This document shows the user experience as tested using Login VSI®, the industry standard tool for testing VDI user performance. It is designed to simulate real-world users by scripting each phase of a user experience: login, loading applications, working on documentation, and logout.

The applications used to test the environment were Microsoft® Office 2013, Adobe® Acrobat®, WinZip, and other applications running on Windows 10.

## Objectives

This document provides design guidance to help customers benefit from the low cost and high performance of the ME4024 array. The data provided shows the following:

- ME4024 performance
- Scalability options
- Login VSI test results

## Audience

This reference architecture is intended for all audiences interested in the performance of an ME4024 array for VDI workloads. It details the systems to drive the workload from an overview perspective. The focus is on the storage portion of the environment under VDI loads. Performance under other workloads can be found on the page [Dell EMC PowerVault ME4 Series technical documents](#), and hardware options can be found on the [ME4 Series product page](#).

# 1 PowerVault ME4024 overview

The PowerVault ME4 Series (including the ME4024 array) is next-generation, entry-level storage that is purpose-built and optimized for SAN and DAS virtualized workloads. Available in 2U or dense 5U base systems, the low-cost ME4 Series simplifies the challenges of server capacity expansion and small-scale SAN consolidation with up to 336 drives or 4 PB capacity. It also comes with all-inclusive software, incredible performance, and built-in simplicity with a new, web-based HTML5 management GUI, ME Storage Manager. Connecting ME4 Series storage to a Dell EMC PowerEdge™ server or to a SAN ensures that business applications will get high-speed and reliable access to their data — without compromise.

Product features include the following:

**Simplicity:** ME4 Series storage includes a web-based management GUI (HTML5), installs in 15 minutes, configures in 15 minutes, and easily deploys in 2U or 5U systems.

**Performance:** Compared to the predecessor MD3 Series, the ME4 Series packs a lot of power and scale with the Intel® Xeon® processor D-1500 product family. The ME4 Series processing power delivers incredible performance gains over the MD3 Series, as well as increased capacity, bandwidth, and drive count.

**Connectivity:** ME4 Series storage goes to the next level with robust and flexible connectivity starting with a 12Gb SAS back-end interface, and front-end interface options including four 16Gb FC ports per controller, four 10Gb iSCSI ports per controller (SFP+ or BaseT), or four 12Gb SAS ports per controller.

**Scalability:** Both 2U and 5U base systems are available, with the 2U system supporting either 12 or 24 drives and the 5U system supporting 84 drives. Each of the 2U (ME4012 and ME4024) and 5U (ME4084) base systems supports optional expansion enclosures of 12, 24, and 84 drives, allowing you to use up to 336 drives. Drive mixing is also allowed.

**All-inclusive software:** ME4 Series software provides volume copy, snapshots, IP/FC replication, VMware® VCenter Server® and VMware Site Recovery Manager™ integration, SSD read cache, thin provisioning, three-level tiering, ADAPT (distributed RAID), and controller-based encryption (SEDs) with internal key management.

**Management:** An integrated HTML5 web-based management interface (ME Storage Manager) is included.

For more information, see the [ME4 Series product page](#).

## 2 PowerVault ME4024 features

The PowerVault ME4024 storage array is targeted at entry level workloads. It is designed to provide excellent performance at an entry-level price.

The ME4024 platform can be configured in all-flash, hybrid, or spinning-drive configurations. These options provide flexibility to support a large variety of workloads.

For VDI workloads, flash drives provide high throughput, low latency, and a small footprint to maximize the cost benefits of running a virtualized desktop solution. The solution tested for this document is an all-flash array.

### 2.1 All-around simplicity

PowerVault ME4 Series provides features that simplify tasks such as system installation, configuration, and serviceability, enabling IT generalists to manage resources more efficiently and focus on the bigger picture. ME4 Series storage enables task simplification with the following:

- Simple to order with all-inclusive software
- Customer installable and configurable in 15 minutes
- Intuitive web-based (HTML5) management
- Easily expandable without disruption

### 2.2 Affordable enterprise-level capabilities

PowerVault ME4 Series storage arrays deliver the software you need to store, manage, and protect your data:

- ADAPT (distributed RAID): Improved data protection functionality that delivers faster drive rebuild times
- Thin provisioning: Allocate and consume physical storage capacity as needed in disk pools
- Snapshots: Easily recover data with point-in-time copies
- Replication: Replicate data to any global location
- Volume copy: Enable seamless volume relocation and disk-based backup and recovery
- SSD read cache: Increase the execution speed of applications by caching previously read data
- Three-level auto-tiering: Optimize data performance with less expense
- Virtualization integration: Integrate ME4 Series arrays with VMware® vSphere® and vCenter® SRM, as well as Microsoft® Hyper-V®

### 2.3 Optimized for SAN and DAS

PowerVault ME4 Series storage is purpose-built and optimized for SAN and DAS virtualized workloads. Connecting the PowerVault ME4 Series array to a PowerEdge server enables you to address the challenges of server capacity expansion, or connecting to a SAN provides flexibility, scalability, and the ability for business applications to have high-speed and reliable access to their data. ME4 Series storage offers the following SAN and DAS options:

- Direct-attach to PowerEdge servers over SAS, FC, or iSCSI
- Consolidate SAN storage through a single port over FC or iSCSI

## 2.4 Data protection

ME4 Series storage keeps your valuable information safe with the following features:

- Remote replication: Replicate data to any global location that includes mirroring thin provisioned pools.
- Snapshots: Easily recover files after accidental deletion or alteration with point-in-time copies of data.
- Virtual disk copy (VDC): Enable quick and seamless virtual disk relocation and disk-based backup and recovery with a full, replicated copy of source data.
- Self-encrypting drives (SEDs): Render data useless to unauthorized users with drive-level encryption, even if the drive has been removed from the enclosure.

## 2.5 Improved hardware and performance

Designed as the next-generation successor to the popular PowerVault MD3 Series array, PowerVault ME4 Series storage is simpler, faster, and just as affordable. With the dual-core Intel® Xeon® processor D-1500, active-active controllers, more drives, and a faster back end, ME Series storage delivers the following:

- Up to 320,000 IOPS performance
- Up to 5,500 MB/sec bandwidth
- Up to 4 PB capacity
- Performance at scale with a 12 Gb SAS backend

The ME4 Series base models include dual hot-swappable Intel controllers, iSCSI, Fibre Channel, and SAS protocols, and support for 2U and 5U expansion enclosure options. ME4 Series arrays can be implemented as shared SAN storage or direct attach them to PowerEdge servers.

## 2.6 Simplified data management

The low-cost PowerVault ME4 Series storage brings radical simplicity and exceptional affordability to the entry market. It is simple to install and configure, comes with all-inclusive software, and includes an intuitive web-based HTML5 GUI for anywhere management. ME4 Series storage flexibly configures as DAS or SAN, all flash or hybrid, and supports a mix of HDD and SSD drives. It also includes built-in compatibility with Microsoft and VMware hypervisors to simplifying physical and virtual resource management.

Also included is ME Storage Manager, a web-based management GUI that simplifies ME4 Series storage configuration tasks, alerts you to problems, and provides a recovery guru to automatically help troubleshoot and resolve issues.

## 2.7 Fast recovery with ADAPT

PowerVault ME4 Series ADAPT software protects data by dynamically distributing it across pools of drives. In the event of a drive failure, ADAPT identifies the critical data and dynamically rebalances the data so the array can return to an optimal state faster than it would in the typical RAID environment. ADAPT offers the following benefits:

- Saves time and money
- Supports faster drive rebuilds
- Enables adding only the capacity needed
- Supports up to 1 PB capacity or up to 128 drives.



## 3 Solution architecture

### 3.1 Environment

There are many components required to drive an environment of this scale. They all need to work together to provide a stable and seamless solution for VDI to work correctly.

### 3.2 Software

The solution is built on layers of software and hardware. Each component provides a key piece of the puzzle.

#### 3.2.1 Software components

The solution presented in this paper uses the following software:

- VMware Horizon® 7.6
- VMware vSphere hypervisor 6.7
- VMware vSphere management
- Login VSI® (for simulating real-world VDI workloads)
- Microsoft Windows Server® 2016 and Windows 10

All software components were updated to the most currently available patch level for the tests.

#### 3.2.2 VMware vSphere host

VMware vSphere is the top enterprise virtualization platform used for building VDI and cloud infrastructures. VMware vSphere includes three major layers: virtualization, management, and interface. The virtualization layer includes infrastructure and application services. The management layer is central for configuring, provisioning, and managing virtualized environments. The interface layer includes the vSphere client and the vSphere web client.

Throughout the solution, all VMware and Microsoft best practices and prerequisites for core services are adhered to (for example, NTP, DNS, and Microsoft Active Directory®). The vCenter servers used in the solution are VMware vCenter Server Appliances v6.7. All hosts were running vSphere 6.7.

#### 3.2.3 VMware Horizon 7.6

The VDI management platform used was VMware Horizon 7.6 with linked clones. Horizon allows a number of different cloning options, as well as managing discrete desktops. It is designed to scale to large numbers of end-points in a single interface and provide consistency and manageability in large environments.

Linked clones were chosen for their management and small footprint. This is a very commonly used configuration because of its efficiencies and ease of use.

Horizon has several components that make up the product:

**Connection Server:** The Connection Server is the central hub for managing connections. Users connect using either the Horizon View client or a web browser. The Connection Server then connects the user to the proper virtual desktop session based on the assignments. Users can either be assigned a static machine (in this case, for persistence) or given a random machine in a non-persistent environment.

**Composer:** The Horizon View Composer server handles the tasks of provisioning virtual desktops to the proper pool using the correct base image. It also handles maintenance tasks, such as a desktop refresh or recompose.

**Horizon View agent:** Installed on user devices, the Horizon View agent provides users with quick, secure, multi-protocol access to documents, applications, and desktops from any of the user's devices including smartphones, tablets, and PCs. VMware Horizon provides on-demand access to Windows, web, and Software as a Service (SaaS) applications.

**Management console:** The Horizon View management console is a web service application that can be run from any Windows server in the environment. The management servers used were configured using VMware vCenter™ 6.7 with a central Microsoft SQL Server® 2016 instance. There was one management server configured controlling all 1,300 virtual machines.

### 3.2.3.1 Linked clones

The virtual machines were created using the linked clone method in Horizon View. This provides efficient use of space and simplifies management. By using linked clones, a replica image is used for shared data resulting in a very small footprint. After cloning, the total space consumed is less than 2 GB/VM in a persistent state before user login with the VMs running.

After the user profiles were created, the VMs each consumed approximately 5 GB of space. This includes the user customizations, page file, memory swap file, and changes made to customize each VM to the assigned user. Each VM runs Microsoft Office 2013, Adobe® Acrobat® Reader®, and a mix of Login VSI applications

Virtual desktops are assigned to the same user every time with desktop persistence. All changes made by a user are retained for future sessions. The changes are stored in a delta VMDK stored with the VM.

All the desktops are in an automated desktop pool with dedicated user assignments. Those desktops are based on a master desktop template, which is selected when the pool is created. This ensures each user gets a dedicated machine they can customize.

Horizon View also supports creating non-persistent environments to streamline support and troubleshooting. These desktops automatically revert to the default configuration upon user logoff.

### 3.2.4 Microsoft Windows 10

Each of the desktops was a Windows 10 Enterprise client. Windows 10 64-bit was chosen for this configuration. All patches were applied to the desktop image before the base replica was created.

Some Windows components were disabled to reduce resource requirements, in accordance with best practices. In each desktop, indexing was disabled, the frequency of Windows updates was limited, and the pagefile and temporary files were redirected to a separate volume. All disk traffic was captured during the test runs.

### 3.2.5 Microsoft Windows Server 2016

For all Windows Server based functions, Windows Server 2016 was used, with all current patches. The VM hardware configuration varied based on the roles and is documented in the appendices.

## 3.3 Hardware

A fully functional VDI environment for 1,300 virtual machines requires a large amount of hardware with significant compute and memory resources. The act of virtualizing realizes great efficiencies but cannot eliminate the requirement to process data. The act of virtualizing collapses the environment into dense clusters of resources.

### 3.3.1 Hardware components

The hardware used to host the environment consisted of the following:

- PowerEdge blade servers for VDI workload
- PowerEdge M1000e blade enclosures
- Dell EMC Networking MXL Ethernet blade switches
- Dell EMC Networking S5000 top-of-rack (ToR) Ethernet switch
- Brocade® M5424 Fibre Channel (FC) blade modules
- Brocade 6505 FC ToR switches
- PowerVault ME4024 storage array

There are many sizing tools used to gauge the processor and memory requirements for virtual machines. They are outside the scope of this document.

### 3.3.2 Storage

The storage used was a PowerVault ME4024 array with read-intensive solid-state drives. The read-intensive drives provide excellent performance with a very attractive price point. They are also low-power devices relative to spinning drives and generate far less heat. The storage density is also very good.

Technical highlights of the ME4024 array hardware include the following:

- Up to 3.0 PB capacity
- 24 x 2.5-inch drive bays
- Up to 276 drives
- Intel® Xeon® dual-core, 2.2 GHz processors
- Multi-protocols: SAS, iSCSI, Fibre Channel
- Single/dual controller
- 12 Gb SAS back end
- All premium software features included

### 3.3.3 Hosting environment

The environment running the VMs makes up the majority of the hardware required. The power, rack space, cooling, and management requirements are much larger than the storage components. This is normal based on the processing power and memory requirements of 1,300 virtual machines.

Table 1 Host configuration

Component	Description
Host	PowerEdge M620, two 8-core Intel® Xeon® Processor E5-2680, 320 GB RAM
Operating system	vSphere 6.7
Fibre Channel	QLogic® QME2572 HBA, Brocade M6505 chassis-based switch
Network	Dell EMC Networking MXL 10 Gb dual-port Ethernet module
Virtual desktop configuration	2 vCPUs, 2 GB RAM, VMXNet3, 40 GB volume

Table 2 Virtual machine configurations

Component	Description
Infrastructure VMs	6 vCPUs, 16 GB RAM, VMXNet3 vNIC
Operating system	Windows Server 2016
vNIC	VMXNet3
Applications	Microsoft Active Directory®, DNS, DHCP, vCenter Servers, Horizon Connection and Composer servers, Microsoft SQL Server®, DSM

Table 3 Storage

Component	Description
PowerVault ME4024	Dual-controller storage array
16Gb Fibre Channel	4 Fibre Channel ports, 2 per controller
GT275R003-01	Storage firmware
Drives	24 x 480 GB SSDs
RAID	ADAPT
Pools	Virtual pools

### 3.3.4 Connectivity

The network connectivity for this environment is designed to eliminate bottlenecks for the testing.

The Ethernet connectivity is 10 Gb with multiple ports per server. Each physical server has two 10 Gb Ethernet ports. The blade chassis are connected with 40 Gb trunking. Each chassis has a 40 Gb stacking link between the pair of internal network switches. Each stack is then connected with dual 40 Gb QSFP+ connections to the ToR S5000 switch.

The storage connectivity is also faster than required. Each physical server has two 8 Gb Fibre Channel ports to the two chassis-based switches. Each chassis switch has two 16 Gb connections to the core Brocade 6506 switches. The storage has four 16 Gb connections.

## 4 Testing

### 4.1 Test objectives

The testing and validation processes involve several test phases designed to ensure the storage will meet all throughput and latency requirements. The goal is to ensure the storage will meet all stated performance targets.

### 4.2 Test tools

The test tool used was designed by Login VSI consultants. It delivers a predictable and repeatable workload to benchmark VDI environments. It includes multiple applications to generate, monitor, and report on the workload chosen.

#### 4.2.1 Load generation

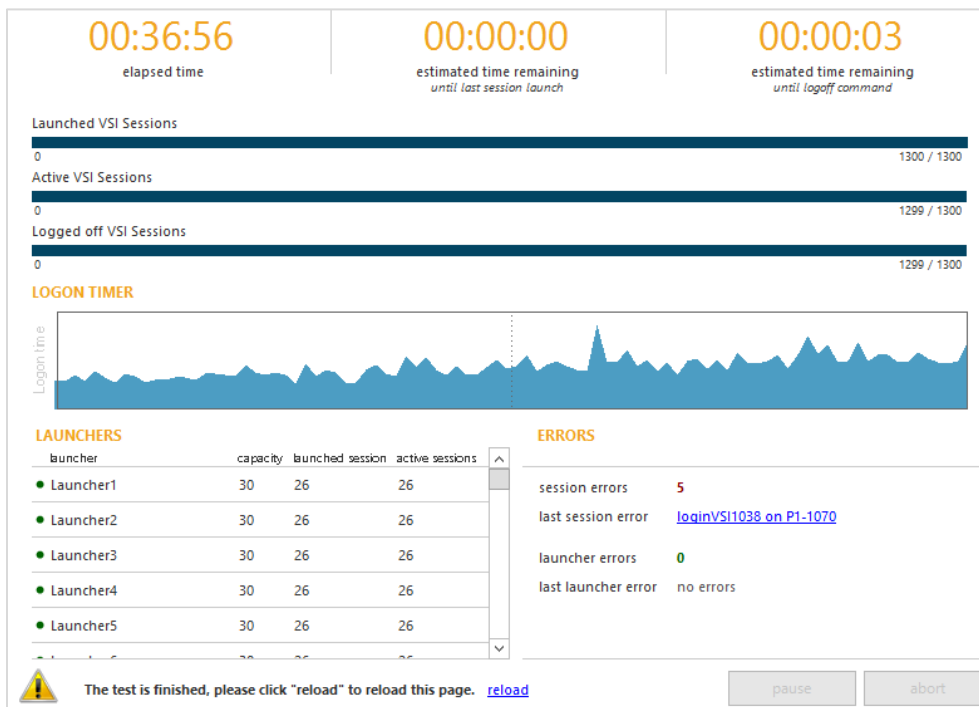
The Login VSI management console controls several tools and provides the interface for accessing them.

The workload is generated using a set of launcher machines. These launcher machines create VMware Horizon client connections to the VMs being tested. For these tests each launcher VM initiated 26 active sessions.

The workload used was the included Knowledge Worker simulation. This generated approximately 12 IOPS/VM.

#### 4.2.2 Load monitoring

The Login VSI Management Console provides a real-time scrolling window showing login performance. It also provides other data to monitor the load during the test runs:



Once the test is complete, a test run analyzer is used to summarize the results.

The screenshot displays the Login VSI Analyzer 4.1.32.1 interface. The title bar reads "Login VSI Analyzer 4.1.32.1 - [1300userWin10knowledgeworkerv9]". The menu bar includes "File", "Window", and "Help". A tabbed interface shows "Summary" as the active tab, with other tabs for "Settings", "VSImax v4", "VSImax v4 Detailed", "VSImax v4 Detailed Weighted", "VSImax v4 Scatter", "UMEM", "IO", "CPU", "ZLC", "ZHC", and "NFP".

The main content area displays the test name "1300userWin10knowledgeworkerv9" and a summary: "Successfully completed Login VSI test with **1293 knowledgeworker** sessions. VSImax (system saturation) was not reached."

A "Test result review" section provides a detailed breakdown:

- 1300** sessions were configured to be launched in **1300** seconds.
- In total **7** sessions failed during the test:
  - 0** sessions was/were not successfully launched
  - 1** launched sessions failed to become active
  - 1299** sessions were active during the test
  - 6** sessions got stuck during the test (before VSImax threshold) > [Click Here](#)

Additional performance metrics are shown: "With **1293** sessions the maximum capacity VSImax (v4.1) **knowledgeworker** was not reached with a Login VSI baseline performance score of **899**".

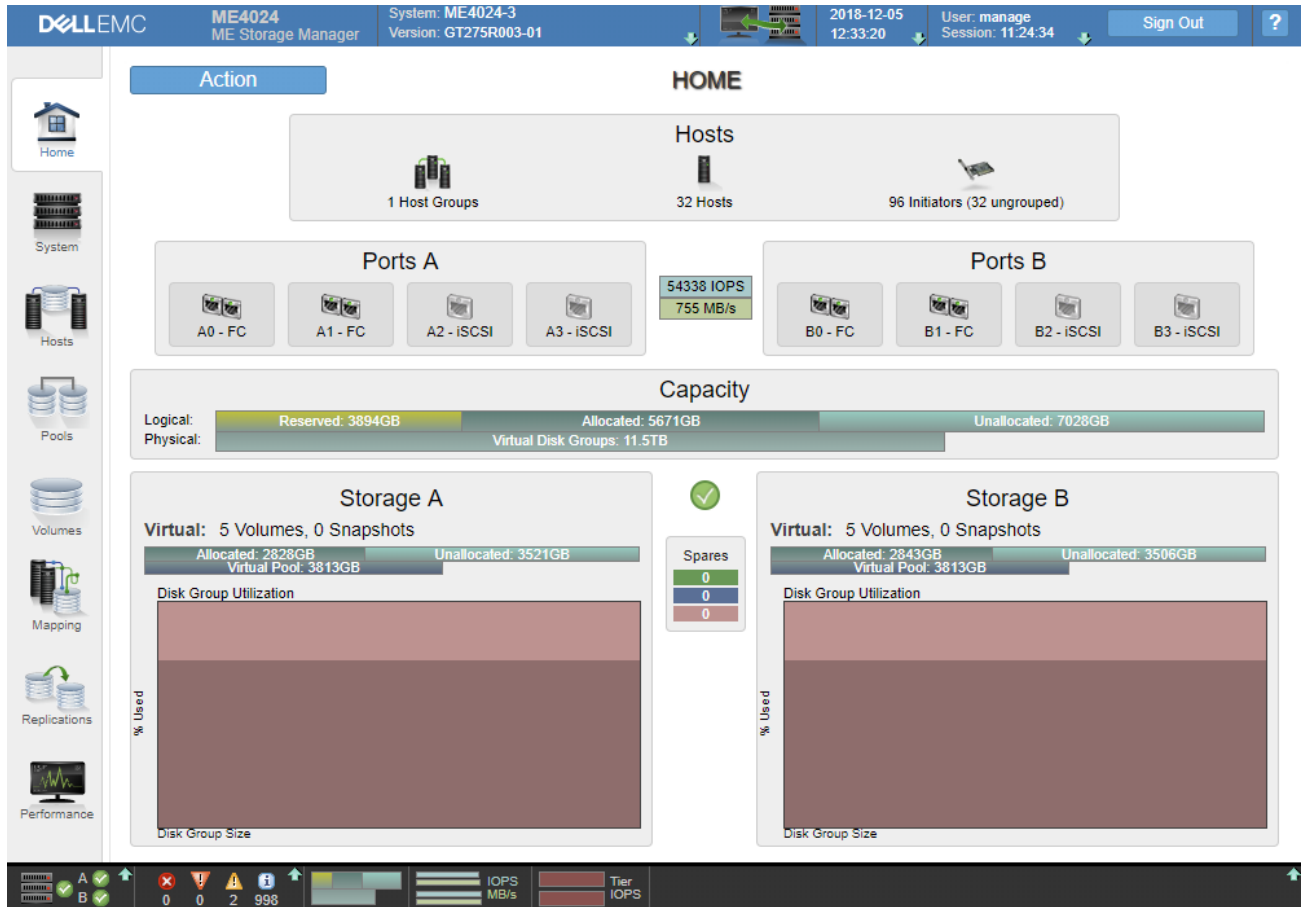
The "Login VSI index average score is **489** lower than threshold. It might be possible to launch more sessions in this configuration."

The baseline performance is summarized as "Baseline performance of **899** is: **Good**".

The detail window provides a fair amount of information. In this test, a small number of sessions failed to complete, which can happen when the software does not return the expected result to the launcher control app.

## 4.3 Storage monitoring

The PowerVault ME4024 array provides a dashboard showing the current state of connectivity as well as the current storage load. This allows a real-time view of the I/O throughput.



The dashboard is designed to present the system state in an intuitive, easy-to-read format, while giving a quick view into the health and performance of the system. In the center of the screen is the current IOP load and throughput.

### 4.3.1 Login phase

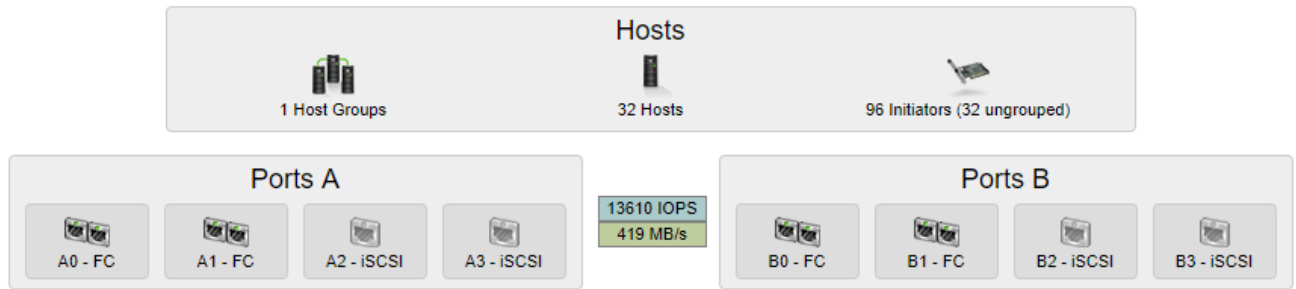
The login phase resulted in over 22,000 IOPS at its peak.





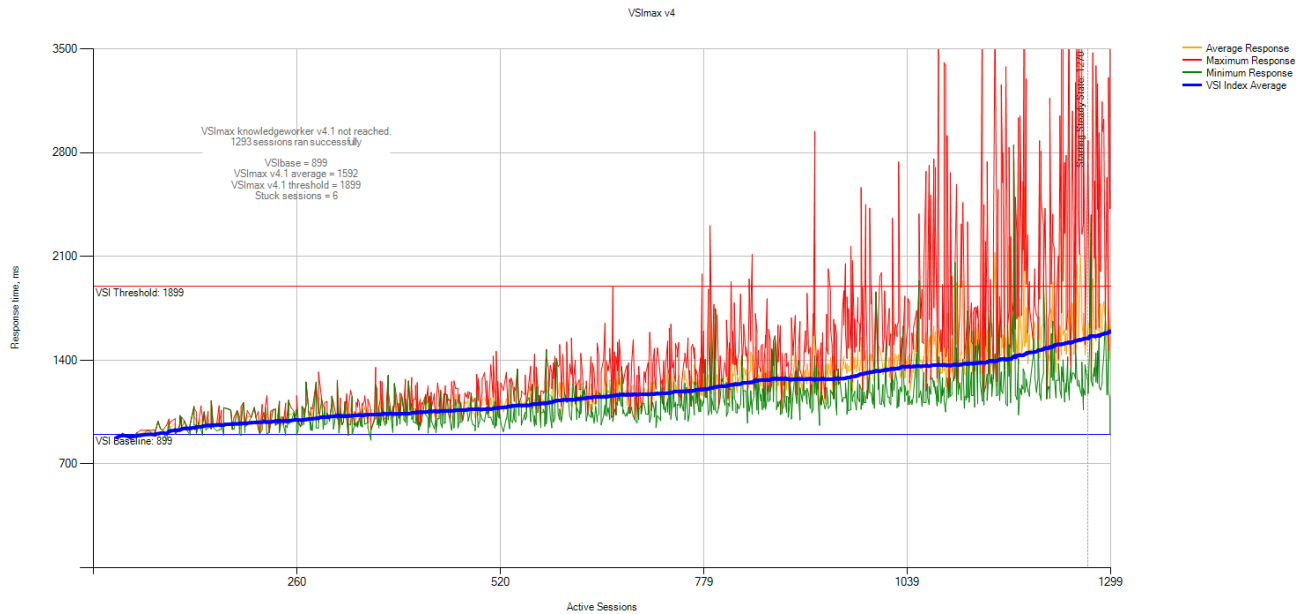
### 4.3.2 Steady state

The steady-state load is where the system spends most of its time and is the most important phase. It is what defines the pass/fail result in Login VSI. The performance of the ME4024 array was rated as **Good** under full load, according to the Login VSI tool, at more than 13,000 IOPS of continuous load.



### 4.3.3 Test results

The following chart shows the test results.



The chart shows the ME4024 array has more than enough performance to support 1,300 users. The load was sized to allow for headroom during workload spikes, or a change in the desktop configuration.

The baseline in the chart is programmatically determined using the first group of machines to log in. This defines the no-load performance. The threshold is determined as the performance change that would be noticeable to users or would cause delays to either the login or application launch process. These two criteria set the boundaries for the VM performance. The blue line shows average performance across the test applications.

## 5 Conclusion

The PowerVault ME4024 array is a capable platform for VDI solutions. It provides an excellent entry-level platform that can grow to petabytes in size. It also supports spinning drives for a mixed-use environment where cost per TB is a major concern.

## A Environment

### A.1 Horizon View

Table 4 Horizon View configuration

Component	Description
Horizon View	7.6
Role	Virtual machine assignment, management, web interface, connection broker
Servers	Four 4-core servers, 12 GB RAM
Cabling	10 Gbps VMXNet3

### A.2 VMware hosts

Table 5 VMware host hardware configuration

Component	Description
VMware host	6.7
Role	End-user compute node
Hardware	Two 8-core processors, 320 GB RAM
Storage	200 GB SSD for boot/log

### A.3 VMware vCenter

Table 6 vCenter server configuration

Component	Description
VMware vCenter appliance	6.7; two virtual vCenter appliances for end-user VMs, one appliance for infrastructure
Role	Management of all hosts, DRM load balancing, host monitoring

### A.4 Login VSI

Table 7 Login VSI configuration

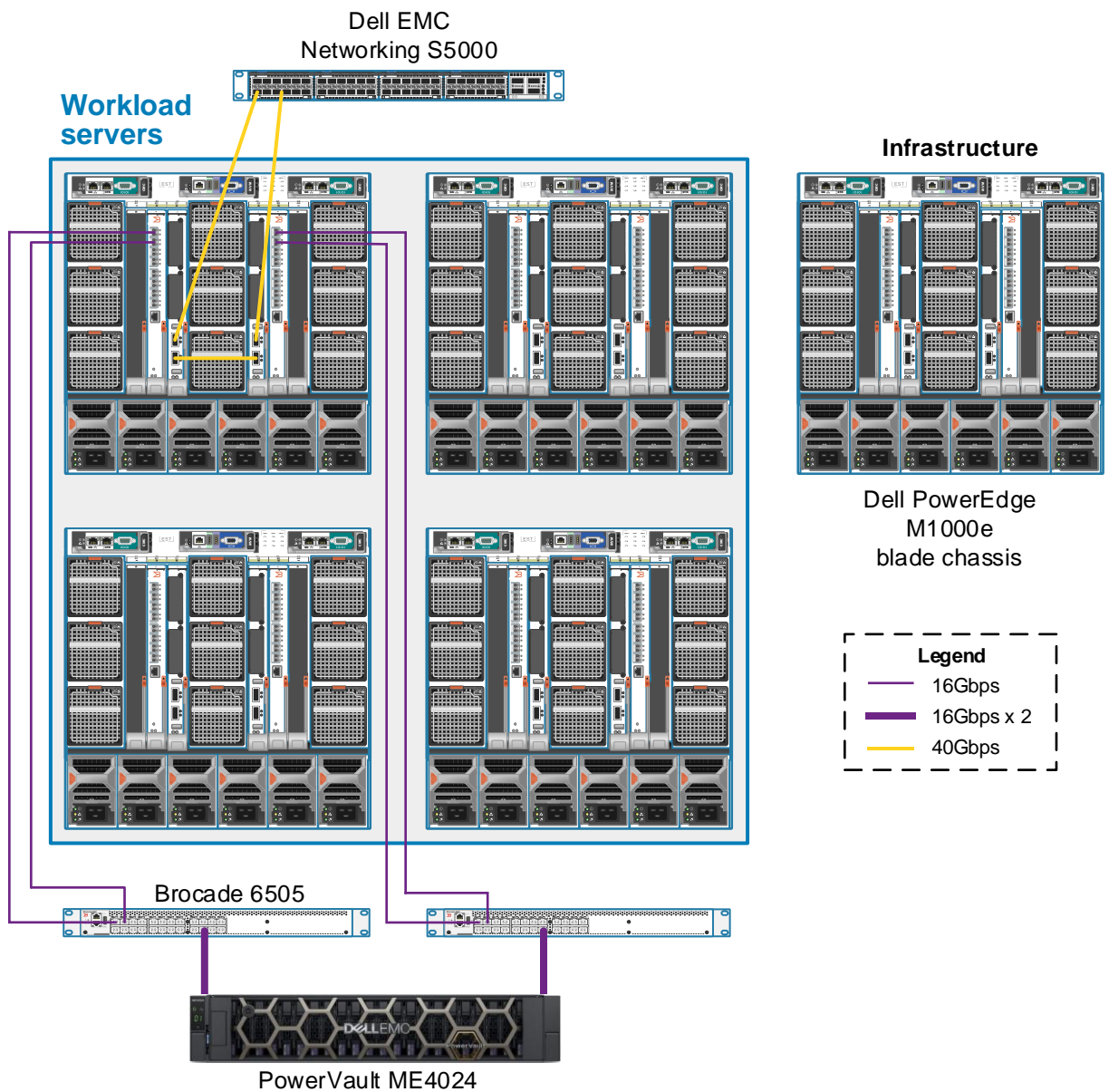
Component	Description
Login VSI	4.1.32
Role	Workload generation and application performance reporting

## A.5 Windows desktops

Table 8 Virtual desktop configuration

Component	Description
Client desktops	Windows 10
Memory	2 GB
Processor	2 vCPUs
Applications	Office 2013, Adobe Acrobat Reader, WinZip®, Freemind, Doro PDF Writer

## A.6 Hardware environment



## B Technical support and resources

[Dell.com/support](https://www.dell.com/support) is focused on meeting customer needs with proven services and support.

[Storage technical documents and videos](#) provide expertise that helps to ensure customer success on Dell EMC storage platforms.

### B.1 VMware support

For VMware support, see the following resources:

- [VMware.com](https://www.vmware.com)
- [Education and training](#)
- [Online documentation](#)
- [VMware communities](#)