



RED HAT ENTERPRISE VIRTUALIZATION FOR DESKTOPS

DELIVERING ON THE PROMISES OF DESKTOP VIRTUALIZATION



TABLE OF CONTENTS

- 3** BENEFITS OF DESKTOP VIRTUALIZATION
 - 3** BENEFITS FOR IT DEPARTMENTS
 - 3 Advantages Relative to Traditional or Physical Desktops
 - 4 Advantages Relative to Terminal Services Models
 - 4 Benefits for End Users
 - 5** DRAWBACKS WITH CURRENT VIRTUAL DESKTOP SOLUTIONS
 - 5 User Challenges with Existing Virtual Desktop Solutions
 - 5 IT Challenges with Existing Retrofitted Virtual Desktop Solutions
- 6** DESCRIPTION OF RED HAT ENTERPRISE VIRTUALIZATION FOR DESKTOPS
 - 6 Overview of Benefits
 - 6 Components of Enterprise Virtualization for Desktops
 - 7 Enterprise Virtualization Hypervisor
 - 9 Enterprise Virtualization Manager
 - 12 SPICE



BENEFITS OF DESKTOP VIRTUALIZATION

The advent of virtualization technology on x86 platforms has allowed a radically new, cost-effective model of desktop delivery. It allows IT to centrally manage, maintain, and enforce policies on desktops in a much more effective and holistic manner than traditional desktops (individual PCs running an operating system (OS) and applications) and legacy SBC/terminal services solutions (shared OS and applications). This enables better compliance and also leads to a significant reduction in the total cost of ownership. In addition, virtual desktops can enable powerful new functionality for end users.

There are several different models with which an enterprise can deploy virtual desktops:

- **Hosted virtual desktops:** The user's desktop is a virtual machine (virtual desktop) running on a server in the datacenter. The user connects to it from any client that has a browser and a remote connection protocol. The client could be a thin client or a repurposed older PC.
- **Client-based virtual desktops:** In this model, the virtual desktop runs on the client (physical desktop) itself.

This paper discusses in depth the benefits of the hosted virtual desktop model and highlights Red Hat solutions. It also covers some of the significant differences between Red Hat solutions and existing hosted virtual desktop solutions.

BENEFITS FOR IT DEPARTMENTS

From an IT perspective, virtual desktops allow many benefits relative to traditional desktop delivery models (physical desktops and terminal services).

ADVANTAGES RELATIVE TO TRADITIONAL OR PHYSICAL DESKTOPS

- **Security and compliance:** Data resides within physically secured datacenter, rather than on less-secure client devices.
- **Rapid provisioning:** Desktops can be centrally provisioned, maintained, and de-provisioned as required.
- **Centralized storage and back-up:** Entire desktop images can be centrally backed up using the enterprise's storage infrastructure.
- **Significantly reduced desk-side visits:** Because a user's PC is now a virtual machine or a file, it can be backed up and restored very easily. The ability to snapshot a virtual desktop and "instantly re-image" it significantly reduces the cost of support.
- **High availability:** In traditional desktop models, if a user's hard disk crashes it leads to a significant amount of downtime. In the case of virtual desktops, hard disk failures cause no downtime and no support overhead for IT.
- **Canonical hardware for desktops instead of multiple classes of machines:** Virtualization enables a canonical view of everything from the hardware to the OS and applications. Hence, IT organizations do not have to spend an inordinate amount of time testing and regression testing applications and operating systems on multiple classes of hardware with different drivers. This greatly simplifies desktop image management.



- Power savings: Thin clients consume 1/4 the power that physical desktops require. Often power consumption for a physical desktop can be in the excess of \$200 per year. This can be significantly reduced using a hosted virtual desktop model.

ADVANTAGES RELATIVE TO TERMINAL SERVICES MODELS

In addition to the above benefits relative to traditional desktops, hosted virtual desktops offer significant advantages over the traditional terminal services models:

- Fully functional desktops for users: Traditional terminal services models are restrictive to users in that they do not easily allow users to install applications, change profiles, or change settings like they are used to doing with their physical desktops. In a virtual desktop model, each user has a dedicated operating system and set of applications. From an end-user perspective it looks and feels exactly like a traditional desktop.
- No expensive re-writing of applications: Many applications have to be re-written to work well in a multi-user terminal services model. With virtual desktops, existing enterprise applications can be taken as-is and deployed in exactly the same manner.
- Complete isolation: A faulty or heavy application run by one user can bring an entire server running terminal services down, despite some of the isolation features present in the current generation of terminal services products. In virtual desktops, the user is completely isolated. Running a faulty or very heavy application brings only the user's virtual desktop down, and does not impact the performance of other users that may be on the same server.
- Faster introduction of new applications: In current terminal services solutions, it is very difficult for IT to introduce new applications. Conflicts with existing applications are common, and getting the application to work often requires re-writing and re-testing applications. In the virtual desktop model, introducing new applications is much easier because it resembles the traditional desktop model, but offers the additional advantage of a unified/canonical hardware view.

BENEFITS FOR END USERS

- Improved productivity via access to a fully functional desktop from anywhere: Since the virtual desktop runs on a server in the datacenter, users can have access to their fully functional desktop from any client with a browser and a remote connection protocol. Unlike other models (like terminal services) where only a few applications with limited functionality can be given to users when they access the system remotely, virtual desktops allow the entire desktop, including all applications, to be delivered to a user. From a user's perspective, it is exactly like being physically in the office.
- Improved productivity via significantly lower downtime: Today if a user's PC crashes, or hard disk fails, it takes at least a day for the user to get up and running. In a virtual desktop model, the user could walk over to another client and be up and running in no time. The state of the desktop is maintained on hardware in the datacenter, and the client is stateless.
- Multiple desktops on-demand: Users can have multiple desktops. For example, a user needs access to a finance desktop for the end of the quarter. IT could provision (instantly) a desktop with all the required finance applications. This could be available to the user for a pre-defined period of time or until the desktop is no longer required. Additionally, the multiple desktop capability can be exploited to enable a seamless transition between operating systems. For example, if an organization is migrating from Microsoft® Windows® XP to Windows 7, a user could be given two virtual desktops (one of each) during the period of the transition. Once all the applications have been migrated, and the user is accustomed to the new environment, the old one could be de-provisioned.



DRAWBACKS WITH CURRENT VIRTUAL DESKTOP SOLUTIONS

Although hosted virtual desktops offer significant advantages relative to traditional desktop delivery models, the current solutions suffer from several drawbacks both from a user perspective and from an IT perspective.

USER CHALLENGES WITH EXISTING VIRTUAL DESKTOP SOLUTIONS

The biggest problem with current desktop virtualization solutions is the end-user experience.

- **User experience:** Remote connection protocols such as RDP do not provide for a good or transparent end-user experience. RDP was designed in the terminal services era when multimedia was not a large part of the corporate computing experience.
- **Graphics:** Graphic-enabled websites, video, and audio playback for training videos, company broadcasts, and other rich media streams pose significant problems. In addition, many of today's solutions do not support multiple monitors in a seamless manner.
- **Bi-directional audio/video:** Emerging multimedia applications like soft and IP phones or video conferencing clients do not work with existing virtual desktop and connection protocol solutions.
- **Peripheral support:** Current solutions have limited support (if any) for connecting USB peripherals such as PDAs or storage devices to the client, and having them appear connected to the virtual desktop.

IT CHALLENGES WITH EXISTING RETROFITTED VIRTUAL DESKTOP SOLUTIONS

In addition to the end-user challenges, current solutions are difficult to implement and manage from an IT perspective. This is because most existing virtual desktop solutions are retrofitted server virtualization solutions, and lack the essential functionality required for virtual desktops. Specifically:

- **User experience and system load/economics:** The user experience problem described above is not only a user problem, but also an IT problem. The reason for this is that if the user experience is not the same or better than a physical PC, end-users will never accept it and will always escalate issues with IT. In addition, RDP-based systems are very heavy on the host CPU, especially when processing multimedia. This reduces the density of virtual desktops on a server, which in turn increases the overall system cost because IT needs more servers to support a given number of virtual desktops. This makes retrofitted server virtualization solutions cost-prohibitive.
- **System scalability:** Server virtualization solutions are designed to scale to hundreds of virtual servers, whereas virtual desktop products are required to scale in the thousands for production deployments. Consider an example of an enterprise that has 100 virtual servers. This is a medium-to-large size deployment. Using an industry average of 45-50 desktops per server, a similar scale deployment in the desktop domain would be about 5,000 virtual desktops. This means 5,000 images, 5,000 users, and 5,000 clients. Very quickly, this gets to be two orders of magnitude larger in terms of the number of objects to manage. Hence, virtual desktops require a virtualization management system designed to scale to thousands of virtual machines. Retrofitted server virtualization management systems simply cannot meet this requirement.



- **End-user support:** In the case of server virtualization, the management system is designed to serve end users that are server administrators or application managers. These are sophisticated users that need a different kind of support. They likely know when they need to add more networking, processing, or memory to a virtual server. A desktop systems administrator needs to deal with end user problems. End users can call with problems ranging from email application difficulties to desktop crashes. The desktop administrator needs to be able to quickly find the user's desktop out of tens of thousands of desktops, cross-correlate different pieces of information, and quickly troubleshoot issues while the user remains on the phone. This requires a different kind of a management system than what is currently offered by server virtualization vendors.
- **System integration:** Virtual server management systems need to integrate with very different back-end systems as compared to virtual desktop management systems. On the desktop side, the systems need to work seamlessly with Microsoft Active Directory and the enterprise desktop build process. It may also need to interface with application streaming technology and management systems. These requirements are very different than those for a virtual server management system.

The above problems make it difficult and expensive for IT to deploy virtual desktop solutions on a large scale.

DESCRIPTION OF RED HAT ENTERPRISE VIRTUALIZATION FOR DESKTOPS

OVERVIEW OF BENEFITS

Red Hat® Enterprise Virtualization for Desktops is a virtual desktop solution that provides the benefits of virtual desktops such as centralized management, maintenance, and policy enforcement, while eliminating the drawbacks of existing solutions. This is a fully integrated component of Red Hat Enterprise Virtualization, a comprehensive and highly scalable platform for both virtual servers and virtual desktops. With Enterprise Virtualization for Desktops, end users experience no difference relative to working on a physical desktop. Graphics intensive applications, multimedia applications like softphones (IP phone clients), and video conferencing all work as they do today on physical desktops. From an IT perspective, Enterprise Virtualization for Desktops is easy to set up, manage, and scale.

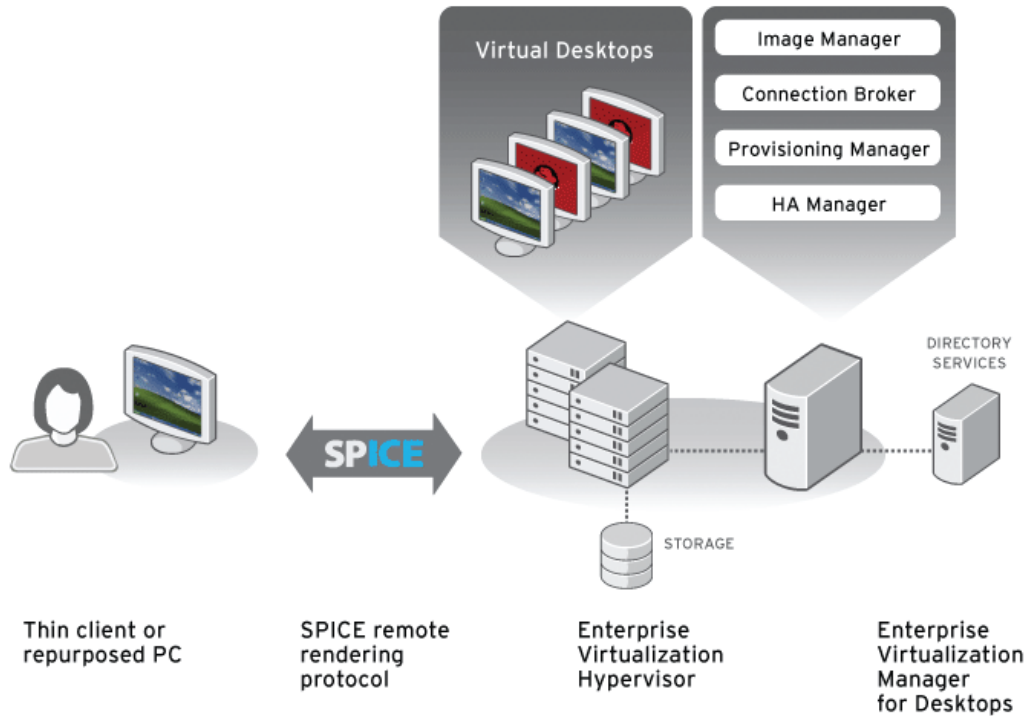
COMPONENTS OF ENTERPRISE VIRTUALIZATION FOR DESKTOPS

From a high level, Enterprise Virtualization for Desktops is a software solution that will run on commodity hardware and consists of three components (see figure on page 7):

- **Enterprise Virtualization Hypervisor:** The server (or cluster of servers) that actually runs the users' virtual desktops.
- **Enterprise Virtualization Manager for Desktops:** The management system for all components of the system.
- **SPICE™:** Adaptive remote rendering technology that allows users to "see" their virtual desktop, and interact with it.



COMPONENTS OF ENTERPRISE VIRTUALIZATION FOR DESKTOPS

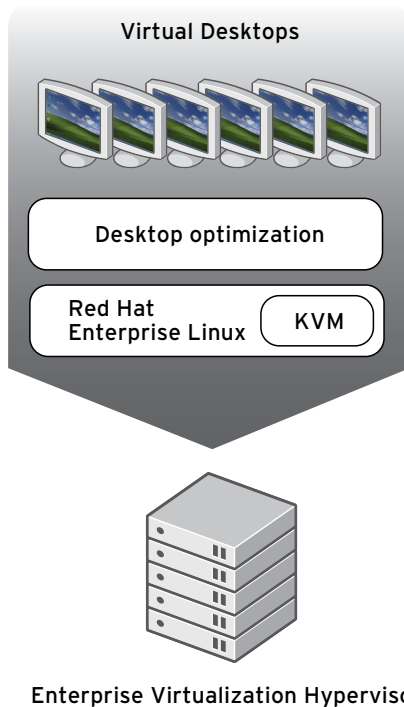


ENTERPRISE VIRTUALIZATION HYPERVISOR

The Red Hat Enterprise Virtualization Hypervisor is a bare metal hypervisor designed for the sole purpose of hosting virtual machines. It is an extremely lightweight piece of software, having a footprint of less than 100 megabytes. It is easily installed and can be booted from either PXE, flash, local disk, or network storage. Built upon the Red Hat Enterprise Linux kernel with KVM (Kernel-based Virtual Machine) technology, the Red Hat Enterprise Virtualization Hypervisor features market-leading scalability of 96 cores and 1TB of memory, with guests scaling up to 16 virtual CPUs and 64GB of memory.



ENTERPRISE VIRTUALIZATION HYPERVISOR: KERNEL-BASED VIRTUAL MACHINE (KVM)



KVM is an open source virtualization solution developed by Qumranet and acquired by Red Hat as part of its acquisition of Qumranet in September 2008. KVM has several advantages over existing proprietary and other open source virtualization solutions.

One of the primary reasons KVM is a superior architecture is that KVM is part of the Linux kernel. Hence, all the improvements made by the vast open source community around the Linux scheduler, memory management system, or other components accrue naturally to the KVM virtualization platform.

Previous generation virtualization solutions are essentially proprietary operating systems (a hypervisor is an operating system of operating systems) and have to maintain their own OS and take on the burden of constantly improving this OS. These include the scheduling mechanism, memory management, and hardware support to keep up with the latest technology. This places other solutions at a significant disadvantage relative to KVM.

Desktop Optimization

The Enterprise Virtualization Hypervisor runs a resource optimization layer that is tied very closely to KVM and plays a role in improving the density of virtual desktops on the server, assisting in the remote rendering of the virtual desktop, and enabling the Enterprise Virtualization Hypervisor to be a part of the Enterprise Virtualization Hypervisor cluster.

The desktop optimization layer includes several industry-leading algorithms and mechanisms like memory page sharing (done at the host level) or memory ballooning (done at the guest with host level interaction) to improve the density of virtual desktops on a given Enterprise Virtualization Hypervisor server.

ENTERPRISE VIRTUALIZATION HYPERVISOR: VIRTUAL DESKTOPS

As described above, the Enterprise Virtualization Hypervisor runs Linux, KVM, a resource optimization layer, and then the virtual desktops. The virtual desktops can be either Windows XP or Red Hat Enterprise Linux desktops.



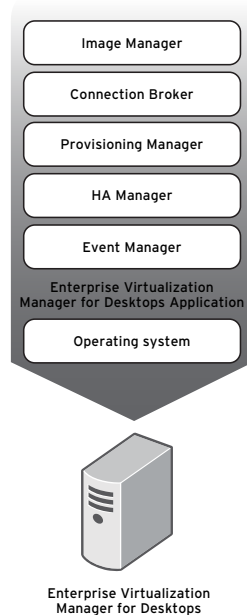
ENTERPRISE VIRTUALIZATION MANAGER

The Enterprise Virtualization Manager is the front-end for the Enterprise Virtualization Hypervisor and contains all of the control functions required for the virtual desktop solution. It is in effect, the management system for the entire Enterprise Virtualization for Desktops solution. It manages the provisioning process, connection protocol, user sessions log-on/log-off, virtual desktop pools, virtual desktop images, and the high availability/clustering system.

IT administrators can search for users, desktops, servers, and specific events from a simple interface, and can then manage or act upon any selected component. The search mechanism also supports complex queries and cross correlation of data for quick troubleshooting. Some examples of management queries are:

- Vms: user.username = *John* AND template.name = *xp* AND Apps = *office*
This will show you all desktops that belong to the user "John" that have been derived from a Windows XP template, and that have Microsoft Office® installed. Out of the thousands of desktops that IT may have in the system, the administrator can quickly locate this desktop and provide assistance to the user if required.
- Vms: CPU_Usage > 90 AND Hosts.Name = vs-a
This returns all desktops that are on vs-a that have a CPU usage of >90 percent. This enables IT to live-migrate the desktop away from that server, and troubleshoot it if required. IT can also log into the console of that machine, and fix any issues that may exist.

ENTERPRISE VIRTUALIZATION MANAGER FOR DESKTOPS



Red Hat is designing the management system from the ground up for virtual desktops. Users will be able to manage every single component or object in the system from one management interface that is easy to use and scalable to thousands of desktops. As opposed to traditional server virtualization management systems that are hierarchical and tree-based, the Red Hat management system will be entirely search-based.



The system was designed to quickly find information about any object (desktop, users, or templates), so that administrators can then manage or operate on that object.

In addition, the Enterprise Virtualization Manager has a PowerShell API which allows easy scripting of power saving policies, load balancing policies, and other bulk operations.

Enterprise Virtualization Manager: Connection Broker

IT administrators are able to instantly provision new desktops for users. All that is required is to go to the provisioning manager, specify the base image to be used (usually a template created in the image manager), specify the number of CPUs and required amount of memory and disk space, and then attach a user (or multiple users if it is going to be a shared desktop) to that particular virtual desktop.

The provisioning manager is able to be connected to the enterprise active directory (AD) to import permissions and policies that can be applied to the created virtual desktops.

Enterprise Virtualization Manager supports two desktop models: A dedicated desktop for a user, or a shared desktop for a group of users called desktop pools. In Enterprise Virtualization Manager, there are three types of pools— automatic, manual, and time-based.

The connection broker determines whether a user has a dedicated virtual desktop or is required to use a desktop pool. If it is the former, then the connection broker will establish a connection with the user's own virtual desktop. If the user is to use a pool of virtual desktops, then the connection broker will connect the user to the first available shared desktop belonging to a certain pool.

The connection broker will also determine the most appropriate connection protocol for the users (see below for a detailed discussion on the connection protocols).



Enterprise Virtualization Manager: Image Management

Enterprises use tools like Ghost™ to manage physical desktop images. Red Hat has applied this operating paradigm in Enterprise Virtualization Manager, and enables a powerful mechanism to manage virtual desktop images. Enterprise Virtualization Manager uses a template/diff mechanism (called the image management system) to easily manage images and create new desktops. The template could be the standard enterprise build with the regular applications required for every user.

Red Hat Enterprise Virtualization Manager includes template/diff mechanisms where only the base image (or template) is stored, and any user customization (profiles, user specific applications) are stored in an additional image layer (or the diff layer). This dramatically reduces the amount of storage required. For example, an enterprise's regular desktop image is 10 GB. Normally, for 100 users, the enterprise would need to allocate 1 TB (10 GB x 100 images). But with Enterprise Virtualization Manager, each user's customization is stored as an "incremental layer" or a diff that usually occupies about 1 GB. Hence, the amount of storage required would be a 10 GB base image + 100 users x 1 GB user diffs = 110 GB. This represents a significant savings for the enterprise (relative to 1 TB), and is seamless from a user and IT perspective. IT administrators are able to leverage the Red Hat image management system in order to create new virtual desktop images, take snapshots of existing images, and create virtual desktop templates. Virtual desktop images can also be archived and backed up to the enterprises storage infrastructure.

Enterprise Virtualization Manager: High Availability (HA) Manager

The HA manager ensures the availability of the Enterprise Virtualization Hypervisor and Enterprise Virtualization Manager.

Enterprise Virtualization Hypervisor High Availability

If a particular Enterprise Virtualization Hypervisor fails, the HA manager will know which desktops were running on that particular Enterprise Virtualization Hypervisor, and will immediately distribute (or load balances) those desktops onto the remaining Enterprise Virtualization Hypervisors and (due to the Enterprise Virtualization Hypervisor failure). The user will experience downtime equal to the time that it takes the OS to restart. IT will not need to intervene during this process. At the same time, the HA manager will alert the IT administrator via the management system that a Enterprise Virtualization Hypervisor has failed and that the desktops have been successfully restarted.

Enterprise Virtualization Manager High Availability

If a particular Enterprise Virtualization Manager fails, the HA manager running on the standby Enterprise Virtualization Manager will pick up the failure event, and instructs the standby Enterprise Virtualization Manager to take over as the master. Failure of an Enterprise Virtualization Manager will be designed to have no impact on users that are already logged into the system. None of the already running virtual desktops will be affected. For the switchover time (less than two minutes) however, new users will not be able to log onto the system and new desktops cannot run until the backup Enterprise Virtualization Manager takes over.

The entire Enterprise Virtualization Manager for Desktops system is designed to be fully redundant at the Enterprise Virtualization Hypervisor and Enterprise Virtualization Manager levels.



SPICE

One of the main reasons that the user experience on virtual desktop systems is inferior to that on a physical desktop is that today's connection protocols are poorly designed and not custom built for virtual desktop environments. For example, RDP was designed in the terminal services era when graphics and multimedia were not a core enterprise computing requirement.

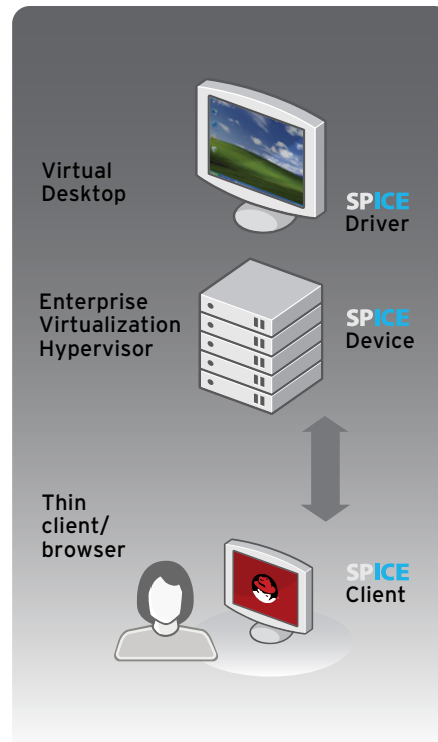
In addition, RDP is inefficient from a CPU consumption perspective regarding a virtual desktop architecture. RDP requires graphics to be processed inside each and every virtual desktop. Processing graphics inside every virtual machine requires several memory copy operations that are extremely expensive and inefficient from a CPU perspective. This limits the density of virtual desktops on a given server, and negatively impacts the economics of the overall solution.

Further, RDP does not support another essential component of the user-experience—namely, bi-directional audio and video. As multimedia becomes a bigger part of the corporate workload (training videos, CEO and executive broadcasts, product launches, announcements, etc.), traditional connection protocols start falling short, and require enterprises to compromise on user experience. Enterprise Virtualization for Desktops overcomes these problems with its revolutionary remote rendering protocol, SPICE (Simple Protocol for Independent Computing Environments).

SPICE

SPICE is a remote rendering technology that is custom-built for virtual environments and designed to provide the same experience to users as with a traditional physical PC.

SPICE has three components. The first is a driver that resides inside the guest (virtual desktop). The second is a virtual graphics device that resides in the host. The third is the SPICE client that resides in the client. The three components work in tandem, determining the most efficient place to process the graphics in order to maximize the user experience and minimize the system load. If the client is powerful enough, SPICE sends the graphics commands to the client, and processes them at the client level, significantly reducing the load on the server. On the other hand, if the client is not powerful enough, SPICE processes the graphics at the host level (where graphics processing is a lot less expensive from a CPU perspective) rather than at the virtual desktop level. SPICE is an adaptive remote rendering technology that maximizes the user experience and minimizes the system load.





SPICE is a fully integrated component of Red Hat Enterprise Virtualization for Desktops and It allows better graphics performance, video quality, and bi-directional audio (for soft or IP phones). In addition, SPICE supports multiple monitors. A thin client could have up to four monitors connected to it, and a user will be able to use all the monitors with a single virtual desktop. Hence, SPICE will work in conjunction with KVM to provide a user experience that is indistinguishable from that of a physical PC.

SPICE requires no specialized hardware. It is a software-only client that can be automatically installed via a browser on a client machine.

Comparison between SPICE and RDP:

FEATURES:	RDP WITH EXISTING VIRTUALIZATION SOLUTIONS	RED HAT ENTERPRISE VIRTUALIZATION
Bi-directional audio (capture)	No	Yes
Bi-directional video (capture)	No	Yes
Audio playback	Yes	Yes
Video playback	Poor quality	Good quality
USB support	No, needs external tools	Yes, fully integrated
Multimedia density on server	Poor	Maximizes density of virtual desktops on server by offloading graphics processing to clients or host



CONCLUSION

Red Hat Enterprise Virtualization for Desktops increases the security, agility, and manageability of enterprise desktop deployments. By moving desktop environments off of the end point and into the datacenter, Red Hat Enterprise Virtualization for Desktops will help enterprises safeguard their data and keep pace with today's fast-changing environment – all while delivering an end user experience that is indistinguishable from that of a traditional desktop. Built upon the the industry-leading security and scalability of Red Hat Enterprise Linux, with support for both Microsoft Windows and Red Hat Enterprise Linux desktops, Red Hat Enterprise Virtualization for Desktops breaks down the barriers that have prevented enterprises from realizing the promise of desktop virtualization.

Learn more at www.redhat.com/virtualization

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