Solution Overview

Desktop Virtualization Solution for Citrix XenDesktop from Cisco and EMC: Create a Secure, Central Infrastructure to Deliver Desktops and Applications as On-Demand Services

Many forces are driving change in the desktop environment today. Data security and compliance with privacy standards are a major concern for many industries, and that security must be maintained to the desktop level. The release of Microsoft Windows 7 is prompting many companies to begin an extensive PC refresh program. At the same time, IT departments must accommodate the proliferation of new devices—especially smart phones and digital tablets—used by employees who want anytime, anywhere access to the enterprise network, data, and applications. IT managers also must find a way to control expenses, even as costs are rising for managing desktop computers. In many cases, these managers have already had success in reducing costs by virtualizing servers. Now, they wonder, can they gain similar benefits by virtualizing the desktop infrastructure?

With the desktop virtualization solution for Citrix XenDesktop from Cisco and EMC, IT organizations can realize the advantage of a secure and centralized infrastructure for virtual desktops. Users benefit as well, with flexible and mobile tools for working more productively.

The Challenge

As organizations everywhere reassess their end-user computing strategy, they do so with a focus toward balancing the competing needs of IT organizations and users. While users are demanding ever more flexibility, mobility, and choice, IT organizations need to reduce cost and complexity, increase security and compliance, establish a high-performance, scalable infrastructure, and choose an agile approach that they can quickly put to work to better meet business needs.

IT organizations are recognizing that the cost and risk of maintaining a traditional desktop infrastructure has become untenable. Today's globally distributed, application-laden desktops and laptops are cumbersome and difficult to manage. Over time, each PC in an organization develops its own unique operating system and application image that leads to problems that must be solved one system at a time. Mission-critical data is distributed across a global pool of resources and cannot be adequately controlled, leading to challenges complying with governmental or industry regulations. Business continuity is threatened by events limiting access to the workplace when access to applications is limited to physical premises. When business events such as mergers, acquisitions, opening of a branch office, or offshoring functions such as call centers demand a rapid response from the IT organization, they are instead saddled with the task of integrating new organizations, or deploying new

desktops, one PC at a time. With the prospect of migrating to Microsoft Windows 7 on the near horizon, IT organizations are looking for an approach to make the transition as swift and cost-effective as possible.

Meanwhile, the challenge of operating in a global economy demands the utmost in productivity. In order to be more effective, users are demanding access to applications anywhere, anytime, and on their choice of devices. User expectations are no longer set by the sophistication of desktop PCs at the office, but instead by a range of new consumer devices including highly featured mobile phones, tablets, and laptop computers that can access wireless networks virtually anywhere. They expect that if their personal devices can load new applications from online stores with click-of-the-mouse simplicity, they ought to have that same level of choice and empowerment from the IT organizations they believe are there to help make them more effective.

A virtual desktop infrastructure (VDI) offers an attractive solution to these problems, but IT organizations understand that they must overcome several hurdles in order to implement a VDI. If funding that would otherwise be used to upgrade a global fleet of PCs is diverted into deploying a centralized infrastructure, it must be as cost-effective as possible. The solution must be simple and easy to deploy in order to be more attractive—and effective—as simply upgrading existing PCs. It must be one that can scale incrementally as the company is shifted to the VDI solution one organization at a time. And most important of all, the solution must achieve a new balance between the needs of users and the needs of the IT organization.

The Solution

The Cisco® Desktop Virtualization Solution with Citrix XenDesktop delivers desktops and applications as on-demand services to users anywhere, anytime, and on their choice of supported devices. The solution increases mobility and flexibility, resulting in greater productivity across a global workforce. Deployed on a platform built from the ground up to support virtualized environments, the solution delivers an uncompromised user experience, centralizes IT operations, secures mission-critical data, and better supports the foundation of any business: its people.

The Solution Delivers Virtual Desktops and Applications as On-Demand Services to Users Anywhere, Any Time, and on Their Choice of Supported Devices.

The solution helps IT organizations achieve an optimal balance between the needs of users for more mobility, flexibility, and choice and the needs of IT organizations to centralize desktop infrastructure, secure mission-critical data, and respond quickly to rapidly changing business requirements. It does all of this in a way that is simpler, easier to deploy, more scalable, and more cost effective than many competing solutions.

Cisco won the **2011 Citrix Ready Business Solution of the Year** for the Cisco Desktop Virtualization Solution with Citrix XenDesktop.

The Cisco Desktop Virtualization Solution with Citrix XenDesktop combines the Cisco Unified Computing System™ with Citrix XenDesktop software and delivers applications as on-demand services. The solution is powered by high-performance Intel® Xeon® processors, and its reach can be extended through the performance and security of Cisco's end-to-end networking technology. The result is an uncompromised user experience for 100 percent of an organization's users, anywhere, anytime, and on any supported device.

The solution uses a modular, scalable architecture. It is assembled using one or more predefined bills of materials, or modules, along with automated configuration instructions embodied in Cisco service profiles. This approach speeds initial deployment and subsequent scaling, while reducing the chance of errors that can cause downtime. The primary module is the Cisco UCS Base Unit for Desktop Virtualization, and two optional modules make the solution easy to scale: the Cisco UCS Expansion Unit for Desktop Virtualization, and the Cisco UCS Expansion Unit for Virtual Application Delivery. The two expansion units are optimized to support desktop virtualization and application virtualization using a shared-hosted model.

Cisco provides a reference architecture that describes how to configure the hardware and the solution's Citrix XenDesktop and Citrix XenApp software. The solution has an open architecture that allows customers to choose the hypervisor that best suits their needs: VMware vSphere is supported today. The solution also provides customers with a coordinated support model with a unified support number to call.

A Mobile, Flexible, Productive Workforce

The Cisco Desktop Virtualization Solution with Citrix XenDesktop provides Microsoft Windows desktops and applications as on-demand services that can be accessed from traditional PCs, Apple Macintosh computers, thin clients, smart phones, and tablets. The solution can be used to reach 100 percent of users while supporting workplace flexibility, business continuity, user mobility, and increased productivity.

The solution delivers desktops and applications as on-demand services. Powered by the Cisco Unified Computing System and delivered end-to-end by Cisco networking, Citrix FlexCast delivery technology provides a range of options that can be tailored to best meet the needs of specific users or groups of users. Virtual desktops can be

hosted in a central data center and accessed using Citrix remote display technologies, or streamed and executed directly on them within a client-side hypervisor. Applications can be supported with a shared-hosted model in the data center or virtualized and run securely on client devices. Users can access applications on demand through a powerful self-service mechanism. Now adding, updating, or removing applications become simple tasks with users empowered to enable their own choice of applications.

This on-demand application delivery is supported by the Cisco Unified Computing System's stateless architecture that allows IT organizations to deploy new desktop and application virtualization infrastructure in minutes, rather than the days or weeks that it requires to deploy traditional infrastructure. So while the solution's desktop and application delivery mechanisms make users more productive, the solution's foundation helps IT organizations to be more productive as well.

An Uncompromised User Experience

The Cisco Desktop Virtualization Solution with Citrix XenDesktop delivers a customized user experience that is superior to desktop PCs. Citrix HDX technology delivers a high-definition user experience that offers better reliability and higher availability than traditional PCs, even when using multimedia, real-time collaboration, USB peripherals, and 3D graphics. While users are empowered to select and deploy the applications they need, they are also freed from the problems that plague traditional PC environments. Centralized management of desktops and applications reduce susceptibility to viruses and conflicts between dynamic-linked libraries, increasing availability and user productivity.

The solution's centralized virtual desktop infrastructure, based on Intel Xeon processor-powered servers, delivers higher performance for virtualized applications and desktops by accelerating the execution of hosted desktops and shared-server environments, while doing so with a higher virtual-machine density than other solutions can provide, lowering capital costs.

The solution excels because of its integrated, 10-Gbps unified fabric that accelerates application responsiveness and performance by providing a low-latency network infrastructure. The unified fabric speeds the streaming of desktops and applications to users. It improves virtual desktop performance by delivering improved storage throughput and increasing the number of I/O operations per second that the infrastructure can provide. It provides an intelligent and scalable foundation for LAN and SAN convergence and the savings of having to deploy only one, not two parallel networks. Beyond the data center, Cisco Wide-Area-Application Services (WAAS) optimize virtual desktop protocols over wide-area networks (WANs), helping to maintain a superior user experience for a mobile workforce.

High-Performance, Scalable, and Agile Infrastructure

Virtual desktop environments demand a high-performance, flexible, and reliable infrastructure, and Cisco Unified Computing System incorporates a unique set of innovations that makes it an ideal platform for virtual desktop infrastructure.

Virtual desktop environments must deploy rapidly and scale linearly as more users transition from traditional PCs. The Cisco Unified Computing System is designed as a cohesive, stateless system whose entire end-to-end server and networking infrastructure is wired once and then configured through software. The solution includes predefined, downloadable Cisco service profiles that make Citrix XenDesktop deployment and scaling fast and error free.

Microsoft Windows 7 has a large memory footprint that demands a new balance between a server's memory capacity and its processing power. Cisco Unified Computing System provides an economical 192-GB memory

footprint on a two-socket server through Cisco Extended Memory Technology. When combined with Intel Virtualization Technology built into every Intel Xeon processor, the platform brings higher performance, scalability, and agility at a lower cost than comparable systems.

High network bandwidth and low latency enhances user experience by making data center-hosted virtual desktops respond as if they are hosted locally. Cisco Unified Computing System's 10-Gbps unified fabric helps the solution deliver a high-definition user experience by speeding the streaming of desktops and applications to users, and by reducing latency and increasing the bandwidth for server storage access. Based on 10 Gigabit Ethernet and Fibre Channel over Ethernet, the system dramatically simplifies rack-level cabling by eliminating a redundant set of adapters, cables, and switch ports to support storage access separately from network traffic. This simplicity reduces cost and complexity and increases scalability, while decreasing power consumption.

Virtual desktop environments are founded on virtual machines, and in traditional virtualized environments, least-common-denominator security is often applied to the networks supporting virtualization pools in order to facilitate virtual machine mobility. Cisco Unified Computing System supports virtualization-aware networking that allows virtual links connected to virtual machines to be secured and managed just the same as physical links, ending the need to compromise security and control to support virtualization. The solution incorporates Cisco virtual interface cards that support all of the hypervisor and virtual machine's networking requirements with a single PCI interface. It also incorporates the Cisco Nexus 1000V Switch, a fully-featured Cisco switch that increases security and control while also implementing virtualization-aware networking.

Secure IT Operations and Increased Compliance

One of the most significant challenges that an IT organization must address is how to regain control of thousands of unique and vulnerable desktop images scattered across the globe. With the Cisco Desktop Virtualization Solution with Citrix XenDesktop, IT organizations can choose to never allow data to leave the data center. Citrix XenDesktop software protects mission-critical data with secure connectivity and multi-factor authentication that helps ensure that only authorized users connect with specified applications and data. In this way, intellectual property is protected according to organizational policies, while IT organizations are empowered with the tools they need to also meet governmental and industry regulations.

The solution's single-instance management enables IT organizations to separate device, operating system, applications, and user personalization to maintain single master images of each. Instead of juggling thousands of static, unique, and vulnerable desktop images, IT organizations can manage everything from a central location. This approach dramatically reduces ongoing patching and maintenance efforts, with users executing approved application and operating system images that have centrally approved patches and security settings.

For hosted virtual desktops, Cisco VN-Link technology provides network visibility and control all the way to individual virtual machines, making the management of virtual links (including VLANs, quality of service, and security) equivalent to the way in which physical links are managed. This enhanced level of security helps IT organizations centralize their network security policies, tightly control and isolate communication paths from virtual machines, and enhance virtual machine mobility by maintaining network profiles regardless of virtual machine location.

Cisco Unified Computing System

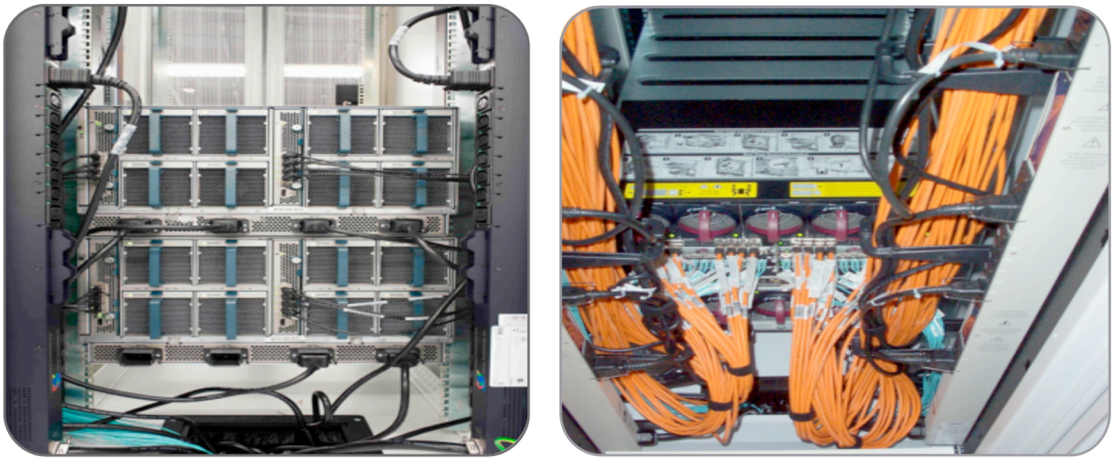
The Cisco Unified Computing System unites compute, network, storage access, and virtualization resources into a single cohesive system. When used as the foundation for the Cisco Desktop Virtualization Solution with Citrix XenDesktop, the system brings lower total cost of ownership, greater performance, improved scalability, increased business agility, and Cisco's hallmark investment protection.

The system represents a major evolutionary step away from the current state-of-the art in which individual components must be configured, provisioned, and assembled to form a solution. Instead, the system is designed to be stateless. It is installed and wired once, with its entire configuration, from RAID controller settings and firmware revisions to network configurations, determined in software by its integrated, embedded management.

The system is architected to radically simplify the way in which the Cisco Desktop Virtualization Solution with Citrix XenDesktop is deployed. The system brings together Intel Xeon processor-powered server resources onto a 10-Gbps unified fabric that carries all IP networking and storage traffic, eliminating the need to configure multiple parallel IP and storage networks at the rack level. The solution dramatically reduces the number of components compared to other implementations, reducing total cost of ownership, simplifying and speeding deployment, and reducing the complexity that can be the source of errors that can cause downtime.

As the architectural discussion that follows will highlight, the system eliminates switching within blade-server chassis, and reduces by a factor of three the number of switching and management devices in its blade-server chassis. This approach cuts the number of cables and upstream switching devices in half, eliminates the need for costly and fragile fiber connections within racks, and its integrated, embedded management gives the system a single point of management. Compare this design to traditional blade server approaches that include dual Ethernet switches, dual Fibre Channel Switches, and dual management modules into each chassis (Figure 1).

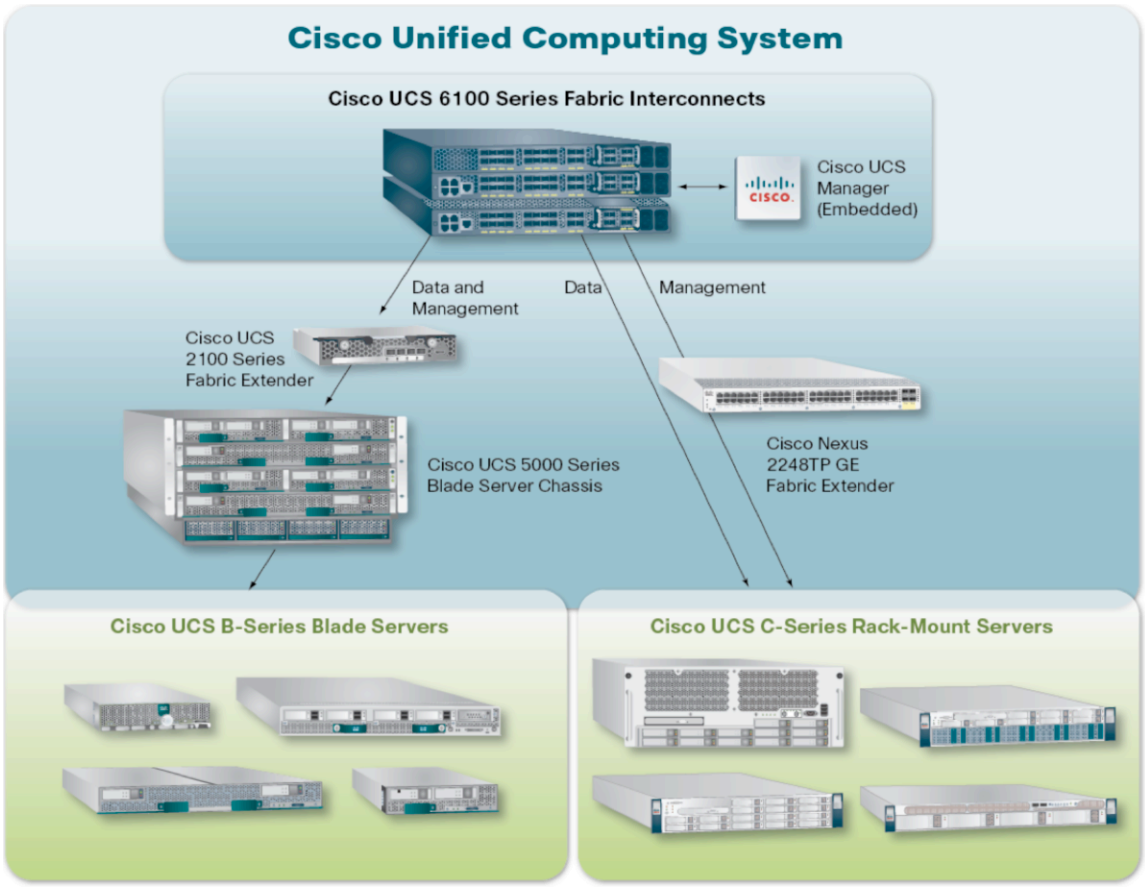
Figure 1. Radical Simplicity is Highlighted by the Dramatic Reduction in Rack-Level Cabling over Traditional Rack-In-A-Box Architectures.



The Cisco Unified Computing System is designed to be form-factor neutral. The core of the system is a pair of fabric interconnects that link all of the compute resources together and integrate all system components into a single point of management. Today, blade server chassis are integrated into the system through fabric extenders that bring the system's 10-Gbps unified fabric into each chassis (Figure 2). In the near future, the system will

integrate Cisco C-Series Rack-Mount Servers, enabling a more incremental deployment approach for organizations that prefer to use rack-mount servers.

Figure 2. Cisco Unified Computing System Integrates Server Resources With a 10-Gbps Unified Fabric Through a Single Point of Management.



Cisco Unified Computing System is built from the beginning to accommodate future technologies without requiring forklift upgrades. The blade server chassis is built with the power and cooling capacity to accommodate future generations of processors. Its midplane is equipped to provide up to 40-Gbps of networking capacity to each of the chassis' eight half-width slots so that a four-fold increase in I/O capacity may be enabled in the future without changing out the blade server chassis. Cisco has already demonstrated its commitment to investment protection through the release of 8-Gbps Fibre Channel expansion modules that increases the system's I/O capacity with a change only to the system's fabric interconnects.

Integrated, Embedded Management and Cisco Service Profiles

Traditional solution architectures involve the manual assembly of components with management as an add-on afterthought. Management servers and networks must be assembled, configured, and maintained. Blade chassis contain multiple management systems that must be wired, configured, and firmware kept up to date. Individual element managers must be used in order to configure system components including RAID controller settings and firmware, BIOS firmware and settings, along with firmware revisions and settings for network components including network interface cards (NICs), host-bus adapters (HBAs), and blade-server-resident switches. While some

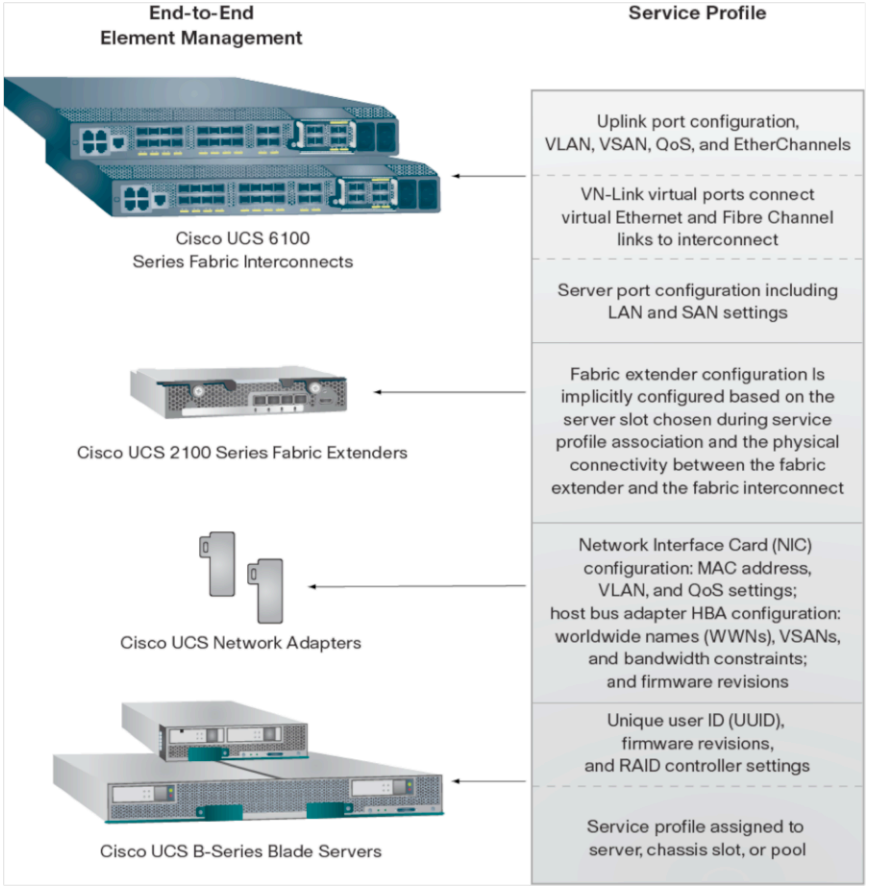
vendors claim that this constitutes integrated management, if it requires a management server and manual configuration, it's not integrated.

Cisco Unified Computing System uses true integrated, centralized, embedded management. Cisco UCS Manager resides on the Cisco UCS 6100 Series Fabric Interconnects and operates with high availability when two fabric interconnects are used, as they are in the Cisco Desktop Virtualization Solution with Citrix XenDesktop. Logically, every system component is aggregated into the system and managed as if it were part of the fabric interconnects. Physically, components are distributed among data center racks and blade server chassis. Cisco UCS Manager acts as an element manager that allows every component to be configured from a single pane of glass. For organizations that wish to integrate Cisco Unified Computing System with higher-level management tools, Cisco UCS Manager can export configuration information for use by ITIL processes (including configuration-management databases). It also features a robust XML API to facilitate deep integration with broader systems management tools.

Cisco UCS Manager offers flexible, role-based management that helps organizations make more efficient use of their limited administrator resources by allowing administrators to focus on defining policies to provision compute infrastructure and network connectivity, automating the actual provisioning. Cisco UCS Manager uses Cisco service profiles to provision servers and their I/O properties.

The system and its resources are stateless, and Cisco service profiles contain all of the information needed to fully define and provision a server (Figure 3), including RAID levels, BIOS settings, firmware revisions and settings, adapter identi¬ties and settings, VLAN and VSAN network settings, network quality of service (QoS), and data center connectivity. The Cisco Desktop Virtualization Solution with Citrix XenDesktop uses predefined, downloadable service profiles that provision each of the solution's server components, allowing the solution to be deployed rapidly and accurately in minutes, rather than the days and weeks required when each data center subject-matter expert must use individual element managers to configure each component in their domain.

Figure 3. Cisco Service Profiles Provide Automatic, End-to-End Configuration of the Entire Hardware Stack



Cisco service profiles provide immense benefit to the solution. They reduce the time-consuming, error-prone, manual assembly of components to a policy-based click-of-the-mouse operation. They speed infrastructure scaling by allowing organizations to add incremental resources and put them to work more quickly and accurately. Servers can be pooled, and service profiles can be assigned to specific slots, so that any server inserted into the slot is provisioned and put to work automatically. Service profiles enables true workload portability so that if a server upgrade is required, an existing service profile can be applied to the upgraded server and put into service within minutes. Service profiles also reduce the number of spares that an organization needs to maintain, as a single spare can be put to any use rapidly simply by invoking the applicable service profile.

Unified Fabric and Fabric Extenders

The backbone of the system is a dual 10-Gbps unified fabric that speeds both IP and storage traffic, enhancing the solution's ability to deliver a high-definition user experience, speed server performance, and to scale the infrastructure without the network limiting performance. The unified fabric can support all of the I/O requirements of today's hypervisors, including network isolation for different functions including hypervisor storage access, console, and virtual machine movement.

The fabric is based on 10 Gigabit Ethernet with standards-based extensions including FCoE and Data Center Bridging (DCB). These enhancements contribute to the system's simplicity because a single network fabric satisfies all server I/O needs and requires only one set of adapters, cables, and switches to install or scale the infrastructure. Ethernet extensions, including Priority Flow Control (PFC), allow FCoE traffic to be managed as a

separate, lossless traffic class so that the implementation of FCoE is completely consistent with Fibre Channel networking. PFC also allows storage traffic to be shaped and managed independently of IP traffic. In total, the unified fabric provides access to IP-based storage (including NFS and iSCSI), and native Fibre Channel SANs as part of the solution's reference architecture.

The fabric is implemented by a pair of Cisco UCS 6120XP or 6140XP Fabric Interconnects with 20 or 40 fixed ports and one expansion module slot. This low-latency, line-rate interconnect provides all of the necessary downstream bandwidth to the solution's blade server chassis. It can connect upstream to standard Ethernet switches and storage systems. The fabric interconnects' cut-through architecture and jumbo frame capacity minimize latency and speed bandwidth to 10 Gigabit Ethernet-equipped storage systems such as the EMC VNX storage systems. The fabric interconnects' capacity can be extended by populating their expansion module slot with one of four modules that increase 10 Gigabit Ethernet connectivity, connect to native Fibre Channel networks at up to 8-Gbps, or both.

Cisco UCS 6100 Series Fabric Interconnects

Traditional rack-in-a-box blade server implementations fragment the network access layer and add two more points of management per chassis by requiring chassis-resident Ethernet switches for connectivity. Cisco's approach is to use fabric extenders to bring the unified fabric and management capability to each blade server chassis. These devices are logically part of the fabric interconnects, with their configuration and firmware managed implicitly by the parent interconnect. These devices are physically part of the blade server chassis, and thus distribute the system's network, storage, and management connectivity needs without adding another device that needs to be managed. Cisco fabric extenders enable scalability without adding complexity, an essential characteristic for meeting the infrastructure-on-demand requirements of a virtual desktop infrastructure.

Virtualization-Optimized Compute Resources

To achieve the best price/performance in a virtual desktop environment requires an efficient, scalable, virtualization-optimized infrastructure that is optimized for the unique workload requirements of virtualized environments. The Cisco Desktop Virtualization Solution with Citrix XenDesktop is implemented using Cisco B-Series Blade Servers housed in Cisco UCS 5108 Blade Server Chassis. Some of the blade servers used in the solution feature Cisco Extended Memory Technology that provides up to 384 GB of memory in a two-socket server. The servers use Cisco virtual interface cards that speed I/O in virtualized environments while adding increased visibility and control over virtual machine network traffic.

The blade chassis are six-rack-unit (6RU) devices that have removable partitions to allow them to contain up to eight half-width blade servers or up to four full-width blade servers. Every component except the midplane is customer replaceable. Efficient power supplies are configurable as non-redundant, N+1 redundant, or grid-redundant; the chassis' eight fans are hot swappable, and all cables enter from the rear of the chassis and all blade servers are front-panel accessible.

Cisco UCS B230 M1 Extended Memory Blade Server

The Cisco UCS B230 M1 is used to populate the solution's virtual desktop server farm. The server is a half-width, two-socket server designed to increase performance, energy efficiency, and flexibility for demanding virtualized applications. Combining the performance of the Intel Xeon 6500 and 7500 series processors with up to 32 DIMM slots, the Cisco UCS B230 M1 delivers compact performance and exceptional memory-per-core count to improve virtualization performance, reduce software license costs, and help enable more virtual machines.

In the context of the Cisco Desktop Virtualization Solution with Citrix XenDesktop, the server is fully populated with low-cost, industry-leading 1066-MHz Samsung 40-nm DDR3 memory for a total capacity of 256 GB. (Alternatively, the server can be configured with up to 512 GB of memory using 16-GB DIMMs).

The Cisco UCS B230 M1 Blade Server is one of the industry's highest-density two-socket blade server platforms. It is an excellent choice for IT departments that are looking for ways to increase computing performance and memory capacity while getting the most value from the available space in their data centers.

With this broadened portfolio, Cisco continues its commitment to being a trusted x86 systems provider with a full range of system options. With the addition of the Cisco UCS B230 M1, the Cisco Unified Computing System gives customers new choices to help avoid deployment of mission-critical applications into silos of "accidental" architectures.

The Cisco UCS B230 M1 is a half-width blade. Up to eight of these high-density, two-socket servers can reside in the six-rack-unit (6RU) Cisco UCS 5100 Series Blade Server Chassis, offering one of the highest densities of servers per rack unit in the industry.

The server’s memory capacity, combined with 12 powerful processor cores, establishes a new balance between the large memory requirements of environments such as Microsoft Windows 7 and the processing power required to support a large number of virtual desktops. This balance is key to the solution’s cost effectiveness, and is unmatched in the industry for a two-socket server. Cisco’s measurements show that the server can support between 110 and 120 virtual desktops per server based on a knowledge worker profile. The solution has an open architecture that runs on the IT organization’s choice of hypervisor, including Citrix XenServer, Microsoft Windows 2008 R2 Hyper-V, and VMware vSphere. The Cisco UCS B230 M1 server’s support for up to 256 GB of memory is leveraged by all three hypervisors to increase virtual machine density and reduce capital cost per virtual desktop.

Cisco Network Adapters

Each Cisco UCS B-Series Blade Server uses Cisco network adapters for consolidated access to the unified fabric. Both the Cisco UCS B230 M1 can accommodate one mezzanine-format adapter. The Cisco Desktop Virtualization Solution with Citrix XenDesktop uses network adapters most appropriate for the customer’s choice of hypervisor. Cisco UCS M81KR Virtual Interface Cards (VICs) are optimized for virtualization and provide up to 128 virtual devices, including any combination of NICs and HBAs.

Cisco VICs were used for desktop virtualization with VMware vSphere and EMC storage.

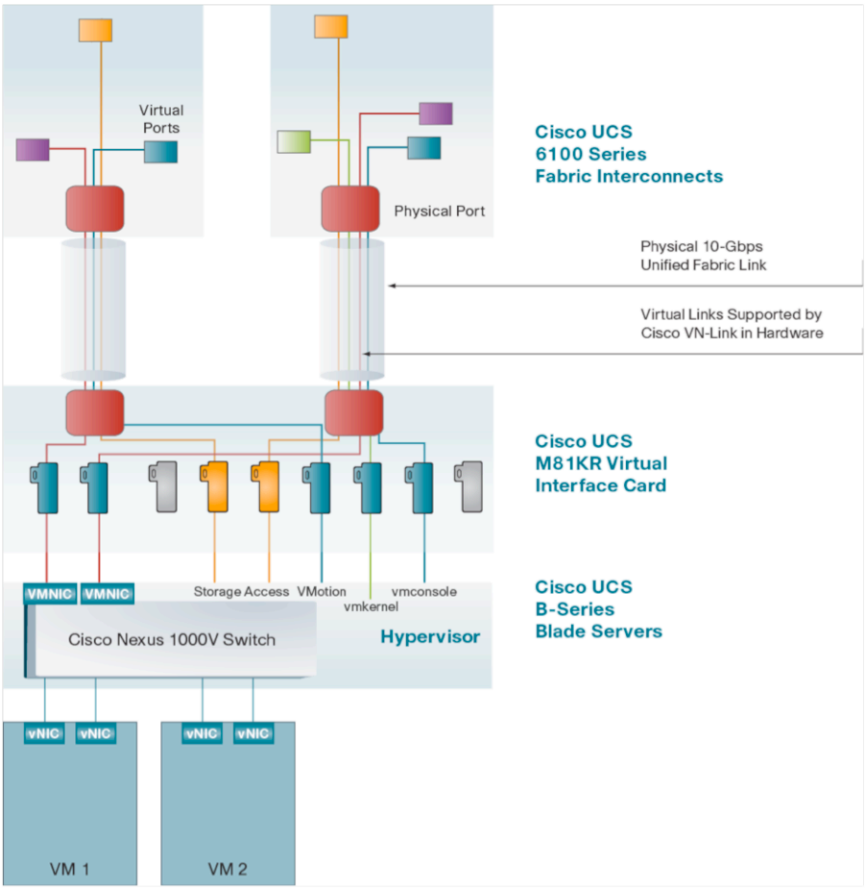
Virtualized I/O and Cisco VN-Link Technology

Virtualized environments are I/O intensive, and best practices for software such as the VMware vSphere hypervisor require the use of separate, redundant NICs and HBAs for functions including vmconsole, vmkernel, vMotion, virtual machine traffic, and storage access. In traditional server environments, this practice requires equipping each server with the appropriate number of interfaces and cabling each one to upstream Ethernet and Fibre Channel switches. At this point, the server is for all practical purposes dedicated to a single function for its entire lifecycle due to the time and complexity of equipping it for running different applications.

Cisco Unified Computing System is stateless down to the type and number of I/O devices installed in a server, allowing just-in-time provisioning of such fundamental characteristics as I/O interfaces. This capability speeds virtual infrastructure deployment, supports true workload portability, and extends the lifecycle of servers due to the ability to repurpose them simply by applying a different Cisco service profile. This virtualized I/O capability is enabled by the Cisco UCS M81KR Virtual Interface Card that can be configured to provide up to 128 virtual devices per server. These are standard PCI devices that appear on the server’s PCI bus. The actual number of

available interfaces is determined by upstream switch resources. In the context of this solution, the card can support up to 58 virtual devices. A single Cisco virtual interface card can thus support all of a hypervisor's I/O requirements with a single interface. It also can provide superior network throughput due to its support of a separate I/O queue for each device (Figure 4).

Figure 4. Cisco Virtual Interface Cards Can Satisfy All of a Hypervisor's I/O Needs With a Single Card



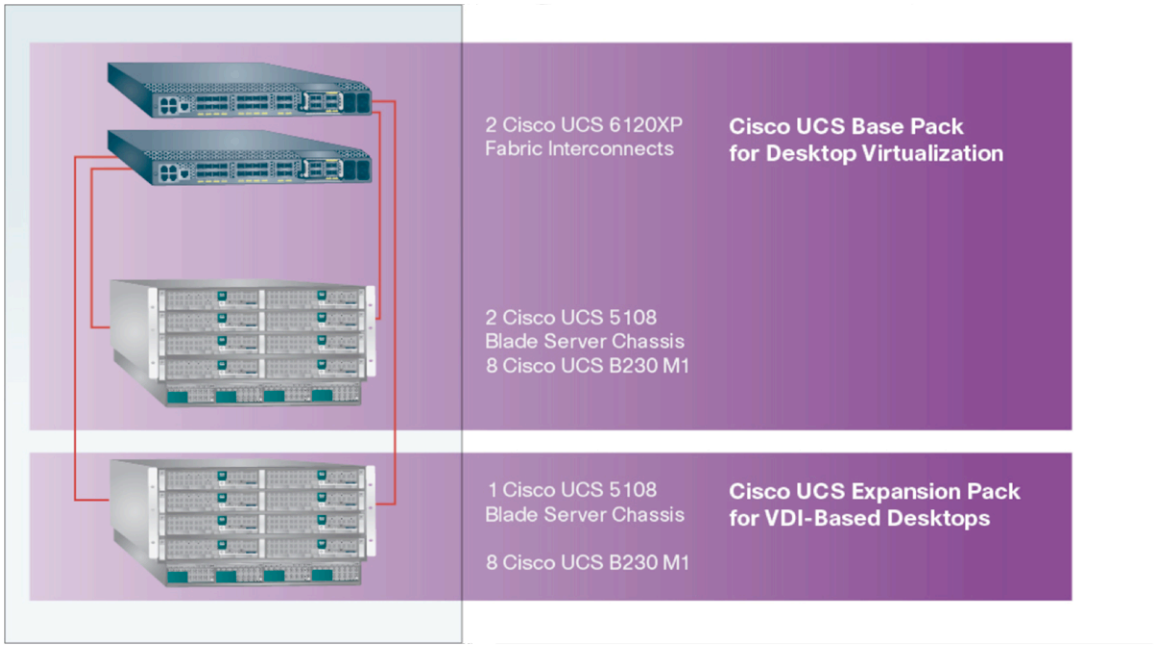
The Cisco Desktop Virtualization Solution with Citrix XenDesktop uses Cisco VN-Link technology to give unprecedented visibility and control over network links connected to hypervisors and virtual machines. Cisco VN-Link technology makes virtual links just as visible and manageable as physical links. Now network security, QoS, and network settings can be applied on a per-virtual-machine basis, and they remain constant regardless of VM location. This capability overcomes the least-common-denominator security that is often applied in virtualized environments in order to facilitate virtual machine movement.

Cisco VN-Link technology is implemented in both hardware and software. The Cisco UCS M81KR VIC implements VN-Link in hardware, and as Figure 4 (above) illustrates, each of the NICs and HBAs that provide connectivity for the hypervisor and virtual machines are connected to virtual links that terminate in the parent fabric interconnects. To support the virtual desktop server farm, VN-Link is also implemented in software by the Cisco Nexus 1000V Switch. This fully-featured Cisco switch is embedded in the VMware vSphere hypervisor and replaces the default VMware vSwitch. The Cisco Nexus 1000V establishes a virtual link to each virtual desktop and allows that virtual link to move automatically when a virtual desktop is moved between servers in order to balance the workload.

Solution Architecture

Cisco packages the Cisco Desktop Virtualization Solution for Citrix XenDesktop as a set of modular building blocks that are used to build the larger reference architecture defined by a Cisco Validated Design. Packaging the solution as a set of building blocks accelerates solution deployment while providing a straightforward, incremental path to accommodate growth. The solution's packaging is designed to give organizations a way to implement a proof-of-concept project or establish an initial virtual desktop infrastructure for production use. The solution is packaged in three units. (Figure 5) The base unit is required, and one or more expansion units can be configured to expand the solution's capacity to support more virtual desktops or virtualized applications. With the base unit defined (Figure 5), up to 18 additional expansion units can be added to bring the solution's total number of chassis to 20.

Figure 5. The Solution is Packaged As Three Modules: One Base Unit and Two Expansion Units



- **Cisco UCS Unit for Desktop Virtualization:** This module establishes the virtual desktop infrastructure with servers optimized to support Citrix management software, and an initial virtualization farm to support upto 1000 desktops. The module includes two Cisco UCS 6120XP Fabric Interconnects with downloadable Cisco service profiles defined for configuring the servers. Only a minimal number of parameters need to be set by customers. The module includes one Cisco UCS 5108 Blade Server Chassis, each equipped with two Cisco UCS 2104XP Fabric Extenders for I/O connectivity. One chassis is populated with servers, additional chassis can be added so that customers can incrementally expand their virtual desktop infrastructure one server at a time. The module includes eight Cisco UCS B230 M1 servers, each with 256 GB of memory and with configurable processors and mezzanine cards.

EMC VNX5500 Series Storage System

As part of the Cisco Desktop Virtualization Solution, the EMC VNX5500 platform provides storage by using IP NAS connections for virtual desktops and Citrix XenDesktop controllers.

Planning and designing the storage infrastructure is a critical step in architecting a VDI solution because small changes in I/O requirements have a big impact on storage workloads. For example, a single desktop might execute

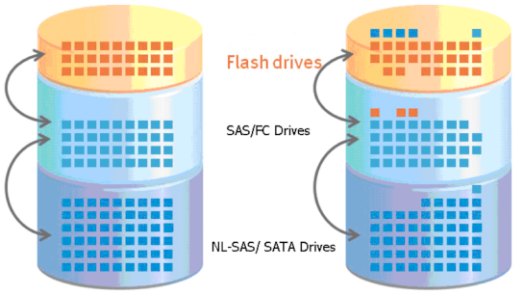
15-20 I/O operations per second (IOPS). In a traditional desktop environment, an individual laptop or desktop hard drive can easily support a 15-20 IOPS workload. When a virtual desktop solution is deployed across an organization, that same 15-20 IOPS workload multiplies very quickly to 15,000 or 20,000 IOPS. In a traditional storage environment, customers would need to buy and provision hundreds of high-performance FC or SAS drives to meet these workload demands.

EMC FAST VP

The EMC solution leverages Flash drives and EMC FAST VP (Fully Automated Storage Tiering for Virtual Pools) technology to help reduce storage requirements, optimize storage performance, and scale storage to serve thousands of virtual desktop users.

As an example, rather than move an 800 GB LUN to Flash drives, FAST VP identifies and monitors the entire storage pool in 1 GB chunks. As shown in Figure 6, when data becomes active, FAST VP automatically moves only these “hot” chunks to a higher tier like Flash.

Figure 6. EMC FAST VP Technology Moves Active Data to Flash Drives



As data "cools," FAST VP correctly identifies which chunks to proactively move to lower tiers. This granular tiering makes it possible to reduce storage acquisition while improving storage performance and response time.

EMC FAST Cache

EMC FAST Cache technology enables Flash drives to be used as an expanded cache layer for the storage array, with array-wide features available for both file and block storage. FAST Cache works by examining 64 KB chunks of data in FAST Cache-enabled objects on the array. Frequently accessed data is copied to the FAST Cache and subsequent accesses to that data chunk are serviced by FAST Cache. This feature allows immediate promotion of very active data to the Flash drives, dramatically improves the response time for that data, and reduces the data hot spots that can occur within the LUN.

Data Compression for Greater Efficiency

EMC features for block data compression allow customers to save and reclaim space anywhere in their production storage environment with no restrictions. Data compression works as a background task to minimize performance overhead. Block data compression supports thin LUNs and automatically migrates thick LUNs to thin during compression, freeing valuable storage capacity. In addition to compression at the Block LUN level, the EMC VNX5500 also offers file-level deduplication and compression.

Storage Scalability

To enhance scalability, EMC supports Citrix Machine Creation Services (MCS), a provisioning mechanism introduced in Citrix XenDesktop 5. MCS is integrated with the Citrix XenDesktop Desktop Studio management

interface to provision, manage, and decommission desktops from a central management point. MCS allows several types of machines to be managed within a catalog in Desktop Studio, including dedicated and pooled machines.

Quality of Experience for Desktop Users

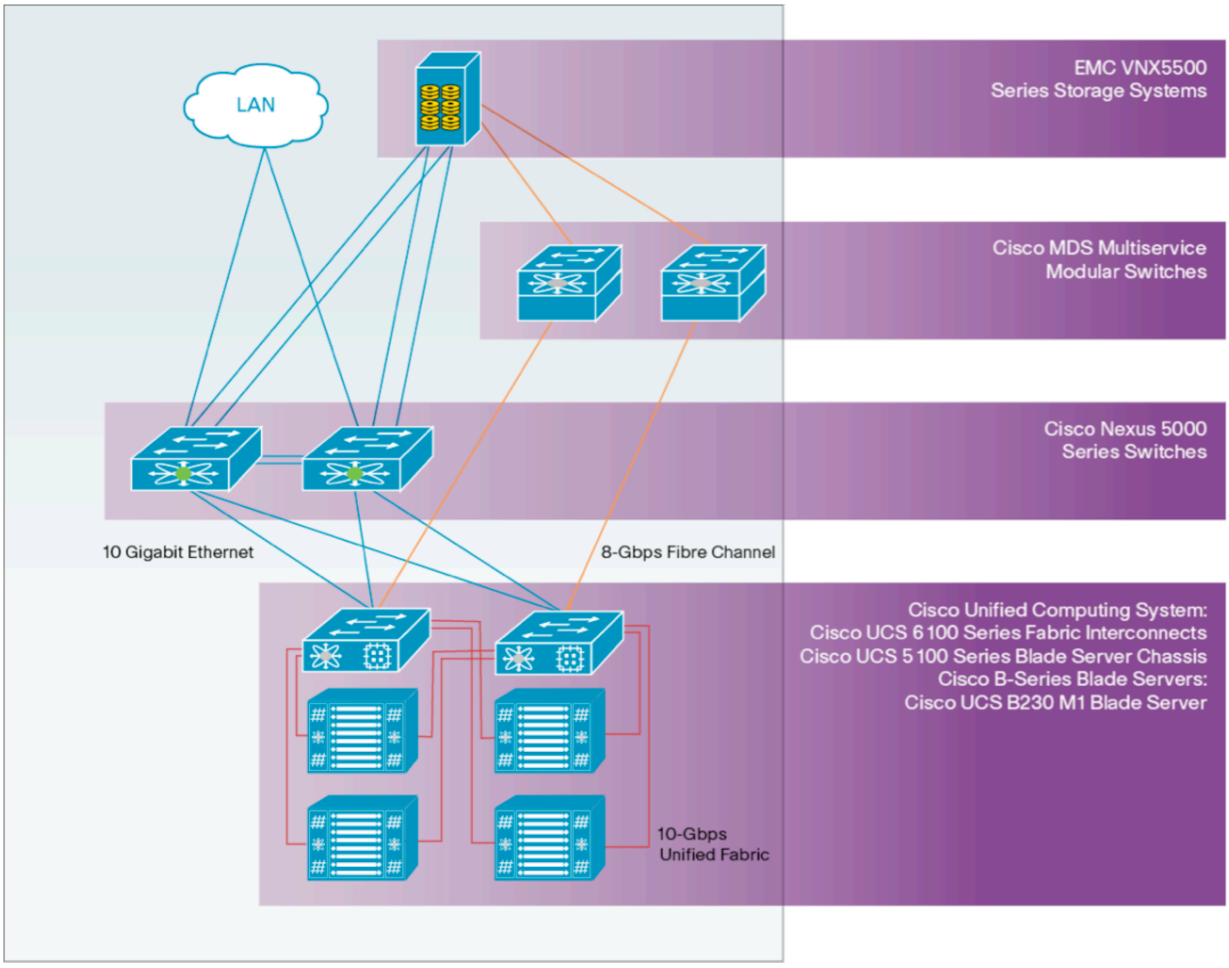
When deploying virtual desktops across the enterprise, it is important to leverage storage solutions that support technologies such as EMC FAST Cache to help ensure the quality of experience for virtual desktop users. EMC FAST Cache reduces the impact on virtual desktop performance caused by read-heavy activities such as boot storms and antivirus scans as well as write-heavy workloads such as operating system patches and application updates.

Reference Architecture Overview

Reference architectures reflect the tested, validated designs that Cisco develops for implementing solutions, and they illustrate how organizations can incorporate the Cisco Desktop Virtualization Solution for Citrix XenDesktop in their own data centers. The solution's reference architecture is summarized briefly in this section. A complete description of the architecture can be found in the Cisco Validated Design on the topic.

The Cisco Unified Computing System supports the Citrix management software and the server and application virtualization farm. The four blade server chassis in Figure 7 illustrate the deployment of a single Cisco UCS Base Unit for Desktop Virtualization and two expansion units, bringing the total number of chassis to four.

Figure 7. The Base and Expansion Units Are Incorporated into an Overall Data Center Architecture



The network access layer is comprised of a pair of Cisco Nexus® 5000 Series Switches, 10-Gbps, low-latency, line-rate, cut-through switches that are used to establish a scalable, flexible access layer that can accommodate multiple Cisco Unified Computing Systems as well as data center servers equipped with Gigabit Ethernet, 10 Gigabit Ethernet, and converged network adapters. Beyond the solution, and across the data center, the access layer established by the Cisco Nexus 5000 Series can support all Ethernet speeds including 100-Mbps and Gigabit Ethernet through standalone Cisco Nexus 2000 Series Fabric Extenders that provide additional scalability without complexity.

The switches are configured with virtual port channels (vPCs) that make the two switches appear as a single switch to external devices. Traditional port channels use multiple links in an active-standby configuration to provide high-availability connectivity even in the event of a single switch or link failure. This approach wastes switch ports and limits available bandwidth. The vPCs configured in the reference architecture enable active-active links in which every port participates in the vPC. This approach increases available bandwidth while providing high-availability connectivity. For example, the EMC VNX5500 series storage system illustrated has 40 Gbps of available bandwidth over the four 10 Gigabit Ethernet links that connect it to the access layer because of the use of vPCs.

Cisco MDS 9000 Series Multiservice Switches comprise the Fibre Channel access layer. Two switches are used, one to support each of two distinct SANs. The Cisco Unified Computing System and the EMC VNX5500 series storage system connect to the Fibre Channel access layer through 8-Gbps Fibre Channel connections.

The EMC VNX5500 series storage systems support network-attached storage via IP protocols, block-based storage over traditional Fibre Channel, and also direct connectivity to block-based storage through FCoE. In the context of the reference architecture, logical units for booting the hypervisors are stored on the EMC VNX5500 series storage systems and accessed through Fibre Channel. Network File System (NFS) storage is used to store the virtual disks for booting individual virtual desktops. The network-attached storage meets the shared-storage requirements that allow hypervisors such as VMware ESX Server to perform dynamic movement of virtual machines, or vMotion, in order to balance virtual desktop workloads.

Conclusion

The Cisco Desktop Virtualization Solution with Citrix XenDesktop achieves an optimal balance between the needs of users for more mobility, flexibility, and choice, and the needs of IT organizations to centralize desktop infrastructure, secure mission-critical data, and respond quickly to rapidly changing business requirements. As business organizations reassess their end-user computing strategy, they know that they have to move forward with a new approach, yet they must also choose a solution that is as cost effective and risk free as possible.

The Cisco Desktop Virtualization Solution with Citrix XenDesktop is designed for straightforward, rapid deployment with minimal risk. The solution is backed by a set of preconfigured Cisco Unified Computing System deployment units with downloadable service profiles that provide on-demand infrastructure to match the solution's on-demand virtual desktops and applications. The solution is proven and tested through a Cisco Validated Design that includes components from Cisco, Citrix, and EMC. Cisco has tested the solution's ability to host virtual desktops in the data center using Citrix XenDesktop software, and also applications hosted using Citrix XenApp software to support a hosted-shared model. The solution was tested on VMware vSphere. Making the solution even more straightforward to deploy, Cisco offers coordinated support with a single number to call.

There is a reason why the Cisco Desktop Virtualization Solution with Citrix XenDesktop is the first of its kind in the industry. Cisco and Citrix designed the solution to address a common vision of the changing workplace, and both companies have aligned to deliver the software, end-to-end networking, and the rock-solid virtualization platform that empower IT organizations to successfully navigate today's rapidly changing business environment. With Cisco as the leader in enterprise networking and the creator of the industry-leading Cisco Unified Computing System, and with Citrix as the leader in desktop virtualization, the time is right to move to a centralized, virtual desktop environment.

For More Information

For more information about the Cisco technology referenced in this document, please refer to the following:

- Cisco Unified Computing System: http://www.cisco.com/go/ucs
- Cisco VDI reference architecture: http://www.cisco.com/go/vdi or http://www.cisco.com/en/US/netsol/ns1004/index.html
- Cisco VXI vision and end-to-end architecture: http://www.cisco.com/en/US/solutions/ns340/ns414/ns742/ns1100/landing_vxi.html

- The Cisco Desktop Virtualization Solution with Citrix XenDesktop: http://www.cisco.com/go/citrix
- Citrix XenDesktop 5 on EMC VNX and Cisco UCS: http://www.emc.com/collateral/hardware/technical-documentation/h8243-virtualdesktop-vnx-citrix-xendesktop5-vsphere-ra.pdf

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