UNICOM Government, Inc. Response for: Computer Hardware, Enterprise Software and Solutions (CHESS) Thin Client White Paper

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1.0 INTRODUCTION

This white paper provides support to the Computer Hardware, Enterprise Software and Solutions' (CHESS) Thin-Client request made to Information Technology Enterprise Solutions-3 Hardware (ITES-3H) contract holders. Contained herein, UNICOM Government Inc. (UGI) outlines a solution-based approach and subsequent methodologies around optimal thin-client computing environment deployments to include hardware, software, and resource requirements.

UGI is proposing an implementation methodology based on years of experience and adherence to industry proven best practices. Within this draft is the approach, methodologies, materials needed to build a solution, and continued benefits of incorporating such a solution. Through our knowledge and experience, this document will allow the Army an ease of use and secure application delivery mechanism while continuing to allow for secure, centralized administration of Army information technology (IT) assets and tools.

The focus of this document is to provide established reference architectures, materials, and project methodologies around a thin-client deployment. Encapsulating the requirements, this document will cover thin-client computing solutions around VMware to include best practices, methodologies, and scope.

This standard and scalable design can be easily adapted to specific environments and customer requirements. The reference architecture building-block approach uses common components to minimize support costs and deployment risks. It is based on information sought to support an organization with less than 500 users and an organization with more than 500 users respectively.

UGI's reference architectures offer customers:

- **Standardized, validated, repeatable components.** By using a building-block approach and common components, the reference architecture offers IT organizations the ability to implement a predictable, familiar solution.
- **Scalable designs that allow room for future growth.** The building-block approach allows organizations to scale out to meet growing demand for thousands of users predictably.
- **Validated and tested designs that reduce implementation and operational risks.** The reference architecture provided in this white paper addresses the integration with components commonly found in today's enterprise; providing proven, tested, and implemented designs.

The architecture uses common components and a standardized design to reduce the overall cost of implementation and management. All the infrastructure components used to validate the reference architecture are interchangeable, so anyone can use components from their vendor of choice to incorporate unique features that enhance the value of the overall solution.

2.0 BACKGROUND

There are a variety of business drivers for implementing thin-client architecture. Two of the most prominent business-focused drivers are end-user productivity and corporate data security.

For years the Army, as well as other government agencies, has made strategic decisions around server/client hardware and software architectures which pulled applications and user data away from the older traditional mainframe systems to smaller 'fat-clients' systems. This allowed for great processing power at the end-user level, lower cost of hardware, and extended control. In today's computing environments there is a need to provide greater security controls over classified and unclassified data as well as to reduce cost of systems, administrative overhead, and operations; enter thin-client computing environments.

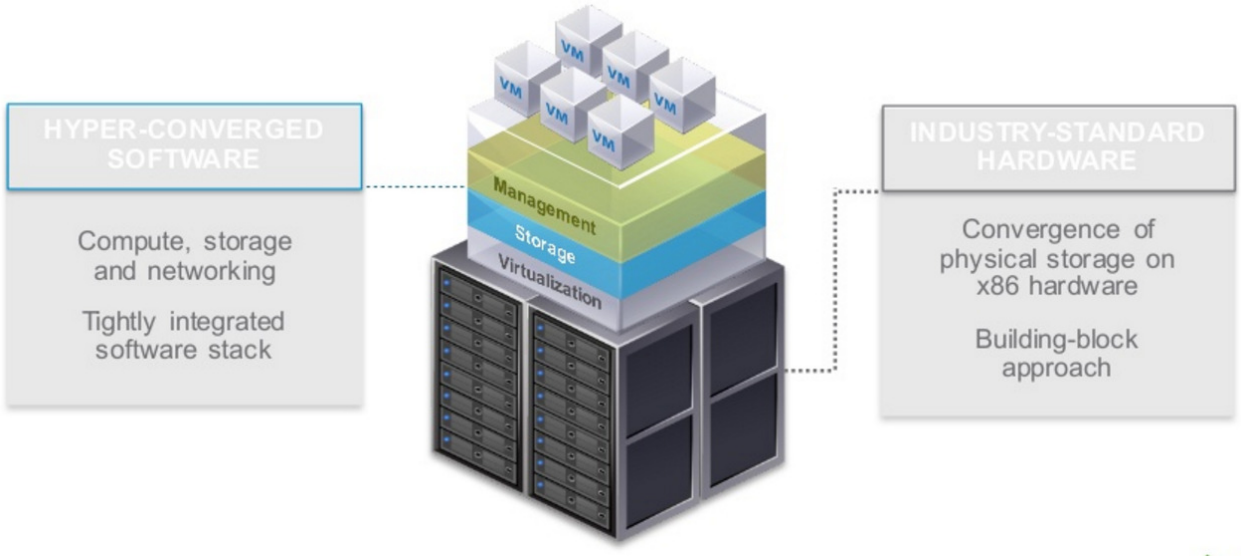
Technology undergoes a massive shift every so often as new models emerge to meet changing business needs. The hyper-converged infrastructure is the culmination and conglomeration of a number of trends; all of which provide specific value to the modern enterprise.

Hyper-convergence (HC) – Today's thin-client systems architectures use scalable infrastructure architecture to enable cloud-like economics and scale without compromising the performance, reliability, and availability expected in a data center. Serving as a technical catalyst to enterprise infrastructures, allowing them to leverage upon the benefits delivered by HC systems, customers are seeing that deploying remote virtual desktops and applications (virtual desktop infrastructures [VDI], Remote Desktop Session Host [RDSH], Session/App virtualization) is simpler than ever, requiring fewer dedicated technical support personnel, with less training and expertise.

The hyper-converged model is opening up previously implausible end-user computing scenarios, by successfully reducing complexity and high-costs.

UGI has provided reference architectures built and validated in the field by supporting partners, address common use cases, such as enterprise desktop replacement, remote access, and disaster recovery. This white paper provides reference architecture to help customers—IT architects, consultants, and administrators—involved in the early phases of planning, designing, and deploying a similarly scoped thin-client environment.

Figure 1: Hyper-converged Infrastructure Architecture



3.0 DISCUSSION

3.1 Thin-Client Concept

Thin-client environments have been best described as the warehousing of all the data, applications, tools, and the operating system in a centralized datacenter location, using terminal emulation, which provides the end-user computing experience. It is this terminal emulation, also known as VDI, where desktops and applications use the thin-client, offering rapid deployment of a common, supported desktop environment.

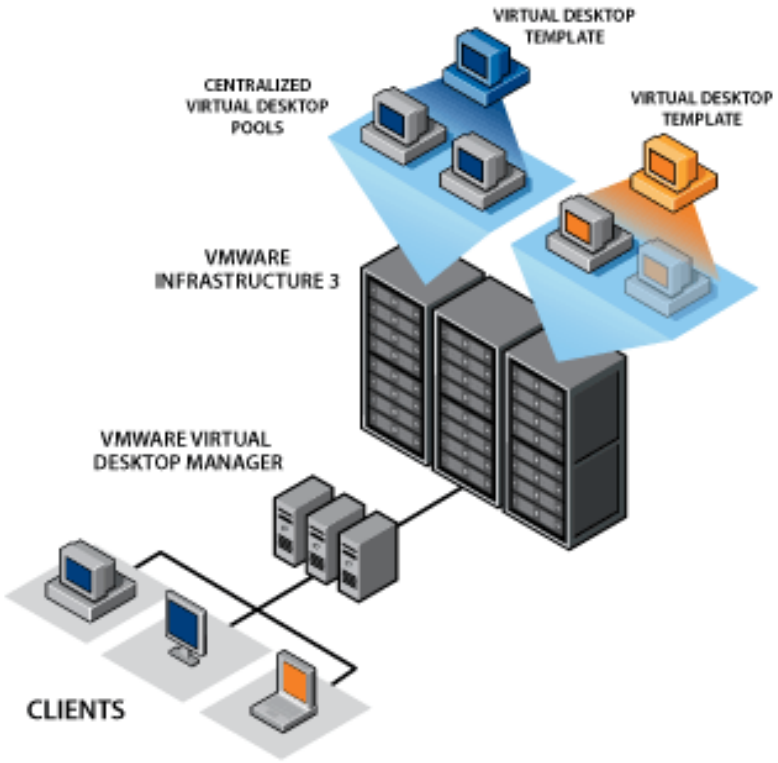
Conceptually, thin-client computing completes the circle from mainframe processing, to individual personal computer (PC) based operations, back to a server-based architecture; however, with a great deal more advantages than mainframe usage. In today's computing environments, thin-client architectures provide many advantages that far exceed the older terminals, such as:

- Streaming desktops and applications
- Streaming video and audio
- Session sharing and monitoring
- Negating loss of data or corruption due to local system failures
- Compact but powerful terminals
- Localized peripheral sharing and access

3.2 Thin-Client Implementation Considerations

An unanticipated, yet often large, challenge to deploying thin-clients is workforce acclimation and user acceptance before, during, and after deployment. With traditional end-user computing environments workers became accustom to accesses and storing data locally, interacting with a locally installed operating system (OS) and their own unique programs, sometimes installing unauthorized and hazardous applications that have not been approved for security, and customizing.

Figure 2: Depiction of Thin-Client System Architecture



Familiar, reliable, and trusted hardware and software platforms are critical to our Government customers, big and small. Prior to the introduction of VDI and HC infrastructure, a thin-client deployment simply introduced a greater level of management and control with little consideration for usability and overall computational power.

For these and many other reasons, it is essential to provide communication and end-user training to ensure a seamless transition as well as end-user buy-in to the benefits of such a solution.

The days of a thin-clients inability to deliver a rich and feature familiar experience is over. Specifically, when blended with today's modern infrastructures and software enhancements. The modern protocols and infrastructures provide multimedia redirection, so the user gets the best experience by locally rendering video content on the thin-client while simultaneously reducing the load on the server.

Application exceptions: In many instances, organizations use custom applications that are not engineered to exist and run effectively within these thin-client architectures. Tools such as VMware ThinApp help to eliminate application conflicts and streamline deployment. Similarly, these application virtualization tools reduce management's burden of re-engineering fat-clients applications, their provisioning, patching and application, and image updating.

Redundancy Planning: Because thin-client devices rely heavily on a number of separate but interoperable components like networks, servers, security, and storage the need to plan for redundancy accelerates at every single-point of failure such as dual switches/routers, dual Network Interface Cards (NICs), clustered or failover/failback server, and storage systems. This should be accounted for and recommended in the planning and design phases.

Planning and design: The most important aspect to any integration project is that of planning and design, even more so in thin-client computing environments. In these types of environments, the end-user interaction with a thin-client terminal is based on the streaming of data, so there are many points of failure that need to be addressed and accounted for. The most fundamental points that require strict planning and design are:

- User to Application Mapping: What users or groups will get what applications? This is not only important to a seamless transition but to also understand user provisioning.
- Single Points of Failure: Thin-client terminals rely heavily on working network components such as switches and routers, server, and storage resiliency.
- Thin-client Configuration: The user experience and the ability to function correctly will depend on the necessary and appropriate configuration aspects to provide optimal computing needs.

Software licensing: Software licensing is an important consideration, especially when determining whether to use a thin-client environment similar to the VMware solution used for the development of this white paper. Today, Microsoft alone has adopted its licensing model providing a licensing vehicle for such thin-clients. For this, and other such thin-client architectures, Microsoft Virtual Desktop Access (VDA), provides a device-based subscription that has been designed to help organizations license devices for these types of architectures.

It is important to make note, the difference between the Virtual Desktop Architecture license and the Remote Desktop Services (RDS) client access licenses (CAL) typically found in within an enterprise environment. Microsoft's RDS allows you to run user applications on a single Windows Server operating system with multiple sessions on one server. This enables each user to remotely access a full desktop or single application from the user's local device via a remote protocol such as Microsoft Remote Desktop Protocol (RDP).

However, Microsoft VDA license will be required when accessing the full virtual environment. Customers who want to use devices that do not qualify for Windows Client Software Assurance (SA), such as thin clients, will need to license those devices with Windows VDA in order to access a Windows VDI desktop.

4.0 SOLUTION REQUIREMENTS

4.1 Hardware Components

For this reference architecture, UGI used a Hewlett Packard Enterprise (HPE) Hyper Converged system configured for thin-client VDI solution, using a 16-disk hybrid storage and optional host cache solid state drives (SSD). This provided the general design information and different aspects of the bill of materials (BOM) considered when designing an organization: 1) with less than 500 users and 2) with more than 500 users.

Table 1. Recommended Hardware Components (quantities are per node) for 1-500 Users

Component	Description
CPU	2 – Intel Xeon E5-2690v3 (2.6GHz/12-core/30MB/135W) Processors
Memory	32 – 32GB (1x32GB) Dual Rank x4 DDR4-2133 CAS -15-15-15 Memory
10Gb Networking	2 – Ethernet 10Gb 2P 560FLR-SFP+ Adapter
1.2TB HDD Storage 800GB Write Intensive SSD Storage	24 – 1.2TB 12G SAS 10K rpm SFF (2.5-inch) Hard Drive disk packs 8 – 800GB 6G SATA Write Intensive-2 SFF 2.5-in SC 3yr Wty Solid State Drive

Table 2. Recommended Hardware Components (quantities are per node) for 500 or More Users

Component	Description
CPU	4 – Intel Xeon E5-2690v3 (2.6GHz/12-core/30MB/135W) Processors
Memory	64 – 32GB (1x32GB) Dual Rank x4 DDR4-2133 CAS -15-15-15 Memory
10Gb Networking	4 – Ethernet 10Gb 2P 560FLR-SFP+ Adapter
1.2TB HDD Storage 800GB Write Intensive SSD Storage	48 – 1.2TB 12G SAS 10K rpm SFF (2.5-inch) Hard Drive disk packs 16 – 800GB 6G SATA Write Intensive-2 SFF 2.5-in SC 3yr Wty Solid State Drive
240GB SSD* (Optional)	2 – 240GB 6G SATA Read Intensive-2 SFF 2.5 Solid State Drive

The hardware recommendations use a four (4) node hyper-converged appliance that offers highly available server and storage infrastructure and can be deployed and configured, with a minimal number of clicks. The characteristic hyper-converged solution is complete with all server, storage, networking, and management tools needed for deployment. The solution can be configured to support from two (2) to sixteen (16) nodes per management group, scalable based on the end-user computing.

Because many environments require several clusters, or management groups, HC infrastructures like the HC 380 utilizes the HPE OneView InstantOn software, to enable rapid expansion of appliances and facilitation of simple, cost-effective, and linear growth per management group. From a software perspective, we used vSphere 6.0 and included API integration via the HPE OneView for VMware vCenter plug-in to facilitate simplistic platform management and solution deployment. With VMware Horizon licensing applied, these types of hyper-converged platforms serve as an ideal solution for customers looking for the rapid deployment and expansion of a wide range of end-user computing, to include thin-clients utilization from 1-500 and 500 or more thin-clients.

The scope of the hardware recommendations in **Table 1** and **Table 2** used VMware Horizon 6.2 on the HPE Hyper Converged 380 using Login VSI 4.1. For the hardware recommendation above, the hardware tested a local area network (LAN) based solution but the solution supports external access using VMware Horizon View Security Servers and load balancing available from a variety of HPE and VMware partners. Virus protection and security measures can be provided from a variety of UGI partners. This white paper does not make a recommendation on which solution to use.

Additionally, the reference architecture uses network, rack, and power components—external to the primary hardware components above—as listed below in **Table 3**.

Table 3. Other Components, Switch, Rack and Power (used in reference architecture)

Hardware	Quantity
48XG-4QSFP+ Switch (JC772A)	2
48G-4XG-2QSFP+ Switch (JG510A)	2
42U 600x1200mm Enterprise Shock Rack	1
14.4kVA 208V 50A 3Ph NA/JP ma PDU	1

4.2 Other Technical Solution Recommendations

To achieve an end-user experience similar to that of a traditional PC requires an optimal network infrastructure. In the design phase, both network bandwidth and latency should be considered. Depending on the end-users workload, the amount of bandwidth needed per virtual desktop user can vary. A good rule of thumb is to have a preliminary starting point; 100–150Kbps is often the written standard to use until environment-specific usage patterns can be determined.

Further enhancing the end user experience of UGI's presented thin-client architecture is our designs use of virtualization. This provided architecture establishes a software layer consisting of the software distinct to furnishing the end user thin-client environment. **Table 4** highlights the VMware software layer used to complete the design and validation of this white paper.

Table 4. Other Solution Components, Software (used in reference architecture)

Software	Version
VMware Horizon Connection Server	6.2.2
VMware Horizon View	6.2.2
VMware App Volumes Manager	2.10
VMware vSphere 6.0	6.0 U1
VMware vCenter Server 6.0	6.0 U1

The software layer in **Table 4** does not include the Microsoft Windows OS versions, virtual machine (VM) sizing, or the details to the configuration of each VM. The desktop VM counts will vary vastly based on the unique environment for which this architecture is applied.

5.0 TIMELINE AND ENGINEERING EFFORTS

Presented below is the foreseeable outline to provide an overview of the key tasks and objectives, deliverables, and estimated duration in accordance with UGI's Project Management Body of Knowledge (PMBOK)-based Plan Design, Implement, and Operate (PDIO) processes. The distinctive phases, tasks, and estimated durations necessary for this particular whitepaper implement of a thin-client solution are defined in **Table 5**.

Iterations of this white paper will require the refinement of the provided timeline, specifying a more exhaustive list of tasks. This timeline, key tasks, objectives, deliverables, and estimated duration for implementation will be affected by environmental conditions, security requirements, policies, and planned usage that could alter each.

Table 5. Key Phases, Tasks, Deliverables, and Duration Estimations

Phase	Key Tasks & Objectives	Sample Deliverables	Duration
Plan	• Project Kick-Off • Definition of Roles & Responsibilities • Identification of Key Milestones & Target Delivery Dates • Develop High Level Project Plan • Identify Risk Associated With Project • Technical Discovery & Documentation • Schedule & Perform Analysis Interviews • Process Review & Analysis • Technical Review & Analysis • Define Acceptance Criteria • Develop Site Survey template • Pre-installation Audit • Readiness Monitoring Report	• High-Level Project Plan (Outline Level) • Project Contact Sheet • Network Discovery Documentation • Process Discovery Documentation • Technical Discovery Documentation • Systems Discovery Documentation • Project Phase sign-off	1-500 Users estimation: 5-days (40-Hours)
Design	• Analysis of Review Findings • Storage Design • Thin-client Design Session • Conceptual Design • Architecture Design • Implementation Design • Operational Processes Design • Proof of Concept Design & Planning Session • Implementation Design & Planning Session • Staging, Implementation, Migration, and Escalation Plan templates • Solution Test & Acceptance Checklist templates • Site Survey • Pre-installation Audit • Readiness Monitoring Report	• Findings Review Documentation (Final) • Requirements & Assumptions Documentation • Storage Design Document (draft) • Thin-client Server Design Document (draft) • Network access Design Document (draft) • Proof of Concept Design (draft) • Implementation Plan (draft) • Hardware requirements checklist • Software requirements checklist • Project Phase sign-off	1-500 Users estimation: 20-days (160-Hours)
Implementation	• Build storage Infrastructure • Build thin-client (client) Infrastructure • Integrate storage architecture • Build thin-client server infrastructure as per Proof of Concept • Publish/Host Applications • Implement design fundamentals policies • Integrate solution • Upgrade/rebuild/deploy servers as needed • Configure network services, secure gateway	• Completion of storage infrastructure • Completion of thin-client (client) infrastructure integration implementation • Completion of thin-client server build/deploy • Completion of network integration • Completion of physical server decommissioning • Completion of Continuity of Operations Plan (COOP)/Disaster	1-500 Users estimation: 20-days (160-Hours)

Phase	Key Tasks & Objectives	Sample Deliverables	Duration
	• Configure storage • Migrate Servers/Applications (if needed) • Solution Design Document • Staging, Implementation, and Migration Plans • Solution Test & Acceptance Checklist • Solution	Recover (DR) solutions integration (if any) • Completion of Backup Implementation • Updated Project Plan • Project Phase sign-off	
Documentation & Knowledge Transfer	• Complete as-built Network Documentation • Complete system build sheets • Complete Administrative Notes, as appropriate • Deliver & Review documentation with Client IT Team • Conduct Knowledge Transfer with Client IT Team	As-built Network Documentation, including: • Design documentation (final) • Administrative solutions Design documentation (final) • System build sheets • Updated Project Plan • Project Phase sign-off	TBD
Operate	• Verification of Deliverables against Project Scope • Evaluation against Success Criteria • Identification & resolution of any open issues • Identification of additional needs or requests • Solution Operation Monitoring Checklist	• Next Steps for Support • Final Project Sign-off	TBD

6.0 RESOURCES

Success and timely execution of projects often hinge on the ability of the internal staff to work with the solutions delivery team and participate in the operation of the solution. UGI makes a best effort to estimate these commitment levels in terms of time; however, these requirements can vary based on a number of potential factors. **Table 6** provides an understanding of the expectations of internal staff and their participation in the scoped solution.

Table 6. Estimated Staffing Requirements

Staff	Typical Role	Commitment
Government Furnished Resource	IT Director/Manager	10% or 4 hours/week: • Participate in Design & Planning sessions • Review & Approve deliverables • Issue escalation & conflict resolution • Budget approval
Government Furnished Resource	Windows System Administrator	25% or 10-12 hours/week during the systems builds portion of the project: • Participate in Design & Planning sessions • Review & Approve deliverables • Participate in critical application assessment, OS activities • Participate in knowledge transfer sessions
Government Furnished Resource	VMware Administrator	50% or 20-24 hours/week during all VMware related implementation aspects of the project: • Participate in Design & Planning sessions • Review & Approve deliverables • Participate in critical VMware activities • Assist in application migration procedures • Participate in knowledge transfer sessions

APPENDIX A: SAMPLE BILL OF MATERIALS

Part numbers are current as of time of testing and subject to change. The BOM does not include complete support options or other rack and power requirements.

A.1 1-500 User Design BOM

Table 7 provides a sample BOM to implement a thin-client design for 1-500 users.

Table 7. 1-500 User Design BOM

Quantity	Description	Quantity	Description
1	HP 42U 600x1200mm Enterprise Shock Rack	1	HP 600mm Rack Stabilizer Kit
1	HP Factory Express Base Racking Service	1	Include with complete system
2	HPE HC380 Cluster Node	2	HP 5xc13 PDU Extension Bars Kit
2	Factory integrated	2	Factory integrated
2	HPE HC380 VDI SW	2	HPE Intelligent 17.3kVA/60309/NA/J PDU
2	HP DL380 Gen9 E5-2690v3 FIO Kit	2	Factory integrated
2	HP DL380 Gen9 E5-2690v3 Kit	1	HPE Installation Service
2	Factory integrated	1	HPE Rack and Rack Options Install SVC
32	HP 32GB 2Rx4 PC4-2133P-R Kit	30	VMw Horizon Std 10pk 3yr CU E-LTU
32	Factory integrated	1	HPE 3Y Proactive Care 24x7 Service
8	HP 800GB 6G SATA WI-2 SFF SC SSD	30	HPE VMw Horizon View 10Pk 3yr ESW Supp
8	Factory integrated	1	HP Technical Installation Startup SVC
24	HP 1.2TB 12G SAS 10K 2.5in SC ENT HDD	2	HPE HyperConverged 380 Startup SVC
24	Factory integrated	1	HPE 59xx CTO Switch Solution
2	HP Smart Array P440ar/2G FIO Controller	1	HPE 5900AF 48G 4XG 2QSFP+ Switch
2	HP Smart Array P840/4G Controller	1	Factory integrated
2	Factory integrated	2	HPE X240 10G SFP+ SFP+ 1.2m DAC Cable
4	HP DL380 Gen9 8SFF SAS Cable Kit	2	Include with complete system
4	Factory integrated	2	HPE X240 10G SFP+ SFP+ 3m DAC Cable
2	HP DL380 Gen9 8SFF H240 Cable Kit	2	Include with complete system
2	Factory integrated	1	HPE X240 40G QSFP+ QSFP+ 1m DAC Cable
2	HP Ethernet 10Gb 2P 560FLR-SFP+ Adptr	1	Include with complete system
2	Factory integrated	2	HPE 58x0AF 650W AC Power Supply
4	NVIDIA GRID K2 RAF PCIe GPU Kit	2	Factory integrated
4	Factory integrated	2	U.S. - English localization
2	HP DL380 Gen9 Graphics Enablement Kit	2	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
2	Factory integrated	2	Factory integrated
4	HP 1400W FS Plat Pl Ht Plg Pwr Spply Kit	1	HPE 3Y Proactive Care 24x7 Service
4	Factory integrated	1	HPE 5900AF-48 2QSFP Switch Support
2	HP DL380 Gen9 Sys Insght Dsply Kit	1	HP Installation and Startup Service
2	Factory integrated	2	HPE Top of Rack Startup SVC
2	HP DL380 Gen9 Primary Riser	1	HPE 59xx CTO Switch Solution
2	Factory integrated	1	HPE 5900AF 48XG 4QSFP+ Switch
2	HP DL380 Gen9 Secondary Riser	1	Factory integrated
2	Factory integrated	2	HPE X240 10G SFP+ SFP+ 3m DAC Cable
2	HP 2U SFF Easy Install Rail Kit	2	Include with complete system
2	Factory integrated	2	HPE 58x0AF 650W AC Power Supply

Quantity	Description	Quantity	Description
2	HP 2U Security Bezel Kit	2	Factory integrated
2	Factory integrated	2	U.S. - English localization
2	HP 2U CMA for Easy Install Rail Kit	2	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
2	Factory integrated	2	Factory integrated
2	HP Legacy FIO Mode Setting	1	HPE 3Y Proactive 24 Service
2	HPE HC380 Base SW Image 6.0 FIO Kit	1	HP Networks 5900-48 Switch JW Support
1	HPE 3Y Proactive Care 24x7 Service	1	HP Installation and Startup Service
2	HPE HC380 Cluster Node Support	2	HPE Top of Rack Startup SVC

A.2 500 or More User Design BOM

Table 8 provides a sample BOM to implement a thin-client design for 1-500 users.

Table 8. 500 or More User Design BOM

Quantity	Description	Quantity	Description
1	HP 42U 600x1200mm Enterprise Shock Rack	1	HPE Rack and Rack Options Install SVC
1	HP Factory Express Base Racking Service	30	VMw Horizon Std 10pk 3yr CU E-LTU
4	HPE HC380 Cluster Node	1	HPE 3Y Proactive Care 24x7 Service
4	HPE HC380 VDI SW	30	HPE VMw Horizon View 10Pk 3yr ESW Supp
4	HP DL380 Gen9 E5-2690v3 FIO Kit	1	HP Technical Installation Startup SVC
4	HP DL380 Gen9 E5-2690v3 Kit	4	HPE HyperConverged 380 Startup SVC
64	HP 32GB 2Rx4 PC4-2133P-R Kit	2	HPE 59xx CTO Switch Solution
16	HP 800GB 6G SATA WI-2 SFF SC SSD	2	HPE 5900AF 48G 4XG 2QSFP+ Switch
48	HP 1.2TB 12G SAS 10K 2.5in SC ENT HDD	4	HPE X240 10G SFP+ SFP+ 1.2m DAC Cable
4	HP Smart Array P440ar/2G FIO Controller	4	Include with complete system
4	HP Smart Array P840/4G Controller	4	HPE X240 10G SFP+ SFP+ 3m DAC Cable
8	HP DL380 Gen9 8SFF SAS Cable Kit	4	Include with complete system
4	HP DL380 Gen9 8SFF H240 Cable Kit	2	HPE X240 40G QSFP+ QSFP+ 1m DAC Cable
4	HP Ethernet 10Gb 2P 560FLR-SFP+ Adptr	2	Include with complete system
8	NVIDIA GRID K2 RAF PCIe GPU Kit	4	HPE 58x0AF 650W AC Power Supply
4	HP DL380 Gen9 Graphics Enablement Kit	4	U.S. - English localization
8	HP 1400W FS Plat Pl Ht Plg Pwr Spply Kit	4	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
4	HP DL380 Gen9 Sys Insght Dsply Kit	1	HPE 3Y Proactive Care 24x7 Service
4	HP DL380 Gen9 Primary Riser	2	HPE 5900AF-48 2QSFP Switch Support
4	HP DL380 Gen9 Secondary Riser	1	HP Installation and Startup Service
4	HP 2U SFF Easy Install Rail Kit	4	HPE Top of Rack Startup SVC
4	HP 2U Security Bezel Kit	2	HPE 59xx CTO Switch Solution
4	HP 2U CMA for Easy Install Rail Kit	2	HPE 5900AF 48XG 4QSFP+ Switch
4	HP Legacy FIO Mode Setting	4	HPE X240 10G SFP+ SFP+ 3m DAC Cable
4	HPE HC380 Base SW Image 6.0 FIO Kit	4	Include with complete system
1	HPE 3Y Proactive Care 24x7 Service	4	HPE 58x0AF 650W AC Power Supply
4	HPE HC380 Cluster Node Support	4	U.S. - English localization
1	HP 600mm Rack Stabilizer Kit	4	HPE 58x0AF Bck(pwr) Frt(prt) Fan Tray
1	Include with complete system	1	HPE 3Y Proactive 24 Service
2	HP 5xc13 PDU Extension Bars Kit	2	HP Networks 5900-48 Switch JW Support
2	HPE Intelligent 17.3kVA/60309/NA/J PDU	1	HP Installation and Startup Service
1	HPE Installation Service	4	HPE Top of Rack Startup SVC

APPENDIX B: CONFIGURATION ADJUSTMENTS & ASSUMPTIONS

The scope of work and build of materials contained in this white paper is based on the following assumptions. If any of the following assumptions are discovered to be incorrect or inaccurate, the scope of work and build of materials may be impacted, for which case additional efforts in design will be required to further define the customers' requirements.

- A pristine thin-client architecture environment will be created and all end-users, unless deemed inappropriate, will use this solution
- Access to work areas, systems, and key IT staff will be made available in a timely manner throughout the duration of this project
- All applications published or hosted in this environment will need minimal configuration; any application needing additional configuration to exist in a thin-client environment will require additional engineering time
- That a high-availability solution will be implemented consisting of redundant systems, shared storage, and load balanced thin-client environments
- That sufficient network, hardware, and software is available for this project taking into account

Minimum bandwidth is required for simultaneous access for typical productivity users of a VDI thin-client. For this white paper, UGI made the following assumptions:

- A full duplex, end-to-end network link is used
- Network connectivity and sufficient bandwidth is available between the VMware View server, VMware View manager, and the thin-client
- Chosen thin-client uses the Pixel Compression over Internet Protocol (PCoIP) protocol
- The ability to segmenting PCoIP traffic via IP Quality of Service (QoS) differentiated services code point (DSCP) or a layer 2 Class of Service (CoS) or virtual LAN (VLAN)
- If a virtual private network (VPN) is used, User Datagram Protocol (UDP) traffic is supported
- Network latency and jitter is considered, ensuring that the round trip network latency is less than 200ms.