



# VMware Horizon with View Reference Implementation Case Study for Carroll Hospital Center

Architecture for 1,500 End Users and Multiple Data Centers

TECHNICAL WHITE PAPER

## Table of Contents

Introduction .....	4
VMware Reference Implementation Case Studies .....	4
Executive Summary .....	5
Implementation Overview .....	5
Project Overview .....	5
Architecture Overview .....	6
VMware Horizon .....	7
Horizon Solution Components .....	8
CHC Reference Implementation .....	9
Business Drivers, Business Case, and Benefits .....	10
Business Drivers .....	10
Business Case .....	11
Benefits .....	11
Project Overview .....	11
Lessons Learned .....	12
Architecture .....	13
View Logical Infrastructure Design .....	13
View Management Block Design .....	13
View Pod Logical Design .....	13
View Desktop Block Design .....	14
Virtual Desktop Design .....	14
Logical Storage Infrastructure Design .....	15
Network Infrastructure .....	16
Conclusion .....	17
Appendix: Detailed Design .....	18
End-User Experience Design .....	18
User Classification Categories .....	18
User Workload Categories .....	19
Application Requirement Categories .....	19
Use Case Definitions .....	24
Virtual Desktop Pool Design .....	25
Virtual Desktop Pool Attributes .....	25
Refresh, Recompose, and Refresh Schedule .....	26
Desktop Pool Deployment and Maintenance of Full Clone Virtual Machines .....	26
View Pool Policies .....	27

Storage Performance Requirements .....	27
View Pod .....	28
VMware vCenter Server Settings .....	29
View Management Block .....	29
VMware vCenter Configuration .....	29
View Connection Servers Specifications .....	29
View Security Servers Specifications .....	30
View Desktop Block .....	31
Parent Desktop Virtual Machine - Virtual Hardware Specifications .....	31
Virtual Desktop Guest Operating System .....	31
View Desktop Operating System Specification .....	31
View Desktop Block Shared Storage .....	32
End-User Experience Configuration .....	34
Antivirus Scanning and Updates .....	35
Microsoft Outlook Cached Exchange Mode .....	35
Virtual Printing .....	36
Location-Based Printing .....	36
Authors and Contributors .....	37
References .....	37
Additional Resources .....	37
About VMware .....	37

## Introduction

This document is a reference implementation case study for VMware Horizon® with View at Carroll Hospital Center (CHC), a Maryland health provider. The solution delivers desktop virtualization for 1,500 users across sites throughout Maryland.

The intended audience is technical decision-makers considering deploying Horizon with View at scale. The Executive Summary and Business Benefits sections are also suitable for nontechnical decision-makers.

### VMware Reference Implementation Case Studies

A reference implementation case study shows how specific customers in differing geographies and industry verticals have deployed and benefited from a VMware solution. It details the project approach, the business benefits for a specific customer site, the lessons learned, and the architecture used. These implementations are usually based on reference architectures validated by VMware.

A reference implementation is built on a foundation of best practices, but trade-offs are made to meet specific project requirements or constraints. When referencing these implementations, it is critical to know where the architecture has deviated from best practice and where improvements could be made. To understand the modifications, you can compare a reference implementation to VMware reference architecture documentation. For information about other technical reference architectures, visit [VMware Horizon with View Design resources](#).

This case study is intended to help customers—IT architects, consultants, and administrators—involved in the early phases of planning, design, and deployment of Horizon-based solutions. It provides an example of a successful implementation that meets specific industry vertical challenges and the benefits gained.

## Executive Summary

Carroll Hospital Center's goal was to simplify its desktop management strategy while increasing control of its corporate assets and improving the security of end-user data. CHC wanted to transform its end-user computing desktops to a secure, centralized desktop environment for local and remote users using a virtual desktop infrastructure (VDI) solution.

CHC wanted to start with converting 800 users initially, with the ability to scale up to 1,500 users, encompassing CHC's main location in Westminster, Maryland, as well as users in managed practices throughout the surrounding area. The infrastructure is located in the CHC server rooms.

The hospital center wanted the design to address the following business requirements:

- **Scalable** – Support up to 800 desktop virtual machines initially, expanding to 1,500 with no significant change in performance or stability
- **Disaster recovery** – Ensure availability in the event of an outage at the primary data center.
- **Efficient and flexible** – Support the current access infrastructure without further complexity and allow for flexibility
- **Best practices** – Employ whenever possible while addressing requirements and constraints
- **Resilient** – Provide high levels of availability where possible
- **Maintenance** – Support planned infrastructure maintenance, and facilitate automated deployment of systems and services
- **Cost** – Reduce long-term operating costs

In light of these requirements, CHC chose the Horizon with View solution.

### Implementation Overview

CHC's main location is in Westminster, Maryland, with managed practices throughout the surrounding area. The server rooms are in the main location.

The View implementation initially supplies 800 concurrent virtual desktops, with the ability to scale to 1,500. A disaster recovery (DR) solution is a part of the initial implementation to provide a seamless transition from production to DR in the event of an outage.

### Project Overview

At CHC, the hardware infrastructure to virtualize data center operations was already in place. Desktop virtualization was a critical step in light of adopting the new electronic medical record (EMR) system. A VDI enabled CHC to have a desktop as a single point of reference that could be quickly multiplied rather than touch hundreds of physical desktops to install the EMR system.

CHC had a Citrix XenApp solution for remote connectivity for several applications hosted offsite. The initial plan was to expand this Citrix environment, because CHC thought that switching to Horizon with View would be too ambitious of a project. However, CHC found the Citrix environment not stable or mature enough and considered improving it.

After carefully evaluating both technologies, CHC preferred the Horizon with View solution because it was using more advanced virtualization technology development and moving progressively faster than the Citrix products.

In addition, VMware has a smaller footprint. The Citrix solution requires many physical machines. CHC is a lean organization that has few physical resources and a preference to keep its hardware footprint to a minimum.

## Architecture Overview

A professional services organization created the Horizon with View architecture design as part of the production implementation engagement for CHC. This architecture design incorporates VMware best practices within the project's technical and business constraints and specific customer requirements identified through design sessions and interviews. Technical, organizational, procedural, and policy-related requirements were considered.

The infrastructure for the Horizon with View solution is hosted in two data centers, each balancing the load of all user connections to their desktops. The architecture also includes security servers to allow remote access for approved staff. This solution initially supports up to 800 concurrent floating desktop users and 25 dedicated desktop users, with the ability to scale to 1,500 users.

By using a standard building block design, CHC followed the reference architecture of eight hosts per cluster, with each Cisco UCS host having two 2.7 GHz CPUs with 16 logical cores and 288 GB of RAM. Each host is designed to support up to 128 users. For 1,500 users, two clusters of eight hosts are implemented. Shared storage is provisioned to all hosts in each cluster to provide high availability and VMware vSphere® vMotion® and VMware vSphere Distributed Resource Scheduler™ capabilities.

## VMware Horizon

Horizon is a desktop virtualization solution that simplifies IT manageability and control while delivering the highest fidelity end-user experience across devices and networks.

IT organizations can automate desktop and application management, reduce costs, and increase data security by centralizing the desktop environment. This centralization results in greater end-user freedom and increased control for IT. By encapsulating the operating systems, applications, and user data into isolated layers, IT organizations have greater flexibility and control over how they deliver a desktop. The Horizon with View solution lets IT deliver dynamic, elastic desktop cloud services, such as applications, unified communications, and 3D graphics, to promote increased productivity and greater business agility.

Horizon is built on and tightly integrated with VMware vSphere, the industry-leading virtualization platform, allowing customers to extend the value of their VMware infrastructure and its enterprise-class features, such as high availability, disaster recovery, and business continuity. Support for vSphere leverages the latest functionality of the cloud infrastructure platform for highly available, scalable, and reliable desktop services.

For more information, see the [Horizon with View documentation](#).

## Horizon with View Solution Components

Typical Horizon with View deployments consist of several common components, as shown in Figure 1, which represents a typical architecture.

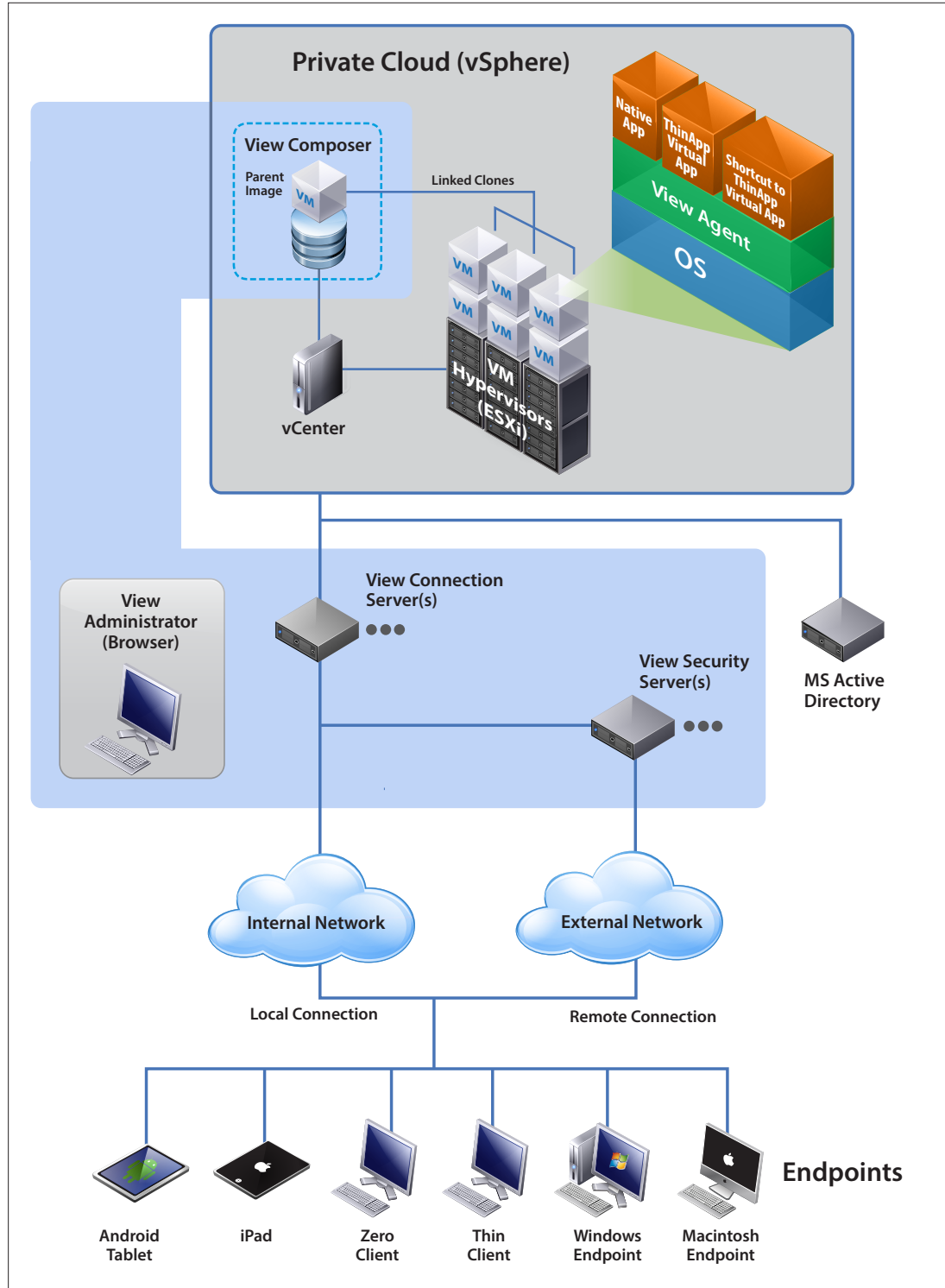


Figure 1: Typical Horizon with View Architecture



## CHC Reference Implementation

The CHC Horizon with View solution delivers Windows 7 virtual desktops to CHC staff initially via repurposed desktops acting as terminals in kiosk mode. CHC will replace these desktops with thin clients at a later phase.

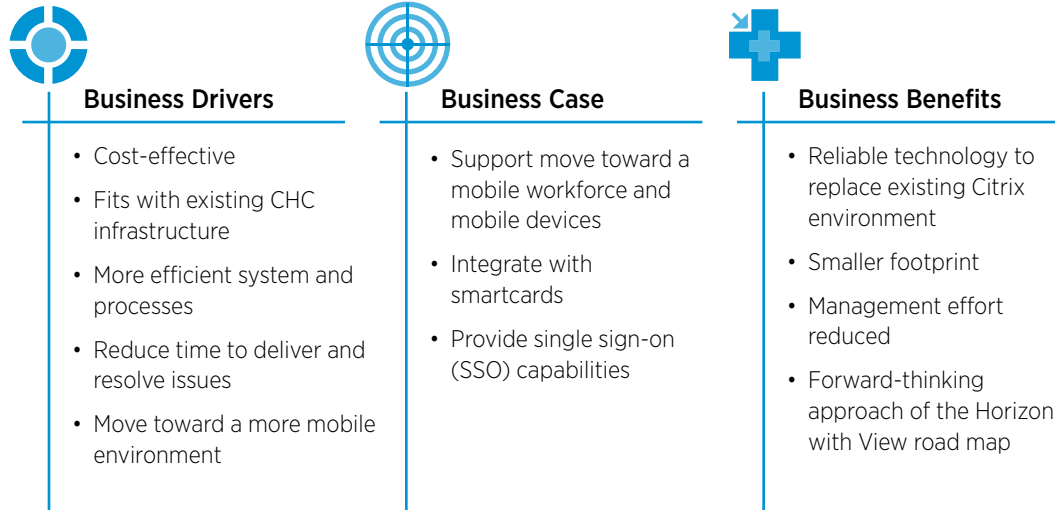
CHC has many different types of users across divisions and departments. The initial phases focused on the Nursing/General and Information Services use cases, which account for more than half of the CHC staff.

USE CASE	DESKTOP TYPE	QUANTITY
Nursing/General	Floating desktop, linked clones	800
Information Services	Dedicated desktop, full clones	25

**Table 1:** CHC Uses Cases

CHC has already planned to increase the number of users to 1,500 and move the remaining use cases to the Horizon with View environment during phase 2. This reference implementation details how CHC was able to plan and implement the solution to 800 users and the key lessons learned.

## Business Drivers, Business Case, and Benefits



### Business Drivers

CHC had clear goals and requirements for its VDI project. Minimizing cost was a key factor, but the solution also had to be cost effective. CHC realized that expanding its Citrix environment was not going to give the organization the user experience and reliability it needed.

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*“There were two options available to us: improve the current Citrix installation or implement a new VMware Horizon with View solution. To improve and expand the Citrix installation would be quicker but not cheaper, initially or in the future. After evaluation, CHC preferred the Horizon with View solution because the virtualization uptake and technology development at VMware is more progressive, and the technology is moving faster.”*

– CHC

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CHC needed to have a solution that was more efficient in managing its desktop environment. As with all physical desktop environments, the costs in maintenance and support were high, even with streamlined processes and tools. The technology had reached a point where it was nearly impossible to further reduce costs. A Horizon with View VDI allowed CHC to easily manage and support its users in a way that is not possible with physical desktops. Floor walking can now be kept to a minimum. Desk visits to resolve operating system or application issues are no longer necessary.

Being a hospital environment, many CHC users are constantly moving around and are not attached to a dedicated desk or terminal (thin client). Therefore, the solution must provide free roaming and allow any user to log in to any terminal and access a desktop and work with their applications and resources. Stateless (floating) desktops provide this capability, allowing CHC to vastly reduce the costs in supporting staff.

## Business Case

CHC must keep up with current technologies to benefit from industry-related market research findings. By moving to a VDI solution, it is preparing for the adoption of mobile devices and helping CHC take mobilization to the next level.

The ability to use smartcards and SSO is a key requirement for CHC. Because healthcare staff are moving around and focused on the hospital's needs, constantly entering usernames and passwords is a distraction. Smartcards and SSO technologies can be fully integrated into Horizon, enabling users to touch to log in and have access to all the applications they are entitled to without reentering login information.

## Benefits

After going live with Horizon with View, users experienced a more reliable platform than the previous Citrix environment. The integrated SSO technology has been beneficial for all users.

As users migrate over from the Citrix environment to Horizon, CHC is able to reduce the hardware footprint for its desktop infrastructure, a major benefit because data center space is limited.

Desktop management has been simplified—managing physical desktops was complicated and expensive. CHC is now moving to replace its Citrix solution with Horizon with View to realize these benefits across the organization and take full advantage of VMware's roadmap for Horizon with View.

## Project Overview

The CHC VDI project evolved at a fast pace. During July and August 2013, CHC was tasked to deliver a VDI solution by the end of September 2013. Given the extremely short timeframe, expanding the existing Citrix environment seemed the obvious choice. However, due to issues with performance and reliability, CHC decided to invest instead in Horizon with View, extending the delivery time to January 2014.

A professional services organization was selected to deliver the solution, which included the architectural design and implementation. After the design was completed, a test environment was implemented for approximately 80 users for a four-week period, with the main focus to evaluate load capabilities, SSO, and the EMR system.

The successful test phase allowed CHC to go live at the end of January 2014. Subsequently, 600 users were migrated to the production environment.

CHC has already planned the next stages of the project:

- Replace client hardware with thin or zero clients after the current hardware lease agreement expires.
- Document the identified use cases and implement desktop pools to support these users.
- Complete the migration of 1,500 users to the Horizon with View production environment.

## Lessons Learned



### Project

- Engage end users throughout the project
- Maintain a knowledge base or wiki regarding issues



### Technical

- Understand the login experience of the different use cases
- Assess device compatibility upfront



### Operational

- Adopting the new technology and toolset is a learning process

It was important to engage end users throughout the implementation to ensure that the requirements were captured and to manage user expectations. As the project progressed, it was evident that issues and resolution steps needed to be documented. A knowledge base was put together to provide a future reference.

CHC had a clear objective to minimize user login times to access desktops and applications. Although the login time was reduced to under a minute, CHC realized that logging in to a machine was not the user experience that CHC staff wanted. In a hospital environment, time is critical, and the staff requires instant access to applications without going through the Windows login process. CHC invested time and effort to understand what users wanted and which options were available, which resulted in operating the View desktops in kiosk mode with smartcard “tap in” access and SSO software to manage application authorization.

The concept of virtual desktops was new to CHC, and both end users and IT staff had a learning curve. CHC was familiar with managing, maintaining, and supporting a physical desktop environment, but IT operations and support staff were not knowledgeable about using the new tools and standard operating procedures and fully understanding the differences in the technologies.

As with all technologies and toolsets, it is important that IT operations and support staff have user education and knowledge transfer to gain the benefits offered, such as ease of management, maintenance, and supportability.

## Architecture

The high-level overview of the Horizon with View design consists of the following:

- VMware vSphere as the basis of the design, which includes View and VMware ThinApp®
- Support for up to 1,500 concurrent users
- Primary and secondary data centers for disaster recovery, providing a seamless transition between the two in the event of an outage
- Offloading of antivirus scanning to the VMware ESXi™ hosts with VMware vShield™
- ThinApp packaged applications streamed to the virtual desktops

### View Logical Infrastructure Design

The design approach for CHC's View implementation is to provide a scalable and modular architecture that facilitates standardization, expansion, and ease of management.

#### View Management Block Design

The View management block is a key component of the overall infrastructure supporting the View architecture. The virtual machines that support the View pod and block infrastructure reside in the management block.

The management block has the following physical components:

- VMware vCenter Server™ – Placed on the View management block.
- Clustered database – This design required at least four databases: one vCenter Server database for the View blocks, one View Composer database, and one VMware vSphere Update Manager™ database. The database server is clustered for high availability.
- ESXi hosts – To support the virtual machine requirements, CHC has four ESXi hosts.
- vSphere cluster – All virtual machines are contained in one cluster with vSphere Distributed Resource Scheduler and VMware vSphere High Availability.
- View Connection Servers – Two virtual machines are used for brokering View client connection requests.
- Security servers – One virtual machine.

#### View Pod Logical Design

This View pod is the core of the logical View Manager architecture design. The View pod design consists of the following components:

- Connection servers – Three View Connection Servers are actively brokering and possibly tunneling connections.
- Security servers – Two security servers are paired directly with a single View Connection Server.
- View blocks – This design has one View block.
- The project scope calls for an architecture design to support 800 initial virtual desktops that can scale out to meet a future requirement of 1,500 desktops.

### View Desktop Block Design

View Block #1 supports up to 2,000 users.

OBJECT	CONTAINER	ATTRIBUTES
ESXi hosts	VDI cluster	Eight 2.7 GHz, 16 logical cores, 288 GB RAM
LUNs		Ten 1024 GB
Pools	Nursing/General	800 desktops, floating linked-clone pools
	Information Systems	25 desktops, persistent full-clone pools
	All others	Number of desktops to be determined Mix of floating linked-clone pools and persistent full-clone pools

**Table 2:** View Desktop Block Design

### Virtual Desktop Design

All virtual desktops have 3 GB RAM and one vCPU. The following table details the configuration on the virtual desktops.

USE CASE	OS DISK	USER DATA (ESTIMATED)	SUSPEND FILE*	PAGE FILE	LOG FILES	DATASTORE USAGE
Nursing/General	60 GB, thin provisioned	1 GB per user	N/A	3 GB	100 MB	~7.5 GB per linked clone
Information Services	60 GB, thin provisioned	1 GB per user	N/A	3 GB	100 MB	~30 GB per full clone
All Others	60 GB, thin provisioned	1 GB per user	N/A	3 GB	100 MB	~7.5 GB per linked clone

\*Optional. Suspend file is required only if suspending desktop virtual machines.

**Table 3:** Virtual Desktop Pool Attributes

### Logical Storage Infrastructure Design

This design uses storage conservatively to optimize the end-user experience. Desktops, images, persistent disks, linked-clone replica disks, and templates reside on separate storage to allow tiering.

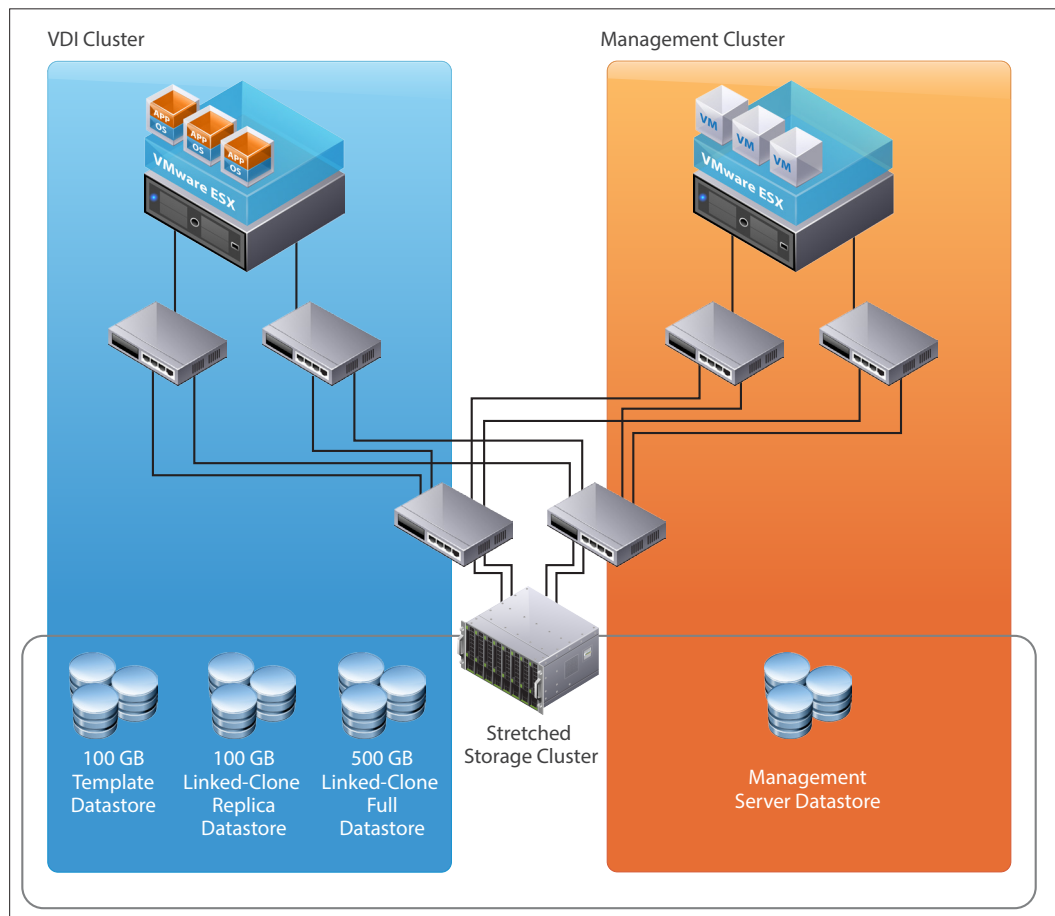


Figure 2: Storage Infrastructure

## Network Infrastructure

The CHC solution relies on network connectivity across multiple data centers and LAN-connected offices. Users access their virtual desktops using a mix of LAN and WAN connectivity.

The key considerations for connectivity in a View environment include:

- Each View Connection Server must have connectivity to all vCenter Server machines and virtual desktop machines within the View pod.
- Virtual desktops must be able to resolve the address of the View Connection Server through its fully qualified domain name.
- VMware View clients must be able to connect directly to virtual desktops via PCoIP or directly to a View security server if tunneling connections.
- Each View Connection Server must be able to resolve the address of all vCenter Servers.
- The View Connection Servers in the same instance should not be split across a WAN connection.
- View desktops should be connected to the View Connection Servers across a LAN connection.
- The network should be optimized for PCoIP.

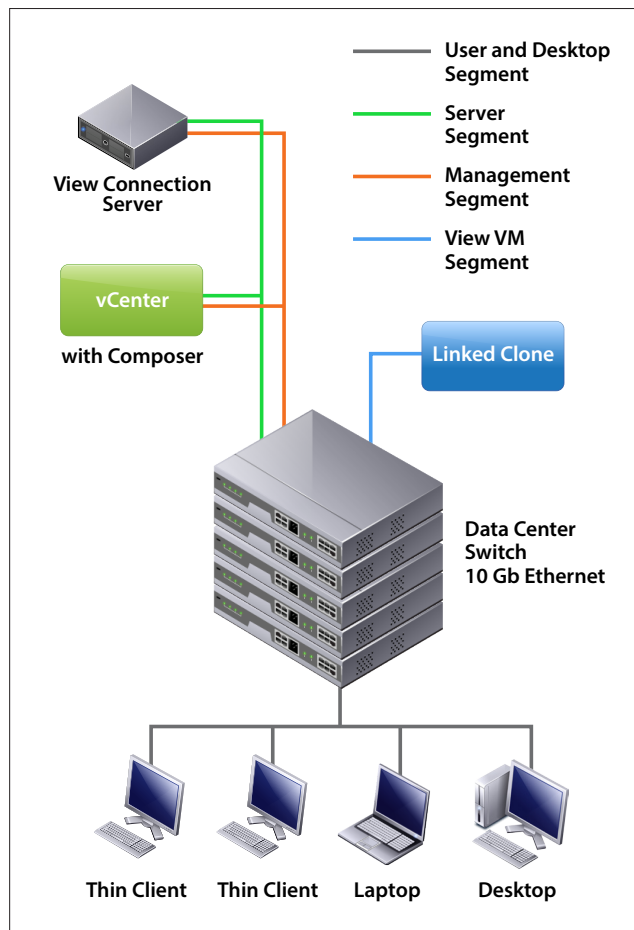


Figure 3: Network Infrastructure



## Conclusion

Since going live with Horizon with View, CHC has been enjoying the benefits of moving to a virtual desktop infrastructure with VMware. Most importantly, the process enabled CHC to have a clear understanding of user requirements and the particular needs of the healthcare sector, which differs from typical corporate organizations.

CHC is experiencing a faster and smoother rollout of applications and lower stress levels because no time is needed to set up thick clients. Less staff time is needed for setup, with as few as three people on go-live nights. The effort to manage the Horizon with View environment has been considerably less compared to the time spent on Citrix.

The fact that the original Citrix users liked the Horizon with View user experience meant that CHC had made the correct decision at the initiation of the project. CHC can now confidently move to the next phase, which is to migrate its full user base to Horizon with View and decommission the Citrix environment.

## Appendix: Detailed Design

### End-User Experience Design

Horizon with View provides the familiar, personalized desktop environment that end users expect. CHC identified the following types of users, along with their target objectives, access and performance requirements, and application environments.

#### User Classification Categories

CHC USE CASES		
Administrative	Marketing	Psychiatry
Associate Health	Medical Affairs	Physical Therapy
Nursing/General	Medical Library	Radiology
Biomed	Operating Rooms	Respiratory Therapy
Lab	Outpatient	Risk and Compliance
Case Management	Admitting/Registration	Security
Echo	Patient Care Services	Sleep
Emergency Room	Pharmacy	Sterile Processing and Decontamination
Environmental Services	Performance Improvement	Telco
Facilities	Professional Support Services	Training
Family Birth Place	Finance	Transporters
Food Service	Patient Accounting	Vascular Lab
Foundation	Carroll Health Group	Volunteer Services
Health Information Management	Human Resources	Women's Place
Information Services		

**Table 4:** Types of Users

### User Workload Categories

User workload categories help determine workload and capacity expectations and other optimization settings.

CATEGORY TYPE	DESCRIPTION
Task worker	Limited privileges in the operating system. Cannot install applications or device drivers. Session runs few applications in total and a limited number of applications concurrently. The user is not guaranteed session persistence, except when redirected outside the operating system.
Standard worker	Can have limited or full-access privileges in the operating system. Might be able to install applications and devices, and might be guaranteed session persistence.
Power user	Full privileges to the local operating system and is expected to install applications and devices. User expects session persistence.

**Table 5:** Privileges According to Category Type

### Application Requirement Categories

CATEGORY	APPLICATION	DELIVERY
Typical application set	Microsoft Office 2013 Adobe Flash 11, Adobe Reader 11 Java 1.6 latest update Fujitsu and Signature Pad drivers PG October PCA 17 Thin Client Team Note Library WSP Updated MedRec viewer files in Paragon Radiology packages (MI View, MedRec View JAR file) Horizon Cardiology Distributed (CPACS) Paragon, RX Label, and Leica Printers Internet Explorer 9 OneSign Agent 4.8.100.72 - type3 Palliative Care Downtime Bedboard REALVNC Crystal Reports runtime libraries ILE Added Templates to Windows to <b>Twain_32\ftscan</b> directory FormFast (Web site) BGINFO MCKESSON NTFS and Registry perms MCKESSON Form Routing / Markup MCKESSON Form Macro Tool MCKESSON HSM web MCKESSON PAE web Scandall	Installed in base image

CATEGORY	APPLICATION	DELIVERY
	McAfee Move 3.0	VMware vShield endpoint and compatible security image
Administrative application set, in addition to typical application set	HECM	Installed into administrative parent image or delivered via ThinApp
Associate health application set, in addition to typical application set	Midas Respond	Installed into associate health parent image or delivered via ThinApp
Nursing/general application set, in addition to typical application set	None	All applications included in the typical application set
Biomed application set, in addition to typical application set	Versus Temp Genius	Installed into biomed parent image or delivered via ThinApp
Case management application set, in addition to typical application set	CDS Desktop Fax CommDir Printer Midas	Installed into case workers parent image or delivered via ThinApp
Echo application set, in addition to typical application set	MUSE CPACS Cadwell	Installed into echo parent image or delivered via ThinApp
Emergency room application set, in addition to typical application set	LifeNET Temp Genius PeerVue FRED DXView	Installed into emergency room parent image or delivered via ThinApp
Environmental services application set, in addition to typical application set	None	All applications included in the typical application set
Facilities application set, in addition to typical application set	Temp Genius Johnson Controls TMA	Installed into facilities parent image or delivered via ThinApp
Family birthplace application set, in addition to typical application set	Pericalm Tracing Temp Genius	Installed into family birthplace parent image or delivered via ThinApp

CATEGORY	APPLICATION	DELIVERY
Food service application set, in addition to typical application set	Delegate Agilisys – Universal Desktop Nutritionist Pro	Installed into food service parent image or delivered via ThinApp
Foundation application set, in addition to typical application set	Raiser’s Edge Donor 2 Marketware	Installed into foundation parent image or delivered via ThinApp
Health information management application set, in addition to typical application set	HPF HBF 3M Coder Desktop	Installed into health information management parent image or delivered via ThinApp
Human resources application set, in addition to typical application set	API Lawson Skype PeopleFluent HealthStream HECM	Installed into human resources parent image or delivered via ThinApp
Information systems application set, in addition to typical application set	None	Applications installed by users into their full-clone desktops
Lab application set, in addition to typical application set	HLAB BloodBank NovoPath Data Innovations Temp Genius FormFast Scanning Pathology – Nikon for slide pictures BayScribe	Installed into lab parent image or delivered via ThinApp
Marketing application set, in addition to typical application set	FileMaker Pro Marketware Adobe Photoshop	Installed into marketing parent image or delivered via ThinApp
Medical affairs application set, in addition to typical application set	PrivPlus HECM More TBD	Installed into medical affairs parent image or delivered via ThinApp
Medical library application set, in addition to typical application set	None	All applications included in the typical application set

CATEGORY	APPLICATION	DELIVERY
Operating room application set, in addition to typical application set	PAE CPACS Stedman's Medical Dictionary Temp Genius	Installed into operating room parent image or delivered via ThinApp
Outpatient application set, in addition to typical application set	Sleep center – Custom Apps Registration – BBT, FormFast, Paragon Wound Care – Camera Cardio Rehab – Exercise Pro	Installed into outpatient parent images or delivered via ThinApp
Admitting/registration application set, in addition to typical application set	HPF Web Scanning	Installed into parent image or delivered via ThinApp
Patient care services application set, in addition to typical application set	HPF Web	Installed into patient care services parent image or delivered via ThinApp
Pharmacy application set, in addition to typical application set	Temp Genius APK – Hardesty Pediatric Dosing DoseEdge	Installed into pharmacy parent image or delivered via ThinApp
Performance improvement application set, in addition to typical application set	Midas HPF CERME	Installed into performance improvement parent image or delivered via ThinApp
Professional support services application set, in addition to typical application set	None	All applications included in the typical application set
Psychiatry application set, in addition to typical application set	None	All applications included in the typical application set
Physical therapy application set, in addition to typical application set	Exercise Pro Timecard system	Installed into physical therapy parent image or delivered via ThinApp
Radiology application set, in addition to typical application set	None	All applications included in the typical application set

CATEGORY	APPLICATION	DELIVERY
Respiratory therapy application set, in addition to typical application set	HLAB for HBGs Breathalyzer peripheral software	Installed into respiratory therapy parent image or delivered via ThinApp
Risk and compliance application set, in addition to typical application set	Midas HPF CERME	Installed into risk and compliance parent image or delivered via ThinApp
Security application set, in addition to typical application set	ExactVision	Installed into security parent image or delivered via ThinApp
Sleep center application set, in addition to typical application set	Custom applications to be determined	Installed into sleep center parent image or delivered via ThinApp
Sterile processing and decontamination application set, in addition to typical application set	SPM	Installed into sterile processing decontamination parent image or delivered via ThinApp
Telco application set, in addition to typical application set	Applications to be determined	Installed into telco parent image or delivered via ThinApp
Training application set, in addition to typical application set	None	All applications included in the typical application set
Transporters application set, in addition to typical application set	MPV	Installed into transporters parent image or delivered via ThinApp
Vascular lab application set, in addition to typical application set	CPACS Web Datacheck	Installed into vascular lab parent image or delivered via ThinApp
Volunteer services application set, in addition to typical application set	None	All applications included in the typical application set
Women's services application set, in addition to typical application set	Library World	Installed into women's services parent image or delivered via ThinApp

CATEGORY	APPLICATION	DELIVERY
Finance application set, in addition to typical application set	Lawson PCA HECM 3M Chargemaster	Installed into finance parent image or delivered via ThinApp
Patient accounting application set, in addition to typical application set	Cahaba VisionShare Homecare USB modem drivers	Installed into patient accounting parent image or delivered via ThinApp
Carroll Health Group application set, in addition to typical application set	Scanners Replacement for UniPrint	Installed into CHC parent image or delivered via ThinApp

**Table 6:** Application Requirements per Category

### Use Case Definitions

The initial phase had the following use cases.

ATTRIBUTE	GENERAL/NURSING	INFORMATION SERVICES
Number of users	800	25
Workload category	Standard worker	Standard worker
Locations	Throughout user base	Throughout user base
Time of use	12:00 AM - 11:59 PM EST, Monday-Sunday	12:00 AM - 11:59 PM EST, Monday-Sunday
Access methods	Local LAN	Local LAN and remote
Authentication method (smart card)	Standard Windows login	Standard Windows login
Core applications	Typical application set	Typical application set, plus user-installed applications
Operating system	Windows 7 SP1	Windows 7 SP1
Ability to install applications	No	Yes
Use of video	Limited	Moderate
Use of audio (input)	No	Yes
Printers	Network print servers	Network print servers
Monitors	Up to two, 1920 x 1200	Up to two, 1920 x 1200
Devices	USB devices	USB devices
User access device	PC, thin or zero client, portable device	PC, thin or zero client, portable device
Connectivity	LAN (100 Mbps+)	LAN (100 Mbps+), remote, low bandwidth, and high latency

**Table 7:** Use Case Definitions



## Virtual Desktop Pool Design

Virtual desktop systems are created and deployed as needed through the use of desktop pools. You manage these pools with VMware View Manager™.

Each use case differentiates itself in relation to View pools, the desktop configuration and the application workload. Pools define and control a user's session and integration with Active Directory, GPO, PCoIP, antivirus, firewall, systems management (including patching), user profile or persona management, user data, application management and deployment, and peripheral support.

At CHC, each use case is aligned with a unique View desktop pool with the following characteristics.

USE CASE OR POOL NAME	DESKTOP TYPE	DESKTOP PERSISTENCE	PROVISIONING METHOD	DEFAULT PROTOCOL	USER DATA PERSISTENCE
Nursing/ General	Automatic	Floating	Linked clones	PCoIP	Folder redirection, roaming profiles, View persona
Information Services	Automatic	Persistent	Full clones	PCoIP	Folder redirection, roaming profiles, View persona

**Table 8:** Desktop Pool Requirements per Use Case

## Virtual Desktop Pool Attributes

Each use case is aligned with a unique View Desktop Pool, with the following attributes and design considerations.

POOL INFORMATION AND SETTINGS	NURSING/GENERAL	INFORMATION SERVICES
Type	Automated	Automated
User assignment	Floating	Persistent
Desktop source	vCenter Server	vCenter Server
Use View Composer linked clones	Yes	No
ID	Nursing_General	IS_Full_Clones
Display name	Carroll Hospital Paragon Desktop	Carroll Hospital IS Desktop
View folder	/	/
Description		
Pool state	Enabled	Enabled
Connection Server restrictions	No	No
Remote desktop power policy	Keep powered on	Keep powered on
Automatic logoff after disconnect	After 120 minutes	After 120 minutes
Allow user to reset desktop	No	Yes
Delete or refresh OS disk on logoff	Refresh immediately	Never
Default display protocol	PCoIP	PCoIP
Allow users to choose protocol	No	No
Max number of monitors	2	2

POOL INFORMATION AND SETTINGS	NURSING/GENERAL	INFORMATION SERVICES
Max resolution of any one monitor	1920 x 1200	1920 x 1200
Adobe Flash quality	Do not control	Do not control
Adobe Flash throttling	Do not control	Do not control
Disposable file redirection	Disabled	Redirect disposable files
Provisioning	Disabled, stop provisioning on error	Disabled, stop provisioning on error
Virtual machine naming	TBD	TBD
Maximum number of desktops	800	25
Spare (powered on) desktops	80	3
Provisioning	Provision all desktops up-front	Provision all desktops up-front
Parent VM	<Parent Image>	TBD
Virtual machine folder	Unique Pool ID	Unique Pool ID
AD container	<Desktop OU>	TBD
View Storage Accelerator Enabled	Enabled	Enabled

Table 9: View Pool Attributes

### Refresh, Recompose, and Refresh Schedule

POOL	REFRESH	RECOMPOSE	REBALANCE	CHC DESIGN DECISION
Floating Pool	On logout	When critical core patches need to be applied.	Manual	Floating desktops are refreshed on each logout. This ensures a fresh desktop for each user on login and reduces the size of the delta disk.
Dedicated Pool	N/A	N/A	N/A	Dedicated desktops may be maintained by enterprise class desktop management solutions, so a recompose may not be required.

Table 10: Refresh, Recompose, and Refresh Schedule

### Desktop Pool Deployment and Maintenance of Full Clone Virtual Machines

The full clone virtual desktops, which are dedicated desktops, should be managed similarly to physical desktops. Because this is a management overhead, the number of dedicated desktops should be kept to an absolute minimum when possible.

### View Pool Policies

All pools are governed by a global policy, which denies or allows access to certain features within View Manager.

POLICY	SETTING
USB access	Allow for connecting to virtual desktop sessions
Multimedia redirection (MMR)	Allow to enhance video and audio playback sessions
Remote Mode	Allow
PCoIP hardware acceleration	Allow - medium priority

**Table 11:** Global Policy Settings

### Storage Performance Requirements

VMware recommends that consultants validate the disk I/O profile of a standard Windows desktop during a working period. The figures used in the following table are estimates. If the actual figures do not match these estimates, modify the design accordingly.

When designing a storage solution, it is important to understand the I/O profile of the virtual machines placed on the storage. An I/O profile is a description of an application or server I/O pattern. Some applications are heavy on reads, while others are heavy on writes. Some applications favor sequential access, and others favor random access. Recognizing the profile is essential for good storage design because it dictates which RAID type to use.

Although the I/O profile can be assumed based on application type, it is best to measure the I/O patterns before rolling out to a production implementation.

USE CASE	IOPS PER VIRTUAL MACHINE
Nursing/General	10-20 IOPS
Information Systems	20-30 IOPS
All others	10-20 IOPS

**Table 12:** IOPS Estimate per Virtual Machine

### View Pod

View Manager is configured using the View Administrator console. You can configure each View Manager Server, including the connection mode (direct or tunneled), tags (for specifying pool types to be accessed), authentication methods, and View Manager database backup (ADAM backup, not SQL Server).

ATTRIBUTE	SPECIFICATION
Direct Connect Mode	Deselected
Smart card authentication	Deselected
RSA authentication	Deselected
View Manager automatic backup	
Backup frequency	Every day
Backup time	12 midnight
Maximum number of backups	10
Folder location	C:\ProgramData\VMware\VDM\backups
View administrators	Active Directory Group for users with administrative rights to the View Administrator console. By default, all local administrator users on the View Manager Server can log in to the View Administrator console.

**Table 13:** View Manager Server Specifications

The View pod hosts a single instance of View Manager. Each View Manager server shares a common group configuration, also known as global settings. Global settings specify connection, security, and local mode operation settings.

ATTRIBUTE	SPECIFICATION
Session timeout	720 (12 hours)
Require SSL for client connections and View Administrator	Yes
Re-authenticate secure VPN connections after network interruption	No
Message security mode	Disabled
Disable SSO for local mode operations	No
Auto update	Disabled
Pre-login message	No
Display warning before forced logoff	Yes

**Table 14:** View Manager Global Settings

### VMware vCenter Server Settings

View Connection Servers use the vCenter Server to provision and manage View desktops. View can use multiple vCenter Servers to do this. In View Manager, configure each vCenter Server in the View pod, as shown in the following table.

ATTRIBUTE	SPECIFICATION
Description	View vCenter Server 1
Connect using SSL	Yes
Port	443
Enable View Composer	Yes
Advanced Settings	
Maximum Concurrent Provisioning Operations	24
Maximum Concurrent Power Operations	24

**Table 15:** VMware vCenter Server Settings

### View Management Block

The View management servers (View block vCenter Servers and View Connection Servers) are hosted in a separate management block.

**Note:** The View management hosts must be in the same location as the View desktop hosts and connected to the same switching infrastructure, because the Java Message Services used by the View Connection Servers is not latency tolerant.

### VMware vCenter Configuration

A single management vCenter Server (and associated database server) can manage the ESX and ESXI hosts accommodating the entire View server infrastructure for each instance. This management vCenter Server and database server should be installed on an environment outside the vSphere infrastructure dedicated to View, such as on an existing virtual infrastructure. In addition, a number of desktop vCenter Servers should be used to manage the ESX and ESXI hosts running virtual desktops. The desktop vCenter Servers should be hosted on the VDI management cluster in each View pod.

All vCenter Server machines should be VMware virtual machines. VMware vCenter Update Manager shares the same vCenter Server solution.

### View Connection Servers Specifications

The View Connection Server runs on Windows Server 2008 R2 Enterprise 64-bit. It provides user authentication and redirects incoming remote desktop requests to the appropriate View desktop. View Connection Servers within the same pod are replicas of each other and can be used for scaling and load balancing. View Connection servers in the same pod share a single ADAM (Active Directory for Application Mode) database. In addition, each View Connection Server runs the View Administrator, the primary mechanism for configuring and administering View. View Connection Servers must be part of the AD forest.

Each View Connection Server can service up to 2,000 concurrent users. At CHC, a minimum of two View Connection Servers are required to service 800 concurrent users, due to the multisite and load-balancing configurations.

The following table lists the View Connection Server specifications.

ATTRIBUTE	SPECIFICATION
Number of View Connection Servers	2
Physical or virtual machine	Virtual machine – VMware virtual hardware version 9
Number of processors Processor type	4 vCPU
Memory	16 GB
Number of NICs and speed	1x Gigabit
Total storage	60 GB
Operating system	Windows Server 2008 R2 Enterprise
View Connection Server	VMware View Connection Server 5.2
Other customizations	Verify that View logs are excluded from antivirus scans
SSL certificate	Each View Connection Server requires an SSL certificate for client machines to connect using SSL.

**Table 16:** View Connection Server Specifications

### View Security Servers Specifications

The View security servers provide secure, encrypted access from the client access device to the virtual desktop. The component is included in the View Connection Server and can be deployed separately as a View security server.

View security servers run Windows Server 2008 R2 Enterprise, which provides user authentication and proxies incoming remote desktop requests through the View Connection Server and to the appropriate View desktop.

The following table lists the View security server specifications.

ATTRIBUTE	SPECIFICATION
Number of View Connection security servers	2
Physical or virtual machine	Virtual machine – VMware virtual hardware version 9
Number of processors Processor type	4 vCPU
Memory	16 GB
Number of NICs and speed Networks	1x Gigabit TBD
Total storage	60 GB
Operating system	Windows Server 2008 R2 Enterprise
View Connection Server	View Connection Server 5.2
Other customizations	Verify that View logs are excluded from antivirus scans
SSL certificate	Each View Connection Server requires an SSL certificate for client machines to connect using SSL.

**Table 17:** View Security Server Configuration

## View Desktop Block

The View desktop block hosts the virtual desktops, including the parent desktop images used to create desktop pools.

### Parent Desktop Virtual Machine – Virtual Hardware Specifications

The virtual hardware configuration of the parent desktop virtual machine varies based on the computing resources required by the end user. The following table shows the default specifications. Exceptions to the defaults are handled on a case-by-case basis.

ATTRIBUTE	SPECIFICATION
Hardware	VMware virtual hardware version 9
vCPU	1
vMemory	3072 MB
vNICs	1
Virtual network adapter 1	Template designated VLAN
Virtual network adapter 1 type	VMware VMXNET3
Virtual SCSI controller 0	VMware Paravirtual
Virtual disk OS – VMDK	60 GB
Virtual floppy drive 1	Removed
Virtual CD/DVD drive 1	Removed
View Agent	View Agent 5.3

**Table 18:** Virtual Hardware Specifications

### Virtual Desktop Guest Operating System

Multiple master OS images are used to provision desktop sessions in the View environment. VMware recommends using a fresh installation of the guest OS so that correct versions of the HAL, drivers (including the VMware Paravirtual SCSI and VMware VMXNET3 network driver), and OS components are installed. A fresh install also avoids performance issues with any legacy applications or configurations of the desktop virtual machine.

### View Desktop Operating System Specification

The operating system image deployed for the desktop image uses Microsoft Windows 7 SP1 (fully patched). These images are considered the Gold images. Subsequent application sets are included in additional templates built from the Gold Windows 7 SP1 images.

### View Desktop Block Shared Storage

Typically, a vSphere implementation uses shared storage for virtual machine data, enabling VMware features such as HA, DRS, and vMotion. Shared storage should be presented to ESX hosts through a redundant SAN fabric encompassing redundant storage adapters in the ESX host, SAN switches, and storage array processors. Virtual machine storage is presented to ESX in the form of datastores, sized and configured optimally for the virtual machine workload expected.

The following table provides an example of sizing linked-clone desktop datastores for View.

ATTRIBUTE	SPECIFICATION	DESCRIPTION	
OS disks per datastore	64-140 VMFS 250 NFS	Based on best practices and configuration maximums	
OS disk datastore size	At least 1.98 TB for NFS At least 500 GB for VMFS	Size based on the following calculations:	
		Master replica size	40 GB (Windows 7)
		Swap file size	3072 MB
		Pagefile size	1500 MB
		Log file size (maximum)	100 MB
		Maximum VMDK growth	4096 MB (conservative)
		Free space allocation	10% additional overhead
		Minimum allocated datastore size (NFS) 1.98 TB (250 VMs * (1500 + 1500 + 100 + 4096) + 16 GB + 180 GB free space overhead) Minimum allocated datastore size (VMFS) 500 GB (64 VMs * (1500 + 1500 + 100 + 4096) + 16 GB + 46 GB free space overhead)	
Total number of datastores (based on capacity)	One per 64 VMs (VMFS) One per 250 VMs (NFS)	One required for 20 desktops on VMFS (FC/iSCSI) One for 20 desktops on NFS (NAS)	
Hosts per datastore	All ESX hosts in View desktop cluster	All ESX hosts in the View desktop cluster must mount all shared storage in that cluster to enable DRS load balancing and HA failover.	

Table 19: Desktop Datastore Configuration Specifications



The following table shows the number of disks required per datastore to meet the storage capacity requirements. Each datastore for the virtual desktops is at least 1.98 TB.

NUMBER OF DISKS PER DESKTOP DATASTORE	DISK SIZE	RAID	TOTAL AVAILABLE STORAGE
5 (4+1)	300 GB	5	1200 GB (1 TB)
4 (2*2)	300 GB	10	600 GB (.5 TB)
5 (8+1)	600 GB	5	3000 GB (2.8 TB)
4 (2*2)	600 GB	10	1200 GB (1 TB)

**Table 20:** Number of Disks Required per Desktop Datastore for Storage

The following table shows the number of disks required per datastore to meet the IOPS requirements.

BACK-END IOPS REQUIRED PER DATASTORE	READ/WRITE RATIO	RAID	NUMBER OF DISKS (180 IOPS PER 15 K FULL-CLONE DISK)
608	70% read, 30% write	5	4
704	60% read, 40% write	5	4
800	50% read, 50% write	5	5
416	70% read, 30% write	10	3
448	60% read, 40% write	10	3
480	50% read, 50% write	10	3

**Table 21:** Number of Disks Required per Desktop Datastore for IOPS

Assuming that the read/write ratio of the physical desktop is approximately 60 percent reads and 40 percent writes, three disks are needed to achieve the required IOPS for RAID 5. Alternatively, two disks are required for RAID 10.

However, due to the storage requirements, five 300 GB or 600 GB disks are required for RAID 5, or four 300 GB or 600 GB disks are needed for RAID 10. The storage array is required to provide a throughput of 4300 KB/s (4.2 MB/s) per datastore for 20 users.

For performance and cost efficiency on a daily refresh cycle, RAID 10 is recommended for each virtual desktop datastore based on the assumption of using four disks with 60 percent reads and 40 percent writes. In this case, four disks are required, making the datastores 1200 GB (1.2 TB).

## End-User Experience Configuration

The following tables identify the GPO properties available with the use of the View Server GPO template (`vdm_server.adm` and `vdm_common.adm`), which properties to use, and the values to apply.

PROPERTY	UPDATED	REMARKS
Recursive enumeration of trusted domains	Yes	Enabled

**Table 22:** Computer Configuration GPO for View Servers

PROPERTY	UPDATED	REMARKS
Log configuration	Yes	
Day to keep		7 days
Maximum number		10 logs
Maximum size		100 MB

**Table 23:** GPO Properties for View Servers

The following table identifies the GPOs available for Terminal Services that are applied to virtual desktops used for the View solution.

PROPERTY	UPDATED	REMARKS
Enforce removal of remote desktop wallpaper	Yes	Set to enable
Limit maximum color depth	Yes	Fixed to 24-bit
Allow users to connect remotely using Terminal Services	Yes	Set to enable
Remote Windows Security Item from Start Menu	Yes	Set to enable
Remove disconnect option from shut down dialog	No	Left at default (users require disconnect feature)
Set time limit for disconnected session	No	Managed by View Manager settings
Set a time limit for active but idle Terminal Services sessions	No	Managed by View Manager settings

**Table 24:** GPO Properties for Terminal Services

The following table identifies the GPO properties available with the View Agent GPO template (`vdm_client.adm`).

PROPERTY	UPDATED	REMARKS
Always wait for network at computer start-up	Yes	Enabled – Avoids inaccessible user profile or data during the login process

**Table 25:** GPO Properties for View Agent

The following table identifies the GPO properties available with the View Agent GPO template (`vdm_agent.adm`).

PROPERTY	UPDATED	REMARKS
Recursive enumeration of trusted domains	Yes	Set to disabled. Only INTERNAL domain is allowed.
AllowDirectRDP	Yes	Set to disabled – Does not allow users to RDP to desktop outside of View control.

**Table 26:** GPO Properties for View Agent

The following table identifies the GPO properties available with the PCoIP GPO template (`pcoip.adm`).

PROPERTY	UPDATED	REMARKS
Minimum image quality	No	50 (default)
Maximum initial image quality	Yes	Set to 70, default is 90
Frame rate limit	Yes	Default is 30 frames per second; set to 12
MTU size	Yes	Set this equal to or less than the lowest MTU size of the endpoints; default is 1400
Maximum link rate	Yes	Set to 80% of available bandwidth (maximum bandwidth that can be consumed per session); default is 1 Gbps.
Disable Build-to-Lossless	Yes	Enabled

**Table 27:** GPO Properties for PCoIP

### Antivirus Scanning and Updates

VMware Professional Services recommends a vShield endpoint-enabled antivirus product to secure virtual desktops while reducing compute and storage overhead associated with traditional in-guest agents.

### Microsoft Outlook Cached Exchange Mode

Microsoft Outlook is a common application used in many environments. In Cached Exchange mode, a synchronized copy of users' Microsoft Outlook items is saved on the local machine. Microsoft Outlook downloads the users' emails the first time they run the application on a new desktop.

Because floating desktops are fresh, which is equivalent to a new desktop, the download occurs each time the user logs in if Cached Exchange Mode is enabled. To prevent this, CHC disabled Cached Exchange mode because the feature is not necessary in a virtual desktop environment. All desktops are located in the data centers with excellent network connectivity.

**Note:** Other applications with a local cache that is created when run the first time might have a similar issue, which must be addressed with the application teams. In addition, disabling Cached Exchange mode ensures that the Exchange server is not impacted by floating desktops because they will not download emails when Outlook is started.

### Virtual Printing

The virtual printing feature allows end users to use local or network printers from a View desktop without requiring that additional print drivers be installed in the View desktop. For each printer available through this feature, you can set preferences for data compression, print quality, duplex printing, color, and so on.

After adding a printer on the local computer, View adds the printer to the list of available printers on the View desktop. No further configuration is required.

To send print jobs to a USB printer, you can either use the USB redirection feature or use the virtual printing feature.

The location-based printing capabilities allow IT organizations to map View desktops to the printer that is closest to the endpoint client device. For example, as a doctor moves from room to room in a hospital, each time the doctor prints a document, the print job is sent to the nearest printer.

For sites that do not leverage virtual printing, a GPO setting can be applied through the View client group policy template.

Virtual printing is not supported on Mac OS X operating systems.

### Location-Based Printing

The traditional mechanism to map network printers via login scripts might not be suitable for CHC because users move around and are not fixed to locations. The printer drivers for the network printers must be installed on the virtual desktops.

In this design, View location-based printing enables the correct network printers to be mapped based on location.

Location-based printing allows virtual desktops to automatically map to network printers based on rules specified in the ThinPrint component, *TPVMGPOACmap.dll*, which appears as a Group Policy local computer setting when registered.

The ThinPrint AutoConnect component included with VMware Tools™ rebuilds the virtual desktop's printer list based on these rules when the user logs in or reconnects from a disconnected View session.

The ThinPrint GPO rules apply to one printer per rule. If multiple printers are mapped to the same set of virtual desktops, multiple rules are required.

## Authors and Contributors

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## References

[VMware Horizon with View](#)

[VMware vSphere](#)

[VMware Horizon with View Technical Resources](#)

## Additional Resources

For more information or to purchase VMware products, call 1-877-4VMWARE (outside of North America dial +1-650-427-5000), or visit [www.vmware.com/products](http://www.vmware.com/products), or search online for an authorized VMware reseller. For detailed product specifications and system requirements, refer to the [VMware Horizon with View documentation](#).

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