The Intelligent Edge Workspace
Transforming Remote Workspaces with HPE Edgeline and Citrix

Technical white paper
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Overview

As user needs evolve, companies are adopting new models for delivering workspace compute capabilities to their end users. This typically includes enabling working from multiple locations using a variety of devices such as laptops, tablets, or phones. In conjunction with these evolving needs, there are now requirements to better enable the end users in remote scenarios such as branch office, factory floor, warehouse, and other remote locations as well as provide a rich desktop and application experience wherever the user is located. To address these needs, Citrix and HPE are developing an edge solution that will provide a Citrix-based mobile workspace capability that can be rapidly deployed and easily managed. This solution delivers an excellent user experience by putting high performance HPE Edgeline EL4000 Converged Edge System, running Citrix Mobile Workspace software, near the user desktop.

HPE is bringing enterprise-level workplace mobility solutions to remote locations by creating systems that not only have enterprise-class performance and manageability, but are also ruggedized for remote and office environments outside of the datacenter. Enter the HPE Edgeline EL4000 Converged Edge System, a 1U chassis that holds up to four high-performing x86-based HPE ProLiant server cartridges bristling with Intel® Xeon® CPUs, graphics, memory, and fast local storage, everything needed for today’s most demanding user and applications workloads. Aside from the hardware advances that have enabled enterprise-level workplace mobility at the edge, mobility and virtualization software is also key in delivering a rich desktop and application experience to every user. Workplace mobility at the edge will require systems such as HPE Edgeline that are certified and tested with Citrix, the industry’s leading Virtual Client Computing and Enterprise Mobility Management software.¹ ²

To this end, HPE and Citrix are offering a new Intelligent Edge Workspace solution built for remote office environments that utilize the industry’s latest Intel Xeon processors through HPE Edgeline, highly-available storage through Atlantis Computing™, virtualization through Citrix XenServer™, and remote access through Citrix XenApp™ and XenDesktop™. This white paper describes use cases, components, and capabilities of the solution so that every remote office location can reap the benefits of an Intelligent Edge Workspace. Each component of the solution will be described in detail starting with what is the Intelligent Edge Workspace, followed by a definition of how to size application and user workloads for the ProLiant server cartridges, a description of hardware specifications, how Citrix XenServer is used in the solution, how to configure highly available storage using Atlantis, and finally with how to scale the solution using multiple chassis.

![Figure 1. HPE Intelligent Edge Workspace running on the Edgeline EL4000](image)

² IDC, Worldwide Enterprise Mobility Management Software Market Shares, 2015: Consolidation of Vendors and Market Share Changes the Landscape, May 2016

What is the Intelligent Edge Workspace?

The Intelligent Edge Workspace is an edge solution that can be quickly deployed and configured in an enterprise branch office, factory floor, or warehouse using industry standard deployment techniques. The solution is built off of the success of HPE ProLiant server cartridges running Citrix Mobile Workspace, XenDesktop and XenApp within the datacenter, and placed into a smaller, more ruggedized chassis. Just as the Citrix Mobile Workspace for the datacenter has recently seen dramatic performance improvements across the board in compute, graphics, memory, storage, and manageability in its server portfolio, so too does the Intelligent Edge Workspace benefit from these same performance improvements. The HPE EL4000 chassis supports both of the two newest members of the HPE ProLiant server cartridge family, the ProLiant m710x server cartridge with extreme storage and graphics capabilities, and the ProLiant m510 server cartridge with extreme memory and compute capabilities. The ProLiant m710x and m510 server cartridges are used for everything needed within the solution from Citrix infrastructure with highly-available storage, to the end-user compute nodes. The Citrix infrastructure and highly available storage as well as the Citrix XenApp servers operate on ProLiant m510 server cartridges running Citrix XenServer. The ProLiant m710x server cartridge is used for the most demanding graphical
workloads of Citrix XenDesktop or XenApp. The entire solution initially fits into a single HPE EL4000 chassis which can be rack or wall-mounted in virtually any communications closet, office environment, or warehouse floor for over 300 XenApp users. The solution can quickly and easily scale through the addition of EL4000 chassis or be customized within a single chassis if more users are required. Through the Intelligent Edge Workspace, HPE has continued delivering innovative solutions for workspace transformation of the mobile and remote workforce.

**Application Workloads**

As mentioned in the overview section, the solution can support the most demanding graphically intensive workloads such as CAD and 3D as well as over 600 Citrix XenApp users per additional chassis. Understanding which ProLiant server cartridge should be used for each application workload is key in getting the best performance out of your Intelligent Edge Workspace. This section will outline types of desktop and application workloads as well as recommend the server cartridge that best meets the needs of each workload.

**Citrix XenApp delivered desktops and applications for non-graphically intensive office and knowledge workers**

The HPE ProLiant m510 server cartridge with the 16-core Intel Xeon D-1587 is best suited for delivering both user density and high-performing shared desktops and applications that do not require graphics through use of a GPU. With Citrix XenApp the ProLiant m510 can deliver applications, or full virtual desktops to end-users. Examples of this type of workload include general office workers using Microsoft Word, Microsoft Outlook, Internet Explorer, Adobe Reader, Microsoft PowerPoint, Microsoft Excel, Freemind/Java, and Photo Viewer. LoginVSI testing of the ProLiant m510 server cartridge shows that each 16-core server can support up to 167 XenApp office worker sessions and over 660 users per 1U chassis using less than 1/2 Watt per session. With this type of performance it is easy to see why Citrix has chosen to “go to the moon” with HPE on this solution. Citrix tested the ProLiant m510 server cartridge in June 2016.

If non-graphical office workloads are the target within the Intelligent Edge Workspace, then the ProLiant m510 server cartridge with 16 CPU cores is the best option on the market.

3 Tony Sanchez, Citrix Systems, *We Choose to Go to the Moon!,* June 2016
4 Tony Sanchez, Citrix Systems, *"Size Matters" > 150 XenApp sessions @ < 1 watt per user in 7.5 inches!,* June 2016

“This beast of a cartridge offers more compute resources than all of its predecessors. While the m510 doesn’t include Iris Pro graphics [like its] brother the m710x, its gains in memory and processing allow it to handle lots of non-GPU based applications without even a blink. For those customers whose applications are hosted in XenApp and are compute and memory intense, this solution meets and exceeds those challenges all while being bare-metal! Now if the thought of using XenServer crossed your mind then you’re in luck as the m510 can also run XenServer for delivering virtual desktops.”
Citrix XenDesktop delivered desktops for the graphically intensive workloads of designers and engineers

If a powerful GPU for graphically intensive workloads sounds interesting, then the HPE ProLiant m710x server cartridge should be considered using Citrix XenDesktop and the HDX 3D Pro VDA. Using the 3.7GHz Intel Xeon E3-1585L v5 quad-core CPU with built-in Iris Pro graphics P580 GPU and Citrix XenDesktop on the ProLiant m710x a single user can discreetly utilize all system resources. Examples of this graphically intensive workload include 3D and computer-aided design, manufacturing, and engineering (CAD/CAM/CAE) applications, geographical information system (GIS) software, Picture Archiving Communication System (PACS) for medical imaging, and OpenGL, DirectX, and CL applications for today’s designers and engineers. HPE is certifying many of these applications on the Intel Iris Pro™ graphics and ProLiant m710x server cartridge for use with Citrix HDX 3D Pro, contact your HPE sales representative for more information on applications tested.

Just how powerful is the GPU in the ProLiant m710x server cartridge? When Citrix Technology Professional, Thomas Poppelgaard, was asked this question, he found that the ProLiant m710x server performed equally well when compared against the NVIDIA GRID™ K260Q. Thomas also shared the following findings⁵:

- User experience is king with HPE m710x, the cartridge with Windows 10 anniversary update and Citrix XenDesktop 7.9 HDX 3D Pro is ready for CAD vendors such as Siemens, PTC and Autodesk.
- Applications performance is great, fast and no graphics elements are lost. Graphics are smooth, responsive and acceptable.
- The performance of the CAD applications in these test are equal with Intel P580 vs GRID K2 K260Q.
- Elements such as loading large files, zoom-in, rotating, working in layers and rendering works great with HPE m710x.
- The new HPE m710x cartridge is ready for mainstream CAD requirements.

⁵ Thomas Poppelgaard, CTP, Independent blogger/Consultant, HPE m710x & Citrix – Next generation engineer workstation, October 2016

An HPE Edgeline EL4000 chassis can support up to four CAD/CAM/CAE users each running on a separate ProLiant m710x with XenDesktop. If further user density is desired on each ProLiant m710x then this server also supports shared desktops and application virtualization through Citrix XenApp. LoginVSI test results on the ProLiant m710x support over
67 office workers with shared graphics capabilities per server cartridge for over 260 user sessions per 1U chassis with Citrix XenApp.

Figure 3. Performance of Intel Iris Pro (left) compared to NIVIDIA GRID K2 (right)

To see all comparisons performed by Thomas Poppelgaard visit http://www.poppelgaard.com/hpe-m710x-citrix-next-generation-engineer-workstation.

Hardware Components
The hardware innovation, engineering, and design that went into the solution should not be overlooked when investigating the Intelligent Edge Workspace. This section will describe the hardware components and specifications that make up the solution starting with the chassis, then detailing the HPE ProLiant server cartridges, and finishing with remote manageability characteristics.

HPE Edgeline EL4000 Converged Edge System
HPE Edgeline EL4000 Converged Edge Systems are low-power consuming, ruggedized, and compact platforms with multiple network connectivity and expandable PCIe options that are designed specifically for harsh and remote environments—providing data center-level capabilities at the edge to deliver a rich desktop and application experience to every user. This enables businesses to transform their remote workspaces, adding value to their IT processes that result in better business outcomes.

The HPE Edgeline EL4000 brings new and distinct business values to remote operating locations, offering:

- **Converged solutions**: Deep, open x86 compute, with expandable PCIe slots, and enterprise class device and systems management
- **Compact size and footprint**: Various mounting options to suit space constrained edge environments
- **Ruggedized form factor**: Designed to withstand increased shock, vibration, and broad temperature ranges compared to traditional servers
- **Reduced cost**: Shared infrastructure in a converged box lowers TCO
- **Ease of upgrade or replacement**: Modular, integrated design enables easy subsystem replacements and upgrade
- **Highly available storage**: Redundant and fast m.2 NVMe storage available on each server cartridge
The HPE EL4000 chassis with four HPE ProLiant m710x or m510 server cartridges should be used in this solution to provide the Citrix infrastructure, highly available storage, XenApp, and XenDesktop capabilities. The HPE ProLiant m710x and m510 server cartridges are modular servers that can be sized accordingly with memory and local storage space required for maximum performance of the solution. The HPE Edgeline chassis is versatile in the ability to operate in a wide range of environments, and be installed in multiple locations through rack and wall-mount options. HPE Edgeline EL4000 enables enterprise-class remote manageability through HPE Integrated Lights-Out technology which is embedded directly on the HPE ProLiant server cartridges.

HPE EL4000 technical specifications

<table>
<thead>
<tr>
<th>COMPUTE</th>
<th>Four Intel® Xeon® based HPE ProLiant m510 high-density server 8 or 16 cores or HPE ProLiant m710x 4 cores + GPU high-density server</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIMENSIONS</td>
<td>1U, 23&quot; deep, 17&quot; wide, reversible rackmount with slide rails All power and I/O are connected on the same side</td>
</tr>
<tr>
<td>I/O</td>
<td>One x8 PCI-E slot per server (four total) or four assignable x8 PXIe slots</td>
</tr>
<tr>
<td>NETWORK</td>
<td>2 port 10GbE pass through per cartridge (dual, combined QSFP+) or aggregated 2 port 10GbE SFP+ uplinks (layer 2 switch)</td>
</tr>
<tr>
<td>STORAGE</td>
<td>Onboard server cartridge storage up to 4x 4 TB total External storage via PCI-E or iSCSI</td>
</tr>
<tr>
<td>COOLING</td>
<td>N+1 redundant fans Optional air filter</td>
</tr>
<tr>
<td>ENVIRONMENTAL</td>
<td>Extended operating temperature: 0–55°C 95% non-condensing humidity</td>
</tr>
<tr>
<td>POWER</td>
<td>95-265 VAC or -48 VDC input, 1+1 redundant power, high efficiency</td>
</tr>
</tbody>
</table>

Figure 4. HPE Edgeline EL4000 Converged Edge System
HPE ProLiant m510 Server Cartridge
The HPE ProLiant m510 Server cartridge is a compute workhorse designed to enhance the performance of workloads such as extreme user density application delivery when installed in HPE Edgeline Systems. The ProLiant m510 Server cartridge has one Intel® Xeon® D-1548 (8-core) or D-1587 (16-core) CPU with up to 128GB of ECC protected memory, dual 10Gb Ethernet along with up to two (2) 1TB NVMe M.2 flash storage modules, and one (1) 240GB SATA M.2 for local OS booting. The server cartridge will be available in two versions (both with CPU fixed on board and not changeable): m510 (8 core SoC) and m510-16c (16 core SoC).

Figure 5. HPE ProLiant m510 Server Cartridge

HPE ProLiant m510 server cartridge technical specifications

<table>
<thead>
<tr>
<th>WORKLOAD</th>
<th>All Purpose Compute Workhorse, Big Data, Media Processing, and more!</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC</td>
<td>Intel® Xeon® D “Broadwell-DE” 2.0GHz, 8 core and 1.7GHz, 16 core</td>
</tr>
<tr>
<td>GRAPHICS</td>
<td>iLO Remote Console</td>
</tr>
<tr>
<td>MEMORY</td>
<td>(4) DDR4 SDRAM (2400MHz) (8GB, 16GB, 32GB)</td>
</tr>
<tr>
<td></td>
<td>Maximum Configuration 128GB (4x32GB)</td>
</tr>
<tr>
<td>NETWORK CONTROLLER</td>
<td>Mellanox Connect-X3, Dual 10GbE NIC</td>
</tr>
<tr>
<td>ONBOARD STORAGE</td>
<td>Three (3) m.2 Modules, ~2TB NVMe capacity</td>
</tr>
<tr>
<td></td>
<td>(1) - SATA m.2 (2242) – up to 240GB</td>
</tr>
<tr>
<td></td>
<td>(2) – x4 NVMe m.2 (2280): up to 1TB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor Intel® Xeon® Model</th>
<th>SoC Frequency</th>
<th>Turbo Frequency</th>
<th>Cores</th>
<th>L3 Cache</th>
<th>Power</th>
<th>DDR4 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1548</td>
<td>2.0GHz</td>
<td>2.3-2.6GHz</td>
<td>8-core</td>
<td>12MB</td>
<td>45W</td>
<td>2400</td>
</tr>
<tr>
<td>D-1587</td>
<td>1.7GHz</td>
<td>2.1-2.3GHz</td>
<td>16-core</td>
<td>24MB</td>
<td>65W</td>
<td>2133</td>
</tr>
</tbody>
</table>
**HPE ProLiant m710x Server Cartridge**

The HPE ProLiant m710x Server Cartridge is designed to enhance the performance of Rich Application Streaming, Remote Workstation/Desktop Delivery and Video Transcoding. It has one Intel® Xeon® E3-1585L v5 four-core processor with integrated Intel® Iris ProTM P580 graphics, up to 64GB of ECC protected memory, dual 10Gb Ethernet along with up to Four (4) 1TB NVMe M.2 SSD storage modules, and up to One (1) 240GB M.2 SSD for local OS booting.

**Figure 6. HPE ProLiant m710x Server Cartridge**

**HPE ProLiant m710x server cartridge technical specifications**

<table>
<thead>
<tr>
<th>WORKLOAD</th>
<th>Application Delivery, Video Transcoding, Big Data Analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC</td>
<td>Intel® Xeon® E3 v5 SoC with Integrated Iris Pro Graphics (3.1 or 3.7 GHz/4-core) 128 MB shared level 4 cache</td>
</tr>
<tr>
<td>GRAPHICS</td>
<td>Intel Iris Pro GT4e GPU with 72 execution units iLO Remote Console</td>
</tr>
<tr>
<td>MEMORY</td>
<td>(4) DDR4 SODIMMS (2133/2400MHz) (8GB, 16GB) Maximum Configuration 64GB (4x16GB)</td>
</tr>
<tr>
<td>NETWORK CONTROLLER</td>
<td>Mellanox Connect-X3, Dual 10GbE NIC</td>
</tr>
<tr>
<td>ONBOARD STORAGE</td>
<td>Five (5) m.2 Modules, ~4TB NVMe capacity (1) - SATA m.2 (2242) – up to 240GB (4) – NVMe m.2 (2280): up to 1TB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Processor</th>
<th>SoC Frequency</th>
<th>Turbo Frequency</th>
<th>Cores</th>
<th>L3 Cache</th>
<th>Power</th>
<th>DDR4 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® Xeon®</td>
<td>3.0GHz</td>
<td>3.4-3.7GHz</td>
<td>4-core</td>
<td>6MB</td>
<td>45W</td>
<td>2133</td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3-1585L V5</td>
<td></td>
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</tbody>
</table>

**Remote Management using HPE Integrated Lights-Out (iLO) Server Management™**

As datacenter-grade systems are deployed to the edge, the need for remote access and management becomes critical for maintenance and operation of the solution. HPE has included enterprise-class remote management capabilities through
HPE Integrated Lights-Out (iLO) Server Management technology which is embedded into HPE ProLiant m710x and m510 server cartridges. HPE iLO provides server health, reliability, management and performance tracking anytime, anywhere.

HPE iLO automatically monitors, controls, and can even issue alerts based on system health of the server. HPE Integrated Lights-Out is accessible from any web browser, SSH client, or from the iLO Mobile App. HPE iLO technology enables remote management not only through health monitoring, but also through provisioning, firmware updates, virtual media connectivity, operating system installation, integrated remote console, and access to BIOS settings. HPE iLO is also Redfish compliant through the Redfish API and RESTful communication protocol.

![Figure 7. HPE Integrated Lights-Out (iLO) Server Management](image)
XenServer Enabling the Edge

Previous Citrix solution architectures on Moonshot operated in bare-metal mode, where the operating system supporting the user applications is installed directly on the hardware as the base OS, i.e. no hypervisor technology was needed. There are several benefits to bare-metal mode, the most prominent being lower cost, simplicity, and performance. XenServer has been added to Edgeline solutions to increase autonomy at the Edge by enabling enterprise-class functionality in remote locations. Besides enabling standard datacenter applications, XenServer also brings enhanced platform management and high availability to remote environments. The bare-metal model that Moonshot enables with its unique hardware design integrates well with the new Intelligent Edge Workspace based on XenServer. This architecture delivers the best of both worlds, performance where it matters, and platform management where it’s needed. This approach still enables best-in-class density, performance, and cost, while enabling enterprise-class deployments in remote sites.

The Intelligent Edge Workspace extends traditional remote user solutions by moving the user compute systems to remote locations. Traditional remote user solutions look similar to the following diagram. Security for these deployment models are automatic because there is no remotely stored data, only screen pixels travel across the network to the end user. However, performance may suffer or go down completely because of network issues.

Several problems arise when moving compute to the edge which typically requires a significant investment in hardware. The EL4000 can deliver a complete micro-datacenter in a single 1U box.
XenServer plays a major role in enabling the EL4000 to perform datacenter functions at the Edge. User productivity is less likely to be impacted by network bandwidth and latency issues. There is enough infrastructure to run a completely autonomous environment. Of course, a network connection back to the corporate datacenter enables data backup and access to important applications and data that aren’t available at the edge.

**Multiple Functions to the Edge**

XenServer is the leading open source virtualization platform, powered by the Xen Project hypervisor and the XAPI tool stack. It is used in the world’s largest clouds and enterprises, and now can be used to enable enterprise-class environments at the edge with the HPE EL4000. XenServer has been optimized to support XenApp and XenDesktop deployments. XenServer is a comprehensive server virtualization platform with enterprise-class features, handling different workloads simultaneously. It also allows for mixed operating systems which supports user-familiar Windows interfaces while enabling Linux, which is a favorite for automation tasks. XenServer’s industry-leading scalability and performance under load caters to diverse environments like branch offices, factories, and warehouse floors.

The XenServer platform also delivers several free tools which enable physical-to-virtual migration to XenServer and virtual-to-virtual server conversion. XenServer is also designed to work specifically with Citrix XenApp and XenDesktop infrastructure tools for the seamless management of desktop and application virtualization.

The cost of deploying XenServer is low because of its open-source availability, but for those requiring world-class support, this may be purchased separately. It is also available to XenApp and XenDesktop license holders who can apply their product licenses directly to the XenServer infrastructure via the Citrix license server, with no separate or specific XenServer license being required.

**The Citrix XenServer Standard Edition** the entry-level commercial virtualization platform which includes:

- Full 64-bit kernel architecture
- High Availability, Fault Tolerance, Data Protection
- Live VM Migration (XenMotion)
- Live Storage Migration (Storage XenMotion)
- Shared-Nothing Migrations
- Distributed Virtual Switch Controller (DVSC)
- GPU Pass-through (NVIDIA & AMD)
- XenServer Health Check with available Citrix Insight Services (CIS) reporting

The Citrix XenServer Enterprise Edition includes advanced virtualization features which include:
- In-Memory Read Cache (for NFS arrays)
- Dynamic Resource Scheduling (Workload Balancing)
- Hypervisor Measured Boot (Intel Trusted eXecution Technology (TXT))
- vSphere Conversion Manager
- NVIDIA GRID and Intel GVT-g GPU Virtualization

Management Made Easy: XenCenter
Citrix XenCenter is the Windows-native graphical user interface (GUI) for managing Citrix XenServer. This front-end enables users to easily create, configure, install, and manage virtual machines.

Figure 10 Citrix XenCenter GUI console

Citrix XenCenter Features include:
Full virtual machine installation, configuration and lifecycle management

High availability configuration

Access to VM consoles: VNC for installation-time, Xvnc for graphical displays on Linux, and Remote Desktop for Windows

Active Directory integration, for user authentication and revocation

vApps which is a logical group of one or more related virtual machines (VMs) which are managed as a single entity

Role-based access control

Remote storage configuration, including iSCSI storage support

VM snapshot management

Host networking management, including VLANs and internal networks, bonded and dedicated NICs

Full memory snapshots and VM rollback

XenSearch: searching, sorting, filtering, and grouping, using tags, folders and custom fields

Disaster Recovery

Dynamic memory management

Performance metrics display

Complete resource pool management

Long term metrics gathering and analysis

Shared Storage Support (Atlantis USX)

Citrix XenServer plays a key role in enabling high performance storage with high availability. There are many software defined storage (SDS) solutions available on the market today. Many SDS products are deployed as virtual machines, as is the case with Atlantis USX, the storage solution used in the Intelligent Edge Workspace. Below is a full section on Atlantis USX, but it’s important to note that XenServer and Atlantis have been working together for years to offer highly available storage. Atlantis USX will be described in detail later in this document.

Figure 11 Atlantis USX Management Console
**Future Support for 3D vGPU**

Citrix XenServer 7 is the leading hypervisor providing support for high-performance enhanced 3D graphics, with the widest variety of GPU pass-through and virtualized GPU options. XenServer includes support for Intel’s Virtual Graphics Technology (GVT-g), a CPU embedded GPU with no extra hardware required to facilitate enhanced graphics workloads.

The ProLiant m710x server cartridge uses the latest Intel E3 processor with embedded Iris Pro. HPE and Citrix are working to bring GPU functionality to the next release of the Intelligent Edge Workspace solution, running on this cartridge featuring the Intel Iris Pro GPU in several configurations.

**Atlantis USX™**

Atlantis USX has been integrating with Citrix XenServer to provide the preferred storage solution for Citrix Enterprise deployments for years. Atlantis has a strong focus on Remote Office / Branch Office (ROBO), retail, and manufacturing deployments making their USX product a natural fit with HPE’s Intelligent Edge Workspace which is focused on bringing enterprise compute to the edge. Atlantis USX brings a strong history of delivering enterprise class SAN and NAS functionality to virtualized environments:

- **Storage** – Atlantis USX enables customers to pool and abstract all storage (SAN, NAS, Flash, RAM, and DAS) and instantly deliver virtual storage volumes to any application. By pooling storage, both storage capacity and performance are used more efficiently, lowering cost, increasing performance and making edge deployments more agile.

- **Data Services** - Atlantis USX includes integrated HyperDup™ Content-Aware Data Services that leverage Atlantis real-time deduplication technology to provide data reduction, IO acceleration, provisioning, data mobility, security and business continuity for any storage.

- **Management** - Atlantis USX provides policy-based management of virtual storage volumes allows administrators to define the capacity, performance and availability requirement for individual VMs or applications.

- **Automation** - Atlantis USX delivers automation of all storage functions through REST APIs that are leveraged by third-party orchestration systems to provide Quality of Service (QoS), self-healing to provide resiliency, autonomic to create the optimal storage volume configurations, and event-based management to automate self-provisioning of applications.

**Atlantis Deployment Model on HPE Edgeline**

Atlantis USX is a highly scalable architecture, able to consolidate resources from any host in the environment. It efficiently utilizes high speed SSD and memory cache from Edgeline resources for maximum benefit. The primary use for Atlantis storage with the Intelligent Edge Workspace is for infrastructure VM images, typically for Microsoft Active Directory, SQL Server, and Citrix Infrastructure including XenApp and XenDesktop VMs. This storage can also be used for application and user data.
Minimum Storage Configuration
The minimum USX deployment requires two fully configured m510 hosts using the following topology:

Atlantis USX VM types are:

- **USX Manager** – The console used to manage the USX platform. The USX Manager is deployed as a virtual appliance. Up to three allowed for redundancy.

- **Volume VM** - USX volume VM optimizes performance and consolidates storage for specific application use. These VMs access resources from Service VMs and materialize them as volumes.

- **Service VM** - Service VMs are deployed on all hosts with local resources (RAM, SSD) to export to Volume VMs.

- **Witness VM** – Witness VM is an external tiebreaker deployed outside the site, and is used when volumes cannot communicate between hosts or sites (aka split-brain condition). Multiple two-node deployments can use the same tiebreaker.

- **HA VM** - A USX HA VM is a standby container to which a volume can fail over.

![Figure 12 Atlantis USX two-node cluster configured on ProLiant m510 hosts](image)

Typical Storage Configurations
Storage capacity and Atlantis USX VM configuration changes as more m510 nodes are added to the infrastructure. The ProLiant m510 server cartridge supports up to 2TB of NVMe SSD and 128GB of system memory, which is available for Atlantis USX to use, balanced with application needs. The maximum Atlantis USX configuration is limited only by number of hosts in the environment. Most Intelligent Edge Workspace deployments will be between three and eight m510 hosts, or two fully configured EL4000 chassis.

<table>
<thead>
<tr>
<th>Number of ProLiant m510 Hosts</th>
<th>Number of Volume VMs</th>
<th>Number of Service VMs</th>
<th>Number of HA VMs</th>
<th>Witness VM required?</th>
<th>Available Storage</th>
<th>RAID Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>Y</td>
<td>2TB</td>
<td>RAID1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>N</td>
<td>4TB</td>
<td>RAID5</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>N</td>
<td>6TB</td>
<td>RAID5</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>N</td>
<td>8TB</td>
<td>RAID5</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td>N</td>
<td>12TB</td>
<td>RAID5</td>
</tr>
</tbody>
</table>
The following figure shows an example of a four node configuration. Note that the witness VM is no longer needed:

![Diagram of a four node configuration](image)

**Figure 13** Atlantis USX four-node cluster using ProLiant m510 server cartridges

**Advanced Storage Configurations**
Atlantis USX can also be pooled with external SAN, NAS or DAS storage to accelerate its performance, while consolidating storage to increase storage capacity by up to ten times (using HyperDup™ technology).

**Performance**
IOMeter is an I/O subsystem measurement and characterization tool for single and clustered systems. It is used as a benchmark and troubleshooting tool and is easily configured to replicate the behavior of applications. In this test, IOMeter was configured to simulate a VDI workload and determine the maximum available IOPS of the Atlantis USX environment. The workload tested was configured to be 80% write, 20% read and 80% random with a 4K block size using a 20GB test file. A virtual machine with IOMeter was run with this test profile to determine the maximum available IOPS for the Atlantis HyperScale Solution.

For more information on how to use IOMeter to test desktop workload, visit:

http://blog.atlantiscomputing.com/2013/08/how-to-use-IOMeter-to-simulate-a-desktop-workload/
The following table provides a summary of the performance results achieved on the Intelligent Edge Workspace leveraging Atlantis USX:

**Table 2: Atlantis Iometer Performance on Four m510 Hosts.**

<table>
<thead>
<tr>
<th>Total IOPS</th>
<th>IOPS per User Session</th>
<th>Read/Write Ratio</th>
<th>Random/Sequential Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>117,163</td>
<td>183</td>
<td>20% / 80%</td>
<td>80% / 20%</td>
</tr>
</tbody>
</table>

**Solution Scalability**

The Intelligent Edge Workspace uses the EL4000 chassis, which comes in two versions, everything between them being the same, except networking. Different networking options are offered to address different deployment models, based on solution needs and to optimize cost. Networking can have a significant impact on software defined storage solutions, and need to be examined. The two models available are:

**Table 3: EL4000 chassis types.**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Short Name</th>
<th>Long Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>847534-B21</td>
<td>HPE EL4000 10GbE Passthru System</td>
<td>HPE Edgeline EL4000 10GbE Passthru System</td>
</tr>
<tr>
<td>847535-B21</td>
<td>HPE EL4000 10GbE Switch System</td>
<td>HPE Edgeline EL4000 10GbE Switch System</td>
</tr>
</tbody>
</table>

More information about the HPE Edgeline EL4000 System can be found here: [https://www.hpe.com/h20195/v2/GetPDF.aspx/c05211375.pdf](https://www.hpe.com/h20195/v2/GetPDF.aspx/c05211375.pdf)

**Switched Chassis Topology**

For single and dual chassis deployments, the following "Switched" model is recommended for lower cost as expensive external switching isn’t required.
- HPE ProLiant server cartridges have dual 10Gbit NICs, called NIC_A and NIC_B. The Switched model connects all NIC_A’s together on an internal switch. This enables cartridge to cartridge communication with an external uplink. The same is applied for NIC_B’s.

- The SFP+ network uplink ports are capable of running at 1Gbit with RJ45 insert and CAT6 cabling or 10Gbit copper or fiber. These uplinks will work with a wide array of industry standard switches.

- The internal switches are flat in that they don’t support VLANs. All traffic is untagged and rely on external switching to enable VLAN tagging if required.

- Uplinks can be connected between two chassis if remote network communication isn’t necessary, as may be the case for local storage networks.
Switched Chassis Cabling for Single Chassis
The simplest and lowest cost design is to use a single switched chassis design. The storage network doesn’t need to leave the chassis unless there are external devices that need to consume storage. The domain/data network needs to be connected to an external switch to enable infrastructure communication as well as XenApp and/or XenDesktop traffic.

Switched Chassis Cabling for Two Chassis
For deployments where more compute is required, two chassis can still be deployed without expensive external switching. The storage network may be connected between chassis uplinks using 10Gbit copper SFP+ cabling, enabling high performance storage traffic between chassis. The domain/data network must be connected to an external switch to enable infrastructure communication as well as XenApp and/or XenDesktop traffic.
**Passthru Chassis Topology**

For three or more chassis deployments, the Passthru chassis model is recommended. Deployments can also become quite large, limited only by the external switching that is used.

- Each cartridge NIC_A and NIC_B is brought to the back of the chassis through a QSFP+ connector. QSFP+ to 4xSFP+ copper cables are available to avoid the expense of fiber cabling. These cables come in 1/3/5M lengths.
- VLAN tagging and LACP trunks are supported, if the external switch used also supports LACP.
**Passthru Chassis Cabling for Three or More Chassis**

The Passthru model using external switching starts to look a lot more like enterprise class networking. The diagram below shows two fully redundant IRF clustered HPE Comware 5900AF switches. This is the best solution for network redundancy and failover. The Intelligent Edge Workspace solution doesn’t require redundant switching, but if Atlantis USX is being used, 10Gbit switches must be used for optimal storage performance.

![Diagram of Passthru Chassis Cabling](image)

**Figure 18** HPE Edgeline chassis networking for three or more Passthru chassis

**Conclusion**

The Intelligent Edge Workspace running on HPE Edgeline EL4000 has been purpose-built, designed, and tested for delivering highly available, flexible, easily deployable, and scalable systems to meet the needs of an evolving remote workspace model. Whether delivering a rich desktop experience with the ProLiant m710x and Citrix XenDesktop, or delivering extreme density of virtual desktop and application workloads on the ProLiant m510 and Citrix XenApp, it is clear to see the value in deploying an Intelligent Edge Workspace. The Intelligent Edge Workspace solution developed by Citrix and HPE provides the best-in class performance, reliability, and manageability for a remote workforce.

**Learn more at**
hpe.com/info/edgeline