WHITE PAPER

Desktop Virtualization and Storage Solutions Evolve to Support Mobile Workers and Consumer Devices

Sponsored by: Citrix and NetApp

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EXECUTIVE SUMMARY

Desktop virtualization initiatives have become part of strategic discussions in most companies because of market trends such as the ever-increasing mobile workforce and the ever-growing swath of "bring your own device" (BYOD) users. Desktop virtualization is gaining attention and interest at the highest levels in organizations. IT and line-of-business leaders are investigating desktop virtualization because it can benefit both desktop operations and workforce productivity in the following ways:

- **Increase workforce flexibility.** IT can empower users with teleworking programs and mobile users with desktop images on their own devices.
- **Leverage the latest mobile device technologies.** By abstracting underlying end-user devices and focusing on the application, IT can offer users more flexibility by making productivity apps available on devices such as tablets, smartphones, and alternate PC platforms such as Mac OS X and Linux.
- **Adapt to business change.** IT can enable new branch expansion, offshoring, and merger and acquisition (M&A) initiatives with higher security and lower costs.
- **Enable new levels of mobility, security, and cost reduction.** By rethinking desktop computing, IT can morph from an asset-driven approach to a service-driven approach.

A prevalent approach to desktop virtualization is the centralized virtual desktop (CVD, aka VDI) — where the desktop OS is abstracted from the endpoint device and run as a virtual machine in the datacenter. While this approach centralizes and streamlines management, adoption has been a challenge because the technology is expensive to deploy. Using just this one model also limits flexibility, particularly as the workforce becomes increasingly mobile.

Flexible desktop virtualization solutions offer a very different value proposition as vendors realize that no single technology model can address an entire organization's needs. These solutions offer multiple delivery models to virtualize desktops and applications, with different models best suited for different use cases — all within a single solution suite. A good example is Citrix XenDesktop with FlexCast, which offers multiple delivery models to virtualize both desktops and application sessions.

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Storage remains the most complex component of the infrastructure necessary to support a virtual desktop deployment. Because addressing the needs for different user types adds complexity at the storage layer, desktop virtualization vendors such as Citrix were prudent to engage in partnerships with leading storage solution providers such as NetApp. Their efforts in leveraging the storage optimization, data management, and scalability capabilities of storage platforms are yielding benefits — such solutions are more nimble, flexible, and scalable. At the same time, they offer exceptionally low costs per desktop without sacrificing performance.

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 $2.4 billion in 2011, growing nearly 12% year over year. IDC sees the market growing to $3.5 billion through 2016, representing a five-year CAGR of 7.6%. It is important to note that the virtual client computing market is more than just CVDs. In 2011, CVDs accounted for only 25% of the 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.

In a recent study conducted by IDC, over 65.4% of respondents said they currently have virtual desktops, with an additional 25.4% expecting to deploy in the next year. Interest in and implementations of VDI are growing definitively, with only 8.6% of respondents saying they have no plans to deploy. Estimates put the total number of virtual desktop instances deployed in 2012 at over 14 million.

The rapidly changing virtualization landscape continues to have a significant impact on storage systems. In 2010, 41.8% of external storage systems capacity was attached to virtualized environments. IDC expects 2014 to be the crossover year in which more storage capacity will be shipped to virtualized environments than to nonvirtualized environments — a good chunk of this capacity will be for desktop virtualization infrastructures. This is because overhead-free storage optimization technologies as well as reduced component prices are making external storage systems more attractive for desktop virtualization environments. External storage systems provide high levels of resiliency, availability (up to 6-9s uptime), and data protection that their direct-attached counterparts cannot offer. IDC forecasts that by 2016, storage attached to virtualized x86 workloads will be 71.1% of external storage systems capacity.

MARKET ACCELERATORS

Storage solutions that support desktop virtualization environments have to be flexible in terms of interfaces and support the ultimate goal of keeping per-desktop costs low without compromising performance, availability, or scale. It is now possible to decrease the cost of desktop virtualization per desktop significantly to achieve a quick ROI; however, it requires that the appropriate infrastructure be deployed up front. Storage vendors are rapidly making their storage solutions scalable, cost-effective, and desktop virtualization friendly, working in partnership with desktop virtualization vendors such as Citrix and VMware to modify relevant features. It is important to note that not all storage architectures are automatically CVD friendly, and for several storage vendors, developing this support required a fairly significant effort. Two cases that illustrate such challenges are the ability to provide multiple data interfaces and the ability to deploy multiple storage optimization features concurrently in an effort to drive down costs.

Requirements for Desktop Virtualization

It is also important to note that not all desktop virtualization solutions are equal. Therefore, storage configurations also vary widely from one solution to another. What may work for one virtual desktop delivery model may not work for another. This underscores the need for tight partnerships between storage, networking, compute, and hypervisor vendors in an effort to crisply define what these configurations should look like and what requirements they are based on.

To understand 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. The selection of an appropriate desktop virtualization solution is an important decision that should factor in the use cases for buyers. 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.

End-User Requirements

The consumerization of IT and the rapid rise of BYOD are dramatically changing the dynamic between IT and end users. IT no longer has absolute control over an end user's environment like it used to. End users are demanding rapid response times from IT and an agile workplace to take advantage of the latest software. And if IT cannot support the end user, the end user will circumvent IT. This can be great for productivity but can also create a governance and compliance nightmare.

Desktop virtualization offers a solution that can provide users with the agility they demand and the compliance IT needs. Centralizing the management of desktops by virtualizing them also improves the speed and cadence to patch, update, and fix desktops. And providing virtual desktops and desktop applications to nearly any device, anywhere, anytime through a secure, encrypted container enables end users to choose which devices they want to use and IT to enforce governance.

Simplified IT Administration

CIOs everywhere are pushing IT departments to offer a solution to overcome limited workplace flexibility and securely offer mobility, including access to corporate assets on user-owned devices. They are demanding an alternative to the distributed asset-centric mindset that is a drag on IT productivity. For example, an ongoing but ever-shrinking asset refresh cycle with limited gains; a siloed delivery of desktops, apps, and data; and changes that take days to minimize downtime work against productivity.

Thus, the desktop virtualization solution should provide an alternative without breaking the bank. A key consideration is to rightsize the infrastructure. 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 poor user experience, which means IT is back to square one with the old model.

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. From a storage perspective, this means that the solutions need to have the following characteristics:

- **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.

- **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 on how 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. 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.

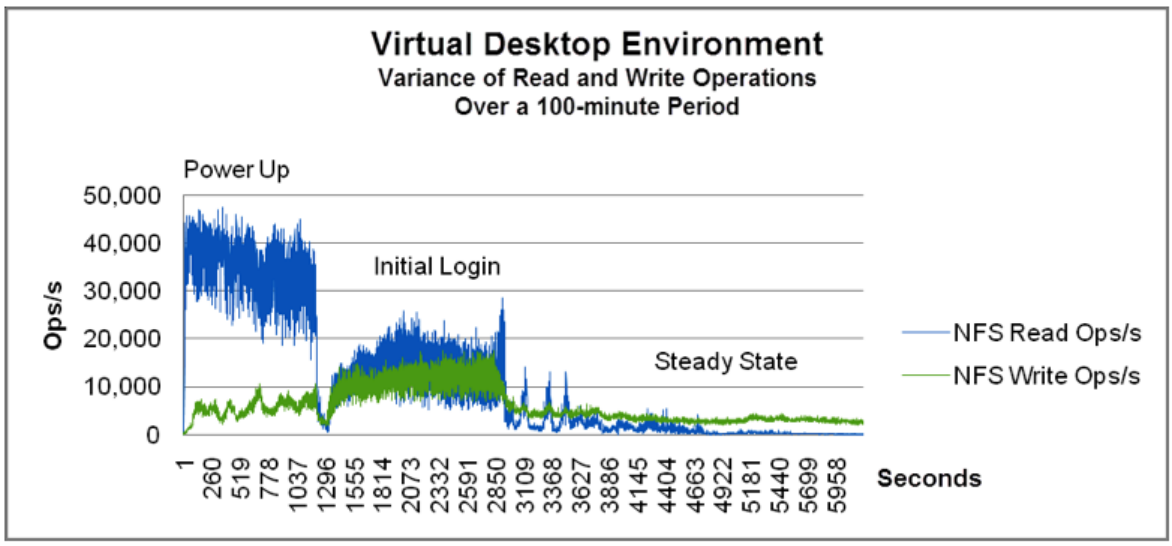
- **Cloning for quick duplication of desktop images.** As with server virtualization environments, one of the key requirements for desktop virtualization environments is the ability to use the storage system to quickly clone desktop images. One of the challenges businesses face with using internal storage 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 Figure 1 illustrates, 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) IO operations, as shown in Figure 2.

FIGURE 1

Virtual Desktop Environment: Variance of Read and Write Operations Over a 100-Minute Period

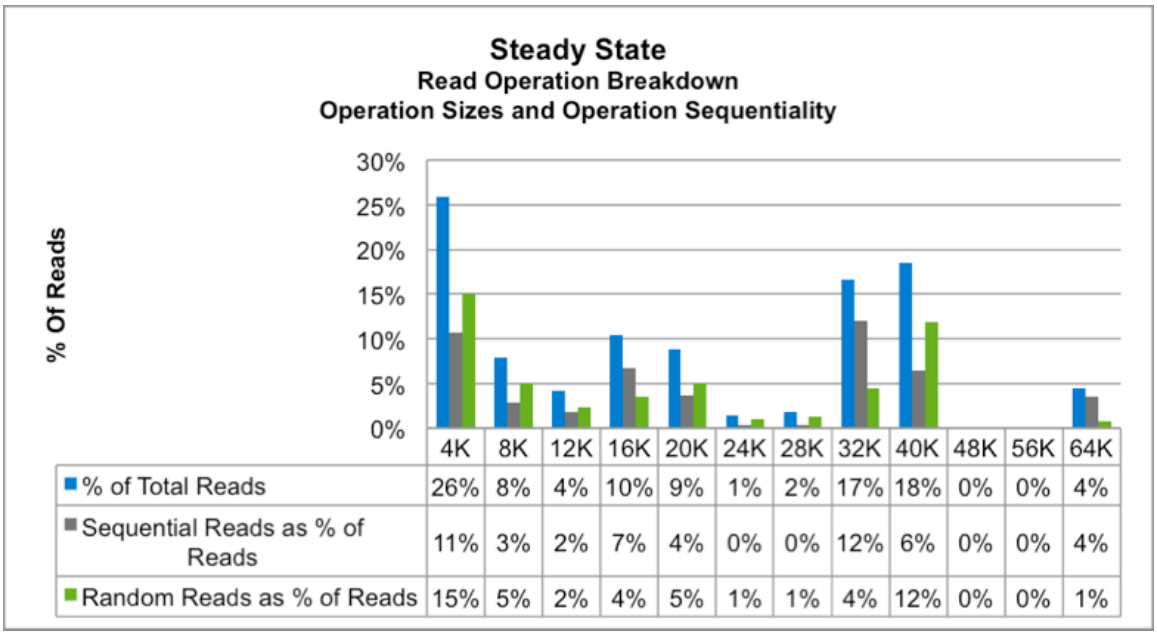


Note: The IO composition and intensity of a virtual desktop workload can vary greatly over a short period of time as it moves from one operational phase to another.

Source: NetApp, 2012

FIGURE 2

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



	4K	8K	12K	16K	20K	24K	28K	32K	40K	48K	56K	64K
% of Total Reads	26%	8%	4%	10%	9%	1%	2%	17%	18%	0%	0%	4%
Sequential Reads as % of Reads	11%	3%	2%	7%	4%	0%	0%	12%	6%	0%	0%	4%
Random Reads as % of Reads	15%	5%	2%	4%	5%	1%	1%	4%	12%	0%	0%	1%

Note: Virtual desktop workloads can present a mix of random and sequential IO during steady state operations.

Source: NetApp, 2012

THE CITRIX/NETAPP DESKTOP VIRTUALIZATION SOLUTION

While the infrastructure and virtualization industry is busy developing solutions for the next wave of virtualization, storage and VDI vendors that have been integrating each other's solutions are moving ahead of the competition in their respective market segments. With performance in the compute layer predictably following Moore's law, the focus is increasingly shifting to partnerships between storage and desktop virtualization vendors. As noted previously, IDC believes that a strong partnership between storage and desktop virtualization vendors helps businesses realize the many benefits of desktop virtualization, including greater flexibility, low management overhead, and lower per-desktop costs.

The integrated approach taken by Citrix and NetApp to solving desktop virtualization challenges for the enterprise makes their solution a key differentiator in the industry. IDC believes Citrix and NetApp are uniquely positioned to offer businesses a desktop virtualization solution that provides consistent, reliable scalability and performance at a competitive cost per desktop.

So what makes the Citrix/NetApp solution stand out? For starters, the level of integration these vendors have achieved to make their respective offerings (i.e., Citrix XenDesktop on NetApp arrays) interoperate with each other is one of the highest in the VDI and storage industries, respectively. Second, 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 the compute or hypervisor layer, the storage and desktop virtualization vendors provide a converged support model, minimizing overhead. Citrix XenDesktop provides a complete solution for virtual apps and desktops. Central to Citrix's strategy is the Citrix FlexCast technology, which gives customers the ability to deliver applications and desktops using different technologies to ensure the best user experience with a single XenDesktop license. XenDesktop includes FlexCast technologies for centralized virtual desktops, shared hosted apps and desktops via XenApp, and distributed virtual desktops via XenClient. Citrix simplifies the complexity of delivering desktops and applications with Citrix Receiver, which acts as a gateway to the user's desktop, applications, and data. Additionally, the Citrix portfolio includes VDI-in-a-Box, a VDI software appliance for small and medium-sized businesses (SMBs) and branch offices that combines affordability with deployment and operational simplicity by providing high availability with patent-pending server grid technology using direct-attached storage.

Citrix XenDesktop 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. NetApp has dedicated countless engineering hours to optimizing Data ONTAP for use with solutions such as XenDesktop. The payoff is in the ability of this platform to offer superior performance and scalability for desktop virtualization deployments. Businesses can extend the benefits of NetApp's storage optimization, availability, and centralized management and data services to their virtual desktop environments:

- 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 overhead.

- Protect virtual desktops and user data directly on the storage system while keeping a daily history of critical desktop data for months or years.
- Leverage NetApp's partnerships with leading hypervisor vendors such as VMware, Microsoft, and Citrix to ensure that no matter which hypervisor the VDI solution piggybacks on, the overall solution remains flexible, highly available, and cost-effective.

Key elements of NetApp's Data ONTAP 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 Tiering 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, collecting them in the storage controller, and assembling them into more efficient, sequential writes to the disk subsystem.

CUSTOMER CASE STUDIES

University of Tennessee, Knoxville

The University of Tennessee, Knoxville (UTK) is the biggest land grant institution in Tennessee, with nearly 30,000 students in attendance every year. At UTK, the Office of Information Technology has taken on the main role of organizing technology, such as bringing new services to students. UTK has made major investments in upgrading its wired and wireless infrastructure. Thus, as more students enter the university with their own devices, rather than equip each student with specialized software, the university relies on a desktop virtualization infrastructure from Citrix and NetApp to publish a suite of applications.

UTK's virtual desktop infrastructure is built on Cisco-NetApp FlexPods, XenApp, and XenDesktop. It uses PVS to deliver images to XenDesktop and XenApp environments and uses Active Directory from an authentication and authorization perspective. UTK opted for the Citrix solution because it offers multiplatform support versus solutions from competitors that offer limited platform support. UTK is extremely satisfied with the performance of the solution. The flexibility and customizability of XenApp allow UTK to make the solution work for its unique needs. Today, UTK can customize almost every program thanks to how it deploys home directories and file redirection, and it expects to tap into the full capabilities of the suite with XenDesktop.

Combis

Combis is a systems integrator — the largest in Croatia and one of the largest in the Adriatic region, according to IDC reports. It has approximately 350 employees and boasts an annual turnover of about 60–65 million euros. It has a presence in all industries and caters to businesses of all sizes. Because of the economic situation in Europe, Combis has found that businesses are hesitant to invest and are looking for more savings as and when they invest. In its own research, Combis has found that technologies from NetApp and Citrix fit nicely into the deployment of VDI as a solution in several specific business cases for its clients.

For example, many of Combis' banking clients leverage a NetApp/Citrix VDI solution for front desk or branch offices for banking clerks. Many of its telecom clients leverage XenDesktop to provide VDI or public cloud services. The ability to securely deploy Windows desktop to remote offices is appealing to businesses that subscribe to such services.

There are two major reasons that Combis likes using NetApp when deploying virtual desktop solutions: Flash Cache and integrated backup and restore functionality. Flash Cache is a cost-effective way for Combis to deploy and serve a gold virtual desktop image from the cloud to any organization. The integrated backup and restore functionality allows Combis to provide self-service functionality. XenDesktop and XenApp technologies complement NetApp storage system capabilities.

CHALLENGES/OPPORTUNITIES

Unlike other storage vendors that stop at providing recommended guidelines for deploying their storage solutions for desktop virtualization, NetApp has gone ahead and partnered with all leading hypervisor vendors to integrate CVD solutions on their platforms. And while NetApp may not have direct control over how the solution is eventually deployed, it has gone to great lengths to educate its buyer base on the appropriate ways to deploy CVD on its solutions. NetApp and Citrix continue to work closely to develop and publish detailed deployment guides. NetApp also has enabled its users with sizing tools to recommend storage system configurations for the capacity and performance requirements of a given XenDesktop workload. With the FlexPod (Cisco/NetApp) platform, NetApp can go further with Cisco Validated Designs detailing not only storage but also compute and network configurations for the workload.

Similarly, too many times, hypervisor vendors only suggest best practices for the storage tier and leave the integration to the enterprise. This can result in mixed results. Citrix, to its credit, not only has certified its XenDesktop platform with leading providers such as NetApp but also has maintained flexibility by jointly certifying it with other hypervisor platforms in addition to its own XenServer platform.

As both NetApp and Citrix focus on jointly taking their solution to market, they will need to continue to strengthen brand recognition in each other's IT demographic. NetApp, for its part, will need to build awareness of its blueprints for the Citrix platforms on any server platform in addition to their integrated offerings such as

FlexPod. On the other hand, Citrix will need to educate its own customers, many of which may not be familiar with the NetApp value proposition. Both Citrix and NetApp should take this opportunity to start enterprises on the journey to offering desktop as a service to their users.

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 asset management outfits to service delivery organizations. A desktop virtualization infrastructure with an agile, scalable, and cost-effective storage solution helps CIOs achieve this metamorphosis and provides low and measurable ROI.