

# EMC VSPEX BLUE END-USER COMPUTING

## With Citrix XenDesktop

### EMC VSPEX

#### Abstract

EMC VSPEX BLUE delivers agile, scalable and trusted hyper-converged infrastructure for end-user-computing. This Proven Infrastructure Guide describes the VSPEX BLUE end-user computing solution with Citrix XenDesktop.

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**EMC VSPEX BLUE End-User Computing for Citrix XenDesktop  
Proven Infrastructure Guide**

Part Number H14025.1

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# Chapter 1 Executive Summary

This chapter presents the following topics:

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## Introduction

Mid-market and enterprise customers, as well as Managed Service Providers (MSP), are challenged to deliver a high performance end-user computing environment that provides data and application access for hundreds of desktop users. EMC VSPEX BLUE is a hyper-converged infrastructure appliance that provides a platform for both the virtualization environment and the desktops. VSPEX BLUE's building-block approach to the software-defined data center provides high availability, simplified management, and data protection to meet those needs, offering customers the fastest, lowest-risk path to end-user computing.

EMC VSPEX is the industry's leading reference-architecture based converged infrastructure – integrating virtualization, servers, networking, storage and backup into a single solution dramatically lowering your risk and speeding your time to production. EMC VSPEX BLUE redefines simplicity by delivering virtualization, compute and storage in a simple, scalable, easy to manage hyper-converged infrastructure appliance. Powered by VMware EVO:RAIL and designed for simplicity, fully orchestrated installation, management, patching and upgrading, EMC VSPEX BLUE provides linear scaling that grows or contracts based on business needs.

This forms end-user computing architecture provides the customer with a modern system capable of hosting a large number of virtual desktops at a consistent performance level. This end-user computing solution for Citrix XenDesktop runs on VSPEX BLUE. In this solution, both the desktop virtualization infrastructure components and the desktops are layered on a VSPEX BLUE appliance in a hyper-converged infrastructure.

This VSPEX BLUE End-User-Computing Solution is validated to support up to 220 virtual desktops on a single appliance. The validated configurations are based on a reference desktop workload and form the basis for creating cost-effective, custom solutions for individual customers.

## Audience

This guide is intended for internal EMC personnel and qualified VSPEX BLUE partners. The guide assumes that VSPEX BLUE partners who intend to deploy this VSPEX BLUE Proven Infrastructure for Citrix XenDesktop have the necessary training and background to install and configure an end-user computing solution based on Citrix XenDesktop using vSphere as the hypervisor, Virtual SAN storage, 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 are familiar with these documents. For details, see [Appendix A: Reference Documentation](#).

## Purpose of this guide

An end-user computing or virtual desktop infrastructure (VDI) is a complex system offering. This Proven Infrastructure Guide describes how to design an end-user computing solution for Citrix XenDesktop according to best practices, how to size the solution to fit the customer's needs using the EMC VSPEX Sizing Tool or the Customer Sizing Worksheet, and how to implement, with best practices, the resources necessary to deploy an end-user computing solution for Citrix XenDesktop using VSPEX BLUE.

## Business needs

The VSPEX BLUE operational framework enhances business agility to respond more quickly and efficiently to changing business needs. VSPEX BLUE offers the fastest and lowest-risk path to new application and technology adoption with simplified operations.

Business applications are moving toward a consolidated or hyper-converged compute, network, and storage environment. This VSPEX BLUE end-user computing solution with Citrix XenDesktop and VMware reduces the complexity of configuring every component of a traditional deployment model. The solution reduces the complexity of 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 BLUE end-user computing solution for Citrix XenDesktop include:

- An end-to-end virtualization solution leveraging the capabilities of the hyper-converged infrastructure components
- Efficient virtualization of up to 220 virtual desktops on a VSPEX BLUE appliance for varied customer use cases
- Reliable, flexible, and scalable reference architectures
- Capable of handling peak performance requirements such as login storms
- Quick and easy deployment and configuration
- Application uptime ensured through VMware EVO:RAIL software
- Easy virtual machine deployment: Only minutes transpire, from powering on the VSPEX BLUE appliance until virtual machine creation
- Non-disruptive patches and upgrades for the appliance software, including EVO:RAIL and EMC VSPEX BLUE Manager
- Simplified management
- EMC Secure Remote Support

## Chapter 2 Solution Overview

This chapter presents the following topics:

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## Introduction

This chapter provides an overview of the key technologies used in the VSPEX BLUE end-user computing solution for Citrix XenDesktop. The solution has been designed and proven by EMC to provide the desktop virtualization, server, network, and storage resources to support your virtual desktop deployment.

## VSPEX BLUE Proven Infrastructures

VSPEX BLUE redefines simplicity by delivering virtualization, compute, storage, and data protection in an agile, scalable, easily managed hyper-converged infrastructure appliance. The VSPEX BLUE infrastructure combined with Citrix XenDesktop offers a fast, low-risk path to end-user computing. Available as a single, all-inclusive product for easy ordering, VSPEX BLUE accelerates time-to-value by enabling customers to go from power-on of the VSPEX BLUE appliance to virtual machine creation in as little as 15 minutes. Designed for simplicity of installation, management, patching and upgrades, VSPEX BLUE provides linear scaling that can grow based on business needs.

The VSPEX BLUE architecture, based on Intel® Xeon® processor-based X-86 hardware with VMware EVO:RAIL and EMC software, is a scale-out system consisting of common software defined building blocks that scale linearly.

The solution, validated by EMC, ensures predictable performance and scalability, reducing the need for upfront investment and the burden of predicting eventual computing capacity needs. You can start small with a single 2U/4-node appliance and scale up to a total of four appliances. EMC VSPEX BLUE automatically discovers and non-disruptively adds each new appliance. The infrastructure automatically rebalances resources and workloads across the cluster, creating a single resource pool.

VSPEX BLUE, through the use of VMware EVO:RAIL software, delivers a simplified, management experience that automates administrative tasks. An intuitive management dashboard drives day-to-day operations addressing the requirements of both non-technical and technical VMware power users. Minimal IT experience is required to deploy, configure, and manage VSPEX BLUE, allowing it to be used where there is minimal IT staff on-site. For power users with end-user computing experience, all vCenter Server and vSphere Enterprise Plus interfaces and application programming interfaces (APIs) are still in place, enabling you to apply existing knowledge, best practices, and processes.

## Key components

This section provides an overview of the key technologies used in this solution, as outlined in Table 1.

**Table 1. Solution components**

Component	Description
Desktop Virtualization Broker	Manages the provisioning, allocation, maintenance, and eventual removal of the virtual desktop images that are provided to users of the system. This software is critical to enable on-demand creation of desktop images, allow maintenance to the image without affecting user productivity, and prevent the environment from growing in an unconstrained way.  The desktop broker in this solution is Citrix XenDesktop.
VSPEX BLUE Appliance	Powered by Intel Xeon processor technology and VMware EVO:RAIL and EMC software, EMC VSPEX BLUE enhances business agility by allowing IT to build, deploy, scale and maintain the system through a more flexible operational framework. Automating the provisioning of the complete deployment life-cycle provides IT organizations with agility, operational simplicity and reduced risk.
Network	Connects the users of the environment to the resources they need and connects the storage layer to the compute layer within the appliance. The VSPEX program defines the minimum number of network ports required for the solution and provides general guidance on network architecture.

## Desktop Virtualization Broker

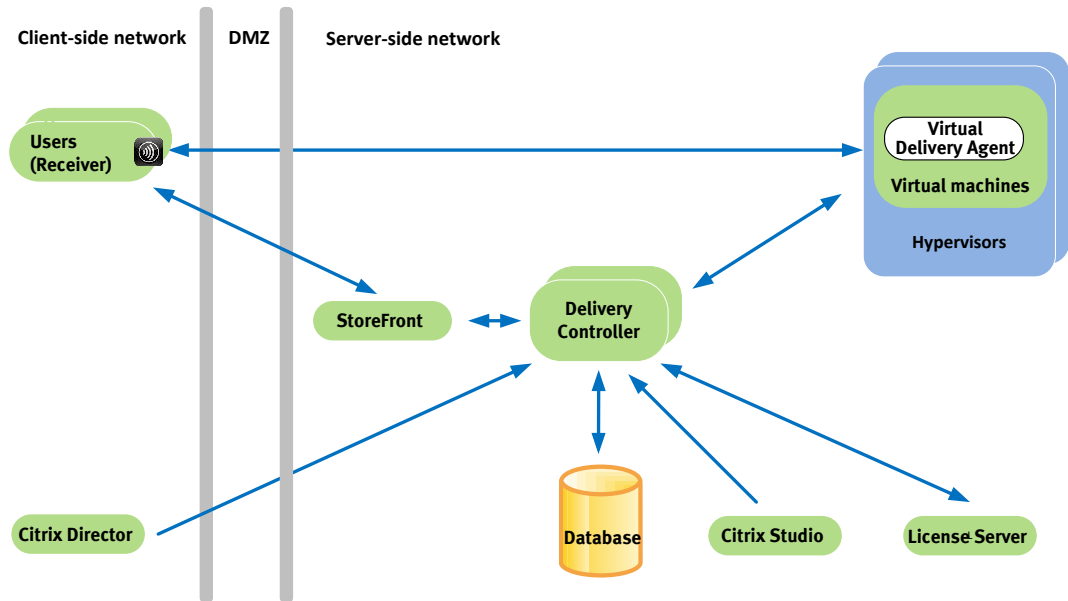
Desktop virtualization encapsulates and hosts desktop services on centralized computing resources in a data center. This enables end users to connect to their virtual desktops from different types of devices across a network connection. Devices can include desktops, laptops, thin clients, zero clients,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

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

### Citrix XenDesktop 7.6

XenDesktop is the desktop virtualization solution from Citrix that enables virtual desktops to run on the vSphere virtualization environment. Citrix XenDesktop 7.6 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 1 shows the XenDesktop 7.6 architecture components.



**Figure 1. XenDesktop 7.6 architecture components**

The XenDesktop 7.6 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, Citrix 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, eliminating 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.

- **License Server**—License server assigns a user or device license to the XenDesktop environment. Install License server along with other Citrix XenDesktop components or on a separate virtual or physical machine.
- **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.
- **Database**—Database stores all the XenDesktop site configuration and session information. Microsoft SQL server is required as a database server.
- **Server OS machines**—Virtual machines or physical machines, based on the Windows Server operating system, used for delivering applications or hosted shared desktops (HSDs) to users.
- **Desktop OS machines**—Virtual or physical machines, based on the Windows Desktop operating system, deliver personalized desktops to users or applications from desktop operating systems.

### Machine Creation Services

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

MCS enables the management of several types of machines within a catalog in Citrix Studio. Desktop customization is persistent for machines that use the Personal vDisk (PvDisk or PvD) feature, while non-Personal vDisk 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 naturally use VMware Virtual SAN cache, where frequently accessed data is promoted 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 lets organizations 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 the operating system during a reboot operation.

### Citrix Personal vDisk

The Citrix Personal vDisk (PvDisk or 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 Personal vDisk. 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 Personal vDisk 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.

## **VSPEX BLUE Appliance**

### **Overview**

VSPEX BLUE redefines simplicity by delivering virtualization, compute, storage and protection in an agile, scalable, easy to manage hyper-converged infrastructure appliance. Available as a single, all-inclusive product for easy ordering, EMC VSPEX BLUE accelerates time to value by enabling customers to go from power-on to virtual machine creation within 15 minutes. Designed for simplicity of installation, management, patching and upgrades, VSPEX BLUE provides linear scaling capability that grows or contracts based on business needs. A single point of hardware and software support by EMC provides customers with 24X7 support and repair service at their fingertips. VSPEX BLUE offers midmarket enterprise customers the fastest, lowest-risk path to the private/hybrid cloud. The VSPEX BLUE approach is ideal for virtualized environments, general purpose IT applications (e-mail, SharePoint), VDI, ROBO, test/dev and departmental workloads in midmarket and enterprise environments that are growing rapidly.

### **Virtualization**

VSPEX BLUE is based on VMware vSphere virtualization technology and the VMware EVO:RAIL platform. EVO:RAIL provides a simplified management interface, but all vCenter and vSphere interfaces and APIs are still in place, enabling integration with existing management systems. It leverages proven capabilities of VMware vSphere HA, vMotion, DRS, and Virtual SAN to ensure high availability at both the compute and storage layers. EVO:RAIL management provides health monitoring of CPU, memory, storage, and virtual machine usage for individual nodes, complete appliances, and the entire cluster.

### **Compute**

VSPEX BLUE is delivered as an appliance that contains both compute and storage hardware for the solution. The compute layer includes four compute nodes based on Intel Xeon processors. There are two models available. The standard model contains 128 GB of RAM per node while the performance model contains 192 GB of RAM per node. This solution uses the performance model.



**Storage**

Storage in VSPEX BLUE is provided by local disks inside the appliance nodes presented using VMware Virtual SAN. Each node contains three SAS disks and one SSD which are shared in a single pool among all the virtual machines running on the appliance.

**Other features**

In addition to the specific features used in this solution, VSPEX BLUE includes other items that increase the value of the platform.

**Table 2. Features and benefits of VSPEX BLUE**

Feature	Benefits
EMC VSPEX BLUE Manager and Market	<ul style="list-style-type: none"> <li>• VSPEX BLUE Manager seamlessly integrates and extends the EVO:RAIL appliance management experience.</li> <li>• The VSPEX BLUE Manager provides the following:               <ul style="list-style-type: none"> <li>▪ Access to EMC support, online chat and customer forum/knowledge base</li> <li>▪ Tight integration with VMware log insight for health/event monitoring as well as hardware, application and virtual machine alerts</li> <li>▪ VSPEX BLUE Market - Access to EMC VSPEX BLUE qualified software</li> <li>▪ Maintenance and upgrades for automated patches and software updates</li> <li>▪ Field service assistance, Remote access via ESRS and FRU/CRU replacement</li> </ul> </li> </ul>
EMC Cloud Array	<ul style="list-style-type: none"> <li>• EMC CloudArray technology provides virtually unlimited cloud storage</li> <li>• Leverages CloudArray for NAS storage (File services), Capacity expansion and archive and offsite backup target and snapshots</li> <li>• 1 TB license included at no cost, includes EMC Support</li> <li>• Works with public and private cloud infrastructure</li> <li>• Cloud storage limits expensive upgrade-cycles, reduces management cost and easily resizes to business requirements</li> <li>• On-site dynamic disk cache eliminates latency and maintains local performance</li> <li>• CloudArray handles API, presents cloud storage as familiar SAN or NAS</li> <li>• Multi-layer encryption and local key management guards against unauthorized access</li> <li>• Sophisticated bandwidth optimization and data reduction technology minimized network impact</li> </ul>

Feature	Benefits
EMC RecoverPoint for VMs	<ul style="list-style-type: none"> <li>• Protects at VM-level granularity with RPO less than 15 minutes</li> <li>• Built on proven RecoverPoint technology</li> <li>• Delivered free for up to 15 VMs</li> <li>• Continuous Data Protection</li> <li>• WAN efficiency</li> <li>• Built-in Orchestration and Automation</li> <li>• VMware vCenter integration</li> <li>• Local and Remote Replication – Sync or Async</li> <li>• Disaster Recovery to any point-in time – replicate data to and from remote/branch office locations</li> <li>• Operational Recovery to any point-in-time – Protects customers against outages caused by human errors, data corruption and virus attacks</li> <li>• Technology Refresh – replicate data for tech refresh, edge data center moves and cluster expansion</li> <li>• Data Migration – Multi-layer encryption and local key management guards against unauthorized access</li> </ul>
EMC Secure Remote Services (ESRS)	<ul style="list-style-type: none"> <li>• Heartbeat ensures continuous monitoring, notification and remote trouble shooting for 15percent higher levels of availability</li> <li>• Fast remote diagnostics and repair of potential problems before impact to business resulting in 5X faster service event resolution</li> <li>• Around the clock monitoring and notification of EMC Customer Service in the event of a problem</li> <li>• Proactive and predictive customer service</li> </ul>
EMC Global Support	<ul style="list-style-type: none"> <li>• One call support with single point of accountability</li> <li>• Includes seamless hardware and seamless VMware software support</li> <li>• Simplifies and streamlines the resolution of customer support issues</li> <li>• Incorporates EMC Secure Remote Services (ESRS)</li> </ul>
Proven EMC Server Technology	<ul style="list-style-type: none"> <li>• Product reliability and support experience consistent with EMC customer expectations</li> <li>• EMC engineers have taken the risk out of adopting cutting edge technology</li> <li>• All-in-one appliance that is simple and easy to deploy, maintain, protect and upgrade</li> <li>• Uptime ensured through high availability Virtual SAN and EVO:RAIL engine</li> </ul>

Feature	Benefits
vSphere Data Protection - Advanced	<ul style="list-style-type: none"> <li>• Rapid recovery and simple management through a familiar vSphere Web Client integration</li> <li>• Reliably protect virtual machines and business critical applications</li> <li>• Multi-layer encryption and local key management guards against unauthorized access</li> <li>• Single production site replicates to multiple remote sites; multiple branch offices replicate to a central site</li> <li>• Backup targets could be local or central</li> <li>• 90 percent reduction in backup window; 30 percent faster recoveries</li> <li>• Minimize storage and network bandwidth consumption with compression and encrypted replication to lower backup infrastructure costs</li> <li>• Scale – capable of backing up 200 VMs per appliance; stores up to 8TB of deduplicated data and up to 20 virtual appliances per vCenter Server</li> <li>• Deduplication reduces storage consumption by up to 75 percent</li> </ul>

## Network

The VSPEX BLUE network creates a Virtual SAN cluster topology between the server nodes. In practice, this means that the system distributes data so that the loss of a single node will not impact data availability. This, in turn, requires that the nodes send data to other nodes to maintain consistency. A high-speed, low-latency IP network is required for this to work correctly. Each VSPEX BLUE server node comes with two 10 Gb Ethernet (GbE) NICs designed for high availability and to meet the high-speed, low-latency requirements.

## Solution architecture

### Logical architecture

The EMC VSPEX BLUE end-user computing for Citrix XenDesktop solution provides a complete system architecture capable of supporting up to 220 virtual desktops on a VSPEX BLUE appliance.

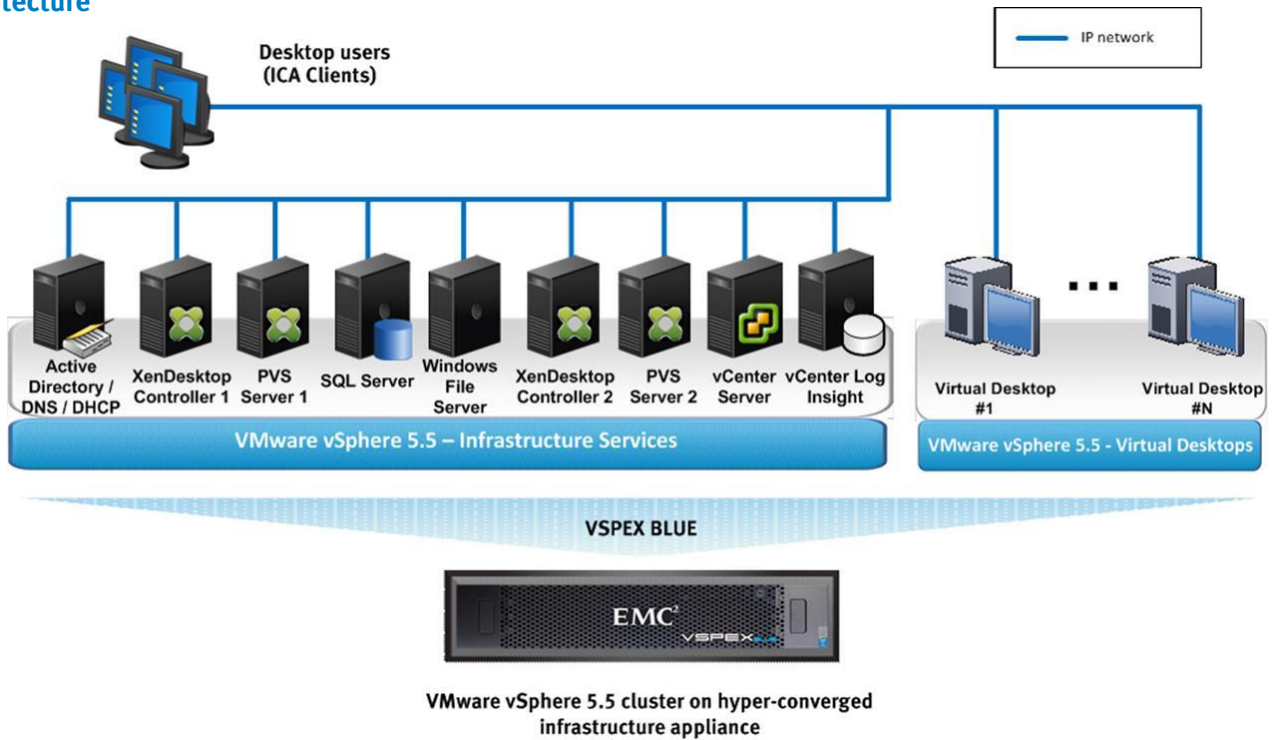
The solution uses VSPEX BLUE, a Hyper-Converged Infrastructure Appliance (HCIA) based on VMware EVO:RAIL, to provide the compute, storage, and virtualization platform for a Citrix XenDesktop environment of Microsoft Windows 7 virtual desktops provisioned by Citrix Provisioning Services (PVS) or Machine Creation Services (MCS).

The desktop virtualization infrastructure components of the solution is provided by deploying them on the VSPEX BLUE appliance, as shown in Figure 2. Alternatively, existing infrastructure at the customer site can be used.

To provide predictable performance for end-user computing solutions, the storage system must be able to handle the peak I/O load from the clients while keeping response time to a minimum. The EMC VSPEX BLUE solution leverages VMware Virtual SAN storage technology to take advantage of the servers' local disks to build a storage system with high performance and scalability to handle peak I/O load such as boot storms and virus scans.

**Logical architecture**

Figure 2 shows the logical architecture of this solution.



**Figure 2. Logical architecture**

**Note:** The infrastructure servers for the solution, as shown in the diagram, are provided by VSPEX BLUE. However, if existing infrastructure at the customer site is available, it also can be used.

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**

Component	Solution configuration
Citrix XenDesktop 7.6 Delivery Controller	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.
Citrix Provisioning Services (PVS) server (optional for MCS)	We used two Citrix PVS servers to provide redundant stream services to stream desktop images from vDisks, as needed, to target devices.
Virtual desktops	We used MCS or PVS to provision virtual desktops running Windows 7.

Component	Solution configuration
VMware vSphere 5.5	This solution uses VMware vSphere to provide a common virtualization layer to host the server environment. We configured high availability in the virtualization layer with vSphere features such as VMware High Availability (HA) clusters and VMware vMotion.
VMware vCenter Server Appliance 5.5	In the solution, all vSphere hosts and their virtual machines are managed through a vCenter Server Appliance that is preloaded with the EVO:RAIL software.
VMware vRealize Log Insight Appliance	The vRealize Log Insight Appliance is preloaded with the EVO:RAIL software to provide real-time log management for the VMware environment.
EMC VSPEX BLUE	The EMC VSPEX BLUE architecture is a scale-out system consisting of modular SDDC building blocks such as VMware Virtual SAN, that scale linearly, ideal for end-user computing deployments.
Microsoft SQL Server	Citrix XenDesktop controllers and provisioning servers require a database service to store configuration and monitoring details. We used Microsoft SQL Server 2012 running on Windows Server 2012 R2 for this purpose.
Active Directory server	Active Directory services are required for the various solution components to function properly. We used the Microsoft Active Directory Service running on a Windows Server 2012 R2 virtual machine for this purpose.
DHCP server	The 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. We used Microsoft DHCP Service running on a Windows 2012 R2 virtual machine for this purpose.
DNS server	DNS services are required for the various solution components to perform name resolution. We used the Microsoft DNS Service running on a Windows 2012 R2 virtual machine for this purpose.
IP networks	All network traffic is carried by a standard Ethernet network with redundant cabling and switching. User and management traffic is carried over a shared network, while Virtual SAN storage traffic is carried over a private, non-routable subnet.

# Chapter 3 Solution Design Considerations

This chapter presents the following topics:

<b>Overview .....</b>	<b>24</b>
<b>Configuration best practices .....</b>	<b>24</b>
<b>Network configuration.....</b>	<b>28</b>
<b>Solution sizing.....</b>	<b>30</b>
<b>Customer sizing worksheet.....</b>	<b>33</b>

## Overview

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

## Configuration best practices

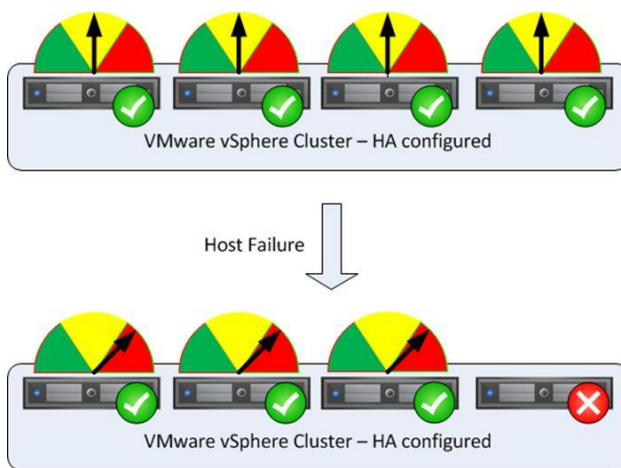
VSPEX BLUE solutions are designed to run on the VSPEX BLUE hyper-converged infrastructure appliance, which contains server hardware sufficient to host up to 220 virtual desktops. This chapter shows how to calculate how many desktops can be hosted by the appliance, and how to expand the environment if needed.

### High availability

Because of the scale-out multi-node architecture of VSPEX BLUE, EMC recommends considering the possibility of the loss of a system node. VSPEX BLUE is designed to keep copies of data on multiple nodes to protect against just such an occurrence. Any node loss impacts the virtual machines running on that node, but you need to ensure that it does not impact the other users of the VSPEX BLUE environment.

### Virtualization layer

At the virtualization layer, the hypervisor is configured to automatically restart virtual machines that fail. Figure 3 illustrates the hypervisor layer responding to a failure in the compute layer. To ensure that service levels are maintained, you should plan the compute resources with some capacity in reserve to handle services in the event of a disruption. The exact level of reserve will be dependent on your environment.



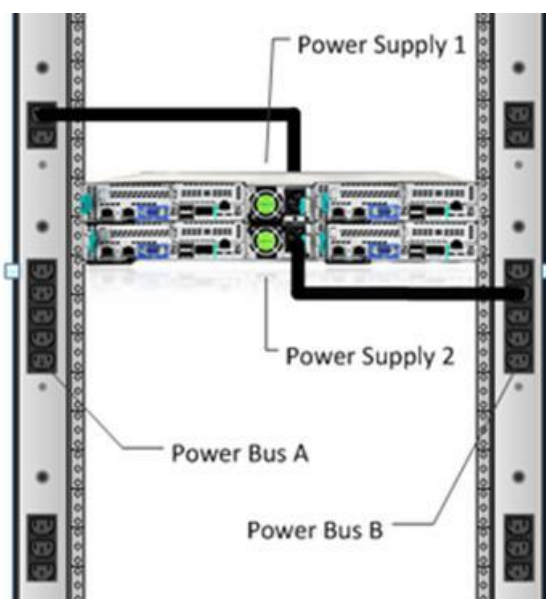
**Figure 3. High availability at the virtualization layer**

By implementing high availability at the virtualization layer, the infrastructure will attempt to keep as many services running as possible, even in the event of a hardware failure.



### Compute layer

While the server hardware is contained in the EMC VSPEX BLUE appliance, you should still plan for high availability and make use of the capabilities of the platform. The appliance has redundant power supplies, as shown in Figure 4. You should connect these to separate Power Distribution Units (PDUs) in accordance with published best practices.



**Figure 4. Redundant power supplies**

### Storage layer

The VSPEX BLUE storage is designed for high availability by using mirrored copies. Each chunk of data has a redundant copy that is created by VMware Virtual SAN, and the copy of the same chunk is never stored on the same physical node to avoid exposure during a single physical node failure. The whole VSPEX BLUE system is capable of continued operation in the event of a single physical drive or node failing. After a disk or node fails, Virtual SAN starts the rebuild process automatically. The data chunk on the failed disk or node is copied to the remaining disks or nodes. When the rebuild is complete, all data is restored to the two-copy mirror.

### Server memory

Memory is a critical component of any virtual system, and the mapping between physical memory present in a server and virtual memory presented to a guest virtual machine is a major component of the design of the target service. This section outlines some of the relevant considerations.

#### Virtual machine memory management

VMware vSphere has a number of 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 BLUE solution.

- **Memory over-commitment**

Memory over-commitment occurs when more memory is allocated to virtual machines than is physically present in a VMware vSphere host. Using sophisticated techniques such as ballooning and transparent page sharing, vSphere is able to handle memory over-commitment without any performance degradation. However, if more memory is being actively used than is present on the server, vSphere might resort to swapping portions of a virtual machine's memory.

---

**Note:** EMC VSPEX BLUE End User Compute solutions do not account for memory over-commitment in sizing examples because the performance risks associated with that configuration will depend heavily on the customer environment.

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- **Transparent page sharing**

Virtual machines running similar operating systems and applications typically have identical sets of memory content. Page sharing allows the hypervisor to reclaim the redundant copies and return them to the host's free memory pool for reuse.

- **Memory compression**

vSphere uses memory compression to store pages that would otherwise be swapped out to disk through host swapping, in a compression cache located in the main memory.

- **Memory ballooning**

This relieves host resource exhaustion by allocating free pages from the virtual machine to the host for reuse, with little to no impact on the application's performance.

- **Hypervisor swapping**

This causes the host to force arbitrary virtual machine pages out to disk.

For further information, refer to the VMware white paper [Understanding Memory Resource Management in VMware vSphere 5.0](#).

### Memory configuration guidelines

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

#### *vSphere memory overhead*

There is some memory space overhead associated with virtualizing memory resources. This overhead has two components:

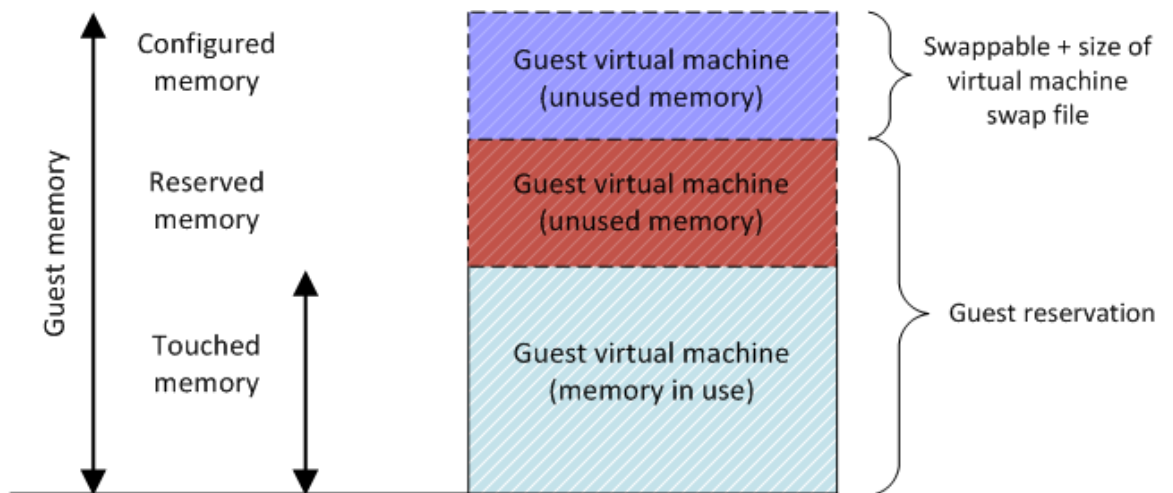
- The system overhead for the VMkernel
- Additional overhead for each virtual machine

The overhead for the VMkernel is fixed, whereas the amount of additional memory for each virtual machine depends on the number of virtual CPUs and the amount of memory configured for the guest OS.

### *Virtual machine memory settings*

Figure 5 shows the memory settings parameters in a virtual machine, including:

- **Configured memory**—Physical memory allocated to the virtual machine at the time of creation
- **Reserved memory**—Memory that is guaranteed to the virtual machine
- **Touched memory**—Memory that is active or in use by the virtual machine
- **Swappable**—Memory that can be de-allocated from the virtual machine if the host is under memory pressure from other virtual machines using ballooning, compression, or swapping.



**Figure 5. Virtual machine memory settings**

EMC recommends that you follow these best practices for virtual machine memory settings:

- Do not disable the default memory reclamation techniques. These lightweight processes provide flexibility with minimal impact to workloads.
- Intelligently size memory allocation for virtual machines.

Over-allocation wastes resources, while under-allocation causes performance impacts that can affect other virtual machines' sharing resources. Over-committing can lead to resource exhaustion if the hypervisor cannot procure memory resources. In severe cases, when hypervisor swapping occurs, virtual machine performance might be adversely affected.

Having performance baselines of your virtual machine workloads assists in this process.

### *Allocating memory to virtual machines*

Server capacity is required for two purposes in the solution:

- To support the required infrastructure services such as authentication/authorization, DNS, and database.

For further details on the hosting requirements for these infrastructure services, refer to [Chapter 4: VSPEX Blue Solution Implementation](#).

- To support the virtualized desktop infrastructure.

In this solution, each virtual desktop is assigned 2 GB of memory, as defined in [Table 5](#) on page 31. The solution was validated with statically assigned memory and no over-commitment of memory resources. If memory over-commitment is used 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.

### **Storage configuration**

The solution uses local disks included with the VSPEX BLUE hyper-converged infrastructure appliance to provide the primary storage for the solution.

#### **Validated storage configuration**

VSPEX BLUE creates a single Virtual SAN datastore from all local hard disk drives (HDDs) to connect to vSphere as the storage for virtual desktops.

The storage for user data and user profile should reside on Common Internet File System (CIFS) shares to connect to the Citrix XenDesktop desktops. If existing CIFS shares are present they can be used, otherwise it is recommended to create a Windows File Server virtual machine on the VSPEX BLUE appliance and provision storage via CIFS for use as user home directories.

#### **vSphere storage virtualization**

VMware vSphere provides host-level storage virtualization. It virtualizes the physical storage and presents the virtualized storage to the virtual machine.

A virtual machine stores its OS and all other files related to the virtual machine activities in a virtual disk. The virtual disk can be one file or multiple files. VMware uses a virtual SCSI controller to present the virtual disk to the guest OS running inside the virtual machine.

## **Network configuration**

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 needed, it is important to add capability at the hypervisor host to meet the requirements.

VSPEX BLUE recommends traffic isolation on separate VLANs for vSphere vMotion, Virtual SAN, client access, and management. For reference purposes in the validated environment, EMC assumes that each virtual desktop generates eight I/Os per second 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 220 MCS provisioned desktops, this means a minimum of approximately 7.04 MB/sec, which is well within the bounds of modern networks. However, this does not take other operations into consideration. For example, additional bandwidth is needed for:

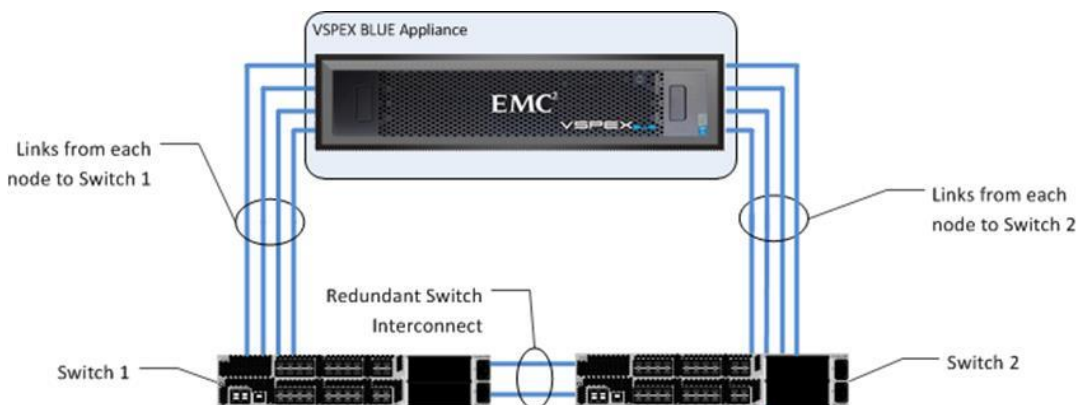
- User network traffic
- Virtual desktop migration
- Administrative and management operations
- Virtual SAN rebuild or rebalance

The requirements for each of these operations depend on how the environment is being used. It is not practical to provide concrete numbers in this context since the requirements for these operations will necessarily depend on how the system is being managed. However, the networks described for the reference architectures in this solution should be sufficient to handle average workloads for these operations.

### Network redundancy

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

Figure 6 provides an example of a highly available network topology.



**Figure 6. Highly-available network design example**

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**Note:** Each node in the appliance also contains an optional 1GbE network connection for out-of-band management.

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### Traffic isolation

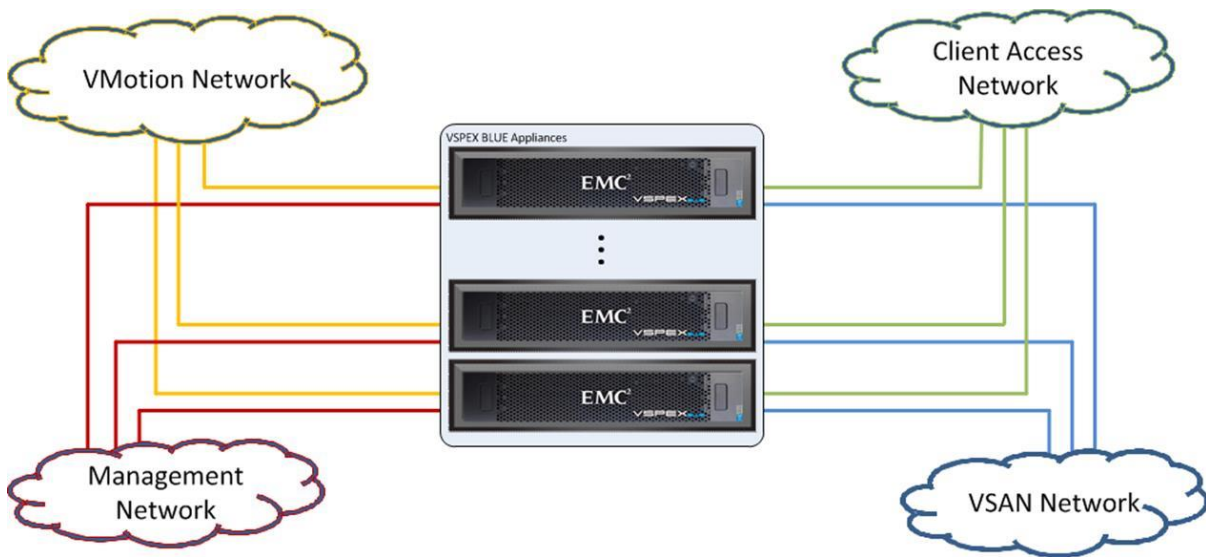
This solution uses virtual local area networks (VLANs) to segregate network traffic of various types to improve throughput, manageability, application separation, high availability, and security.

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

This solution calls for a minimum of four VLANs:

- Client access
- VMware Virtual SAN
- Management
- VMotion

Figure 7 shows the design of these VLANs.



**Figure 7. Required networks**

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.

In this solution, we used two 10 GbE networks for management, VMotion, Virtual SAN, and client access networks. These four VLANs are configured during the VSPEX BLUE initial setup.

## Solution sizing

This section describes how to size a VSPEX BLUE end-user computing for Citrix XenDesktop solution to fit the customer’s needs. It introduces the concepts of a reference workload, building blocks, and validated end-user computing maximums, and describes how to use these to size your environment. Table 4 outlines the high-level steps you need to complete when sizing the solution.

**Table 4. VSPEX BLUE end-user computing: Design process**

Step	Action
------	--------

Step	Action
1	Use the Customer Sizing Worksheet in <a href="#">Appendix C</a> to collect the customer requirements for the end-user computing environment.
2	Use the <a href="#">EMC VSPEX BLUE Sizing Tool</a> to determine the recommended VSPEX BLUE reference architecture for your end-user computing solution, based on the customer requirements collected in Step 1.  <b>Note:</b> If the Sizing Tool is not available, you can manually size the end-user computing solution using the guidelines in this chapter.

### VSPEX 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 BLUE deployment.

This solution used Login VSI 4.1 to run a user load against the desktops. Login VSI provided the guidance to gauge the maximum number of users a desktop environment can support. The Login VSI workload is categorized as task/office/knowledge/power worker, and custom. The Login VSI office worker workload is used in this reference workload.

For VSPEX BLUE end-user computing solutions, the reference workload is defined as a single virtual desktop—the reference virtual desktop—with the workload characteristics indicated in Table 5 corresponding to the Login VSI office worker workload standard.

Since customer desktops may not have the same resource requirements as the virtual desktop, the sizing approach used here is to convert the customer desktop requirement into the equivalent number of reference virtual desktops that represent those resources. This reference desktop count can be used to ensure that the solution is sized appropriately. This is described in detail in the [Customer sizing worksheet](#) section.

**Table 5. Reference virtual desktop characteristics**

Characteristic	Value
Virtual desktop type	Desktop OS (PvD and non-PvD desktop types): Microsoft Windows 7 Enterprise Edition (32-bit)
Virtual processors per virtual desktop	1
RAM per virtual desktop	2 GB
Average IOPS per virtual desktop at steady state	10

This desktop definition is based on user data that resides on Windows File Server running on VSPEX BLUE. 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.

**Validation test profile**

Table 6 shows the desktop definition and storage configuration parameters that we validated with the environment profile.

**Table 6. Validated environment profile**

Profile characteristic	Value
Virtual desktop OS	Windows 7 Enterprise (32-bit) SP1
vCPU per virtual desktop	1 vCPU per desktop
Number of virtual desktops per physical CPU core	4.5 (average)
RAM per virtual desktop	2 GB
Desktop provisioning method	MCS and PVS
Average IOPS per virtual desktop at steady state	10 IOPS
Number of datastores to store virtual desktops	1

**Note:** The 4.5:1 vCPU to physical core ratio applies to the reference workload defined in this Proven Infrastructure Guide. Additional software deployed as part of the desktop image may change the required ratio.

**VSPEX BLUE building blocks**

Sizing the system to meet the end-user computing requirement can be a complicated process. When applications generate an I/O operation, server components, such as server CPU, server dynamic random access memory (DRAM) cache, and disks, serve that I/O. Customers must consider various factors when planning and scaling their infrastructure to balance capacity, performance, and cost for their applications.

VSPEX BLUE uses a building block approach to linearly scale out and reduce complexity. A building block is an appliance with pre-defined CPU, memory, and disk spindles that can support a specific number of virtual desktops. The building block for the solution supports the optional infrastructure services that are available on VSPEX BLUE.

**Validated building block**

The configuration of a building block includes the physical CPU core number, memory size, and disk spindle per appliance.

Table 7 shows the aggregated compute and storage resources of all four nodes of a VSPEX BLUE appliance building block that have been validated to support up to 220 virtual desktops with both MCS and PVS provisioning methods.

**Note:** A single VSPEX BLUE appliance supports up to 220 virtual desktops. For larger configurations VSPEX BLUE can scale to more than one appliance. Using this method you



can support up to 440 desktops with two appliances and 880 desktops with four appliances.

The scale points indicated in this section represent the maximum recommended values for the system and do not maintain any resources in reserve to address node failure conditions or high-availability planning.

**Table 7. Building block appliance configuration with persistent or non-persistent desktops**

Reference virtual desktops	Physical CPU cores	Memory (GB)	SSD drives	10 K SAS drives
220	48	768	4	12

Building block configurations are shown for the following desktop types:

*Persistent desktops with Personal vDisk:*

Persistent Desktops are created using Citrix Personal vDisks (PvD). The PvD Desktops are created by selecting “Desktop OS with personal vDisk desktop experience.” A user is assigned to a particular desktop and all the changes made by the user are stored on personal vDisk and saved between reboots.

*Non-persistent desktops:*

Non-Persistent Desktops are created by selecting “Desktop OS with Random desktop experience.” A user is randomly connected to one of the available desktops and all changes made by the user are lost upon reboot.

**Scaling out**

A VSPEX BLUE appliance consists of four independent nodes. This solution is validated with the performance model. Each node has the following core hardware components:

- Two Intel E5-2620v2 six-core CPUs
- 192GB of memory
- Two 10GbE ports for all network traffic
- Three SAS 10K RPM 1.2TB HDD for the VMware Virtual SAN datastore
- One 400 GB MLC enterprise-grade SSD for Virtual SAN read/write cache

EVO:RAIL version 1.0 can scale out to four appliances for a total of 16 ESXi hosts. This solution validated the VSPEX BLUE configurations of a single appliance with four hosts. Unlike most traditional storage systems, as the number of servers grows, so does capacity and throughput. The scalability of performance is linear with regard to the growth of the deployment. Whenever the need arises, additional appliances can be added modularly. Storage and compute resources grow together so the balance between them is maintained.

## Customer sizing worksheet

To choose the appropriate reference architecture for a customer environment, first 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 5 on page 31](#). This section describes how to use the Customer Sizing Worksheet to simplify the sizing calculations and factors you should take into consideration when deciding which architecture to deploy.

### Using the worksheet

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

Table 8 shows an example worksheet for a sample customer environment. [Appendix C](#) provides a blank Customer Sizing Worksheet that you can print out and use to help size the solution for a customer. This section helps you complete this worksheet.

**Table 8. Customer Sizing Worksheet example (blank)**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
Total							

To complete the Customer Sizing Worksheet, follow these steps:

1. Identify the user types planned for migration into the VSPEX BLUE 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.

### Identify the user types

Different types of users require different capabilities in their desktop environments. When determining the size of the system to deploy it is important to consider these requirements separately. For example, you may have a large group of “Typical Users”; these users may require email, office applications, and little else. There is likely a smaller group of “Moderate Users” who have more demanding applications, or keep more things open at once on their desktop and consequently have slightly different requirements for their virtual desktop resources. Finally, a small group of “Heavy Users” may run specialty applications that have significant resource needs

well above what is required by the typical desktop environment. The first step in using the Customer Sizing Worksheet is to identify these groups and the level of resources they require.

Each group of users will be identified and assigned resources separately in the Customer Sizing Worksheet, as shown in Table 9.

**Table 9. Customer Sizing Worksheet example with user numbers added**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
Heavy Users	10	Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
Moderate Users	30	Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
Typical Users	100	Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
Total							

**Determining the resource requirements**

Consider the following factors when determining resource requirements.

*CPU*

The reference virtual desktop outlined in Table 5 assumes that most desktop applications are optimized for a single CPU. 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 must 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 amount of available memory that is considered acceptable. Like the CPU calculation, if a group of users requires

additional memory resources, simply adjust the number of planned desktops to accommodate the additional resource requirements.

For example, if there are 100 desktops to be virtualized, but each one needs 4 GB of memory instead of the 2 GB that the reference virtual desktop provides, plan for 200 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 run 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 type of provisioning, the types of applications in use, and specific customer policies. The virtual desktops in this solution rely on additional shared storage on VSPEX BLUE for user profile data and user documents. This requirement is an optional component that can also be met by using existing file shares in the environment.

Using this information, fill in the “Resource Requirements” line in the Customer Sizing Worksheet for each group of users, as shown in Table 10.

**Table 10. Customer Sizing Worksheet example with resource requirements added**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
Heavy Users	10	Resource Requirements	2	8 GB	12	---	---
		Equivalent Reference Virtual Desktops					
Moderate Users	30	Resource Requirements	2	4 GB	10	---	---
		Equivalent Reference Virtual Desktops					
Typical Users	100	Resource Requirements	1	2 GB	10	---	---
		Equivalent Reference Virtual Desktops					
Total							

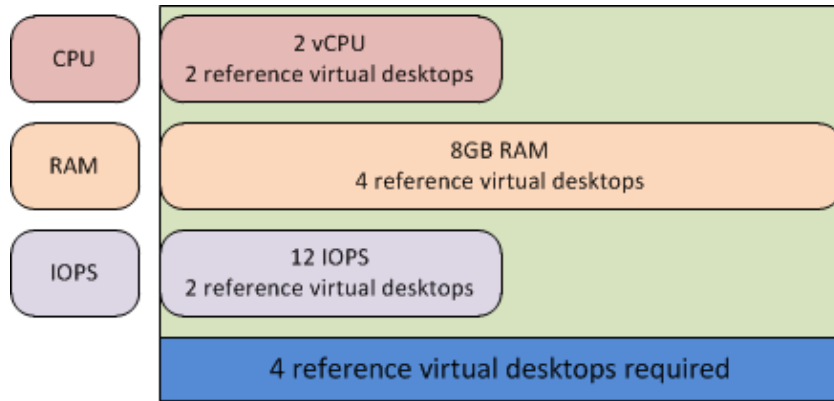
**Determining the equivalent reference virtual desktops**

With all of the resources defined, determine the number of equivalent reference virtual desktops by using the relationships listed in Table 11. Round all values up to the closest whole number.

**Table 11. Reference virtual desktop resources**

Resource	Value for reference virtual desktop	Relationship between requirements and equivalent reference virtual desktops
CPU	1	Equivalent reference virtual desktops = Resource requirements
Memory	2	Equivalent reference virtual desktops = Resource requirements/2
IOPS	10	Equivalent reference virtual desktops = Resource requirements/10

For example, the heavy user type in Table 10 requires two virtual CPUs, twelve IOPS, and eight GB of memory for each desktop. This translates to two reference virtual desktops of CPU, four reference virtual desktops of memory, and two reference virtual desktops of IOPS. As shown in Figure 8, the example requires four virtual machines.



**Figure 8. Required resources from the reference virtual machine pool**

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 10 is four, as this number will meet the resource requirements for IOPS, vCPU, and memory.

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

Using this information, fill in the “Equivalent Reference Virtual Desktops” line in the Customer Sizing Worksheet for each group of users, as shown in Table 12.

**Table 12. Customer Sizing Worksheet example with equivalent reference virtual desktops added**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
Heavy Users	10	Resource Requirements	2	8 GB	12	---	---
		Equivalent Reference Virtual Desktops	2	4	2	4	
Moderate Users	30	Resource Requirements	2	4 GB	10	---	---
		Equivalent Reference Virtual Desktops	2	2	1	2	
Typical Users	100	Resource Requirements	1	2 GB	10	---	---
		Equivalent Reference Virtual Desktops	1	1	1	1	
Total							

**Determining the total reference virtual desktops**

After the worksheet is completed for each user type that the user wants to migrate into the virtual infrastructure, 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 13, the total is 200 virtual desktops.



**Table 13. Customer Sizing Worksheet example with totals calculated**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
Heavy Users	10	Resource Requirements	2	8 GB	12	---	---
		Equivalent Reference Virtual Desktops	2	4	2	4	40
Moderate Users	30	Resource Requirements	2	4 GB	10	---	---
		Equivalent Reference Virtual Desktops	2	2	1	2	60
Typical Users	100	Resource Requirements	1	2 GB	10	---	---
		Equivalent Reference Virtual Desktops	1	1	1	1	100
Total							200

In the example, there are 140 users of the system, but due to their resource requirements, they need the equivalent of 200 “reference desktops” of capability in the system design.

### Calculating the building block requirement

The VSPEX BLUE end-user computing building block defines discrete server appliance sizes—for example, an appliance defined in [Table 7](#) supports 220 reference virtual desktops with MCS provisioning. The total number of reference virtual desktops from the completed worksheet is used to determine how many building blocks are required to meet the customer requirements. In the example in [Table 13](#), the customer requires 200 virtual desktops of capability from the pool. Therefore, one building block defined in [Table 7](#) provides sufficient resources for current needs and room for growth.

In addition to the validated desktop numbers, consider the following factors when deciding which reference architecture to deploy:

- **Concurrency**—The reference workload used to validate this solution assumes that all desktop users will be active at all times. We tested the reference architecture with 220 desktops, all generating workload in parallel, all booted at the same time, and so on. If the customer expects to have 400 users, but only 50 percent of them will be logged on at any given time due to time zone

differences or alternate shifts, then 200 active users out of the total 400 users can be supported by the 220-desktop capacity of a single appliance.

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

If a company has 214 users and, due to custom corporate applications, each user generates 14 IOPS as compared to the 10 IOPS used in the reference workload, you need about 300 reference desktops. In this example, a single appliance configuration is underpowered because it has been rated to 220 reference desktops. In this circumstance, you should deploy two appliances bringing the aggregate number of desktops supported up to 440, which is sufficient to meet the requirements.

- **High Availability** – The scale points indicated in this section represent the maximum recommended values for the system and do not maintain any resources in reserve to address node failure conditions or high-availability planning as described in this chapter. In environments where high-availability is desired, it is recommended to leave some resources in reserve to cover that requirement. When sizing this solution with the VSPEX Sizing Tool, the default behavior is to maintain 25% reserve capacity so that system performance can be maintained in the event of a single node failure.

### Summary

The requirements stated 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 varies 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 may need to add more of that resource to the system.

## Chapter 4 VSPEX BLUE Solution Implementation

This chapter presents the following topics:

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<b>Installing and configuring the VSPEX BLUE Appliance.....</b>	<b>46</b>
<b>Installing and configuring the SQL Server database .....</b>	<b>46</b>
<b>Installing and configuring XenDesktop Delivery Controllers .....</b>	<b>47</b>
<b>Installing and configuring Citrix Provisioning Services (PVS).....</b>	<b>49</b>

## Overview

This chapter describes how to implement the reference architectures of the end-user computing solution. If you already have an existing infrastructure environment, you can skip the sections that are not applicable for your infrastructure.

Table 14 lists the main stages in the solution implementation process, with links to the relevant sections in the chapter.

**Table 14. Implementation process overview**

Stage	Description	Reference
1	Configure the switches and networks and connect to the customer network.	<a href="#">Setting up the network</a>
2	Install and configure the VSPEX BLUE appliance.	<a href="#">VSPEX BLUE Installation Guide</a>
3	Set up SQL Server (used by Citrix XenDesktop and Provisioning Services).	<a href="#">Installing and configuring the SQL Server database</a>
4	Set up XenDesktop Controller.	<a href="#">Installing and configuring XenDesktop Delivery Controllers</a>
5	Set up Citrix Provisioning Services.	<a href="#">Installing and configuring Citrix Provisioning Services (PVS)</a>
6	Provision virtual desktops.	<a href="#">Provisioning the virtual desktops</a>

---

**Note:** The infrastructure services and virtual desktops can coexist on the first appliance. Subsequent appliances can be configured to support virtual desktops only.

---

## Setting up the network

This section describes the requirements for preparing the network infrastructure required to support this solution. Table 15 summarizes the tasks to be completed, with references for further information.

**Table 15. Tasks for switch and network configuration**

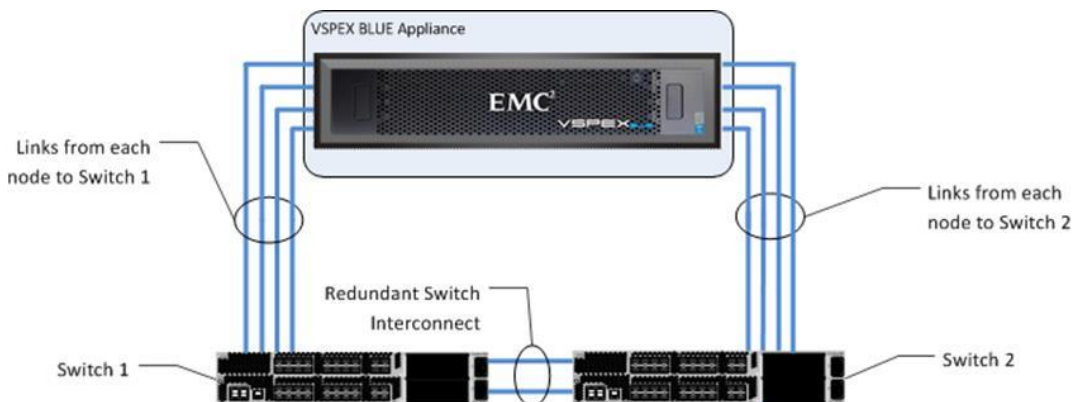
Task	Description	Reference
Configure the infrastructure network	Configure the vSphere host infrastructure networking.	<a href="#">Configuring the infrastructure network</a>
Configure the VLANs	Configure private and public VLANs as required.	<ul style="list-style-type: none"> <li>• <a href="#">Configuring the VLANs</a></li> <li>• Vendor's switch configuration guide</li> </ul>
Complete the network cabling	Connect the switch interconnect ports, and vSphere server ports.	<a href="#">Completing the network cabling</a>

### Configuring the infrastructure network

The infrastructure network requires redundant network links for each vSphere host and the switch interconnect and switch uplink ports. This configuration provides both redundancy and additional network bandwidth.

This configuration is required regardless of whether the network infrastructure for the solution already exists or is being deployed with other components of the solution.

Figure 9 shows a sample redundant Ethernet infrastructure for this solution. It illustrates the use of redundant switches and links to ensure that no single point of failure exists in network connectivity.



**Figure 9. Sample Ethernet network architecture**

In this solution, we used two 10 GbE networks for management, vMotion, Virtual SAN, and client access networks.

### Configuring the VLANs

Ensure that there are adequate switch ports for the storage array and vSphere hosts. EMC recommends that you configure the vSphere hosts with a minimum of four VLANs:

- **Client access network:** Virtual machine networking
- **Virtual SAN network:** Virtual SAN data networking
- **Management network:** vSphere management
- **vMotion network:** VMware vMotion

### Completing the network cabling

Ensure that all solution servers, switch interconnects, and switch uplinks have redundant connections and are plugged into separate switching infrastructures. Ensure that there is a complete connection to the existing customer network.

## Installing and configuring the VSPEX BLUE Appliance

The *EMC VSPEX BLUE Installation* Guide includes step-by-step instructions on setting up the appliance hardware, as well as the EVO:RAIL software. As soon as the EVO:RAIL software is initialized, the VSPEX BLUE appliance will be up and running with two preloaded system virtual machines: vCenter server appliance and vCenter Log Insight. Use the following URLs to access the management interfaces of EVO:RAIL and vCenter server:

- EVO:RAIL management: <https://<evorail-mgmt-ip>:7443/>
- vCenter management via vSphere web client: <https://<vCenter-ip>:9443/>

For more information on completing the installation of the VSPEX BLUE appliance, refer to the VSPEX BLUE Installation Guide.

## Installing and configuring the SQL Server database

Table 16 describes the tasks for setting up and configuring a Microsoft SQL Server database for the solution. When the tasks are complete, SQL Server is set up on a virtual machine, with all the databases required by Citrix XenDesktop and Provisioning Services (optional for MCS) configured for use.

---

**Note:** EMC recommends that you put the OS volume for the SQL Server virtual machine into the VSPEX BLUE appliance. The recommended values for CPU and memory are 2 vCPUs and 6 GB respectively.

---

**Table 16. Tasks for SQL Server database setup**

Task	Description	Reference
Create a virtual machine for Microsoft SQL Server	Create a virtual machine to host SQL Server on one of the vSphere servers designated for infrastructure virtual machines, and use the datastore designated for the shared infrastructure.  Verify that the virtual server meets the hardware and software requirements.	<i>vSphere Virtual Machine Administration</i>
Install Microsoft Windows Server on the virtual machine	Install Microsoft Windows Server 2012 R2 on the virtual machine.	<a href="#"><i>Installing Windows Server 2012 R2</i></a>
Install Microsoft SQL Server	Install Microsoft SQL Server on the virtual machine.	<a href="#"><i>SQL Server Installation (SQL Server 2012)</i></a>

## Installing and configuring XenDesktop Delivery Controllers

This section provides information on how to set up and configure XenDesktop Delivery Controllers for the solution. For a new installation of XenDesktop, Citrix recommends that you complete the tasks in Table 17 in the order shown.

**Table 17. Tasks for XenDesktop controller setup**

Task	Description	Reference
Creating virtual machines for XenDesktop Delivery Controllers	Create two virtual machines in the vSphere Client. These virtual machines are used as XenDesktop Delivery Controllers.	<i>vSphere Virtual Machine Administration</i>
Installing the guest operating system for the XenDesktop Delivery Controllers	Install the Windows Server 2012 R2 or Windows Server 2012 guest operating system on the virtual machines.	
Installing the XenDesktop server-side components	Install the required XenDesktop server components on the first Delivery Controller.	<a href="#">Citrix website</a>
Installing Citrix Studio	Install Citrix Studio to manage XenDesktop deployment remotely.	
Configuring a site	Configure a site in Citrix Studio.	
Adding a second XenDesktop Delivery Controller	Install an additional Delivery Controller for high availability.	
Preparing a master virtual machine	Create a master virtual machine as the base image for the virtual desktops.	
Provisioning the virtual desktops	Provision the virtual desktops using MCS.	

### Installing server-side components of XenDesktop

Install the following XenDesktop server-side components on the first Delivery Controller, as described in Citrix documentation:

- **Delivery Controller:** Distributes applications and desktops, manages user access, and optimizes connections
- **Citrix Studio:** Creates, configures and manages infrastructure components, applications, and desktops
- **Citrix Director:** Monitors performance and troubleshoot problems
- **License server:** Manages product licenses
- **Citrix StoreFront:** Provides authentication and resource delivery services for Citrix Receiver

### Configuring a site

Start Citrix Studio and configure a site as follows:

1. License the site and specify which edition of XenDesktop to use.
2. Set up the site database using a designated login credential for SQL Server.
3. Provide information about your virtual infrastructure, including the vCenter SDK path that the controller will use to establish a connection to the VMware infrastructure.

### Adding a second controller

After you have configured a site, you can add a second Delivery Controller to provide high availability. The XenDesktop server-side components required for the second controller are:

- Delivery Controller
- Citrix Studio
- Citrix Director
- Citrix StoreFront

Do not install the license-server component on the second controller because it is centrally managed on the first controller.

### Installing Citrix Studio

Install Citrix Studio on the appropriate administrator consoles to manage your XenDesktop deployment remotely.

### Preparing the master virtual machine

Complete the following steps to prepare the master virtual machine:

1. Install the Windows 7 guest OS.
2. Install appropriate integration tools such as VMware Tools.
3. Optionally, optimize the OS settings to prevent unnecessary background services from generating inessential I/O operations that adversely affect the overall performance of the storage array. Refer to the following White Paper for details: [Citrix Windows 7 Optimization Guide for Desktop Virtualization](#).
4. Install the Virtual Delivery Agent.



5. Install the third-party tools or applications, such as Microsoft Office, relevant to your environment.

## Provisioning the virtual desktops

Complete the following steps in Citrix Studio to deploy MCS-based virtual desktops:

1. Create a machine catalog using the master virtual machine as the base image.

MCS allows the creation of a machine catalog that contains various types of desktops. We tested the following desktop types for this solution:

- **Windows Desktop OS:**
    - **Random:** Users connect to a new (random) desktop each time they log on.
    - **Personal vDisk:** Users connect to the same (static) desktop each time they log on. Changes are saved on a separate Personal vDisk.
  - **Windows Server OS:** Provides hosted shared desktops for deployment of standardized machines
2. Add the machines created in the catalog to a delivery group so that the virtual desktops are available to the end users.

## Installing and configuring Citrix Provisioning Services (PVS)

This section provides information about how to set up and configure Citrix PVS for the solution.

---

**Note:** This is not required for MCX-only deployments.

---

For a new installation of PVS, Citrix recommends that you complete the tasks in Table 18 in the order shown.

**Table 18. Tasks for XenDesktop controller setup**

Task	Description	Reference
Creating virtual machines for PVS servers	Create two virtual machines in the vSphere Client. These virtual machines are used as PVS servers.	<i>vSphere Virtual Machine Administration</i>
Installing the guest operating system for the PVS servers.	Install the Windows Server 2012 R2 or Windows Server 2012 guest OS for the PVS servers.	
Installing the PVS server-side components	Install the PVS server components and console on the PVS server.	<a href="#">Citrix website</a>
Configuring a PVS server farm	Run the Provisioning Services Configuration Wizard to create a PVS server farm.	
Adding a second PVS server	Install the PVS server components and console on the second server and join it to the existing server farm.	

Task	Description	Reference
Creating a PVS store	Specify the store path where the vDisks will reside.	
Configuring inbound communication	Adjust the total number of threads to be used to communicate with each virtual desktop.	
Configuring a bootstrap file	Update the bootstrap image to use both PVS servers to provide streaming services	
Configuring boot options 66 and 67 on the DHCP server	Specify the TFTP server IP and the name of the bootstrap image used for the Preboot eXecution Environment (PXE) boot	
Preparing a master virtual machine	Create a master virtual machine as the base image for the virtual desktops.	
Provisioning the virtual desktops	Provision the virtual desktops using PVS.	

### Configuring a PVS server farm

After the PVS server components are installed on the PVS server, start the Provisioning Services Configuration Wizard and configure a new server farm using the following options:

1. Specify the DHCP service to be run on another computer.
2. Specify the PXE service to be run on this computer.
3. Select **Create farm** to create a new PVS server farm using a designated SQL database instance. When creating a new server farm, you need to create a site. Provide an appropriate name for the new site and target device collection.
4. Select the license server that is running on the XenDesktop controller.
5. Select **Use the Provisioning Services TFTP service**.

### Adding a second PVS server

After you have configured a PVS server farm, you can add a second PVS server to provide high availability. Install the PVS server components and console on the second PVS server and run the Provisioning Services Configuration Wizard to join the second server to the existing server farm.

### Creating a PVS store

A PVS store is a logical container for vDisks. PVS supports the use of a CIFS share as the storage target of a PVS store. To create a PVS store, follow these steps:

1. Set the default store path to the local PVS drive or universal naming convention (UNC) path of a CIFS share that is hosted on the shared storage such as a Windows File Server virtual machine running on VSPEX BLUE.
2. Right-click a store in the **Provisioning Services** console.
3. Select **Properties** and **Validate** to confirm that all PVS servers in the server farm can access the CIFS share.

## Configuring inbound communication

Each PVS server maintains a range of User Datagram Protocol (UDP) ports to manage all inbound communications from virtual desktops. Ideally, there should be one thread dedicated to each desktop session. The total number of threads supported by a PVS server is calculated as:

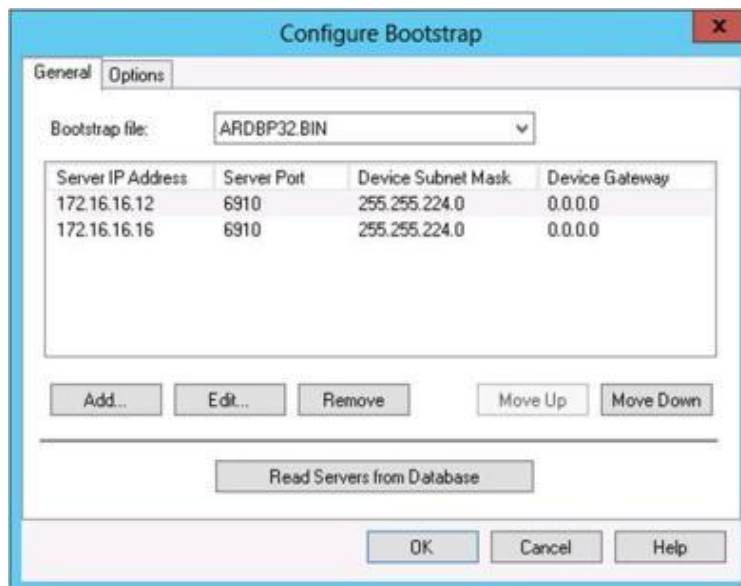
$$\text{Total threads} = (\text{Number of UDP ports} * \text{Threads per port} * \text{Number of network adapters})$$

Adjust the thread count accordingly to match the number of deployed virtual desktops.

## Configuring a bootstrap file

To update the bootstrap file required for the virtual desktops to PXE boot, complete the following steps:

1. In the Provisioning Services console, select **Farm > Sites > Site-name > Servers**.
2. Right-click a server and select **Configure Bootstrap**. The **Configure Bootstrap** dialog box appears, as shown in Figure 10.



**Figure 10. Configure Bootstrap dialog box**

3. Update the bootstrap image to reflect the IP addresses used for all PVS servers that provide streaming services in a round-robin fashion. Select **Read Servers from Database** to obtain a list of PVS servers automatically or select **Add** to manually add the server information. If the PVS server information is incorrect (IP address, port, subnet mask, or default gateway), highlight the PVS server entry and select **Edit** to make the change.
4. After modifying the configuration, click **OK** to update the ARDBP32.BIN bootstrap file, which is located at C:\ProgramData\Citrix\Provisioning Services\Tftpboot.
5. Navigate to the folder and examine the timestamp of the bootstrap file to ensure that it is updated on the intended PVS server.

### Configuring boot options 66 and 67 on DHCP server

To PXE boot the virtual desktops successfully from the bootstrap image supplied by the PVS servers, set the boot options 66 and 67 on the Microsoft DHCP server.

Complete the following steps to configure the boot options on the DHCP server:

1. From the DHCP management interface of the DHCP server, right-click **Scope Options** and select **Configure Options**.
2. Select **066 Boot Server Host Name**. In **String value**, type the IP address of the PVS server configured as the TFTP server.
3. Select **067 Bootfile Name**. In **String value**, type **ARDBP32.BIN**. The ARDBP32.BIN bootstrap image is loaded on a virtual desktop before the vDisk image is streamed from the PVS servers.

### Preparing the master virtual machine

Complete the following steps to prepare the master virtual machine:

1. Install the Windows 7 guest OS.
2. Install appropriate integration tools such as VMware Tools.
3. Optionally, optimize the OS settings to prevent unnecessary background services from generating inessential I/O operations that adversely affect the overall performance of the storage array. Refer to the following White Paper for details: [Citrix Windows 7 Optimization Guide for Desktop Virtualization](#).
4. Install the Virtual Delivery Agent.
5. Install the third-party tools or applications, such as Microsoft Office, relevant to your environment.
6. Install the PVS target device software on the master virtual machine.
7. Modify the BIOS of the master virtual machine so that the network adapter is at the top of the boot order to ensure PXE boot of the PVS bootstrap image.

### Provisioning the virtual desktops

Complete the following steps to deploy the PVS-based virtual desktops:

1. Run the PVS imaging wizard to clone the master image onto a vDisk.
2. When the cloning is complete, shut down the master virtual machine and modify the following vDisk properties:
  - **Access mode:** Standard Image
  - **Cache type:** Cache in device RAM with overflow on hard disk
3. Prepare a virtual machine template to be used by the XenDesktop Setup Wizard in the next step.
4. Run the XenDesktop Setup Wizard in the PVS console to create a machine catalog that contains the specified number of virtual desktops.
5. Add the virtual desktops created in the catalog to a delivery group so that the virtual desktops are available to the end users.

# Chapter 5 Verifying the Solution

This chapter presents the following topics:

- Overview .....54**
- Verifying installation with post-installation checklist.....54**
- Deploying and testing a single virtual desktop .....55**
- Verifying the redundancy of the solution components .....55**

## Overview

After you configure the solution, complete the tasks in Table 19 to verify the configuration and functionality of specific aspects of the solution and ensure that the configuration supports core availability requirements.

**Table 19. Tasks for testing the installation**

Task	Description	Reference
Verify installation with post installation checklist	Verify that adequate virtual ports exist on each vSphere host virtual switch.	<i>vSphere Networking</i>
	Verify that each vSphere host has access to the required datastores and VLANs.	<ul style="list-style-type: none"> <li>• <i>vSphere Storage Guide</i></li> <li>• <i>vSphere Networking</i></li> </ul>
	Verify that the vMotion interfaces are configured correctly on all vSphere hosts.	<i>vSphere Networking</i>
Deploy and test a single virtual desktop	Deploy a single virtual machine from the vSphere interface by using the customization specification.	<ul style="list-style-type: none"> <li>• <i>vCenter Server and Host Management</i></li> <li>• <i>vSphere Virtual Machine Management</i></li> </ul>
Verify redundancy of the solution components	Verify the redundancy of switches.	Vendor documentation
	Verify the virtual machine vMotion.	<i>vCenter Server and Host Management</i>
Provision remaining virtual desktops	Provision desktops using MCS or PVS.	<ul style="list-style-type: none"> <li>• <a href="#">Installing and configuring XenDesktop Delivery Controllers</a></li> <li>• <a href="#">Installing and configuring Citrix Provisioning Services (PVS)</a></li> </ul>

## Verifying installation with post-installation checklist

The following configuration items are critical to the functionality of the solution, and should be verified prior to deployment into production. On each vSphere server used as part of this solution, verify that:

- The vSwitches hosting the client VLANs are configured with sufficient ports to accommodate the maximum number of virtual machines a host can accommodate.
- All the required virtual machine port groups are configured and each server has access to the required VMware datastores.
- The interface is configured correctly for vMotion. Refer to *vSphere Networking* for details.

Refer to the list of documents in [Appendix A](#) for more information.

## Deploying and testing a single virtual desktop

Deploy a single virtual machine to verify the operation of the solution. Ensure that the virtual machine has been joined to the applicable domain, has access to the expected networks, and that it is possible to log in.

## Verifying the redundancy of the solution components

To ensure that the various components of the solution maintain availability requirements, test the following scenarios that are related to maintenance or hardware failures:

- Power off one VSPEX BLUE node and ensure that the data access of the Virtual SAN datastore is maintained and that the data rebuild process is running properly.
- Disable each of the redundant switches in turn and verify that the vSphere host virtual machine remains intact.
- On a vSphere host that contains at least one virtual machine, enable maintenance mode and verify that the virtual machine can successfully migrate to an alternate host.

# Appendix A Reference Documentation

This appendix presents the following topics:

<b>EMC documentation .....</b>	<b>57</b>
<b>Other documentation .....</b>	<b>57</b>



## EMC documentation

The following documents, located on [EMC Online Support](#), provide additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your EMC representative.

- *EMC VSPEX BLUE Installation Guide*
- *Deploying Microsoft Windows 8 Virtual Desktops*

## Other documentation

### VMware

The following documents, available on the [VMware website](#), provide additional and relevant information:

- *Understanding Memory Resource Management in VMware vSphere 5.0*
- *vCenter Server and Host Management*
- *vSphere Installation and Setup Guide*
- *vSphere Networking*
- *vSphere Resource Management*
- *vSphere Storage Guide*
- *vSphere Virtual Machine Administration*
- *VMware EVO:RAIL User Guide: Configuration and Management*
- *What's New in VMware Virtual SAN*
- *VMware Virtual SAN Design and Sizing Guide*

### Citrix

Refer to the [Citrix](#) website for Citrix XenDesktop documentation, including:

- *Citrix Windows 7 Optimization Guide for Desktop Virtualization*

### Microsoft

Refer to the following topics on the Microsoft TechNet and Microsoft MSDN websites:

- *Installing Windows Server 2012 R2*
- *SQL Server Installation (SQL Server 2012)*

# Appendix B Customer Configuration Worksheet

This appendix presents the following topics:

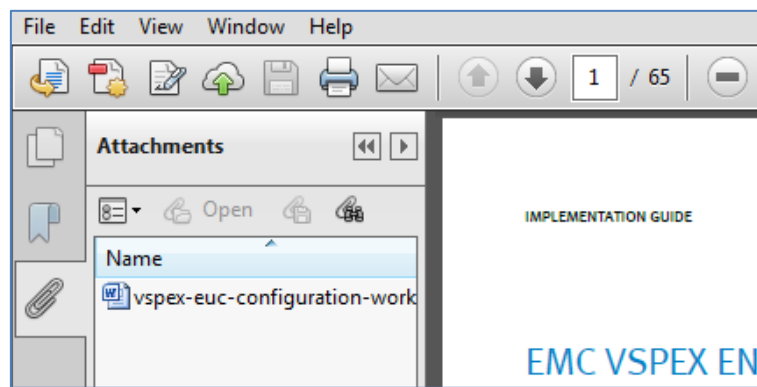
**Customer Configuration Worksheet .....59**

## Customer configuration worksheet

Before configuring the solution, you need to gather some customer-specific configuration information such as IP addresses, hostnames, and so on. You can use the tables in this appendix as a worksheet to record the information. You can also print the worksheet and give it to the customer for future reference.

A standalone copy of the worksheet is attached to this document in Microsoft Office Word format. To view and print the worksheet:

- 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 11.



**Figure 11. Opening attachments in a PDF file**

- Under **Attachments**, double-click the attached file to open and print the worksheet.

Use the tables below to record the server, vSphere, network infrastructure, VLAN, and service account information for your configuration.

**Table 20. Common server information**

Server name	Purpose	Primary IP
	Domain Controller	
	DNS Primary	
	DNS Secondary	
	DHCP	
	NTP	
	SMTP	
	SNMP	
	VMware vCenter Console	
	XenDesktop Console	
	Microsoft SQL Server	
	Provisioning Services Console	

**Table 21. ESXi node information**

Server Name	Purpose	Primary IP	Private Net (storage) addresses	VMkernel IP	vMotion IP	Virtual SAN IP
	ESXi node 1					
	ESXi node 2					
	ESXi node 3					
	ESXi node 4					

**Table 22. Network infrastructure information**

Name	Purpose	IP	Subnet mask	Default gateway
	Ethernet switch 1			
	Ethernet switch 2			
	...			

**Table 23. VLAN information**

Name	Network purpose	VLAN ID	Allowed subnets
	Client access network		

Name	Network purpose	VLAN ID	Allowed subnets
	Virtual SAN network		
	Management network		
	vMotion network		

Table 24. Service accounts

Account	Purpose	Password (optional, secure appropriately)
	Windows Server administrator	
Root	vSphere root	
	VMware vCenter administrator	
	Citrix XenDesktop administrator	
	SQL Server administrator	
	Citrix Provisioning Services administrator	

# Appendix C Customer Sizing Worksheet

This appendix presents the following topics:

**Customer Sizing Worksheet for end-user computing .....63**

## 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 25 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.

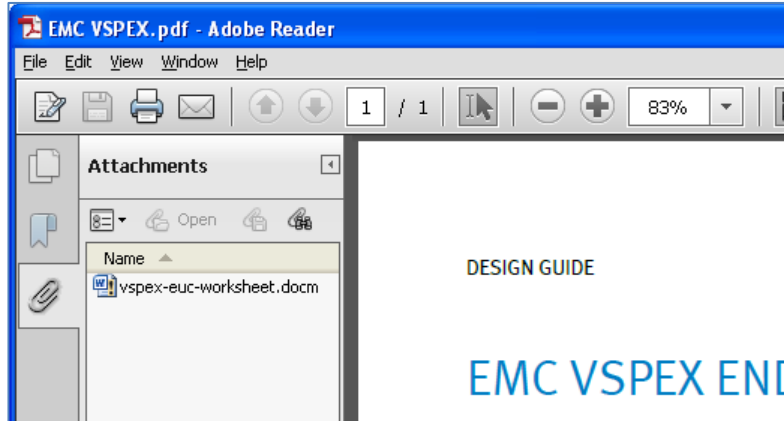
**Table 25. Customer sizing worksheet**

User Type	Number of Users		CPUs	RAM	IOPS	Equivalent Reference Virtual Desktops	Total Reference Desktops
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
		Resource Requirements				---	---
		Equivalent Reference Virtual Desktops					
Total							

## Printing the worksheet

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 12.



**Figure 12. Printable customer sizing worksheet**

2. Under **Attachments**, double-click the attached file to open and print the worksheet.