



WHITE PAPER

Streamlining Deployment and Management of Desktop Virtualization: The Case for Integrated Infrastructure

Sponsored by: Citrix, NetApp, and Cisco

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EXECUTIVE SUMMARY

CIOs everywhere are pushing IT departments to offer a solution that securely provides more workplace flexibility and mobility for employees, including access to corporate assets on user-owned devices. CIOs, IT administrators, and employees are all demanding an alternative to the distributed device-centric mindset that has long been a drag on IT productivity. The ongoing but ever-shrinking device refresh cycle is producing limited gains, and the siloed delivery of desktops, apps, and data is creating roadblocks to productivity, delaying change management cycles, and inflating end-user downtime.

One of the primary forces driving desktop virtualization today is the consumerization of IT. To fully embrace this trend, organizations need to be faster, more agile, and more responsive to the needs of end users. The result is that IT needs a platform to deliver Windows, SaaS, and mobile apps to any device simply and securely.

However, desktop virtualization solutions can be difficult to architect, design, deploy, and manage correctly. Desktop virtualization solutions can provide an alternative to siloed management without breaking the bank. But this requires the ability to rightsize the infrastructure and create the proper balance of compute, networking, and storage components. Oversizing can deliver the performance required, but it is expensive and results in excess capacity during nonpeak periods. On the other hand, undersizing doesn't deliver the performance required and results in a poor user experience, which can drive users away from corporate-managed systems.

Integrated infrastructure has been introduced in the past few years to alleviate these issues and to simplify the deployment, management, and scalability of the hardware. Integrated infrastructures are pre-integrated vendor-certified systems containing server hardware, networking equipment, disk storage systems, and basic element/systems management software. Integrated infrastructures are differentiated from traditional hardware platforms and architectures in that they are designed to be deployed quickly using a modular building-block approach to rapidly scale up resources and workloads. They are simpler to deploy and maintain while reducing processing, network overhead, and latency.

Citrix[®], NetApp[®], and Cisco[®] have designed, validated, and optimized such a solution for desktop virtualization. FlexPod[®] Datacenter with Citrix XenDesktop[®] provides:

- Fast time to value with rapid deployment
- Improved manageability
- Scalability
- Reduced total cost of ownership

SITUATION OVERVIEW

Desktop virtualization is rapidly growing and expanding to new devices as organizations seek to adapt to new user trends and increase productivity by enabling mobile work styles. Worldwide revenue for the virtual client computing (VCC) market was \$2.8 billion in 2013, growing nearly 6% year over year. IDC sees the market growing to \$4.7 billion through 2018, representing a five-year compound annual growth rate of 10.7%. It is important to note that the virtual client computing market is more than just VDI, or centralized virtual desktops (CVDs) as IDC refers to it. In 2012, CVDs accounted for only 28.5% of VCC revenue, while virtual user session (VUS) software that can share desktop or application sessions and includes products such as Citrix XenApp[®] accounted for 60%. Also included in the VCC market are distributed virtual desktops (DVDs), which are centrally managed but locally executed solutions such as Citrix XenClient[®] and application virtualization products such as Microsoft[®] App-V[™].

Desktop virtualization is being driven by the increasing demand put on IT by end users. End users are no longer a passive group willing to be told what type of hardware and software they must use. End users today are more powerful and knowledgeable about IT than ever before. However, end users can create governance and regulatory nightmares by bringing their own personal devices to work (BYOD) and using apps and resources outside the purview of IT. This creates tension between IT, which needs control and security to protect valuable intellectual property, and the end users, who want freedom of choice. To embrace the consumerization of IT, organizations need to be faster, more agile, and more responsive to the needs of end users. The result is that IT needs a platform to deliver Windows[®], SaaS, and mobile apps to any device simply and securely.

Desktop virtualization centralizes the resources, applications, and governance. It provides a systematic and simple platform to deliver and manage desktops and applications without having physical access to the endpoints. Desktop virtualization also provides on-demand scalability that is well suited for seasonal or temporary workers. The desktop virtualization platform has recently been married to mobile enterprise application management, identity management, and SaaS integration to provide a suite capable of addressing the needs of the most challenging and progressive end users.

Challenges

Desktop virtualization stresses every dimension of the datacenter – servers, network bandwidth, storage, management software, and more. To eliminate potential bottlenecks, IT managers must develop an infrastructure that enables them to deploy proportional resources of every type (server, network, storage, etc.) quickly. This in turn requires precise standards for infrastructure elements that work together seamlessly to create a manageable, maintainable, and scalable environment. The challenge involves not only planning for the speed and number of server CPUs but also planning for their associated memory capacity, corresponding network I/O capacities, backplane, and fast storage. The infrastructure architecture must also keep all of these elements – storage, I/O, memory, and compute – close together, reducing any potential latency bottlenecks caused by wire distances or hops. Most IT organizations find these demands challenging, and they spend considerable time performance tuning the environment to get it right. IT organizations run the risk of inefficient overbuilding of resources at one end and user dissatisfaction with delays and slowness at the other end.

To determine what infrastructure is required, organizations need to understand the number and different types of users who will be supported and the different types of VCC technologies that will be deployed. Each of the potential use cases needs to factor into the selection of an appropriate desktop virtualization solution for both IT and end users. These factors include mobility, BYOD policies, security- and policy-based application access, and flexible deployment models. With that in mind, IT can configure the appropriate servers, storage, and networking. In addition, IDC has consistently found that the storage solution has been the most consequential part of the physical infrastructure because it provides the backbone for multiple desktop images to boot off and access data. The storage solution needs to support performance on demand, be scalable, provide continuous access, be secure, and offer integrated data protection – and do all of this in a cost-effective manner.

Infrastructure Requirements

To meet the demanding needs of today's end users, specifically a mobile multidevice workforce, the virtual desktop infrastructure has to be designed to function seamlessly. In other words, the infrastructure components (i.e., compute, networking, and storage layers) need to work in unison with each other and with the hypervisor solution to offer an agile, scalable, and cost-effective infrastructure that is aligned with user and administrator requirements. This means that the solutions need to have the following characteristics:

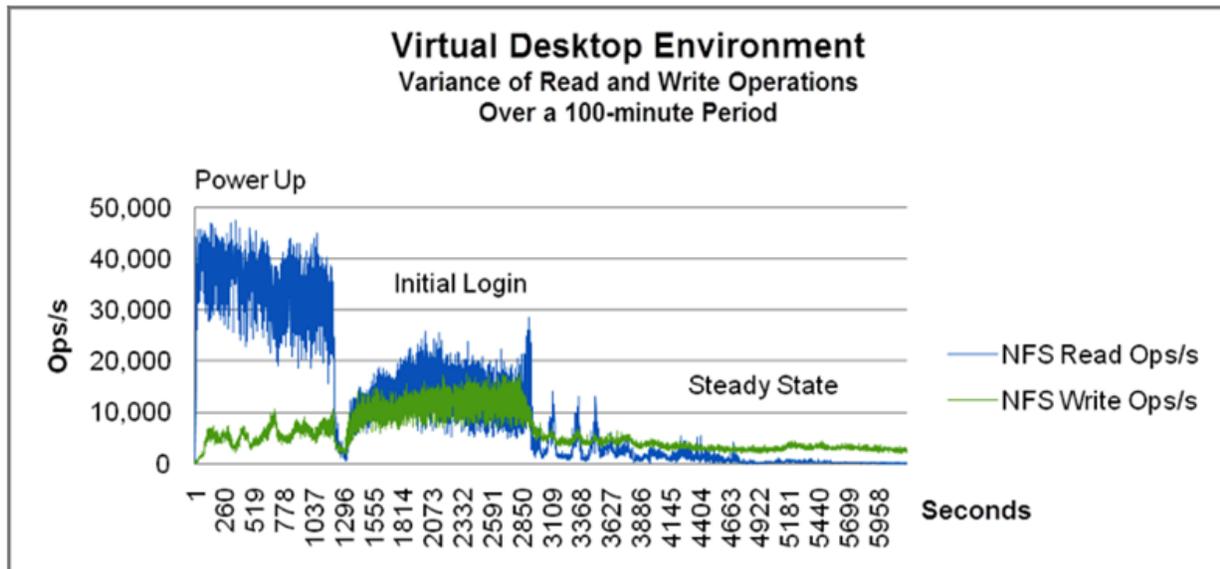
- **Rapid deployment.** The days of having to put together piecemeal hardware solutions are nearing an end. The compute, network, and storage all need to be validated to work together and be easily deployed in unison.
- **Manageability.** As updates come out for not only the software but also the hardware, it is important to be able to quickly and seamlessly roll them out.
- **Scalability.** The infrastructure needs to be able to scale with the demands of the workload. Different dimensions of the infrastructure can be stressed, depending on the applications the end users are accessing. So having a flexible, scalable architecture is important when designing the underlying IT environment for a desktop virtualization workload.

- **High availability (HA)/disaster recovery (DR).** Downtime is never acceptable for any enterprise workload, but especially for the desktop, which is where users typically access other applications, further necessitating the need for HA/DR.
- **Multiprotocol.** Multiple storage protocols are needed for optimal support of all desktop components – OS, applications, user data, and profiles – within a delivery model and across delivery models.
- **Low latency.** Regardless of the design and regardless of how many desktops are being supported, from a user's perspective, the solution needs to offer near-local performance in terms of latency. This requirement is accentuated even more in situations where the users are mobile and access the desktop on the go, in many cases via cellular or wireless networks. External storage solutions, especially when used in shared network environments, introduce latency into the mix depending on what type of data interfaces are used (e.g., NFS versus Fibre Channel or iSCSI), the overhead posed by storage optimization solutions such as deduplication or compression, and the manner in which the disks are configured. The intelligent use of flash as a caching layer or as a storage tier is an important consideration because certain elements of the desktop image accessed can be served from flash cache or tiers, thereby reducing the latency without driving up cost.
- **Security.** Now that all the data will be stored in the datacenter, it is critically important that the datacenter is physically secure, the servers are equipped with the latest in hardware security, and the data is encrypted when possible. Having logs, policies, and governance over how the hardware is managed will go a long way in keeping the datacenter secure.
- **Performance on demand (extreme burst IOPS).** One of the often talked about but frequently misrepresented attributes for storage in VDI stems from multiple virtual machines booting up at the same time and then all users logging in. This purportedly causes the storage system to be hit with a tsunami of read and subsequently write IOPS (it is routine to find a three to five times increase in IOPS during a boot storm). It is then up to the storage system to mitigate and manage the resulting bottleneck in terms of how data is served. Several storage vendors have simply added a caching layer to tackle this issue, but the problem is not solved there. Storage vendors also have to alter their fetching and caching algorithms to detect such a storm and pin relevant data sets before it hits the system. This is especially necessary when the boot images are neither cloned nor deduplicated. Pinning data into the cache is not necessary, however, when the images are cloned or deduplicated at the block level. The first read of a shared block will be at disk speed, and subsequent reads of the block (for subsequent boot images) will be at cache speed. This may appear to be an easy task, but it is not. This is perhaps one of the biggest challenges with scalability and agility that makes some storage solutions better than others. It needs to be noted that IOPS requirements increase with newer platforms. For example, a Windows 7 deployment is often 110-120% more IOPS intensive than a Windows XP deployment.
- **Storage optimization.** Optimization technologies make asset utilization as efficient as possible. As noted previously, one of the biggest inhibitors to the adoption of external disk systems is the cost-effectiveness of the solution. Businesses demand that the solution be able to sustain a low fully loaded cost per virtual machine without compromising functionality or scalability. One of the ways storage vendors can lower the per-desktop costs of the solution is by heavily leveraging storage optimization technologies such as deduplication, compression, dynamic flash-based tiering, and thin provisioning. Some vendors now offer all-flash systems for extreme IOPS and ultralow-latency requirements. Since OS images of virtual desktop images, like their server counterparts, are highly redundant, their combined footprint can be highly optimized by removing the redundant blocks of data. However, the "rehydration" effect should not unduly penalize the storage subsystem. In other words, the storage optimization technologies should function without interfering with the performance or scalability of the overall solution. This is one of the key differentiators for leading desktop virtualization-friendly storage solutions.

- **Cloning for quick duplication of desktop images.** As with server virtualization environments, one of the key requirements for desktop virtualization environments is the ability to use the storage system to quickly clone desktop images. One of the challenges businesses face with using internal storage or storage with no data services (such as JBOD arrays) is that the task of cloning images is time consuming and often adds administrative overhead. With storage-assisted cloning that is VDI friendly, this task is simpler and faster and, more importantly, does not penalize the storage system in the process. In a large desktop virtualization environment, this task can quickly become a fairly routine operation, so automation capabilities that are integrated with the hypervisor's management UI can add to the differentiating capabilities of the storage solution.
- **Integrated local and geographical data protection.** Most businesses are forced to reexamine how they protect or distribute key data components of the virtual desktop infrastructure. For example, desktop images may need to be backed up locally for fast restoration and replicated to another geographic location for disaster recovery. Similarly, to cater to the needs of a mobile workforce, businesses may need to serve certain desktop images locally from a different location. Storage-based data services need to be efficient to handle desktop images and enable quick and granular operational and disaster recovery capabilities.
- **Workload predictability.** The storage solution must be designed to handle a highly variable workload. As illustrated in Figure 1, the read/write ratio can change greatly from one operational phase to another over a short period of time. Furthermore, the steady-state phase of the workload is often characterized by a mix of random (small-block) and sequential (large-block) I/O operations, as shown in Figure 2.

FIGURE 1

Virtual Desktop Environment: Variance of Read/Write Operations over a 100-Minute Period

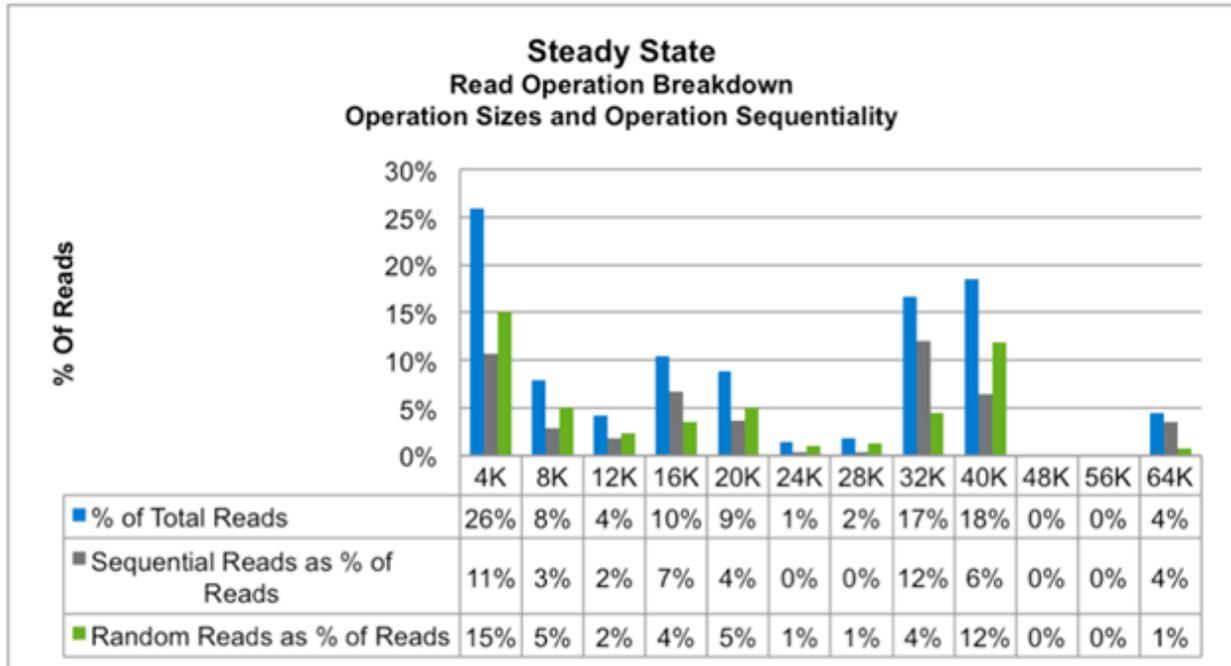


Note: The I/O composition and intensity of a virtual desktop workload can vary greatly over a short period of time as the workload moves from one operational phase to another.

Source: NetApp, 2012

FIGURE 2

Steady State: Read Operation Breakdown, Operation Sizes, and Operation Sequentiality



Note: Virtual desktop workloads can present a mix of random and sequential I/O during steady-state operations.

Source: NetApp, 2012

Opportunities

There have been major strides to simplify the architecture/design, deployment, management, and scalability of the hardware. This has come in the form of integrated infrastructure, which brings disparate systems such as compute, storage, and networking into a more easily managed platform. Integrated infrastructures are designed to be deployed quickly using a modular building-block approach to rapidly scale up resources and workloads. They are simpler to deploy and maintain while reducing processing and network overhead and latency, creating a more agile and valuable infrastructure to free up IT to focus on creating more business value rather than trying to keep the lights on.

Other key attributes of integrated infrastructure include:

- **Fast time to value.** Because compute, networking, and storage are all validated to work together and the vendors provide reference architectures for different workloads, rapid deployment and fewer professional services ensue.

- **Improved manageability.** The vendors certify that the different pieces work together, even giving a list of certified parts in case a customer wants to upgrade a part. In addition, since these systems are built in cooperation with best-of-breed products, the vendors are able to reduce overhead and streamline the design of these systems, which cannot be achieved with traditional hardware.
- **Reduced TCO.** These streamlined systems are also able to eliminate some cabling and physical hardware that are no longer needed, resulting in a reduced datacenter footprint. Add up the savings from the reduced footprint, improved manageability, and faster time to value, and it is clear that the total cost of ownership will be better than that for traditional hardware.

In addition, IDC has found that the cost of solid state drives (SSDs) has come down over the past few years. These SSDs are faster performing, can deliver higher IOPS, and are better suited for workloads such as VDI than traditional spinning disk storage.

SOLUTION

Citrix, NetApp, and Cisco Integrated Infrastructure Solution – FlexPod Datacenter with Citrix XenDesktop

As noted previously, IDC believes that a strong partnership between compute, networking, storage, and desktop virtualization vendors helps businesses realize the many benefits of desktop virtualization, including greater flexibility, low management overhead, increased security, and lower per-desktop costs.

In this light, Citrix, NetApp, and Cisco joined together to create an integrated system called FlexPod Datacenter with Citrix XenDesktop (see Figure 3). FlexPod is a highly efficient, robust, validated solution that integrates Cisco UCS[®] servers, Cisco Nexus[®] networking, and NetApp[®] storage with Citrix XenDesktop. The integrated approach taken by Citrix, NetApp, and Cisco to solve desktop virtualization challenges for the enterprise makes their solution a key differentiator in the industry. IDC believes Citrix, NetApp, and Cisco are well positioned to offer businesses a desktop virtualization solution that provides consistent, reliable scalability and performance at a competitive cost per desktop.

The level of integration these vendors have achieved to make their respective offerings (i.e., Citrix XenDesktop on Cisco[®] servers and NetApp arrays) interoperate with each other is one of the highest in the VDI industry. Further, Citrix XenDesktop can run on any of the major hypervisors today (VMware vSphere[®], Microsoft Hyper-V[™], or Citrix XenServer[®]) without any performance degradation. It offers businesses the assurance that no matter what hypervisor layer – the compute, storage, and desktop virtualization vendors will provide a cooperative support model, minimizing overhead.

Citrix XenDesktop with FlexCast[®] virtualizes both desktops and applications in one enterprise solution and supports virtual desktops, as well as hosted-shared desktops, remote/offline desktops, and streamed desktops, along with XenApp[®] functionality for applications. Citrix simplifies the complexity of delivering desktops and applications with Citrix Receiver[™], which runs on any endpoint device and enables access to the user's desktop, applications, and data. The vendors have fine-tuned these systems with rigorous testing to optimize XenDesktop. The payoff of this platform is in the ability to offer superior performance and scalability for desktop virtualization deployments. Businesses can

extend the benefits of FlexPod storage optimization, availability, and centralized management and data services to their virtual desktop environments to:

- Provision thousands of virtual desktops in minutes with nearly instant, low-overhead storage-cloning capabilities.
- Reduce XenDesktop storage costs by deduplicating redundant data stored across virtual desktops, user directories, and backup and disaster recovery copies.
- Provide users with continuous access to their virtual desktops with clustered Data ONTAP[®], automated disaster recovery, and VDI performance acceleration for each phase of desktop operations.
- Deploy a centralized storage platform that simplifies operations by supporting all content associated with whichever FlexCast delivery model is chosen.
- Ensure that the XenDesktop solution scales linearly from a few hundred to thousands of virtual desktops while maintaining per-desktop costs and without compromising provisioning, workload, and ongoing management resources.
- Protect virtual desktops and user data directly on the storage system while keeping a daily history of critical desktop data for months or years.

Key elements of the Cisco UCS solution that enable businesses to achieve these results are:

- **A platform that combines industry-standard x86 architecture servers with networking and storage access into a single unified system.** The system is entirely programmable using unified, model-based management to simplify and speed deployment of enterprise-class applications and services running in bare metal, virtualized, and cloud computing environments.
- **Service profiles – an extension of the virtual machine abstraction applied to physical servers.** The definition has been expanded to include elements of the environment that span the entire datacenter, encapsulating the server identity (LAN and SAN addressing, I/O configurations, firmware versions, boot order, network VLAN, physical port, and quality-of-service [QoS] policies) in logical "service profiles" that can be dynamically created and associated with any physical server in the system within minutes rather than hours or days.
- **Cisco UCS Manager, which provides unified, embedded management of all software and hardware components in the Cisco UCS solution.** These components include server, networking, and storage access resulting in improved operational efficiency, flexibility, visibility, and control.

Key elements of the Cisco Nexus solution that enable businesses to achieve these results are:

- High-performance, low-latency 10GbE delivered by a cut-through switching architecture for 10GbE server access in next-generation datacenters
- End-to-end FCoE (FCoE is an open standards-based protocol that encapsulates Fibre Channel over Ethernet, eliminating the need for separate switches, cabling, adapters, and transceivers for each class of traffic. This feature dramatically decreases power consumption and reduces both capital expenditures [capex] and operating expenses [opex] for businesses.
- Unified ports that support Ethernet, Fibre Channel, and FCoE
- Virtual machine-optimized services for higher asset utilization, simplified server connections, rapid server provisioning, security, and quality of service

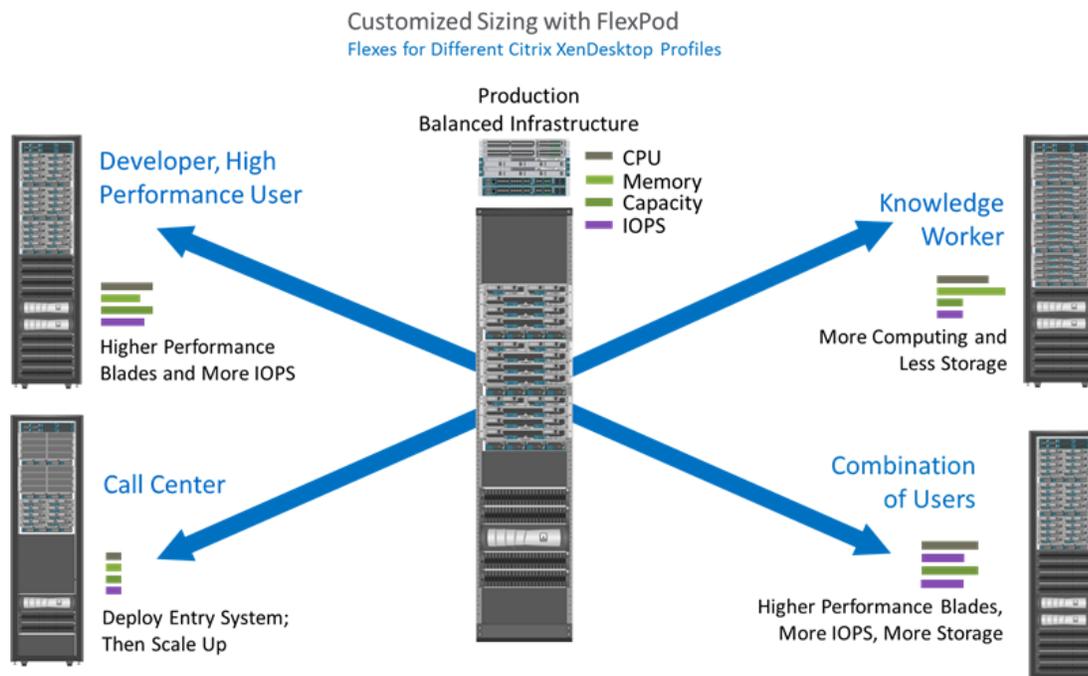
Key elements of the NetApp solution that enable businesses to achieve these results are:

- A multiprotocol stack with file- and block-based storage protocols that supports all desktop components: OS, applications, user data, and profiles
- Use of NetApp Virtual Storage Tier for optimized read performance (NetApp Flash Cache™, for example, allows boot images to be served from cache without rehydrating them from disk. This provides superior read performance during boot storms.)
- An architecture that optimizes performance during the write-intensive steady-state phase of desktop operations by quickly acknowledging random writes and collecting them in the storage controller and assembling them into more efficient, sequential writes to the disk subsystem
- NetApp Flash Pool™, which configures SSDs and HDDs – either performance disk drives or capacity disk drives – into a single aggregate or storage pool (The SSDs are then used to cache data for all volumes that are provisioned on the aggregate.)
- All-flash FAS (NetApp all-flash arrays are designed to deliver extreme IOPS and ultralow latency to drive greater speed, responsiveness, and value from the applications that control key business operations, including virtual desktop environments that require high IOPS per desktop.)
- Clustered architecture that allows storage capacity to be added on demand without disrupting usage

Citrix XenDesktop with FlexCast technology delivers virtualized desktops and apps in one enterprise solution that supports all types of use cases such as task workers, knowledge workers, and power users. FlexPod balances the infrastructure for XenDesktop use cases.

FIGURE 3

FlexPod Datacenter with Citrix XenDesktop



Source: Citrix, NetApp, and Cisco, 2014

CUSTOMER CASE STUDY

University of São Paulo

University of São Paulo, Brazil, was founded by the state in 1934. It is now the largest university in Latin America, with classes and faculties in all areas of science and over 100,000 students and 17,000 employees on 11 campuses in 9 cities. Because the university is located in an emerging but tumultuous market and is funded by the government, it is prone to many disruptions, including worker strikes. Even in these times, however, the university cannot afford any downtime.

The university provides virtual desktops and applications to nearly 3,500 students and employees using a combination of Citrix XenDesktop and XenApp. The university was able to leverage the FlexPod architecture to consolidate 150 geographically dispersed datacenters into 6 physical datacenters. Originally, the university deployed Citrix to a different hardware platform but ran into manageability and scalability issues. At this point, because it is a government institution, it had to publicly post a request for proposal (RFP) for new hardware solutions. The main criteria were as follows: The new solution needed to be able to be managed by a minimal team, have remote management capabilities, and be cost effective.

After reviewing all of the proposals, the university chose FlexPod because its service profiles allowed the university to manage the systems remotely, migrating applications from one blade to another without having to physically be at the datacenter. The efficiency of the FlexPod solution provides more processing power while using less energy in the same amount of space. The FlexPod solution has also reduced downtime and given the university the ability to dynamically scale storage, thanks to NetApp clustered Data ONTAP.

The university is in the process of standardizing on FlexPod running Citrix workloads along with other enterprise workloads like CRM, ERP, and databases. User provisioning is down to a matter of minutes, and the university is in the process of completely automating this activity. It is now running an agile and efficient private cloud made up of 34 FlexPod configurations, 576 servers, and 15PB of storage while reducing the number of datacenters from 150 to only 6.

CONCLUSION

Desktop virtualization is enabling businesses to move from PC-centric IT to data-centric and even cloud-centric IT. In the post-PC era of BYOD and BMYOD (bring and manage your own device), IT needs to shift from the PC-centric world of managing and protecting individual PC components, such as hard drives, to a datacenter model where corporate data is centrally stored, managed, and protected; users are given access to the relevant data using their own or assigned devices; and user data management can be centrally governed.

This is a big deal for CIOs as they try to transform their IT departments from device management outfits to service delivery organizations. However, deploying and managing complex systems like desktop virtualization require new and innovative validated designs that better integrate the software with the compute, networking, and storage. A desktop virtualization infrastructure with an agile,

scalable, and cost-effective solution, such as FlexPod Datacenter with Citrix XenDesktop, can help CIOs achieve this metamorphosis and provide a quick and measurable ROI because it offers:

- Rapid deployment
- Remote manageability
- Efficient use of hardware and IT resources

Any organization looking to deploy a desktop virtualization solution or upgrade its hardware infrastructure should take a look at an integrated infrastructure solution like FlexPod Datacenter with Citrix XenDesktop.

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