HPE Reference Architecture for Citrix XenApp on HPE Synergy Platform

Delivering cost effective client virtualization with Citrix XenApp on VMware ESXi Server
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Executive summary

Delivering discrete applications from a centralized location, such as a data center, has been a common practice for many years. And today Citrix® XenApp, one of the leading solutions for application virtualization, is found in a production deployment in just about every sizable enterprise. As successful as application virtualization has been, the modern digital workplace has created new challenges for administrators due to the consumerization of IT and the increased end-user expectations for high-performance anywhere, any device access.

Fortunately, application virtualization technology has consistently advanced. Today, delivering not only apps, but full desktops with 3D graphics is viable from a centralized environment. The development of graphics processing units (GPUs), from companies such as AMD®, boosts the end-user graphics experience and expands the types of supported applications. Additionally, the maturation of solid state storage solutions delivers fast and reliable performance at a much lower cost per seat than previously possible.

To meet IT environment management needs, Citrix has introduced Citrix Workspace Suite. It includes a broad toolset to manage the entire user connection path - from user connectivity, to authentication, device management, application deployment, and monitoring. It provides IT administrators the means to easily manage thousands of virtualized users.

Now nearly every user within an enterprise can benefit from the increased performance and ubiquitous access of a virtualized application and desktop delivery model; and IT administrators can effectively drive improved data security, simplified management, and faster app delivery to a larger population of users within their organization, that had not been ideal target users in the past.

In this Hewlett Packard Enterprise Reference Architecture (RA) we examined end users who require workstation class compute and graphic rendering, and we conducted a Citrix XenApp Hosted Shared Desktops user density performance study on how their needs can be addressed on HPE Synergy infrastructure.

This Reference Architecture demonstrates how HPE Synergy facilitates the delivery of Citrix XenApp in a cost-effective and highly manageable fashion. HPE Synergy is an ideal platform for server-based computing deployments providing enhanced GPU acceleration for optimum user experience. Using HPE Synergy Image Streamer with Citrix Provisioning Services (PVS), creates a simple way to manage server boot and user configurations, leveraging multiple user configurations. With HPE Synergy Composer and the HPE OneView API, IT administrators can easily change the deployment characteristics to meet their current needs.

In this RA, the Hewlett Packard Enterprise solution engineering team used an HPE Synergy system consisting of eight (8) HPE Synergy 480 Gen10 Compute Modules, six (6) HPE 480 Multi MXM Expansion Modules with AMD FirePro S7100X Server GPUs in passthrough mode, across three (3) HPE Synergy 12000 Frames, an HPE Nimble CS3000 storage array to enable larger user-to-disk ratios than are possible with traditional HDDs, and HPE FlexFabric 5940 top-of-rack switches that provide low latency and high performance resulting in robust end-user experiences in high-traffic environments.

Citrix Provisioning Services (PVS) used in this RA can reduce network traffic between PVS clients and the HPE Synergy 480 Gen10 Compute Modules thereby providing faster boot times during boot storms, and overall improved device performance in a Citrix XenApp 7.17 environment.

Target audience: This document is intended for IT decision makers and channel partners, as well as architects and implementation personnel who want to understand the HPE Composable Infrastructure capabilities offered by the HPE Synergy platform. The reader should have a solid understanding of end-user and graphic intensive applications, familiarity with the AMD Multiuser GPU with passthrough technology and Citrix XenApp products, and an understanding of sizing/characterization concepts and limitations in client virtualization environments.

Introduction

One of the key drivers in the end-user computing market is end-user productivity. Users today expect a fully integrated and seamless experience that integrates mobile and desktops with applications and connectivity to quickly perform business tasks.

HPE Synergy is an enterprise-level solution designed to be able to service all workloads. Hewlett Packard Enterprise storage, servers, and networking provide the resilient and integrated infrastructure that meets the reliability, speed, and security needs of client infrastructure administrators.
Client virtualization, desktop and application delivery, can vary based on use case requirements that range from task workers to workstation users. Figure 1 below illustrates the client virtualization technology landscape as it exists today.

**Client Virtualization Technology Landscape**

![Client Virtualization Technology Landscape Diagram]

The challenge for desktop and application virtualization has been to enable rich user experiences with graphics capabilities in a cost-effective manner. Over the last 10 years, high-end applications with intensive graphics requirements were not compatible with virtualized environments. They were expensive to develop and implement. In addition, the Graphics Processing Unit (GPU) resources could not be virtualized and had to be dedicated to users or applications needing direct access to the GPU, making the solution expensive and difficult to scale. This is no longer true with the HPE Synergy 480 Gen10 Compute Module via HPE Synergy 480 Multi MXM Expansion Module with up to 6 x AMD FirePro S7100X GPUs. The GPUs can then be automatically or manually assigned to virtual machines on the VMware® ESXi host using the VMware vDGA passthrough method, providing a rich user experience in a cost-effective manner.

The Reference Architecture demonstrates an architecture that facilitates the delivery of Citrix XenApp in a cost-effective and highly manageable fashion. The purpose of this Reference Architecture is to deliver an experience to the broadest spectrum of multimedia-enabled end users with a minimal set of compromises. HPE Synergy systems are uniquely architected as Composable Infrastructure (CI) to match the powerful ‘infrastructure-as-code’ capabilities of the HPE intelligent software architecture. Flexible access to compute, storage, and fabric resources allows for use and repurposing. Linking multiple HPE Synergy Frames efficiently scales the infrastructure with a dedicated single view of the entire management network.

HPE Synergy Frames, HPE Synergy Compute Modules, HPE Nimble CS3000 storage arrays, and HPE FlexFabric 5940 network switches reduce complexity and can accelerate workload deployments to provide the resilient and integrated infrastructure that meets the reliability, performance, and security needs of end-user computing architects. This drives IT efficiency as the business grows and delivers balanced performance across resources to increase solution effectiveness.

Hewlett Packard Enterprise has tested this solution utilizing Citrix Provisioning Services (PVS) and Citrix XenApp Hosted Shared Desktops. HPE successfully ran the Login VSI multimedia workload in order to showcase an integrated solution with the latest advancements in HPE Composable Infrastructure and client virtualization technologies.
Figure 2 illustrates a high-level overview of Citrix XenApp to enable users to securely access their apps and data from anywhere. The architecture relies on Microsoft® Windows® app and desktop delivery from Citrix XenApp, network security with NetScaler architecture designed on HPE Synergy which can be leveraged by Hewlett Packard Enterprise customers and service provider partners to deliver solutions.

The Reference Architecture described in this document focuses on testing AMD GPU-enabled hosted shared desktops, with graphics virtualized workloads within the context of Citrix XenApp to demonstrate that they run as designed on HPE Synergy. All the Citrix Hosted Shared Desktop resources, applications, and data resources were hosted on an HPE Nimble CS3000 iSCSI Storage Network, and compute modules within an HPE Synergy 12000 Frame.

While testing was limited to a Citrix XenApp Hosted Shared Desktops use case, HPE Synergy supports all use cases within the Citrix XenApp 7.17 architecture, regardless of provisioning method.

**Solution overview**

**Citrix software**

This Reference Architecture provides an overview of Citrix Hosted Shared Desktops virtualization features, and the ability to provide user experiences via Citrix XenApp. The solution outlined offers secure, remote access deployed on an HPE Synergy multi-Frame Architecture. It is not a step-by-step installation and configuration guide. The installation and configuration of the Citrix software layer can be understood by consulting the documentation for Citrix Workspace Suite at citrix.com/products/xenapp-xendesktop.

Testing for this RA concentrated on the on-premises software that is testable by Login VSI. The tested pieces form the traditional core of the Citrix XenApp offering. Citrix XenApp provides a unified framework for developing a solution comprised of virtual application resources. This framework provides a better understanding of the technical architecture for the most common virtual application deployment scenarios.
For this Reference Architecture HPE utilized Citrix XenApp 7.17. Figure 3 describes at a high level the test environment for this Reference Architecture and the general configuration of the solution deployed. HPE Synergy Image Streamer was used to boot VMware ESXi.

This Reference Architecture is based on a unified and standardized 5-layer model as shown in Figure 3. These layers are as follows:

- **User Layer** – This layer defines the unique user groups, endpoints, and locations for the solution. There are three distinct delivery groups corresponding to different sets of users defined in solution.

- **Access Layer** – This layer defines how a user group gains access to their resources including providing secure access policies and desktop/application stores. Users access a list of available resources through Citrix StoreFront. Users not on a protected network must establish an encrypted SSL tunnel across public network links to the NetScaler VPX Gateway, which is deployed within the DMZ of the network.

- **Resource Layer** – This layer defines the virtual applications, and data provided to each user group. This layer defines the graphics hosted shared desktops and applications; desktops and applications that are delivered based on a hosted Microsoft Windows Server® 2016 operating system which is shared amongst multiple users at runtime.

**Figure 3.** High level architecture for HPE Synergy with Citrix XenApp 7.17
• **Control Layer** – This layer defines the Citrix management layer which supports users accessing resources. The Delivery Controllers authenticate users and enumerate resources from the StoreFront while creating, managing, and maintaining the virtual resources. All configuration information about the Citrix XenApp site is stored within a SQL database.

• **Hardware Layer** – This layer defines the physical implementation of the overall solution. The corresponding hosts provide compute and storage resources to the workloads hosted on the resource layer. One set of hosts centrally delivers virtual servers and virtual applications.

This Reference Architecture leveraged AMD FirePro S7100X GPU passthrough for offloading graphic processing operations from physical CPUs for Windows Server 2016 hosted shared desktops created by Citrix PVS.

Citrix Provisioning Services minimizes the I/O to disk which can lower the amount of storage, and offloads physical CPU graphics processing cycles to GPUs.

This Reference Architecture leverages dual Citrix Delivery Controller, Provisioning Services, and StoreFront servers which are hosted on the dedicated dual HPE Synergy 480 Compute Modules for redundancy.

The following Citrix software components were leveraged as part of the testing performed.

• **Citrix Provisioning Services (PVS):** Citrix PVS allows for the streaming of a single shared vDisk image, rather than copying images to individual machines. Citrix Provisioning Services enables organizations to reduce the number of disk images that they manage. Even as the number of machines continues to grow, Citrix PVS provides centralized management and offers distributed processing. An administrator can update a single image and this update is reflected in all disks associated with that image.

This Reference Architecture leverages PVS with the RAM Overflow to Nimble Storage option turned on in order to stream Microsoft Windows Server 2016 hosted shared desktops.

• **Citrix StoreFront:** Citrix StoreFront allows internal users to access Citrix XenDesktop or Citrix XenApp either directly through Citrix Receiver or via the Citrix StoreFront web page by offering a complete list of available resources for each user. It also allows users to mark certain applications as favorites which makes them appear prominently to the end user. The subscriptions are synchronized to the other StoreFront servers automatically. Upon successful authentication, StoreFront contacts the Delivery Controller to receive a list of available resources (desktops and/or applications) for the user to select. Redundant StoreFront servers should be deployed to provide N+1 redundancy where, in the event of a failure, the remaining servers have enough spare capacity to fulfill any user access requests.

• **Citrix Delivery Controller:** The Delivery Controller is the server-side component that is responsible for managing user access, as well as brokering and optimizing connections. Controllers also provide Citrix Machine Creation Services and Citrix Provisioning Services which create desktop and server images. Each Controller communicates directly with the site database. In a site with more than one zone, the controllers in every zone communicate with the site database in the primary zone. Redundant Delivery Controller servers should be deployed to provide N+1 redundancy where, in the event of a failure, the remaining servers have enough spare capacity to fulfill any user access requests.

• **Citrix NetScaler:** The NetScaler VPX software delivers reliable application availability, comprehensive L4-L7 load balancing, robust performance optimization features, and secure remote access. It adds advanced traffic management, clustering support, stronger security features, extended optimizations, SSO, and more. It also encompasses powerful security features, expanded application acceleration capabilities, and enhanced management and visibility resources.

**Solution components**

**Hardware**

HPE Synergy systems are uniquely architected as Composable Infrastructure (CI) to match the powerful 'infrastructure-as-code' capabilities of the HPE intelligent software architecture. Flexible access to compute, storage, and fabric resources allows for use and repurposing. The combination of hardware flexibility with embedded intelligence enables auto-discovery of all available resources for quick deployment and use. Management of hardware by profiles defined in software allows fast repurposing of compute, storage, and fabric resources to meet workload demands.

This Reference Architecture focuses on deploying a Citrix XenApp 7.17 graphics-enabled hosted shared desktop environment on VMware vSphere 6.5. The hardware is viewed as "blocks" of functionality and technology segmentation, namely compute, management, network, and storage blocks. This Reference Architecture can be viewed as a series of building blocks which are summarized below.

Tested solutions save you time and resources compared to the do-it-yourself approach. This helps reduce deployment risk and can help lower total cost of ownership. The HPE Composable Infrastructure gives you the foundation to successfully deliver client virtualization solutions to a
wide variety of users across your IT environment. Designed as modular, repeatable, and scalable building blocks, HPE Synergy can easily integrate into your existing virtualization environment.

Figure 4 depicts the physical layout of the tested configuration.

**Figure 4.** HPE Synergy sample configuration with Multi MXM Expansion Modules

**Compute block**

The main compute block for this solution is comprised of six (6) HPE Synergy 480 Gen10 Compute Modules plus HPE Synergy 480 Multi MXM Expansion Modules, with six AMD FirePro GPU graphics cards in each expansion module running within the context of an HPE Synergy 12000 Frame.

Descriptions of all of the components appear in the sections that follow.
HPE Synergy 12000 Frame

The HPE Synergy 12000 Frame is the base infrastructure that ties together compute, storage, network fabric, and power into a scalable solution that easily addresses and scales with various customer workloads and infrastructure. The Synergy 12000 Frame reduces complexity in the IT infrastructure by unifying all these resources into a common bus, and with the myriad of available network and storage interconnects, allows the frame to interoperate with any other IT environment. At a high level the Synergy Frame supports the following:

- 12 half-height or 6 full-height compute modules per frame. The HPE Synergy design allows for the inclusion of double-wide modules as well as support for internal storage with the HPE Synergy D3940 Storage Module
- Two Frame Link Modules for in-band and out-of-band management
- Up to six 2650 watt power supplies and ten fans
- Up to six interconnect modules for full redundancy of three fabrics

The HPE Synergy 12000 features a fully automated and managed composer module. HPE OneView handles all the setup, provisioning, and management both at the physical and logical level.

HPE Synergy Composer

HPE Synergy Composer is a hardware management appliance that is powered by HPE OneView. The HPE Synergy Composer provides a single interface for assembling and reassembling flexible compute, storage, and fabric resources to support business-critical applications and a variety of workloads, whether they are bare metal, virtualized, or containerized.

The HPE Synergy Composer provides lifecycle management to deploy, monitor, and update your infrastructure using a single interface or the Unified API. IT departments can rapidly deploy infrastructure for traditional, virtualized, and cloud environments in just a few minutes - sometimes in a single step. Resources can be updated, expanded, flexed, and redeployed without service interruptions. Key features of the HPE Synergy Composer are:

- Simplify deployment and configuration of resources in your environment
- Accelerate updates using templates
- Automate applications and workloads using the Unified API
- Designed for high availability using redundant physical appliances

HPE Synergy Image Streamer

HPE Synergy Image Streamer is a management appliance option for the HPE Synergy solution that is used to deploy stateless compute modules within the HPE Synergy environment. The HPE Synergy Image Streamer solution offers a stateless deployment experience for bare-metal compute modules by managing and maintaining the software state (operating system and settings) separate from the physical state (firmware, BIOS settings, etc.). Boot volumes for the compute modules are hosted and maintained on the HPE Synergy Image Streamer appliance as iSCSI boot volumes. Image Streamer uses scripts and build plans to generalize and personalize the OS boot volumes during capture and deployment.

HPE Synergy Image Streamer adds a powerful dimension to “infrastructure as code” - the ability to manage physical servers like virtual machines. In traditional environments, deploying an OS and applications or hypervisor is time-consuming because it requires building or copying the software image onto individual servers, possibly requiring multiple reboot cycles. In HPE Synergy, the tight integration of HPE Synergy Image Streamer with HPE Synergy Composer enhances server profiles with images and personalities for true stateless operation.

HPE Synergy Composer, powered by HPE OneView, captures the physical state of the server in the server profile. HPE Synergy Image Streamer enhances this server profile (and its desired configuration) by capturing your golden image as the “deployed software state” in the form of bootable image volumes. These enhanced server profiles and bootable OS images, plus application images are software structures (infrastructure as code) - no compute module hardware is required for these operations. The bootable images are stored on redundant HPE Synergy Image Streamer appliances, and they are available for fast implementation onto multiple compute modules at any time. This enables bare-metal compute modules to boot directly into a running OS with applications, and multiple compute modules to be quickly updated.

HPE Image Streamer:

- Manages physical servers like virtual machines
- Enables true stateless operation by capturing software (OS and settings) state separate from the hardware (firmware, BIOS) state
• Deploys, updates, and rolls back compute images rapidly for multiple compute modules
• Enables automation via Unified API

Figure 5 depicts the HPE Synergy Composer, Image Streamer, compute, and server profile configuration.

HPE Synergy 480 Compute Module
The HPE Synergy 480 Compute Module delivers superior capacity, efficiency, and flexibility in a two-socket, half-height, single-wide form factor to support demanding workloads. Powered by Intel® Xeon® Scalable Family of processors, up to 3TB DDR4, more storage capacity and controllers and a variety of GPU options within a Composable Architecture. HPE Synergy 480 Gen10 Compute Module is the ideal platform for general-purpose enterprise workload performance now and in the future.

• The most secure server with exclusive HPE Silicon Root of Trust. Protect your applications and assets against downtime associated with hacks and viruses.
• More customer choice for greater performance and flexibility with Intel Xeon Scalable Family of processors on the Synergy 480 Gen10 architecture.
• Intelligent System Tuning with processor smoothing and workloads matching to improve processor throughput/overall performance up to 8% over previous generation.
• Max memory 3TB for large in-memory database and analytic applications.
• New hybrid Smart Array for both RAID and HBA zoning in a single controller; internal M.2 storage options that add boot flexibility and additional local storage capacity.

HPE Virtual Connect SE 40Gb F8 Module for HPE Synergy
The HPE Virtual Connect SE 40Gb F8 Module, master module based on composable fabric, is designed for composable Infrastructure. Its disaggregated, rack-scale design uses a Master/Satellite architecture to consolidate data center network connections, reduce hardware and scales network bandwidth across multiple HPE Synergy 12000 Frames. The HPE Virtual Connect SE 40Gb F8 Module for HPE Synergy eliminates network sprawl at the edge with one device that converges traffic inside the HPE Synergy 12000 Frames, and directly connects to external LANs.
HPE Synergy 20Gb Interconnect Link Module

The HPE Synergy 20Gb Interconnect Link Module (satellite module) is designed for Composable Infrastructure. Based on a disaggregated, rack-scale design, it uses a Master/Satellite architecture to consolidate data center network connections, reduce hardware and scale network bandwidth across multiple HPE Synergy 12000 Frames.

Network block

This Reference Architecture is built on HPE FlexFabric 5940 network switches configured redundantly using a stacked network and shown to function as intended during solution testing. Figure 6 depicts the network connectivity from the HPE Synergy 480 Gen10 Compute Module to the HPE switches.

To provide high availability and maximum performance, VMware vSwitches with multiple active vmnics were created.

Figure 6 depicts the network logical design for deploying the solution.

**Figure 6.** Network layout from the compute block to top of rack

Solution, production, storage network, VLANs, and configuration

HPE OneView manages the infrastructure and is used to define the network and infrastructure related components. Several VLANs are defined to segment and isolate traffic including separate networks for the management of hardware and hypervisors, end-user productivity resources and VM migration. An Active/Active configuration is used throughout the network. Brief descriptions of the VLANs follow.

**Solution management network (VLAN 21)**

The network used for solution management connects all physical components managed by HPE Synergy Composer and HPE Nimble Storage management components. This network has its own domain/DNS infrastructure and is isolated from users.

**Production network (VLAN 223)**

The production network is dedicated to virtual desktops, virtual apps, file shares, and user data. This solution leverages a Login VSI environment hosted on a separate infrastructure in order to generate load by emulating end users. These virtual end users also reside on the production network. This network is represented by a single VLAN during test but might be tied to a number of VLANs in a production environment.

**Storage network (VLANs 22 and 23)**

The storage network is dedicated to providing access to HPE Nimble iSCSI storage which houses virtual machines running Citrix software, VMware infrastructure, and end-user applications, file shares, and data. This solution leverages dual iSCSI VLANs 22 and 23 network segments for VMware ESXi iSCSI software initiator via VMkernel interfaces to access Nimble iSCSI storage target via iSCSI protocol.
Management block
The management block of the solution is comprised of two HPE Synergy 480 Gen10 Compute Modules that host Citrix XenApp and VMware infrastructure VMs for management of the solution. The solution management software stack includes HPE Synergy Composer, HPE Nimble Management WebUI, VMware vCenter, and Citrix XenApp management components. The core enterprise services, such as Active Directory, are hosted outside of this solution stack.

Note
The solution utilized a Microsoft Windows Storage Server with Failover Clustering enabled connected to HPE Nimble iSCSI Storage for hosting end-user profiles and data.

Storage block
This Reference Architecture utilizes a 2-node HPE Nimble CS3000 storage. The HPE Nimble CS3000 iSCSI storage is connected to the HPE Synergy 480 Gen10 Compute Modules via HPE Virtual Connect and HPE FlexFabric 5940 switching. HPE Nimble virtual volumes are created to store Citrix and VMware infrastructure VMs, Citrix XenApp Provisioning Services Master Images, Citrix Hosted Shared Desktops with PVS Overflow Cache disk as well as hosting external Microsoft file services to store end-user data for the solution. Table 1 highlights the configuration of the volumes utilized for testing.

Note
HPE Nimble Storage uses Triple Parity RAID (or RAID-3P) which allows for greater protection of your data in a drive failure scenario, yet has zero impact to performance or usable capacity.

Table 1. Storage volumes used for testing

<table>
<thead>
<tr>
<th>Volume Name</th>
<th>Volume Function</th>
<th>Volume Size</th>
<th>ESXi Cluster Datastore Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosted Shared Desktops Virtual Volume</td>
<td>End user Windows Server 2016 Desktops with Application and write cache hosted on storage</td>
<td>500GB</td>
<td>Hosted-Shared-Desktop-Vol</td>
</tr>
<tr>
<td>PVS Image Virtual Volume</td>
<td>End user read only template with pre-installed and configured operating system with applications which are assigned on a per user bases during access of hosted shared desktops</td>
<td>250GB</td>
<td>PVS-Vol</td>
</tr>
<tr>
<td>Citrix and VMware Infrastructure Virtual Volume</td>
<td>Citrix Provisioning Services Virtual Machines hosted on storage</td>
<td>500GB</td>
<td>Mgmt-Vol</td>
</tr>
<tr>
<td>Citrix User Data Volume</td>
<td>End user profiles and data hosted on storage</td>
<td>500GB</td>
<td>N/A (Hosted on HPE StoreEasy Server)</td>
</tr>
</tbody>
</table>
Figure 7 depicts the storage logical design for deploying the solution.

**Figure 7.** Illustrates HPE Nimble iSCSI Storage solution design

**AMD FirePro S7100X GPU**

The AMD FirePro S7100X Server GPU is part of AMD’s family of hardware-based virtualized GPUs bringing the power of a physical GPU to virtual environments, which lets users effortlessly run professional applications. Equipped with 8GB of GDDR5 memory, the FirePro S7100X Server GPU can accelerate applications and process computationally complex workflows with ease. It enables consistent, predictable and secure performance from your virtualized desktop with a workstation-class user experience.

**Note**

Graphics solution sizing is highly application centric which results in a wide range of sizing scenarios. AMD has performed extensive testing on a variety of use cases. For more information, search for sizing information at amd.com/mxgpu.

**Solution software**

Software for this Reference Architecture is segmented primarily into solution software and management software.
Management software
This layer is comprised of the software that IT administrators will use to manage the environment. HPE Synergy utilizes the software outlined in Table 2, below.

Table 2. Management server software specifications

<table>
<thead>
<tr>
<th>Management</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware vCenter</td>
<td>6.5</td>
</tr>
<tr>
<td>HPE OneView</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Solution software
This layer is comprised of the software resources that create end-user experiences. This includes Citrix software as well as the individual applications that make up the end-user virtual machines. Table 3 describes the versions of Citrix and Microsoft software used in the creation of this Reference Architecture.

Table 3. Citrix and Microsoft software

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citrix XenApp</td>
<td>7.17</td>
</tr>
<tr>
<td>Citrix PVS</td>
<td>7.17</td>
</tr>
<tr>
<td>Citrix NetScaler VPX</td>
<td>12.0</td>
</tr>
<tr>
<td>Citrix Virtual Desktop Agent</td>
<td>7.17</td>
</tr>
<tr>
<td>Radeon Pro and AMD FirePro</td>
<td>18.01</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2016</td>
</tr>
<tr>
<td>Citrix Receiver</td>
<td>4.11</td>
</tr>
</tbody>
</table>

Virtual machines
In addition to the pre-installed solution management VMs, several virtual machines have to be created as part of the Citrix software infrastructure.

Table 4 details the configuration of each of these VMs. VM counts varied based on the test conducted and will vary widely based on the customer environment and image configuration. As such, the master image configuration is included in the table but no counts are given for the total VMs deployed from that image.

Table 4. Virtual machine specifications during testing

<table>
<thead>
<tr>
<th>Virtual Machine (VM)</th>
<th>vCPU</th>
<th>Memory</th>
<th>ESXi Datastore Storage Size</th>
<th>Networks</th>
<th>Number of VMs</th>
<th>Operating System (OS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMware vCenter</td>
<td>8</td>
<td>24GB</td>
<td>Mgmt-Vol 300GB</td>
<td>Management</td>
<td>1</td>
<td>OVA</td>
</tr>
<tr>
<td>Citrix Deliver Controller</td>
<td>4</td>
<td>8GB</td>
<td>Mgmt-Vol 60GB</td>
<td>Management</td>
<td>2</td>
<td>Windows Server 2016 Standard</td>
</tr>
<tr>
<td>Citrix StoreFront Server</td>
<td>4</td>
<td>8GB</td>
<td>Mgmt-Vol 60GB</td>
<td>Management</td>
<td>2</td>
<td>Windows Server 2016 Standard</td>
</tr>
<tr>
<td>Citrix Provisioning Services</td>
<td>6</td>
<td>12GB</td>
<td>Mgmt-Vol 100GB PVdisk-Vol 250GB</td>
<td>Management Production (iSCSI)</td>
<td>2</td>
<td>Windows Server 2016 Standard</td>
</tr>
<tr>
<td>Citrix NetScaler VPX</td>
<td>2</td>
<td>2GB</td>
<td>Mgmt-Vol 20GB</td>
<td>Management</td>
<td>2</td>
<td>OVA</td>
</tr>
<tr>
<td>Citrix License Server</td>
<td>2</td>
<td>4GB</td>
<td>Mgmt-Vol 40GB</td>
<td>Management</td>
<td>1</td>
<td>Windows Server 2016 Standard</td>
</tr>
<tr>
<td>Microsoft Windows Server 2016 (Image Template)</td>
<td>4</td>
<td>4GB</td>
<td>Hosted-Shared-Desktop-Vol 40GB</td>
<td>Production</td>
<td>1</td>
<td>Windows Server 2016 Standard</td>
</tr>
<tr>
<td>Citrix Hosted Shared Desktops</td>
<td>12</td>
<td>30GB</td>
<td>Hosted-Shared-Desktop-Vol 1000GB</td>
<td>Production</td>
<td>36</td>
<td>Windows Server 2016 Standard</td>
</tr>
</tbody>
</table>
Best practices and configuration guidance for the solution

The success of any end-user computing deployment greatly depends on a robust and fully thought out evaluation plan. Service personnel and IT shops must be clear about desired outcomes prior to beginning an evaluation. This plan will influence how your hardware and software stacks will be procured, configured, and tuned. During the development of the evaluation plan for infrastructure deployment, best practices must be considered for each deployment phase and technology area.

Below are the best practices that Hewlett Packard Enterprise utilized in the testing of this solution.

Hardware configuration
ESXi deployment using Image Streamer

The first step in an HPE Image Streamer deployment is building the golden image from a reference host operating system. At a high level the steps for deploying ESXi using Image Streamer are:

1. Create Server Profiles to be used by HPE Synergy 480 Compute Modules.
   a. Create an empty volume and deploy the server profile.
   b. The OS deployment plan creates an empty volume on the HPE Synergy Image Streamer local storage.
   c. The empty volume of 20 GB size will be mapped to the server profile as an iSCSI volume, later VMware ESXi 6.5 will be installed.

2. Create a golden image for installing VMware ESXi 6.5 on HPE Synergy 480 Compute Modules.
   a. Assign the server profile created in step 1 and power on the server.
   b. Install ESXi 6.5 on an HPE Synergy Image Streamer OS volume using iLO on to iSCSI disk.
   c. Log in to ESXi with user credentials, configure basic IP Address to download HPE Nimble iSCSI Multipath using FTP network access. Below is the Nimble iSCSI Multipath downloadable link. (An HPE Passport account is required to access the website).
   d. Shut down the OS.

3. Create deployment and build plans for Image Streamer to install VMware ESXi 6.5 OS on HPE Synergy 480 Compute Modules.
   a. Choose a build plan for customization. We have used the HPE-ESXi-2017-10-06-v3.0 build plan, which was available from the HPE-ESXi Artifact bundle at the link below.
   b. Add the HPE-ESXi Artifact bundle under HPE Image Streamer Deployment.
   c. Find the golden image OS volume name created as per step 2, select the OS build plan that was extracted using the HPE-ESXi-2017-10-06-v3.0 Artifact bundle as per step 3a.

4. Create the server profile template for HPE Image Streamer to deploy ESXi 6.5 OS on HPE Synergy 480 Compute Modules.
   a. Under the OS deployment plan, choose the deployment build plan that was created in step 3.
   b. Under Connections, create two NICs for Management and Production, and two NICs for Nimble iSCSI Storage with respective VLAN IDs.
   c. Under the Deployment setting, supply the domain name, host name, management NIC IP Address, and password.
   d. Under default BIOS settings, configure the settings to take full advantage of the virtualization capabilities of HPE Synergy 480 Compute Modules to optimize server performance. For a high-end graphics VDI configuration, the BIOS settings were tweaked to maximize performance and user experience. See table 5 below for the BIOS settings.
   e. Create the Server Profile Template for deploying across 8 HPE Synergy 480 Compute Modules.
Server tuning
The default BIOS tunings for the Synergy compute modules were altered. Table 5 below shows the BIOS settings used for the compute modules in this Reference Architecture.

Table 5. Server BIOS tunings

<table>
<thead>
<tr>
<th>BIOS Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Management (Power Profile)</td>
<td>Maximum Performance</td>
</tr>
<tr>
<td>Power Management (Power Regulator)</td>
<td>Static High Performance Mode (Default)</td>
</tr>
<tr>
<td>Minimum Processor Idle Core C-State</td>
<td>No C-states</td>
</tr>
<tr>
<td>Minimum Processor Idle Package C-State</td>
<td>No Package States</td>
</tr>
<tr>
<td>Intel QPI Link Power Management</td>
<td>Disabled</td>
</tr>
<tr>
<td>Energy Performance Bios</td>
<td>Maximum Performance</td>
</tr>
<tr>
<td>QPI Bandwidth Optimization (RTID)</td>
<td>Optimized for I/O (Alternate RTID)</td>
</tr>
<tr>
<td>Hyper-Threading</td>
<td>Enabled</td>
</tr>
<tr>
<td>Intel Turbo Boost</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

Software configuration
ESXi iSCSI Multipath deployment for Nimble iSCSI Storage access
VMware vSphere offers iSCSI Multipathing that provides both high availability and load distribution for Nimble iSCSI storage targets. This solution utilized software iSCSI adapters connected to dedicated VMkernel ports within ESXi bound to individual vmnics.

To provide high availability for Nimble iSCSI storage access at the ESXi host level, a dedicated vSwitch is defined with an iSCSI VMkernel port group and two vmnic interfaces with active/unused failover policy enabled.

Figure 8 shows a screenshot of the ESXi host-level iSCSI software adapter bound to VMkernel, for carrying iSCSI traffic to the HPE Nimble iSCSI storage target.

Figure 8. iSCSI software adapter network port binding
Figure 9 shows a screenshot of the ESXi host vSwitch iSCSI portgroup teaming and failover policy settings. This configuration needs to be repeated for each port group as shown in Figure 8 and you should ensure a different physical network adapter is set to active for each port group.

![Figure 9. vSwitch iSCSI adapters failover order policy](image)

**Nimble Storage Management and iSCSI Storage Data access**

To enable dedicated iSCSI Data and Management access on Nimble Storage, it is recommended to have 1Gb Ethernet interfaces, eth1 and eth2, for management traffic, and 10Gb Ethernet interfaces, tg1 and tg3, for iSCSI Data storage. You need to make sure that a private address (non-routable) set is used for connectivity between the ESXi VMkernel ports and the Nimble Storage Controllers (Active / Passive) data access interfaces for traffic isolation.

Figure 10 shows a screenshot of the Nimble Ethernet interfaces dedicated to carrying management and iSCSI data traffic.

![Figure 10. Rear view of HPE Nimble CS3000 storage active front-end ports](image)
**Nimble iSCSI Multipath for ESXi**

To enable iSCSI Multipathing between the ESXi server and the Nimble iSCSI storage system, which provides the ability to load-balance between multiple paths for performance and also to handle failures of a path at any point between the server, network and storage, it is recommend to select the Nimble path selection policy (PSP) for iSCSI Multipathing environments.

Figure 11 shows selecting the Nimble Path selection policy (PSP).

![Figure 11](image.png)

**Figure 11.** Manage Path selection policy in vCenter 6.5 under ESXi host Configure → Storage Devices → Device Details → Properties → Multipathing Policies

Figure 12 shows a CLI view of the enabled Nimble Path selection policy (PSP).

```
[root@CTXESXi62 ~]# esxcli storage nmp device list -d eui.4ad42d81e11ef8596c9ce900c4dd316a
Device Display Name: Nimble iSCSI Disk (eui.4ad42d81e11ef8596c9ce900c4dd316a)
Storage Array Type: VMWare SATP ALUA
Storage Array Type Device Config: {implicit_support=on, explicit_support=off, explicit_allow_on=
ala_followover=on, action_on_retry_errors=off, {TPG_id=0, TPG_state=AO}}
Path Selection Policy: NTMBLE_PSP_DIRECTED
Path Selection Policy Device Config: {policy=ipcs, lops=1, bytes=0, useANO=0, isVtoPFE=0, GROUP_ID=0,
numIOsForIssueIn=10000, numIOsSinceLastInq=3238, GROUP_MODE=0, MODE_CHANGED=0, NUM_OF_MEM_ARRAY=1
lastPathIndex=1, numIOsPending=0, numBytesPending=0}
Path Selection Policy Device Custom Config:
  Working Paths: vhba64:C1:T5:L0, vhba64:C0:T5:L0, vhba64:C3:T5:L0
  Is USB: false
```

**Figure 12.** CLI view for ESXi host path selection policy

**Microsoft Windows Server 2016 session environment**

**Configure the hardware graphics renderer group policy**

To enable hardware-based virtualization for all Remote Desktop Services sessions on Microsoft Windows Server 2016, the local group policy should be enabled with the hardware graphics renderer instead of the Microsoft Basic Render Driver as the default adapter.

The local group policy Remote Session Environment can be found under Local Computer Policy → Computer Configuration → Administrative Templates → Windows Components → Remote Desktop Services → Remote Desktop Session Host → Remote Session Environment
Figure 13 shows the Microsoft Windows 2016 group policy setting used to enable hardware graphics renderer for Remote Desktop Services sessions.

**Figure 13.** Group policy setting to enable hardware GPU graphics rendering for RDS sessions

### AMD FirePro and Radeon Pro software

To utilize AMD GPUs in passthrough mode from the Guest Citrix XenApp VM, download the Radeon Pro Software, Enterprise Edition for Microsoft Windows Server 2016, 64-bit platforms from the following link.


### AMD FirePro passthrough setting

Hardware-based virtualization enables workstation-grade AMD graphics acceleration using the PCI passthrough method. This eliminates proprietary and complex software from the hypervisor, and allows each VM to use native Radeon Pro drivers with natural compatibility and access to all GPU and compute functions on the server. Each physical GPU can be dedicated in passthrough mode directly to support users for hosted desktops and applications.

The table below shows Citrix XenApp Windows 2016 hosted desktop virtual machine CPU, memory, and GPUs settings.

<table>
<thead>
<tr>
<th>User Type</th>
<th>vCPU</th>
<th>System memory (GB)</th>
<th>Number PCI devices (passthrough)</th>
<th>GPU Memory per Server (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia</td>
<td>12</td>
<td>30</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

**Note**

Each physical AMD FirePro GPU S7100X was assigned using the ESXi vDGA passthrough mode directly to Citrix XenApp Windows 2016 hosted server VMs to render graphics related tasks.

For detailed configuration information, refer to amd.com/Documents/MxGPU-Setup-Guide-VMware.pdf
Figure 14 shows the ESXi host level settings of AMD FirePro GPUs assigned to Windows Server 2016 VMs that were configured by editing the hardware settings for the PCI/PCIe devices.

Figure 14. Enable GPU passthrough mode in ESXi 6.5

**Capacity and sizing**

This document shows the flexibility that HPE channel partners and customers can have in taking advantage of Citrix XenApp, resulting in a more fully functional solution that scales well on HPE Synergy. To demonstrate the validity of the solution, HPE used Login VSI to run user simulations against a fully configured environment.

**About Login VSI**

Login VSI is a load generating test tool designed to test remote computing solutions via a variety of different protocols. HPE maintains an infrastructure dedicated to running Login VSI against a variety of solutions from Citrix. The test software works by starting a series of launchers which are best thought of as virtual end-user access devices. These launchers connect to the end-user computing infrastructure under test via a connection protocol, then a series of scripts executed on the compute resources simulate the load of actual users. The test suite utilizes a series of desktop applications running via automated scripts within the context of the Citrix XenApp virtual environment. A standardized set of applications are installed within every virtual machine and actions are taken against the installed applications. The set of applications HPE tested with are listed in the table below, with versions shown where applicable.

**Table 7. Standard Login VSI worker software specifications**

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft Windows</td>
<td>2016 Standard x64</td>
</tr>
<tr>
<td>Adobe® Acrobat®</td>
<td>11</td>
</tr>
<tr>
<td>Adobe Flash Player</td>
<td>11</td>
</tr>
<tr>
<td>Adobe Shockwave Player</td>
<td>11</td>
</tr>
<tr>
<td>Bullzip PDF printer</td>
<td></td>
</tr>
<tr>
<td>Freemind</td>
<td></td>
</tr>
<tr>
<td>7-Zip</td>
<td></td>
</tr>
<tr>
<td>Microsoft Office Professional x64 bit</td>
<td>2013</td>
</tr>
<tr>
<td>Microsoft Internet Explorer</td>
<td>11</td>
</tr>
</tbody>
</table>
New to Login VSI is the ability to look at users with multimedia requirements via a Multimedia workload. The Multimedia workload is a type of workload designed to really stress the CPU by using software that benefits from graphics acceleration. When a GPU is added, the most compute-intensive sections of an application are offloaded to the GPU while the CPU processes the remaining code. From a user perspective, this means users will experience an improvement in their perception of the environment. From an IT administrator perspective, it means that the resources will be utilized in a more efficient fashion and that more users may fit onto any given resource.

The multimedia workload uses the applications shown in Table 8 for its GPU/CPU-intensive operations.

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows client</td>
<td>2016 standard x64</td>
</tr>
<tr>
<td>Adobe Acrobat</td>
<td>11</td>
</tr>
<tr>
<td>Google™ Chrome browser</td>
<td>59.0</td>
</tr>
<tr>
<td>Google Earth mapping service</td>
<td>7.1.8</td>
</tr>
<tr>
<td>Microsoft Office Professional</td>
<td>2013 x64</td>
</tr>
<tr>
<td>Microsoft Internet Explorer</td>
<td>11</td>
</tr>
</tbody>
</table>

Response times are measured for a variety of actions within each session. When response times climb above a certain level on average, the test is finalized and a score, called VSImax, is created. VSImax represents the number of users at or below the average response time threshold. A detailed explanation can be found on the Login VSI website at loginvsi.com/documentation/index.php?title=Login_VSI_VSImax.

For purposes of showing a solution functions as intended, Hewlett Packard Enterprise does not drive load to a saturation point in order to achieve a VSImax score. Rather, the goal is to show that the environment behaves as expected and that all paths work and users receive an experience as expected under a given load.

**Login VSI Multimedia workload**

Table 9 shows the characteristics of the Login VSI Multimedia workload utilized in the creation of this Reference Architecture.

<table>
<thead>
<tr>
<th>Workload</th>
<th>Login VSI version</th>
<th>Workload</th>
<th>vCPU</th>
<th>Memory</th>
<th>Apps open</th>
<th>Video</th>
<th>CPU usage</th>
<th>Estimated IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia worker</td>
<td>4.1.25</td>
<td>Medium</td>
<td>2 vCPU</td>
<td>15GB</td>
<td>8-11</td>
<td>360p</td>
<td>100%</td>
<td>10</td>
</tr>
</tbody>
</table>

**Testing strategy**

Citrix XenApp 7.17 was tested via the Login VSI Multimedia workload with and without accelerated graphics.

**Benchmarks versus field implementation**

Login VSI provides a set of tests that can be used to compare platforms and solutions within a fairly close range, provided that all underlying variables remain the same including CPU, memory, disk, software versions, system tunings, VM tunings, networks, and Login VSI version. The test uses a standardized set of workloads to create those comparison points. In the real world, it is highly unlikely that a customer will be running the exact set of applications featured in the test. As with most test tools, Login VSI results should be used in conjunction with results from actual system performance data from the field or via proof-of-concept (POC) or production implementations. Login VSI presents response times from various tasks and applications that could be used as a primitive baseline in a controlled environment with limited applications and resource assignments. Although these metrics are useful when comparing systems with similar resource attributes, they can be misleading when used to simulate real-world implementations. As a result, the numbers in this document are guidelines only.

Hewlett Packard Enterprise recommends a complete analysis of the specific user requirements prior to any VDI implementations and not sizing implementations based solely on benchmark results. Customers, new or inexperienced with VDI, should undergo a deeper assessment of their environment prior to implementing VDI to make sure they attain the results they desire. If such an assessment interests you, please engage with your Hewlett Packard Enterprise account team or find further information on our HPE Mobility and Workplace Services web page, hpe.com/us/en/services/consulting/mobility-workplace.html.
Single node Hosted Shared Desktops for multimedia worker results

Table 10 shows the Citrix Hosted Shared Desktops use case of multimedia worker that was tested on HPE Synergy with an HPE Synergy 480 Gen10 Compute Module in an HPE Synergy 12000 Frame in a single-node configuration with a server pool of Citrix XenApp on PVS Hosted Shared Desktops with Windows Server 2016.

Table 10 below shows the configuration and workload results for the multimedia worker user type and summarizes the Login VSI score for the platform.

Table 10. Test results on Windows Server 2016 Hosted Shared Desktops without GPU acceleration

<table>
<thead>
<tr>
<th>User type</th>
<th>VM type</th>
<th>Microsoft Office version</th>
<th>Microsoft Windows Server version</th>
<th>Number of users</th>
<th>VM vCPU</th>
<th>VM memory</th>
<th>PVS Write Cache Disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia worker</td>
<td>Hosted Shared Desktops</td>
<td>2013</td>
<td>2016</td>
<td>119</td>
<td>12</td>
<td>36GB</td>
<td>10GB</td>
</tr>
</tbody>
</table>

Figure 15 shows a single server Login VSI score of 119 multimedia workers using Citrix XenApp PVS Hosted Shared Desktops with locally installed applications on a single-node HPE Synergy 480 Gen10 Compute Module.

Figure 15. Multimedia Workload test result on one HPE Synergy 480 Compute Module without AMD graphics card

Single node Hosted Shared Desktops with AMD GPUs for multimedia worker results

Table 11 shows the Citrix Hosted Shared Desktops with AMD GPUs use case of multimedia worker that was tested on HPE Synergy with an HPE Synergy 480 Gen10 Compute Module with AMD GPUs in an expansion module in an HPE Synergy 12000 Frame in a single-node configuration with a server pool of Citrix XenApp on PVS Hosted Shared Desktops with Windows Server 2016.

Table 11 below shows the configuration and workload results for the multimedia worker user type and summarizes the Login VSI score for the platform.

Table 11. Test results for Windows Server 2016 Hosted Shared Desktops with AMD GPUs

<table>
<thead>
<tr>
<th>User type</th>
<th>VM type</th>
<th>Microsoft Office version</th>
<th>Microsoft Windows Server version</th>
<th>Number of users</th>
<th>VM vCPU</th>
<th>VM memory</th>
<th>PVS Write Cache Disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia worker</td>
<td>Hosted Shared Desktops</td>
<td>2013</td>
<td>2016</td>
<td>165</td>
<td>12</td>
<td>36GB</td>
<td>10GB</td>
</tr>
</tbody>
</table>
Figure 16 shows a single server Login VSI score of 165 multimedia workers using Citrix XenApp PVS Hosted Shared Desktops with locally installed applications on a single-node HPE Synergy 480 Gen10 Compute Module with AMD GPUs in an expansion module.

**Multiple nodes Hosted Shared Desktops with AMD GPUs for multimedia worker results**

Table 12 shows the Citrix Hosted Shared Desktops with AMD GPUs use case of multimedia worker that was tested on HPE Synergy with HPE Synergy 480 Gen10 Compute Modules with AMD GPUs in expansion modules in multiple HPE Synergy 12000 Frames across a 6-node configuration with a server pool of Citrix XenApp on PVS Hosted Shared Desktops with Windows Server 2016.

For this test, Login VSI Multimedia worker for Citrix Provisioning Services with XenApp Hosted Shared Desktops and PVS RAM Cache overflow to Nimble storage shared disk features were enabled on non-persistent Windows Server 2016 Graphic Apps.

Table 12 shows the configuration and workload results for the multimedia worker user type and summarizes the Login VSI score for the platform.

<table>
<thead>
<tr>
<th>User type</th>
<th>VM type</th>
<th>Microsoft Office version</th>
<th>Microsoft Windows version</th>
<th>Number of users</th>
<th>VM vCPU</th>
<th>Memory Minimum</th>
<th>PVS Write Cache Disk</th>
<th>Number of compute modules</th>
</tr>
</thead>
</table>
Figure 17 shows a multiple-server Login VSI score of 949 multimedia workers using Citrix XenApp PVS Hosted Shared Desktops with locally installed applications on a 6-node configuration of HPE Synergy 480 Gen10 Compute Modules with AMD GPUs in expansion modules.

**Analysis and recommendations**

The data presented in the prior sections suggests that HPE Synergy deployed with VMware ESXi hypervisor and HPE Nimble CS3000 storage is a flexible platform for running multimedia enabled end-user computing workloads. The platform offers demonstrated performance, simplified management, and cost effective, linear scaling for end-user computing solutions.

Key takeaways:

- Hewlett Packard Enterprise provides industry leading compute, storage, and networking infrastructure that you can use to deploy Citrix XenApp solutions in your environment.
- This HPE Reference Architecture is a tested and tuned solution architecture that offers optimal performance to deploy Citrix XenApp 7.17 virtual Hosted Shared Desktops application environments.
- HPE Nimble CS3000 storage provides uncompromising performance to run Citrix XenApp 7.17 client virtualization workloads.
- HPE Synergy performance testing of Citrix XenApp 7.17 with GPU-enabled Hosted Shared Desktops with 165 users, compared to Hosted Shared Desktops with 119 users and no GPU, on a single HPE Synergy 480 Gen10 Compute Module exhibited up to 38% higher scaling.

**Summary**

Delivering both discrete applications and full desktops within the modern digital workplace has been a challenge for many IT admins due to the consumerization of IT and the increased end-user expectations for high-performance anywhere, any device access.

Citrix XenApp 7.17, with or without AMD Multiuser GPU virtualized graphics, can deliver and manage published applications with local desktop-like performance, from the data center to virtually any device, anywhere.

This Reference Architecture demonstrates how HPE Synergy facilitates the delivery of Citrix XenApp in a cost-effective and highly manageable fashion. HPE Synergy is an ideal platform for server-based computing deployments providing enhanced GPU acceleration for optimum user experience. Using the HPE Synergy Image Streamer with Citrix PVS creates a simple way to manage server boot and user configurations, leveraging multiple user configurations. With the HPE Synergy Composer with the HPE OneView API, administrators can easily change the deployment characteristics to meet current needs.
The infrastructure-as-code capability of HPE Synergy accelerates transformation to a hybrid infrastructure and provides on-demand creation and delivery of applications and services with consistent governance, compliance, and integration. HPE OneView creates, aggregates, and hosts internal IT resources so automation tools can provision on-demand and programatically, without needing a detailed understanding of the underlying physical elements.

The following points define the value of deploying a Citrix XenApp solution on HPE Synergy and AMD GPU platform.

- HPE Synergy server profiles and templates are a powerful new way to quickly and reliably update and maintain existing infrastructure.
- HPE Synergy Composer uses templates to simplify one-to-many updates and manage HPE Synergy Compute Module profiles. These templates allow changes to be implemented automatically, significantly reducing manual interactions and errors.
- HPE Synergy Image Streamer enables HPE Synergy to quickly deploy new compute modules or update existing ones by booting them directly into their desired running OS in minutes.
- HPE Synergy offers unmatched AMD Multiuser GPU with passthrough technology, and virtualized graphics density per HPE Synergy 480 Compute Module via HPE Synergy 480 Multi MXM Expansion Module with up to 6 x AMD FirePro S7100X GPUs.
Appendix A: Bill of materials

The following table shows the bill of materials (BOM) for this solution.

**Note**

Part numbers are at time of testing and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your HPE Reseller or HPE Sales Representative for more details [hpe.com/us/en/services/consulting.html](http://hpe.com/us/en/services/consulting.html).

<table>
<thead>
<tr>
<th>Qty</th>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frame components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>797739-B21</td>
<td>HPE Synergy 12000 Frame</td>
</tr>
<tr>
<td>2</td>
<td>804353-B21</td>
<td>HPE Synergy Composer</td>
</tr>
<tr>
<td>2</td>
<td>804937-B21</td>
<td>HPE Synergy Image Streamer</td>
</tr>
<tr>
<td>6</td>
<td>804942-B21</td>
<td>HPE Synergy Frame Link Module</td>
</tr>
<tr>
<td>2</td>
<td>794502-B23</td>
<td>HPE Virtual Connect SE 40Gb F8 Module for HPE Synergy</td>
</tr>
<tr>
<td>18</td>
<td>798095-B21</td>
<td>HPE 2650 Watts Titanium Hot Plug AC Power Supply</td>
</tr>
<tr>
<td>4</td>
<td>779218-B21</td>
<td>HPE Synergy 20Gb Interconnect Link Module</td>
</tr>
<tr>
<td><strong>HPE Synergy Compute Module components</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>871940-B21</td>
<td>HPE Synergy 480 Gen10 Configure-to-order Compute Module</td>
</tr>
<tr>
<td>8</td>
<td>872139-L21</td>
<td>HPE Synergy 480 Gen10 Intel Xeon-Gold 6140 (2.3GHz/18-core/140W) FIO Processor Kit</td>
</tr>
<tr>
<td>8</td>
<td>872139-B21</td>
<td>HPE Synergy 480/660 Gen10 Intel Xeon-Gold 6140 (2.3GHz/18-core/140W) Processor Kit</td>
</tr>
<tr>
<td>8</td>
<td>777430-B21</td>
<td>HPE Synergy 3820C 10/20Gb Converged Network Adapter</td>
</tr>
<tr>
<td>48</td>
<td>815100-B21</td>
<td>HPE 32GB (1x32GB) Dual Rank x4 DDR4-2666 CAS-19-19-19 Registered Smart Memory Kit</td>
</tr>
<tr>
<td>6</td>
<td>872627-B21</td>
<td>HPE Synergy 480 Gen10 Multi MXM FIO Expansion Module</td>
</tr>
<tr>
<td><strong>HPE Nimble Storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Q8B39A</td>
<td>HPE Nimble Storage CS3000 Hybrid Dual Controller 10GBASE-T 2-port Base Array</td>
</tr>
<tr>
<td>1</td>
<td>Q8B64A</td>
<td>HPE Nimble Storage CS/SF Hybrid Array 3x1.92TB Cache Bundle</td>
</tr>
<tr>
<td>1</td>
<td>Q8B68A</td>
<td>HPE Nimble Storage CS/SF Hybrid Array 21x1TB HDD Bundle</td>
</tr>
<tr>
<td>1</td>
<td>Q8B80A</td>
<td>HPE Nimble Storage CS Hybrid Array 3x240GB Cache Bundle</td>
</tr>
<tr>
<td>1</td>
<td>Q8B89A</td>
<td>HPE Nimble Storage 4x10Gb 2-port Adapter Ki</td>
</tr>
<tr>
<td>1</td>
<td>Q8G27A</td>
<td>HPE Nimble Storage NOS Default Software</td>
</tr>
<tr>
<td><strong>HPE Switches</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>JH179A</td>
<td>HPE FlexFabric S930 4-slot Switch</td>
</tr>
<tr>
<td><strong>AMD FirePro GPU</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>M3X68A</td>
<td>HPE AMD FirePro S7100X x2 Accelerator Kit</td>
</tr>
</tbody>
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Resources and additional links

HPE Reference Architectures, hpe.com/info/ra
HPE Servers, hpe.com/servers
HPE Storage, hpe.com/storage
HPE Networking, hpe.com/networking
HPE Technology Consulting Services, hpe.com/us/en/services/consulting.html
HPE Nimble Storage User Guide (Requires HPE Passport Account), https://infosight.hpe.com/InfoSight/media/cms/active/Nimble_OS_2_1_3_user_guide_2_1_x_PN970_0013_002.pdf
AMD MxGPU Radeon Pro Settings for VMware vSphere Client, https://www2.ati.com/relnotes/radeon_pro_settings_for_vmware_vsphere_client_user_guide_v1.0.pdf

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