



# WHITE PAPER

## **Desktop Virtualization Efficiencies with Citrix and NetApp**

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## Executive Summary

Deploying desktop virtualization challenges IT infrastructure requirements—both storage and servers. Any efficiency and TCO gains from centralization can quickly be wiped out by the costs of supporting desktop virtualization initiatives. Citrix XenDesktop and NetApp storage systems provide an optimal combination of operating system image management, operating system and application virtualization, and storage management solutions to minimize the impact on IT infrastructure and deliver on the promise of a more efficient, secure, and easier to manage desktop environment.

It is essential that customers choose the right desktop virtualization solution and storage strategy to match user requirements, whether a shared desktop environment for task workers or customized work environments for office workers. Storage management technologies from NetApp, such as data deduplication, thin provisioning, and business continuity solutions, complement Citrix's desktop delivery components. Citrix delivers unique value with its virtual desktop provisioning capabilities and dynamic desktop assembly to optimize the deployment and management of a next generation VDI solution, while NetApp maintains the chain of efficiency with highly optimized storage management solutions.

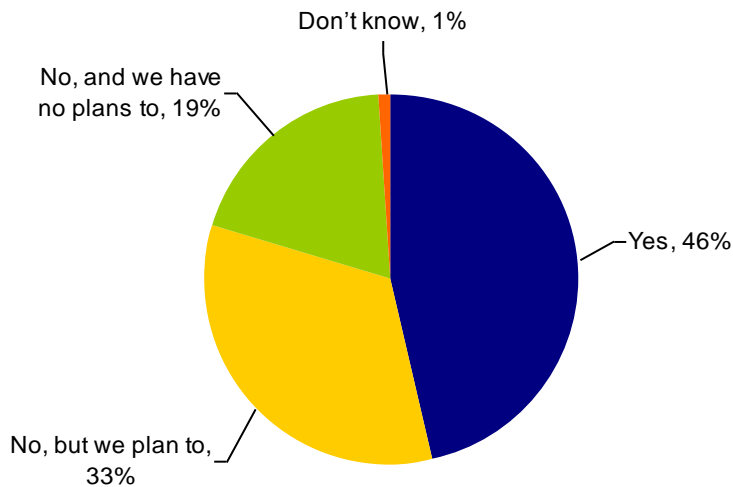
## Virtualization is Sweeping Through the Data Center

The mass adoption of virtualization is one of the biggest data center transformation initiatives to hit the IT world in years. It is sweeping its way across companies and receiving rave reviews. Once its initial benefits are recognized, IT is anxious to continue virtualization initiatives throughout the entire IT landscape. Server virtualization is experiencing the first wave of success as companies look to consolidate, improve resource utilization, and enable disaster recovery solutions for the server and application infrastructure. Server virtualization has already proven to reduce capital costs, lower IT operational costs, and introduce broad improvement in overall IT efficiency of production applications.

While it is true that some organizations may opt to limit the use of server virtualization to test and development environments in order to learn how to operate the technology without any risk to mission-critical business applications and data, a recent ESG Research Report has already revealed that 81% of current adopters are using server virtualization in production environments to some extent. What's more, many users surveyed by ESG appear to be increasingly comfortable with the use of virtual machines for their most demanding application environments as almost half (46%) currently run "tier 1" applications on virtual machines and 33% plan to do so in the future (see Figure 1).

**FIGURE 1. TIER 1 APPLICATION USAGE ON VIRTUAL MACHINES**

**Would you say that your organization currently runs "tier 1" applications on virtual machines? (Percent of respondents, N = 365)**



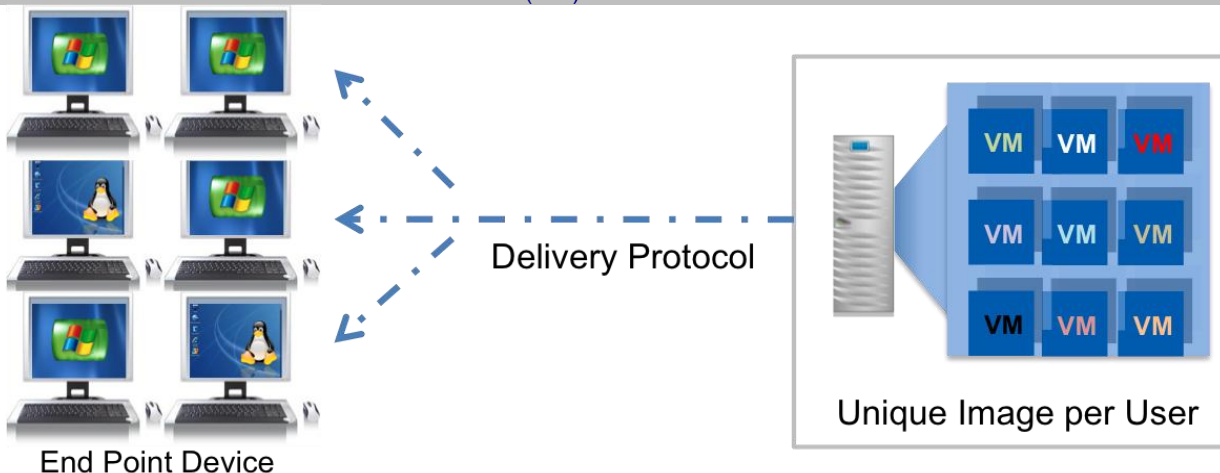
*Source: Enterprise Strategy Group, 2007*

Due to the successful results associated with server virtualization, the next wave of virtualization adoption is poised to target the desktop operating environment. As successful as server virtualization has been, the opportunity for desktop virtualization is exponentially greater. Thousands, and potentially tens of thousands, of desktops connect to hundreds of servers and many of the same benefits of server virtualization can be applied to the mass of desktop operating environments spread throughout organizations.

Virtual Desktop Infrastructure (VDI), also known as Desktop Virtualization or Client Virtualization, is an emerging technology solution in which an end-user's entire desktop environment—including the operating system, applications, storage, and user preferences—is hosted in a central data center and accessed remotely by the

user. In a VDI solution, a hypervisor-based virtualization layer enables a single physical server to host many concurrently-available end-user desktop environments, as shown in Figure 2.

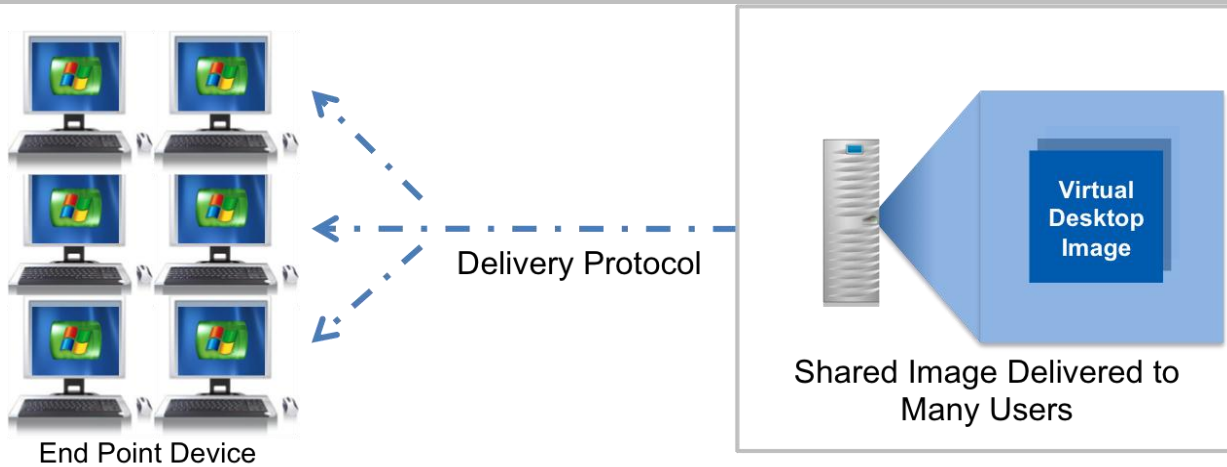
**FIGURE 2. VIRTUAL DESKTOP INFRASTRUCTURE (VDI)**



Source: Enterprise Strategy Group, 2008

An alternative method of deployment is shared desktops, in which multiple users share the same desktop environment, as shown in Figure 3. A single, centrally stored and maintained image is accessed by many users. Customers may choose to deploy this method if subsets of users require identical operating environments to perform their daily tasks. One image serves the needs of many users, enabling administrators to simply manage a single image rather than multiple unique operating environments.

**FIGURE 3. SHARED IMAGE TO MANY USERS**



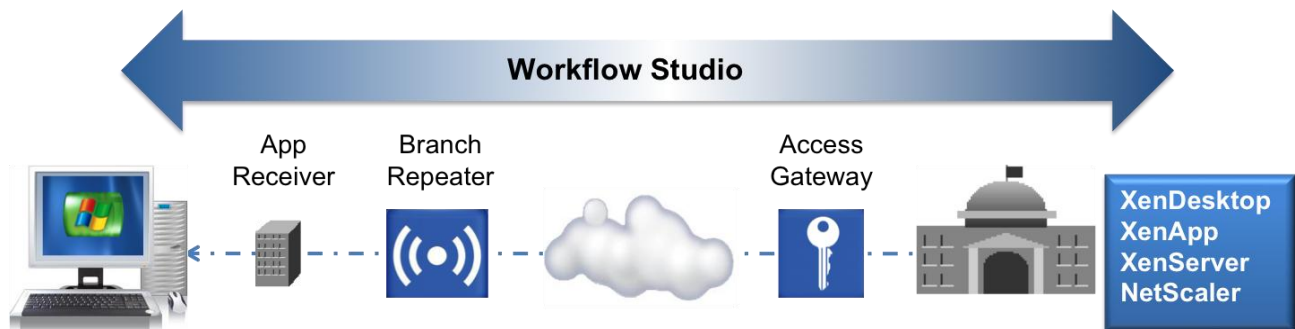
Source: Enterprise Strategy Group, 2008

Virtualizing the desktop involves multiple pieces of technology working in harmony to provide a robust solution that has the stability, performance, and achievable cost model to be adopted throughout the organization. However, one weak link can quickly break the chain of efficiency and risk the success of the entire implementation. Citrix and NetApp are working together to maximize the available networked storage infrastructure and deliver a cost effective, stable platform that surpasses end-user expectations and leverages available IT resources to the fullest.

## Citrix Delivery Center Optimizes VDI

Citrix XenDesktop is one of the core components of the Citrix Delivery Center product family. As shown in Figure 4, the Citrix Delivery Center product family is a set of solutions that blends individual products into an end-to-end virtualization architecture focused on application delivery. The vision here is to turn static data centers into more dynamic “delivery centers” that enable advanced business value and an enhanced end-user experience. Citrix Delivery Center can improve IT operations while providing a dynamic architecture to meet real-time business needs.

**FIGURE 4. CITRIX DELIVERY CENTER**



*Source: Enterprise Strategy Group, 2008*

The Citrix virtualization vision extends beyond server consolidation in order to apply virtualization value to applications, business processes, and the desktop environment. Citrix Delivery Center encompasses endpoints, data center servers, and the networks that bridge them. With all of these options, large organizations can customize their virtualization strategy based upon their physical assets, user locations, security requirements, and operational objectives. Taken as a whole, the Citrix Delivery Center can be tuned to meet all types of business and application needs.

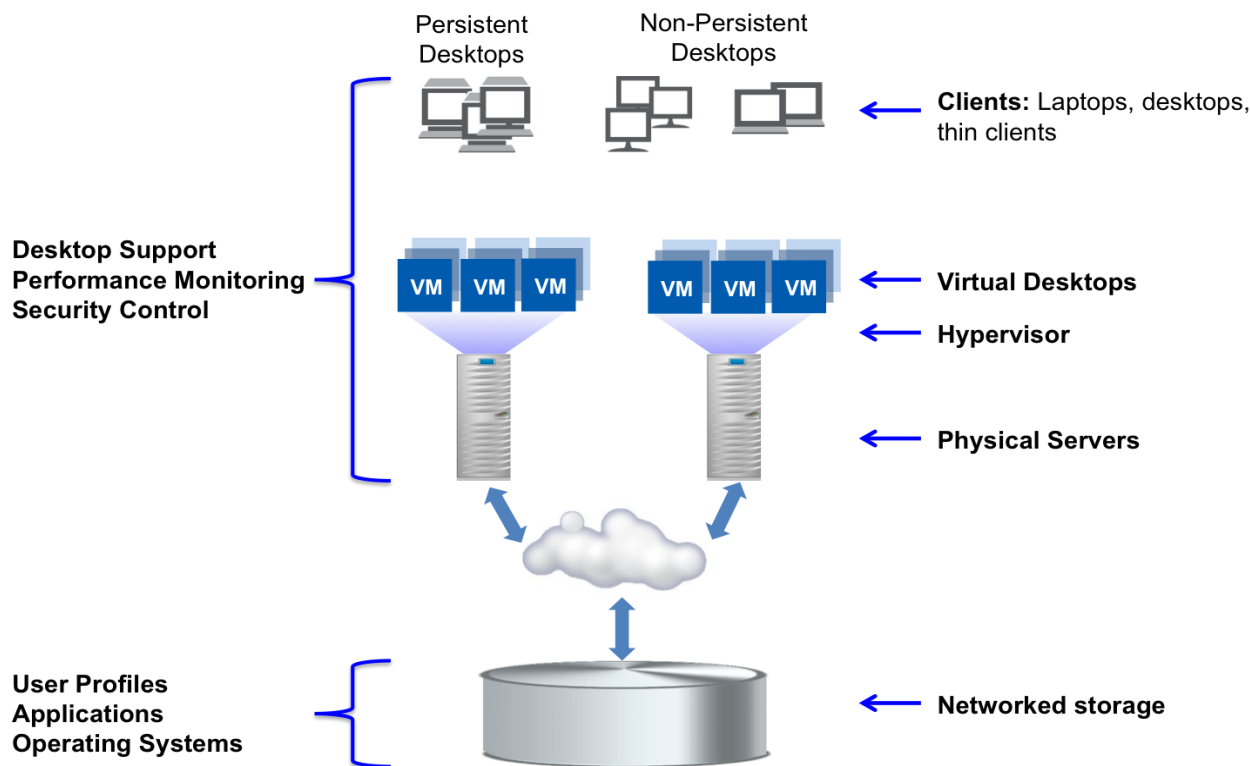
End-user desktops are some of the most challenging assets to manage and control in an IT environment. VDI helps companies regain control of the desktop with these additional benefits:

- **Simplified management and control.** Patching, updating, and troubleshooting operations are greatly simplified with VDI since all the images are stored in a central location. A single patch can quickly be applied to the entire pool of VDI images. IT administrators can also quickly clone a desktop image and perform troubleshooting techniques while the end-user remains productive.
- **Improved security and compliance.** Storing and managing desktop images from a central location enables IT to easily apply best practices for security and compliance to the entire pool of desktop images. Before VDI, IT requested that users leave their PCs powered on at night for maintenance. Some industry studies reveal that it may cost up to \$1.5 billion to keep PCs powered on a 7 by 24 basis in the U.S. alone. Aside from unnecessary power consumption, this led to imprudent security practices and difficult reporting for compliance purposes.
- **Reduced costs.** IT operations in a VDI environment can significantly streamline management and help control desktop costs by enabling end-user self service portals, performing backups from a central location, and contributing to improved end-user uptime and application availability. Thin client endpoint devices in a VDI environment also typically consume less power and have longer life spans.

Along with the benefits of VDI comes an investment in architecture to provision, store, manage, and deliver desktop images on a massive scale. Figure 4 shows an example of a VDI architecture and all of its many moving

pieces. The figure clearly shows the potential complexity of the VDI architecture and emphasizes the importance of maintaining the benefits of virtualization throughout the entire infrastructure stack.

**FIGURE 5. VDI ARCHITECTURE**



Source: Enterprise Strategy Group, 2008

Figure 4 also shows how the entire VDI environment relies on the networked storage infrastructure. Operating systems, applications, and user data are all stored on networked storage—as opposed to the traditional relatively inexpensive disks spinning inside desktops and laptops. The shift from internal to networked storage at the endpoint device is an important transition that requires careful consideration. Deploying hundreds, thousands, and even tens of thousands of virtual desktop images will have a significant impact on networked storage. Citrix and NetApp have solutions that make efficient use of the investment in networked storage capacity and hypervisor server resources while maintaining performance, reliability, and manageability.

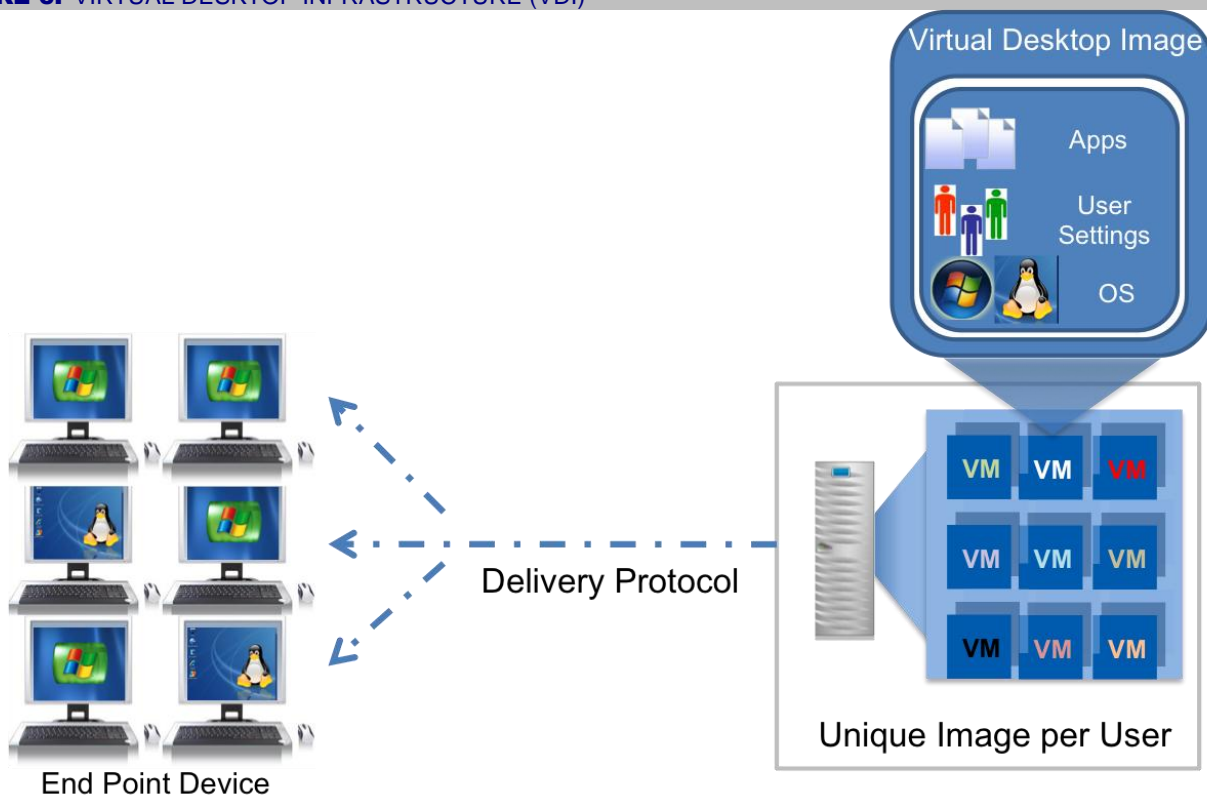
## VDI Efficiencies with Citrix

Desktop virtualization is not a one-size-fits-all proposition. There are different paths to take that will depend largely on the task of the end-user. Each member of the workforce plays a different role and requires access to different applications. Some end-users require a highly customized and personalized workspace, while, for example, call center or customer support departments may only need access to a small set of applications to perform their job responsibilities—the operating system has no real impact on their productivity. Some users need the same environment every time they log on and some employees can fully perform their individual job function with a bare bones, locked down operating environment. The key take away is that there are numerous deployment scenarios and the most efficient desktop virtualization technology must be applied to the individual user type—whether via VDI, shared desktops, or streamed OS solutions.

VDI is one of the options customers can choose as they embark upon their desktop virtualization initiatives. In the VDI scenario, there are two distinct image management strategies. Each has unique advantages and disadvantages that must be carefully considered:

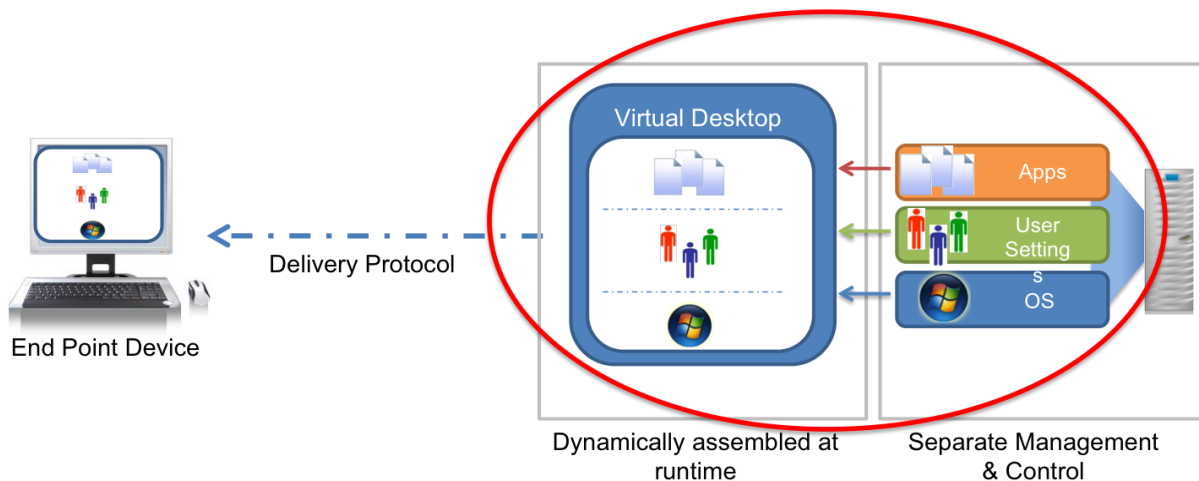
**One Image per User:** As shown in Figure 6, each user has a dedicated virtual desktop image that includes a unique operating system, applications, and user data. The images are centrally stored, managed, and secured. End-users access their personalized images from a variety of endpoint devices, including desktops, laptops, thin clients, and even mobile devices in some cases. The important point is that each image has to be individually managed, patched, upgraded, backed up, and secured. End-users that require a highly customized operating environment and make modifications to the operating systems on a regular basis will require this type of deployment scenario.

**FIGURE 6. VIRTUAL DESKTOP INFRASTRUCTURE (VDI)**



*Source: Enterprise Strategy Group, 2008*

**Shared Image across many users:** Due to the common data shared between multiple operating environments, it's feasible to consider separating the operating system, applications, and user settings as shown in Figure 7. In this use case, a single operating system image is shared and provisioned for many users, instantaneously delivering management, infrastructure overhead, and storage capacity efficiencies. Individual users leverage a common image, log on to receive personalized user settings—such as desktop images, icon placement, and network drive mappings—and applications are either streamed or presented to the virtual machine, stored centrally for security and manageability purposes. This method of deployment lends itself to improved flexibility, simplified maintenance, and significant VDI infrastructure efficiencies. The OS image is streamed—essentially broadcasted—to all the virtual desktops on demand, leveraging the high speed networking infrastructure in the data center to provide a faster boot time and more responsive system than with SATA connected hard-drives on traditional PCs. Pools of standard imaged VMs allow for an “instant-on” experience while enabling green computing as all unused VMs outside of the pool are powered off. Most importantly, the desktop provisioning approach makes it simple to update the standard image. The single image is taken offline, updated, and put back online. Any VM subsequently powered on will simply boot to the newly updated image.

**FIGURE 7. OPERATING SYSTEM, APPLICATION, AND USER SETTINGS SEPARATION**

Source: Enterprise Strategy Group, 2008

Citrix Delivery Center has the ability to meet both deployment methods to match the individual requirements and tasks of the end-user. Citrix XenDesktop is specifically designed to deliver highly customized and personalized desktop images as well as standard shared images—all while keeping the best end-user experience in mind.

Much in the same way server virtualization and Citrix XenServer have had a significant impact on the underlying networked storage infrastructure, Citrix XenDesktop deployments have the potential for a far greater impact on the networked storage infrastructure. Storing primary and secondary copies of virtual desktop images, regardless of the deployment method, will take up considerable capacity, demand superior performance, and remain highly available. NetApp networked storage systems have key features that are able to extend the value of VDI into the underlying networked storage infrastructure.

## VDI Efficiencies with NetApp

As previously mentioned, the first efficiency gained is Citrix's ability to deploy the most optimal desktop virtualization solution for the user type. Second, applications are separated from desktop OS. Third, Citrix utilizes a single operating system image for multiple users. With scalability being a major concern in VDI deployments, Citrix vastly improves efficiencies by not requiring a unique individual OS image for each user. These are the first steps in maximizing VDI efficiency. By leveraging efficient storage management technologies, the storage impact of all the other elements of the VDI solution, including user file storage, user profiles, etc., can be optimized. Also, some users cannot be served by single image provisioning, requiring strategies on the storage side.

### Virtual Desktop Image Deduplication

If a company chooses to deploy unique virtual desktop images for each individual user, it must consider the amazing amount of duplicate data between the images. For example, an image running a Windows XP operating system has arguably 100% the same data as any other image running Microsoft Office productivity applications. The amount of duplicate data is staggering and, when combined with backup and replicated copies of the virtual machine images for business continuity and disaster recovery purposes, the sheer amount of capacity consumption can quickly turn the TCO calculation upside down.

NetApp storage systems offer a cost effective approach to deduplicating virtual desktop images—storing only unique data. NetApp estimates that VDI deployments will use up to 50% less storage than traditional storage

systems, which results in instant savings. IT can now confidently deploy individual images to end-users and efficiently store the individual images at massive scale.

## Thin Provisioning

Capacity utilization is another major concern when deploying VDI. Desktops are dynamic environments that constantly change on an hourly basis. Planning for the best use of capacity can be a burden for any IT department as VDI still has some unknown variables to be discovered. NetApp FlexVol enables the storage of virtual desktop images on a thin provisioned volume that can dynamically expand as the VDI deployment scales. Thin provisioning is an excellent example of how the benefits of virtualization extend throughout the data center and should be considered at all layers. NetApp FlexVol has the potential to drive higher utilization rates without affecting performance, stability, and reliability.

## Storage Services Adapter

Provisioning and managing storage at the rapid pace VDI demands can be a burdensome task that consumes valuable IT time. Citrix and NetApp have developed “one-click” storage integration for server administrators. The NetApp adaptor plugs into the Citrix XenCenter management suite and enables the management of thin provisioning, snapshots, cloning, data deduplication, backup, and recovery. This integration saves valuable time, empowers the server and desktop administrators, and simplifies the deployment and management of the networked storage infrastructure.

## Business Continuity

A great advantage of deploying a VDI solution is the ability to consistently back up and instantaneously recover virtual desktop images. In the physical world, this was a difficult task that often resulted in extended end-user downtime and loss of productivity. In today's virtual environment, virtual desktop images can be backed up on a regular basis and quickly recovered in the event of data corruption, application incompatibility, or a rogue virus. NetApp storage systems require no additional load on the VDI servers to provide a space efficient full backup of the virtual desktop image. IT administrators can maintain a daily history on disk and even choose to store that disk image on immutable (WORM) storage.

## Disaster Recovery

Careful disaster recovery (DR) planning is a must have in a VDI deployment. Now that end-user productivity relies heavily on the availability of the infrastructure, the entire operating environment has to remain available—even in the event of a local site failure. NetApp storage systems have the ability to replicate data to a remote site for DR purposes. The desktop images are always available on a secondary site should the primary site experience a failure.

## Common Storage Pool

VDI implementations are often part of a large data center consolidation and/or virtualization initiative. An overarching goal is to make efficient use of all resources and enable a data center that can instantaneously respond to change based on business policy. One of the best ways to achieve this is to leverage a single common pool of storage. NetApp's unified storage enables virtual desktops, virtual servers, applications, and user data to all utilize a commonly managed storage pool that can expand data across multiple sites. NetApp enables users to best match protocols with design criteria. CIFS and NFS can be used for user data while iSCSI and Fibre Channel can be utilized for the backend Citrix XenServer, XenDesktop, and Citrix XenApp (the new name for Presentation Server) deployments. It's a one-size-fits-all deployment choice.

# VDI Implementation Considerations

VDI solutions have some very attractive benefits that, when carefully deployed, can make great strides across the entire business. It's imperative that when making IT infrastructure decisions, the end-user experience is always a top priority. Without maintaining and improving the end-user experience, VDI implementations will fail. There are multiple cost variables to consider when deploying VDI that include the VDI solution as well as the networked storage infrastructure. The right choice of desktop virtualization solution, including VM-based VDI and shared desktop solutions, is imperative. Deploying a separate application virtualization infrastructure minimizes image complexity and the impact on virtualization infrastructure. A single desktop image drastically reduces the storage impact of VDI solutions and makes it much easier to maintain.

Networked storage will be a part of most, if not all, VDI production deployments and the decision a company makes will impact the end result in terms of management, performance, and cost. Regardless of the VDI deployment method, it's important to consider the impact VDI will have on capacity and how the storage system can help maintain efficient capacity utilization with technologies like data deduplication and thin provisioning. The storage system also has to be ready to scale with the adoption of VDI as it moves from evaluating to piloting and into production.

VDI has multiple deployment strategies to match the different types of workers. Regardless of the deployment strategy, the VDI has to be ready to respond and deliver a superior user experience. End to end consideration of the entire desktop delivery infrastructure will ensure that IT administrators can efficiently provision, manage, support, and optimize the entire stack of technology required to run and maintain a robust VDI ecosystem.

## Conclusion

It is unrealistic to think that VDI will replace 100% of current end-user environments, but it is feasible to see it have widespread adoption across all industries and markets. VDI is in its early adopter stage and there is significant progress to come. Businesses are trying to determine which VDI solution to hang their hats on while IT technology vendors jockey for position. The ultimate winner is the IT department that recognizes the benefits of VDI early on and can begin deployments on a highly optimized infrastructure.

Existing Citrix XenApp customers have the unique opportunity to further consider how they can extend its benefits into a VDI deployment with Citrix XenDesktop. Since these customers are already using client virtualization solutions, they understand the benefits of centrally hosted and streaming applications. Citrix XenDesktop has the ability to extend the benefits of client virtualization and efficiently deliver a centrally managed and secured personalized desktop environment.

NetApp's networked storage systems further extend the value and efficiencies of VDI deployments into the underlying storage infrastructure. VDI deployments rely heavily on networked storage and NetApp's robust set of features nicely complement such environments. NetApp helps customers significantly reduce virtual desktop storage, quickly provision desktops, maintain continuous access to desktop images, and ensure compliance of desktop data.

Tight integration and consideration of networked storage efficiencies have the ability to deliver a VDI infrastructure that can adapt to the needs of the business while carefully considering the costs of the overall deployment. IT can regain control of the desktop environment, manage images from a central location, and still deliver a personalized environment to the end-user. The Citrix Delivery Center product family, combined with NetApp networked storage solutions, has the capability to deliver a hard-hitting win for VDI deployments.



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