IBM's Virtual Client Solution

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What is VCS?

IBM's Virtual Client Solution (VCS) is a *centralized* alternative to conventional *distributed* desktop computing. VCS enables access to a desktop environment through thin-client user devices connected to Windows or Linux desktop operating systems running within virtual machines on IBM BladeCenter or System x servers. With little impact to the end-user experience, VCS moves the software computation and the software management associated with desktop computing to the datacenter, where the environment can be centrally managed and the user personal computing can benefit from datacenter class infrastructure such as 1-10Gb/s Ethernet and SAN storage. Figure 1 illustrates the VCS's 4 tiered architecture and its' centralized management.

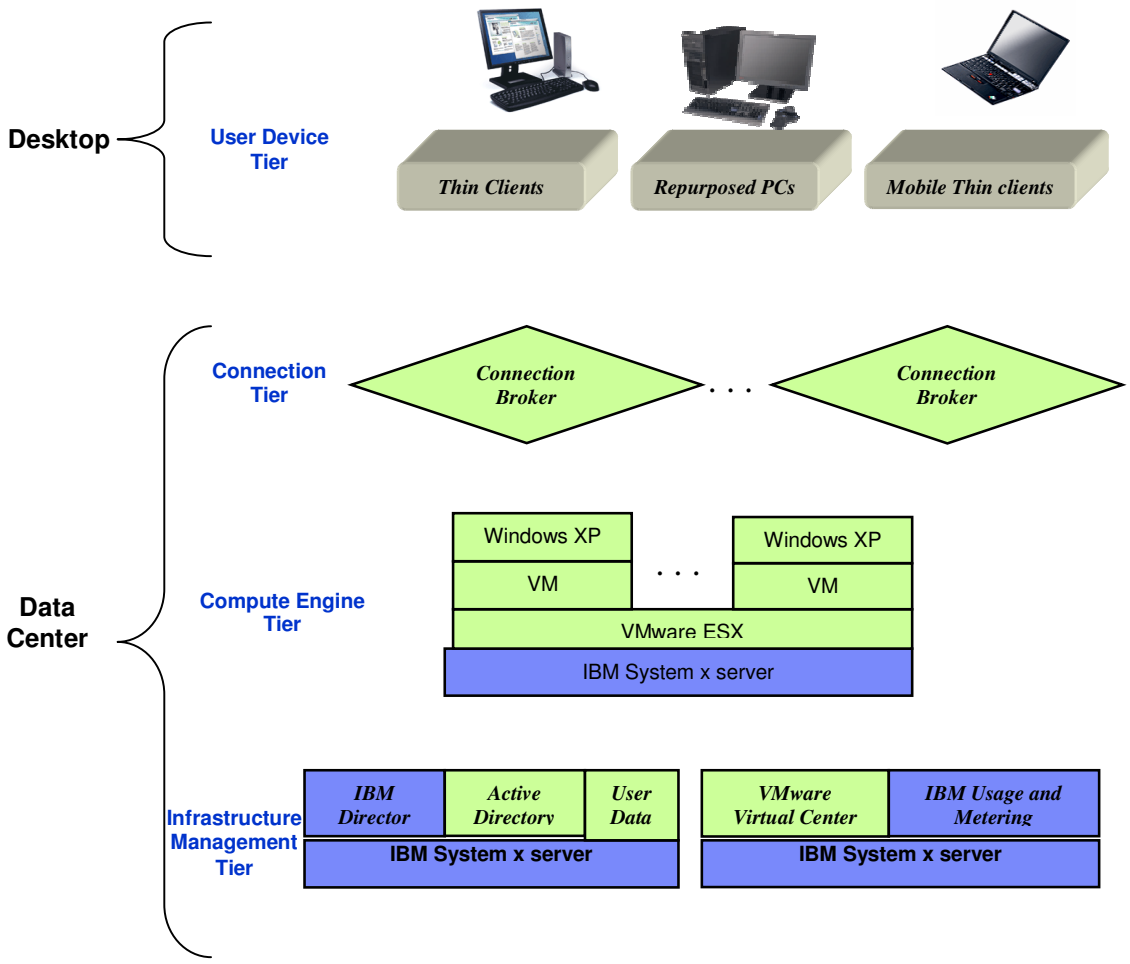

Figure 1. VCS Architecture

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Figure 1 shows the VCS's 4 tiered architecture. Starting from the top and moving down, the tiers are the user devices, the connection broker, the compute servers, and finally the infrastructure management.

The ***User Device Tier*** embodies the desktop devices through which the user interacts with his virtual PC. VCS supports a wide range of user devices, from stateless thin clients with embedded operating systems to traditional fat clients repurposed and locked down operating systems.

The second tier of the VCS architecture hierarchy is the ***Connection Broker Tier***. The VCS connection broker is a software component that authenticates the user and negotiates a connection between the user device and a virtual machine that meets the individual user's software and hardware capacity requirements. A description of the policy and configuration details that bind individual users to specific virtual machines can be found in the ***Infrastructure Management Tier*** section. The VCS Connection Broker Tier is made of one or more connection brokers to enable fault tolerance, scaling, and the geographic dispersion of a customer's enterprise.

The third VCS tier is the ***Compute Engine Tier***. This Compute Engine Tier runs the software that traditionally ran on traditional desktop systems. With VCS the desktop software stack, from operating systems to user applications, is executed within a VMware virtual machine running on IBM System x or BladeCenter servers. The VCS Compute Engine is essentially the desktop analog of server consolidation via virtualization. VCS can support running multiple client virtual machines on a single BladeCenter blade or System x server (approximately 6.5 virtual machines per core), where each virtual machine is running the full software stack for one specific desktop user.

The fourth VCS tier is the ***Infrastructure Management Tier***. The VCS Infrastructure Management Tier is comprised of several components that serve key roles in enabling the central management within VCS. This tier includes managing the following desktop properties for each user: the user's data file storage and management, the user's personalized desktop customization is stored, the virtual machine "golden image templates", the management of each virtual machine, per user usage and metering data, and the policy definitions that group users and assign them to groups of virtual machines. Removing the state (applications, configuration information, and user data) from the user desktop device is key to eliminating the desktop management that has become the bane of traditional desktop computing. It is the movement of desktop software and its' associated configuration state from the user device to the data center server that enables VCS centralized management model.

The VCS User Experience

From a physical desktop environment perspective, VCS provides benefits over the traditional desktop approach. VCS enables the use of thin-client devices that are much smaller and quieter than traditional desktops (no moving parts, no fans to cool high performance CPUs), and use less power and produce less heat. The result is a physical environment that takes up less overall desk space, reduces noise at the desk, and reduces

heat in the user's workspace. Thin clients connect directly into existing LAN connections and therefore require no special cabling or other office infrastructure changes.

From a user interface perspective, VCS creates an environment that's compatible with the look and feel of the traditional desktop. When power is applied to a user's thin-client device, the familiar logon dialogue box is displayed. The user enters the username and password within the dialogue box and is authenticated and connected to a desktop operating system running in a virtual machine. This VCS feature is called ***seamless single sign-on*** (the user's logon dialogue is compatible with the conventional logon and this single logon request is the only logon required of the user). Figure 2 is a screen shot of the VCS logon dialogue box on a Wyse S10 thin-client.

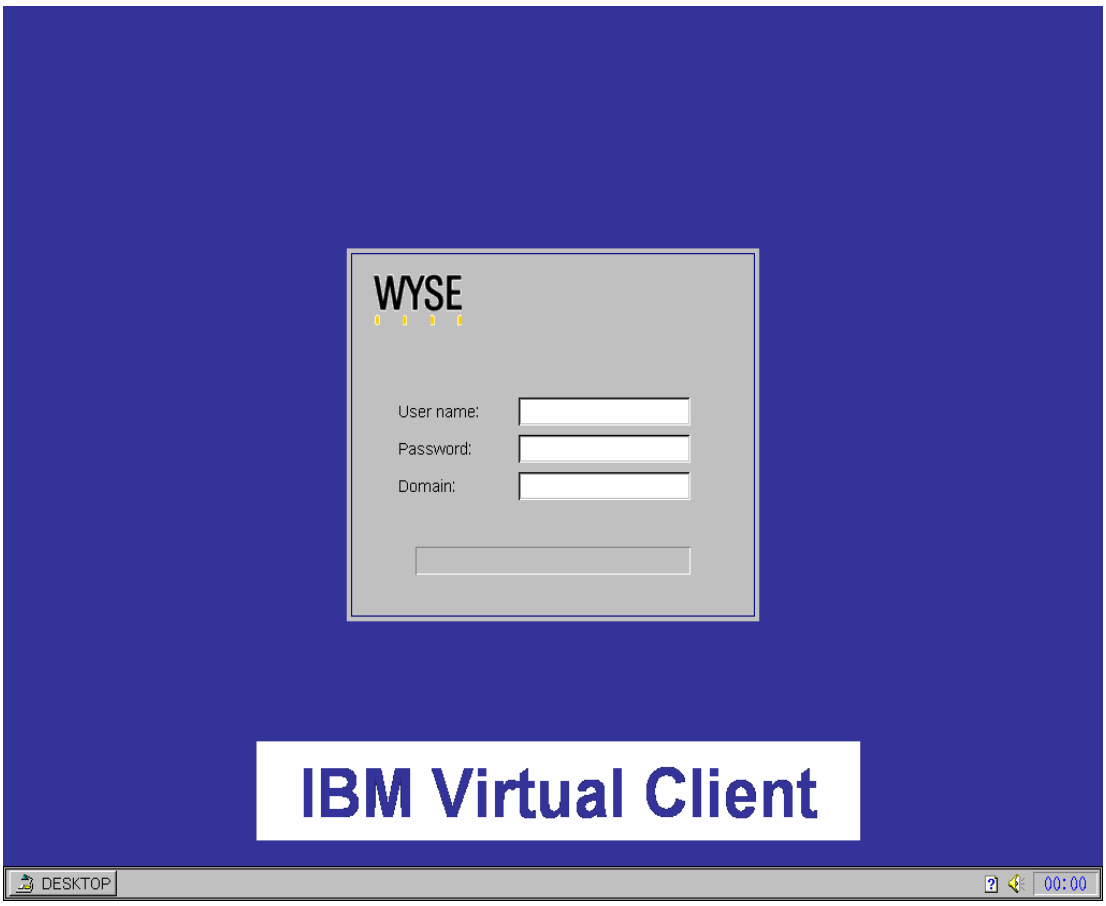

Figure 2. VCS Logon Screen on Wyse S10

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Following logon, the user experiences the familiar OS initialization process that populates the Windows desktop – at this point, all of the user's applications are available for execution and their environment is configured to store data files and user persona settings on servers in the management tier. This operating environment is a Windows or Linux desktop environment running in a data center, sending display updates to the thin-client.

In addition to the traditional desktop look and feel compatibility, VCS offers the user specific look and feel as user's logon from any user device within the enterprise. This enables mobile work centers equipped with thin-clients to support each user's personal desktop experience without requiring the users to transport their client device. This VCS feature is referred to as ***free seating*** (users are free to sit at any end-user device connected to the VCS infrastructure and access their environment). Free seating benefits scenarios where the user's office or location changes without requiring that the user device move to the new location.

What the user won't experience with VCS is desktop support personnel making office visits to administer the system. VCS has moved all the computation, configuration, and data to the data center – leaving nothing that requires desk side management.

VCS supports user device attached printers and locally attached USB devices. Although in some cases playing multi-media content can produce good quality, the Remote Desktop Protocol (RDP) used to support the display remoting does not currently guarantee a quality multi-media experience. Another remote display protocol limitation is audio, which is currently limited to a single direction.

Support for multiple displays is limited to display spanning and not true multi-monitor. The display spanning support provided within RDP enables 2 displays to be attached to a thin-client device, and both displays are melded into a single user interface display.

The VCS Management Experience

It is from the administrator's perspective that VCS offers the largest difference from traditional desktop management. VCS enables centralized operational management whereas traditional desktop management is distributed and often requires visits to offices that house the user devices. VCS leverages stateless thin client devices to serve as user interfaces devices for displaying pixels and capturing and forwarding mouse and keyboard interrupts. The result is a stateless desktop environment.

VCS enables centralized management by moving all the software, configuration settings, and user data off the user device and into the data center as shown in Figure 3. The data that is traditionally located on desktops in the old personal computing model can summarized as follows: desktop operating system, desktop applications, software configurations settings, user's environmental customization, or ***persona***, and user data. Each of the data sets is centrally managed within VCS. The desktop operating system is installed and configured within a virtual machine on an IBM BladeCenter or System x server within the datacenter. The operating system installations and configurations are automated by IBM's Director's Virtual Machine Manager. The desktop applications are installed and configured within the operating system as are software configuration

settings. User persona data is centrally maintained and managed within Microsoft's Active Directory. User data is stored on network fileservers and referenced as network home directories. Moving the user application data, user persona data, software configuration settings, and software components into the management tier enables a stateless compute engine running within the virtual machine.

Another VCS benefit is ***resource sharing*** and high server utilization levels. Supporting multiple client operating systems on a single virtualization platform and server enables higher level of resource utilization. The peaks and valleys of users' resource demands are spread across a farm of IBM Servers running x86 VMs.

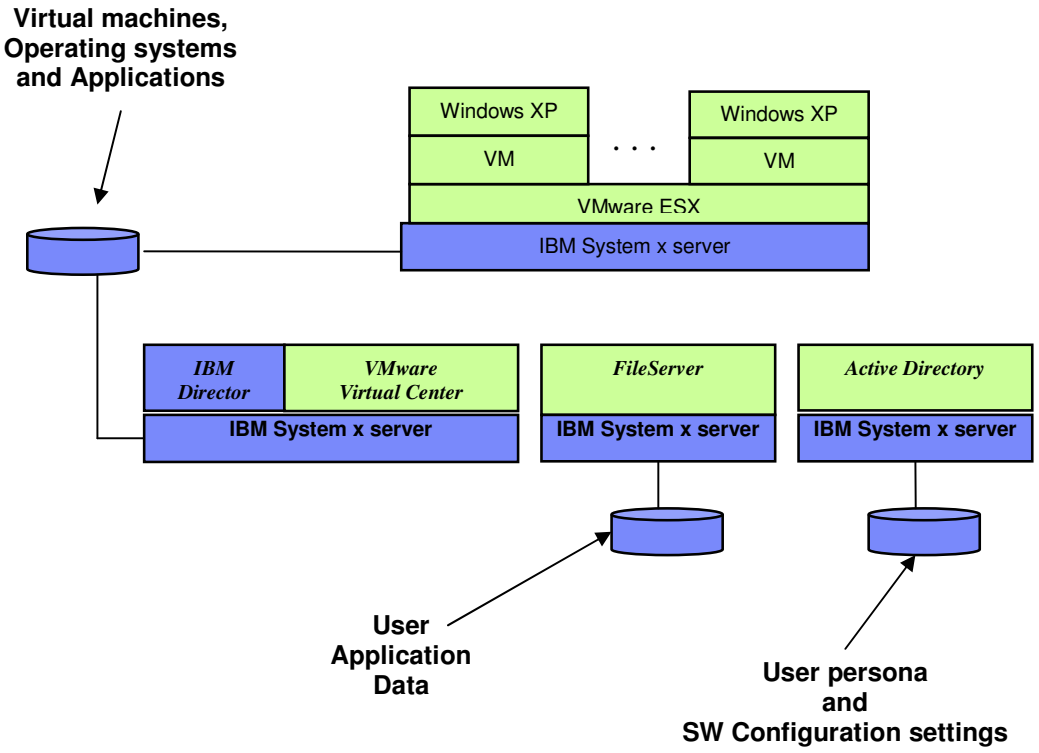

Figure 3. VCS Centralized State Management

This resource sharing model is in contrast to the traditional distributed model of desktop personal computing where few if any resources are shared. Resource sharing within VCS does not come at the cost of reduced software isolation. ***Software isolation*** refers to the degree that an operating system or application is separated from other instances of the same software. In VCS, each virtual machine, guest operating system and application software stack is dedicated to a specific user while the user is logged on – offering a high

degree of software encapsulation. In summary, VCS offers dedicated software stacks per user on shared servers to increase server utilization.

In addition to the management benefits of moving users' application data to the data center - ***data security*** and data backup and recovery are achieved. With VCS sensitive data need never leave the datacenter, even while the user is viewing, editing or analyzing that data. The company benefits from regulated, centralized data backup processes and frequencies of the traditional datafloor environment. For customers that require local data be downloaded or printed from client devices, VCS can be configured to enable local printing and USB downloads. The key point being that the users' data and the policies that control downloading data are under centralized management control.

The bridge from the state-less thin client systems to the centralized infrastructure is achieved via the VCS connection broker. At user logon time, the connection broker intercepts user logons, validates the user's credentials, assigns the user to a virtual machine that meets the user's requirements and establishes a Remote Desktop Protocol (RDP) session from the user's device to the VCS infrastructure. Once this connection is established, the connection broker monitors the state of the connection and records user logoff activity. The VCS connection broker understands user groups and pools of virtual machines such that it can establish connections between the two. The connection broker is not a proxy and therefore is not in the data path following the successful connectivity between client devices and virtual machines.

Virtualization features and flexibility are key to the VCS value proposition. Virtualization enables rapid deployment, rapid disaster recovery, resource sharing with isolated software stacks, high resource utilization, ease of hardware upgrades – all via software encapsulation.

Rapid deployment of user environments is achieved via IBM Director Virtualization Manager exploitation of virtual machine templates. Using a common virtual machine configuration definition and common operating system configuration, virtual machines with common attributes (number of CPUs, amount of memory, operating system version, installed application software) can be quickly created and added to the VCS run time infrastructure. In addition to rapid initial deployment benefits, IBM Director's Virtualization Manager template based virtual machine and guest operating system provisioning also significantly simplifies the patch and update management of the software stack. The template virtual machine becomes the root golden software stack image, essentially becoming a ***single image update model*** across the virtualized enterprise. The single image update model uses a reference virtual machine and guest operating system to populate virtual machines for a set of users. In VCS deployments that provide multiple virtual machine classes (i.e. one set of virtual machines for engineering, one set of virtual machines for call centers, and one set of virtual machines for administrative personnel), each of the virtual machine classes would be populated from a golden image template that provides the necessary virtual resources and software components required for the specific user group. This multi-user class single image model provides the necessary environmental flexibility and enables rapid provisioning and ease of software patch/update management.

Virtual machine software encapsulation also enables ***rapid disaster recovery***. The virtual machine and guest operating system image are encapsulated into a set of files and as mentioned above, the user applications and persona is stored in the data center that can

be clustered across various geographies. So a catastrophic event that hits a large set of user devices or a data center location can be quickly recovered by hosting VCS in another datacenter. Because no data is stored on the user's desktop, no data is lost during such an event. Due to the fact that the VCS environment is centrally managed and the file systems can be clustered or backed up across distinct physical locations, rehosting VCS is a matter of pulling the data files from back up locations.

Virtualization enables an abstraction between the physical hardware and the operating system. Virtualization decouples the software from the underlying IBM server significantly easing the hardware upgrade process for customers moving to next generation server platforms. Within VCS, customers can migrate to new physical platforms without refitting and reconfiguring their centralized management infrastructure.

VCS offers availability benefits over the conventional desktop approach. In the conventional desktop approach, the user's software stack is strictly bound to the physical system the user interacts with. In the case of system hardware failures, the system must be serviced or replaced and reconstructed. In a disaster this reconstruction of all of the users traditional PCs has proven to be a major impediment to reestablishing normal business operations. At service intervals, the user experiences down time, loss of compute environment and potential loss of critical data. By leveraging virtualization, VCS breaks the binding between the software stack and a specific compute engine, rather the user's software stack can run on any server within a VCS infrastructure. Further, IBM Director's Virtualization Manager is capable of driving the migration of running virtual machines from one physical server to another physical server. Virtualization Manager can drive these migrations based on error rate sampling from the physical servers. For example, a single bit error threshold can be set at 100 errors a minute, and upon reaching this threshold Virtualization Manager will migrate a virtual machine from what appears to be a failing system, to a healthy system within the VCS infrastructure. This level of ***predictive fault analysis***, increases overall VCS availability and minimizes user down time.

For VCS installation and configuration details, please ask your IBM sales representative or IBM Business partner for a copy of the VCS Installation and Configuration document.

VCS Scalability and Performance

VCS uses Microsoft's Remote Display Protocol (RDP) to move display pixels, mouse and keyboard input, between the thin-client and the server running the desktop software stack. Various user experience tests have been conducted using the RDP protocol to remotely access a user environment. The results have been published and demonstrate that for most office productivity desktop usage, RDP is either on par with the user perceived performance of a traditional desktop system, or a superior performer. Although it seems odd that RDP could offer improved performance of a traditional desktop scenario, there is rationale explanation. Many desktop software applications leverage databases that do not reside within the physical desktop system, and rather reside in a database within the datacenter (many email packages available on Windows operate in this fashion). The access to databases from a traditional desktop system results in network I/O traffic to retrieve data files or database records. This IO activity inserts

latency, which impacts the performance of the application. In a VCS environment, the desktop application runs in the datacenter, so the database accesses stay within the datacenter where they take advantage of high bandwidth, networks, and the low latency afforde by close proximity to the database server. Another factor to the RDP performance benefit in a VCS environment is that the database I/O is initiated from server class hardware (instead of desktop class hardware), and consequently benefits from the performance difference.

Further studies have evaluated the network bandwidth utilization of RDP. From the papers published on this subject, the consensus is that, on average, RDP consumes about 27 KB/sec of network bandwidth. This is an average consumption measurement. Thin-clients sitting idle consume no RDP bandwidth, and users running video gaming software with a high display update frequency may consume more bandwidth than the 27 KB/Second average.

At the time of this publication, VCS has deployments scaling up to 2500 users. However, the VCS infrastructure can be scaled well beyond 2500 users. A closer look at the scalability of the central VCS components helps serve as a VCS scaling gauge. Referring back to the key state that is centrally managed within VCS, the components include; the user application data, the user persona data, the user authentication database, and the virtual machines images with user software stacks. User application data is stored on fileserver(s) in the datacenter. Network fileserver scaling has demonstrated a high degree of scaling when used as network home drives for Citrix, Terminal Server, or even traditional desktop environments that have been tailored to leverage and depend on network fileservers for a data store. Active Directory (the user authentication database and the user persona database) has demonstrated high levels of scaling, as is predominately deployed as the authentication database for traditional desktop systems. Virtual machine images, have demonstrated scalability of up to thousands of virtual machines in a single VMware Virtual Center environment. The current maximum number of virtual machines supported by VirtualCenter 2.0.1 is 1500. [1] The VCS connection broker supports clustering of multiple connection broker appliances to support large numbers of users The Connection Broker can be deployed as a single Virtual Appliance complete with its integrated database, or with a separate database. The integrated version can support up to 20,000 Virtual Desktops and up to 20 VirtualCenters. The separated version can be scaled out with up to 128 Connection Brokers load balanced with a DNS load balancer and connected to a central database. This arrangement will scale to over a million Virtual Desktops. [2] The VCS connection broker leverages VMware Virtual Center for virtual machine discovery and Windows Active Directory for user identification, and as cited above offers good scalability.

The VCS user per server density naturally varies with the user load and the IBM BladeCenter or System x server it's deployed on. At of the time of this writing, deployments of up to 18 users per 2 single core processor blades have been used in product environments. On average VM density per core is 6.5, provided you have

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[1] **Configuration Maximums for VMware Infrastructure 3**
http://www.vmware.com/pdf/vi3_301_201_config_max.pdf, page 4

[2] Leostream CB Product Sheet. http://www.leostream.com/pdf/leoStreamBrokersheet4_3_0.pdf, page 2

enough memory on the system to run at that VM count. Virtual ma
capacity can certainly limit overall scalability, however for 4 GB vi
memory configurations; IBM servers can conservatively support 6-
per physical processor.