

THE POWER OF CLIENT VIRTUALIZATION

Desktop and application virtualization deliver operating efficiencies and improved security while providing users with the mobile capabilities they need.

EXECUTIVE SUMMARY

Client virtualization technologies are redefining the way IT resources are delivered to end users, and creating exciting new opportunities for IT organizations as they work to streamline and improve operations. By abstracting applications and operating systems from client hardware, virtualization enables client assets to be stored on central servers and delivered to client endpoints.

The implications are profound. End users can log on to any network-connected computing device and access their custom operating system and application environment. For IT departments, central management of client virtual machine (VM) images brings efficiencies in everything from routine maintenance and updating to operating system upgrades.

In addition, client virtualization has emerged as a compelling solution for tablets and smartphones, especially in bring-your-own-device (BYOD) scenarios that can pose significant management challenges. App virtualization can deliver existing desktop applications to mobile endpoints, eliminating the need to write and maintain expensive mobile apps. What's more, virtualized apps don't have to store or cache data on a mobile device. When a virtual session is finished, the app and its sensitive information cease to reside on the mobile device — a huge benefit for enterprises concerned about lost or stolen devices.

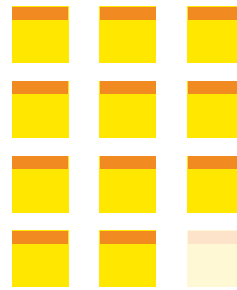
Client virtualization does pose challenges to IT organizations, which must contend with new service models as they move from traditional client-server management. Also, investments in server, storage and network infrastructure are necessary to ensure an effective environment.

What Is Client Virtualization?

Over the past 10 years, few technologies have revolutionized IT and computing the way virtualization has. IT tasks and workflows that once required physical, one-to-one interaction with servers and systems are now broadly automated and orchestrated across virtualized systems. The result has been a fundamental rethinking of IT architectures and workflows that has enabled major advances in scale, efficiency and responsiveness.

A similar, if quieter, revolution is taking place at the client level, as IT teams oversee an increasingly diverse, mobile and unmanaged universe of client PCs, tablets and smartphones. Virtualization solutions from vendors such as VMware, Citrix and Microsoft offer new ways to deliver rich client applications and environments to endpoints beyond the traditional boundaries of enterprise networks. By serving these assets from centrally managed, server-based images, client virtualization solutions provide uniquely secure, efficient and manageable delivery of applications and environments to end users.

The compelling benefits of client virtualization are driving growth in the sector, according to [a Research and Markets report](#).



<12 months

The estimated time needed to achieve a full return on investment in centralized virtual desktops*

Worldwide, spending on client virtualization solutions is expected to rise at a brisk pace over the next few years. For example, the desktop virtualization market is expected to grow from \$1.6 billion in 2014 to \$14.1 billion by 2019.

Server-hosted delivery of client applications and resources is hardly new. Microsoft Windows Terminal Services – today known as Remote Desktop Services (RDS) – debuted with Windows NT 4.0 back in 1996. Over time, client virtualization options have expanded to enable robust delivery of applications and operating systems to client endpoints. Among the options:

- **Presentation virtualization:** As the name implies, presentation virtualization enables access to client applications by transmitting elements of the presentation layer from a central server to connected clients. Client systems initiate a presentation session via a web portal, which gives them access to a virtualized instance of an application on a shared Windows Server operating system. All application processing occurs on the server, with only the graphical user interface and mouse/keyboard inputs exchanged with the client. **SOLUTIONS:** Citrix XenApp, Microsoft RDS
- **Virtual desktop infrastructure (VDI):** Similar to presentation virtualization, VDI solutions use a remote display protocol to host centrally managed VMs that client PCs connect to in a one-to-one relationship over the network. VDI, often referred to as desktop virtualization, employs a hypervisor that hosts a dedicated operating system VM for each client. Since each client session is completely separate from others on the server, this approach offers significant flexibility, management and security. **SOLUTIONS:** Citrix XenApp and XenDesktop, VMware Horizon, Microsoft RDS
- **Application virtualization:** This approach can deliver an application as an executable file that runs on the client device, or it can provide remote access – via a protocol such as Remote Desktop Share Hosted (RDSH) technology – to an application running in a VM at the data center. The application exists inside a VM instance that comprises all the requisite operating system assets, registry settings and configuration details for the application. The result: Applications are compartmentalized and abstracted from the underlying client hardware and operating system. **SOLUTIONS:** Citrix XenApp, Microsoft App-V, VMware Horizon



DESKTOP AS A SERVICE: VDI IN THE CLOUD

Virtual desktop infrastructure (VDI) has for years been a popular option for streamlining delivery of operating systems and applications to client PCs and devices. More recently, providers have begun rolling out a flavor of VDI known as Desktop as a Service (DaaS), in which virtual desktops are delivered to clients from the cloud. According to [451Research](#), DaaS has become a \$2 billion market sector that is expected to grow 30 percent annually through 2017.

Cloud-served DaaS solutions imbue VDI with many of the benefits present in cloud delivery models such as Software as a Service (SaaS):

- Minimal capital expenditures and predictable monthly operational expenditures that ease budget management
- Reduced IT staffing requirements and sharply reduced management workloads
- Rapid implementation and streamlined operations for patching, fixing and updating systems
- Access to robust back-end resources, such as data mirroring and backup

Currently, DaaS is regarded as a solution for small and midsized organizations that aren't in a position to take on the overhead of a VDI deployment. However, private cloud-based DaaS offerings could motivate larger enterprises to try it. Among the leading DaaS solutions, Citrix XenDesktop and VMware Horizon DaaS provide ready-made solutions for organizations considering a cloud-served VDI deployment.

*SOURCE: IDC, "Driving Business Value with Desktop Virtualization," April 2015

Virtualization Drivers: The Mobility Imperative and Beyond

Client virtualization enables broad value across IT and enterprise operations, yet some of the most compelling gains are in mobility, which has emerged as an existential challenge for IT departments. Rapid adoption of smartphones and tablets has created a surge of personal and often poorly managed devices connecting to enterprise networks. The BYOD phenomenon has swamped IT departments, undermining traditional authentication and firewall defenses and exposing proprietary enterprise data and assets in the event of theft or loss.

In a [2014 survey by Dimensional Research](#), 95 percent of responding organizations said they have mobile devices connecting to their networks, while nearly three-quarters of all organizations actively support BYOD. The sheer number of BYOD devices connecting to enterprise networks is growing fast. One-quarter of survey respondents claimed a greater than fivefold increase in BYOD device connections over the past two years.

Faced with broad mobile uptake, enterprises are compelled to mobilize workflows by surfacing application-driven processes beyond the firewall. The aim is to boost efficiency, improve response speed and maintain competitive advantage — all while keeping a firm cap on IT expenditures and ensuring the security of enterprise assets.

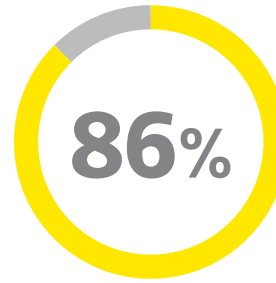
That's hard to do. Mobile app development can be both costly and complex, especially for organizations that support two, three or more client platforms. App updates and maintenance, and the need to write secure code hardened against attack, inflate the cost of deployments. In its [2014 predictions report](#), research firm Forrester estimated that a marketing app can cost up to \$500,000 per year to write and maintain, while the cost for a transactional app can cost up to \$2 million. Mobile-friendly web app development offers cross-platform reach and compatibility, but requires development shops to maintain discrete code bases for mobile and rich-client applications.

SOFTWARE MANAGEMENT CONSIDERATIONS



IT organizations need to assess and realign software licenses as part of a virtualization deployment. Vendors have improved their support for virtualization scenarios with sensible licensing plans, but this area remains complex. IT shops should prepare to renegotiate existing license terms to reflect new usage models. A third-party provider can help with this process.

In fact, a virtualization push is a good time to identify and eliminate redundant software licenses, which can burden organizations with thousands of dollars in unnecessary costs. A [2014 report from UK software firm 1E](#) found that unused software costs for U.K. and U.S. organizations totaled more than \$7 billion — \$224 per desktop in the United States.



The percentage of IT leaders who say virtualization is a "significant priority" for their organization in 2015*

Client virtualization allows IT shops to quickly and cost-effectively mobilize existing applications and workflows, without the burden of creating and maintaining mobile-specific code. Among the benefits:

- **Centralized hosting and management:** Apps run inside VMs, which are hosted in a data center or downloaded (or streamed) to client endpoints. Configuration and management occur behind the firewall, reducing cost and complexity.
- **Improved security:** Virtualized apps run in containers abstracted from the underlying mobile hardware and operating system. This protects against data loss and significantly reduces the available attack surface on mobile endpoints.
- **Centralized storage:** Data residing on mobile clients is a major headache, as information can be easily lost or stolen. Client virtualization solutions don't cache or store data on the client; instead, they stream it over encrypted links. This approach also provides robust backup and recovery of mobile client data.
- **Rapid deployment:** Writing web, hybrid or native mobile apps takes time. Virtualization enables existing applications and business logic to be packaged and delivered in a fraction of the time, and at reduced initial and ongoing cost.
- **Cross-platform reach:** Virtualization solutions can interoperate with all major mobile platforms — iOS, Android, Windows Phone and BlackBerry. This reach is a key advantage over native or even hybrid app development.

Of course, desktop and application virtualization are appealing for IT organizations beyond mobile scenarios. Streamlined client management; improved cross-platform reach; and the ability to support regulatory compliance, business continuity and disaster recovery are all tangible benefits of the technology.

There are also significant gains in IT operational efficiency, as reported in a [2015 white paper by research firm IDC](#):

- Computing device cost reductions of up to 70 percent, with the useful life of devices extended from 3.3 years to 5.4 years
- A nearly one-third reduction in the level of security risk to client systems
- A reduction in unplanned downtime of more than 80 percent
- More than 50 percent reduction in cost of desktop services delivery

*SOURCE: Protiviti, "Today's Enterprise — Cyberthreats Lurk Amid Major Transformation," March 2015

IT organizations can expect operational expense savings to be offset in part by the need to invest in network infrastructure, central server and storage resources, and updated software licensing. But worker productivity should improve through reduced client downtime related to patching and application upgrades. Swift problem resolution, centralized management and deployment, and robust security combine to maximize uptime and minimize service disruptions when they occur.

Client Virtualization's Limitations

While client virtualization's benefits are many, it is not a do-it-all panacea. Organizations that plan to deploy the technology face real challenges, including licensing questions, imperfect compatibility, and problems related to performance and connectivity.

In mobile scenarios, care must be taken to ensure that the rich-client application or operating system user experience is appropriate for the targeted client devices. Presenting a desktop OS — via desktop virtualization solutions such as VDI — on smartphones and even tablets comes with a high risk for failure. Among the issues that can crop up:

Compact screens: Screens that are 3.5 to 6 inches are simply too small to effectively display a user interface intended for screens that are at least 11 inches — and often significantly more.

Limited input: Traditional OS environments such as Windows 7 and Mac OS X depend on keyboard and mouse input. Navigating these OSs on touch-based smartphones and tablets can be difficult.

Poor controls: Desktop apps and OSs often employ controls that work poorly in mobile contexts, such as long drop-down lists or wide grids that run off the edges of the screen.

Mobile refactoring can help desktop applications work on mobile devices. Solutions such as Citrix FlexCast can recast desktop interface elements to better work in mobile

environments. They can also enable IT organizations to modularize app functionality, so that a manageable subset of app features and capabilities are delivered to mobile clients.

Performance concerns are another sticking point. Virtualized solutions often impose overhead (on the server, network and client) that impair responsiveness and reduce user satisfaction. Presentation virtualization and, to a lesser extent, streaming app virtualization are vulnerable to network bandwidth and latency issues. Even slight performance lags can frustrate mobile users.

Also, the virtualization environment has its limitations. For example, client virtualization solutions until recently offered no support for accelerated 3D graphics using on-board graphics processing units (GPUs). The result: Apps that ably display high-fidelity images and graphics in a traditional client may run poorly (if at all) in a virtualized environment. However, technologies such as Nvidia GRID vGPU can speed up the delivery of graphics in virtual desktops and applications, allowing the use of even intensive 3D graphics in client virtualization environments.

Back-End Benefits for IT Staff

Regardless of the type of client virtualization deployed, centralizing client operating system and application assets yields immediate and obvious gains. These include reduced operating costs, improved security and vastly simplified management. The following security benefits are particularly compelling with mobile devices.

- **Data stays in the data center.** App and desktop virtualization enable critical files and data to reside in the data center, rather than on countless client PCs and devices. Administrators can forbid local storage or caching of data, though this reduces functionality in connection-limited scenarios. Centralized data handling allows for robust data backup and recovery. IT organizations can also adopt effective business continuity policies via server-based load balancing, mirroring and failover solutions.
- **Lost devices can't compromise security.** According to a [2014 employee BYOD survey by ZixCorp](#), one in five respondents said they would wait anywhere from a few days to over a week to report a missing device to their employer. The reason: Users feared losing personal data to a remote wipe from the IT department. The delay represents a huge window of vulnerability for IT organizations, which virtualization can help close by eliminating data at rest on smartphones, tablets and PCs.
- **Virtualization fills mobility gaps.** Mobile device management (MDM), mobile app management (MAM) and, more recently, enterprise mobility management (EMM) suites allow IT shops to manage, track, update and secure mobile devices and software. Unfortunately, the diversity of mobile client endpoints makes 100 percent coverage difficult, and jailbroken or rooted devices can undermine effectiveness. Virtualization compartmentalizes apps and data to provide an additional level of security.
- **Security controls come with the package.** Most virtualization solutions include robust management tools, such as Citrix NetScaler Gateway, that provide granular control at the application and data level. Administrators can limit privileges

SIMPLIFIED MANAGEMENT

Moving beyond security, a [2015 report by research firm IDC](#) found that desktop virtualization solutions can significantly improve operational efficiency. Organizations in the IDC study were able to increase the number of applications supported by 72 percent, while reducing time engaged on traditional desktop support and management by 52 percent. Significant IT staff time savings were evident across the board, but most sharply in software deployment and patch operations (83 percent reduction) and desktop software installations (75 percent reduction).

Client virtualization also delivers even more benefits for IT staff. By consolidating hardware resources on virtualized servers, IT departments can reduce costs as well as downtime. Further, by centralizing backup, IT staff can better manage backup and recovery operations.



based on user identity, client endpoint and other factors, ensuring that only authorized users and devices interact with critical resources.

- **Malware remains at arm's length.** Malicious software on mobile clients is a huge problem. Security firm [Arxan](#) found that malware threats identified by its service rose 167 percent in 2013. What's more, many mobile apps exist in hacked or spoofed form in the wild — with many designed to exfiltrate data. The Arxan survey also found that 87 percent of the top 100 paid iOS apps and 97 percent of Android apps had been distributed in some way in hacked form in 2014. Management tools can help prevent users from downloading mobile apps from untrusted sources — a leading source of malware infection on smartphones and tablets — but they aren't foolproof. Virtualization can replace mobile apps with trusted software.

Preparing for Client Virtualization

Remaking client deployments in a virtualized environment should not be taken lightly. According to a [2014 Research and Markets report](#), client virtualization can impose “high initial deployment costs” and increased solution complexity. These issues, combined with a shortage of IT professionals skilled in managing virtualized solutions, can threaten client virtualization initiatives. To ensure success, IT organizations must develop a robust understanding of the scope, scale and character of the proposed deployment, which can occur through a six-step approach.

Determine the Right Deployment Model

1 Before an organization can begin any client virtualization project, it must figure out the best option for delivering information to users. IT decision-makers must study the kind of information users need and how they use it. For some organizations, a form of client virtualization will provide the most effective way to deliver data and services to mobile users. For others, mobile applications — whether custom-developed specifically for the organization, purchased off the shelf or partially customized — will be a better fit.

Each of these delivery models brings its own strengths and weaknesses. IT leaders should consider several factors when deciding which to deploy. These include:

- **Security requirements:** Because client virtualization doesn't process or store data on a device, it can offer a higher level of security.
- **Network access:** Many mobile apps don't require a continuous network connection in order to operate effectively.

- **Devices:** Mobile apps may be better suited to devices with smaller screen space than client virtualization rollouts.
- **Cost:** Each deployment model comes with different costs, which should be weighed against the benefits they deliver.
- **IT staff expertise:** The different deployment models place a variety of demands on IT staff — during development, rollout and support. Organizations must determine whether they have the necessary skills on staff or if they should seek help from outside experts.

Define Goals

2 An effective virtualization rollout must target tangible requirements. Stakeholders from both an organization's IT department and its lines of business should work together to formulate goals for the rollout.

The first step is to understand the direction of the underlying IT environment and how it supports business operations. For instance, a Windows 7 shop should determine if it plans a move soon to Windows 8 or Windows 10. Likewise, the stakeholders should articulate key requirements and goals, such as:

- Enabling a more secure computing environment
- Reducing the cost of managing clients
- Implementing a disaster recovery solution
- Supporting internal and remote users on diverse endpoints
- Delivery of applications and data to mobile clients
- Replacement of a complex application deployment solution
- Replacement or enhancement of an OS deployment or imaging solution
- Replacement or enhancement of a terminal services solution

Once the project goals are established, the team should create a realistic timeline for implementation.

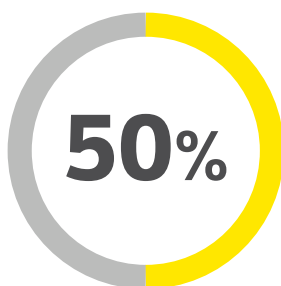
Assess the Environment

3 Assessment begins with a detailed review, documentation and analysis of the current IT environment. This should include a profile of key IT activities, including help desk and incident management, configuration management, software distribution, and image deployment.

A provider, such as Flexera Software or Lakeside Software, can provide tooling and expertise for this complicated task. These partners can also help manage software licenses across the transition.

The assessment should capture a wealth of information, including:

- The number, age and brand of deployed desktop and notebook PCs
- Specifics of all deployed client software and applications, including operating systems, web browsers and office productivity suites
- Details on the number and configuration of servers in the data center
- Profile of storage implementations, including direct-attached storage (DAS), network-attached storage (NAS) and storage area networks (SANs)

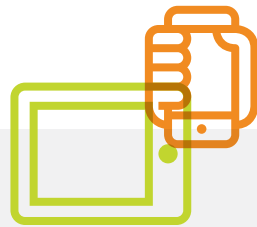


The percentage reduction in annual costs for delivering PC services that organizations can achieve via client virtualization*

*SOURCE: IDC, “[Driving Business Value with Desktop Virtualization](#),” April 2015

- Specifics on server storage hardware, including media type (hard-disk drive versus solid-state drive) and attachment type (SCSI/SAS, SATA)
- Review of networked storage in the data center, including running protocols (such as iSCSI, Fibre Channel and Fibre Channel over Ethernet)

A rigorous software review, including details on usage patterns, helps organizations determine what applications and processes to target for virtualization. A detailed understanding of deployed server virtualization solutions is also vital, because these may interact with a proposed client solution.



BUILD VERSUS BUY: WEIGHING MOBILE APP OPTIONS

App virtualization can deliver existing desktop-bound applications and services to a wide range of mobile devices in a secure and cost-effective way. However, it is not always the best approach.

Virtualization can impose burdens on back-end infrastructure, mandate a significant rethinking of IT processes and skill sets, and fall victim to interface mismatches between desktop and mobile clients. In some instances, mobile app deployments, including the following three options, may be best.

Off-the-shelf apps: We live in the age of the "application economy." A growing universe of rich, mobile apps for iOS, Android and Windows Phone address core activities, ranging from email and scheduling to office productivity and file sharing. Apps such as Microsoft Office 365 arm mobile users with high-quality tools and strong workflow integration with desktop users. The drawbacks? Third-party apps may not support key mobile platforms, and the ability to integrate third-party apps with existing processes may be limited.

Custom apps: For complex or niche app scenarios that demand tight integration and precise functionality and control, custom mobile app development may be the best solution. The cost of developing and maintaining a custom app is not insignificant, and any such effort requires an investment in either in-house or contract-based developer skills. Cross-platform tool sets can help developers versed in C# build cross-platform, mobile apps from a single code base.

Partially customized apps: For organizations needing a custom solution, hybrid (or platform) apps offer a balanced approach that maximizes cross-platform reach while avoiding the expense and complexity of custom mobile app development. Visual, template-based tools, such as those from Kony, Salesforce.com and SAP, offer rapid development and ease of use, producing a single code base that supports multiple platforms. Many products produce HTML5 code that is almost universally accessible to modern devices.

Plan and Design the Solution

4 Assessment and planning are tightly linked. The assessment helps drive the focus on the architectures that best fit the existing environment while achieving organizational goals. At the planning stage, it's important to know the number and type of users in the environment, such as:

- **Basic or light users:** These users generally make low use of available CPU resources for applications such as office productivity software and web browsers.
- **Power office or moderate users:** For this group, CPU use is higher (perhaps up to 15 percent) because of client-heavy software, such as graphics programs.
- **Developers or tech support users:** This group uses programs such as Visual Studio, AutoCAD and enterprise monitoring software that require more computing resources.
- **Mobile users:** These users access resources and applications from smartphones and tablets, often over wireless or cellular links.

Planners should remember to account for remote users and also capture details about connectivity and bandwidth to ensure full coverage of the infrastructure.

Organizations should strongly consider adhering to IT Infrastructure Library (ITIL) practices throughout the planning stage. This will ensure that the IT solution aligns effectively with the organization's needs.

The next step is to select and design the client virtualization solution. IT decision-makers should evaluate vendor products, services and programs based on their available features, compatibility with deployed software and systems, service contracts, and upfront and ongoing costs. They also should query vendors on their product roadmaps to ensure that solutions will align with plans for IT infrastructure in the future.

Test the Concept

5 Organizations that rush into a pilot deployment can find themselves mired in problems. They should consider a two-stage testing process that consists of a proof of concept followed by a limited pilot deployment.

The goal of a proof-of-concept deployment is to test the entire virtualization stack in a controlled setting — from virtualization options to applications, endpoints and peripherals to remote access connections. When the proof of concept is complete, the IT team will have validated the technology and confirmed all the required features and functionality in the client virtualization solution. The stage is then set to move on to a pilot deployment, which can be done in one of two ways.

The first option is to target a low-intensity workgroup of mostly basic or light users, preferably in a self-contained department with a finite set of applications. This approach affords the most control over the environment and allows a gentle ramp-up, but may fail to expose issues early in the process.

The second option is to target groups that can benefit most from client virtualization or groups with expert users, such as developers and engineers, who can help troubleshoot the solution and assist others as the deployment ramps up. While more difficult, this approach is more likely to reveal important issues ahead of a broader deployment.

Any pilot program should include a fallback plan that allows the pilot group to revert to an operational desktop computing platform if things go wrong.

Implement the Environment

6 Implementation and rollout each require their own plans, detailing when each workgroup will be migrated to the new client virtualization platform and when legacy solutions will be phased out. In addition to managing timelines, IT staff should do the following to ensure that the rollout progresses smoothly:

- Identify IT dependencies
- Establish teams and steering committees
- Conduct periodic reviews

During implementation, the IT team might need to transition to a new model of service and support reflecting the new roles, responsibilities and skill sets needed in a virtualized environment.

The IT group must also train end users, who may be confronted by changes in how they access their applications and data. Failure to properly prepare end users will result in numerous help desk calls, declining productivity and, ultimately, a failed transition.

Deployment Considerations

Client virtualization places new stresses on different elements of the IT infrastructure. Workloads that resided on desktop PCs may now burden servers in the data center, or may fall to tablets and even smartphones in the field. Likewise, data that rested on thousands of client hard drives may find its way onto the central storage system. Virtualization solutions come with implications for network bandwidth, too, as once-local client processes and data flows become intertwined with central servers.

Client virtualization deployments must account for these challenges and anticipate how the new model will stress the client and data center infrastructure. The challenge is especially acute in mobile scenarios, where processing power, storage, network bandwidth, power consumption and screen real estate are all radically reduced compared with traditional desktop PCs.

Ultimately, IT organizations should tread carefully when projecting cost reductions around a client virtualization effort. Savings that accrue from fewer redundant desktop PCs, centralized storage and more efficient software licensing may be offset by upgrades to network and storage infrastructure, as well as deployment of additional servers.

Server Stresses

Client virtualization often shifts large amounts of distributed processing from scattered desktop PCs to servers in the data center. Without a thoughtful server upgrade plan, a virtualization rollout could cripple a data center. A lot depends on the type of virtualization employed. For instance, VDI will stress servers

more than an app virtualization deployment.

What should IT organizations plan for? Many virtualization experts recommend running six to eight users per server processor core, and budgeting 1 gigabyte to 1.5GB of system memory for each active VM. It's also good practice to build in headroom for growth, in the range of 40 percent or more.

Finally, IT staff should be aware that a client virtualization rollout can result in a data center with more servers operating under greater loads. The resulting spike in power consumption and heat output will likely require action around power and cooling infrastructure.

Network Burdens

Regardless of the type of client virtualization deployed (desktop or app), the act of streaming or downloading virtualized sessions from central servers to client endpoints will burden existing networks. The challenge is twofold:

Bandwidth: The network will add large amounts of data traffic, with significant spikes occurring when groups of workers sign on and initiate new virtual sessions. Solutions such as VDI, which pass interface elements between server and client, can produce enduring traffic increases.

Latency: Client virtualization solutions are sensitive to network lag, which can cause delayed user interface response and other issues. Latency issues are particularly troubling for mobile scenarios, where uneven screen response can frustrate users and cause spurious touch inputs.

IT organizations should budget for updated and improved network infrastructure during a client virtualization rollout. Careful monitoring of network traffic during proof-of-concept and pilot deployments can help IT managers develop solid targets for these improvements.

Storage Capacity

More data means more storage. And more storage in a client virtualization deployment means adding significant disk capacity to the data center. Centralized NAS and SAN are best for client virtualization buildouts because they can be scaled to meet performance and capacity demands. However, the fabrics and networks these storage controllers sit on must be up to the task. A 10 Gigabit Ethernet copper or fiber link can support up to 2,000 VMs per host — more than twice the capacity of Fibre Channel and several times that of iSCSI.

Disk throughput is a key performance metric. With each Windows VDI client consuming 5 megabits per second to 7Mbps of throughput, IT administrators will almost certainly need to boost disk arrays and controllers to meet the additional demand. Flash-based solid-state drives (SSD) and disk arrays with solid-state caches can work in the most demanding performance environments. In addition to boosting throughput, these approaches can significantly reduce disk latency to ensure responsive client interfaces.

Beyond infrastructure considerations, a virtualized environment may respond differently to IT activities than one based on rich-client PCs and devices. For instance, virus and security scanning have a reputation for being annoying

because of the slowdown it can cause on stand-alone PCs. But move that aggregate task load to the data center serving thousands of client VMs, and it can become a crippling event. The same goes for boot storms, which occur when numerous systems start up simultaneously and make concurrent demands of storage, processor and network resources.

As with most things in IT, the solution is in the planning. Organizations that develop solid metrics around data traffic, processing and storage loads can best prepare the infrastructure to meet these loads. By taking a considered

and iterative approach, organizations can sidestep pain points and more quickly take advantage of the benefits of client virtualization.

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