Virtual desktop savings using Cisco UCS Blade Servers

Payback in 4 months or less

CISCO

intel

CITRIX

Offset your modest investment with savings in administration, management, security, energy, and productivity

The Cisco desktop virtualization solution with Citrix XenDesktop® combines Cisco Unified Computing System, Intel Xeon® processors, Citrix desktop virtualization technologies, and NetApp storage to deliver a cost-effective solution for hosting, securing, and optimizing the delivery of virtual desktops and applications. Organizations deploying a desktop virtualization solution benefit by using the Cisco UCS B250 M2 Extended Memory Blade Server, which supports many users and properly scales with additional servers. The Cisco desktop virtualization solution, which includes key technologies from Intel and Citrix, also delivers low data center infrastructure costs combined with improved manageability, security, energy usage, and productivity to provide TCO savings when compared to traditional desktop environments.

We analyzed three payback models. In our analysis, the Cisco desktop virtualization solution delivered payback in

- Less than 24 months based on desktop management and administration savings alone
- Less than 17 months with the addition of savings on energy and laptop loss, including theft
- Less than 4 months with the addition of productivity savings

JUNE 2011

A PRINCIPLED TECHNOLOGIES WHITE PAPER

Commissioned by Cisco Systems, Inc.

SIMPLIFIED DESKTOP ADMINISTRATION AND APPLICATION MANAGEMENT DELIVER SAVINGS IN LESS THAN 2 YEARS

The Cisco desktop virtualization solution brings simplicity and consistency to desktop management. Many of the management tasks traditionally required on a per-user basis are now performed across all client devices simultaneously, take minutes rather than hours, and can be done remotely.

The Cisco UCS Manager is an embedded, model-based management approach, which allows IT organizations to define server configuration policies that cover every detail from firmware revisions and BIOS settings to network and storage connectivity. Once IT defines configuration policies, it can deploy individual servers against these predefined policies in less time and with fewer steps than traditional methodologies. This automation increases speed to production for adding additional virtual desktops, which can dramatically improve worker productivity as well as lower IT cost to deploy.

We estimate that the Cisco desktop virtualization solution can deliver significant desktop, OS, and application management operating costs savings compared to traditional, partially managed desktops. In less than 2 years, these savings alone can pay back the modest investment costs and data center operating costs of the solution. A 2009 TCO report estimates total per-user savings for desktop virtualization of $360 over partially managed desktop PCs.[1] For the savings here, we use that report's estimates for desktop management and application administration costs per user, increasing those costs 3 percent each year to allow for rising labor costs. Figure 1 summarizes savings for desktop and administration for the Cisco desktop virtualization solution compared to traditional/partially managed desktops, showing the cost savings of efficient and simplified desktop and application administration.

---

[1] TCO Savings with XenDesktop Virtualization, Citrix, http://www.sata.ca/file/CostSavingsWhitepaper.pdf.

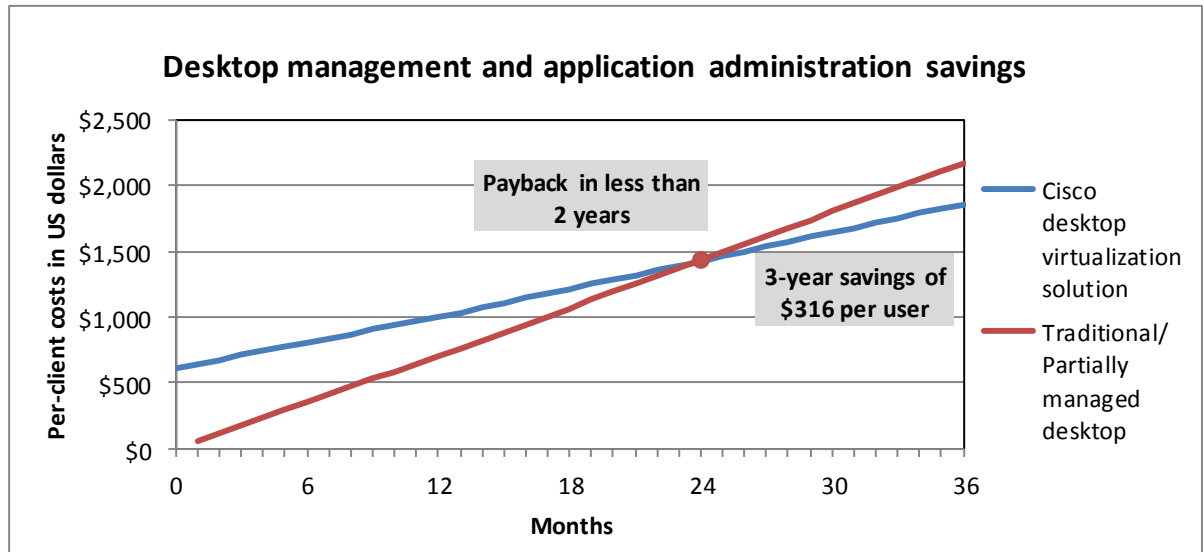**Desktop management and application administration savings**

Figure 1: The Cisco desktop virtualization solution can deliver savings through desktop management and application administration efficiencies alone in less than 2 years.

ADDITIONAL SAVINGS SHAVE MONTHS OFF PAYBACK TIME

Enterprise requirements, current practices, and choice of delivery models and client devices can affect the cost model and savings. In a second model, we calculate additional savings for endpoint device energy and laptop loss (including theft) remediation. We discuss additional potential for security savings at the end of this section.

- **Energy savings.** Desktop energy savings come in many forms when using desktop virtualization. For example, in hosted models, the desktop workload and its energy demands move from the PC to the data center, allowing the use of low-energy thin clients. Additionally, with better PC power management practices and energy-efficient clients featuring Intel vPro™ Technology, IT can also force use of the sleep/standby/hibernate function on more PCs. For the purpose of this paper, because we are assuming the repurposing of existing PCs, we include PC energy savings of 6 watts per client device per year, a savings of a little more than $10 per device per year.
- **Laptop loss or theft remediation.** Improved data security, protection from viruses and other attacks, and physical security can provide additional savings. We include security savings related to laptop loss. A 2010 Ponemon study sponsored by Intel estimated that the cost of a single lost laptop without confidential data was $4,078, the cost of one with unencrypted confidential data was $56,165, and the average cost per lost laptop overall

was $25,454.[2] Most enterprises lose multiple laptops each year. The Ponemon study calculates an average loss (from theft or other causes) of 2.28 percent of laptops per year for enterprises between 1,000 and 5,000 employees and 2.32 percent per year across all organizations based on their study of 329 organizations. They include laptops lost to known theft, likely theft, and those that are missing. They estimate that almost half of the lost laptops contain sensitive or confidential data. We estimate that 400 of the client systems for our enterprise are laptops and apply the 2.28 percent loss rate to that count, resulting in a loss of nine laptops per year for both the traditional and Cisco desktop virtualization solutions. The cost of the loss is significantly lower for the Cisco desktop virtualization solution for two reasons: (1) because sensitive data is stored in the data center, not on the laptop, it is protected from theft; and (2) opportunity cost due to lost work product is mitigated whether loss is from hardware failure, theft, or other causes. We calculate the cost of laptop loss for the Cisco desktop virtualization solution using the Ponemon study estimate for the loss of a laptop without confidential data and the loss for the traditional solution at the study's estimated average cost per lost laptop.

Added to the manageability savings in Figure 1, these savings reduce the payback period to less than 17 months. Figure 2 shows these savings.
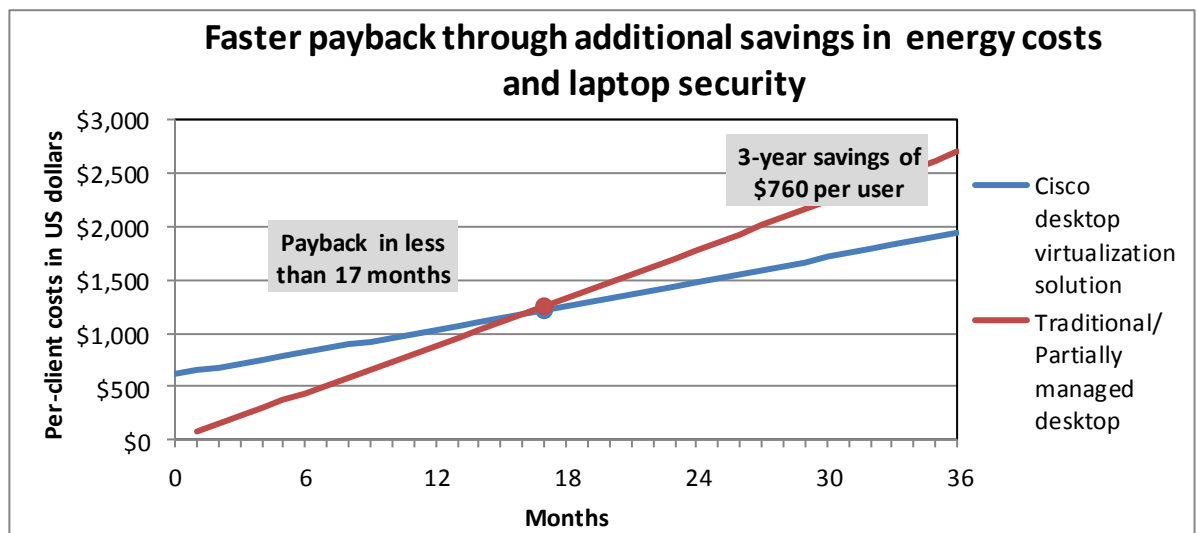

Figure 2: The Cisco desktop virtualization solution can deliver payback in less than 17 months when you add in savings in energy costs and laptop security.

---

[2] The Billion Dollar Lost Laptop Problem, Benchmark study of U.S. organizations, September 2010, http://newsroom.intel.com/docs/DOC-1544

User productivity savings

By reducing the amount of time users spend on desktop administration tasks such as backup and self support, and reducing overall user downtime, the Cisco desktop virtualization solution should deliver productivity gains for workers. Workers need the flexibility to work from anywhere and at any time using their favorite devices with little downtime. IT can customize desktops on a per-user or group basis, matching desktops to user requirements. Users can then access their desktop and corporate applications from their desktop, their laptops, their personal computers, and other mobile devices as IT policies allow. Their virtual desktop is available to them at the office, at home, and throughout their travels. This flexibility inherent in the Cisco desktop virtualization solution can dramatically aid productivity. We estimate that the Cisco solution can save at least 10 minutes a day or almost 40 hours per year in worker productivity in these areas, amounting to an extra week of productivity per worker per year.

Added to the savings in Figure 2, these savings shorten the payback period to less than 4 months. Figure 3 shows these savings.
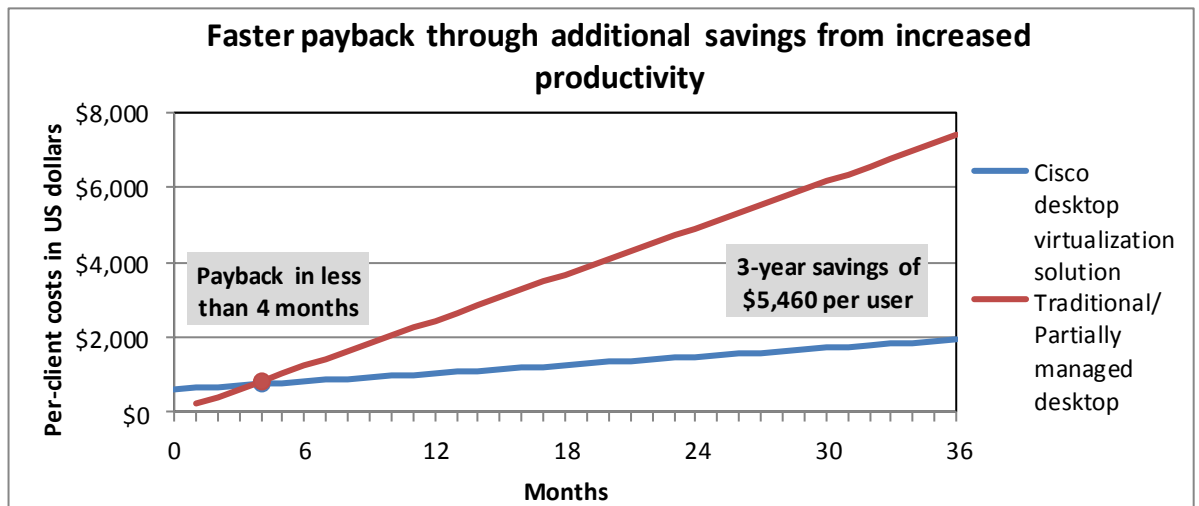

Figure 3: The Cisco desktop virtualization solution can deliver payback in less than 4 months when you add in savings from increased productivity.

Other areas of potential savings

Other savings are not as easy to quantify, but can be of equal or greater importance to an enterprise than some of the savings we have quantified.

Migration

When planning a Microsoft® Windows® 7 migration, moving first, or at the same time, to a Cisco desktop virtualization solution can cut the time, cost, and hassle of the migration. The newer operating system offers potential for user productivity savings and savings in management and administration costs.

Regulatory compliance and security

Environments at risk of high costs for regulatory non-compliance and security breaches with traditional desktop environments get additional, possibly substantial savings by ensuring security and compliance with the Cisco desktop virtualization solution. Additional elements of value are more difficult to quantify in a TCO/ROI analysis because they are more "avoidance" centric or deliver value for legal mandate adherence. Figure 4 presents some examples of these savings.

Key areas of savings	Problems in traditional desktop environment	Potential savings with Cisco desktop virtualization solution
Regulatory compliance		
Adherence with corporate data and email retention policies and mandates	It is next to impossible to force adherence to corporate data and email retention policies/mandates when there is local storage.	• Corporate data retention policies are easily enforced since all data resides in data center storage. • Corporate data retention policies for "delete after X days/months" can be enforced, which is critical to successful defense in liability situations.
Document searches	Document searches as part of compliance efforts are time-consuming and often incomplete.	Documents can be easily archived and searched for all relevant content.
Security - The soft cost of security breaches can be high.		
Insurance costs	Enterprises can face potential insurance cost increases as a result of illegal or unauthorized data access.	Avoid the cost of breaches by keeping data safe in centralized stores and restricting data portability (local to client device download/upload) via enforceable policy.
Operational costs	After data loss, enterprises may need to provide additional costly customer	Avoid costs associated with loss of critical data that is stored locally to

TCO: Savings through desktop virtualization with the
Cisco/Intel/Citrix VDI solution
A Principled Technologies white paper **6**

Key areas of savings	Problems in traditional desktop environment	Potential savings with Cisco desktop virtualization solution
	services such as free credit check subscriptions.	the end user by keeping the data safe in centralized stores.
Loss of business	Enterprises that lose sensitive customer data can lose customer loyalty and goodwill, and can face negative publicity that costs them future customers.	By preventing loss of sensitive customer data, the enterprise saves these soft costs of security breaches.

Figure 4: Additional savings potential in compliance and security.

OUR METHODOLOGY

For this cost analysis, we sized a Cisco desktop virtualization solution for 1,400 users, a reasonable count for a small- to mid-size enterprise, and one that tests in our labs show 15 Cisco UCS B250 M2 Extended Memory Blade Servers can comfortably support.[3] We then defined the enterprise. Appendix B describes our assumptions about the enterprise, including the desktop delivery method they choose to employ.

We calculated acquisition costs and operating expenses for the solution. See Appendix A for cost details.

We used publically available estimates from Citrix for savings in desktop and administration costs compared to traditional/partially managed desktops. See Appendix C for a list of those savings.

Assumptions key to our analysis were choices of client hardware and deployment models.

Deployment models

Citrix XenDesktop with FlexCast™ technology offers a range of hosted and streamed desktop and application delivery models that deliver resources to a wide variety of client devices. These desktop virtualization technologies can enforce centralized data storage or allow local data stores. While one desktop or application delivery model will not work for all users, for the purpose of this

---

[3] http://principledtechnologies.com/clients/reports/Cisco/UCS_VDI_Scaling.pdf

analysis, we looked at a Hosted VDI desktop delivery model that provides online access to desktops, applications, and data; centralizes and secures data; and delivers desktops to any device, anywhere.

The Hosted VDI FlexCast technology increases your dependence on server resources because system and applications run on the servers rather than the clients or endpoints. Other FlexCast technologies, specifically those that rely on the local processing power of the client rather than the server to run operating systems and applications, would reduce server demand and cost. Below is a brief summary of the other FlexCast technologies that are available:

- o Local VM desktops extend the benefits of centralized, single-instance desktop management to intelligent clients. This technology utilizes the local client resources to run multiple virtual machines on a dedicated PC.
- o Streamed Virtual Hosted desktops provide a locked down, streamlined, and standardized environment with a core set of applications, which is streamed down to the local device to gain the benefits of dedicated local computing resources.
- o Hosted Streamed desktops provide a server-based, locked down, and standardized desktop environment with a core set of applications that users access remotely on any device.
- o On-Demand Apps enables any Windows app to be virtualized, centralized, and managed in the datacenter and instantly delivered – via hosting or streaming –to users anywhere on any device.

For information on these alternative delivery technologies, please visit http://flexcast.citrix.com.

Enterprises can achieve further benefits by combining these technologies with Intel vPro-based intelligent client devices. These clients allow companies to support Local VM desktops and on-demand applications that take advantage of local resources where users who require high-demand or breach-prone

applications can run them in the most optimized way. These clients can also reduce server resources by offloading high demand processing, such as video, to the client while still keeping the applications and data in the datacenter.

About the Cisco UCS B250 M2 Extended Memory Blade Server

The Cisco UCS B250 M2 Extended Memory Blade Server helps maximize performance and capacity for demanding virtualization applications. The Cisco UCS B250 M2 Extended Memory Blade Server supports up to 384 GB of RAM, which allows VDI scaling when client memory requirements are high.

In our testing, we used a dual-socket Cisco UCS B250 M2 Extended Memory Blade Server with Intel Xeon processor X5670s. The blade had two 146GB SAS hard drives, but we configured the blades to boot from SAN for testing. We configured the blade with 256 GB of system memory.

About the Intel Xeon processor 5600 series

The Intel Xeon processor 5600 series—the next generation of intelligent server processors—automatically regulates power consumption to combine industry-leading energy efficiency with intelligent performance that adapts to a changing workload. Intel Xeon processor 5600 series-based servers deliver energy-efficient performance along with secure, flexible virtualization solutions for next-generation data centers.

About Citrix XenDesktop

Citrix XenDesktop transforms Windows desktops to an on-demand service to any user, any device, anywhere. XenDesktop quickly and securely delivers any type of virtual desktop or Windows, Web, and SaaS application to all the latest PCs, Macintoshes, tablets, smartphones, laptops, and thin clients – all with a high-definition HDX™ user experience. For more information on XenDesktop, see http://www.citrix.com/virtualization/desktop/xendesktop.html. In our testing, we used Citrix XenDesktop 4; this report includes costs for the recently released Citrix XenDesktop 5.

CONCLUSION

Cisco UCS blade servers with Intel Xeon processors, Citrix XenDesktop/ XenServer, and NetApp storage have low front-end costs and offer many opportunities for savings during a desktop virtualization implementation and beyond. As your enterprise develops an ROI analysis of transitioning from a traditional desktop environment to desktop virtualization with the Cisco solution, considering these savings and technologies is vital.

APPENDIX A – COSTS

We estimate per-seat front-end hardware costs for a deployment of 15 Cisco UCS B250 M2 Extended Memory Blade Servers and NetApp storage for the virtual desktops at $317.33 per user. We used a NetApp FAS3040 filer with four disks shelves. Each shelf contained 14 300GB hard drives. We configured the Cisco UCS B250 M2 Blade Servers to boot from SAN using Fibre Channel connections. We created a NFS share for all virtual desktops through a NetApp X1008A 10Gbps expansion card.

Figure 5 shows the Cisco UCS system components we priced. This configuration expands the one we tested in the companion report, adding two fully loaded chassis to serve additional users. Costs include the first year of support.

Quantity	Cisco Unified Computing System component
15	Cisco UCS B250 M2 Blade Server with 2.93GHz Intel Xeon processor X5670s, 256GB memory, 146GB 6Gb SAS 10K RPM drives, and two UCS M71KR-Q QLogic® Converged Network Adapters. These blades host the virtual desktops.
2	Cisco UCS B200 M2 Blade Server with 2.93GHz Intel Xeon processor X5670s, 48GB memory, 146GB 6Gb SAS 10K RPM drives, and 2 UCS M71KR-Q QLogic Converged Network Adapters. These blades serve as infrastructure servers.
4	Cisco UCS 5108 Blade Server Chassis with 2 UCS 2104XP Fabric Extenders
2	Cisco UCS 6120XP 20-port Fabric Interconnects

Figure 5: Cisco desktop virtualization solution hardware components in this cost analysis.

Figure 6 shows the Cisco UCS hardware retail prices provided by Cisco as of 12/15/2010 for the components in Figure 5, cost estimates for NetApp hardware and data center switches, and the average price per user for 1,400 users for all those components.

Cost category	Cost
Total retail price for Cisco UCS hardware (Cisco provided prices as of 12/15/2010. (Includes all components in Figure 5.)	$420,452.35
Estimated cost for NetApp DS14MK4 disk shelf for the hosted desktops (this does not include user data stores) and NetApp X1008A-R6 2-Port 10GbE NIC	$12,950.00
Estimated cost for data center switches (pro-rated based on ports used)	$10,860.00
Total cost for data center hardware for the virtualized desktops	**$444,262.35**
Average cost per user for data center hardware for the virtualized desktops	**$317.33**

Figure 6: Cisco desktop virtualization solution hardware costs.

For this cost analysis, we assume the enterprise has a NetApp FAS3040 storage array already in house with available shelf capacity and all necessary licenses, so we do not include its costs. We include costs to add an additional NetApp DS14MK4 disk shelf with 14 300GB 15K disks to that storage array to support the VDI

virtual machines. We also include costs for a NetApp X1008A-R6 2-Port 10GbE NIC that we added to the NetApp FAS3040 storage array for our testing.

We calculated a one-time data center infrastructure cost of $468.90 per user, which includes the costs in Figure 6 plus costs for Windows Server® 2008 R2 licenses for the two management servers and 1,400 XenDesktop Enterprise software licenses. We calculated XenDesktop Enterprise costs of $145.86 per user based on an assumed partner discount of slightly more than 35 percent off Citrix XenDesktop Enterprise User/Device license pricing of $225 per seat, based on the 1,400 licenses.[4] To the infrastructure costs, we add solution planning, setup, migration, and training costs averaging $142.83 per client for a total acquisition cost of $611.73 per client for the solution.

For the sake of this cost analysis, we assume the repurposing of existing PCs, we include PC energy savings of 6 watts per client device per year, a savings of a little more than $10 per device per year. We also include only the cost of data storage for the hosted desktops, not the user data; we assume that end user data is already backed up by policy, so the data storage for user data already exists. See Appendix B for a list of assumptions we used in the analysis.

Figure 7 shows TCO that we project for the traditional desktop and Cisco desktop virtualization solutions over 4 years.

	Year 1	Year 2	Year 3	Year 4	Total
Traditional desktop model					
Desktop management and application administration costs per device	$705.00	$726.15	$747.93	$770.37	$2,949.45
Damage costs from ten lost or stolen laptops, many of which contain sensitive data (per-device average)	$163.63	$163.63	$163.63	$163.63	$654.52
Higher power costs per client device compared to Cisco model	$10.40	$10.40	$10.40	$10.40	$41.60
Decreased user productivity compared to Cisco model	$1,566.80	$1,566.80	$1,566.80	$1,566.80	$6,267.20
Total	$2,445.83	$2,466.98	$2,488.76	$2,511.20	$9,912.77

---

[4] Citrix provided the XenDesktop license price and assumed partner sell price at the specified volume offered.

	Year 1	Year 2	Year 3	Year 4	Total
Cisco desktop virtualization model					
Data center costs	$46.37	$69.06	$69.06	$69.06	$253.55
Desktop management and application administration costs per device	$345.00	$355.35	$366.01	$376.99	$1,443.35
Damage costs from lost or stolen laptops that do not contain sensitive data (per-device average)	$26.22	$26.22	$26.22	$26.22	$104.88
Total	$417.59	$450.63	$461.29	$472.27	$1,801.78
Operational cost savings	**$2,028.24**	**$2,016.35**	**$2,027.47**	**$2,038.93**	**$8,110.99**
Cisco/Citrix model acquisition costs					$603.97
Operational cost savings minus acquisition costs					**$7,507.02**

Figure 7: Projected 4-year savings for the Cisco desktop virtualization solution.

Figure 8 illustrates the configuration.
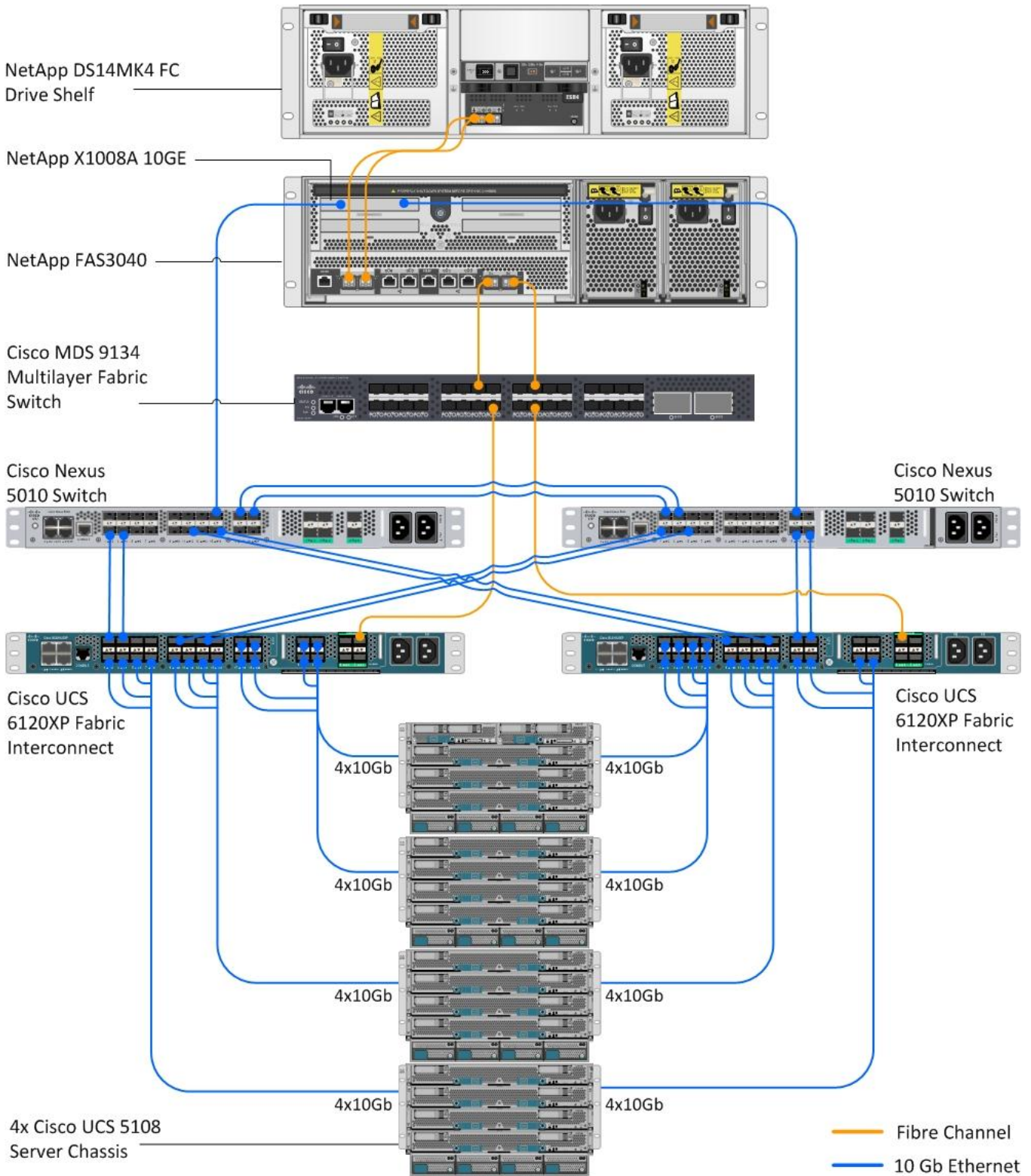
Figure 8: The Cisco desktop virtualization solution configuration we used for our hardware cost analysis.

APPENDIX B – ASSUMPTIONS

We base our estimates on the following assumptions about the modeled enterprise:

- The enterprise has 1,400 users with one virtualized desktop each and 400 of the users have laptops.
- Our companion report demonstrates the virtual desktop capacity and scalability of the Cisco desktop virtualization solution.[5] Seven Cisco UCS B250 M2 Extended Memory Blade Servers running at peak capacity could each support up to 112 users while giving an acceptable response time and user experience. Peak capacity is a useful comparison measure, but we prefer to size the solution for lower capacity. Assuming utilization at about 84 percent, we estimate 93 to 94 virtual desktops per server, or 1,400 desktop virtualization instances supported on 15 Cisco UCS B250 M2 Extended Memory Blade Servers.
- The solution uses two Cisco UCS B200 M2 Blade Servers for infrastructure management. We include Windows Server 2008 R2 licenses for these servers.
- The average desktop virtualization working set is 2 GB of memory per virtual desktop.
- Our test bed in the companion report included two Cisco Nexus 5010 switches to connect to storage and one Cisco MDS 9143 Fabric Switch that connected the Cisco Fabric Interconnects to the data center devices. The four-chassis Cisco desktop virtualization solution here does not use all the 40 switch ports on the Nexus switches or the 24 ports on the MDS switch. We estimate a per-port average cost for hardware and hardware support for the Cisco MDS 9134 Fibre channel switch of $258 and use four of its ports for a total of $1,032. We estimate $702 per port for the Nexus 5010 switch and use 14 of the ports for a total of $9,828. Divided among 1,400 client endpoint devices, the combined $10,860 hardware and support costs of these switches would add about $8 to the per-client device cost of the solution.
- For this analysis, we chose the XenDesktop Hosted VDI delivery model, which provides online access to desktops, centralizes and secures data, and delivers desktops to any device, anywhere.
- We include only the cost of data storage for the hosted desktops, not the user data. We assume that end user data is already backed up by policy, so the data storage for user data already exists. In tests for the companion report, we used a NetApp FAS3040 storage array and NetApp DS14MK4 expansion shelves. A single shelf would provide 2GB storage for each desktop virtualization working set at a cost of about $9 per client device, based on the street price of a NetApp DS14MK4 expansion shelf with 14x 300GB 15K drives expansion shelf for that array and the X1008A-R6 NetApp NIC that our testing required.
- We assume endpoints are the same for the two solutions and therefore omit the hardware costs of the client systems for both the traditional desktop and Cisco desktop virtualization solutions.
- Desktop virtualization requires SAN performance and bandwidth that holds up to large numbers of users accessing the network at once. We assume that our hypothetical enterprise has adequate SAN performance and does not require a network upgrade to handle the typical office worker workload that we consider in this analysis.
- Software Assurance costs for the Microsoft Office and Microsoft Windows software would be the same for the traditional or virtualized desktops and the licenses are transferrable. Because the

---

[5] http://principledtechnologies.com/clients/reports/Cisco/UCS_VDI_Scaling.pdf

desktop virtualization decision does not affect these costs, we omit the licensing and Software Assurance costs for Microsoft Office from this analysis.

- We assume the enterprise maintains current renewable Microsoft Software Assurance Volume License for Microsoft Office and Microsoft Windows for its PCs and will be able to upgrade its current PCs to Windows 7 and to Microsoft Office 2010.
- Solution training cost estimates include end-user training and training for IT and help desk staff. We estimate costs for hour of training for end users, and two weeks of training for five help desk staff and one week of training for three system administrators. Average cost for all training is $97.80 per user. We include 400 hours of system administrator time and 30 hours of other staff members' time for solution planning and pilot for an average per user cost of $18.00. For setup, we include 102 hours of system administrator time plus outside consulting services for an average per-user cost of $27.03. We estimate total costs for training, solution planning and pilot, and setup and migration of $142.83.
- Data center costs include hardware administration, hardware support, server management software, Windows Server 2008 Software Assurance, energy costs for power and cooling, rack space, and port costs. We estimated these costs at $46.37 per user. We also include Citrix XenDesktop Subscription Advantage Add-on costs for years 2 through 4 of $22.69 based on a slightly more than 35 percent discount on $35 Subscription Advantage Add-on. The total average annual data center cost per user for years 2 through 4 is $69.06.

APPENDIX C: DESKTOP ADMINISTRATION COST SAVINGS WITH CITRIX XENDESKTOP

Figure 9 presents the desktop administration costs per device per year.[6]

Area of savings	Included management tasks	Virtual desktop	Traditional/ unmanaged	Traditional/ partially managed
Technical support	Frontline tech support Backline tech support	$260	$600	$425
PC engineering	Moves, adds, changes, deletions Data recovery, archiving, purging, restructuring, backup Patching OS, reimaging systems, resolving corruptions Configure/upgrade/repair hardware	$40	$130	$110
Application management	Regression/compatibility testing Application rollout, provisioning Updates, maintenance, training	$45	$230	$170
Total for desktop administration and application management	**N/A**	**$345**	**$960**	**$705**

Figure 9: Desktop administration and application management costs per device per year.

---

[6] Source: TCO Savings with XenDesktop Virtualization, Citrix, http://www.sata.ca/file/CostSavingsWhitepaper.pdf.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
1007 Slater Road, Suite 300
Durham, NC, 27703
www.principledtechnologies.com

We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.