



TABLE OF CONTENTS

Virtual Desktops – Attributes and Benefits	2
VDI Architectures and Technologies	4
The Pano System – a Zero-Client VDI Architecture	5
Physical and Virtual Infrastructure Components	5
Physical Infrastructure – Servers	5
Physical Infrastructure – Storage	6
Physical Infrastructure – Local Area Network	6
Hypervisors – VMware ESX and ESXi	7
Connection Broker and DVM Management - Pano Manager	7
Enhanced Management – VMware vCenter Directory Services and Authentication	8
Constructing Desktop Virtual Machines	8
Managing Pano System Virtual Desktops	9
Sizing Hardware for Virtual Desktop Workloads	12
Putting it all Together	13
The Pano Device	14
Remote Access to Virtual Desktops	15
Pano Remote	15
Pano Gateway	15
Benefits from the Pano System	16
For More Information	16

Virtual Desktops and the Pano System: An Architectural Overview

Extending Server Virtualization to the Desktop and Beyond

Virtualized desktops, running a standard Windows operating system but hosted on centralized servers, promise to radically reduce the ever-increasing drain on IT resources from deploying and supporting desktop computing. By consolidating these virtual desktops in the data center, benefits including improved IT productivity, increased data security, reduced user downtime and even significant power conservation can be realized.

Pano Logic® is the first company to offer a complete, purpose-built solution for virtual desktops combining a unique zero-client endpoint device with tools designed specifically for the deployment and management of virtual desktops.

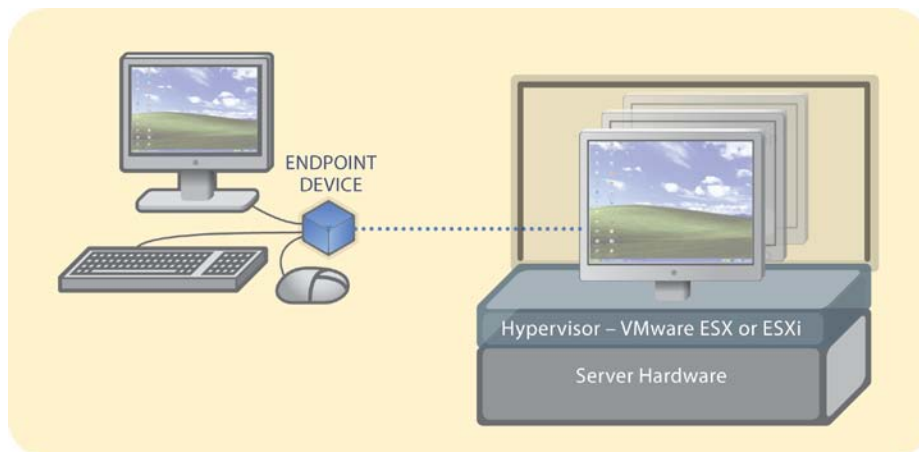
This whitepaper explains the technology and architecture used in server-based virtual desktop computing, exploring some of the benefits and challenges seen by IT organizations adopting the technology. The required hardware and software components are also discussed, using the Pano System™ as an illustration of how they can be combined in different scenarios to deliver the unique benefits of virtual desktops.

Figure 1:
Virtualized desktops connect virtual machines running on a server-based hypervisor to endpoint devices.

Virtual Desktops – Attributes and Benefits

Virtual desktops enable users to access a standard Windows operating system installation, along with whatever applications and data are needed, running on centralized servers in a data center. These servers use specialized software called hypervisors to create a “virtual machine” that simulates roughly the same capabilities as physical desktop computers. Desktop virtual machines (DVMs) connect over local area networks to specialized endpoint devices at the users’ location that in turn are connected to peripherals like monitors, keyboards, mice and other peripherals to make a complete system.

While there are many technological and architectural approaches to virtual desktops, they all share a common goal – to free the user’s desktop computing



environment from the constraints and problems associated with deploying, maintaining, securing and supporting it on physically distributed personal computer hardware.

Personal computers have provided knowledge workers with great utility and power, growing into a robust environment for a wide variety of applications and tasks. Unfortunately along with that growing utility has come an even more rapid growth in deployment and management headaches for the supporting IT organizations. Physical desktop PCs can require an inordinate amount of management to make them secure, reliable platforms – and even more troublesome is that support issues often require a trip by IT staff to the user’s desk in order to physically troubleshoot problems. PCs also pose many potential security problems as they make it easy for users to create uncontrolled local copies of critical data – exposing the organization to difficulties ranging from simple data archiving and destruction policy violations to complex and costly thefts of customer or financial data resulting in legal liabilities and public relations disasters.



Virtual desktops are growing in popularity because they address many of these issues through their two key attributes: being consolidated in a central location, and by being virtual rather than physical in nature.

Benefits from the consolidation and centralization of desktops include:

- Improved IT and Help Desk Productivity – centralization largely eliminates the need for IT staff to spend time traveling to the user’s location in order to resolve trouble tickets or perform routine maintenance.
- Hardware Capital Savings –PCs typically use only a small fraction of their peak processing capacity meaning that a huge number of CPU cycles, RAM capacity, and local hard disk storage goes unused – consolidating those desktops onto shared server hardware gives users more cost-effective peak computing resources with much greater utilization levels overall.
- Simplified Maintenance – centralized DVM images can easily and quickly be monitored, backed up and recovered, and patched or upgraded.
- Greater Data Security – by centralizing all user files and data rather than relying on distributed, uncontrolled local PC storage devices, data loss stemming from both hardware failures and from the loss or theft of PCs and laptops can be eliminated.

Virtualizing desktop computers can also contribute a number of benefits:

- Rapid Provisioning – setting up a virtual computing environment for a new user requires only a few simple commands at a management console.
- Faster Upgrades – increasing the hardware or storage resources allocated to a user is a simple configuration change to the DVM, without any need to travel to a user’s location or to ship a computer for upgrading.
- Greater Flexibility – virtual desktops make it easy for users to switch their computing environments – for example, where an employee has two distinct roles requiring different configurations or application sets.
- Less User Downtime – virtual desktops can be rapidly recovered by substituting a newly cloned image, allowing users to recover from an OS corruption or malware infection with minimal downtime.
- Improved Standardization – enforcing common standards is much easier with virtualized “hardware,” making support and troubleshooting for driver and configuration conflicts much faster and further reducing help desk workload and user downtime.
- Easier Roaming – since the user’s connection to the virtual desktop can be suspended at any location and then immediately resumed without any interruption of applications or open files – such as when moving from your office to a conference room – allowing users to quickly access their computing environment from any location.
- Reduced Power Consumption – when used with the right client endpoint devices, virtual desktops can use just a few percent of the electricity consumed by traditional desktop PCs, saving substantially on energy bills both to power the devices and for air-conditioning to remove the resulting waste heat – saving enough to pay for the endpoint devices in just a few years.



These are some of the benefits you may realize from virtual desktops – as with any advanced technology you need to make careful choices of the strategies and architectures you use in a virtual desktop deployment to achieve optimal results.

VDI ARCHITECTURES AND TECHNOLOGIES

Virtual desktop infrastructure (VDI) architecture choices include what endpoint hardware to deploy, what hypervisors to support, whether virtual desktops are only server-based or also client-based, and what level of management capabilities and tools are used to support and manage the VDI deployment.

Endpoint technology choices can also drive a great deal of the maintenance and cost overhead for a virtual desktop deployment. One common architecture choice for an endpoint devices is what is commonly referred to as a thin-client – the term “thin” being a comparison to the relative “fatness” of a PC used as a client device.

However, thin-clients almost universally still require a client-side operating system, typically Windows XP embedded (XPe) or Windows CE – this thin-client OS in turn requires license fees and will have to be patched, managed, and even protected from malware such as Windows-based viruses. Some thin-client vendors even charge significant fees for firmware and protocol maintenance and upgrades, further increasing costs and complexity. In many cases these thin-clients begin to duplicate the CapEx/OpEx costs and IT management overhead of the traditional PCs they replaced, significantly neutering the potential benefits from deploying VDI. Over the years, many thin clients have evolved into “chubby” clients with the addition more and more hardware.

One endpoint alternative to thin-client complexity is a “zero-client” where the term “zero” refers to the complete lack of client-side CPU, software or even firmware, eliminating all of the licensing costs and maintenance complexity from the distributed endpoints and providing a much stronger base for fully realizing the potential benefit of virtual desktops.

Putting adequate server and storage resources in place for a virtual desktop rollout (or even a pilot) can have a significant impact on the success of the project. Getting users to accept a physical to virtual conversion of their personal computing environment will be conditioned in large part by what performance changes they perceive. Choosing the right architectures and technologies will help ensure that perception is favorable but only if the virtual desktops have sufficient CPU capacity, allocated RAM and storage throughput. IT organizations often run trials of virtual desktops on servers that have some spare capacity or that might be underutilized after a server consolidation rollout. That approach may work for limited trials but committing the resources needed to provide sufficient capacity in servers, storage, and networks can be one of the most important choices made in rolling out a full-scale virtual desktop deployment.

To help illustrate the above benefits and how VDI architecture choices influence them, we will examine the specific architecture and technology choices in the Pano System in the sections that follow.



Figure 2:

The Pano System – consisting of the Pano Device, Pano Manager, and the Pano Direct Service

THE PANO SYSTEM – A ZERO-CLIENT VDI ARCHITECTURE

The complete Pano Logic solution includes the Pano Manager™, the Pano Direct Service™, and the Pano Device™. In addition, the solution requires the VMware hypervisor and a few additional infrastructure components—which you are probably already running—necessary to manage and authenticate the Pano virtual desktops. Together, these elements form an integrated solution, as illustrated in

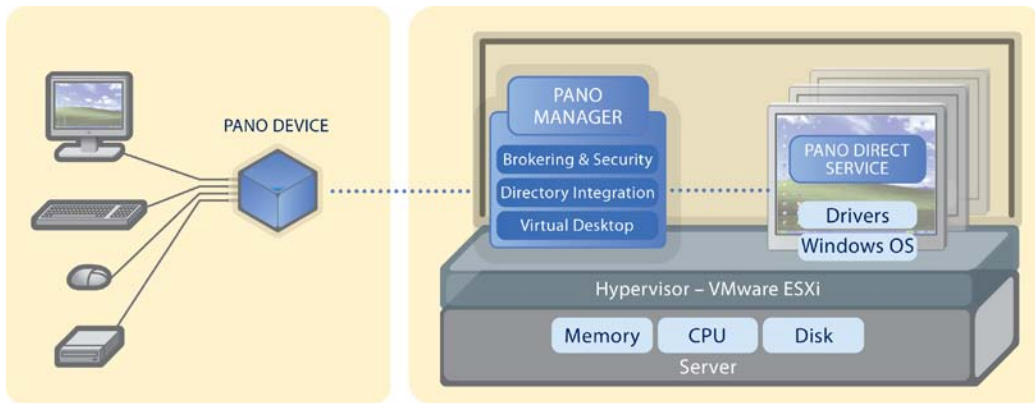


Figure 2. The rest of this document examines each of the key building blocks—the server-based physical and software components, the Pano Device, and the supporting infrastructure—in detail.

Physical and Virtual Infrastructure Components

Virtual desktops, at least in server-based approach such as that used by the Pano System, rely on a physical computing infrastructure of servers, storage, and networks along with a number of centralized virtual infrastructure software components running on the physical infrastructure. This section will discuss each of these components along with making some general configuration or sizing suggestions – more detailed suggestions for scoping DVM configurations based on user workloads is provided on page 12.

PHYSICAL INFRASTRUCTURE – SERVERS

The foundation of the virtualization infrastructure is a standard x86-based virtualization server or cluster of servers, often with multiple multi-core processors and a large complement of RAM. These servers' primary responsibility is to host the DVMs as well as the VMware management VMs and the Pano Manager VM or appliance. These servers are often configured as a cluster of servers for scalability and deployed in a failover configuration to provide enhanced reliability using the VMware High Availability, Dynamic Resource Scheduling, and vMotion features in the VMware vSphere 4.0 and VI3 software suites.

The processing load from DVMs, and therefore the sizing of the servers, is highly dependent on the workload and activities of the DVM users. For typical users, five



DVMs per server CPU core are recommended, although eight or more DVMs may be deployed per CPU core for lighter workloads.

Memory allocated to DVMs may be anywhere from 512MB to 1GB or more depending on the type of user workload and applications being used. It is important not to under-allocate RAM to prevent individual DVMs from paging their simulated memory to the DVM image file and thereby burdening the storage sub-system. To avoid this, more memory should be allocated to DVMs that are exhibiting significant levels of paging when possible. The total RAM on the virtualization server may be over-allocated to the supported DVMs, thus allowing the hypervisor itself to make more intelligent paging decisions than the Windows OS in any individual DVM can. Typically, 70-80% of the memory allocated to DVMs will be in the server's physical memory, with the rest being in the ESX swap (page) file on disk.

PHYSICAL INFRASTRUCTURE – STORAGE

Another key physical infrastructure component is storage, usually in the form of arrays of disks either directly attached to the servers running the DVMs (referred to as local storage) or more commonly as part of a shared Storage Area Network (SAN). Because the Windows OS reads and writes often to the virtualized disk drives presented to it by the hypervisor, the performance of the storage subsystem used by the servers is a critical factor in how well the virtual desktops perform and scale under load.

Availability can also be a critical factor as any DVM stored on local storage is at risk of not being available if the server it is stored on is unavailable due to a failure or maintenance. If this risk is acceptable, or there are alternate equivalent DVMs on other hosts, then local storage can be used to reduce infrastructure costs. If DVMs are unique, such as with DVMs that have been permanently assigned to users, and availability is a significant concern, then shared storage should be used.

The local disk sub-system or shared storage servers used to store DVM image files must deliver a sufficient number of IOPS (Input/Output Operations per Second) at a low enough latency to support an adequate response time. Disks in storage servers are usually configured in RAID arrays for hardware redundancy and performance reasons with non-parity disks storing data and parity disks storing information needed to reconstructed lost data in the event of a hardware failure.

High performance SAS disks rotating at 15,000 rpm will typically support 10 – 15 DVM images per non-parity disk. Less expensive disks, including SATA drives, may be used if fewer or less demanding DVMs are deployed per disk. Parity disks in a RAID configuration do not contribute IOPS and should not be included in these scoping calculations. For larger SANs, large on-controller caches will often greatly improve performance. Optimizing storage usually requires some empirical testing as the specifics of workloads and server configurations will determine what impact a particular storage configuration has on DVM performance.

PHYSICAL INFRASTRUCTURE – LOCAL AREA NETWORK

Getting adequate user experience from virtual desktops depends on having low latency, high-bandwidth local-area network connections provided by standard 10/100 networks (i.e. Ethernet) between the servers running the hypervisor hosting DVMs and the endpoint devices. In some cases where support of virtual desktops is needed in remote locations that are linked by wide-area networks



(WANs), customers have been able to get adequate performance by using local servers running just the ESX hypervisor and the local DVMs on a LAN while still managing all of the desktops from Pano Manager and VMware management VMs connecting over WAN links.

HYPERVISORS – VMWARE ESX AND ESXI

A fundamental software component supporting the Pano System is VMware ESX or ESXi - these hypervisors host both the DVMs, running Microsoft Windows XP Professional, and other specialized VMs including the Pano Manager VM, that perform management and support functions. These VMware hypervisors are referred to as class 1 or native, bare-metal hypervisors meaning that no server operating system is required to support them as they run directly on the server hardware without any other software. The VMware vSphere 4.0 and VI3 suites include an extensive toolset for managing hypervisor servers and hosted virtual machines.

CONNECTION BROKER AND DVM MANAGEMENT - PANO MANAGER

Pano Manager coordinates management and administration of DVMs with the VMware software components. A self-contained software appliance can be placed on any ESX server, Pano Manager enables managers, administrators, and IT staff to configure, provision, restart, update, and retire DVMs.

The functions performed by Pano Manager include:

- Authenticating users at login via the directory server
- Authorizing users and user groups to access specific DVMs
- Creating new DVMs for users
- Monitoring the availability of running DVMs
- Discovery and inventory of Pano Devices
- Handling of the Pano Button request to return to the login screen, restart the DM or, for pooled collections, even get a fresh DVM
- Creating and managing thresholds for available DVMs, ensuring instant access for users while managing compute and power resources by shutting down unused DVMs
- Backup and recovery of the management database used by Pano Manager

Pano Manager performs numerous functions that dovetail with the management capabilities of VMware's vCenter (covered below) to provide an enhanced set of end-to-end management capabilities – however, Pano Manager and the Pano System can also be used without vCenter.

ENHANCED MANAGEMENT – VMWARE VCENTER

VMware vCenter Server (formerly called Virtual Center) provides highly scalable management of VMware virtual machines. When used with Pano Manager, the vCenter console also enables administrators to configure many options that determine how the DVMs operate, including thresholds for resource usage, load balancing, and the cloning of DVMs from a specified template. Firewall settings and network configuration for access to DVMs are also set up in vCenter.



A single instance of vCenter, which can also be installed on an ESX hypervisor, is capable of managing tens of thousands of virtual machines, but servers and desktops. VMware also supports the use of Microsoft Cluster Services to provide redundancy via failover for vCenter.

DIRECTORY SERVICES AND AUTHENTICATION

The user authentication performed by Pano Manager relies on a Directory Services server – supported servers and protocols include Microsoft Active Directory, Novell eDirectory, and OpenLDAP protocols. The Directory Services are used to identify and authenticate users from the login screen displayed when the Pano Device endpoint starts up and connects to Pano Manager. The user identification provided as a user name and password not only confirms the user's identity to Pano Manager but is also used to link users to their assigned DVM if the user is part of a permanently assigned desktops collection (discussed below).

Constructing Desktop Virtual Machines

To simplify recovery and reconstruction of Pano DVMs in the event of corruption or malware infection, a few simple rules can be applied when building virtual machine templates. This approach relies on standard Windows capabilities and works by logically and, in some cases, physically segregating DVM components into four basic groups:

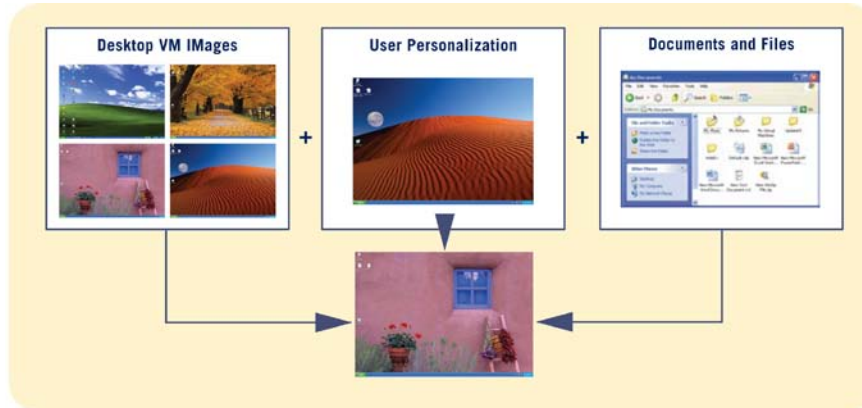
- A VMware virtual machine image running the Microsoft Windows XP Professional operating system along with whatever installed applications are needed for the DVM's intended use.
- The Pano Direct Service device driver (also referred to as Pano DAS), is installed in the Windows OS and extends the graphics and device bus across the LAN to the Pano Device as well as providing local configuration capabilities. A set of extensions called VMware Tools also must be installed in each DVM image.
- A Microsoft Windows user profile. This standard Windows capability records the user's personalization preferences for customizable aspects of the environment, including wallpaper, background colors, and display preferences.
- A mapping or pointer to the user's files stored on a storage server file system. Because the DVM image does not store user files internally, the file system for a given user must be mapped to it using folder redirection or by mounting network shared folders. In this way, even though the user's files are external to the DVM, they appear to be local to the user. Credentials obtained at login determine which files are mounted or mapped for the user to access.

This approach provides the ability to easily re-create a user's DVM at any time. For example, if a user were to corrupt their DVM by opening a virus-bearing e-mail, IT staff could delete the current DVM, and start a new one created with the same DVM image template, standard applications and drivers, user personalization profile, and file access as the original DVM—and the user would be ready to resume work.

This form of recovery can also be applied when an application becomes unreliable or misconfigured. In such cases, it is often easier just to provision a new DVM with



Figure 3:
Desktop Virtual
Machine (DVM)
components



the application software already installed rather than spend hours trying to diagnose and fix the problem. This is one of a number of ways that centrally managed virtual desktops can improve IT productivity while cutting user downtime.

With Windows policies the personalization of the DVM can be limited to a fixed set of options (such as wallpaper and display preferences) or extended in essentially any manner, such as user-specific software bundles or access to special devices.

Managing Pano System Virtual Desktops

One significant advantage of using systems purpose-built for virtual desktops over generalized OS virtualization tools is their customized support for time saving features used to provision and manage different types of DVMs.

In the Pano System DVMs are most often generated from a template that the IT staff has preconfigured. These templates are generally tailored to provide a DVM with all the necessary software for a particular user role, such as a member of the accounting department. Once this template has been configured, tested, and validated, it is stored in the vCenter inventory. DVMs are then cloned from this template to rapidly provision new users or workstations.

These templates and the clones made from them can be more easily managed as a group, known as a collection. A key characteristic of a DVM collection is the method by which users or devices are mapped to DVMs. Mappings are determined by two basic methods: by user and by device.

There are three main types of user-based DVM collections supported by Pano Manager – Pooled Desktops, Permanently Assigned Desktops, and Existing Desktops:

- A **Pooled Desktops collection** consists of a group of identically configured DVMs running on the virtualization server. When a user logs into the Pano Device, authentication credentials identify which group the user belongs to and with which pool of DVMs the group is associated. The user is then assigned to a DVM in that pool, the personalization and file systems are



attached, and the DVM is issued to the user. In a typical deployment, such as in a call center, a pool has some number of DVMs in use and a few hot spares running on the server, so that a desktop can be provisioned quickly at login. Additional DVMs for the pool are typically powered off and can be turned on automatically when needed. Pooled desktops collections have several key benefits:

- The mapping of the user to the DVMs is not persistent in a pooled collection. As a result, sites can achieve a higher utilization level because they can allocate hardware resources based on the average number of active users rather than the total number of possible users. Therefore, if a site has 100 users but they work in several different shifts, it needs to size the environment only to the number of expected concurrent users.
- Since all logins build a new desktop from the DVM pool, the ability to phase in patches and updates from a new “gold image” is possible. However typically DVMs are used, and then returned to the pool, rather than being built for each login. To overcome this, administrators can “refresh” the pool, so that users are assigned DVMs from the updated pool upon next login.

This approach has a limitation compared to other types of DVM collections – a user’s sessions and changes are not persistent, so some users may feel restricted by not having the ability to fully customize their desktop or install applications that are not part of the application set for the pool.

- A **Permanently Assigned Desktops collection** consists of a group of DVMs in which the user-DVM link is persistent. As in a pooled collection, DVMs in a permanently assigned collection are created from a template, but once created the cloned desktop is assigned to only one user. In this type of a collection, personalization can extend beyond profiles, such as permitting users to install new software and extensively customize their Windows configuration. This is possible because users are always assigned to their specific DVM. This approach provides important flexibility to knowledge workers who have individual application preferences or who need the ability to install or update their own software or utilities – allowing them to manage their computing environment just as they might on a traditional physical PC.

This collection type has two caveats: Allowing users to make these changes to their environments also permits them to inadvertently install malware or corrupt applications, although these DVMs can be sometimes be fixed by rolling them back if a previous snapshot was made by the administrator. In addition, updates and patches must be implemented on an individual basis.

Permanently assigned desktop DVMs may be deployed on local storage to reduce infrastructure costs. However, in the event that a server hosting those DVMs becomes unavailable, the corresponding users will be unable to access their Pano desktops until service has been restored or an administrator has intervened to assign alternate desktops to the users. Depending on the deployment model, the delays this might produce may be an acceptable risk.

Permanently assigned desktops may also be deployed on shared storage (on a SAN to ensure higher availability). In the event that a server storing those DVMs unavailable, the DVMs can be migrated to other servers in the cluster either manually or automatically.



- An **Existing Desktops collection** consists of unique DVM configurations that individual users might already be using before a transition to virtual desktops. By gathering these unique DVMs in their own collection, Pano Manager is capable of managing and administering them as a group. One of the benefits of existing desktops collections is the ability to produce a unique DVM for a user by using a physical-to-virtual (PAVE) tool to capture the existing PC desktop OS image and then host it as a virtual desktop through the Pano System. The user gains the convenience of accessing the same OS and application configuration they were used to on their prior PC. The notable disadvantage of this approach is that, similar to a permanently assigned desktops collection, the DVMs in an Existing Desktops collection must be managed individually.

In addition to these three user-based collection types, Pano Manager supports three device-based DVM collection types to simplify the administration of specialized virtual desktops:

- An **Automatic Login collection** type allows you to set up Pano devices and their corresponding DVMs to act like kiosks without the administrative burden of managing multiple accounts and passwords. Rather than displaying the Pano client login screen, the Pano device automatically connects and logs on to the associated DVM using a specified account name and password that is the same for all DVMs in the collection.
- A **Different Accounts w/ Automatic Login collection** allows you to set up Pano Devices and their corresponding DVMs to act like kiosks. This collection type is best when you wish to create a set of kiosks of fixed-use workstations and want to have a unique user name and password assigned to each DVM. Rather than displaying the Pano client login screen, the Pano Device automatically connects and logs into the associated DVM using a saved account name and password. This collection type relies on a user group that has the individual saved account names as members and these accounts must exist in the directory service being used – local user accounts are not supported.
- A **Windows Login collection** allows you to set up a Pano device and a corresponding DVM to act like a general-purpose Windows computer. This collection type is useful if you require users to use biometric devices (such as a fingerprint scanner) for authentication. Rather than displaying the Pano client login screen, the Pano Device automatically connects to the DVM and then requires the user to login to the Windows OS prior to using the DVM.

Finally, there is a user-based **VMware DVM collection** that can be used when Pano Manager is set up with VMware's View Manager. Credentials that users input through the Pano client login screen are then passed directly to VMware View. In this collection type, Pano Manager does not communicate with vCenter to start the DVM – instead VMware's View handles these tasks.

DVMs provide valuable systems management benefits, especially in pooled desktops collections as desktops can be upgraded on the IT department's schedule without interfering with users. To upgrade user desktops, the IT staff simply upgrades the template for the given configuration and then creates the DVM clones to restock the pool on the virtualization server. Then as users log off and log in again, they automatically run the updated DVMs. In addition, it is easier to contain virus outbreaks, because IT can delete infected DVMs and provide fresh



replacement DVMs to the pool. With other collection types, IT can also manually remove infected DVMs and replace them with uninfected snapshots of the DVMs.

Sizing Hardware for Virtual Desktop Workloads

Workloads generated by virtual desktop users can usually be grouped into Light, Typical and Heavy classes – while these groupings are of necessity generalizations, they provide useful guides to match each level to their different demands on server and storage hardware infrastructure supporting typical Windows XP DVMs.

Light class user workloads include task- or knowledge-workers that typically run only one or two applications such as a web browser or a billing application concurrently. Such users may be allocated as little as 512MB of server memory per DVM and can be run as densely as eight DVMs per server processor core.

Typical class user workloads include knowledge workers that run multiple applications simultaneously, including large Office suite applications. Such users should be allocated up to 1GB of server memory per DVM and should be run at up to five DVMs per server processor core.

Heavy class user workloads include software development, large spreadsheet use and scientific or statistical applications, including very demanding graphical applications used for visualization. These applications can cause large peak loads on either the server CPU and/or the storage disk sub-system. This is especially the case when large applications or data sets consume more virtualized RAM and lead to page faults inside the virtualized OS – creating a large number of read-write operations to the memory page file on the virtual OS system drive.

DVMs for users with heavy workloads should be allocated 1 to 3GB of server RAM to reduce this disk I/O and as many server processor cores as is necessary, and may be candidates for using reservations in the hypervisor to ensure adequate response times. In some cases, allocating dual virtualized CPUs will help performance, even if there are significantly more DVMs than available physical processor cores on the virtualization servers.

New processors and server architectures that have much greater CPU performance, memory bandwidth and optimized local or shared channels to storage can also help handle heavy workloads.



Putting it all Together

To illustrate how the major components of the Pano System work together, this section recaps what happens when a user logs into the Pano DVM via a Pano Device or Pano Remote.

At start-up or when the Pano Button is pressed, the Pano Device searches for and connects to a Pano Manager on the local network. The Pano Manager then displays the Pano logic screen on the Pano Device's monitor. After the user enters their user name and password, those credentials are authenticated using the directory services server attached to Pano Manager. The corresponding entry determines which group the user is in and, thereby, from which collection of DVMs the desktop should be provisioned.

If the user is remotely connecting to the DVM via Pano Remote (described in more detail on page 15) the process is similar with a few key differences. Instead of the Pano Device hardware connecting to Pano Manager, the Pano Remote software on the USB is launched and display a login screen. The user credentials are passed over the wide-area-network (like the Internet) using RDP protocol to Pano Gateway where they connect to a Pano Manager. From there on the process is much like that with the Pano Device – just the final leg of the connection from Pano Remote to the DVM is different as it uses RDP and SSL to provide secure, reliable communications over an external network.

Once a DVM is selected and “powered up” on a hypervisor server by Pano Manager, communications are then run directly from the DVM to the Pano Device, without any involvement by Pano Manager. During the session the user's keystrokes are encrypted and sent to the DVM running on the virtualization server over the local area network. The send-transit-response cycle is so quick the user cannot tell that anything other than a local PC is in use. Mouse clicks and any I/O from a USB peripheral are sent in the same way to the DVM although USB peripheral data is not encrypted. The DVM optimizes the use of network bandwidth by only sending the minimum number of bits necessary to update the screen display on the attached monitor.

A heartbeat connection to Pano Manager is monitored in case the Pano Device is disconnected from the DVM. This feature helps users suspend the connection to a running DVM and then change desks, rooms, or even buildings and be able to reconnect to the DVM and resume working at the point at which they disconnected. The user's DVM remains running across disconnects, so that a break in connection or a transition from one Pano Device to another does not end the user session.

Finally, when the user logs out, the DVM may shutdown depending on the power management policy of the collection. At that point, it is returned to the pool for use by another user. If, while the user is logged on, the load on one server node begins to detrimentally affect performance, the server may begin migrating DVMs to a different node (if VMware DRS is being employed). To completely terminate the user-DVM connection, the user must log out of the DVM. Administrative policies at a site can also be configured to force disconnect or logout after a certain period of idle time.



The Pano Device

The Pano Device is the heart of the Pano System, consisting of a compact purpose-built desktop virtualization hardware endpoint that sits on the user desk and connects the display, input devices and other USB peripherals to the DVM running on the ESX server. It is referred to as a zero-client because in contrast to thin-client and PC endpoints it contains no CPU, no local storage, and no operating system. As a result, it consumes very little power—about 3.5 watts—and is tamper-resistant and never stores any data locally. More importantly, it requires no endpoint management software, no patch management, no firmware upgrades, and no local OS licensing fees or updates – both significantly reducing virtual desktop deployment costs and improving on-going IT productivity.

Figure 4 shows the rear of the Pano Device and the various jacks it contains for connecting desktop components to the Pano Device. These include a VGA plug, an RJ-45 Ethernet jack, three USB connectors, plus an audio out port for headphones or speakers.

Figure 4:
Ports and connectors on the zero-client Pano Device



In contrast to most thin-clients, the zero-client Pano Device itself contains no USB or other drivers. Instead, the Pano System utilizes only the native drivers in Windows XP running in the connected DVM and simply handles communications between the DVM operating system and the ports on the Pano Device, much like a PC system bus or chipset.

This approach improves performance when displaying video or other multimedia and also greatly simplifies deployments since most types of USB devices work on a Pano DVM without any specialized support – unlike thin-clients, vendors do not have to write or supply special drivers to allow peripherals like scanners or printers to connect to the endpoint – instead standard Windows drivers can be used.

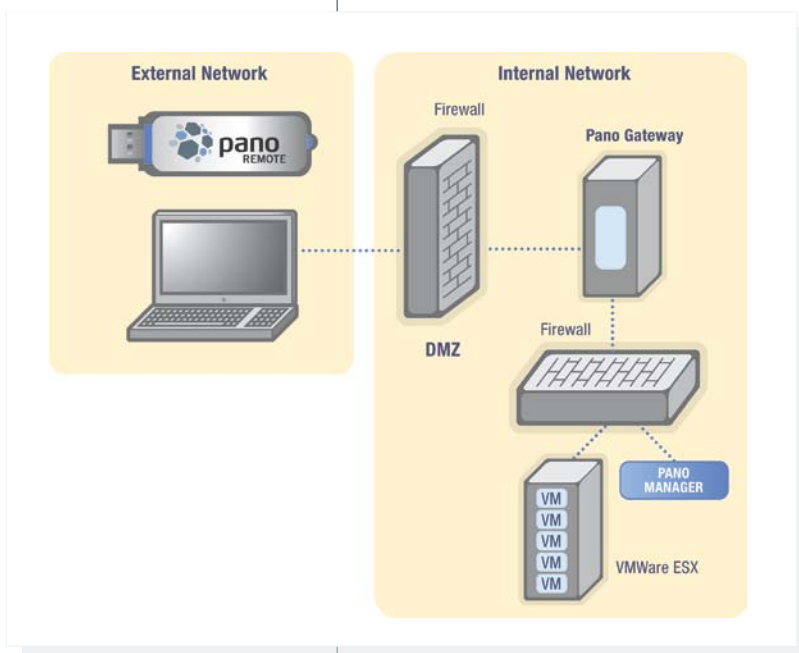
The Pano Devices also includes a single user interface element, the Pano Button[®], located on the front corner of the top. The

Pano Button serves both as an indicator of the connection status, glowing a steady blue when connected to a DVM, and as a button that allows the user to interrupt the DVM and return to the Pano login screen. When the Pano button is pressed, the Pano Device is reconnected to Pano manager and the user can use the login screen to disconnect from the current DVM and reconnect to a new one. Pressing the Pano Button can act almost as a virtualized equivalent of the Ctrl-Alt-Del used to regain control of a physical PC.

There is also an option button on the login screen that allows a user to move their current DVM to a special Trash folder managed by VMware's vCenter software – this option is only available to users running a DVM from a Permanently Assigned Desktops collection. This option is typically used when a user suspects that their DVM OS or applications are corrupted or infected with malware. After moving a DVM to trash, the user receives a new DVM (cloned from the collection's template) upon the user's next login allowing them to continue working without waiting for assistance from IT.



Figure 5:
Pano Remote provides secure access to Pano virtual desktops from any Windows desktop or laptop



One add-on for the Pano Device is the Pano Dual Monitor external video adapter. In order to directly support dual monitors, as well as those with DVI inputs, while still letting IT managers keep to a single, uniform population of virtual desktop endpoints, Pano Logic designed a USB-based video add-on. Using a single USB port, even one on a hub attached to the Pano Device, along with technology from DisplayLink Pano Dual Monitor allows a second monitor to be added to the desktop, supporting up to 1920x1200 landscape resolution on each monitor.

Remote Access to Virtual Desktops

PANO REMOTE

Pano Remote™ is an option in the Pano product line that allows Pano users to reach their Pano DVMs from a remote location over a WAN like the Internet. Pano Remote lets users temporarily access their Pano virtual desktops when they are away from the office, whether working in the evening or when travelling by simply plugging a special secure USB key into any Microsoft Windows PC. Pano Remote can also help you inexpensively extend your Pano virtual desktop deployment to larger populations of transient users, such as guest users, users needing limited and intermittent access to a virtual desktop or to mobile workers. Anywhere and anytime they can find a Windows PC with a network connection, they can use their Pano virtual desktop.

Pano Remote provides access to a running Pano DVM either in a window (at a resolution set by the user in the login screen) or using the full screen. Administrators can set policies in Pano Manager to allow or restrict access to local printers and drives along with controlling transfer of data on the clipboard between the virtual and host operating systems. Pano Remote is

delivered already installed on a USB key and can be used with either Microsoft Windows XP or Windows Vista on the remote host desktop computer.

PANO GATEWAY

Pano Gateway is a communication portal bundled with Pano Remote that provides secure connections from external networks using Microsoft Windows Server 2008 Terminal Services Gateway (also called Remote Desktop Services) as supporting infrastructure. Pano Gateway does not require the use of VPN software or hardware to communicate with Pano Remote users, but instead uses standard secure protocols (RDP via HTTPS/Secure Sockets Layer) to connect to the Pano Gateway plug-in in the Terminal Services Gateway server and in turn to the virtual desktops on VMware ESX servers inside the data center LAN, simplifying the configuration of firewalls and security policies. Pano Gateway connects to Pano Remote users via the standard Microsoft RDP protocol to ensure that users get



suitable performance in the remote Windows desktop, even over WAN connections like consumer-level Internet DSL or cable modems, although performance will be better over higher speed connections.

Benefits from the Pano System

The Pano System delivers the benefits of virtualization to the desktop. It makes it possible for IT staff to deploy, manage and support desktops entirely from within the data center—including provisioning, security, backups, upgrades, and updates—and it removes the many inconveniences, costs, and security threats of having traditional PCs at user's desks.

Key benefits of deploying VDI with the Pano System include:

- Reduces operating costs by up to 70%: By replacing traditional desktop PCs with centralized virtual desktops connected to an unmanaged zero-client, the Pano System dramatically reduces the cost of support, maintenance, and management of Windows desktops.
- Improves reliability and data security: Since all user data is stored on secured file systems controlled by the IT staff, rather than on desktop PCs drives, the loss or theft of the endpoint can no longer result in costly disclosures of confidential data. DVMs enable suspected malware outbreaks to be quickly contained by swapping infected DVMs for fresh, clean instances.
- Provides an eco-friendly solution with lowered energy costs: The Pano Device requires only 3.5 watts of power, producing significant savings—even when compared to PCs that conform to the highest energy-savings regulations. By replacing two PCs with Pano Devices, as much as 3,290 kWh can be saved over three years.

For More Information

For more detailed information on setting up and managing the Pano System, along with detailed help in optimizing your virtual desktop deployment can be found in the Online Help available from the help.panologic.com website.

For more information about the Pano System, go to:
www.panologic.com/why-pano/

For more information visit www.panologic.com or call 650-454-8940

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