Remote desktops are steadily making inroads in corporate IT. Gartner estimated that virtual desktop infrastructure (VDI) had achieved a 2% penetration rate in 2012, the firm projects that adoption will top 8% by 2015. The healthcare industry, in particular, is firmly embracing the idea of remote computing. 35% of healthcare businesses are embracing VDI, according to a study conducted by Imprivata. This places healthcare among the highest adopting industries for VDI. Reasons that healthcare is ahead of other industries in remote computing include large number of employees who require remote access to patient information as well the ability for desktop roaming while caring for patients, strict information security requirements, and relatively uniform application sets in each practice area. Desktop support costs are also typically lower for remote desktops that work off of a small number of identical OS/application images. Indeed, Citrix, the maker of the widely used XenDesktop software, has published that their clients are saving money with VDI while improving their IT support. For instance, Citrix says that Seattle Children’s Hospital has saved $1,000,000 per year with VDI.

Abstract

The healthcare industry has been an early adopter and leader in remote desktop computing. Today, as ultra-dense server form factors and low-power Advanced Processing Unit (APU) processors become available, healthcare IT professionals are getting a new option for remote desktop: Hosted Desktop Infrastructure (HDI), which provisions a desktop session on a dedicated, APU-based hardware cartridge in an ultra-dense server. The HP ConvergedSystem 100 for Hosted Desktops combines the HP Moonshot 1500 Chassis and AMD Opteron™ X2150 APU to provide several advantages for classes of users who may not have been candidates for virtual desktop infrastructure (VDI) in the past. This includes improved graphics capabilities, more efficient handling of storage, and more consistent performance. This paper reviews how the HP ConvergedSystem 100 for Hosted Desktops solution addresses some of the more pressing concerns facing healthcare IT departments that want to deliver the performance of a local experience but the security and administrative efficiency of a remote desktop. HP ConvergedSystem 100 for Hosted Desktops complements the healthcare IT organization’s evolving data security and remote desktop strategies and expands its potential to serve new classes of users.

Overview

The challenge for healthcare IT managers is to provide the right remote desktop technology for each of its user classes. VDI and Microsoft® Remote Desktop Services (RDS)/Terminal Services may be effective for some nurses, lab technicians, and structured-task office workers. But, practitioners, clinical administrators, researchers, and other heavy PC-using workers have remote desktop needs that are not well-matched to the VDI or terminal services model. A new technology now makes it possible to give these users a remote desktop experience that will meet their needs. “Hosted Desktop Infrastructure” or HDI delivers a remote desktop from dedicated hardware in a central location. This is accomplished with low-power accelerated processing units (APUs), each running an individual hosted desktop on a compact microserver cartridge in the data center. HDI provides the user with a dedicated Windows® desktop image on exclusive hardware. It is a breakthrough solution that merges the support, security, and centralized control benefits of remote desktop with an end user experience that is graphically rich and responsive.

This paper explores how HDI using the HP ConvergedSystem 100 for Hosted Desktops, powered by the AMD Opteron X2150 APU, enables healthcare IT managers to expand the use of remote desktops to classes of users who are not compatible with VDI. The paper will review how the HP ConvergedSystem 100 for Hosted Desktops’ combination of dedicated hardware and its distinctive Citrix software architecture deliver a remote desktop user experience that helps healthcare IT advance its remote desktop strategy improve utilization of IT support resources, centralize data, and improve delivery of care.

The Goal: More Pervasive Use of Remote Desktops in Healthcare

As a business, healthcare has long been a good candidate for remote desktops. Healthcare is an information-intensive field as virtually every employee is processing patient information regularly throughout the (24 hour) day. Every procedure, every lab test, every x-ray and prescription is represented by a series of data points entered into medical records systems, reviewed by practitioners for delivery of care, and processed by clerical staff for insurance payment.

The industry’s economic profile begs for technology that will improve worker productivity. Healthcare is labor and information technology intensive, but revenue per employee is low. With these financial dynamics at work, healthcare IT managers are under intense pressure to find new ways of equipping millions of staffers with cost-effective desktop technologies.

Compounding the challenge is the fact that many healthcare desktop users are constantly on the move. Nurses and practitioners go from room to room in hospitals and clinics, often pushing a PC on a cart (known, in industry parlance as a “Computer on Wheels” or “COW”). Remote desktops allow the nurse or practitioner to move around the hospital without the need to cart around a costly, breakable PC that is vulnerable to theft. With the remote desktop, the healthcare worker can easily and compliantly process patient information anywhere, including outside the hospital premises on an inexpensive thin client device. The thin client can be portable or fixed.

“The healthcare industry is constantly looking for ways to improve care while simplifying IT management. HDI is a game changer in that department.”

Jaymes Davis
Director of Cloud & Virtualization Strategies
Entisys
How VDI Works

VDI works by creating a virtual machine (VM) desktop for each remote user. VDI involves setting up virtual machines on a server and connecting users to a VM-based virtual PC. Typically, VDI employs large-scale, conventional servers, both blade and rack-mounted, each able to host multiple virtual PCs.

As shown in Figure 1, the VDI stack involves a hypervisor, which divides the resources of a server into VM desktops. The end user accesses the VM desktop over a client device. The VDI stack virtualizes applications that the end user needs and interfaces with storage. A communication broker handles the traffic going back and forth between the end users and the VM desktops. Microsoft RDS has a different, but analogous system architecture. It also brokers virtual desktop sessions to remote users who are on thin clients.

VDI can be quite efficient in infrastructure terms. It is possible to host a large number of VM desktops on a fairly small hardware footprint. For instance, in a recent study conducted by AMD, it was possible to host 120 virtual desktops on a 1U server running dual AMD Opteron 6378 processors (2.4 GHz, 16 cores, 115 Watt) with 192 GB of RAM. This translates into 3.75 virtual desktops per processor core. Infrastructure managers might assign more or fewer virtual desktops per core depending on the use case.

Infrastructure efficiency notwithstanding, there are three essential reasons why VDI is not ideal for everyone in the healthcare field:

- VDI is not compatible with the computing needs of some healthcare desktop user classes.
- Sub-optimal results due to the trade-off between network and compute capacity vs. user experience.
- IT complexity and costs

Support costs are a significant driver of interest in expanding the user base of remote desktops in healthcare. Healthcare organizations that provision individually imaged PCs to employees face high support costs compared with what is possible with VDI and Terminal Services. Typically, with actual PCs, although the IT department may mass-image many PCs and provision them to employees, these images become unique over time. Users download new applications and adjust settings. Sometimes, new updates are not installed. The IT staff finds itself in time-consuming "one-off" diagnostics of failed PCs. The full-time employee (FTE) to IT staff ratio at a healthcare company is better when desktop computing is remote and under centralized control.

Within each practice area, users tend to have similar application needs. For instance, most patient-facing users get the same electronic medical records (EMR) application. Then, within a practice area, such as the Emergency Room or Oncology, all users will have the same practice-specific application needs. Remote PCs can be provisioned from a limited pool of identical, practice-based images that can be updated centrally, further streamlining IT support.
Constraints on Remote Desktop Growth in Healthcare

As a business, healthcare has long been a good candidate for remote desktops. Healthcare is an information-intensive field as virtually every employee is processing patient information regularly throughout the (24 hour) day. Every procedure, every lab test, every x-ray and prescription is represented by a series of data points entered into medical records systems, reviewed by practitioners for delivery of care, and processed by clerical staff for insurance payment.

Under-served User Classes

VDI and RDS favor lighter-weight, routine tasks, such as the hospital admissions clerk who enters patient information into an online form. Graphics heavy workloads are not a good fit for VDI. Nor is any kind of data or media-intensive user interaction. This deficit makes VDI unsuitable for several user classes.

• **Practitioners** Doctors require a level of graphics and media output on a desktop that is quite difficult to replicate reliably on VDI. These include graphic intensive tasks such as viewing digital images from radiological exams, watching a video recording of a sonogram, reviewing large PDF documents, and so forth.

• **Power Users** This user class includes executives, administrators, clinic managers, financial managers, pharmacy managers, and researchers. Power users require a desktop that can easily handle heavy quantitative work. They may need access to digital video and may have multiple enterprise business applications running at once.

• **Nurses** Given the diversity of specialized tasks and roles within nursing, this user class falls in two subcategories: Those who can get their work done with lightweight VDI solutions and those who need a more robust, PC-like experience.

Medical practice and nursing are high-pressure occupations. Doctors and nurses want a totally consistent PC user experience so they can get their work done without interruption. IT departments that serve them are usually expected to help reduce their stress level in this context. Having practitioners be frustrated with IT tools, such as VDI, is counter-productive and bad for morale—a seemingly intangible issue that can have a real impact on quality of care and costs. Some healthcare IT departments will actually over-provision PC hardware so that practitioner users can have a totally consistent user experience.

“VDI is amazing for many healthcare workers, but it has difficulty satisfying the practice needs of more high-end workers, such as hospitalists, nurses, and administrators.”

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Director of Cloud & Virtualization Strategies
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Network and Compute Capacity vs. User Experience

By definition, VDI is a shared resource solution. Multiple users share the same server, processor, network, and storage array. Virtual machine administrators can use soft partitioning to create a consistent, “near native” user experience. This involves allocated infrastructure based on well-understood end-user workload. Changing the user base, however, can bring challenges. If more users are added to the system without a commensurate increase in all necessary infrastructure elements, user experience will suffer.

IT Complexity and Costs

VDI is a challenging technology to get right. Getting a VDI environment set up the first time is an involved affair requiring serious system integration. VDI is actually a complex, inter-dependent architecture that relies on the choreography of multiple servers and clients. System architects have to understand potential user load and create a balance between virtual machines and infrastructure resources. Once they have established that balance, change is potentially destabilizing the network.

Inevitably, however, the user base will change over time. Adding users or modifying resource allocation based on shifting user demands can create difficulties in balancing the user experience for the whole user group. These VDI growth problems are surmountable, but it can be distracting and costly to reset the delicate balance that made the VDI deployment work well initially.

Storage management and capacity are the other IT factors that add complexity and cost to VDI. Virtual desktops need a SAN for storage. SANs tend to be costly, so setting up storage for VDI is a sizeable up-front investment. System administrators must stay on top of VDI storage allocation and processing of I/O to ensure a good user experience. Then, as the user base grows, and its storage needs increase, there will be the need for investment in more SAN capacity with related network enhancements.

“Storage is a big deal for desktop admins that have to deal with large VDI implementations. It’s sort of like the 800 Terabyte gorilla in the corner.”

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If the use case is uniform and workers are mostly using the same software for tasks that can be predicted, such as health claims management, the load on the virtual machines running the desktops will be even and manageable. If there is variability, there can be spikes in usage and input/output operations per second (IOPS) that can cause “bad neighbor” behavior and cause delays for everyone else who is sharing their desktop on the same server.

VDI also has the potential to create bottlenecks in the network. For example, each virtual machine must be loaded onto the server from a Storage Area Network (SAN). At the start of a shift, it is necessary to “spin up” hundreds of virtual desktops. This activity can generate thousands of input/output operations per second (IOPS) on the SAN. The resulting load on the SAN and network can negatively affect the user experience for everyone on the network.

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Realizing HDI with the HP ConvergedSystem 100 for Hosted Desktops

The new HP ConvergedSystem 100 for Hosted Desktops attacks the remote desktop challenge from a different direction. Rather than relying on virtualization in large, multi-core processors to support virtual desktops, the HP ConvergedSystem 100 for Hosted Desktops provisions remote unshared desktops on dedicated hardware. This dedicated hardware approach combined with a unique, Citrix-based software stack and a graphically powerful APU processor, makes the HP ConvergedSystem 100 for Hosted Desktops capable of delivering a remote desktop experience that will satisfy user classes who are not currently well-served by VDI. HDI on the HP ConvergedSystem 100 for Hosted Desktops transforms the “near native” experience of VDI to a truly native user experience.

Ultra-Dense Servers and Hosted Desktop Infrastructure

The HP ConvergedSystem 100 for Hosted Desktops is built on the HP Moonshot 1500 microserver chassis, an ultra-dense form factor that consumes relatively little energy per server node. HP ConvergedSystem 100 for Hosted Desktops has 45 removable HP ProLiant m700 cartridges inside a 4.3U sled. Each cartridge contains four low-power AMD Opteron X-Series quad-core processors. As a result, HP ConvergedSystem 100 for Hosted Desktops can host 180 desktops, each on its own dedicated hardware node. To understand how the HP ConvergedSystem 100 for Hosted Desktops delivers a PC-like user experience, it is first helpful to review what makes HP ConvergedSystem 100 for Hosted Desktops function so efficiently in the first place:

- **Distinctive Network Design** The cartridges and other system elements in the HP ConvergedSystem 100 for Hosted Desktops share a 2D torus interconnect “mesh fabric”. Each HP ProLiant m700 node has two hot-plug Ethernet switches – allowing for dual active/active teaming, failover support, and 2 GB of aggregate bandwidth. Each switch has 180 downlink ports, one for each node. Both switches have a corresponding uplink module, each with four 40 GB QSFP+ uplink ports. These ports can be used for switch stacking and uplinks to a top-of-rack or network core switch. The net result is HP ConvergedSystem 100 for Hosted Desktops’ ability to enable fast, efficient handling of hosted desktop user interactions.

- **HP ProLiant m700 Cartridge** It takes a highly compact server technology to get 180 hosted desktops into a 4.3U form factor. The HP ProLiant m700 cartridge serves this purpose:
  1. Four “shared nothing” hosted desktops per HP ProLiant m700 cartridge, running on a dedicated AMD Opteron X2150 APU SoCs. The APU contains all of the elements necessary to handle hosted desktop workloads on a single integrated circuit.
     - Four-core 1.5 GHz processor.
     - High-performance memory with 8 GB of RAM and a DDR3 controller per hosted desktop.
     - Built-in AMD Radeon™ HD 8000 Series GPU, with a built-in video decoder and video compression engine. The APU is also able to offload many parallel processing tasks to the GPU, which is typically an energy efficient, powerful but underutilized processing element.
     - Power efficiency with the small-die AMD Opteron X2150 APU offering a thermal design point of between 11-22 watts.
  2. Each HP ProLiant m700 cartridge has a dedicated 32 GB local hard drive (iSSD). (An upcoming model will offer 64GB, which will help deliver a persistent desktop to remote users.) The AMD Opteron X2150 complements with efficient storage interconnect through integrated 2X SATA 2.3 ports. This offers high performance storage for each desktop node, with several end-user benefits.
     - Windows is deployed as a complete operating system (OS) image before being moved to the Citrix XenDesktop Provisioning Server.
     - After streaming the OS image, the storage is used as a local write cache saving IOPS and SAN load.

Figure 3
HP ProLiant m700 cartridge, each containing four dedicated hardware hosted desktops powered by an AMD Opteron X2150 APU.
HDI’s Software Stack

HP ConvergedSystem 100 for Hosted Desktops manages dedicated HDI desktops by adding on to a standard Citrix VDI deployment. Citrix XenDesktop management tools provide a complete delivery model for the HDI desktops. By leveraging existing Citrix XenDesktop software, which many IT departments already own, HDI on ConvergedSystem 100 for Hosted Desktop helps extend the utility and asset value of XenDesktop. Doing a proof of concept for HDI only requires acquiring the hardware if the department already has XenDesktop.

The Citrix Provisioning Server is a key technology for enabling HP ConvergedSystem 100 for Hosted Desktops to deliver HDI. As shown in Figure 4, the Citrix Provisioning Server streams the complete OS and application image to desktops running in both virtual and physical environments. The vDisk image can be shared by many desktops, making it more efficient to load through the network than remote desktops based on VDI. The Citrix Provisioning Server is also versatile enough to enable a multi-site Citrix Provisioning Server farm, depicted in Figure 5. The Citrix Provisioning Server farm brings together several shared infrastructure elements, including a database server, shared storage, license server, and active directory. The advantage of the Citrix Provisioning Server farm approach is that end user devices can be in more than one site, with each site being supported by a separate, but connected set of Citrix Provisioning Servers. For large, multi-site healthcare organizations, the Citrix Provisioning Server farm confers administrative and architectural efficiency to HDI.

Figure 4
The Citrix Provisioning Server streams vDisk images to HP ConvergedSystem 100 for Hosted Desktops one time, after which it can be shared locally by all 180 hosted desktops.

Figure 5
Multi-site Citrix Provisioning Server farm deployment of HP ConvergedSystem 100 for Hosted Desktops.
Completing the Remote Computing Picture in Healthcare

HP ConvergedSystem 100 for Hosted Desktops rounds out healthcare IT’s approach to remote computing and provisions dedicated HDI desktops to user classes that are not suited to VDI and Terminal Services. And, they can do so in ways that answer a number of pressing IT concerns that arise with VDI. With HDI through the HP ConvergedSystem 100 for Hosted Desktops, healthcare IT can take a big step toward a completely centralized desktop environment and be free from the issues that come with supporting individual PCs.

Satisfying New User Classes

Practitioners, administrators, nurses and data-intensive power users who are not well-served by VDI can enjoy a satisfying, consistent user experience on HDI desktops. This outcome is possible for several reasons. The dedicated, unshared hardware approach taken by HDI desktops on HP ConvergedSystem 100 for Hosted Desktops gives each individual user a discrete, exclusive processor and remote hard drive. The resource sharing issues that potentially overtax VDI systems are greatly reduced in HDI. Plus the HP ConvergedSystem 100 for Hosted Desktops network strength further mitigates the potential for service disruptions on the client side.

HP ConvergedSystem 100 for Hosted Desktops end users benefit from application software running locally on the dedicated hardware during their individual sessions. Windows, Microsoft Office, and specific healthcare applications run locally, on a dedicated AMD Opteron X2150 APU. In cases where the user’s HDI desktop is the client for an application hosted elsewhere, the HP ConvergedSystem 100 for Hosted Desktops dedicated hardware approach and network efficiencies make the client/server experience feel as if it were taking place on a local machine. The local iSSD on the HP ProLiant m700 cartridge serves as the users c:. This cuts down on network use and speeds up the responsiveness of the desktop.

Graphically, the HDI desktop on HP ConvergedSystem 100 for Hosted Desktops is vivid enough to satisfy even demanding high-end users such as a physician who needs to view a digitally recorded video of an endoscopy or a clinical professor who is creating 3D visual displays of large research data sets. Citrix supports HDX video for rich graphics on HP ConvergedSystem 100 for Hosted Desktops. HDX works by removing the cap on memory that is usually allocated to graphics on individual remote desktops. HDX makes possible HD video and PDF scrolling that is up to 6x faster graphics frames per second versus traditional VDI.

HDX on HP ConvergedSystem 100 for Hosted Desktops is session-based and non-persistent. Each end user is able to enjoy the benefits of central control but experience a personalized user interface. When a user logs in and initiates a remote desktop session on the HP ConvergedSystem 100 for Hosted Desktops, the server loads their personalized HDI desktop. Preferences, such as icon placement, color schemes, file folders, and so forth, all appear as if the user were booting a laptop. At the same time, centralized control enables IT to maintain just one master image for each desktop type. For example, staffers at a hospital pharmacy would all share the same image, but each would experience it with personalization.

Patient Care Benefits

The technical performance potential of the HDI desktop can have a beneficial impact on patient care. For example, practitioners such as hospitalists, who treat patients in their rooms, can benefit from seeing radiological images at bedside. Until now, this has proved difficult with thin client technology and VDI due to graphics processing limits on the technology. With HDI, the hospitalist can view a JPEG image from an MRI scan, for instance, from the hospital’s Picture Archiving and Communication System (PACS). Being able to look at the image and the patient at the same time improves the quality of care and enables more patients to be served each day, helping to keep the cost of care under control.
Solving for IT Pains

Delivering HDI on HP ConvergedSystem 100 for Hosted Desktops eases several stresses facing healthcare IT departments that have struggled with supporting user classes that were not able to take advantage of VDI. By enabling IT to provision hosted desktops to users who are currently on physical PCs, HDI should improve the full-time employee to IT staff ratio and cut support costs and associated problems.

- Security issues present on physical laptops largely disappear once the machine is centrally controlled and remotely hosted.
- By using existing Citrix XenDesktop software, HDI enables IT managers to realize greater utilization of already-installed software assets and generate better return on investment (ROI) on Citrix software purchases. There’s no need to “reinvent the wheel” for the software side of HDI. Proof of concept testing for HDI can also be easily accomplished on existing XenDesktop setups.

HDI makes it possible to add remote desktop users up to 90x faster than traditional PCs, without concern for upsetting the kind of delicate balance between network, storage, and compute that concern administrators with VDI.

- There is no tradeoff between user experience and compute/network load.
- Sizing of infrastructure requirements is simple. 180 users per chassis (4.3U) helps maximize data center space.
- Testing and validation with Citrix XenDesktop ensures delivery to virtually any endpoint device.
- Deliver a fixed cost per user with predictably sized, dedicated hardware resources.
- No virtual machines or SAN storage to manage.

Financial Advantages to HDI

What does a hosted desktop actually cost? And, how does that compare to an actual PC? Some observers peg the numbers as being fairly close. Art Wittmann, writing for Next Generation Data Center, estimates the total cost of a virtual PC at about $900 (See Appendix B.) In this model, he assumes that the server and processor portion of the cost is $250. Substituting the HP ConvergedSystem 100 Hosted Desktops into this total cost formula, the price of a ultra-dense server-based hosted desktop is $1,334. Both figures are about the same or higher than what it would cost to purchase a good quality laptop for an employee. Where HDI generates savings, however, is with support:

- Appendix A shows the average cost of desktop support as measured by MetricNet. Annual desktop support costs average $1,170 per seat for physical PCs. This is where organizations can save using hosted desktops. Streamlined HDI desktop administration lowers support costs and complexity, up to 44% lower TCO vs. traditional desktops. Saving on over-specced PC hardware for practitioners and nurses.
- Having more centrally controlled, remote machines translates into supporting fewer “one off” trouble shooting calls and unique image issues.
Conclusion

HDI is a new approach to provisioning centrally managed, remote desktops. HDI delivers a solution to a problem that healthcare IT has been grappling with for several years: How to reduce, or even eliminate, reliance on physical PCs for all users in a healthcare organization. To date, VDI and Terminal Services, while excellent for many healthcare information tasks, have not been suitable for high-end users such as practitioners and clinical administrators. Now, with HDI, it is possible to provide a remote desktop for those users. HDI on HP ConvergedSystem 100 for Hosted Desktops offers the kind of graphically rich, responsive, “PC-like” experience that these user classes demand. On the operational and IT cost fronts, HDI on HP ConvergedSystem 100 for Hosted Desktops promises to facilitate reductions in employee PC support time and cost. HDI on HP ConvergedSystem 100 for Hosted Desktops also makes it possible to expand remote desktop use without necessarily expanding costly SANs and upsetting the delicate compute/SAN/network balance that is required with VDI. HDI is a promising technology that will usher in a new era of broader adoption of remote desktops in healthcare.

4. Based on internal HP testing, October, 2013. Compared to traditional desktop PC. Results from running 3D-Glaze on m700 (Glenn) AMD cartridge and a single vCPU Virtual Machine on a BL460c Gen8 Server Blade
5. Based on internal testing, October, 2013. Calculations are based on conservative one hour minimum to reimage a standard PC; and multiplied by the 180 desktops contained in the HP ConvergedSystem 100 for Hosted Desktops chassis. Calculating total time from unboxing to completed images integrated into a Citrix environment and ready for use on 180 nodes took 2 hours. 180 divided by 2 hours = 90 times faster.
6. Estimate based on $125,000 list price for Moonshot, with 180 desktops per machine, or $694 per hosted desktop.
7. Based on internal HP testing, October, 2013. Calculations are based on comparisons between the HP ProLiant m700 Moonshot server cartridge and the Compaq 4300 SFF desktop model. Comparisons were based on 1800 total desktops for calculations purposes with a total 3 year per user support total of $971.73 for the HP ProLiant m700 Moonshot server cartridge and $2,301.20 for the Compaq 4300 SFF desktop. Total 3 year productivity losses due to self-repair were $789.58 for the HP ProLiant m700 Moonshot server cartridge and $2,133.99 for the Compaq 4300 SFF desktop. Total 3 year hardware, software and power costs were $1,661.62 for the HP ProLiant m700 Moonshot server cartridge and $1,376.67 for the Compaq 4300 SFF. This amounts to 3 year total costs of $3,422.92 for the HP ProLiant m700 Moonshot server cartridge and $5,811.86 for the Compaq 4300 SFF. This results in a cost savings of 42% for the HP ProLiant m700 Moonshot server cartridge over the traditional Compaq 4300 SFF desktop.

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## Appendix A: Desktop Service Support Estimates

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per ticket</td>
<td>$ 62</td>
</tr>
<tr>
<td>Cost per incident</td>
<td>$ 48</td>
</tr>
<tr>
<td>Cost per service request</td>
<td>$ 113</td>
</tr>
<tr>
<td>Tickets per seat month</td>
<td>0.78</td>
</tr>
<tr>
<td>Incidents per seat month</td>
<td>0.6</td>
</tr>
<tr>
<td>Services requests per seat month</td>
<td>0.18</td>
</tr>
<tr>
<td>Incidents as a % of total ticket volume</td>
<td>77%</td>
</tr>
<tr>
<td>Ratio of seats to desktop support technicians</td>
<td>164</td>
</tr>
<tr>
<td>Number of seats</td>
<td>5,000</td>
</tr>
<tr>
<td>Seat months per year</td>
<td>60,000</td>
</tr>
<tr>
<td>Tickets per year</td>
<td>46,800</td>
</tr>
<tr>
<td>Incidents per year</td>
<td>36,000</td>
</tr>
<tr>
<td>Services requests per year</td>
<td>10,800</td>
</tr>
<tr>
<td><strong>Cost of service</strong></td>
<td></td>
</tr>
<tr>
<td>Tickets</td>
<td>$ 2,901,600</td>
</tr>
<tr>
<td>Incidents</td>
<td>$ 1,728,000</td>
</tr>
<tr>
<td>Services</td>
<td>$ 1,220,400W</td>
</tr>
<tr>
<td>Total</td>
<td>$ 5,850,000</td>
</tr>
<tr>
<td>Cost per seat/year</td>
<td>$ 1,170</td>
</tr>
</tbody>
</table>

*Source* MetricNet “The True Cost of Desktop Support”
### Appendix B: Complete VDI Cost per Desktop

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost per Virtual Desktop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software - Citrix VDI in a box</td>
<td>195</td>
</tr>
<tr>
<td>Citrix support</td>
<td>35</td>
</tr>
<tr>
<td>Windows® 7 Pro</td>
<td>150</td>
</tr>
<tr>
<td>Thin client hardware</td>
<td>200</td>
</tr>
<tr>
<td>Server and CPU</td>
<td>250</td>
</tr>
<tr>
<td>Storage</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$890</strong></td>
</tr>
</tbody>
</table>

**Source**: Art Wittmann, “Calculating the True Cost of VDI,” Next Generation Data Center (April 15, 2013)