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Virtualization: The Antidote for Hospital Computing Ills

WHITE PAPER

Sponsored by: HP

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EXECUTIVE SUMMARY

This white paper presents an overview of virtualization technology, with an emphasis on client virtualization. It also presents the findings and analysis of an in-depth interview conducted with a senior information technology (IT) executive at Synernet Inc.

The increasing sophistication of healthcare computing is creating a level of complexity and a corresponding increase in IT infrastructure cost. Virtualization of the IT infrastructure on several levels represents one solution for addressing this problem.

In the case of the early adopter whose experience is highlighted in this white paper, and with other organizations that we have interviewed in the course of our related research, virtualization technology consistently demonstrates measurable economic benefits, as well as other benefits that translate into improved service to end users and more efficient IT operations.

These benefits accrue in the following areas:

- Lower total cost of ownership (TCO)
- Easier deployment and reduced maintenance expense, including fewer help desk calls that necessitate onsite support
- Enhanced data security
- Better system performance
- Improved system reliability and availability
- Improved end-user satisfaction

IN THIS WHITE PAPER

The increasing sophistication of healthcare computing is creating a level of complexity and a corresponding increase in IT infrastructure cost. Virtualization of the IT infrastructure on several levels represents one solution for addressing this problem.

This white paper presents an overview of virtualization technology, with an emphasis on client virtualization. It also presents the findings and analysis of an in-depth interview conducted with a senior IT executive at a leading regional IT and business process outsourcing firm serving healthcare providers in northern New England — Synernet Inc. in Portland, Maine. The objectives of this interview were to understand the business and technology drivers for the adoption of client virtualization technology, review the organization's implementation experience, and develop guidelines for other organizations considering such an initiative.

SITUATION OVERVIEW

We are in a time of both trepidation about economic conditions and hopefulness about the long-term prospects for fundamental change in the delivery of healthcare services and the growing role of healthcare IT in facilitating that change. In the coming months, we expect healthcare providers to see a new urgency when it comes to aligning their services with national goals for efficiency, access, and quality. These goals will create new policies and initiatives that will drive demand for IT-enabled solutions. However, the financial climate will drive rationalization of spending in all areas of the healthcare system, and IT solutions that seek to gain ground in 2009 must be able to demonstrate their cost-benefit advantages to the market.

In some ways, the challenges facing healthcare providers have accelerated the adoption of IT in almost every aspect of healthcare delivery. The need for implementing information technology has never been higher, as the industry seeks to improve patient safety and the quality of care while creating efficiencies that allow it to meet the demands of legions of baby boomers approaching retirement and new methodologies for improving the delivery of healthcare. IT is expected to play an increasingly central role in meeting the demand for care, quality, and safety while bridging the gap of affordability.

In some ways, the need for implementing information technology has never been higher, as the industry seeks to improve patient safety and the quality of care while creating efficiencies that allow it to meet the demands of legions of baby boomers approaching retirement.

But while IT is seen as a critical agent of change, the chronic capital shortages and intense intraorganizational competition for capital that have plagued the industry for years are major limiting factors on the rate of IT investment. Virtualization represents an important new technology for addressing several of the enormous pressures healthcare providers face today. Virtualization offers healthcare IT executives the opportunity to mitigate the proliferation of infrastructure costs,

maximize their ability to allocate limited capital across more initiatives, and improve IT-enabled clinical workflows.

Hardware costs represent a substantial portion of IT's budget. Despite rapidly falling prices for PCs, these cost savings have been offset by dramatic increases in the number of PCs deployed. Unlike traditional office settings, many hospital employees, particularly clinicians, such as physicians and nurses, are highly mobile. As clinicians have become increasingly dependent on access to patient data in digital form, the installed base of PCs in hospitals has dramatically increased. IDC data shows that the ratio of PCs to employees in healthcare organizations is one of the highest across a wide range of industries.

Moreover, the initial purchase price of both servers and PCs is, over their useful life, only a small portion of the TCO. The challenge for IT management is to reform the existing IT infrastructure and implement an architecture that reduces TCO while simultaneously delivering improved levels of service and the flexibility to adapt to today's rapidly changing IT demands. Virtualization can be a key strategic weapon in this battle.

THE RISE OF CENTRALIZED COMPUTING IN HEALTHCARE

According to IDC research, virtualization technologies are now largely considered mainstream in many industries. Recent demand-side surveys have found that as many as 50% of survey participants from a variety of industries use virtualization in production environments, including components of such mission-critical applications as supply chain management and enterprise resource planning.

In fact, those employing virtualization in their organizations on average report that roughly one-quarter of their production applications are running on virtual machines. Despite healthcare's rather late adoption of virtualization, in general, our survey findings show dramatic increases over the past year, particularly in the area of client virtualization, and we expect this trend will not only continue but also accelerate.

What Is Virtualization?

Current commercially available software products encompass three types of virtualization: server virtualization, application virtualization, and, most recently, client virtualization. The focus of this report is on virtualization of the desktop. A comparison of the various infrastructure delivery models is detailed in the Learn More section.

Server Virtualization

Server virtualization is a software-based technology that can be employed to create multiple, machine-independent images of an operating system and its related components. Multiple "virtual images" can be configured to run on a single physical server or across a related group of physical servers. The key software component in this virtualized environment is known as a "hypervisor," which allows each virtual image to run independently of other images executing on the same physical server(s). The hypervisor manages, prioritizes, and schedules the demands of each image on the underlying hardware platform components and mitigates conflicts.

Application Virtualization

Application virtualization is an umbrella term that describes software technologies that improve portability, manageability, and compatibility of applications by encapsulating them from the underlying operating system on which they are executed. It is, arguably, the most widely adopted aspect of virtualization technology by healthcare providers and is perhaps best represented by Citrix's XenApp product. A fully virtualized application is not installed in the traditional sense, although it is still executed as if it were. The application is fooled at runtime into believing that it is directly interfacing with the original operating system and all the resources managed by it, when in reality it is not. Application virtualization differs from operating system virtualization in that in the latter case, the whole operating system is virtualized rather than only specific applications.

Client Virtualization

Client virtualization is a datacenter-centric computing model that borrows from the traditional thin-client model but is designed to give system administrators and end users the best of both worlds: enabling system administrators to host and centrally manage virtual and/or physical desktop machines in the datacenter while giving end users the traditional PC desktop experience to which they have become accustomed. In general, this can take two forms: a virtual desktop infrastructure (VDI) model or blade-based client computing.

In a VDI environment, the software image of a physical desktop PC is replaced by a virtual PC running on a server. Each user accesses a unique virtual PC, complete with its own virtual CPU, RAM, and hard disk. Virtual PCs run concurrently on top of the virtualization layer provided by the hypervisor software, which also controls the computing resources (mainly CPU and RAM) allocated to the virtual PCs. Although multiple virtual PCs typically run on a single server, the crash of a single virtual PC is unlikely to cause other virtual PCs on the same server to crash. Citrix XenDesktop and VMware VDI are the main software products available today that can provide a complete VDI solution.

In the case of blade-based client computing, desktop images are run on individual client blades. As in virtual PC implementations, users access datacenter resources via thin-client workstations, but rather than multiple users sharing the resources of a single physical server, each user is assigned the full power of a rackmounted client blade (CPU, RAM, hard disk, graphics card, network interface card) located in the datacenter. This device is dedicated to that user for the duration of his or her session.

Is Client Virtualization Right for Your Organization?

Virtual desktop infrastructure removes the application compatibility issues encountered in server-based computing — while keeping the same advantages. If an application runs on a physical PC, it should work identically on a virtual PC. Virtual PCs are more suitable for knowledge workers who are using content-rich applications such as Microsoft PowerPoint and Web 2.0 applications. The deployment of a provisioning server is strongly recommended as it leverages the full capabilities of the architecture through the dynamic creation of disk images and the possibility of patching only master copies.

The user experience on a virtual PC can be identical to that of a standard PC, while the user's physical device can be an inexpensive thin client, one of the organization's legacy desktop devices, or a remote device — one that need not be highly compatible with the organization's standard architecture.

For some organizations, client virtualization offers the added benefit of prolonging the service life of outdated PCs. In traditional IT environments, as desktop PCs age and as the applications they access evolve or as their end users require access to more applications, upgrade or replacement of the PC is necessary to meet the demands of those applications. In a virtualized desktop environment, the processing functions formerly performed on the desktop device are executed on the server, minimizing the processing demands required of the desktop device and improving overall application performance.

But client virtualization may not be right for all organizations or for some user populations. Virtual desktop infrastructure does add a layer of complexity to the existing infrastructure that might deter some organizations from going ahead in a short time frame. Provisioning servers in large enterprises will be mandatory to avoid the huge impact on storage due to static disk files and resulting administration overhead. Some multimedia applications are still not working well in a virtual environment; VDI uses the physical server GPU, which causes poor graphics performance. Support for peripherals is usually limited to printers and USB keys.

Care should be taken when implementing client virtualization to ensure that it is an efficient approach for utilizing all of the application services that a specific user, or class of users, is accustomed to accessing. Applications that are graphic intensive, for example, may not perform as well in a virtualized desktop environment.

Virtualization Goes Mainstream: VDI's Role in Today's Healthcare Environment

The migration toward virtualization and centralized computing is not a simple journey, but when carefully planned, it can bring tangible operational and economic benefits, not only by rendering infrastructure more efficient but also by adding a layer of flexibility to the infrastructure that will enable IT to be more agile and respond more quickly to changes to the organization.

The key IT benefits fall into five principal areas:

- **Cost.** When properly configured and deployed, virtualization technology can significantly reduce IT infrastructure costs by allowing organizations to emulate the functionality they currently provide through robust, expensive desktops with a variety of far less expensive PCs, thin desktop client devices, or simply extending the useful life of their existing PC inventory. In addition, software image maintenance and desk-side support costs are reduced.

- **Performance.** In a virtualized world, when peak demands are encountered, the ability to add processing power to virtualized clients allows the process time to be cut significantly.

- **Availability.** Virtualization can help to eliminate unplanned outages by enabling automatic switchover to working resources.

- **Security.** As more healthcare workers become mobile, client virtualization provides the ability to log in to essentially any computer connected to the network while securely maintaining all data inside the datacenter.

- **Accessibility.** Offloading a user's session to a centralized image of his or her desktop enables the mobile worker to more easily reestablish a previous session. Clinicians whose workday requires moving from one location to another can leave their session active and merely log off one workstation and then log in at another. Once their password is validated, they will be returned to the active session at the point at which they left it. This will significantly reduce the time clinicians now spend "picking up where they left off."

While IT improvements are certainly impressive in their own right, enhancing the quality of care and patient safety is a top priority for the healthcare industry as a whole. Virtualization can be a critical component of strategies to achieve these goals. Specifically, it can facilitate:

While IT improvements are certainly impressive in their own right, enhancing the quality of care and patient safety is a top priority for the healthcare industry as a whole. Virtualization can be a critical component of strategies to achieve these goals.

- **Greater investment in customer-facing capabilities.** Investments in clinical systems, specifically electronic medical records, or EMRs, are growing at a rate in excess of 10% per year. But executives also recognize that the implementation of these applications is dramatically increasing not only the cost of their IT server environment but also their IT infrastructure, desktop, and help desk support staffing costs. Hospital IT executives recognize that these costs, though essential for service delivery, are relatively "invisible" to the organization at large and that new approaches are needed to maximize IT service levels while mitigating the expected increases in cost. Technologies such as virtualization shift investment dollars from these "invisible" services to more customer-facing capabilities, providing greater visibility of the value IT can deliver to the end-user community.

- **Regulatory compliance.** The standardization of a virtualized image and the ability to secure and patch only that image as new threats emerge also provide benefits by showing regulators that the healthcare organization is taking a proactive approach to PC security and data management.

- **Customer service.** Improved customer service in the form of reductions in help desk call volumes and improvements in first call resolution rates results from replacement of aging desktops with new equipment, standardized desktop images, and improved remote desktop support and network management tools. Many of these benefits will accrue even if a provider organization chooses to retain some or all of its legacy workstations.

THE EXPERIENCE OF AN EARLY ADOPTER

With these concepts and benefits in mind, Health Industry Insights interviewed HP customer Synernet Inc. in Portland, Maine, a leading regional IT and business process outsourcing firm serving healthcare providers in northern New England. The objectives of this interview were to understand the business and technology drivers for the adoption of client virtualization technology, review the organization's implementation experience, and develop guidelines for other organizations considering such an initiative.

Synernet: Seeking a Sense of Security

Founded in 1985, Synernet is a hospital-owned organization in Maine that provides a host of solutions such as medical transcription services, third-party claims management, and physician credential verification services to providers throughout New England. About 110 employees, the majority of the company's 140+ workforce, are remote transcriptionists, all of whom work from home and are located throughout the United States. This is Synernet's largest service offering and the business function most directly impacted by the remote desktop solution.

The Business Imperative

There were several confluent factors that made the fall of 2007 ripe for Synernet to investigate a thin-client solution. Synernet entered the medical transcription business approximately five years ago, growing steadily, and now serves about 20 hospitals. Its volume of transcribed reports has been growing at more than 33% annually. The volume of help desk calls and its support costs also continued to grow. Because the staff used their own PCs not only for work but also for personal computing needs, virtually every PC configuration was unique unto itself. As a result, many of the help desk calls were extremely time-consuming to address and difficult to permanently resolve.

All of Synernet's transcriptionists work from home. In the past, when new remote staff came on board, they used their own personal PCs and components. While this appeared to be a convenient approach, over time IT was faced with attempting to support a variety of software programs and various components on home-based equipment. Additionally, the very nature of the business — transcribing sensitive health information — made security a top priority. Though Synernet was HIPAA compliant and had incurred no violations, the company wanted to make sure its compliance was absolute.

The IT staff evaluated a variety of products and vendors. While price was certainly a factor, the primary motivations were security and performance. Synernet selected HP for the job.

The Implementation

The company took a three-phase approach based on geography. Since many of the staff were located in Maine, this location was deployed first, followed by New England and then the rest of the United States. The whole deployment took approximately five months from the first quarter of 2008.

Accomplishments

Today, when a new employee comes on board, setup couldn't be easier. Synernet sends a thin client, keyboard, and foot pedal (for medical transcription services). The total cost of the configuration is priced at less than $500. The new employee calls IT and is up and running in about 15 minutes. Now that the program is fully up and running, Synernet is documenting its experience and preparing a complete economic analysis of the investment for its board. Its preliminary assessment suggests that it will achieve a significant return on its investment.

THE BENEFITS OF VIRTUALIZING: MEASURING RESULTS

In the case of this early adopter, and with other organizations that we have interviewed in the course of our related research, virtualization technology consistently demonstrates measurable economic benefits, as well as other benefits that translate into improved service to end users and more efficient IT operations.

These benefits accrue in the following areas:

- Lower TCO
- Easier deployment and reduced maintenance expense, including fewer help desk calls that necessitate onsite support
- Enhanced data security
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Organizations considering the use of virtualization technology should develop a TCO model to demonstrate the business case for the investment. The TCO model should compare current costs with anticipated costs in a virtualized environment. Since one of the potential benefits of client virtualization is the opportunity to significantly lower the TCO by lengthening the standard desktop refresh cycle, at least a three-year period is recommended (or however long the period should be to cover what would normally have been the organization's standard cycle). The TCO model should include hardware, software, and support cost models for each of the "typical" configurations the organization expects to deploy. The models should represent both capital costs and operating costs over at least a three-year period. Organizations should include the cost of installation (cabling and power connections, racks, etc.), as well as the cost of

space and energy consumption in these models, because any reduction in the total number of servers will reduce both the "footprint" of the datacenter and power and cooling costs.

Similar cost models for future provisioning and replacement should be developed using current hardware and software configurations and comparing the two. Anticipated growth in server and desktop populations should be factored in, and the "per-configuration" three-year cost comparisons should be extrapolated across all devices that are virtualization candidates and the total cumulative cost savings calculated. These metrics should be measured during the course of initial pilot deployments, and the TCO models should be updated with the results. End-user satisfaction surveys are another important tool for measuring the success of pilot deployments and refining plans for subsequent, large-scale deployment.

Organizations that have utilized this approach have clearly demonstrated both the quantitative benefits and the qualitative benefits associated with virtualization.

CHALLENGES OF VIRTUALIZATION

While there are clearly many benefits to client virtualization, adoption of the technology is not without challenges. First, because the technology is just beginning to be adopted in the healthcare industry, integrators experienced with both virtualization technologies and the specific vertical market applications found in healthcare are rare. While many technology providers have extensive experience with virtualization projects in general, few have implemented the technology in a healthcare organization.

Look for this situation to change, however, as integrators see healthcare as a major opportunity. Similarly, there has been a lack of active participation and cooperation on the part of packaged application software providers that specialize in healthcare — which has hindered the advance of virtualization across the industry — and have been slow to embrace virtualization or to certify the performance of their products in a virtualized environment. However, this is more of an issue with respect to server virtualization than with client virtualization, and IT executives in provider organizations have responded accordingly. As noted earlier, our survey data suggests that provider organization implementations of client virtualization models of various kinds are rapidly accelerating.

Virtualization at the desktop requires investment in datacenter infrastructure and brings its own set of complexity issues, particularly with managing server capacity and workload. Typically, organizations implement server virtualization first, but they also should pilot desktop

programs to ensure that the server consolidation can handle the added capacity of virtualization at the client side.

Another major challenge is cultural — user resistance. Virtualization requires not only IT staff but also any worker using a computer to adapt to a more centralized, structured computing infrastructure. In particular, healthcare workers are used to having control over their patient information, as long as it is used in compliance with company and government regulations. With virtualization, these knowledge workers now must also adhere to authorization restrictions on data and applications.

Many workers install local departmental or even personal applications on their corporate desktops or laptops. With virtualization, this is difficult and often even impossible. While this gives greater control to the IT department, and ensures a higher level of certainty of compliance, it does take some of the "personal" out of personal computers.

Meeting these challenges can be difficult for an IT department. However, they usually can be overcome by proper planning and training. Health Industry Insights believes that healthcare IT staff, executives, and knowledge workers will look past the cultural concerns when they see the benefits to them and their organization. Furthermore, the benefits will more than justify the conversion effort.

FUTURE OUTLOOK: VIRTUALIZATION AND THE HEALTHCARE PROVIDER OF TOMORROW

As healthcare organizations become increasingly dependent on IT, and IT-enabled business and clinical processes become more ubiquitous and pervasive, ease of access, enhanced security, and improved application performance will be critical attributes for end-user acceptance. These characteristics will be particularly important to those applications targeted at clinicians and other mobile knowledge workers who will need "anytime/anywhere" access to these applications. Simultaneously, increasingly stringent demands, both internal and external, on the IT departments of healthcare providers to reduce operating costs will demand the most cost-effective solutions for delivering these applications. Virtualization of both server environments and desktop environments can effectively address these demands.

Application virtualization, as best represented by Citrix terminal services, has been widely deployed at hospitals throughout the United States for almost a decade. This technology has become the de facto method for enterprisewide deployments of major clinical applications implemented at multiple, geographically dispersed sites of large IDNs

and hosted at regional or national datacenters. It is widely adopted by the independent software vendors (ISVs) that are the source of packaged, mission-critical clinical, EMR, and ERP applications.

Virtualization technology supporting both Unix and Wintel server operating system environments is now about five years old. But while virtualization is having a noticeable, and profound, technical and economic impact in other industries, it has seen relatively slow adoption among healthcare provider IT organizations, due primarily to the reluctance of the same ISVs, which, to date, have been slow to incorporate the technology into their product offerings. Also, the IT environments of many healthcare providers today are relatively small and lack the critical mass of servers to justify the investment needed to convert their existing inventories.

Conversely, client virtualization is not subject to the same constraints, and the majority of provider organizations support desktop environments sufficient to justify the investment and reap considerable economic and operational benefits.

Ultimately, healthcare provider IT organizations, and the vendors that serve the industry, will embrace and rely on virtualization in the same way they did when virtual operating systems transformed mainframe computing 30 years ago.

Health Industry Insights' survey data shows a clear and pronounced trend in the number of provider organizations utilizing client virtualization on either a pilot basis or a widespread basis today. This trend is expected to accelerate, and we believe that client virtualization will become as mainstream as application virtualization within the next 12–24 months. The business case is simply too compelling to ignore.

ESSENTIAL GUIDANCE: CHECKLIST FOR SUCCESS

Healthcare organizations, especially larger hospitals and medical facilities confronted with major IT cost and technology challenges, have much to gain from virtualization. IDC offers the following counsel as first steps toward embarking on this journey:

- **Develop a strategic plan.** Begin to develop a strategic plan for virtualization, starting with an inventory of IT resources and an assessment of the potential economic benefits of standardization, consolidation, and virtualization.

- **Learn from other "virtualization pioneers."** Seek case studies and reference customers both within and outside healthcare.

- **Document a sound business case.** Change is always difficult, and for the average IT department, there are typically far more demands for capital funds than there are funds available. There may be other, competing projects that are more visible to end users or executive management, so it is important to develop a sound business case. The potential for cost savings makes the economics of virtualization quite compelling, but the savings need to be quantified. A side-by-side TCO analysis, such as the one described earlier, is a crucial part of the planning process.

- **Plan big, start small.** Having a broad vision and plan is essential for success, but it can sometimes make the task at hand seem overwhelming. Start with meaningful but manageable pilot projects. The best candidates are projects that are likely to be successful and have visibility within the organization. Some early wins can build momentum for future initiatives.

To assist with the preparation and planning for a client virtualization initiative, hospitals and other healthcare organizations will likely need a technology partner — one that will work as hard as they will to be successful. When evaluating vendors, healthcare organizations should consider the following factors:

- **Flexible, proven technology.** Does the potential supplier offer a comprehensive set of products with a proven track record of deployments in a wide variety of technical environments?

- **Industry-specific experience.** Does the potential supplier have direct experience in the healthcare industry? Does it have direct experience virtualizing the specific technologies required?

- **Extensive partner ecosystem.** Does the potential supplier have established, formal relationships with your application suppliers? With your hardware platform vendors? With systems integrators or consultants whose services you are considering?

- **Professional services offerings.** Does your potential supplier offer professional services to assist in training, implementation, and ongoing support to leverage or augment your own internal resources? Do these services address your organization's unique requirements?

- **Integration system management tools.** How effectively does the potential supplier's offerings integrate with the system management tools currently in use or being considered? What additional tools does it offer that are unique to managing a virtualized environment, and do these tools meet your requirements?

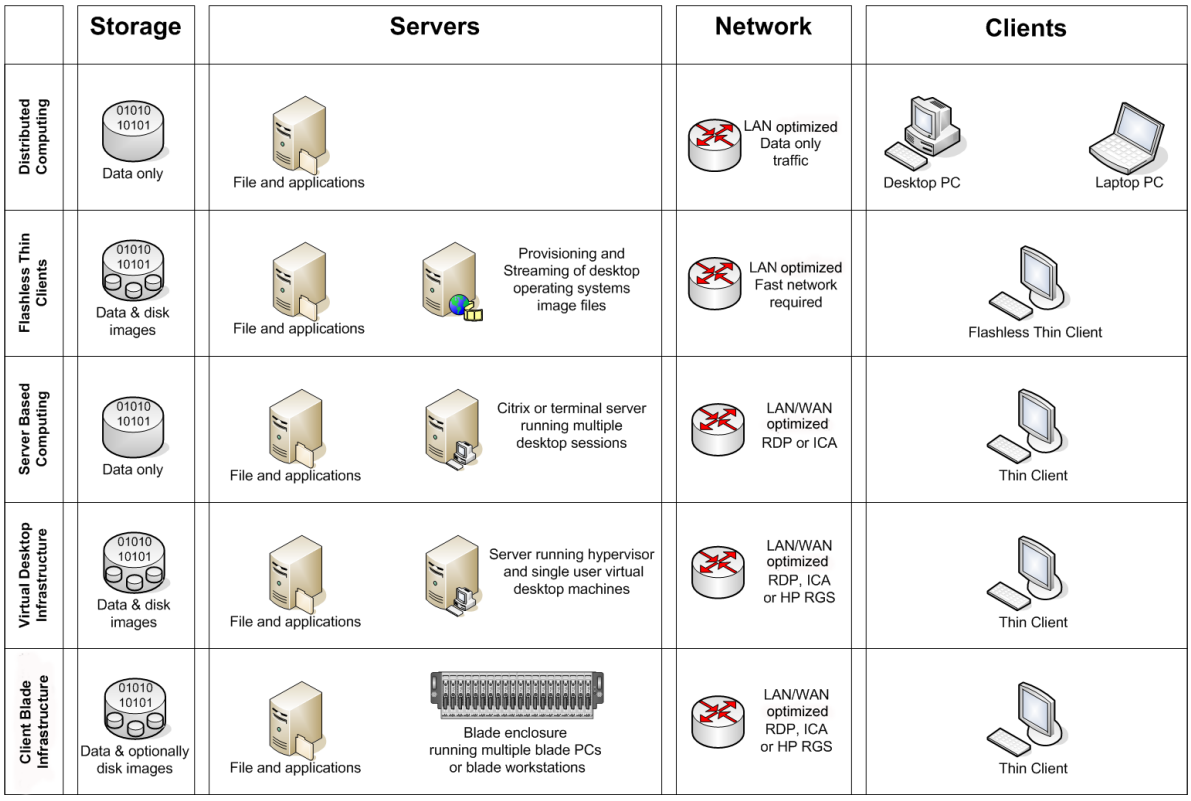
LEARN MORE

The Various IT Infrastructure Delivery Models Available Today

Figure 1 depicts the various ways of delivering IT that are available today. IT managers are presented with multiple ways of obtaining the same theoretical result. The challenge for them is to determine which solution or mix of solutions is best adapted to their specific environment. Variables influencing the technical choices are numerous: the number of employees, the number of sites, the quality and capacity of the network infrastructure, the types of applications accessed and computing tasks performed, and the need for mobility, among others. Making the right decision is not easy and requires careful testing and preparation.

FIGURE 1

IT Infrastructure Delivery Models



Source: Health Industry Insights, 2009

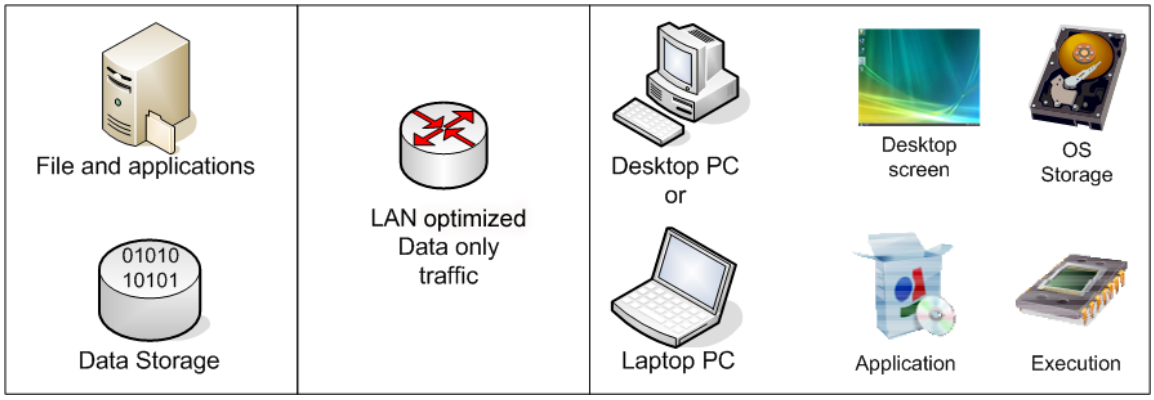
Traditional Distributed Computing

Distributed computing (see Figure 2) has been the dominant delivery model for the past 20 years. It is shown to serve as a baseline reference for comparison with the other models presented.

In distributed computing the local computer is handling most of the execution, and the operating system and some components (or perhaps all) of the user's applications are installed on a local hard disk.

FIGURE 2

Traditional Distributed Computing



Source: Health Industry Insights, 2009

Pros and Cons

Pros

- Well-known delivery model
- Strong local processing power
- Easy desktop customization

Cons

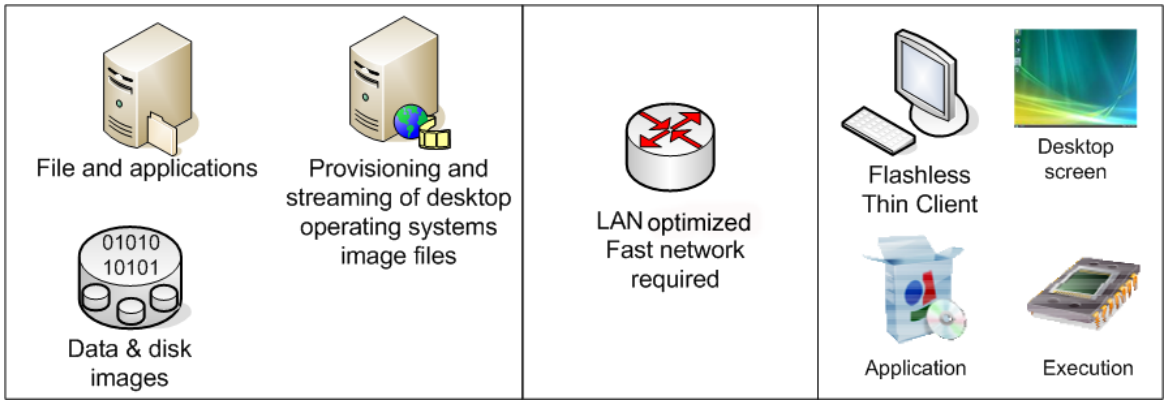
- Performance degrades over time due to disk fragmentation and multiple applications installed
- Need to regularly upgrade and patch operating system and applications
- High administration overhead
- Not optimized for WAN traffic

Flashless Thin Clients

In a flashless thin-client configuration (see Figure 3), the devices have CPU, RAM, and video characteristics comparable to those of PCs and are able to directly run the Windows operating system. The flash memory of thin clients is removed, and the devices are booted from the network using the Preboot eXecution Environment (PXE) protocol. The provisioning server will establish connections with virtual hard disks stored on a storage area network (SAN), and thin clients will then load the operating system from the network. From the device perspective, the hard disk is still seen as local although it resides on the network.

FIGURE 3

Flashless Thin Clients



Source: Health Industry Insights, 2009

Pros and Cons

Pros

Flashless thin clients are an elegant solution to the problem of maintaining client operating systems and applications. All the execution is still happening locally. Pristine disk images can be created dynamically from master copies to ensure that performance is maximized. Only master copies need to be upgraded and patched, hence reducing administration overhead.

Cons

Because flashless thin clients do not fundamentally change the way IT is delivered and because the additional capex cost can be substantial compared with traditional distributed computing (additional provisioning servers, storage, network, software licenses, and integration services), developing a solid business case for flashless thin clients can be very difficult. In addition, the impact on storage can be

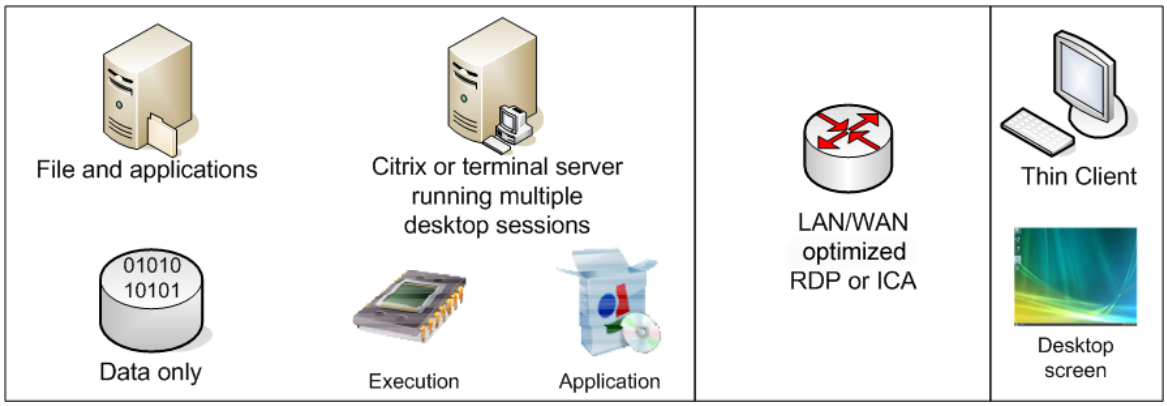
very significant if disk images are stored permanently on the network, and network implications need to be considered since the devices are constantly accessing hard disks over the network.

Server-Based Computing

Server-based computing (see Figure 4), which was popularized by Citrix, has gained strong market acceptance in the past 10 years as an efficient way of delivering centralized applications and desktops to clients. In this model, desktop sessions are running on Citrix or similar terminal servers and sent over the network using the Citrix Independent Computing Architecture (ICA) or Microsoft Remote Desktop Protocol (RDP) protocols to thin-client devices. Only screen updates, keyboard strokes, and mouse actions travel over the network; all the processing happens on the servers where applications are installed. This approach can also be used with legacy workstations in lieu of replacing them with thin-client devices.

FIGURE 4

Server-Based Computing



Source: Health Industry Insights, 2009

Pros and Cons

Pros

This approach allows for the maximization of server usage as servers can run multiple desktops sessions and are limited only by the CPU and memory capacity of the server. All intelligence and processing remain centralized in the datacenter. Client devices are easily replaceable in case of failure, hence lowering administration costs. Access to data is potentially faster as storage typically resides on the same network as the servers.

Cons

Applications need to be compatible with terminal services. The main challenge in a server-based computing environment is to fully test all applications to determine if they work together and, if not, establish which applications need to be siloed on separate servers. Despite careful testing, problems still happen sometimes, and one user session behaving incorrectly can cause a whole terminal server to fail and interrupt the work of 20 to 40 users at once. Server-based computing is not well-suited for multimedia, and usually videos and 3D applications do not run properly in this environment. Support for peripherals is usually limited to printers and USB keys.

Virtual Desktop Infrastructure

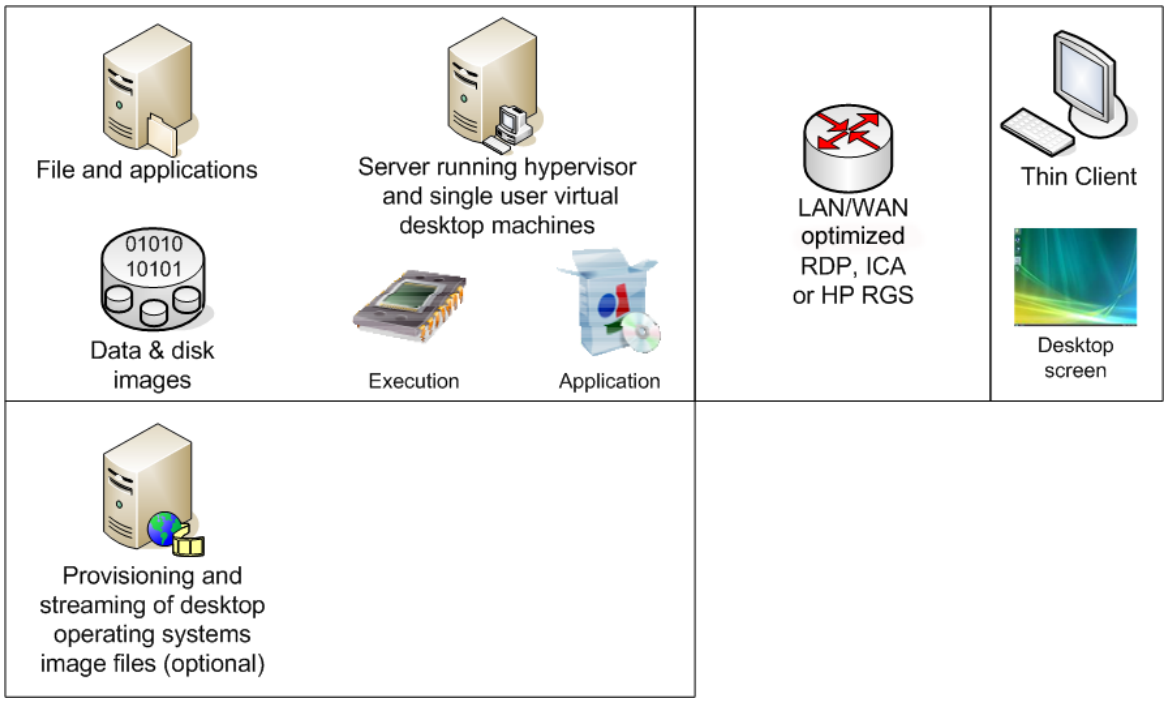
In a virtual desktop infrastructure (see Figure 5), physical desktop PCs are replaced by virtual PCs running on a server. The main difference with terminal services is that each user accesses a unique virtual PC, complete with its own virtual CPU, RAM, and hard disk, instead of multiple user sessions sharing one physical server. This substantially increases system stability as the crash of a virtual PC is unlikely to cause other virtual PCs on the same server to crash, so only one user is affected instead of 20. Virtual PCs run concurrently on top of the virtualization layer provided by the hypervisor software, which also controls resources (mainly CPU and RAM) allocated to virtual PCs.

Virtual PCs are accessed via the Microsoft RDP, Citrix ICA, or HP Remote Graphic Software (RGS) protocols and displayed on thin-client devices. Only screen updates, keyboard strokes, and mouse actions travel over the network; all the processing happens on the servers where virtual PCs are running. Virtual PCs boot either from static disk images stored on the network or, optionally, from images dynamically created from master copies via a provisioning server.

Citrix XenDesktop and VMware VDI are the main software products available today that support a virtual desktop infrastructure solution. It should be noted that all HP thin-client devices and blade products are fully compatible with Citrix XenDesktop and VMware VDI.

FIGURE 5

Virtual Desktop Infrastructure



Source: Health Industry Insights, 2009

Pros and Cons

Pros

Virtual desktop infrastructure removes the application compatibility issues encountered in server-based computing — while keeping the same advantages. If an application runs on a physical PC, then it should work the same on a virtual PC.

Virtual PCs are more suitable for knowledge workers who are using content-rich applications such as Microsoft PowerPoint and Web 2.0 applications. The deployment of a provisioning server is strongly recommended as it leverages the full capabilities of the architecture through the dynamic creation of disk images and the possibility of patching only master copies.

Cons

Virtual desktop infrastructure does add a layer of complexity to the existing infrastructure that might deter some organizations from going ahead in a short time frame. Provisioning servers in large businesses will be mandatory to avoid the huge impact on storage due to static disk files and resulting administration overhead.

Multimedia applications are still not working well in a virtual environment; VDI uses the physical server GPU, which causes poor graphics performance. Support for peripherals is usually limited to printers and USB keys.

Client Blade Infrastructure

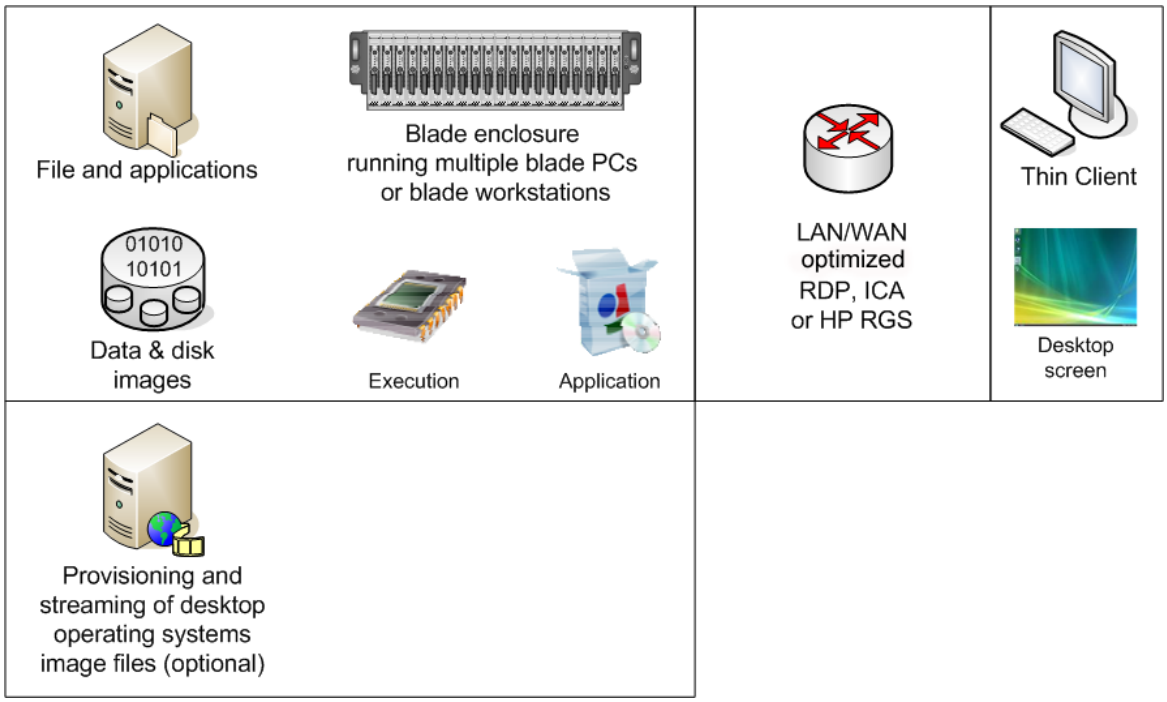
In a client blade infrastructure (see Figure 6), physical desktop PCs are replaced by physical blade PCs running on a blade rack enclosure. Each blade PC has its own CPU, RAM, hard disk, graphics card, and network interface card. A typical blade enclosure can contain up to 20 blade PCs in a 3U rack enclosure, allowing up to 280 blade PCs per 42U rack.

Blade PCs are then accessed via the Microsoft RDP, Citrix ICA, or HP RGS protocols and displayed on thin-client devices. Only screen updates, keyboard strokes, mouse actions, audio, and peripheral data travel over the network; all the processing happens on the blade PCs. Blade PCs boot either from a local hard disk or, optionally, from images dynamically created from master copies via a provisioning server. Users are connected to blade PCs either statically or through a software broker, such as HP's Session Allocation Manager, thus allowing the creation of concurrent pool resources and lowering the amount of IT administration.

Overall computing performance in a client blade infrastructure is on par with that of physical desktop PCs. For more demanding applications such as those that are computationally intensive or involve the visualization and manipulation of diagnostic images, there are blade workstations that have specifications comparable with those of traditional desktop workstations.

FIGURE 6

Client Blade Infrastructure



Source: Health Industry Insights, 2009

Pros and Cons

Pros

Client blade infrastructure takes centralized computing to the next level — it presents all the advantages brought by server-based computing and virtual desktop infrastructure while removing most of the limitations. The main improvement in a client blade environment is that the HP RGS protocol runs video and 3D applications efficiently because blades provide dedicated CPU and graphics subsystems. In a blade environment, RGS also increases support of USB devices compared with RDP and ICA.

For the IT administrator, blade PCs and workstations remain just normal computers that can be managed like any other computer within the organization. Client blade infrastructure presents a major difference with virtual desktop infrastructure regarding Microsoft Windows Vista licensing: Organizations wishing to deploy virtual desktop infrastructure must subscribe to Microsoft Vista Enterprise Centralized Desktop on an annual basis; in that case, the licenses are leased, not owned, whereas blade PCs and blade workstations in a client blade infrastructure are provided with an OEM license of Microsoft Windows Vista that is owned by the organization.

It should be noted that although static local hard disks can be used with blade PCs, the deployment of a provisioning server is strongly recommended as it leverages the full capabilities of the architecture through the dynamic creation of disk images and the possibility of patching only master copies. The lack of a local drive also provides enhanced "lockdown" capabilities for securing applications and confidential patient health information (PHI) to ensure compliance with HIPAA security and privacy requirements.

Cons

Deploying a client blade infrastructure represents a challenge for IT managers because of the potentially greater initial investment cost compared with other solutions such as server-based computing or virtual desktop infrastructure. However, for power users, this approach can provide superior performance when compared with server-based virtual PCs, so IT managers will need to develop solid business cases clearly demonstrating greater ROI through lower administration costs compared with traditional distributed computing.

Thin-Client Devices

Thin-client devices have evolved significantly in the past few years. In the past 12 months, HP has substantially grown its portfolio of thin-client devices to cover the needs of all segments of the market. Models are available with various operating systems, including HP ThinConnect, ThinPro (Linux), Debian Linux, ThinPro GT (Linux), Windows CE, and Windows XP Embedded (XPe).

User types vary greatly (from task worker to knowledge worker), so IT managers will need to work closely with their systems integrator to determine which model(s) corresponds best to their specific user needs as an integral part of the overall remote client solution.

As point-of-care computing becomes more mainstream, mobile solutions such as wireless laptops and tablets can be used as thin clients over a wireless local area network (WLAN). This solution is well-adapted to large campuses where clinicians and other mobile workers often roam between locations.

Manageability is a critical factor for thin-client devices as administrators must be able to remotely configure and patch devices from a centralized system. In the specific case of HP thin clients, manageability is achieved through the standard availability on all models of the integrated Altiris Deployment Solution as well as the HP ThinState tools, HP Device Manager, and HP Client Automation. In addition, enterprises can benefit from Microsoft System Center Configuration Manager on the Windows CE and XPe platforms.

Although the acquisition cost of a thin-client device can appear only marginally lower than the price of an entry-level desktop PC, the real savings are in the reduced operating costs over the life expectancy of the device. The savings are imputable to several factors: lower maintenance costs, better productivity, and lower power consumption. Numerous studies have demonstrated improved clinician productivity and data quality when mobile point-of-care devices are used for accessing and updating patient clinical data.

Related Research

- *Remote Client Solutions: The Multiplication of Virtualisation Technologies* (IDC/HP White Paper, IDC #AU201213Q, June 2008)
- *Virtualization: Healthcare's Cure for the Common Cost? Part 2*, (Health Industry Insights #HI209705, December 2007)
- *Virtualization: Healthcare's Cure for the Common Cost?* (Health Industry Insights #HI205033, January 2007)

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