Introduction
With the widespread adoption of personal computers in the enterprise today, desktop computing has become a core part of our enterprise IT infrastructure. Unfortunately, the personal computer was never designed to handle the requirements of enterprise infrastructure. As distributed end-points, desktops are very difficult to manage, maintain and secure. As a result, most enterprises find themselves with a technology solution that works well most of the time, but at an escalating cost that far outstrips the initial hardware purchase price.

Today, the primary cost for desktops is operational (e.g. application deployment, operating system patch management, backup, support). And there are additional challenges that add to total cost of ownership (TCO). For example, mergers and acquisitions have left many large companies with a hodge-podge of disparate desktops, increasing operational costs. Lack of branch office IT resources requires remote support and maintenance, lengthening time to resolution and a corresponding loss of productivity. Contracting and outsourcing means that more data is mobile, increasing the risk of intellectual property theft and loss.

These and other reasons have prompted an examination of how to reduce the cost and improve the reliability of desktop computing. While alternatives have been evaluated periodically over the years, none have gained widespread acceptance in the enterprise. This white paper proposes a new approach to desktop computing that leverages new technologies to overcome many of the limitations found in early approaches and allows for broad user adoption for the first time. This approach, called server-hosted virtual desktop infrastructure (VDI), combines all the benefits and flexibility of server virtualization with the power and personalization of traditional desktop computing.

Desktop Computing Challenges
By all accounts, desktop computing has been wildly successful. Over 50 million personal computers were shipped in 2005 generating countless hours of user productivity. Desktop computing has become a standard part of the enterprise and accepted cost of doing business. Recently, more comprehensive analysis has been performed on these costs. The results are striking, especially when you look at the non-hardware-related costs associated with desktop infrastructure, such as:

- **Software deployment and patch management.** Processes must be developed and maintained to test, deploy and update software. Gartner estimates that traditional software deployment models add $882 to the price of a PC. [Saving Money on PC Deployment, Dec. 2005] Automated software deployment utilities, such as Microsoft SMS, address part of this problem, but ongoing patch management consumes significant resources with test and validation of increasingly heterogeneous desktop computing environments.

- **Data recovery.** Recovery from data loss, whether minor inconveniences such as deleted files or catastrophic hard drive failures, must be anticipated. Backup software provides a solution for file deletion, but does not handle hard drive failures easily.

- **Business continuity.** The business must continue to function in the event of natural disasters or other systemic failures.

- **User support.** Maintaining service level agreements and user productivity requires a global support presence and the ability to react to software or hardware failures. Gartner estimates there are 20 hours per year of outage per desktop computer. [TCO Comparison Desktops vs. Notebooks, Dec 2005]

- **Intellectual Property Protection.** Corporate IP must be protected from being compromised, especially from contract or outsourced employees. The simplicity of burning CDs and inserting USB memory sticks makes it easy to move information outside the corporate firewall.

These challenges dramatically increase the total cost of ownership of traditional desktop computing.
Desktop Computing Alternatives

There are alternatives to traditional desktop computing including thin-client terminal services and fat-client desktop virtualization. While both of these approaches offer real benefits, neither has effectively addressed enough of the challenges associated with traditional desktop computing to gain widespread acceptance. Recently however, a new approach, called server-hosted virtual desktop infrastructure (VDI) has come on the scene that offers great promise. It combines all the efficiency, flexibility and operational savings of server virtualization with the power and personalization of desktop computing.

In contrast to standard PCs, where applications are run locally, virtual desktops run applications remotely and display applications locally. Virtual desktop computing has been around for a long time, beginning with terminals attached to mainframes. Recent deployments use industry-standard x64 servers that communicate with clients using the Microsoft RDP protocol. The clients can be retired desktops or purpose-built hardware devices.

Virtual desktop computing is designed to have most of the processing and network traffic handled centrally. If you have ever waited for a large email attachment to display, you can appreciate the network activity required by user desktops. With virtual desktops, only keyboard, video and mouse updates are sent over the network. This reduces overall network traffic -- up to 80% in many instances.

Virtual desktop clients (thin-clients) are also more power efficient than their personal computer brethren. Most clients use 85% less power than a PC. The servers where the computing occurs are run at higher utilizations than standard PCs, providing more processing output per kilowatt hour. This in turn reduces both power and cooling costs.

Unlike terminal services, server-hosted virtual desktops (VDI) enable a personalized client experience very similar to that of a dedicated PC including fast performance, a fully isolated and secure environment and standard desktop operating systems. Unlike fat-client desktop virtualization (i.e. VMware ACE), server-hosted VDI also provides advanced virtualization capabilities such as business continuity and disaster recovery. Software can also be easily provisioned, deployed and upgraded. Ongoing patch management is simpler. Applications can be load balanced and corporate IP can be more securely protected, especially with contract or outsourced employees.
Benefits of Server-Hosted Virtual Desktop Infrastructure (VDI)

Server-hosted virtual desktop computing provides a user experience comparable to a desktop personal computer, while simultaneously reducing capital and operational costs. The benefits in reduced hardware, support requirements, increased staff productivity and reduced worker productivity are enormous.

An IDC study on thin client computing [Thin Computing ROI: The Untold Story, Nov. 2005] describes the following benefits:

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Desktop Computer</th>
<th>Virtual Desktop</th>
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<tbody>
<tr>
<td>Lower hardware costs</td>
<td>Average price: $674</td>
<td>Average price: $300 for thin client and $250 for server resources (5$000 server for 20 clients/server)</td>
</tr>
<tr>
<td>Lower IT support costs</td>
<td>Distributed IT resources leads to overstaffing and challenges load balancing resources.</td>
<td>Reduce support staff requirements by 16% or support more users and deploy additional applications without adding staff as centralized support created efficiencies</td>
</tr>
<tr>
<td>Increase IT staff productivity</td>
<td>Staff must provision and maintain each desktop.</td>
<td>The time required for configuration and operations tasks (most notably, hardware setup and configuration as well as software installation and upgrade and asset management) was reduced by 93%.</td>
</tr>
<tr>
<td>Reduce worker downtime</td>
<td>Outages require on-site and manual remediation.</td>
<td>Thin clients have 51% fewer downtime events and require 72% fewer help desk calls.</td>
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“Desktop virtualization offers significant benefits, including better security, manageability, and access to desktop applications in a distributed world.”
Forrester Research, Desktop Virtualization is the Future of the Corporate PC, January 5, 2006

In addition to the benefits outlined by IDC, server-hosted virtual desktops provide capabilities unavailable in traditional personal computers:

- Virtualization allows a common desktop image to be deployed across diverse hardware, simplifying the provisioning process. Provisioning a new PC is as simple as cloning an image, allowing a new employee to have a desktop in minutes. Hardware refreshes can happen “live” without any downtime to users.

- System availability is automated. If a server goes down, whether for planned maintenance or an unplanned hardware failure, all virtual desktops are migrated to alternate hardware in the shared pool, with little or no impact to the quality of service. In addition to servers, highly reliable SAN infrastructure can be used for storage, improving storage utilization and backup reliability.

- Backups are simplified through snapshots of each virtual desktop’s virtual hard disk. Full machine state can be restored in seconds, and file level backups can happen offline, without impacting user or system performance.

- Business continuity plans can be easily expanded to include desktop computing. Alternate data centers can automatically host virtual desktops in the event that the primary data center is down. Likewise, thin clients can be set up anywhere there is network access, providing employee desktop access if work sites are unavailable.
Sensitive applications and data are centrally controlled and managed. Corporate information security policies can extend outside the firewall, protecting intellectual property used by contractors at off-site facilities.

The financial case is clear: server-hosted VDI can save significant IT capital and operational costs. Centralizing servers and server support staff leads directly to higher utilization levels. Simplified software deployment radically reduces rollout and upgrade costs. Longer lifetimes of terminals reduce capital expenditure. Reduced power consumption directly lowers energy costs, and indirectly lowers cooling requirements.

Server-hosted virtual desktops are a viable computing platform that provides significant advantages to traditional desktop computers, and other desktop virtualization technologies, for significantly less cost.

**Virtual Iron and Provision Networks – Server-Hosted VDI**

Virtual Iron and Provision Networks deliver the only pre-integrated/bundled server-hosted virtual desktop solution. The joint solution consists of three components:

**Virtual Infrastructure:** Virtualization decouples operating systems and applications from the functional details of the physical systems, allowing physical resources to be consolidated and increasing the flexibility with which workloads can be matched to physical resources. Virtual Iron provides enterprise-class software for server virtualization and virtual infrastructure management. It enables organizations to dramatically reduce the complexity and cost of managing and operating their data center. Virtual Iron delivers advanced virtualization capabilities that exploit industry standards, open source economics and built-in hardware-assisted acceleration. Organizations use Virtual Iron for server consolidation, rapid provisioning, business continuity, capacity management and policy-based automation to deliver significant improvements in utilization, manageability and agility.

**Access Broker:** The Access Broker provides a highly scalable service responsible for:
- Virtual desktop pool management, such as provisioning virtual desktops
- Managing user assignment to virtual desktops, either dedicated or dynamic virtual desktop pools
- Virtual desktop single sign-on
- Virtual desktop failover
- Monitoring and reporting
- Policy enforcement to ensure users can only use the virtual desktops during prescribed periods

**End Point Terminals:** Terminals provide on-demand access to virtual desktops using thin or thick clients. Clients typically use Microsoft RDP to communicate with virtual desktops securely over SSL.
Virtual Iron and Provision Networks bundle Virtual Infrastructure and the Access Broker for $120 per virtual desktop. Organizations can deploy thick or thin clients as endpoint terminals. Thick clients, for example recycled legacy PCs using Windows and RDP may be available at no up-front cost. Thin clients, such as the HP t5135, provide a low cost of maintenance option.

**Server-Hosted Virtual Desktop Infrastructure Usage Scenarios**

Virtual desktops are not for everyone. For example, workers that require laptops due to long periods without network access are not good candidates for a virtual desktop. But many workers are well served by virtual desktops, including “day extenders” that use laptops only between work and home. The following examples describe standard virtual desktop usage scenarios:

<table>
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<tr>
<th>Organization</th>
<th>Description</th>
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<tbody>
<tr>
<td>Call center</td>
<td>Employees get a session when they arrive that can be permanently or temporarily assigned. Temporary desktop assignments are ideal for application access, reducing the overhead of provisioning more desktops. The system ensures there are sufficient desktops available for employee access.</td>
</tr>
<tr>
<td>Outsourced staff</td>
<td>Outsourced staff performs tasks while sensitive applications and data remain within control of the organization. Organizations can control when users can access the system and where information can go.</td>
</tr>
<tr>
<td>Development &amp; test</td>
<td>Instead of providing multiple PCs to employees for development and test activities, provide multiple virtual desktops, each provisioned with a temporary lease or permanently. Users can access multiple PCs through thin client.</td>
</tr>
<tr>
<td>Hospital</td>
<td>Users that require access to sensitive patient information may have multiple work locations within and outside of the hospital. A virtual desktop ensures compliance with patient confidentiality regulations and provides a consistent desktop no matter where the user is.</td>
</tr>
<tr>
<td>Higher Education</td>
<td>Students arrive and leave universities on a standard cadence that amounts to a big bang in fall and spring that can tax IT organizations. Virtual desktops allow provisioning processes to be automated, reducing much of the operational overhead.</td>
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**Total Cost of Ownership**

The difference in the total cost of ownership of physical desktops and server-hosted virtual desktops (VDI) is striking. Server-hosted VDI increases IT staff efficiency and reduces costs through simplified software deployment, easier and more comprehensive back-up, and streamlined end-user support. In addition to these quantifiable benefits, server-hosted virtual desktops provide a wealth of capabilities physical PCs cannot provide, allowing organizations to achieve much better security protection and business continuity.

The following chart outlines the major cost items for physical and virtual infrastructure. The asterisk symbol references data derived from Gartner’s *TCO Comparison of PCs with Server-Based Computing*, June 2006. This report contains the assumptions and further information on the costs associated with each item.

<table>
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<tr>
<th>Cost</th>
<th>Physical Desktop</th>
<th>Virtual Desktop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client hardware</td>
<td>$900</td>
<td>$300</td>
</tr>
<tr>
<td>Server hardware</td>
<td>-</td>
<td>$250</td>
</tr>
<tr>
<td>Virtual desktop solution</td>
<td>-</td>
<td>$120</td>
</tr>
<tr>
<td>PC deployment costs</td>
<td>$185</td>
<td>$25</td>
</tr>
<tr>
<td>Operations:</td>
<td>$600</td>
<td>$392</td>
</tr>
<tr>
<td>Support, software deployment, backup, security, virus protection</td>
<td>$2215</td>
<td>$704</td>
</tr>
<tr>
<td>End-user operations:</td>
<td>$2215</td>
<td>$704</td>
</tr>
<tr>
<td>Training, self-support</td>
<td>$90</td>
<td>$30</td>
</tr>
<tr>
<td>Annual downtime cost</td>
<td>$90</td>
<td>$30</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$3990</strong></td>
<td><strong>$1821</strong></td>
</tr>
</tbody>
</table>
Part of the TCO equation requires an organization to size the virtual desktop environment to determine how many servers are required to host their virtual desktops. The actual amount of virtual desktops that can run on a physical server varies depending on both physical server configuration such as processor speed, amount of memory, network and storage configurations, and virtual desktop configuration, such as types of applications, frequency of access, and amount of network traffic.

Organizations can expect to run about 3-5 virtual desktops per physical server processor. Thus for a 2 socket, 4 core server (8 cores total) with 16GB RAM, if each virtual desktop requires 512MB RAM, Virtual Iron can run around 30 desktops. Organizations can decrease physical memory and increase swap to get more desktops per server at the expense of performance. Sizing a virtual desktop environment depends on user workloads, activities, and performance requirements.

The results from this cost of ownership model show server-hosted virtual desktops are less than half the cost of physical desktops.

**Conclusion**

Organizations continue to explore ways to reduce IT expenses while increasing the speed by which they grow revenue and profitability. Virtualization is a technology that is changing the way data centers are operated. It reduces capital expenses through server consolidation. It dramatically changes IT operational expenses by automating and streamlining processes that were manual in the physical world.

Server-hosted virtual desktops (VDI) allow these benefits to extend outside the data center to the most pervasive computing resource in an organization: the desktop PC. Virtual Iron and Provision Networks provide a pre-integrated solution that minimizes operational costs for desktop computing while adding capabilities such as high availability and disaster recovery.

In summary, server-hosted virtual desktops reduce costs through:

- **Centralized software deployment and updates:** Windows desktop PCs require specialized tools and processes to test and deploy software products. In addition, operating systems and applications have frequent updates that make software deployments a regular occurrence. Server-hosted virtual desktops streamline this process by allowing updates to be applied centrally and with the ability to roll back in the event that there are issues. This leads to reduced operational costs, as well as improved quality of service to desktop users.

- **Centralized support:** Server-hosted virtual desktops allow support staff to quickly diagnose and resolve users’ desktop support incidents without costly on-site visits. The virtual desktops can run on any server in the data center, and thin clients have no persistent state, creating a disposable infrastructure in the event of hardware failures.

- **Security:** The centralized nature of server-hosted virtual desktops allows an organization to monitor the environment for a variety of threats. In addition, organizations can prevent data from being transferred to the thin client device which reduces the risk that intellectual property will leave the corporate firewall.

- **Backup and restore:** Traditional PC backup is an expensive and generally unreliable endeavor. Server-hosted virtual desktop infrastructure (VDI) backup involves backing up virtual hard drives stored on highly available storage area networks. This decreases the organization’s backup window and improves the reliability of the backups.

- **Software license management:** The cost to acquire and manage software licenses is a significant expense for any IT organization. Server-hosted VDI centralizes license management, and more easily allow licenses to be returned to the pool when needs change.

Server-hosted virtual desktops are suited for a range of usage scenarios. Contact Virtual Iron or Provision Networks to evaluate whether this approach to desktop computing is right for you.
About Provision Networks
Provision Networks is a global provider of server-based application delivery and dynamic desktop deployment solutions. Provision Networks solutions embrace and extend the Microsoft Terminal Services platform and Virtual Desktop Infrastructure, delivering resilient, scalable and dynamic on-demand access for enterprises worldwide.

Provision Networks produces and markets three product suites through a global network of value-added resellers:
- Provision Networks Virtual Access Suite – Enterprise Edition
- Provision Networks Virtual Access Suite – Standard Edition
- Provision Networks Virtual Access Suite – for the Virtual Desktop Infrastructure

With a world-class client list, comprised of some of the world’s largest commercial enterprises, and government organizations, Provision Networks is the most trusted name in application and access infrastructure virtualization. To learn more about Provision Networks and our enterprise access solutions, please visit us at www.ProvisionNetworks.com.

About Virtual Iron Software, Inc.
Virtual Iron provides enterprise-class software for server virtualization and virtual infrastructure management at one-fifth the cost of comparable alternatives. Its solutions enable companies to dramatically reduce the complexity and cost of managing and operating their data center. Virtual Iron delivers advanced virtualization capabilities that exploit industry standards, open source economics and built-in hardware-assisted acceleration. It is available for free download at http://www.virtualiron.com/free. Organizations use Virtual Iron for server consolidation, rapid provisioning, business continuity, capacity management and policy-based automation to deliver significant improvements in utilization, manageability and agility. The company is privately held and based in Lowell, Massachusetts. For more information, visit http://www.virtualiron.com or email info@virtualiron.com.