EMC VSPEX END-USER COMPUTING
Citrix XenDesktop 7.1 and Microsoft Hyper-V
for up to 500 Virtual Desktops
Enabled by EMC VNXe3200 and EMC Powered Backup

EMC VSPEX

Abstract
This Design Guide describes how to design an EMC® VSPEX® end-user computing solution for Citrix XenDesktop 7.1 for up to 500 virtual desktops. EMC VNXe3200™ and Microsoft Hyper-V provide the storage and virtualization platforms.

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EMC VSPEX End-User Computing: Citrix XenDesktop 7.1 and Microsoft Hyper-V for up to 500 Virtual Desktops
Enabled by EMC VNXe3200 and EMC Powered Backup
Design Guide

Part Number H13066
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Chapter 1: Introduction

Purpose of this guide

The EMC® VSPEX® end-user computing architecture provides the customer with a validated system capable of hosting a large number of virtual desktops at a consistent performance level. This VSPEX end-user computing solution for Citrix XenDesktop 7.1 runs on a Microsoft Hyper-V virtualization layer backed by the highly available EMC VNXe3200™, which provides the storage. In this solution, the desktop virtualization infrastructure components, such as the XenDesktop controller, PVS server, Active Directory controller, and Virtual Machine manager, are layered on a VSPEX Proven Infrastructure, while the desktops are hosted on dedicated resources.

The compute and network components, which are defined by the VSPEX partners, are designed to be redundant and sufficiently powerful to handle the processing and data needs of a large virtual machine environment. EMC Avamar® backup and recovery solutions provide data protection for Citrix XenDesktop data.

This VSPEX end-user computing solution is validated for up to 500 virtual desktops with flexible scaling from one building block of 125 virtual desktops up to four building blocks of 500 virtual desktops. These validated configurations are based on a reference desktop workload and form the basis for creating cost-effective, custom solutions for individual customers.

An end-user computing or virtual desktop infrastructure is a complex system offering. This Design Guide describes how to design a VSPEX end-user computing solution for Citrix XenDesktop 7.1 with Microsoft Hyper-V according to best practices and how to size the solution to fit the customer's needs by using the EMC VSPEX Sizing Tool or the Customer Sizing Worksheet.

Business value

Business applications are becoming more integrated with consolidated compute, network, and storage environments. This VSPEX end-user computing solution reduces the complexity of configuring every component of a traditional deployment model. The solution simplifies integration management while maintaining application design and implementation options. It also provides unified administration, while enabling adequate control and monitoring of process separation.

The business benefits of the VSPEX end-user computing solution for Citrix XenDesktop 7.1 include:

- An end-to-end virtualization solution to use the capabilities of the unified infrastructure components
- Efficient virtualization of virtual desktops for varied customer use cases
- Reliable, flexible, and scalable reference architectures
Scope

This Design Guide describes how to plan a simple, effective, and flexible EMC VSPEX end-user computing solution for Citrix XenDesktop 7.1. It provides deployment examples on the next-generation VNXe3200™ storage array.

In this solution the desktop virtualization infrastructure components are layered on a VSPEX Private Cloud with Microsoft Hyper-V Proven Infrastructure, while the desktops are hosted on dedicated resources. This guide illustrates how to size XenDesktop on the VSPEX infrastructure, allocate resources following best practices, and use all the benefits that VSPEX offers.

Audience

This guide is intended for internal EMC personnel and qualified EMC VSPEX Partners. The guide assumes that VSPEX partners who intend to deploy this VSPEX Proven Infrastructure for Citrix XenDesktop have the necessary training and background to install and configure an end-user computing solution based on Citrix XenDesktop with Microsoft Hyper-V as the hypervisor, EMC VNXe3200 as the storage system, and associated infrastructure.

Readers should also be familiar with the infrastructure and database security policies of the customer installation.

This guide provides external references where applicable. EMC recommends that partners implementing this solution be familiar with these documents. For details, see Essential reading and Chapter 6: Reference Documentation.

Terminology

Table 1 lists the terminology used in this guide.

<table>
<thead>
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<th>Term</th>
<th>Definition</th>
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<tr>
<td>End-User Computing</td>
<td>Computing that decouples the desktop from the physical machine. In an end-user computing environment, the desktop operating system (OS) and applications reside inside a virtual machine running on a host computer, with data residing on shared storage. Users access their virtual desktop from any computer or mobile device over a private network or internet connection.</td>
</tr>
<tr>
<td>Hosted shared desktop (HSD)</td>
<td>A server OS from which you can deploy a reference virtual desktop. Each virtual machine in this solution is allocated six vCPUs and 12 GB of RAM, and is shared among 20 virtual desktop sessions.</td>
</tr>
<tr>
<td>Reference architecture</td>
<td>A validated architecture that supports this VSPEX end-user-computing solution for up to 500 virtual desktops</td>
</tr>
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</table>
### Term | Definition
--- | ---
Reference workload | For VSPEX end-user computing solutions, a single virtual desktop—the reference virtual desktop—with the workload characteristics indicated in Table 6. By comparing the customer's actual usage to this reference workload, you can extrapolate which reference architecture to choose as the basis for the customer's VSPEX deployment. Refer to Reference workload for details.
Storage processor (SP) | The compute component of the storage array, which handles all aspects of data moving into, out of, and between arrays.
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**Deployment workflow**

To design and implement your end-user computing solution, refer to the process flow in Table 2.

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<th>Step</th>
<th>Action</th>
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<td>1</td>
<td>Use the Customer Sizing Worksheet to collect customer requirements. Refer to Appendix A of this Design Guide.</td>
</tr>
<tr>
<td>2</td>
<td>Use the EMC VSPEX Sizing Tool to determine the recommended VSPEX reference architecture for your end-user computing solution, based on the customer requirements collected in Step 1. For more information about the Sizing Tool, refer to the <a href="#">EMC VSPEX Sizing Tool</a> portal. <strong>Note:</strong> If the Sizing Tool is not available, you can manually size the application using the guidelines in Chapter 4.</td>
</tr>
<tr>
<td>3</td>
<td>Use this Design Guide to determine the final design for your VSPEX solution. <strong>Note:</strong> Ensure that all resource requirements are considered and not just the requirements for end-user computing.</td>
</tr>
<tr>
<td>4</td>
<td>Select and order the appropriate VSPEX reference architecture and Proven Infrastructure. Refer to the VSPEX Proven Infrastructure Guide in <a href="#">Essential reading</a> for guidance on selecting a VSPEX Private Cloud Proven Infrastructure.</td>
</tr>
<tr>
<td>5</td>
<td>Deploy and test your VSPEX solution. Refer to the VSPEX Implementation Guide in <a href="#">Essential reading</a> for guidance.</td>
</tr>
</tbody>
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**Essential reading**

EMC recommends that you read the following documents, available from the VSPEX space on the [EMC Community Network](#) or from the [VSPEX Proven Infrastructure](#) pages on [EMC.com](#).

- **VSPEX Solution Overview**
  - Refer to the following VSPEX Solution Overview document:
    - [EMC VSPEX End User Computing](#)

- **VSPEX Implementation Guide**
  - Refer to the following VSPEX Implementation Guide:
    - [EMC VSPEX End-User Computing: Citrix XenDesktop 7.1 and Microsoft Hyper-V for up to 500 Virtual Desktops](#)

- **VSPEX Proven Infrastructure Guide**
  - Refer to the following VSPEX Proven Infrastructure Guide:
    - [EMC VSPEX Private Cloud: Microsoft Windows Server 2012 R2 with Hyper-V for up to 125 Virtual Machines](#)
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Overview

This chapter provides an overview of the VSPEX end-user computing solution for Citrix XenDesktop with Microsoft Hyper-V and the key technologies used in the solution. The solution has been designed and proven by EMC to provide the desktop virtualization, server, network, storage, and backup resources to support reference architectures for up to 500 virtual desktops.

The desktop virtualization infrastructure components of the solution are designed to be layered on a VSPEX Private Cloud with Microsoft Hyper-V Proven Infrastructure. However, the reference architectures do not include configuration details for the underlying infrastructure. Refer to the VSPEX Proven Infrastructure Guide in Essential reading for information on configuring the required infrastructure components.

VSPEX Proven Infrastructures

EMC has joined forces with the industry-leading providers of IT infrastructure to create a complete virtualization solution that accelerates the deployment of the private cloud and Citrix XenDesktop virtual desktops. VSPEX enables customers to accelerate their IT transformation with faster deployment, greater simplicity and choice, higher efficiency, and lower risk, compared to the challenges and complexity of building an IT infrastructure themselves.

VSPEX validation by EMC ensures predictable performance and enables customers to select technology that uses their existing or newly acquired IT infrastructure while eliminating planning, sizing, and configuration burdens. VSPEX provides a virtual infrastructure for customers who want the simplicity characteristic of truly converged infrastructures, with more choice in individual stack components.

VSPEX Proven Infrastructures, as shown in Figure 1, are modular, virtualized infrastructures validated by EMC and delivered by EMC’s VSPEX partners. They include virtualization, server, network, storage, and backup layers. Partners can choose the virtualization, server, and network technologies that best fit a customer's environment, while the highly available EMC VNX family of storage systems and EMC Powered Backup technologies provide the storage and backup layers.
Chapter 3: Solution Overview

EMC VSPEX End-User Computing: Citrix XenDesktop 7.1 and Microsoft Hyper-V for up to 500 Virtual Desktops Design Guide

Figure 1. VSPEX Proven Infrastructures
Solution architecture

High-level architecture

The EMC VSPEX end-user computing solution for Citrix XenDesktop provides a complete system architecture capable of supporting up to 500 virtual desktops. It supports both block and file storage.

The solution uses EMC VNXe3200 and Windows Server 2012 R2 with Hyper-V to provide the storage and virtualization platforms, respectively, for a Citrix XenDesktop 7.1 environment of Microsoft Windows 8.1 virtual desktops provisioned by Citrix Provisioning Services (PVS) or Machine Creation Services (MCS).

For the solution, we deployed the VNXe3200 array to support up to 500 virtual desktops.

Figure 2 shows the high-level architecture of the validated solution.

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1 In this guide, “we” refers to the EMC Solutions engineering team that validated the solution.
Chapter 3: Solution Overview

The desktop virtualization components are designed to be layered on a VSPEX Private Cloud solution with Microsoft Hyper-V, backed by the highly available EMC VNXe3200, which provides the storage. The required infrastructure services for the solution, as shown in Figure 3, can be provided by a VSPEX Private Cloud, deployed as dedicated resources as part of the solution, or provided by existing infrastructure at the customer site. The virtual desktops cluster, as shown in Figure 3, requires dedicated end-user computing resources and is not intended to be layered on a VSPEX Private Cloud.

Planning and designing the storage infrastructure for a XenDesktop environment is critical because the shared storage must be able to absorb large bursts of I/O that occur when, for example, many desktops boot at the start of the workday or when required patches are applied. These bursts can lead to periods of erratic and unpredictable virtual desktop performance. Users can adapt to slow performance, but unpredictable performance frustrates users and reduces efficiency.

To provide predictable performance for end-user computing solutions, the storage system must be able to handle the peak I/O loads from the clients while keeping response times to a minimum. However, deploying many disks to handle brief periods of extreme I/O pressure is expensive to implement. This solution uses EMC Fully Automated Storage Tiering (FAST™) Cache to reduce the number of disks required.

EMC Powered Backup solutions enable user data protection and end-user recoverability. This XenDesktop solution uses EMC Avamar and its desktop client to achieve this.
Logical architecture

The EMC VSPEX end-user computing for Citrix XenDesktop solution includes two storage-type variants: block storage and file storage. Figure 3 shows the logical architecture of the solution for both variants.

Figure 3. Logical architecture for both block and file storage

The block variant using the Fibre Channel (FC) protocol uses two networks: one 8 Gb FC network for carrying virtual desktop and virtual server operating system (OS) data and one 10 Gb Ethernet (GbE) network for carrying all other traffic. The block variant with iSCSI protocol and the file variant use a 10 GbE IP network for all traffic.

Note: The solution also supports 1 GbE if the bandwidth requirements are met.
Table 3 summarizes the configuration of the various components of the solution architecture. The Key components section provides detailed overviews of the key technologies.

Table 3. Solution architecture configuration

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<td>Citrix XenDesktop 7.1 Delivery Controller</td>
<td>We used two Citrix XenDesktop Delivery Controllers to provide redundant virtual desktop delivery, authenticate users, manage the assembly of the users' virtual desktop environments, and broker connections between users and their virtual desktops. For the solution, the controllers are installed on Windows Server 2012 and hosted as virtual machines on Hyper-V.</td>
</tr>
<tr>
<td>Citrix Provisioning Services (PVS) server</td>
<td>We used two Citrix PVS servers to provide redundant stream services to stream desktop images from vDisks, as needed, to target devices. For the solution, vDisks are stored on a CIFS share that is hosted by the VNXe storage system.</td>
</tr>
<tr>
<td>Virtual desktops</td>
<td>We used MCS and PVS to provision virtual desktops running Windows 8.1.</td>
</tr>
<tr>
<td>Microsoft Windows Server 2012 R2 with Hyper-V</td>
<td>This solution uses Microsoft Hyper-V to provide a common virtualization layer to host the server environment. We configured high availability in the virtualization layer with Hyper-V Server 2012 R2 features such as Live Migration, Storage Migration, and Failover Clustering.</td>
</tr>
<tr>
<td>Microsoft System Center Virtual Machine Manager</td>
<td>In the solution, all Hyper-V hosts and their virtual machines are managed through Microsoft System Center Virtual Machine Manager (VMM) 2012 R2.</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>Microsoft System Center VMM, XenDesktop controllers, and Citrix Provisioning Services require a database service to store configuration and monitoring details. We used Microsoft SQL Server 2012 SP1 running on Windows Server 2012 for this purpose.</td>
</tr>
<tr>
<td>Active Directory server</td>
<td>Active Directory services are required for the various solution components to function correctly. We used the Microsoft Active Directory Service running on a Windows Server 2012 server for this purpose.</td>
</tr>
<tr>
<td>DHCP server</td>
<td>The Dynamic Host Configuration Protocol (DHCP) server centrally manages the IP address scheme for the virtual desktops. This service is hosted on the same virtual machine as the domain controller and DNS server. The Microsoft DHCP Service running on a Windows Server 2012 server is used for this purpose.</td>
</tr>
<tr>
<td>DNS server</td>
<td>Domain Name System (DNS) services are required for the various solution components to perform name resolution. The Microsoft DNS service running on a Windows Server 2012 server is used for this purpose.</td>
</tr>
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<tr>
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<th>Solution configuration</th>
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<td>EMC SMI-S Provider</td>
<td>The solution uses the EMC SMI-S Provider for Microsoft System Center 2012 Virtual Machine Manager to provide storage management for the EMC arrays directly from the client. EMC SMI-S Provider helps provide a unified management interface.</td>
</tr>
<tr>
<td>IP/storage networks</td>
<td>A standard Ethernet network with redundant cabling and switching carries all network traffic. A shared network carries user and management traffic, while a private, non-routable subnet carries Server Message Block (SMB) storage traffic.</td>
</tr>
<tr>
<td>IP network</td>
<td>The Ethernet network infrastructure provides IP connectivity between virtual desktops, Hyper-V clusters, and VNXe storage. For the file (SMB) variant, the IP infrastructure enables Hyper-V servers to access CIFS shares on the VNXe and desktop streaming from PVS servers with high bandwidth and low latency. The IP infrastructure also enables desktop users to redirect their user profiles and home directories to the centrally maintained CIFS shares on the VNXe.</td>
</tr>
<tr>
<td>Fibre Channel (FC) network</td>
<td>For the block (FC) variant, an FC network carries storage traffic between all Hyper-V hosts and the VNXe storage system. The IP network carries all other traffic.</td>
</tr>
<tr>
<td>EMC VNXe3200 array</td>
<td>A VNXe3200 array provides storage by presenting CIFS/FC storage to Hyper-V hosts for up to 500 virtual desktops. This solution uses Cluster Shared Volumes (CSVs) for the block variant and Common Internet File System (CIFS) shares for the file variant.</td>
</tr>
<tr>
<td>EMC Avamar</td>
<td>Avamar software provides the platform for protecting virtual machines. The protection strategy uses persistent virtual desktops, image protection, and end-user recoveries.</td>
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## Key components

### Introduction

This section provides an overview of the key technologies used in this solution, as outlined in Table 4.

<table>
<thead>
<tr>
<th>Table 4. Key solution components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Component</strong></td>
</tr>
<tr>
<td>Desktop virtualization broker</td>
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<td>Virtualization layer</td>
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<td>Compute layer</td>
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<td>Backup and recovery</td>
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<td>Citrix ShareFile StorageZones solution</td>
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</tbody>
</table>
Desktop virtualization broker

Overview

Desktop virtualization encapsulates and hosts desktop services on centralized computing resources at remote data centers. This enables end users to connect to their virtual desktops from different types of devices across a network connection. Devices can include desktops, laptops, thin clients, zero clients, smartphones, and tablets.

In this solution, we used Citrix XenDesktop to provision, manage, broker, and monitor the desktop virtualization environment.

Citrix XenDesktop 7.1

XenDesktop is the desktop virtualization solution from Citrix that enables virtual desktops to run on the Hyper-V virtualization environment. Citrix XenDesktop 7.1 integrates Citrix XenApp application delivery technologies and XenDesktop desktop virtualization technologies into a single architecture and management experience. This new architecture unifies both management and delivery components to enable a scalable, simple, efficient, and manageable solution for delivering Windows applications and desktops as secure mobile services to users anywhere on any device.

Figure 4 shows the XenDesktop 7.1 architecture components.
The XenDesktop 7.1 architecture includes the following components:

- **Citrix Director**
  Director is a web-based tool that enables IT support and help-desk teams to monitor an environment, troubleshoot issues before they become system-critical, and perform support tasks for end users.

- **Citrix Receiver**
  Installed on user devices, Receiver provides users with quick, secure, self-service access to documents, applications, and desktops from any of the user’s devices including smartphones, tablets, and PCs. Receiver provides on-demand access to Windows, web, and software as a service (SaaS) applications.

- **Citrix StoreFront**
  StoreFront provides authentication and resource delivery services for Citrix Receiver. It enables centralized control of resources and provides users with on-demand, self-service access to their desktops and applications.

- **Citrix Studio**
  Studio is the management console that enables you to configure and manage your deployment. It eliminates the need for separate consoles for managing delivery of applications and desktops. Studio provides various wizards to guide you through the process of setting up your environment, creating your workloads to host applications and desktops, and assigning applications and desktops to users.

- **Delivery Controller**
  Installed on servers in the data center, Delivery Controller consists of services that communicate with the hypervisor to distribute applications and desktops, authenticate and manage user access, and broker connections between users and their virtual desktops and applications. Delivery Controller manages the state of the desktops, starting and stopping them based on demand and administrative configuration. In some editions, the controller enables you to install profile management to manage user personalization settings in virtualized or physical Windows environments.

- **Virtual Delivery Agent (VDA)**
  Installed on server or workstation operating systems, the VDA enables connections for desktops and applications. For remote PC access, install the VDA on the office PC.

- **Server OS machines**
  These are virtual machines or physical machines, based on the Windows Server operating system, used for delivering applications or hosted shared desktops (HSDs) to users.
Chapter 3: Solution Overview

- **Desktop OS machines**
  These are virtual machines or physical machines, based on the Windows Desktop operating system, used for delivering personalized desktops to users, or applications from desktop operating systems.

- **Remote PC Access**
  Remote PC Access enables users to access resources on their office PCs remotely, from any device running Citrix Receiver.

**Machine Creation Services**

Machine Creation Services (MCS) is a provisioning mechanism that is integrated with the XenDesktop management console, Citrix Studio, to provision, manage, and decommission desktops throughout the desktop lifecycle from a centralized point of management.

MCS enables several types of machines to be managed within a catalog in Citrix Studio. Desktop customization is persistent for machines that use the Personal vDisk (PvDisk or PvD) feature, while non-PvD machines are appropriate if desktop changes are to be discarded when the user logs off.

Desktops provisioned using MCS share a common base image within a catalog. Because of this, the base image typically is accessed with sufficient frequency to use FAST Cache, which promotes frequently accessed data to flash drives to provide optimal I/O response time with fewer physical disks.

**Citrix Provisioning Services**

Citrix Provisioning Services (PVS) takes a different approach from traditional desktop imaging solutions by fundamentally changing the relationship between hardware and the software that runs on it. By streaming a single shared disk image (vDisk) instead of copying images to individual machines, PVS enables organizations to reduce the number of disk images that they manage. As the number of machines continues to grow, PVS provides the efficiency of centralized management with the benefits of distributed processing.

Because machines stream disk data dynamically in real time from a single shared image, machine image consistency is ensured. In addition, large pools of machines can completely change their configuration, applications, and even OS during a reboot operation.

In this solution, PVS provisions 500 virtual desktops that are running Windows 8.1. The desktops are deployed from a single vDisk.

**Citrix Personal vDisk**

The Citrix PvD feature enables users to preserve customization settings and user-installed applications in a pooled desktop by redirecting the changes from the user’s pooled virtual machine to a separate PvD. During runtime, the content of the Personal vDisk is blended with the content from the base virtual machine to provide a unified experience to the end user. The PvD data is preserved during reboot and refresh operations.
Citrix Profile Management

Citrix Profile Management preserves user profiles and dynamically synchronizes them with a remote profile repository. Profile Management downloads a user’s remote profile dynamically when the user logs in to XenDesktop, and applies personal settings to desktops and applications regardless of the user’s login location or client device.

The combination of Profile Management and pooled desktops provides the experience of a dedicated desktop while potentially minimizing the amount of storage required in an organization.

Virtualization layer

Microsoft Windows Server 2012 R2 with Hyper-V

Microsoft Windows Server 2012 R2 with Hyper-V provides a complete virtualization platform that provides flexibility and cost savings by enabling the consolidation of large, inefficient server farms into nimble, reliable cloud infrastructures. The core Microsoft virtualization components are the Microsoft Hyper-V hypervisor and the Microsoft System Center Virtual Machine Manager for system management.

The Hyper-V hypervisor transforms a computer’s physical resources by virtualizing the CPU, memory, storage, and network. This transformation creates fully functional virtual machines that run isolated and encapsulated operating systems and applications just like physical computers.

Hyper-V runs on a dedicated server and enables simultaneous execution of multiple operating systems as virtual machines. Microsoft clustered services enables multiple Hyper-V servers to operate in a clustered configuration. The Hyper-V cluster configuration is managed as a larger resource pool through the Microsoft System Center Virtual Machine Manager. This enables dynamic allocation of CPU, memory, and storage across the cluster.

Microsoft System Center Virtual Machine Manager

Microsoft System Center Virtual Machine Manager is a scalable, extensible, centralized management platform for the Hyper-V infrastructure. It provides administrators with a single interface that they can access from multiple devices for all aspects of monitoring, managing, and maintaining the virtual infrastructure.

Microsoft Hyper-V high availability

High-availability features of Microsoft Hyper-V 2012 R2, such as Failover Clustering, Live Migration, and Storage Migration, enable seamless migration of virtual machines and stored files from one Hyper-V server to another with minimal or no performance impact.

- **Failover Clustering** enables the virtualization layer to automatically restart virtual machines in various failure conditions. If the physical hardware has an error, the impacted virtual machines can be restarted automatically on other servers in the cluster. You can configure policies to determine which machines are restarted automatically and under what conditions restart operations are performed.

**Note:** For Hyper-V Failover Clustering to restart virtual machines on different hardware, those servers must have resources available. Server design considerations provides specific recommendations to enable this functionality.
Chapter 3: Solution Overview

- **Live Migration** provides live migration of virtual machines within clustered and non-clustered servers with no virtual machine downtime or service disruption.

- **Storage Migration** provides live migration of virtual machine disk files within and across storage arrays with no virtual machine downtime or service disruption

**Compute layer**

VSPEX defines the minimum amount of compute layer resources required, but allows the customer to select any server hardware that meets the requirements. For details, refer to Chapter 5: Solution Design Considerations and Best Practices.

**Network layer**

VSPEX defines the minimum number of network ports required for the solution and provides general guidance on network architecture, but allows the customer to select any network hardware that meets the requirements. For details, refer to Chapter 5: Solution Design Considerations and Best Practices.

**Storage layer**

The storage layer is a key component of any cloud infrastructure solution that serves data generated in a data center storage processing system. This VSPEX solution uses EMC VNXe3200 storage to provide virtualization at the storage layer. This increases storage efficiency and management flexibility, and reduces total cost of ownership.

**EMC VNXe3200**

**Features and enhancements**

EMC VNXe3200 is a flash-optimized unified storage platform that delivers innovation and enterprise capabilities for file and block storage in a single, scalable, and easy-to-use solution. Ideal for mixed workloads in physical or virtual environments, VNXe3200 combines powerful and flexible hardware with advanced efficiency, management, and protection software to meet the demanding needs of virtualized application environments.

VNXe3200 includes many features and enhancements designed and built upon the success of the midrange EMC VNX® family. These features and enhancements include:

- Greater efficiency with a flash-optimized hybrid array
- More capacity with multicore optimization with EMC MCx™ technology, which includes Multicore Cache, Multicore RAID, and Multicore FAST Cache
- Easier administration and deployment with VNXe Base Software components including Monitoring and Reporting and Unified Snapshots
- VMware and Microsoft ecosystem integration
- Unified multiprotocol support for FC, iSCSI, NFS, and CIFS
VSPEX is built with the next generation of VNXe to deliver greater efficiency, performance, and scale than ever before.

**Flash-optimized hybrid array**

VNXe3200 is a flash-optimized hybrid array that provides automated tiering to deliver the best performance for critical data, while intelligently moving less frequently accessed data to lower-cost disks.

In this hybrid approach, a small percentage of flash drives in the overall system can provide a high percentage of the overall I/O operations per second (IOPS). VNXe3200 takes full advantage of the low latency of flash to deliver cost-saving optimization and high performance scalability. EMC Fully Automated Storage Tiering Suite, which includes FAST™ Cache and FAST for Virtual Pools (FAST VP), tiers both block and file data across heterogeneous drives and boosts the most active data to the flash drives, ensuring that customers never have to make concessions for cost or performance.

Data generally is accessed most frequently at the time it is created; therefore, new data is first stored on flash drives to provide the best performance. As the data ages and becomes less active over time, FAST VP can automatically tier the data from high-performance to high-capacity drives, based on customer-defined policies. This functionality has been enhanced with four times better granularity and with new FAST VP solid-state disks (SSDs) based on enterprise multilevel cell (eMLC) technology to lower the cost per gigabyte. FAST Cache dynamically absorbs unpredicted spikes in system workloads. FAST Cache can provide immediate performance enhancement by promoting suddenly active data from slower high-capacity drives to speedier flash drives.

**MCx code path optimization**

The advent of flash technology has been a catalyst in making significant changes in the requirements of midrange storage systems. EMC redesigned the VNXe storage platform to efficiently optimize multicore CPUs to provide the most efficient storage system at the lowest cost in the market.

EMC MCx technology distributes all VNXe data services across all cores, as shown in Figure 5, and can dramatically improve the file performance for transactional applications like databases or virtual machines over network-attached storage (NAS).

VNXe includes the first use of the Intel Non-Transparent Bridge (NTB) in an EMC storage array. NTB enables direct high-speed connectivity between storage processors via a PCI Express (PCIe) interface. This eliminates external PCIe switches, saves power and space, and reduces latency and cost.
Chapter 3: Solution Overview

VNXe Base Software

The enhanced VNXe Base Software extends the EMC Unisphere easy-to-use interface to include VNXe Monitoring and Reporting for validating performance and anticipating capacity requirements. The suite also includes Unisphere Central for centrally managing thousands of VNX and VNXe systems.

Virtualization and ecosystem management

Microsoft Hyper-V Offloaded Data Transfer

The Offloaded Data Transfer (ODX) feature of Microsoft Windows Server 2012 R2 enables data transfers during copy operations to be offloaded to the storage array, freeing up host cycles. For example, using ODX for a live migration of a Microsoft SQL Server virtual machine doubled performance, decreased migration time by 50 percent, reduced CPU on the Hyper-V server by 20 percent, and eliminated network traffic.

EMC Storage Integrator for Windows

EMC Storage Integrator (ESI) for Windows is a management interface that provides the ability to view, provision, and manage block and file storage for Windows environments. ESI simplifies the steps for creating and provisioning storage to Hyper-V servers as a local disk or a mapped share. ESI also supports storage discovery and provisioning through Windows PowerShell.

The ESI for Windows documentation, available on EMC Online Support, provide more information.
Backup and recovery layer

Backup and recovery operations provide data protection by backing up data files or volumes according to defined schedules and restoring data from the backup if recovery is required after a disaster. EMC Avamar delivers the protection in this VSPEX end-user computing solution.

Avamar empowers administrators to centrally back up and manage policies and end-user computing infrastructure components, while allowing end users to efficiently recover their own files from a simple and intuitive web-based interface. By moving only new, unique subfile data segments, Avamar delivers fast daily full backups, with up to 90 percent reduction in backup times. Avamar can also reduce the required daily network bandwidth by up to 99 percent and the required backup storage by 10 to 30 times. All recoveries are single-step for simplicity.

With Avamar, you can choose to back up virtual desktops using either image-level or guest-based operations. Avamar runs the deduplication engine at the Hyper-V virtual hard disk (VHDX) level for image backup and at the file level for guest-based backups. This includes everything you need to ensure complete recovery, including protection of Virtual Hard Disks (VHDs) as well as the operating system components, such as system state, data volumes, and the Hyper-V configuration database. Avamar uses the Hyper-V VSS Writer to deliver disaster recovery for Hyper-V servers, capturing VHD files that make up the Hyper-V guests. Some of the benefits are:

- Image-level protection enables backup clients to make a copy of all the virtual disks and configuration files associated with the particular virtual desktop in the event of hardware failure, corruption, or accidental deletion.

- Guest-based protection runs like traditional backup solutions. You can use it on any virtual machine that runs an OS for which an Avamar backup client is available. Guest-based backup enables fine-grained control over the content and over inclusion and exclusion patterns for application-consistent protection. This enables you to prevent data loss resulting from user errors, such as accidental file deletion. Installing the desktop/laptop agent on the system to be protected enables end-user, self-service recovery of data.

- Scheduled virtual machine backups from the CSV cluster enable Avamar to provide full failover protection for virtual machines running in a shared volume. Avamar protects virtual machines without interruption as they migrate from one Hyper-V server to another using Live Migration. Support for Hyper-V over CSV proxy node backup optimizes backups by enabling administrators to select a physical proxy server within the CSV environment to manage all backups for the Federated Cluster, eliminating backup processing overhead for production servers. In addition, Avamar supports Hyper-V 2012, which eliminates slow I/O write performance caused by redirection of all server I/O in the CSV to the server being backed up.

We tested this solution with guest-based backups.
Citrix ShareFile StorageZones solution

Citrix ShareFile is a cloud-based file sharing and storage service for enterprise-class storage and security. It enables users to securely share documents with other users. ShareFile users include employees and users who are outside of the enterprise directory (referred to as clients).

ShareFile StorageZones enables businesses to share files across the organization while meeting compliance and regulatory concerns. StorageZones enables customers to keep their data on storage systems that are onsite. It facilitates sharing of large files with full encryption and provides the ability to synchronize files with multiple devices.

By keeping data onsite and closer to users than data residing on the public cloud, StorageZones can provide improved performance and security.

The features and benefits available to ShareFile StorageZones users include:

- Ability to use StorageZones with or instead of ShareFile-managed cloud storage.
- Ability to configure Citrix CloudGateway Enterprise to integrate ShareFile services with Citrix Receiver for user authentication and user provisioning.
- Automated reconciliation between the ShareFile cloud and an organization’s StorageZones deployment.
- Automated antivirus scans of uploaded files.
- File recovery from backup of Storage Center (the server component of StorageZones). StorageZones enables you to browse the file records for a particular date and time and tag any files and folders to be restored from Storage Center backup.

With some added infrastructure, the VSPEX end-user computing solution for Citrix XenDesktop supports ShareFile StorageZones with Storage Center.
This chapter presents the following topics:

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- Reference workload .......................................... 34
- Sizing infrastructure virtual servers with VSPEX private cloud .................. 35
- VSPEX storage building blocks .......................... 36
- VSPEX end-user computing validated maximums .......................... 37
- Choosing the appropriate reference architecture ................... 41
Chapter 4: Sizing the Solution

Overview

This chapter describes how to design a VSPEX end-user computing solution for Citrix XenDesktop and how to size it to fit the customer's needs. It introduces the concepts of a reference workload, building blocks, and validated end-user computing maximums and describes their characteristics. It then describes how to choose the appropriate reference architecture for the customer environment by using the Customer Sizing Worksheet. Table 5 outlines the high-level steps you need to complete when sizing the solution.

Table 5. VSPEX end-user computing: Design process

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use the Customer Sizing Worksheet in Appendix A to collect the customer requirements for the end-user computing environment.</td>
</tr>
</tbody>
</table>
| 2    | Use the EMC VSPEX Sizing Tool to determine the recommended VSPEX reference architecture for your end-user computing solution, based on the customer requirements collected in Step 1.  
Note: If the Sizing Tool is not available, you can manually size the end-user computing solution using the guidelines in this chapter. |

Reference workload

VSPEX defines a reference workload to represent a unit of measure for quantifying the resources in the solution reference architectures. By comparing the customer's actual usage to this reference workload, you can extrapolate which reference architecture to choose as the basis for the customer's VSPEX deployment.

For VSPEX end-user computing solutions, the reference workload is defined as a single virtual desktop—the reference virtual desktop—that you can deploy using a desktop OS (also known as a VDI desktop) or server OS (also known as an HSD). For a desktop OS, each user accesses a dedicated virtual machine that is allocated one vCPU and 2 GB of RAM. For a server OS, each virtual machine is allocated six vCPUs and 12 GB of RAM, and is shared among 20 virtual desktop sessions.

Table 6 details the workload characteristics of the reference virtual desktop. The equivalent number of reference virtual desktops for a particular resource requirement is determined by translating the resource requirement to the number of reference virtual desktops needed to meet that requirement.
Table 6. Workload characteristics of the reference virtual desktop

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
</table>
<pre><code>              | - Server OS (HSD): Windows Server 2012 R2                             |
</code></pre>
| Virtual processors per virtual desktop             | - Desktop OS (VDI desktop): 1 vCPU                                   
                  | - Server OS (HSD): 0.3 vCPU                                           |
| RAM per virtual desktop                            | - Desktop OS (VDI desktop): 2 GB                                     
                  | - Server OS (HSD): 0.6 GB                                            |
| Average IOPS per virtual desktop at steady state   | 8                                                                    |

This desktop definition is based on user data that resides on shared storage. The I/O profile is defined by using a test framework that runs all desktops concurrently, with a steady load generated by the constant use of office-based applications such as browsers and office productivity software.

Sizing infrastructure virtual servers with VSPEX private cloud

This solution has infrastructure virtual servers layered on VSPEX Private Cloud with Microsoft Hyper-V Proven Infrastructure, including Active Directory, System Center Virtual Machine Manager, SQL Server, XenDesktop Delivery Controllers, and PVS servers. End user can also use existing infrastructure resources if any of these components already exist in the data center. Table 7 shows resource requirement of the infrastructure validated for this solution.

Table 7. Infrastructure virtual server resource requirement

<table>
<thead>
<tr>
<th>Server</th>
<th>Quantity</th>
<th>CPU</th>
<th>Memory (GB)</th>
<th>Capacity (GB)</th>
<th>IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain Controller (Active Directory/DNS/DHCP)</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>SQL Server</td>
<td>1</td>
<td>4</td>
<td>12</td>
<td>225</td>
<td>50</td>
</tr>
<tr>
<td>System Center Virtual Machine Manager</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>XenDesktop Controller</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>PVS server</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

The *EMC VSPEX Private Cloud: Microsoft Windows Server 2012 R2 with Hyper-V for up to 1,000 Virtual Machines Proven Infrastructure Guide* and *EMC VSPEX Private Cloud: Microsoft Windows Server 2012 R2 with Hyper-V for up to 125 Virtual Machines Proven Infrastructure Guide* provide server and storage resource configuration details.
Sizing the storage system to meet virtual server IOPS is a complicated process. When an I/O reaches the storage array, several components serve that I/O—for example, the SPs, back-end dynamic random access memory (DRAM) cache, FAST Cache (if used), and disks. Customers must consider various factors when planning and scaling their storage system to balance capacity, performance, and cost for their applications.

VSPEX uses a building block approach to reduce complexity. A building block is a set of disk spindles that can support a specific number of virtual desktops in the VSPEX architecture. Each building block combines several disk spindles to create a storage pool that supports the needs of the end-user computing environment.

Two building blocks are currently validated on the VNXe3200 and provide a flexible solution for VSPEX sizing:

- **Building block for 125 virtual desktops with PVS provisioning**
  The smallest building block validated with PVS provisioning can contain up to 125 virtual desktops with 4 SAS drives in a storage pool enabled with FAST Cache. Figure 6 shows the storage layout.

- **Building block for 125 virtual desktops with MCS provisioning**
  The smallest building block validated with MCS provisioning can contain up to 125 virtual desktops with 5 SAS drives in a FAST Cache enabled storage pool. Figure 7 shows the storage layout.
Expanding existing VSPEX end-user computing environments

The EMC VSPEX end-user computing solution supports a flexible implementation model where it is easy to expand your environment as the needs of the business change.

You can combine the reference architecture configurations presented in the solution to form larger implementations. For example, you can build the 500-desktop configuration by starting with that configuration, or by starting with the 125-desktop configuration and expanding it when needed.

Table 8 lists the disks required to support the reference architectures for the four points of scale, excluding hot spare needs.

Table 8. Number of disks required for different numbers of virtual desktops

<table>
<thead>
<tr>
<th>Virtual desktops (Users)</th>
<th>Flash drives</th>
<th>PVS</th>
<th>SAS drives</th>
<th>MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAST Cache</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-PvD</td>
<td>Pvd (Desktop/PvD)</td>
<td>HSD</td>
<td>Non-PvD</td>
</tr>
<tr>
<td>125</td>
<td>2</td>
<td>4</td>
<td>10 (4/6)</td>
<td>4</td>
</tr>
<tr>
<td>250</td>
<td>2</td>
<td>8</td>
<td>10 (4/6)</td>
<td>4</td>
</tr>
<tr>
<td>375</td>
<td>2</td>
<td>12</td>
<td>20 (8/12)</td>
<td>8</td>
</tr>
<tr>
<td>500</td>
<td>2</td>
<td>16</td>
<td>20 (8/12)</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: If you start your configuration with a 125-desktop building block for MCS, you can expand it to 250 desktops by adding five matching SAS drives and enabling the pool to restripe. For details about pool expansion and restriping, refer to the *EMC VNX Virtual Provisioning Applied Technology White Paper.*

VSPEX end-user computing validated maximums

We validated the VSPEX end-user computing configurations on the VNXe3200 platform. As detailed in Table 8, the recommended maximum for VNXe3200 is 500 desktops.

The validated disk layouts are designed to provide support for a specified number of virtual desktops at a defined performance level. You can modify a validated storage layout by adding drives for greater capacity and performance and adding features such as FAST Cache for desktops and FAST VP for improved user data performance. However, decreasing the number of recommended drives or stepping down an array type can result in lower IOPS per desktop and a less satisfactory user experience because of higher response times.
Chapter 4: Sizing the Solution

Core storage layout with PVS provisioning

Figure 8 shows the layout of the disks that are required to store 500 virtual desktops with PVS provisioning. This layout can be used with random, static, Pvd, and HSD provisioning options. This layout does not include space for user profile data.

Figure 8. Core storage layout with PVS provisioning for 500 virtual desktops

The solution uses the following core configuration with PVS provisioning:

- Five SAS disks for the VNXe Operating Environment (OE) and PVS vDisk.
- Sixteen SAS disks in the RAID 10 storage pool 1 to store virtual desktop write cache. We enabled FAST Cache for the entire pool.
  - For file protocol, we provisioned four thin file systems (each for 125 desktops) from the pool to present to the Hyper-V servers as CIFS shares.
  - For block protocol, we provisioned four thin LUNs (each for 125 desktops) from the pool to present to the Hyper-V servers as CSVs.

Note: If Pvd is implemented, half the drives (eight SAS disks for 500 desktops) are sufficient to satisfy the performance requirement. However, the desktop capacity will be reduced by 50 percent. If your environment capacity requirement is met, implement Pvd with MCS provisioning with eight SAS drives for 500 desktops.

- Two SSD drives for FAST Cache. There are no user-configurable LUNs on these drives.
- One SAS disk and one SSD drive for use as hot spares.

Note: The disk layout presented in Figure 8 is for demonstration and might be different in production because VNXe automates disk spreading for best performance. You can substitute larger drives to provide more capacity. To satisfy the load recommendations, the drives must all be 10k rpm and the same size. If you use different sizes, storage layout algorithms might give sub-optimal results.
Core storage layout with MCS provisioning

Figure 9 shows the layout of the disks that are required to store 500 virtual desktops with MCS provisioning. This layout can be used with random, static, PvD, and HSD provisioning options. This layout does not include space for user profile data.

The solution uses the following core configuration with MCS provisioning:

- Four SAS disks for the VNXe OE.
- Twenty SAS disks in the RAID 5 storage pool 1 to store virtual desktops. We enabled FAST Cache for the entire pool.
  - For file protocol, we provisioned four thin file systems (each for 125 desktops) from the pool to present to the Hyper-V servers as CIFS share.
  - For block protocol, we provisioned four thin LUNs (each for 125 desktops) from the pool to present to the Hyper-V servers as CSVs.
- Two SSD drives for FAST Cache. There are no user-configurable LUNs on these drives.
- One SAS disk and one SSD drive for use as hot spares. These disks are labeled “HS” in Figure 9.

**Note:** If PvD is implemented, half the drives (ten SAS disks for 500 desktops) are sufficient to satisfy the performance requirement. However, the desktop capacity will be reduced by 50 percent. If your environment capacity requirement is met, implement PvD with MCS provisioning with ten SAS drives for 500 desktops.

- Two SSD drives for FAST Cache. There are no user-configurable LUNs on these drives.
- One SAS disk and one SSD drive for use as hot spares. These disks are labeled “HS” in Figure 9.

**Note:** The disk layout presented in Figure 10 is for demonstration and might be different in production because VNXe automates disk spreading for best performance. You can substitute larger drives to provide more capacity. To satisfy the load recommendations, the drives must all be 10k rpm and the same size. If you use different sizes, storage layout algorithms might give sub-optimal results.
Optional user data storage layout

In solution validation testing, we allocated storage space for user data on the VNXe array as shown in Figure 10. This storage is in addition to the core storage shown in Figure 8 and Figure 9 and is used to store the infrastructure servers, user profiles and home directories, and Personal vDisks. If storage for these items exists elsewhere in the production environment, this additional storage is not required.

The solution uses the following optional storage configuration:

- One SAS disk for use as a hot spare, labeled “HS” in Figure 10.
- Ten SAS disks in the RAID 5 storage pool 3 to store user data and roaming profiles. Two CIFS file systems are created from this pool where one file system is used to store user data and the other file system is used to store user profile data.

If multiple drive types have been implemented, you can enable FAST VP to automatically tier data to exploit differences in performance and capacity. FAST VP is applied at the block storage pool level and automatically adjusts where data is stored based on how frequently the data is accessed. Frequently accessed data is promoted to higher tiers of storage in 256 MB increments while infrequently accessed data can be migrated to a lower tier for cost efficiency.

This rebalancing of 256 MB data units, or slices, occurs as part of a regularly scheduled maintenance operation. EMC does not recommend FAST VP for virtual desktop storage, but FAST VP can provide performance improvements when implemented for user data and roaming profiles.

- Twelve SAS disks in the RAID 10 storage pool 4 to store the PvD. FAST Cache is enabled for the entire pool.
  - For file protocol, four file systems (one for 125 desktops) are provisioned from the pool to be presented to the Hyper-V servers as CIFS shares.
  - For block protocol, four LUNs (one for 125 desktops) are provisioned from the pool to be presented to the Hyper-V servers as CSVs.
Choosing the appropriate reference architecture

To choose the appropriate reference architecture for a customer environment, you need to determine the resource requirements of the environment and then translate these requirements to an equivalent number of reference virtual desktops that have the characteristics defined in Table 6 on page 35. This section describes how to use the Customer Sizing Worksheet to simplify the sizing calculations. It also describes additional factors you should take into consideration when deciding which reference architecture to deploy.

Using the Customer Sizing Worksheet

The Customer Sizing Worksheet helps you to assess the customer environment and calculate the sizing requirements of the environment.

Table 9 shows a completed worksheet for a sample customer environment. Appendix A provides a blank Customer Sizing Worksheet that you can print out and use to help size the solution for a customer.

Table 9. Sample Customer Sizing Worksheet

<table>
<thead>
<tr>
<th>User type</th>
<th>CPUs</th>
<th>Memory (GB)</th>
<th>IOPS</th>
<th>Equivalent reference virtual desktops</th>
<th>No. of users</th>
<th>Total reference virtual desktops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy users</td>
<td>2</td>
<td>4</td>
<td>12</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Equivalent</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>desktops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>users</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>desktops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>users</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>desktops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>450</td>
</tr>
</tbody>
</table>

To complete the Customer Sizing Worksheet, follow these steps:

1. Identify the user types planned for migration into the VSPEX end-user computing environment and the number of users of each type.
2. For each user type, determine the compute resource requirements in terms of vCPUs, memory (GB), storage performance (IOPS), and storage capacity.
3. For each resource type and user type, determine the equivalent reference virtual desktops requirements—that is, the number of reference virtual desktops required to meet the specified resource requirements.
4. Determine the total number of reference desktops needed from the resource pool for the customer environment.
Determining the resource requirements

**CPU**
The reference virtual desktop outlined in Table 6 on page 35 assumes that most desktop applications are optimized for a single CPU in a desktop OS deployment. If one type of user requires a desktop with multiple virtual CPUs, modify the proposed virtual desktop count to account for the additional resources. For example, if you virtualize 100 desktops, but 20 users require two CPUs instead of one, your pool needs to provide 120 virtual desktops of capability.

**Memory**
Memory plays a key role in ensuring application functionality and performance. Each group of desktops will have different targets for the available memory that is considered acceptable. As with the CPU calculation, if a group of users requires additional memory resources, adjust the number of planned desktops to accommodate the additional resource requirements.

For example, if 200 desktops are to be virtualized using desktop OS, but each one needs 4 GB of memory instead of the 2 GB that the reference virtual desktop provides, plan for 400 reference virtual desktops.

**IOPS**
The storage performance requirements for desktops are usually the least understood aspect of performance. The reference virtual desktop uses a workload generated by an industry-recognized tool to execute a wide variety of office productivity applications that should be representative of the majority of virtual desktop implementations.

**Storage capacity**
The storage capacity requirement for a desktop can vary widely depending on the types of applications in use and specific customer policies. The virtual desktops in this solution rely on additional shared storage for user profile data and user documents. This requirement is an optional component that can be met by the addition of specific storage hardware defined in the solution. It can also be met by using existing file shares in the environment.

**Determining the equivalent number of reference virtual desktops**
With all of the resources defined, you determine the number of equivalent reference virtual desktops by using the relationships indicated in Table 10. Round all values up to the closest whole number.
For example, the heavy user type in Table 9 requires two virtual CPUs, 12 IOPS, and 4 GB of memory for each desktop in a desktop OS environment. This translates to two reference virtual desktops of CPU, two reference virtual desktops of memory, and two reference virtual desktops of IOPS, based on the reference virtual desktop characteristics in Table 6.

The number of reference virtual desktops required for each user type then equals the maximum required for an individual resource. For example, the number of equivalent reference virtual desktops for the heavy user type in Table 9 is two, as this number will meet all the resource requirements—IOPS, vCPU, and memory.

To calculate the total number of reference virtual desktops for a user type, multiply the number of equivalent reference virtual desktops for that user type by the number of users.

**Determining the total number of reference virtual desktops**

Complete a worksheet for each user type that the customer wants to migrate into the virtual infrastructure. Next compute the total number of reference virtual desktops required in the resource pool by calculating the sum of the total reference virtual desktops for all user types. In the example in Table 9 on page 38, the total is 450 virtual desktops.
Selecting a reference architecture

The total reference virtual desktops value from the completed worksheet indicates which reference architecture would be adequate for the customer requirements. In the example in Table 9, the customer requires 450 virtual desktops of capability from the pool. Therefore, the 500 virtual desktop resource pool provides sufficient resources for current needs with room for growth.

However, you might need to consider other factors when deciding which reference architecture to deploy. For example:

- **Concurrency**
  The reference workload used to validate this solution (Table 6 on page 35) assumes that all desktop users will be active at all times. In other words, we tested the 500-desktop reference architecture with 500 desktops, all generating workload in parallel, all started at the same time, and so on. If the customer expects to have 800 users, but only 50 percent of them will be logged on at any given time because of time zone differences or alternate shifts, the 400 active users out of the total 800 users can be supported by the 500-desktop architecture.

- **Heavier desktop workloads**
  The reference workload is considered a typical office worker load. However, some customers might have users with a more active profile.

  If a company has 300 users and, because of custom corporate applications, each user generates 12 IOPS as compared to the 8 IOPS used in the reference workload, this customer will need 3,600 IOPS (300 users x 12 IOPS per desktop). The 375-desktop configuration formed by three building blocks would be underpowered in this case because it has been rated to 3,000 IOPS (375 desktops x 8 IOPS per desktop). This customer should consider moving up to the 500-desktop solution with four building blocks.

Fine tuning hardware resources

In most cases, the Customer Sizing Worksheet will suggest a reference architecture adequate for the customer’s needs. However, in some cases you might want to further customize the hardware resources available to the system. A complete description of system architecture is beyond the scope of this document but you can customize your solution further at this point.

Storage resources

In some applications, separating some storage workloads from other workloads is required. The storage layouts for the reference architectures put all the virtual desktops in a single resource pool. To achieve workload separation, deploy additional disk drives for each group that needs workload isolation and add them to a dedicated pool.

It is not appropriate to reduce the size of the main storage resource pool to support isolation, or to reduce the capability of the pool, without additional guidance beyond this Design Guide. We designed the storage layouts for the solution to balance many different factors, including high availability, performance, and data protection. Changing the components of the pool can have significant and difficult-to-predict impacts on other areas of the system.
Server resources

This solution enables you to further customize server hardware resources. To do this, first total the resource requirements for the server components as shown in Table 11. Note the addition of the Total CPU resources and Total memory resources columns to the worksheet.

Table 11. Server resource component totals

<table>
<thead>
<tr>
<th>User types</th>
<th>vCPUs</th>
<th>Memory (GB)</th>
<th>Number of users</th>
<th>Total CPU resources</th>
<th>Total memory resources (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy users</td>
<td>Resource requirements</td>
<td>2</td>
<td>4</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Moderate users</td>
<td>Resource requirements</td>
<td>1</td>
<td>4</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Typical users</td>
<td>Resource requirements</td>
<td>1</td>
<td>2</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>350</td>
<td>900</td>
</tr>
</tbody>
</table>

The example in Table 11 requires 350 vCPUs and 900 GB of memory. As the reference architectures assume five desktops per physical processor core in a desktop OS environment, and no memory over-provisioning, this translates to 44 physical processor cores and 900 GB of memory. In contrast, the 500 virtual desktop resource pool used in the solution calls for 1,000 GB of memory and at least 63 physical processor cores. This means that you can effectively implement the solution with fewer server resources.

**Note:** Keep high availability requirements in mind when customizing the resource pool hardware.

Summary

The requirements outlined in the solution are what EMC considers the minimum set of resources to handle the workloads based on the stated definition of a reference virtual desktop. In any customer implementation, the load of a system will vary over time as users interact with the system. If the customer virtual desktops differ significantly from the reference definition and vary in the same resource group, you might need to add more of that resource to the system.
Chapter 4: Sizing the Solution
This chapter presents the following topics:

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VSPEX for Citrix XenDesktop with ShareFile StorageZones solution ...........................................68
Overview

This chapter describes best practices and considerations for designing the VSPEX end-user computing solution for Citrix XenDesktop. For more information on deployment best practices of various components of the solution, refer to the vendor-specific documentation.

Server design considerations

VSPEX solutions are designed to run on a wide variety of server platforms. VSPEX defines the minimum CPU and memory resources required, but not a specific server type or configuration. The customer can use any server platform and configuration that meets or exceeds the minimum requirements.

For example, Figure 11 shows how a customer can implement the same server requirements by using either white-box servers or high-end servers. Both implementations achieve the required number of processor cores and amount of RAM but the number and type of servers differ.

![Figure 11. Compute layer flexibility](image)

Figure 11. Compute layer flexibility
The choice of a server platform is not only based on the technical requirements of the environment, but also on the supportability of the platform, existing relationships with the server provider, advanced performance and management features, and many other factors. For example:

- From a virtualization perspective, if a system’s workload is well understood, features like Dynamic Memory can reduce the aggregate memory requirement.
- If the virtual machine pool does not have a high level of peak or concurrent usage, you can reduce the number of vCPUs. Conversely, if the applications being deployed are highly computational in nature, you might need to increase the number of CPUs and amount of memory.

The key constraints are that there must be:

- Sufficient CPU cores and memory to support the required number and types of virtual machines
- Sufficient network connections to enable redundant connectivity to the system switches
- Sufficient excess capacity to enable the environment to withstand a server failure and failover

For this solution, EMC recommends that you consider the following best practices for the server layer:

- **Use identical server units**
  
  Use identical or at least compatible servers. VSPEX implements hypervisor level high-availability technologies that might require similar instruction sets on the underlying physical hardware. By implementing VSPEX on identical server units, you can minimize compatibility problems in this area.

- **Use recent processor technologies**
  
  For new deployments, use recent versions of common processor technologies. It is assumed that these will perform as well as, or better than, the systems used to validate the solution.

- **Implement high availability to accommodate single server failures**
  
  Implement the high-availability features available in the virtualization layer to ensure that the compute layer has sufficient resources to accommodate at least single server failures. This will also enable you to implement minimal-downtime upgrades. [High availability and failover](#) provides further details.

**Note:** When implementing hypervisor layer high availability, the largest virtual machine you can create is constrained by the smallest physical server in the environment.
Monitor resource utilization and modify resources as needed

While the system is running, monitor the utilization of resources and modify resources as needed.

For example, the reference virtual desktop and required hardware resources in this solution assume that there are no more than five virtual CPUs for each physical processor core (5:1 ratio) in desktop OS environments. In server OS environments, it is assumed that there is no oversubscription of CPU cores—that is, the six virtual CPUs configured for the virtual machines that support the 20 hosted virtual desktops are assumed to correspond to six physical processor cores (1:1 ratio). In most cases, this provides an appropriate level of resources for the hosted virtual desktops; however, this ratio might not be appropriate in all cases. EMC recommends monitoring CPU utilization at the hypervisor layer to determine if more resources are required and then adding as needed.

Table 12 identifies the server hardware and the configurations validated in this solution.

### Table 12. Server hardware for 500 desktops

<table>
<thead>
<tr>
<th>Servers for virtual desktops</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td></td>
</tr>
<tr>
<td>Desktop OS: 100 cores (1 vCPU per desktop, 5 desktops per core)</td>
<td></td>
</tr>
<tr>
<td>Server OS: 150 cores (0.3 vCPU per desktop, 3.3 desktops per core)</td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td></td>
</tr>
<tr>
<td>2 GB RAM reservation per Hyper-V host</td>
<td></td>
</tr>
<tr>
<td>Desktop OS: 1 TB RAM (2 GB RAM per desktop)</td>
<td></td>
</tr>
<tr>
<td>Server OS: 300 GB RAM (0.6 GB RAM per desktop)</td>
<td></td>
</tr>
<tr>
<td>Network</td>
<td>2 x 10 GbE NICs per server</td>
</tr>
</tbody>
</table>

**Notes:**

- The 5:1 vCPU to physical core ratio applies to the reference workload defined in this Design Guide. When deploying EMC Avamar, add CPU and RAM as needed for components that are CPU or RAM intensive. Refer to the relevant product documentation for information on Avamar resource requirements.

- Whatever the number of servers you deploy to meet the minimum requirements in Table 12, add one more server to support Hyper-V high availability. This server should have sufficient capacity to provide a failover platform in the event of a hardware outage.

Microsoft Hyper-V memory virtualization

Microsoft Hyper-V has several advanced features that help optimize performance and overall use of resources. This section describes the key features for memory management and considerations for using them with your VSPEX solution.

Figure 12 illustrates how a single hypervisor consumes memory from a pool of resources. Hyper-V memory management features such as Dynamic Memory and
Smart Paging can reduce total memory usage and increase consolidation ratios in the hypervisor.

<table>
<thead>
<tr>
<th>Type 4 desktop users</th>
<th>8 GB per user x 1 user</th>
<th>8 GB consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 3 desktop users</td>
<td>5 GB per user x 2 users</td>
<td>10 GB consumed</td>
</tr>
<tr>
<td>Type 2 desktop users</td>
<td>3 GB per user x 9 users</td>
<td>27 GB consumed</td>
</tr>
<tr>
<td>Type 1 desktop users</td>
<td>2 GB per user x 4 users</td>
<td>8 GB consumed</td>
</tr>
<tr>
<td>Hypervisor (2 GB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total server memory</td>
<td>64 GB</td>
<td></td>
</tr>
<tr>
<td>Total used</td>
<td>55 GB</td>
<td></td>
</tr>
<tr>
<td>Total free</td>
<td>9 GB</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12. Hypervisor memory consumption

Memory virtualization techniques enable the Hyper-V hypervisor to abstract physical host resources, such as Dynamic Memory, to provide resource isolation across multiple virtual machines while avoiding resource exhaustion. In cases where advanced processors (such as Intel processors with EPT support) are deployed, memory abstraction takes place within the CPU. Otherwise, it occurs within the hypervisor itself.

Hyper-V provides the following memory management techniques:

- **Dynamic Memory**

  Dynamic Memory increases physical memory efficiency by treating memory as a shared resource and dynamically allocating it to the virtual machines. The actual consumed memory of each virtual machine is adjusted on demand. Dynamic Memory enables more virtual machines to run by reclaiming unused memory from idle virtual machines. In Windows Server 2012, Dynamic Memory enables dynamic increase of the maximum memory available to virtual machines.
Non-Uniform Memory Access (NUMA)

Non-Uniform Memory Access (NUMA) is a multiprocessor computer technology that enables a CPU to access remote-node memory. This type of memory access is costly in terms of performance. However, Windows Server 2012 employs a process affinity that strives to keep threads pinned to a particular CPU to avoid remote-node memory access. In previous versions of Windows, this feature is available only to the host. Windows Server 2012 extends this functionality to virtual machines, where it improves performance.

Smart Paging

With Dynamic Memory, Hyper-V allows virtual machines to exceed the physical memory that is available. This means that when a virtual machine’s minimum memory is less than its start-up memory, Hyper-V might not always have additional memory available to meet a virtual machine’s start-up requirements. Smart Paging bridges the gap between minimum memory and start-up memory and allows virtual machines to restart reliably. Smart Paging uses disk resources as a temporary memory replacement. It swaps out less-used memory to disk storage and swaps it in when needed. However, this can cause performance to degrade. Hyper-V continues to use guest paging when the host memory is oversubscribed, because it is more efficient than Smart Paging.

Proper sizing and configuration of the solution requires care when configuring server memory. This section provides guidelines for allocating memory to virtual machines and takes into account Hyper-V memory overhead and the virtual machine memory settings.

Hyper-V memory overhead

Virtualization of memory resources incurs associated overhead, including the memory consumed by the Hyper-V parent partition, and additional overhead for each virtual machine. For this solution, leave at least 2 GB of memory for the Hyper-V parent partition.

Allocating memory to virtual machines

Server capacity is required for two purposes in the solution:

- To support the required infrastructure services such as authentication and authorization, DNS, and database
  
  For further details on the hosting requirements for these infrastructure services, refer to the VSPEX Private Cloud Proven Infrastructure Guide listed in Essential reading.

- To support the virtualized desktop infrastructure

In this solution, each virtual desktop is assigned 2 GB of memory, as defined in Table 6 on page 35. We validated the solution with statically assigned memory and no over-commitment of memory resources. If you use memory over-commit in a real-world environment, regularly monitor the system memory utilization and associated page file I/O activity to ensure that a memory shortfall does not cause unexpected results.
Network design considerations

VSPEX solutions define minimum network requirements and provide general guidance on network architecture but allow the customer to choose any network hardware that meets the requirements. If additional bandwidth is required, you should add capability at both the storage array and the hypervisor host to meet the requirements. The options for network connectivity on the server depend on the type of server.

For reference purposes in the validated environment, EMC assumes that each virtual desktop generates eight IOPS with an average size of 4 KB. This means that each virtual desktop is generating at least 32 KB/s of traffic on the storage network. For an environment rated for 500 virtual desktops, this means a minimum of approximately 16 MB/s, which is well within the bounds of gigabit networks. However, this does not consider other operations.

- User network traffic
- Virtual desktop migration
- Administrative and management operations

The requirements for each of these operations depend on how the environment is used, so providing concrete numbers in this context is not practical. However, the networks described for the reference architectures in this solution should be sufficient to handle average workloads for these operations.

Regardless of the network traffic requirements, always have at least two physical network connections that are shared by a logical network to ensure a single link failure does not affect the availability of the system. Design the network so that the aggregate bandwidth is sufficient to accommodate the full workload in the event of a failure.

At a minimum, the network infrastructure must provide:

- Redundant network links for the hosts, switches, and storage
- Support for link aggregation
- Traffic isolation based on industry best practices
Validated network hardware

Table 13 identifies the hardware resources for the network infrastructure validated in this solution.

Table 13. Minimum switching capacity for block and file

<table>
<thead>
<tr>
<th>Storage type</th>
<th>Configuration</th>
</tr>
</thead>
</table>
| Block        | • 2 physical switches  
               • 2 x 10 GbE ports per Hyper-V server  
               • 2 x 10 GbE ports per SP  
               • 1 x 1 GbE port per SP for management  
               • 2 x 8 Gb FC ports per Hyper-V server  
               • 2 x 8 Gb FC ports per SP |
| File         | • 2 physical switches  
               • 2 x 10 GbE ports per Hyper-V server  
               • 1 x 1 GbE port for management  
               • 2 x 10 GbE ports per SP |

Notes:
- The solution can use a 1 Gb network infrastructure if the underlying requirements around bandwidth and redundancy are fulfilled.
- This configuration assumes that the VSPEX implementation is using rack mounted servers; for implementations based on blade servers, ensure that similar bandwidth and high availability capabilities are available.

Network configuration guidelines

This section provides guidelines for setting up a redundant, highly available network configuration. The guidelines take into account network redundancy, link aggregation, traffic isolation, and jumbo frames.

The configuration examples are for IP-based networks, but similar best practices and design principles apply for the FC storage network option.

Network redundancy

The network infrastructure requires redundant network links for each Hyper-V host, the storage array, the switch interconnect ports, and the switch uplink ports. This configuration provides both redundancy and additional network bandwidth. This configuration is also required regardless of whether the network infrastructure for the solution already exists or is deployed with other solution components.
Chapter 5: Solution Design Considerations and Best Practices

Figure 13 provides an example of a highly available network topology.

![Highly available network design example](image)

**Figure 13. Highly available network design example**

**Link aggregation**

EMC VNXe arrays provide network high availability or redundancy by using link aggregation. Link aggregation enables multiple active Ethernet connections to appear as a single link with a single media access control (MAC) address, and potentially multiple IP addresses.²

In this solution, we configured the Link Aggregation Control Protocol (LACP) on the VNXe array to combine multiple Ethernet ports into a single virtual device. If a link is lost in the Ethernet port, the link fails over to another port. We distributed all network traffic across the active links.

---

² Link aggregation resembles an Ethernet channel but uses the LACP IEEE 802.3ad standard. This standard supports link aggregations with two or more ports. All ports in the aggregation must have the same speed and be full duplex.
Traffic isolation

This solution uses virtual local area networks (VLANs) to segregate network traffic of various types to improve throughput, manageability, application separation, high availability, and security.

VLANs segregate network traffic to enable traffic of different types to move over isolated networks. In some cases, physical isolation might be required for regulatory or policy compliance reasons; in many cases, logical isolation using VLANs is sufficient.

This solution calls for a minimum of three VLANs:

- Client access network—Virtual machine networking and CIFS traffic (these are customer-facing networks, which can be separated if needed)
- Storage network—SMB3/iSCSI networking and Live Migration (private network)
- Management network—Hyper-V management (private network)

Figure 14 shows the design of these VLANs.
The client access network is for users of the system, or clients, to communicate with the infrastructure. The storage network is used for communication between the compute layer and the storage layer. The management network provides administrators with dedicated access to the management connections on the storage array, network switches, and hosts.

Some best practices call for additional network isolation for cluster traffic, virtualization layer communication, and other features. These additional networks can be implemented but they are not required.

Notes:
- Figure 14 demonstrates the network connectivity requirements for a VNXe array using 10 GbE network connections. Create a similar topology when using 1 GbE network connections.
- If you choose the FC storage network option for a deployment, similar best practices and design principles apply.

**Jumbo frames**

A jumbo frame is an Ethernet frame with a payload or maximum transmission unit (MTU) greater than 1,500 bytes. The generally accepted maximum size for a jumbo frame is 9,000 bytes. Processing overhead is proportional to the number of frames. Therefore, enabling jumbo frames reduces processing overhead by reducing the number of frames being transmitted. This increases the network throughput. Jumbo frames should be enabled end-to-end, including the network switches and VNXe interfaces. This solution requires MTU set at 9,000 (jumbo frames) for efficient storage and migration traffic.

**Storage design considerations**

The solution includes layouts for the disks used in validation testing. Each layout balances the available storage capacity with the performance capability of the drives. There are several layers to consider when designing the storage layouts. Specifically, the array has a collection of disks assigned to a storage pool. From that pool, you can provision storage to the Hyper-V cluster. Each layer has a specific configuration that is defined for the solution and documented in the *EMC VSPEX End-User Computing: Citrix XenDesktop 7.1 and Microsoft Hyper-V for up to 500 Virtual Desktops Implementation Guide*.

It is generally acceptable to replace drive types with a type that has more capacity with the same performance characteristic or with types that have higher performance characteristics and the same capacity. It is also acceptable to change the placement of drives in the drive shelves to comply with updated or new drive shelf arrangements.

Where there is a need to deviate from the proposed number and type of drives specified, or the pool and volume layouts specified, ensure that the target layout delivers the same or greater resources to the system.
Hyper-V supports more than one method of using storage when hosting virtual machines. We tested the configurations described in Table 14 using SMB3 or FC, and the storage layouts described adhere to all current best practices. A customer or architect with the necessary training and background can make modifications, if required, based on their understanding of the system’s usage and load.

Table 14. Storage hardware for 500 virtual desktops

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Configuration</th>
</tr>
</thead>
</table>
| VNXe shared storage for virtual desktops | Common:  
- 2 x 8 Gb FC ports per SP (block variant only)  
- 600 GB, 10k rpm 2.5-inch SAS disks:  
  | Drive count | PVD | Non-PvD | HSD |
  | PVS | 20 | 16 | 8 |
  | MCS | 22 | 20 | 10 |
  | 2 x 100 GB, 2.5-inch flash drives | |
| Optional for user data | 10 x 600 GB, 10k rpm 2.5-inch SAS disks | |
| Optional for PvD | 12 x 600 GB, 10k rpm 2.5-inch SAS disks | |

Note: EMC recommends configuring at least one hot spare for every 30 drives of a particular type. The recommendations in Table 14 do not include hot spares.

For the solution, we used Login Virtual Session Indexer (Login VSI) to simulate a user load against the desktops. Login VSI provides guidance for gauging the maximum number of users that a desktop environment can support. We selected the Login VSI medium workload for our testing. The storage layouts for 500 desktops on the VNXe3200 array were defined when the Login VSI max average response time was below the dynamically calculated maximum threshold (or VSI max dynamic).

Note: Login VSI has two ways of defining the maximum threshold: VSI max Classic and VSI max Dynamic. The VSI max Classic threshold is defined as 4,000 milliseconds. The VSI max Dynamic threshold is calculated based on the initial response time of the user activities.

Windows Server 2012 Hyper-V and Failover Clustering use CSV v2 and new Virtual Hard Disk Format (VHDX) features to virtualize storage that is presented from external shared storage systems to host virtual machines. Figure 15 shows an example of a storage array presenting either block-based LUNs (as CSVs) or file-based CIFS shares (as SMB3 shares) to the Windows hosts to host virtual machines. An additional option, pass-through disks, allows virtual machines to access a physical disk that is mapped to a Hyper-V host but that does not have a volume configured.

This solution uses CSVs for the block variant and CIFS shares for the file variant.
Figure 15. Hyper-V virtual disk types

CIFS and SMB 3.0 (file-based storage only)

Windows Server 2012 and later supports the use of CIFS (SMB 3.0) file shares as shared storage for Hyper-V virtual machines.

The SMB protocol is the default file-sharing protocol in Windows environments. Windows Server 2012 provides a vast set of new SMB features with an updated (SMB 3.0) protocol. Some of the key features available with Windows Server 2012 SMB 3.0 are:

- SMB Transparent Failover
- SMB Scale Out
- SMB Multichannel
- SMB Direct
- SMB Encryption
- VSS for SMB file shares
- SMB Directory Leasing
- SMB PowerShell

With these new features, SMB 3.0 offers richer capabilities that, when combined, provide organizations with a high performance storage alternative to traditional FC storage solutions at a lower cost.

Note: SMB is also known as CIFS. For more details about SMB 3.0, refer to *EMC VNX Series: Introduction to SMB 3.0 Support*. 
CSV
A CSV is a shared disk that contains an NTFS volume that is made accessible by all nodes of a Windows failover cluster. It can be deployed over any SCSI-based local or network storage.

Pass-through disks
Windows Server 2012 also supports pass-through disks, which enable a virtual machine to access a physical disk that is mapped to the host but that does not have a volume configured.

New Virtual Hard Disk format
Hyper-V in Windows Server 2012 introduces an update to the VHD format called VHDX, which has a much larger capacity and built-in resiliency. The main new features of the VHDX format are:

- Support for virtual hard disk storage with the capacity of up to 64 TB
- Additional protection against data corruption during power failures by logging updates to the VHDX metadata structures
- Optimal structure alignment of the virtual hard disk format to suit large sector disks

The VHDX format also has the following features:

- Larger block sizes for dynamic and differential disks, which enables the disks to meet the needs of the workload
- The 4 KB logical-sector virtual disk that enables increased performance when used by applications and workloads that are designed for 4 KB sectors
- The ability to store custom metadata about the files that the user might want to record, such as the operating system version or applied updates
- Space reclamation features that can result in smaller file size and enable the underlying physical storage device to reclaim unused space (for example, TRIM requires direct-attached storage or SCSI disks and TRIM-compatible hardware)

EMC VNXe Virtual Provisioning™ enables organizations to reduce storage costs by increasing capacity utilization, simplifying storage management, and reducing application downtime. Virtual Provisioning also helps companies to reduce power and cooling requirements and reduce capital expenditures.

Virtual Provisioning provides pool-based storage provisioning by implementing pool LUNs that can be either thin or thick. Thin LUNs provide on-demand storage that maximizes the utilization of your storage by allocating storage as needed. Thick LUNs provide high performance and predictable performance for your applications. Both types of LUNs benefit from the ease-of-use features of pool-based provisioning. Pools and pool LUNs are also the building blocks for advanced data services such as FAST VP and VNXe Snapshots. Pool LUNs also support a variety of additional features, such as LUN shrinking, online expansion, and user capacity threshold settings.
EMC VNXe Virtual Provisioning enables you to expand the capacity of a storage pool from the Unisphere GUI after disks are physically attached to the system. VNXe systems have the ability to rebalance allocated data elements across all member drives to use new drives after the pool is expanded. The rebalance function starts automatically and runs in the background after an expand action. Monitor the progress of a rebalance operation from the jobs panel in Unisphere, as shown in Figure 16.

![Figure 16. Storage pool rebalance progress](Image)

**LUN expansion**

Use pool LUN expansion to increase the capacity of existing LUNs. It allows for provisioning larger capacity as business needs grow.

The VNXe3200 enables you to expand a pool LUN without disrupting user access. You can expand pool LUNs with a few clicks and the expanded capacity is immediately available. However, you cannot expand a pool LUN if it is part of a data protection or LUN-migration operation. For example, you cannot expand snapshot LUNs or migrating LUNs.

For more detailed information of pool LUN expansion, refer to *Virtual Provisioning for the New VNX*.

**User alerting through capacity threshold setting**

Customers must configure proactive alerts when using a file system or storage pools based on thin pools. Monitor these resources so that storage is available for provisioning when needed and capacity shortages can be avoided.
Figure 17 illustrates why provisioning with thin pools requires monitoring.

Monitor the following values for thin pool utilization:

- **Total capacity** is the total physical capacity available to all LUNs in the pool.
- **Total allocation** is the total physical capacity currently assigned to all pool LUNs.
- **Subscribed capacity** is the total host-reported capacity supported by the pool.
- **Over-subscribed capacity** is the amount of user capacity configured for LUNs that exceeds the physical capacity in a pool.
- **Total allocation** might never exceed the total capacity, but if it nears that point, add storage to the pools proactively before reaching a hard limit.

Figure 18 shows the **Storage Pool Utilization** in Unisphere, which displays parameters such as **Used Space**, **Available Space**, **Subscription**, **Alert Threshold**, and **Total Space**.

**Figure 17. Thin LUN space utilization**

**Figure 18. Examining storage pool space utilization**

When storage pool capacity becomes exhausted, any requests for additional space allocation on thin provisioned LUNs fail. Applications attempting to write data to these LUNs usually fail as well, and an outage is the likely result. To avoid this situation, monitor pool utilization, and send an alert when thresholds are reached. Set the **Percentage Full Threshold** to allow enough buffer to make remediation before an outage situation occurs. This alert is only active if the pool has one or more thin LUNs, because thin LUNs are the only way to oversubscribe a pool. If the pool only
contains thick LUNs, the alert is not active as there is no risk of running out of space because of oversubscription.

**EMC FAST Cache**

EMC FAST Cache enables flash drives to function as an expanded cache layer for the array. FAST Cache is an array-wide, nondisruptive cache, available for both file and block storage. Frequently accessed data is copied to the FAST Cache and subsequent reads and/or writes to the data chunk are serviced by FAST Cache. This enables immediate promotion of highly active data to flash drives. This dramatically improves the response time for the active data and reduces data hot spots that can occur within a LUN. FAST Cache is an optional component of this solution.

**EMC FAST VP**

EMC FAST VP can automatically tier data across multiple types of drives to leverage differences in performance and capacity. FAST VP is applied at the block storage pool level and automatically adjusts where data is stored based on how frequently it is accessed. Frequently accessed data is promoted to higher tiers of storage, while infrequently accessed data can be migrated to a lower tier for cost efficiency. This rebalancing is part of a regularly scheduled maintenance operation.

**High availability and failover**

This VSPEX solution provides a highly available virtualized server, network, and storage infrastructure. When implemented in accordance with this guide, it provides the ability to survive single-unit failures with minimal impact to business operations. This section describes the high availability features of the solution.

**Virtualization layer**

EMC recommends configuring high availability in the virtualization layer and allowing the hypervisor to automatically restart virtual machines that fail. Figure 19 illustrates the hypervisor layer responding to a failure in the compute layer.

![High availability at the virtualization layer](image)

**Figure 19. High availability at the virtualization layer**

Implementing high availability at the virtualization layer ensures that, even in the event of a hardware failure, the infrastructure will attempt to keep as many services running as possible.
Chapter 5: Solution Design Considerations and Best Practices

**Compute layer**

While this solution offers flexibility in the types of servers to be used in the compute layer, it is best to use enterprise-class servers designed for data centers. This type of server has redundant power supplies, as shown in Figure 20. You should connect these to separate Power Distribution Units (PDUs) in accordance with your server vendor’s best practices.

![Redundant power supplies](image)

*Figure 20. Redundant power supplies*

EMC also recommends that you configure high availability in the virtualization layer. This means that you must configure the compute layer with enough resources to ensure that the total number of available resources meets the needs of the environment, even with a server failure. Figure 19 demonstrates this recommendation.

**Network layer**

The advanced networking features of the VNXe storage system provides protection against network connection failures at the array. Each Hyper-V host has multiple connections to user and storage Ethernet networks to guard against link failures, as shown in Figure 21. Spread these connections across multiple Ethernet switches to guard against component failure in the network.
Chapter 5: Solution Design Considerations and Best Practices

Figure 21. Network layer high availability

Having no single point of failure in the network layer ensures that the compute layer can access storage and communicate with users even if a component fails.

Storage layer

The VNXe array is designed for five 9s (99.999 percent) availability by using redundant components throughout the array, as shown in Figure 22. All of the array components are capable of continued operation in the event of hardware failure. The RAID disk configuration on the array provides protection against data loss resulting from individual disk failures, and you can dynamically allocate the available hot spare drives to replace a failing disk.

Figure 22. VNXe3200 high availability

EMC storage arrays are designed to be highly available by default. When they are configured according to the directions in the installation guides, no single unit failure results in data loss or unavailability.
Validation test profile

We validated this VSPEX solution with the environment profile characteristics shown in Table 15.

Table 15. Validated environment profile

<table>
<thead>
<tr>
<th>Profile characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of virtual desktops</td>
<td>500</td>
</tr>
<tr>
<td>Virtual desktop OS</td>
<td>• Desktop OS: Windows 8.1 Enterprise (32-bit)</td>
</tr>
<tr>
<td></td>
<td>• Server OS: Windows Server 2012 R2</td>
</tr>
<tr>
<td>CPU per virtual desktop</td>
<td>• Desktop OS: 1 vCPU</td>
</tr>
<tr>
<td></td>
<td>• Server OS: 0.3 vCPU</td>
</tr>
<tr>
<td>Number of virtual desktops per CPU core</td>
<td>• Desktop OS: 5</td>
</tr>
<tr>
<td></td>
<td>• Server OS: 3.3</td>
</tr>
<tr>
<td>RAM per virtual desktop</td>
<td>• Desktop OS: 2 GB</td>
</tr>
<tr>
<td></td>
<td>• Server OS: 0.6 GB</td>
</tr>
<tr>
<td>Desktop provisioning method</td>
<td>• Citrix Provisioning Services (PVS)</td>
</tr>
<tr>
<td></td>
<td>• Machine Creation Services (MCS)</td>
</tr>
<tr>
<td>Microsoft Office</td>
<td>Office Enterprise 2010 SP1</td>
</tr>
<tr>
<td>LoginVSI</td>
<td>3.7</td>
</tr>
<tr>
<td>Average IOPS per virtual desktop at steady state</td>
<td>8</td>
</tr>
<tr>
<td>Number of LUNs or CIFS shares to store virtual desktops</td>
<td>4</td>
</tr>
<tr>
<td>Number of virtual desktops per LUN or CIFS share</td>
<td>125</td>
</tr>
<tr>
<td>Disk and RAID type for LUNs or CIFS shares</td>
<td>• MCS: RAID 5, 600 GB, 10k rpm, 2.5-inch SAS disks</td>
</tr>
<tr>
<td></td>
<td>• PVS: RAID 10, 600 GB, 10k rpm, 2.5-inch SAS disks</td>
</tr>
<tr>
<td></td>
<td>• Pvd: RAID 10, 600 GB, 10k rpm, 2.5-inch SAS disks</td>
</tr>
<tr>
<td>Disk and RAID type for CIFS shares to host roaming user profiles and home directories (optional for user data)</td>
<td>RAID 5, 600 GB, 10k rpm, 2.5-inch SAS disks</td>
</tr>
</tbody>
</table>

Note: We measured the average IOPS per virtual desktop at steady state when the Login VSI medium profile workload was simulated on a 500-desktop configuration. The Login VSImax was below the VSImax Dynamic threshold.
EMC Powered Backup configuration guidelines

Table 16 shows the backup environment profile that we validated for the solution.

The solution outlines the backup storage (initial and growth) and retention needs of the system. Gather additional information to further size Avamar, including tape-out needs, RPO and RTO specifics, and multisite environment replication needs.

Table 16. Backup profile characteristics

<table>
<thead>
<tr>
<th>Profile characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>User data</td>
<td>5 TB for 500 virtual desktops (10 GB per desktop)</td>
</tr>
<tr>
<td><strong>Daily change rate for user data</strong></td>
<td></td>
</tr>
<tr>
<td>User data</td>
<td>2%</td>
</tr>
<tr>
<td><strong>Retention policy</strong></td>
<td></td>
</tr>
<tr>
<td># Daily</td>
<td>30 daily</td>
</tr>
<tr>
<td># Weekly</td>
<td>4 weekly</td>
</tr>
<tr>
<td># Monthly</td>
<td>1 monthly</td>
</tr>
</tbody>
</table>

Backup layout

Avamar provides various deployment options for specific use cases and the recovery requirements. In this case, the solution is deployed with an Avamar Data Store. This enables unstructured user data to be backed up directly to the Avamar system for simple file-level recovery. This backup solution unifies the backup process with industry-leading deduplication backup software and systems and provides the highest levels of performance and efficiency.
VSPEX for Citrix XenDesktop with ShareFile StorageZones solution

With some added infrastructure, the VSPEX end-user computing solution for Citrix XenDesktop supports Citrix StorageZones with Storage Center.

Figure 23 shows the high-level architecture of a ShareFile StorageZones deployment.

The architecture consists of the following components:

- **Client**—Accesses the ShareFile service through one of the native tools such as a browser or Citrix Receiver, or directly through the ShareFile API.

- **Control Plane**—Stores files, folders, and account information, and provides access control, reporting, and various other brokering functions. The Control Plane resides in multiple Citrix data centers located worldwide.

- **StorageZones**—Defines the locations where data is stored.

**StorageZones**

ShareFile Storage Center extends the ShareFile SaaS cloud storage by providing the ShareFile account with onsite private storage—that is, StorageZones. ShareFile onsite storage differs from cloud storage as follows:

- ShareFile-managed cloud storage is a public, multitenant storage system maintained by Citrix.

- A ShareFile Storage Center is a private single-tenant storage system maintained by the customer and accessible only by approved customer accounts.

By default, ShareFile stores data in the secure ShareFile-managed cloud storage. The ShareFile Storage Center feature enables you to configure a private, onsite...
StorageZone, which defines where data is stored and enables performance optimization by locating data storage close to users.

You can use StorageZones with or instead of the ShareFile-managed cloud storage.

Storage Center is a web service that handles all HTTPS operations from end users and from the ShareFile control subsystem. The ShareFile storage subsystem handles operations related to file contents such as uploads, downloads, and antivirus verification. When you create a StorageZone, you are creating a private storage subsystem for your ShareFile data. The ShareFile control subsystem handles all operations not related to file contents, such as authentication, authorization, file browsing, configuration, metadata, file sending and requesting, and load balancing. The control subsystem also performs Storage Center health checks and prevents offline servers from sending requests. The ShareFile control subsystem is maintained in Citrix online data centers.

**Design considerations**

Based on an organization’s performance and compliance requirements, consider the number of StorageZones and where best to locate them. For example, if users are in Europe, storing files in a Storage Center in Europe provides both performance and compliance benefits. In general, assigning users to the StorageZones location that is closest to them geographically is the best practice for optimizing performance.

For a production deployment of ShareFile, the best practice is to use at least two servers with Storage Center installed for high availability. When you install Storage Center, you create a StorageZone. You can then install Storage Center on another server and join it to the same StorageZone. Storage Center servers that belong to the same StorageZones must use the same file share for storage.

**VSPEX for ShareFile StorageZones architecture**

Figure 24 shows the logical architecture of the VSPEX for ShareFile StorageZones solution. The customer can select any server and networking hardware that meets or exceeds the minimum requirements, while the recommended storage delivers a highly available architecture for a ShareFile StorageZones deployment.
**Server requirements**

A high-availability production environment requires a minimum of two servers (virtual machines) with Storage Center installed. Table 17 details the minimum CPU and memory required to implement ShareFile StorageZones with Storage Center.

<table>
<thead>
<tr>
<th>CPU (cores)</th>
<th>Memory (GB)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td><a href="https://citrixdocs.com">Storage Center system requirements</a> on the Citrix eDocs website.</td>
</tr>
</tbody>
</table>

**Network requirements**

You can implement the networking components using 1 GbE or 10 GbE IP networks, provided that bandwidth and redundancy are sufficient to meet the minimum requirements of the solution. Provide sufficient network ports to support the additional two Storage Center servers.


**Storage requirements**

ShareFile StorageZones requires a CIFS share to provide private data storage for Storage Center. The VNX family, which provides the storage for VSPEX end-user computing solutions, provides both file and block access and an extensive feature set that makes it an ideal choice for ShareFile StorageZones deployments. Table 18 details the recommended VNXe storage for the StorageZones CIFS share.

Table 18. Recommended VNXe storage for ShareFile StorageZones CIFS share

<table>
<thead>
<tr>
<th>CIFS share for (number of users)</th>
<th>Configuration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 users</td>
<td>Thirteen 600 GB, 10K rpm 2.5-inch SAS disks (12+1 RAID 5)</td>
<td>The configuration assumes that each user has 10 GB of private storage space.</td>
</tr>
</tbody>
</table>
This chapter presents the following topics:

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Other documentation ............................................................... 74
Chapter 6: Reference Documentation

EMC documentation

The following documents, available on [EMC Online Support](https://www.emc.com) or [EMC.com](https://www.emc.com), provide additional and relevant information. If you do not have access to a document, contact your EMC representative.

- **EMC VNXe3200 Installation Guide**
- **EMC Storage Integrator for Windows Suite—Product Guide**
- **Unisphere System Getting Started Guide**
- **EMC PowerPath and PowerPath/VE for Windows Installation and Administration Guide**
- **EMC VNX Unified Best Practices for Performance—Applied Best Practices**
- **EMC VNX Virtual Provisioning Applied Technology White Paper**
- **EMC Avamar 7 Administrator Guide**
- **EMC Avamar 7 Operational Best Practices**
- **Avamar Client for Windows on Citrix XenDesktop Technical Note**
- **Introduction to the EMC VNXe3200 FAST Suite Overview White Paper**
- **Using a VNXe3200 System with CIFS File Systems**
- **EMC VNXe3200 Capacity and Performance Metrics: A Detailed Review White Paper**
- **EMC VSPEX End-User Computing: Citrix XenDesktop 7 and Microsoft Hyper-V for up to 1,000 Virtual Desktops Design Guide**
- **EMC VSPEX End-User Computing: Citrix XenDesktop 7 and Microsoft Hyper-V for up to 1,000 Virtual Desktops Implementation Guide**

Other documentation

For Citrix and Microsoft documentation, refer to the [Citrix](https://www.citrix.com) and [Microsoft](https://www.microsoft.com) websites.
This appendix presents the following topic:

**Customer Sizing Worksheet for end-user computing**
**Customer Sizing Worksheet for end-user computing**

Before selecting a reference architecture on which to base a customer solution, use the Customer Sizing Worksheet to gather information about the customer's business requirements and to calculate the required resources.

Table 19 shows a blank worksheet. A standalone copy of the worksheet is attached to this Design Guide in Microsoft Office Word format to enable you to easily print a copy.

### Table 19. Customer Sizing Worksheet

<table>
<thead>
<tr>
<th>User type</th>
<th>vCPUs</th>
<th>Memory (GB)</th>
<th>IOPS</th>
<th>Equivalent reference virtual desktops</th>
<th>No. of users</th>
<th>Total reference virtual desktops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource requirements</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Equivalent reference virtual desktops</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Resource requirements</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Equivalent reference virtual desktops</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Resource requirements</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Equivalent reference virtual desktops</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Resource requirements</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Equivalent reference virtual desktops</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Total**

To view and print the worksheet:

1. In Adobe Reader, open the **Attachments** panel as follows:
   - Select **View** > **Show/Hide** > **Navigation Panes** > **Attachments**
   - or
   - Click the **Attachments** icon as shown in Figure 25.
2. Under Attachments, double-click the attached file to open and print the worksheet.