Virtual Desktop Infrastructure (VDI) White Paper

Introduction

The U.S. Department of Defense (DoD) requires a Virtual Desktop Infrastructure (VDI) environment. In support of this effort, Force 3 has provided the following whitepaper as part of the initial steps in accomplishing this charge. The below provided content will walk through the system design for the purpose of achieving an understanding of the required components needed to provide this solution.

Technical Approach

There are a number of industry approaches available to achieve a VDI solution that will meet the basic requirements. Force 3's approach as *The Network Security Company* is to also provide for enhanced Data Center security while combining best of breed hardware and software manufacturers.

At the heart of Force 3's solution lies Software Defined Networking (SDN) technology provided by the market leader VMware. VMware's NSX platform provides enhanced networking and security across the Data Center footprint. Using a new and validated approach called Micro-segmentation, the DoD can achieve unprecedented levels of granularity within the policy and policing of network traffic and user access. VMware accomplishes this with NSX's distributed firewalls (DFW) and Network Function Virtualization (NFV). These resources will be deployed to production virtual machines (VMs) to verify that only authorized traffic is allowed to and from each individual VM. Using the VMware NSX infrastructure will provide the ability to span logical networks between the data centers across the Wide Area Network (WAN).

At the heart of a successful VDI solution is a great hardware solution design. For the solution design Force 3 will position Cisco's new addition to the Data Center family, HyperFlex. Cisco's HyperFlex platform creates an unsurpassed combination of storage, compute, virtualization, and management to support the most demanding VDI environment. Built on Convergences 3.0 standards and specifications, Cisco's HyperFlex (Exhibit 1) provides the ability to enable Enterprise-class data management features that are required for complete lifecycle management and enhanced data protection in distributed storage environments. Key components required for VDI solutions include replication, deduplication, compression, thin provisioning, rapid, space-efficient clones, and snapshots. Along with these benefits, the solution allows for simplified data management that integrates storage functions into existing management tools, allowing instant provisioning, cloning, and snapshots of applications for dramatically simplified daily operations. Other features included with HyperFlex are:

- Independent scaling of the computing, caching, and capacity tiers, giving you the flexibility to scale the environment based on evolving business needs

- Continuous data optimization with inline data deduplication and compression that increases resource utilization with more headroom for data scaling

- Dynamic data placement in node memory, enterprise-class flash memory (on solid-state disk [SSD] drives), and persistent storage tiers (on hard-disk drives [HDDs]) to optimize performance and resiliency—and to readjust data placement as you scale your cluster

- API-based data platform architecture that provides data virtualization flexibility to support existing and new cloud-native data types

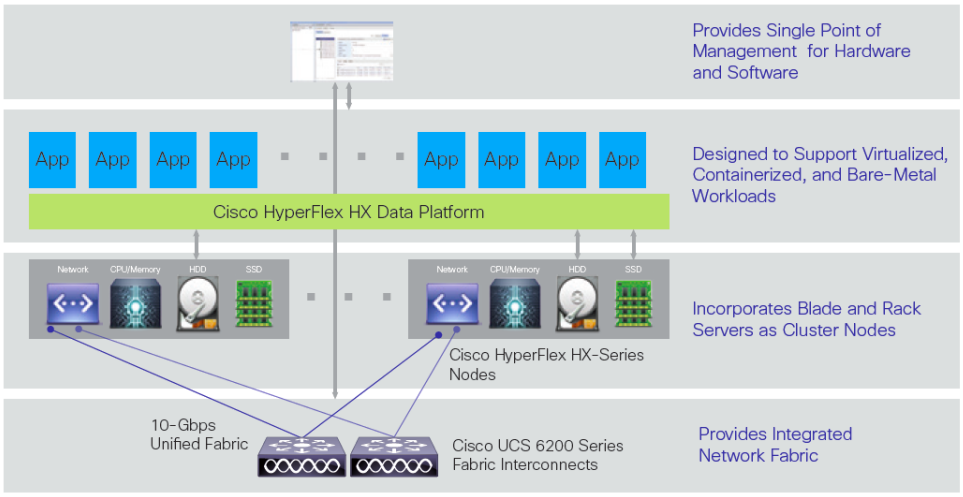

Exhibit 1: High Level HX Node Architecture

Cisco HyperFlex

Cisco HyperFlex Systems unlock the full potential of hyperconvergence. The systems are based on an end-to-end software-defined infrastructure, combining software-defined computing in the form of Cisco Unified Computing System (Cisco UCS) servers; software-defined storage with the powerful Cisco HX Data Platform and software-defined networking with the Cisco UCS fabric that will integrate smoothly with Cisco Application Centric Infrastructure (Cisco ACI). Together with a single point of connectivity and hardware management, these technologies deliver a preintegrated and adaptable cluster that is ready to provide a unified pool of resources to power applications as your business needs dictate.

In Cisco HyperFlex Systems, the data platform spans three or more Cisco HyperFlex HX-Series nodes to create a highly available cluster. Each node includes a Cisco HyperFlex HX Data Platform controller that implements the distributed file system using internal flash-based SSD drives and high-capacity HDDs to store data. The controllers communicate with each other over 10 Gigabit Ethernet to present a single pool of storage that spans the nodes in the cluster. Nodes access data

through a data layer using file, block, object, and API plug-ins. As nodes are added, the cluster scales linearly to deliver computing, storage capacity, and I/O performance.

In the VMware vSphere environment, the controller occupies a virtual machine with a dedicated number of processor cores and amount of memory, allowing it to deliver consistent performance and not affect the performance of the other virtual machines on the cluster. The controller can access all storage without hypervisor intervention through the VMware VM_DIRECT_PATH feature. It uses the node's memory and SSD drives as part of a distributed caching layer, and it uses the node's HDDs for distributed capacity storage. The controller integrates the data platform into VMware software through the use of two preinstalled VMware ESXi vSphere Installation Bundles (VIBs):

IO Visor - This VIB provides a network file system (NFS) mount point so that the ESXi hypervisor can access the virtual disk drives that are attached to individual virtual machines. From the hypervisor's perspective, it is simply attached to a network file system.

VMware vStorage API for Array Integration (VAAI) - This storage offload API allows vSphere to request advanced file system operations such as snapshots and cloning. The controller causes these operations to occur through manipulation of metadata rather than actual data copying, providing rapid response, and thus rapid deployment of new application environments.

The following high-level list of items to consider:

- Establish a VDI design that will maintain the proper level of security to implement with NSX DFW
- Review the network function virtualization (NFV) Proof of Concept requirements
- Development of High and Low Level Design Documents
- Deployment of VMware NSX VMs in the new VDI environment
- Test VMware NSX DFW and NFV functionality
- Implement DFW and NFV functionality in production and test against workloads

Technical Design

Exhibit 2 below provides a high level view of the VDI architecture. VMware NSX security will be used to provide a distributed firewall (DFW) in front of each of the virtual machines (VMs) running on the ESXi servers.

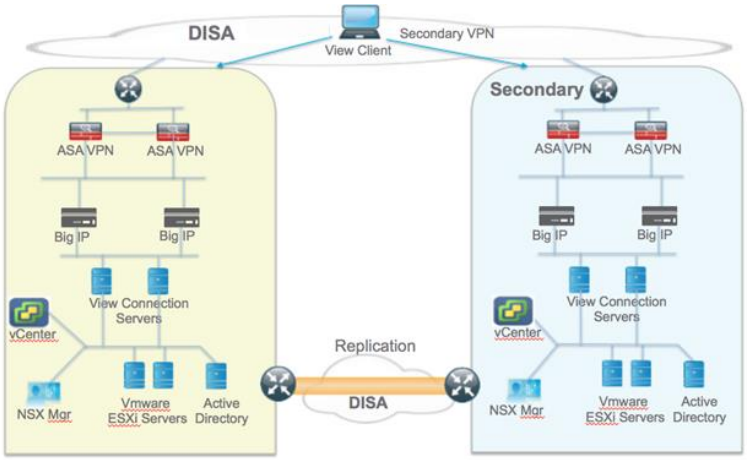

Exhibit 1: High Level VDI Architecture

Exhibit 3 below provides a zoomed in view graphically depicting the DFW running on each ESXi host. Note that individual DFW instances protect each VM allowing for granular control of traffic exiting and entering the VM. The DFW is operating within the kernel of the ESXi host allowing the firewall to pass traffic at near line rate speeds.

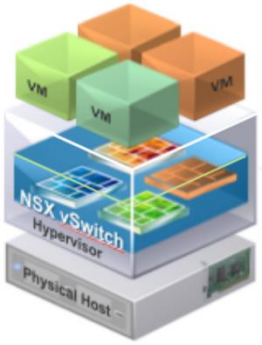

Exhibit 2: DFW

The broader security impact can be seen when viewing the VDI infrastructure through a security lens. This is depicted below, in Exhibit 4, with the capability to deploy a DFW instance in front of any VM.

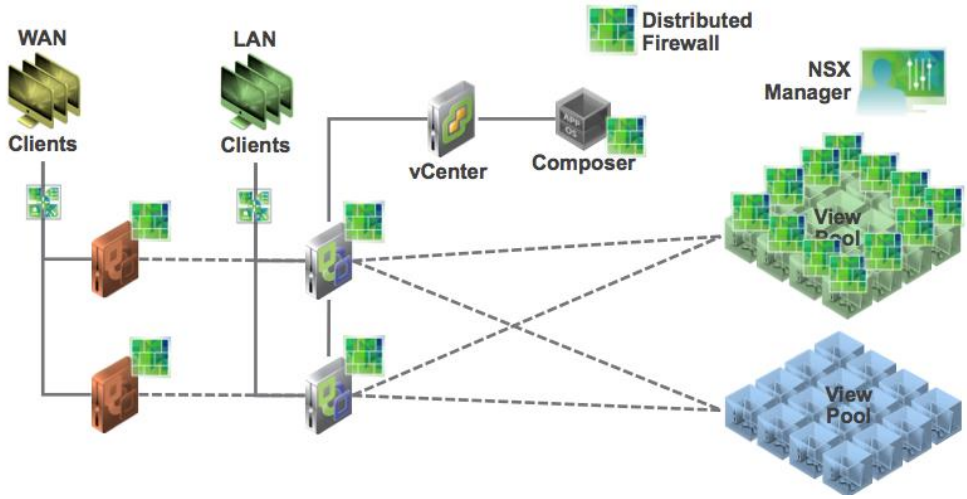

Exhibit 3: VDI Infrastructure Diagram

The spanning of logical networks between data centers provides a great test to execute as part of a test plan. This will allow the production deployment to move forward while still validating this valuable feature for future phases. A dedicated VMware cluster will be used to test this functionality. A high level depiction of this functionality is provided below in Exhibit 5.

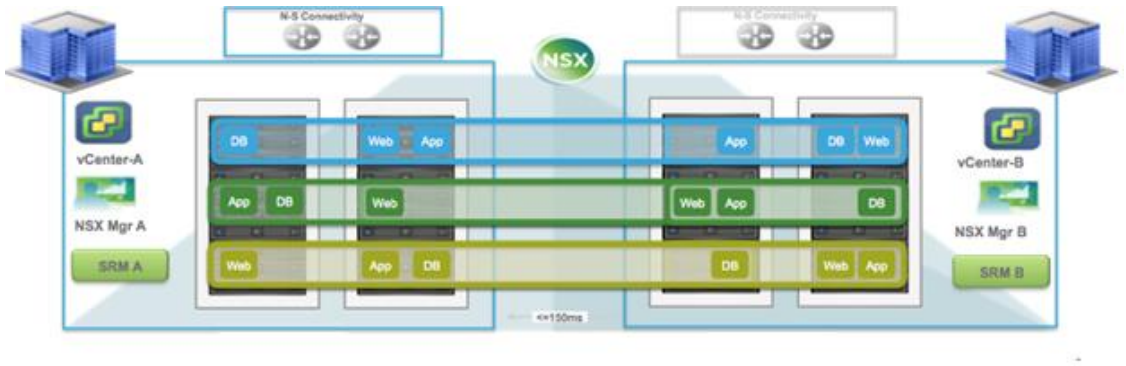

Exhibit 4: Logical Networks – High Level Functionality

Technical Components

The technical components for this solution may include the following:

- VMware NSX licensing to support the required number of ESXi host CPUs within the VDI environment
- ESXi host resources available to deploy the following VMware NSX virtual machines ideally in a management/edge cluster
    - VMware NSX Manager per data center
    - VMware NSX controllers
    - Edge Service Gateways
    - VMware NSX logical router control VM
    - One (1) VM is required per logical router instance
- HyperFlex HX-220 node stack
- Cisco UCS 6200 series Fabric Interconnects
- HyperFlex HX Data Platform

Horizon 6 Reference Architecture

VMware vSphere is the industry-leading virtualization platform for building cloud infrastructures. It enables users to run business-critical applications with confidence and respond quickly to business needs. VMware vSphere accelerates the shift to cloud computing for existing data centers and underpins compatible public cloud offerings, forming the foundation for the industry's best hybrid cloud model.

VMware Horizon 6 with View (Exhibit 6) delivers hosted virtual desktops and applications to end users through a single platform. These desktop and application services—including RDSH applications, packaged applications with VMware ThinApp®, software-as-a-service (SaaS) applications, and even virtualized applications from Citrix—can all be accessed from one unified workspace across devices, locations, media, and connections. Leveraging closed-loop management and optimized for the software-defined data center, Horizon helps IT control, manage, and protect the Windows resources that end users want at the speed they expect and with the efficiency that business demands.

Horizon 6 also provides the ability to manage both virtual and physical desktop images using VMware Mirage. Mirage allows you to manage persistent, full-clone desktops.

Horizon 6 allows users to access desktops and applications via VMware Workspace Portal. Workspace Portal also provides IT a central place to entitle and deliver Windows applications, desktops, SaaS applications, ThinApp packaged applications, and XenApp applications to users.

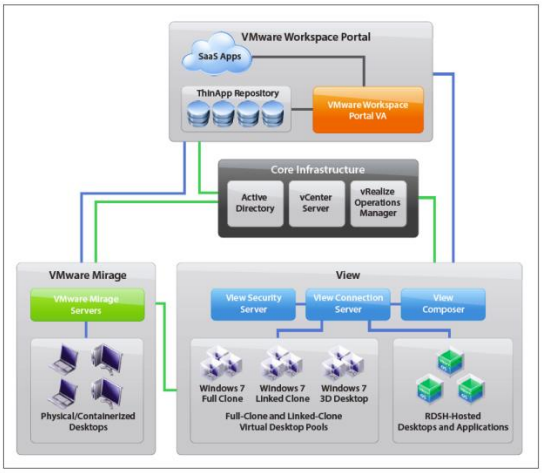

Exhibit 6: Horizon 6 Components

The architecture leverages the benefits of the VMware software-defined data center (SDDC) stack to provide an enterprise-class virtualization platform. Horizon with View for virtual desktops and hosted applications, Workspace Portal for unified application and desktop access, and Mirage for single image management run on top of the vSphere platform. The solution uses VMware vRealize™ Operations Manager™ to provide a single point to monitor the health and performance of all components. In addition, the solution offers a best-of-breed user experience through Blast Adaptive UX (including PCoIP and an HTML5 protocol) and a huge number of supported clients.

Modular Pod and Block Design

This Horizon 6 reference architecture is based on the proven approach of scalable and modular pod and block design principles. The View, Mirage, and Workspace Portal server workloads are placed in the management block of a Horizon 6 pod. All desktop workloads are in the desktop block within the pod, with the separation of desktop and RDSH server workloads maintained via distinct clusters and ESXi hosts.

Hardware-Accelerated 3D Graphics

In response to user demand for an ever-richer set of applications to be supported in the virtual environment, VMware improved 3D graphics support in View 5.x, with additional improvements added in Horizon 6. The following 3D capabilities expand both the target user base and potential use cases that IT organizations can deliver with virtual desktops:

Soft 3D – Introduced with View 5.0, support for software-accelerated 3D graphics is provided by a Soft 3D graphics driver without physical GPUs installed in the VMware ESXi™ (hypervisor) virtual machine host.

vSGA (Virtual Software Graphics Acceleration) – Introduced with View 5.2, multiple virtual machines can leverage physical GPUs installed locally in the ESXi virtual machine hosts to provide hardware-accelerated 3D graphics to multiple virtual desktops.

vDGA (Virtual Dedicated Graphics Acceleration) – Introduced with View 5.3, a single virtual machine is mapped to one physical GPU installed in the ESXi virtual machine host to provide high-end, hardware-accelerated workstation graphics where a dedicated GPU is needed.

The 3D graphics acceleration is built into the VMware vSphere® platform. Horizon with View fully leverages vSphere and delivers a robust set of 3D offerings to end users. You can administer support for 3D desktops from the View Administrator console. You can enable it on a per pool or per virtual machine basis using the vSphere client. More information and a detailed performance study about 3D graphics acceleration are available in the VMware community forum paper, VMware Horizon 6 and Hardware Accelerated 3D Graphics – Performance and Best Practices.

In contrast to a physical workstation that has sole use of its GPU, GPUs in a virtualized environment are a shared resource. Therefore, it is important to ensure that each virtual machine does not waste the GPU resource. For instance, if View is configured to remote at a lower frame rate (the default is 30 FPS), it usually does not make sense for a 3D application to render hundreds of frames per second (FPS). For these situations, you can configure a View registry setting to limit the maximum application frame rate either in the template virtual machine or on a per-virtual-machine basis. The value is typically set to the maximum frame rate used by PCoIP.

RDSH Sizing

With sizing, the goal is to consolidate as many sessions as possible on a particular infrastructure without sacrificing quality. To assess sizing, three aspects of performance were examined:

How many users or sessions per physical core can a desktop or application session support?

How many vCPUs are used for an RDSH virtual machine?

How many RDSH virtual machines are needed?

Calculating the Number of vCPUs and RDSH Virtual Machines

One of the main considerations in RDSH sizing is to decide whether to use a few large RDSH server virtual machines (VMs)—12 to 24 vCPUs—or many small RDSH server VMs (4 to 8 vCPUs). To arrive at the optimal number of RDSH vCPUs and instances, we experimented with several different configurations.

The experimental results show that the number of vCPUs for the RDSH server VM should fit within one CPU NUMA node; that is, the number of vCPUs is less than or equal to the number of cores in the CPU socket.

The total number of vCPUs across all RDSH VMs should be twice the total number of physical cores in the system across all CPU sockets. Because most modern processors have hyperthreading enabled, and each physical core has two hyperthreads, you can conceive of this 2:1 over-commitment ratio as a 1:1 ratio by taking hyperthreaded cores into account.

Calculating the Number of Users per Core

It is important to understand what the optimal number of users (sessions) per physical core so that can be served on the RDSH VMs in terms of response time in seconds. Thorough testing by VMware has shown that users can tolerate delay in a remote desktop or remote application action for 6 seconds. There are sizing tools and charts available to shows how many users per core is required to provide the appropriate response time.

RDSH Virtual Machine Sizing

Using multiple RDSH server VMs instead of one large VM provides the best performance. Make the vCPU for the RDSH VM less than or equal to the number of cores in the socket so that the VM fits within the same NUMA node. For the number of instances, a 2:1 CPU over-commitment works better, for example, 64 vCPUs on 32 cores, or 64 hyperthreaded cores, in our experiments.

If the number of cores in the socket is less, and the requirement is to use a large vCPU RDSH VM that does not fit in the same NUMA node, try the preferHT=TRUE option in the VMX file of the RDSH server VM. This option forces the vCPUs to the fewest number of physical sockets by giving preference to hyperthreaded cores for scheduling purposes, increasing the probability of the VM staying in the same socket.

VDI Thin Client Selection

When selecting a VDI Thin Client a number of features and specification are recommended to make each deployment successful. Thin clients that offer no-hassle virtualization and allow users to connect to the virtualized desktops and applications with support for the latest enterprise-class ISVs and Citrix HDX Ready Premium, VMware HCL, and Microsoft Remote FX Enabled certifications. Also, expansive display and peripheral support is key for longevity while the capabilities for dual-display provide users with productivity. Provide a secure thin computing environment with a thin client that is designed to NIST BIOS specifications and has a range of software and hardware security features, including Secure and Measured Boot and an optional Cable Lock.

Testing Plans

Test Plans are critical to establish a solid Low Level Design Document. The Test Plan should be developed to verify that the solution satisfies the stated requirements. Often times, during the Low Level Design process engineering teams often additional functionality works as designed.

Installation Steps

Below is a detailed list of steps performed during the installation of a VDI solution. Engineering will perform these tasks as part of a detailed deployment plan to ensure the solution is correctly configured and that the required features are deployed.

1. Configure VMware NSX security groups to match on required VM based on VM attributes and/or IP subnets
2. Configure VMware NSX distributed firewall (DFW) to secure individual VMs based on security group membership
3. Push DFW to each ESXi host with requirements to secure VM traffic
4. Complete test plan to validate proper security functionality
    1. Traffic between VDI VMs are blocked
    2. Authorized traffic is allowed
    3. Unauthorized traffic is blocked even if traffic is between VMs on the same subnet
5. Configure POC of VMware NSX logical switching and routing between data centers for one cluster
    1. Configure up to two (2) logical switches to house up to two (2) subnets
    2. Test up to ten (10) workloads on the logical switches
    3. Configure one (1) distributed logical router to route the two subnets within the VMware NSX overlay
    4. Configure up to two (2) edge services gateways per data center to route traffic between the virtual and physical domains
6. Complete POC test plan to validate proper network functionality
    1. Verify that a VM in the DoD data center can access a VM in the secondary data center on the same subnet.
    2. Verify that vMotion between data centers operating correctly without changing VM IP address.
    3. Verify that North-South VM traffic exits the local data center. This will require the implementation of a locale ID associated with VM traffic to tag data center traffic.
    4. Verify that North-South VM traffic enters the correct data center. This will require either NAT or host based routing. (Host based routing will currently need to be done manually. Automatic host based routing using triggered updates when a VM moves is a VMware road mapped item.)

Summary

Force 3's approach as *The Network Security Company* is to provide enhanced Data Center security while combining best of breed hardware and software manufacturers. We strive to provide excellence in all that we do and that starts with a security focused mindset. Since 1991, Force 3 has focused on building a strong reputation for providing innovative, cost-effective information technology and secure network solutions that add business value and exceed customer expectations. Our engineering team develops solutions unique to the needs of our customers with security at the forefront of every deployment.

Attachment 1: Sample Bill of Material for 300 users

Line Number	Part Number	Description	Qty
1.0	**HX220-SP-V1-FI-3A**	UCS SP HX220c w/2xE52660v3,8x32Gmem,3yrSW.Addnl 2xFI reqd	1
1.01	UCS-HX-FI48P	UCS SP Hperflex System 6248 FI w/ 12p LIC	2
1.02	CON-SNT-HXFI48P	SMARTNET 8X5XNBD UCS SP Hperflex System 6248 FI w/ 12p LIC	2
1.03	SFP-10G-SR	10GBASE-SR SFP Module	8
1.04	SFP-H10GB-CU3M	10GBASE-CU SFP+ Cable 3 Meter	8
1.05	DS-SFP-FC8G-SW	8 Gbps Fibre Channel SW SFP+, LC	8
1.06	UCS-ACC-6248UP	UCS 6248UP Chassis Accessory Kit	2
1.07	UCS-PSU-6248UP-AC	UCS 6248UP Power Supply/100-240VAC	4
1.08	N10-MGT012	UCS Manager v2.2	2
1.09	UCS-FAN-6248UP	UCS 6248UP Fan Module	4
1.1	UCS-BLKE-6200	UCS 6200 Series Expansion Module Blank	2
1.11	UCS-FI-DL2	UCS 6248 Layer 2 Daughter Card	2
1.12	CAB-C13-CBN	Cabinet Jumper Power Cord, 250 VAC 10A, C14-C13 Connectors	4
1.13	HX-SP-220M4SV1-3A	UCS SP HX220c Hperflex System w/2xE52660v3,12x32Gmem,3yrSW	3
1.14	CON-SNT-HSP20SV3	SNTC-8X5XNBD UCS SP HX220c Hperflex System w/2xE52660v3,12x3	3
1.15	UCS-CPU-E52660D	2.60 GHz E5-2660 v3/105W 10C/25MB Cache/DDR4 2133MHz	6
1.16	UCS-MR-1X322RU-A	32GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	24
1.17	UCSC-SAS12GHBA	Cisco 12Gbps Modular SAS HBA	3
1.18	UCS-SD-64G-S	64GB SD Card for UCS Servers	6
1.19	UCSC-MLOM-CSC-02	Cisco UCS VIC1227 VIC MLOM - Dual Port 10Gb SFP+	3
1.2	UCSC-PSU1-770W	770W AC Hot-Plug Power Supply for 1U C-Series Rack Server	6
1.21	CAB-C13-C14-AC	Power cord, C13 to C14 (recessed receptacle), 10A	6
1.22	UCS-HD12TB10K12G	1.2 TB 12G SAS 10K RPM SFF HDD	18
1.23	UCS-SD480G12S3-EP	480GB 2.5 inch Ent. Performance 6GSATA SSD(3X endurance)	3
1.24	UCS-SD120GBKS4-EV	120 GB 2.5 inch Enterprise Value 6G SATA SSD	3
1.25	UCSC-HS-C220M4	Heat sink for UCS C220 M4 rack servers	6
1.26	HXDP-001-3YR	Cisco HyperFlex HX Data Platform SW 2 Yr Subscription Add On	3
1.27	HXDP001-3YR	Cisco HyperFlex HX Data Platform SW Subscription 3 Year	3
1.28	UCSC-RAILB-M4	Ball Bearing Rail Kit for C220 M4 and C240 M4 rack servers	3

1.29	HX220C-BZL-M4	HX220C M4 Security Bezel	3
1.3	HX-VSP-FND-D	Factory Installed - VMware vSphere6 Fnd SW+Lic (2 CPU)	3
1.31	HX-VSP-FND-DL	Factory Installed - VMware vSphere6 Fnd SW Download	3
2.0	**HX220C-M4S**	Cisco HX220c M4 Hyperflex System Plus 1 Yr Sub	1
2.01	CON-SNT-HX220M4S	SNTC-8X5XNBD Cisco HX220c M4 Hyperflex System Plus 1 Yr Sub	1
2.02	UCS-CPU-E52660D	2.60 GHz E5-2660 v3/105W 10C/25MB Cache/DDR4 2133MHz	2
2.03	UCS-MR-1X322RU-A	32GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	8
2.04	UCS-HD12TB10K12G	1.2 TB 12G SAS 10K RPM SFF HDD	6
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2.12	UCSC-HS-C220M4	Heat sink for UCS C220 M4 rack servers	2
2.13	HX220C-BZL-M4	HX220C M4 Security Bezel	1
2.14	HXDP-001-1YR	Cisco HyperFlex HX Data Platform SW 1 year Subscription	1
2.15	HXDP001-1YR	Cisco HyperFlex HX Data Platform SW Subscription 1 Year	1
2.16	UCSC-SAS12GHBA	Cisco 12Gbps Modular SAS HBA	1
2.17	HX-VSP-FND-D	Factory Installed - VMware vSphere6 Fnd SW+Lic (2 CPU)	1
2.18	HX-VSP-FND-DL	Factory Installed - VMware vSphere6 Fnd SW Download	1
3	11-2381-LIC-L4	TPP L4 U.S. Federal VMware Horizon 7 Enterprise : 100 Pack (CCU) VMware Inc. - HZ7-ENC-100-F-L4	3
4	11-2381-M1P	U.S. Federal Production Support/Subscription for VMware Horizon 7 Enterprise : 100 Pack (CCU) for 1 year VMware Inc. - HZ7-ENC-100-P-SSS-F	3
5	11-1892-LIC-L4	TPP L4 U.S. Federal NSX for vSphere. Only NSX Partners have access. VMware Inc. - NX-VS-F-L4	8
6	11-1892-M1P	U.S. Federal Production Support/Subscription for VMware Horizon 7 Enterprise : 100 Pack (CCU) for 1 year VMware Inc. - NX-VS-P-SSS-F	8
7	G9F08AT#ABA	HP SB Thin Client t520 GX-212JC 16 GB SSD 4 GB RAM	300

Attachment 2: Sample Bill of Material for 600 users

Line Number	Part Number	Description	Qty
7.0	**HX220-SP-V1-FI-3A**	UCS SP HX220c w/2xE52660v3,8x32Gmem,3yrSW.Addnl 2xFI reqd	1
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7.04	SFP-H10GB-CU3M	10GBASE-CU SFP+ Cable 3 Meter	8
7.05	DS-SFP-FC8G-SW	8 Gbps Fibre Channel SW SFP+, LC	8
7.06	UCS-ACC-6248UP	UCS 6248UP Chassis Accessory Kit	2
7.07	UCS-PSU-6248UP-AC	UCS 6248UP Power Supply/100-240VAC	4
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7.11	UCS-FI-DL2	UCS 6248 Layer 2 Daughter Card	2
7.12	CAB-C13-CBN	Cabinet Jumper Power Cord, 250 VAC 10A, C14-C13 Connectors	4
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7.14	CON-SNT-HSP20SV3	SNTC-8X5XNBD UCS SP HX220c Hperflex System w/2xE52660v3,12x3	3
7.15	UCS-CPU-E52660D	2.60 GHz E5-2660 v3/105W 10C/25MB Cache/DDR4 2133MHz	6

7.16	UCS-MR-1X322RU-A	32GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	24
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7.3	HX-VSP-FND-D	Factory Installed - VMware vSphere6 Fnd SW+Lic (2 CPU)	3
7.31	HX-VSP-FND-DL	Factory Installed - VMware vSphere6 Fnd SW Download	3
8.0	**HX220C-M4S**	Cisco HX220c M4 Hyperflex System Plus 1 Yr Sub	4
8.01	CON-SNT-HX220M4S	SNTC-8X5XNBD Cisco HX220c M4 Hyperflex System Plus 1 Yr Sub	4
8.02	UCS-CPU-E52660D	2.60 GHz E5-2660 v3/105W 10C/25MB Cache/DDR4 2133MHz	8
8.03	UCS-MR-1X322RU-A	32GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	32
8.04	UCS-HD12TB10K12G	1.2 TB 12G SAS 10K RPM SFF HDD	24
8.05	UCS-SD480G12S3-EP	480GB 2.5 inch Ent. Performance 6GSATA SSD(3X endurance)	4
8.06	UCS-SD120GBKS4-EV	120 GB 2.5 inch Enterprise Value 6G SATA SSD	4

8.07	UCSC-MLOM-CSC-02	Cisco UCS VIC1227 VIC MLOM - Dual Port 10Gb SFP+	4
8.08	UCSC-RAILB-M4	Ball Bearing Rail Kit for C220 M4 and C240 M4 rack servers	4
8.09	UCS-SD-64G-S	64GB SD Card for UCS Servers	8
8.1	UCSC-PSU1-770W	770W AC Hot-Plug Power Supply for 1U C-Series Rack Server	8
8.11	CAB-C13-C14-AC	Power cord, C13 to C14 (recessed receptacle), 10A	8
8.12	UCSC-HS-C220M4	Heat sink for UCS C220 M4 rack servers	8
8.13	HX220C-BZL-M4	HX220C M4 Security Bezel	4
8.14	HXDP-001-1YR	Cisco HyperFlex HX Data Platform SW 1 year Subscription	4
8.15	HXDP001-1YR	Cisco HyperFlex HX Data Platform SW Subscription 1 Year	4
8.16	UCSC-SAS12GHBA	Cisco 12Gbps Modular SAS HBA	4
8.17	HX-VSP-FND-D	Factory Installed - VMware vSphere6 Fnd SW+Lic (2 CPU)	4
8.18	HX-VSP-FND-DL	Factory Installed - VMware vSphere6 Fnd SW Download	4
9	11-2381-LIC-L5	TPP L5 U.S. Federal VMware Horizon 7 Enterprise : 100 Pack (CCU) VMware Inc. - HZ7-ENC-100-F-L5	6
10	11-2381-M1P	U.S. Federal Production Support/Subscription for VMware Horizon 7 Enterprise : 100 Pack (CCU) for 1 year VMware Inc. - HZ7-ENC-100-P-SSS-F	6
11	11-1892-LIC-L5	TPP L5 U.S. Federal NSX for vSphere. Only NSX Partners have access. VMware Inc. - NX-VS-F-L5	14
12	11-1892-M1P	U.S. Federal Production Support/Subscription VMware NSX for vSphere for 1 year. VMware Inc. - NX-VS-P-SSS-F	14
13	G9F08AT#ABA	HP SB Thin Client t520 GX-212JC 16 GB SSD 4 GB RAM	600