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HPE Moonshot and Edgeline Edge Workspace Solution

Powered by HPE Moonshot and Edgeline, Citrix XenDesktop and XenApp, and VMware ESXi

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Executive summary

IT is constantly faced with the challenge of meeting their operational, security compliance, and other business requirements while meeting the needs of end-users who want their systems to be quick to respond and easy to use. The goal of this paper is to provide a solution to this challenge through a single product line that can be sized for a wide range of user profiles from published applications through Virtual desktop infrastructure (VDI) through dedicated bare-metal systems, all in an ecosystem that makes it simple for IT to manage, stay within compliance, and provide a great experience for their end users.

This paper discusses three different use cases and solutions which use the HPE Moonshot System and Edgeline Converged Edge System, Citrix XenDesktop and XenApp, and VMware ESXi:

- Published desktops and applications or server-based computing (SBC)
- Virtual desktop infrastructure (VDI)
- Bare-metal desktops or hosted desktop infrastructure (HDI)

Each of these use cases is addressed by one, combined, unique architecture of Moonshot and Edgeline, and together they provide ideal computing environments for a broad range of user types. Some of the use cases include task workers with dense published desktop and application delivery, office workers with some graphics acceleration requirement through VDI, and even high-end users who need individual dedicated compute, graphics, networking, and storage. Each of these use cases can be managed either by on-premises Citrix infrastructure or through Citrix Cloud. This paper also describes client-side hardware that has been tested and validated with this solution to give end-users a great experience.

Purpose

This document describes the solution architectures, hardware and software components, and performance characteristics of several solution options that combine HPE Moonshot and Edgeline technology with Citrix and VMware software. The paper is intended for a pre-sales audience.

Solution components

HPE Moonshot Systems with HPE ProLiant m710x server cartridges

HPE Moonshot System is a huge leap forward in infrastructure design that delivers breakthrough efficiency and scale by aligning the right amount of compute, memory, and storage. The Moonshot Chassis includes all the common resources from a traditional server-power, cooling, management, fabric, switches, and network uplinks-all shared across 45 hot-pluggable server cartridges in a dense 4.3U form factor. It replaces general-purpose processors with more energy-efficient Systems-on-Chips (SoCs) containing integrated accelerators, such as a graphics processor, tailored for specific workloads. The HPE ProLiant m710x Server Cartridge is built on the lower-power Intel Skylake processing architecture, including a powerful, integrated GPU with Iris Pro graphics, and has been optimized for the best possible performance with Citrix XenDesktop and XenApp. The HPE m710x server cartridge also includes onboard iLO on each cartridge to simplify management. Together, the HPE Moonshot System and the HPE ProLiant m710x Server Cartridge provide an architecture well-suited to support high-end desktops hosted in the data center, delivering excellent processing, and graphical capabilities to the end user over Citrix XenDesktop and XenApp.

The **HPE ProLiant m710x Server Cartridge technical specifications** table describes the specifications of the HPE ProLiant m710x Server Cartridge which serves as the compute resource for both XenDesktop and XenApp users.

Table 1: HPE ProLiant m710x Server Cartridge technical specifications

Component	Description
CPU	Intel Xeon E3-1585L v5, 3.0 GHz (3.7 GHz Turbo), 4-core
Memory	64GB of ECC memory, dual memory channels (4) 16GB DDR4-2133 MHz LV DIMMs
Network	Dual 10GbE Mellanox Connect-X3 Pro NICs Supports RDMA over Converged Ethernet (RoCE)
Storage	1x SATA M.2 2242 (up to 240GB) 4x NVMe M.2 2280 or 22110 (up to 1TB each)
Graphics	Integrated Intel Iris Pro P580 graphics and 128MB embedded DRAM

The **HPE ProLiant m510 Server Cartridge technical specifications** table describes the specifications of the HPE ProLiant m510 Server Cartridge, which can host the necessary Citrix XenDesktop infrastructure for this solution.

Table 2: HPE ProLiant m510 Server Cartridge technical specifications

Component	Description
CPU	Intel Xeon D-1548, 2.0 GHz (2.6 GHz Turbo), 8-core, or Intel Xeon D-1587, 1.7 GHz (2.3 GHz Turbo), 16-core
Memory	128GB of ECC Registered memory, dual memory channels (4) 32GB DDR4-2400 MHz RDIMMs
Network	Dual 10GbE Mellanox Connect-X3 Pro NICs Supports RDMA over Converged Ethernet (RoCE)
Storage	1x SATA M.2 2242 (up to 240GB) 2x NVMe M.2 2280 or 22110 (up to 2TB each)

HPE Edgeline Converged Edge Systems

HPE Edgeline Converged Edge Systems deliver unprecedented high performance compute, control systems, data acquisition, and iLO systems management, all converged in a single enclosure, and hardened for edge environments. The HPE Edgeline EL4000 Converged Edge System includes up to four independent server cartridges in a slim 1U form factor, and uses the same server cartridges as the HPE Moonshot System. It also contains four data capture/control slots that can house NVIDIA or AMD GPUs, and has scalable high capacity storage up to more than 16TB in a single enclosure. Dual redundant power supplies, ruggedization (up to MIL-STD through HPE partners), and the backing of industry certifications such as NEBS Level 3 make the HPE EL4000 a highly reliable system. The HPE EL4000 supports several mounting options to fit any environment, be it a rack, wall, desk, or even within customer equipment.

Citrix XenDesktop and XenApp

Citrix XenDesktop is a complete software suite for transforming Windows desktops and applications into an on-demand service accessible from any device, and for managing those desktops and apps, and the users who access them. Using XenDesktop, IT can reduce workload and costs by consolidating control and security for sensitive data and intellectual property in the data center. HDX technologies facilitate XenDesktop to deliver a rich native look-and-feel, dynamically optimized for both the type of device and network conditions. Users interact with the desktop as they would a local desktop by sending keystrokes and mouse movements which are sent to the server. The server then sends screen updates back to the user's device. This paradigm of interaction uses server-side processing, which can free IT from the endless cycle of PC hardware refreshes normally necessary to support new applications and application upgrades when using traditional, user-side compute deployment techniques.

Citrix XenApp delivers Microsoft® Windows apps as secure mobile services. With XenApp, IT can mobilize the business, while reducing costs by centralizing control and security for sensitive data and intellectual property. Users can self-select apps from an easy-to-use app store that is accessible from smartphones, tablets, PCs, Macs, and thin clients. Citrix HDX technology enables XenApp to deliver a native, touch-enabled look-and-feel that is optimized for the type of device, as well as network conditions. XenApp leverages session virtualization, enabling delivery of applications from servers in the data center. XenApp then connects the user to the server where the application is hosted so the application executes entirely on the server. The user interacts with the application remotely by sending mouse-clicks and keystrokes to the server. The server then responds by sending screen updates back to the user's device. XenApp enables Windows, Mac, Linux®, iOS, and Android devices to run any applications using session virtualization through Citrix Receiver. Session virtualization also leverages server-side processing power, which liberates IT from the endless cycle of PC

hardware refreshes typically needed to support application upgrades when using traditional application deployment methods.

Citrix also provides an excellent tool for image management and deployment, called Provisioning Services (PVS). PVS streams a complete operating system image to desktops running on both virtual and physical resources, including Moonshot and Edgeline. PVS can dramatically reduce IT maintenance costs by allowing IT to maintain a single image for all devices. Citrix PVS is not a requirement for this solution, but it is an option that may be implemented as desired.

Citrix XenDesktop version 7.17 was used during testing for this paper. XenDesktop 7.17 is the latest Citrix release at time of publication.

Table 3: Citrix XenDesktop software versions

Software	Version
XenDesktop Controller	7.17.0.89
Virtual Desktop Agent	7.17.0.17027
Citrix Receiver	4.11 (14.11.0.17061)

VMware ESXi

VMware ESXi is a purpose-built bare-metal hypervisor that installs directly onto a physical server. With direct access to and control of underlying resources, ESXi is more efficient than hosted architectures and can effectively partition hardware to increase consolidation ratios and cut costs. ESXi consolidates hardware for higher capacity utilization, simplifies IT administration with its centralized management tool, VMware vSphere, and uses a minimal amount of system resources to run the hypervisor so that end users have access to the most resources possible.

Table 4: VMware ESXi software version

Software	Version
VMware ESXi	6.5 Update 1

Client hardware

While one of the advantages of deploying server-side processing in the data center and delivering desktops via Citrix XenDesktop is that users can access their desktops from any end-point device, special considerations must be taken for support of use cases that includes four or more Full HD monitors at the user's desk. Four to six high-resolution monitors afford the end-user plenty of screen real estate to increase their productivity and efficiency, even with multiple simultaneous workflows. Driving four to six Full HD monitors requires as many display ports on the end-point device, along with an end-point CPU that is powerful enough to handle delivering that many monitors of rich XenDesktop content, including multimedia, simultaneously. The HP t730 Thin Client fits this requirement as a small and quiet client device with expandable graphics ports. Configured with an AMD R-Series processor with AMD Radeon HD 9000 graphics and optional AMD FirePro W2100 graphics adapter, the t730 thin client supports up to six monitors while providing a responsive end-user experience with Citrix XenDesktop. HP Z24nf Narrow Bezel IPS Displays allow for deployment of seamless multi-display setups. They have a standard 1920 x 1080 resolution on a three-sided borderless 23.8-inch diagonal screen.

Table 5: Client hardware technical specifications

Component	Description
Client device	HP t730 Thin Client AMD RX-427BB with AMD Radeon HD 9000 graphics, 8GB RAM, AMD FirePro W2100 Windows 10 Enterprise 2015 LTSB
Displays	HP Z24nf 23.8-inch narrow bezel IPS display, 1920x1080

Putting it all together

All of these components together present a solution that is different from and solves problems with other methods of deploying published applications, virtual desktops, and high-end desktops that are commonly used today.

For published applications, the desired applications are installed along with the Citrix Virtual Delivery Agent (VDA) in a Windows Server OS running on a bare-metal HPE m710x server cartridge. XenApp published applications are relying more on the graphical compute power on the host server as new Windows and Microsoft Office versions become more resource and graphics intensive. A non-graphics published application server may work well for a limited subset of applications, but having graphics capabilities for published applications without the often expensive and complicated graphics options in rack-mount and blade servers can mean a better end-user experience. Having these graphics capabilities also extends the usefulness of published applications and server-based computing from just commodity desktop applications to rich graphical and media applications, such as Adobe Photoshop. The HPE m710x server cartridge provides graphics capabilities to satisfy a wide range of application users, delivered in a building block to add application user capacity as needed in manageable sizes, from a single cartridge through multiple 45-cartridge chassis at a time.

For VDI, Windows 10 virtual machines with the Citrix VDA are deployed within VMware ESXi running on an HPE m710x server cartridge. Most VDI environments are deployed on rack-mount or blade servers, which consolidate large numbers of users on dual-socket systems. Depending on how many users are active on the system at a given time, serious resource contention can occur, which leads to inconsistent end-user experience. These setups also often do not have graphics functionality for users, which reduces performance, especially in Windows 10. If they do have graphics, it can be a expensive addition, both for hardware and the accompanying licensing. When users require higher compute and graphics performance than traditional VDI delivers, the HPE Moonshot and Edgeline Converged Edge Systems with the HPE m710x server cartridge can deliver performance, graphics-accelerated VDI desktops running on VMware ESXi to deliver productivity and user experience improvements. VDI on Moonshot and Edgeline provides this capability on the same hardware as application delivery and bare-metal solutions, which simplifies maintenance and by using one standardized platform.

For bare-metal desktops, Windows 10 and the Citrix VDA are installed directly on the HPE m710x server cartridge. Typical high-end desktop deployments tend to fall into one of two categories. First, there are tower PCs located the user's desk. These are often bulky, loud, and generate extra heat near the user. They also tend to be less secure than resources hosted in a data center with stricter access control and less physical traffic. Remote options can be limited or complicated when the users' primary compute is sitting at their desk; this can be a problem if there was disaster that renders the office inaccessible or without power. Second, there are workstation blades, which have oversized processors and GPUs for many workloads, such as for financial traders, and are often expensive. By right-sizing the hardware for high-end users with the HPE m710x server cartridge, less resources are wasted without compromising the end-user experience. In fact, Citrix XenDesktop provides a simple and performance protocol to access resources from anywhere that corporate policy allows, increasing productivity, simplifying desk moves in the office, and facilitating collaboration. These benefits are achieved without the high-end users having to worry about resource

contention, since they are still assigned dedicated hardware, including CPU, GPU, memory, disk, and networking.

These common deployment issues are addressed by combining the HPE Moonshot System or HPE Edgeline Converged Edge System and HPE ProLiant m710x server cartridges with Citrix XenDesktop and XenApp, VMware ESXi for virtualization, and a smart choice of client-side access device that are tested and validated to drive a rich end-user experience. Moonshot and Edgeline move the user compute away from the user's desk into the more secure data center or edge locations, while also providing simple access from anywhere through Citrix, as permitted by corporate policies. The HPE ProLiant m710x Server Cartridge is an ideal combination of size and compute/graphics capability for published application users, the right number of performance VDI users, and high-end desktop users, providing excellent processing power, fast graphics, and a great end-user experience without wasted CPU cycles.

Figure 1 shows a functional diagram of the solution layout, including the compute, virtualization, and infrastructure options.

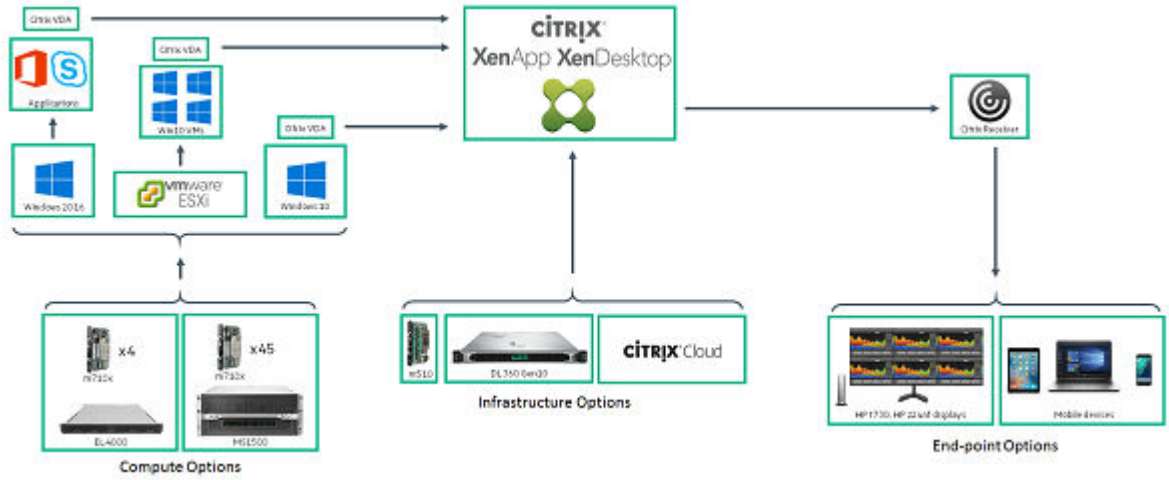

Figure 1: Solution functional diagram

Capacity and sizing

This section presents the results of performance and sizing testing. These results call out the capacity of the m710x cartridge for XenApp for published applications and XenDesktop for VDI or bare-metal deployments. Where sizing is not determined by physical requirements, such as for published applications or VDI, the performance data in this section can be used as a starting point to tailor user density depending on workload requirements.

XenApp sizing

To size XenApp users on HPE m710x server cartridges, scalability testing was conducted using Login VSI software. This section describes the test workload and summarizes the scalability test results.

Login VSI workloads simulate users running generic applications such as Microsoft Office, Internet Explorer, and Adobe Acrobat Reader. The default workloads shipped with Login VSI are designed to simulate different types of workers that perform multiple application tasks. By gradually incrementing the number of simulated users, the system under test will eventually saturate and response times will increase, eventually showing that system resources are close to exhaustion. By pushing the system to its limits, it is possible to discover the maximum density that the system can likely sustain.

Workload description

This section describes the office worker workload profile used to evaluate XenApp performance on HPE Moonshot with HPE ProLiant m710x Server Cartridges. The office worker workload is one of the default workloads in Login VSI 4.1.3. This workload emulates an office worker using Microsoft Office, Microsoft Internet Explorer, PDFs, and more.

The following are applicable to each session:

- Once a session starts, the workload repeats or loops every 48 minutes.
- Each loop has four segments. Each consecutive Login VSI user logon starts a different segment. This method ensures that all elements in the workload get equal use throughout the test.
- During each segment, the response time is measured three times.
- Approximately two minutes of idle time are included between each segment to simulate real-world users.

Each loop will open and use the following applications:

- Microsoft Outlook
- Microsoft Internet Explorer
- Microsoft Word
- Adobe Reader
- Microsoft PowerPoint
- Microsoft Excel
- Login VSI photo viewer
- Doro PDF Writer

A more detailed view of each Login VSI workload can be found in **Login VSI 4.1 Workloads**.

Single-server scalability test results

VSImax represents the maximum number of users the environment can handle before serious performance degradation occurs. It is calculated based on response times during workload execution that are expected to be less than a particular threshold. VSImax is reached when the response times reach or exceed the threshold on multiple consecutive occurrences. **Figure 2** shows the baseline response times versus the number of user sessions for a single HPE m710x server cartridge, delivering sessions through Citrix XenApp, in testing performed by Citrix. For more information, see **HPE Moonshot for Citrix Mobile Workspaces Reference Architecture**. Under the office worker workload, VSImax was reached at 67 users on a single HPE m710x server cartridge.

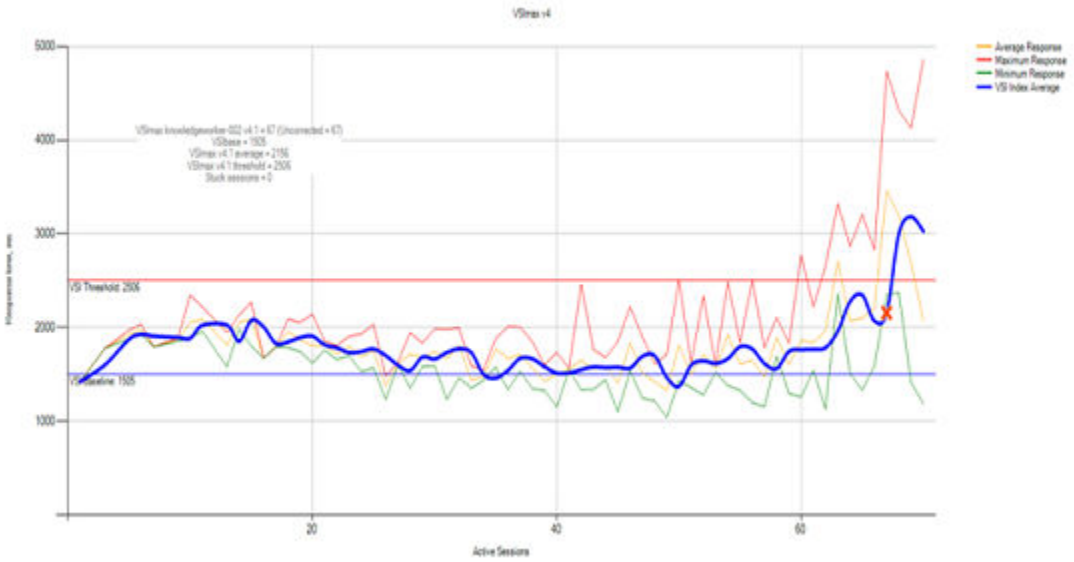

Figure 2: LoginVSI results on m710x server cartridge

Figure 3 projects the linear scaling of the average single cartridge VSImax to a fully populated Moonshot 1500 chassis. This projection is valid since Moonshot cartridges are independent computing resources. Further, none of the shared resources (power, cooling, network) are at risk of being exhausted in this use case.

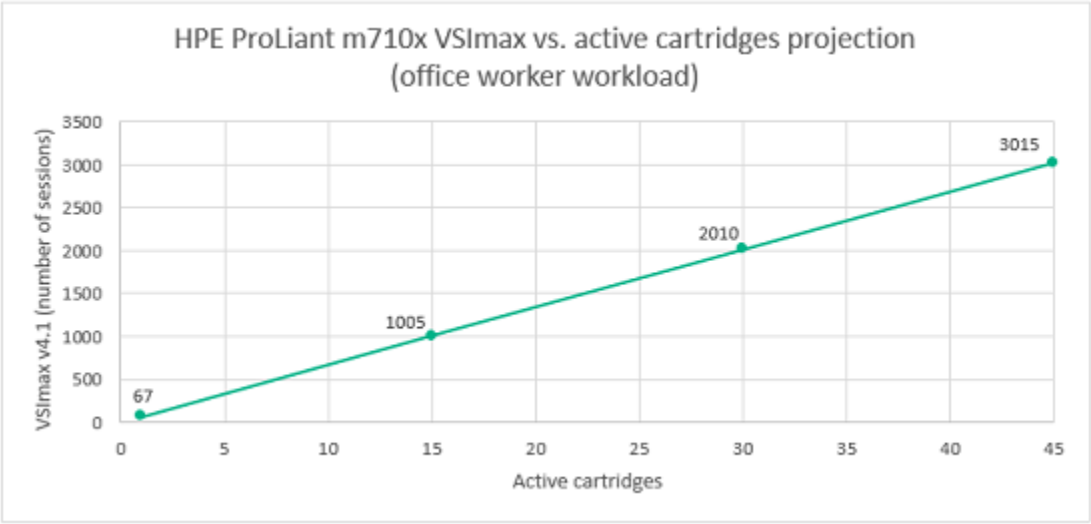

Figure 3: Linear scaling of cartridge capacity to a full Moonshot 1500 chassis

These results can be interpreted, as with other LoginVSI results, in the context of the types of applications and performance expectation of users in a specific deployment.

XenDesktop sizing for VDI and bare-metal

Sizing the solution is straightforward with bare-metal XenDesktop, as each m710x server cartridge is assigned to one single user. In the EL4000 Converged Edge System, four m710x server cartridges fit into each enclosure, for a density of four users per rack unit. This building block can be repeated as necessary to deploy as many users as are necessary. The Moonshot 1500 chassis is recommended or deployments in a traditional data center that do not require compute as close to the edge, because the 1500 consolidates resources across a greater number of server cartridges and provides a denser environment. Forty-five server cartridges fit into each Moonshot 1500 chassis, for a density of over 10 users per rack unit.

To increase user density, the server cartridges can be virtualized with VMware ESXi, or deliver applications with XenApp, as described in the previous section. To size the VMware virtual machines, a starting point of both four and six VMs per physical m710x server cartridge were tested, to provide enough additional density be worth virtualizing, without degrading performance to the point of low-end VDI. Virtual machines running on the m710x server cartridge platform benefit greatly from the ability to share the integrated GPU through an Intel driver for ESXi. Sharing the integrated GPU improves performance across Windows, as newer Windows versions such as Windows 10 rely increasingly on GPU to offload compute when possible, as well as enabling DirectX applications that might not be possible or feasible on commodity VDI.

VMware guidelines on system requirements for ESXi 6.5 call for 8GB of RAM for the hypervisor for a production environment, and this guideline was followed when sizing the memory for the virtual machines. To determine the memory to assign to each virtual machine, 8GB was subtracted from the total memory available on the m710x server cartridge (64GB), and then divided by the number of virtual machines, either four or six, that were to be run simultaneously. The calculation led to a memory sizing of 14GB for a four-VM configuration and 9GB for a six-VM configuration. It is possible in ESXi to oversubscribe the physical memory, but over-subscription is not recommended due to potential issues and slowdowns if multiple users fill up their memory simultaneously.

Each virtual machine was given two vCPUs across both four and six VM configurations. Assigning more than one vCPU allows processes that are multithreaded to benefit from additional resources scheduled by VMware, but adding vCPUs past two (such as four vCPUs per virtual machine) actually demonstrated a decrease in performance across multiple tests when the VMs were running simultaneously.

To compare XenDesktop performance across different density levels, several benchmarks were run across bare-metal and different virtual machine configurations with Windows 10, as seen in the table following.

Table 6: Bare-metal and virtual machine specifications for performance testing

Scenario	Specifications	Operating system
Bare-metal	4 core CPU, 64GB RAM	Windows 10 Pro (build 1703)
1 active VM	2 vCPU, 14GB RAM, 512MB 3D Memory	Windows 10 Pro (build 1703)
4 active VMs	2 vCPU, 14GB RAM, 512MB 3D Memory	Windows 10 Pro (build 1703)
6 active VMs	2 vCPU, 9GB RAM, 512MB 3D Memory	Windows 10 Pro (build 1703)

PassMark PerformanceTest v9

PassMark PerformanceTest v9 is a suite of benchmarks that covers the CPU, GPU, and other system components. This section presents the CPU and graphics benchmarks results across bare-metal and different virtual machine configurations, as seen respectively, in the following two tables following.

Table 7: PassMark PerformanceTest v9 CPU mark results, average of 3 runs

Machine type	CPU mark (Average)
Bare-metal	10506.0
1 active VM	4591.4
4 active VMs	3552.5
6 active VMs	2847.0

Table 8: PassMark PerformanceTest v9 3D mark results, average of 3 runs

Machine type	3D mark (Average)	2D mark (Average)
Bare-metal	1959.7	852.3

ExcelTrader

ExcelTrader benchmark measures Excel performance with six trading-related Excel and Visual Basic for Applications (VBA) tests, consisting of:

- Measuring the time it takes VBA to build and manipulate data
- Measuring the number of price changes that can be displayed in a set time period
- Measuring the number of live formula calculations that can be made within a set time period

For this testing, the ExcelTrader benchmark was run on Office 2013 on each machine. The results are summarized as shown in the following table.

Table 9: ExcelTrader results, average of 3 runs

Machine type	ExcelTrader (Average)
Bare-metal	96.0
1 active VM	92.0
4 active VMs	76.1
6 active VMs	67.6

It is important to note that in the four and six active VM configurations, the benchmarks were run simultaneously across all active machines. The benchmarks present a 'worst-case' sizing scenario, as there is the maximum amount of resource contention while each VM is trying to drive the CPU or GPU, depending on the test, to capacity. In real-world usage, it is expected that all users would not stress the same components to capacity at the same time, which would allow for better resource sharing among VMs than demonstrated in a benchmark use case.

Sizing virtual machines comes down to the applications and processes that users will be running, and the level of performance that they are accustomed to. These numbers can be used as a starting point to compare existing systems and discover where in the spectrum of options users and their IT administrators would be most comfortable assigning their users. Every configuration listed above, even at six VMs per m710x server cartridge, presents a fluid end-user experience as long as there is enough compute and graphics for the users' specific workloads.

Citrix infrastructure options and sizing

Citrix XenDesktop provides flexibility in where its infrastructure can be located. There are options to deploy the Citrix infrastructure on-premises or in the cloud with Citrix Cloud. Within the on-premises option, Citrix infrastructure can be deployed on a variety of hardware platforms.

On-premises

Moonshot and Edgeline compute can easily be integrated into an existing on-premises Citrix infrastructure that is already present, as long as the infrastructure has the capacity for the additional users that will be added. If new Citrix infrastructure is required, there are several hardware options to deploy the infrastructure on, including an HPE DL360 server, or even on an HPE m510 server cartridge, sitting inside an MS1500 chassis or EL4000 enclosure. An HPE m510 server cartridge is an ideal solution to host the necessary Citrix infrastructure for small deployments. For larger deployments, or those looking to scale seamlessly without having to worry about infrastructure capacity, an HPE DL360 server serves the same purpose but with more CPU, memory, and disk that allows for further expansion.

Whether the infrastructure is deployed on an m510 server cartridge or DL360 server, following Citrix best practices for redundancy, it is recommended to install a pair of VMs for each role for high availability and to prevent downtime. The following table defines infrastructure VM specifications based on Citrix sizing recommendations.

Table 10: Infrastructure VM specifications

VM	vCPU	Memory (GB)	HDD (GB)	Number of VMs
Delivery Controller	2	8	40	2
License Server	2	4	40	1
StoreFront	2	4	40	2
SQL Server	2	4	40	2
Provisioning Server (Optional)	2	16	40	2

If a single EL4000 is being used for an edge deployment, it is possible to run all Citrix infrastructure on a single m510 server cartridge, but there are fewer safeguards and failover options in the event of a hardware or software problem.

For Citrix infrastructure installation instructions, refer to the Citrix XenApp and XenDesktop current release Install and configure documentation.

For more information about additional Citrix components, such as Citrix PVS, Netscaler Gateway, and others, see the **HPE Moonshot for Citrix Mobile Workspaces Reference Architecture**.

Citrix Cloud

Citrix Cloud moves the XenApp and XenDesktop control plane from on-premises, where it is managed by the end customer, to the cloud, where Citrix takes care of hosting all the Citrix infrastructure components and keeping them up to date. For Citrix Cloud to manage and monitor on-premises hardware resources, such as Moonshot and Edgeline, a Cloud Connector is needed in the on-premises site to act as a proxy and an agent between the cloud and the on-premises infrastructure. The Cloud Connector is a small software installation on a Windows Server 2012 R2 or 2016 VM, and Citrix recommends that at least two Cloud Connectors be installed at any site for high availability. The figure following shows a functional diagram of the Citrix Cloud architecture, and how it works together with on-premises hardware.

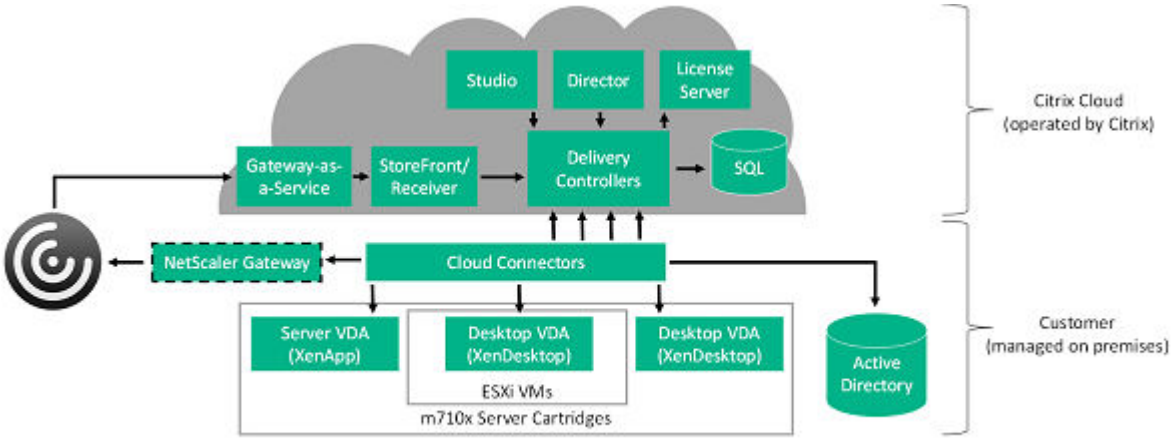

Figure 4: Citrix Cloud functional diagram

The Cloud Connector installation is simple, and only requires a domain-joined Windows 2012 R2 or 2016 virtual machine with Internet access and Internet Explorer Enhanced Security Configuration disabled. From the Citrix Cloud interface on the Cloud Connector VM, add a resource location, which will prompt the Cloud Connector software download. Once it is installed and connected, it will be assigned a DNS name. This name is the Controller address when installing the VDA on virtual and physical machines. Once connected, machines can be put into machine catalogs and delivery groups from the Citrix Cloud interface.

For prerequisites and more guidance on specific deployment scenarios, see **Citrix Install and configuration documentation** for Citrix Cloud.

Configuration guidance

Deploying the proposed application delivery, VDI, or bare-metal desktop solutions into an existing Citrix XenDesktop or XenApp environment is similar in many ways to adding any new server resource. Additional Moonshot and Edgeline specific configuration details that are not covered in this document are detailed in depth in the **HPE Moonshot for Citrix Integration Guide**.

Whether an application delivery, virtualized, or bare-metal solution is being deployed, there are important setup steps on the Moonshot and Edgeline platforms to provide maximum performance and stability

Procedure

1. Ensure that the chassis and cartridge firmware are up-to-date.

   The latest Moonshot and Edgeline Component Packs can be found at **HPE Enterprise Support**.
2. Set the cartridge to run in maximum performance mode:

   a. Access the iLO integrated remote console.

   b. After the initial POST screen, press **F9** to enter **System Utilities**.

   c. Choose **System Configuration > BIOS/Platform Configuration (RBSU) > Power Management**.

   d. Set **Power Mode** to **Maximum Performance**.

   e. Reboot the cartridge.

Application delivery

To ensure maximum benefit of the Intel GPU for end-user applications, it is important to install the latest Intel graphics driver for Windows Server from the Moonshot Windows Deployment Pack (MWDP).

Virtualization

These best practices for VM configuration have been adopted through extensive testing and optimization to ensure optimal performance of the HPE m710x server cartridge with VMware ESXi.

VM settings

While different VM sizing can be adopted depending on workload and customer need, there are two tested and recommended options: four or six virtual machines on a single m710x ESXi host. These two scenarios provide the density necessary to justify virtualizing the m710x server cartridge, while still maintaining the high performance and end-user experience that is expected from Moonshot and Edgeline. Each of these configurations will have different VM settings to fit the required number of VMs into the given hardware, but the m710x configuration stays basically the same between them.

It is important to give the virtual machines more than one vCPU, so that multithreaded tasks can take advantage of running in parallel, but not so many vCPUs that the VMware scheduler causes performance degradation. Testing revealed that simultaneous CPU-bound benchmarks on multiple VMs performed best with a two vCPU configuration, for both four and six virtual machines.

Memory allocation is dependent on what is available in the cartridge, at a maximum of 64GB. ESXi and the virtual machines do have some memory overhead, and therefore the total memory of the four or six VMs do not add up to 64GB. There is 8GB of memory reserved for the system and for virtual machine overhead. VMware ESXi does allow memory over-subscription, so it would be possible to assign each of the VMs in the

four VM configuration 16GB. However, to ensure reliable and consistent performance without the chance of resource contention, this is not recommended.

Table 11: VM settings for an HPE m710x server cartridge with VMware ESXi

Configuration	vCPU	Memory
4 VMs	2	14GB
6 VMs	2	9GB

Note that the necessary Intel Iris Pro driver for VMware ESXi, to enable sharing the Iris Pro graphics to multiple VMs, has not been released yet.

Bare-metal

Windows best practices and tuning parameters

It is important to ensure that Windows is up to date through Windows Update. However, be sure that the Windows-suggested Intel graphics and Mellanox network drivers are not installed through Windows Update. Instead, get the latest graphics and network drivers from **http://hpe.com**. It is also important to make sure that Windows is running in "High performance" mode under Power Options, as seen in the following figure, to avoid unnecessary throttling of the CPU.

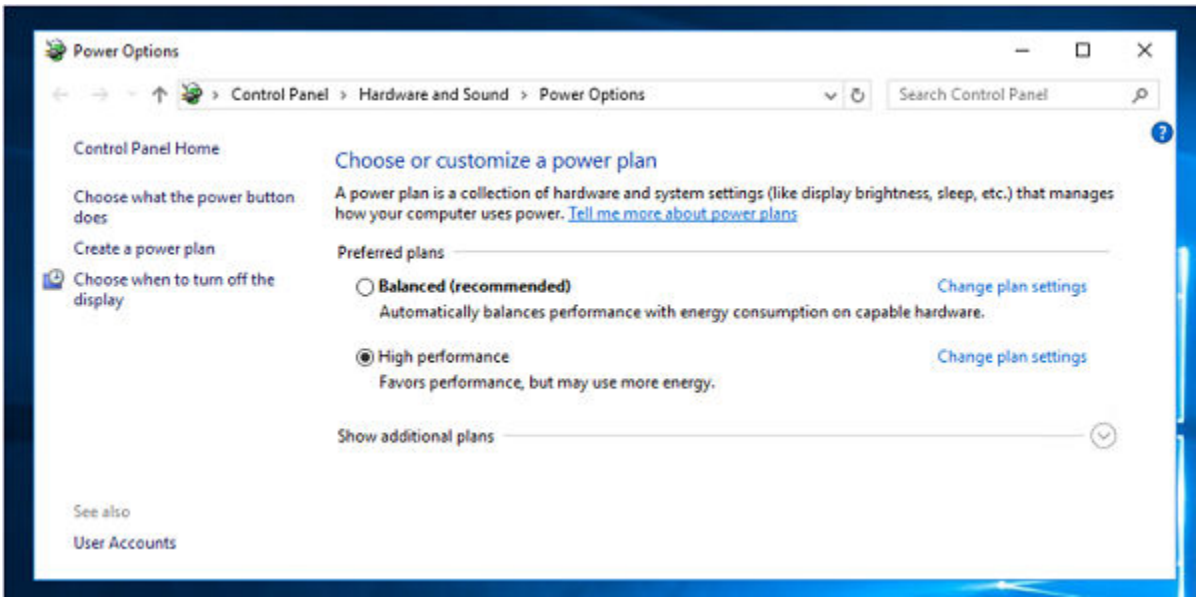

Figure 5: Windows 10 High performance mode setting screen

Intel graphics driver

To support all features of the Moonshot m710x server cartridge, including display configurations with more than three displays, it is important that the supported version of the client Intel graphics driver for Windows is installed. Windows update may automatically update the Intel driver to an unsupported version. The latest Moonshot Windows Deployment Pack (MWDP) for the m710x server cartridge from HPE provides a known and supported version of the Intel graphics driver that should be used instead of the version that Windows may automatically update to.

iLO Video

Once the cartridge has been imaged, iLO video must be disabled to provide full graphics capabilities to the desktop. iLO video can be disabled from the iLO integrated remote console:

1. Access the iLO integrated remote console.
2. After the initial POST screen, press **F9** to enter System Utilities.
3. Choose **System Configuration > BIOS/Platform Configuration (RBSU) > Advanced Options**.
4. Set **Video Options** to **Add-in Video Enabled, Embedded Video Disabled**.
5. Reboot the cartridge.

To re-enable iLO video, the iLO integrated remote console cannot be used, because it loses video after the initial POST screen during boot, before the BIOS settings can be accessed. Instead, the relevant BIOS setting has to be set with a REST API call. More information is available in the **HPE iLO RESTful API Data Model Reference (iLO 4)**, and a sample API call to re-enable iLO video using CURL is given below:

```
curl -k -u "iLOusername:iLOpassword" -H "Content-Type: application/json" -X
"PUT" -d "{\"VideoOptions\":\"BothVideoEnabled\"}" "https://iLO_IP/rest/v1/
Systems/1/Bios/Settings
```

After making the API call, reboot the cartridge.

Summary

There are a wide variety of user types that modern IT organizations must cater to, from published desktop and application users, through VDI users with relatively low application and workload requirements, up to high end users that require fast processors and powerful available graphics to drive intense workloads displayed across multi-monitor setups. This solution allows IT to cater to each of those users at a resource and density level that makes sense for their requirements, all while the underlying compute stays the same. Each of these user types sees appreciable benefits from this solution:

- Published application users benefit from the included graphics on the m710x.
- VDI users benefit from reduced resource contention, higher specs, and shareable graphics on the m710x as opposed to compute-only VDI.
- Bare-metal users eliminate resource contention by getting their own, right-sized compute, graphics, memory, and storage. It allows IT to move users' compute safely into the data center where it can be accessed, as allowed, from any location. Users get a quieter and more ergonomic work environment that is easier for IT to relocate when necessary.

Moonshot and Edgeline present a scalable compute block in the form of the m710x server cartridge that makes it easy to add users as necessary to an existing deployment. The graphical and compute power of the m710x server cartridge was detailed, as well as the ability to share the graphics among several VDI users on each cartridge, to accelerate general performance in Windows and allow use of applications that rely on certain graphics protocols. By using the tested and validated combination of the HPE Moonshot System and HPE Edgeline Converged Edge System, Citrix XenDesktop and XenApp, and VMware ESXi, IT can simply provide end users with an excellent end-user experience and a desktop that they can access from anywhere their IT policies allow them to.

Implementing a proof-of-concept

As a matter of best practice for all deployments, HPE recommends implementing a proof-of-concept using a test environment that matches as closely as possible with the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an **HPE Services representative** or your HPE partner.

Bill of materials

There are many options in this paper focused on user types, Moonshot or Edgeline chassis, and infrastructure hosting. A sample bill of materials is provided following for a configuration with:

- 15 bare-metal users
- 60 VDI users, at a density of four users per m710x server cartridge
    - Each user has a dedicated disk
- 845 XenApp users, at a density of 65 users per m710x server cartridge
- 2 m510 server cartridges to host the Citrix and other necessary infrastructure

Table 12: Moonshot bill of materials

Quantity	Part Number	Description
1	755372-B21	HPE Moonshot 1500 Chassis
43	833105-B21	HPE ProLiant m710x E3-1285v5 3.1GHz 4-core 45W Configure-to-order Server Cartridge
43	866842-B21	HPE 120GB SATA M.2 2242 Solid-State Drive Field Upgradable Kit
43	862161-B21	HPE 512GB PCIe M.2 2280 Solid-State Drive Filed Upgradable Kit
172	863953-B21	HPE 16GB (1x16GB) ECC Dual Rank x8 DDR4-2400 CAS-15-15-15 Unbuffered SO-DIMM Field Upgradable Kit
2	814688-B21	HPE ProLiant m510 Xeon D-1548 2.0GHz 8-core Configure-to-order Server Cartridge
2	866842-B21	HPE 120GB SATA M.2 2242 Solid-State Drive Field Upgradable Kit
4	862161-B21	HPE 512GB PCIe M.2 2280 Solid-State Drive Filed Upgradable Kit
8	854596-B21	HPE 32GB (1x32GB) Dual Rank x4 DDR4-2400 CAS-17-17-17 Registered Memory Kit
4	656364-B21	HPE 1200W Common Slot Platinum Plus Hot Plug Power Supply Kit
4	A0K02A	HPE C13 - C14 WW 250V 10Amp 2.0m Jumper Cord
2	704654-B21	HPE Moonshot-45XGc Switch Module Kit
2	704652-B21	HPE Moonshot-4QSFP+ Uplink Module Kit
1	681254-B21	HPE 4.3U Server Rail Kit
1	681260-B21	HPE 0.66U Spacer Blank Kit

This configuration can also be accomplished using a pair of HPE DL360 for Citrix and other infrastructure. A sample DL360 configuration is given following.

Table 13: Optional DL360 (x2) configuration to host infrastructure

Quantity	Part Number	Description
2	867959-B21	HPE ProLiant DL360 Gen10 8SFF Configure-to-order Server
2	860687-L21	HPE DL360 Gen10 Intel Xeon-Gold 6130 (2.1GHz/16-core/125W) FIO Processor Kit
2	860687-B21	HPE DL360 Gen10 Intel Xeon-Gold 6130 (2.1GHz/16-core/125W) Processor Kit
16	835955-B21	HPE 16GB (1x16GB) Dual Rank x8 DDR4-2666 CAS-19-19-19 Registered SmartMemory Kit
2	804331-B21	HPE Smart Array P408i-a SR Gen10 (8 Internal Lanes/2GB Cache) 12G SAS Modular Controller
2	P01366-B21	HPE 96W Smart Storage Battery (up to 20 Devices) with 145mm Cable Kit
8	872374-B21	HPE 400GB SAS 12G Mixed Use SFF (2.5in) SC 3yr Wty Digitally Signed Firmware SSD
2	813661-B21	HPE Ethernet 10Gb 2-port 535T Adapter
2	874543-B21	HPE 1U Gen10 SFF Easy Install Rail Kit
4	830272-B21	HPE 1600W Flex Slot Platinum Hot Plug Low Halogen Power Supply Kit
4	AF573A	HPE C13 - C14 WW 250V 10Amp Flint Gray 2.0m Jumper Cord

This configuration can also be deployed without m510 or DL360 onsite, through the use of Citrix Cloud.

Access for end users is simple with Citrix XenApp and XenDesktop, with most devices having a native application to access Citrix resources. For high-end users that require multiple monitors, it is important to have an end-point device with enough processing power and monitor outputs to meet the requirements. The following table gives the configuration for a single high-end user requiring six monitors.

Table 14: Client bill of materials, single-user, six monitors

Quantity	Part Number	Description
1		HPE t730 Thin Client
1		AMD FirePro W2100 Graphics Card
6		HPE Z24nf 23.8-inch Narrow Bezel IPS Display
1		Ergotron DS100 Quad Monitor Mount
1		Ergotron DS100 Quad Monitor Mount

A sample bill of materials is provided for an Edgeline deployment, with eight VDI users on two m710x server cartridges and two m510 server cartridges for Citrix and other infrastructure.

Table 15: Edgeline bill of materials

Quantity	Part Number	Description
1	879808-B21	HPE Edgeline EL4000 10GbE 2xSFP+ v2 Switch System
2	833105-B21	HPE ProLiant m710x E3-1285v5 3.1GHz 4-core 45W Configure-to-order Server Cartridge
2	866842-B21	HPE 120GB SATA M.2 2242 Solid-State Drive Field Upgradable Kit
2	862161-B21	HPE 512GB PCIe M.2 2280 Solid-State Drive Filed Upgradable Kit
8	863953-B21	HPE 16GB (1x16GB) ECC Dual Rank x8 DDR4-2400 CAS-15-15-15 Unbuffered SO-DIMM Field Upgradable Kit
2	814688-B21	HPE ProLiant m510 Xeon D-1548 2.0GHz 8-core Configure-to-order Server Cartridge
2	866842-B21	HPE 120GB SATA M.2 2242 Solid-State Drive Field Upgradable Kit
4	862161-B21	HPE 512GB PCIe M.2 2280 Solid-State Drive Filed Upgradable Kit
8	854596-B21	HPE 32GB (1x32GB) Dual Rank x4 DDR4-2400 CAS-17-17-17 Registered Memory Kit
1	868577-B21	HPE Edgeline EL4000 Full Rack Rail Kit
2	720479-B21	HPE 800W Flex Slot Platinum Hot Plug Power Supply Kit

Additional resources

HPE Moonshot for Citrix Integration Guide

https://support.hpe.com/hpsc/doc/public/display?docId=c04751464

HPE Moonshot for Citrix Mobile Workspaces Reference Architecture

https://www.citrix.com/content/dam/citrix/en_us/documents/partner-documents/hpe-moonshot-for-citrix-mobile-workspaces-reference-architecture.pdf

HPE iLO RESTful API Data Model Reference (iLO4)

http://h22208.www2.hpe.com/eginfolib/servers/docs/HPRestfultool/iLo4/data_model_reference.html%20

HPE Enterprise Support

https://www.hpe.com/us/en/support.html

Citrix XenApp and XenDesktop Install and configure

https://docs.citrix.com/en-us/xenapp-and-xendesktop/current-release/install-configure.html

Citrix Cloud Install and Configure

https://docs.citrix.com/en-us/xenapp-and-xendesktop/service/install-configure.html

VMware ESXi Hardware Requirements

https://docs.vmware.com/en/VMware-vSphere/6.5/com.vmware.vsphere.upgrade.doc/GUID-DEB8086A-306B-4239-BF76-E354679202FC.html

LoginVSI 4.1 Workloads PDF

http://www.loginvsi.com/documents/documentation/Login-VSI-41-Workloads.pdf

Learn more at:

https://www.hpe.com/us/en/servers/moonshot.html

https://www.hpe.com/us/en/servers/edgeline-iot-systems.html