Microsoft

VDI TCO Analysis for Office Worker Environments

Abstract

Many organizations are evaluating Virtual Desktop Infrastructure (VDI) as an alternative to traditional PCs for their office workers. The perception is that VDI desktops accessed from thin clients will reduce costs and optimize service desk operations. While VDI may result in savings in overall hardware costs, these savings will be offset by higher software and engineering costs. After all the costs are tallied, VDI is more expensive than a well-managed PC environment for office workers. This paper is based on data generated over a six-month period that included surveys, vendor research, on-site benchmarks and a review by an expert panel of analysts.

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Executive summary

OVERVIEW

Many organizations are considering Virtual Desktop Infrastructure (VDI) as a replacement for traditional PCs for office workers. The perception is that VDI reduces desktop TCO while delivering a high quality user experience. Our findings indicate that VDI tends to reduce costs in some areas, but increase costs in others. The net result is that VDI is more expensive than a well-managed PC environment for office workers. While VDI proponents evangelize the areas where VDI saves money, they often ignore the new costs introduced into the system.

RESEARCH METHODOLOGY

The methodology for this study is unique in that several research techniques were used to generate a robust portfolio of data, which was then reviewed by an expert panel of analysts. The research portfolio consisted of:

- 105 phone surveys with organizations that employ 500 or more VDI desktops
- Two-week benchmarking studies conducted at four deployed organizations
- Sizing and deployment guidance from a Systems Integrator specializing in VDI deployments
- Existing data from vendors, analysts and consulting firms

The panel of independent TCO experts was given the research portfolio and asked to validate default TCO metrics for an environment with 2,500 office workers at a well-managed organization based on research findings. Over a period of a week, the panel discussed, debated and modified the metrics. Final metrics were arrived at by consensus, thereby ensuring an independent analysis of the data.

Their verdict? For office workers in a VDI environment (including VMware), the TCO was higher than that of a well-managed PC environment by up to 11% per user. While VDI reduced hardware and service desk costs, new software and engineering costs offset those savings, actually increasing overall costs.

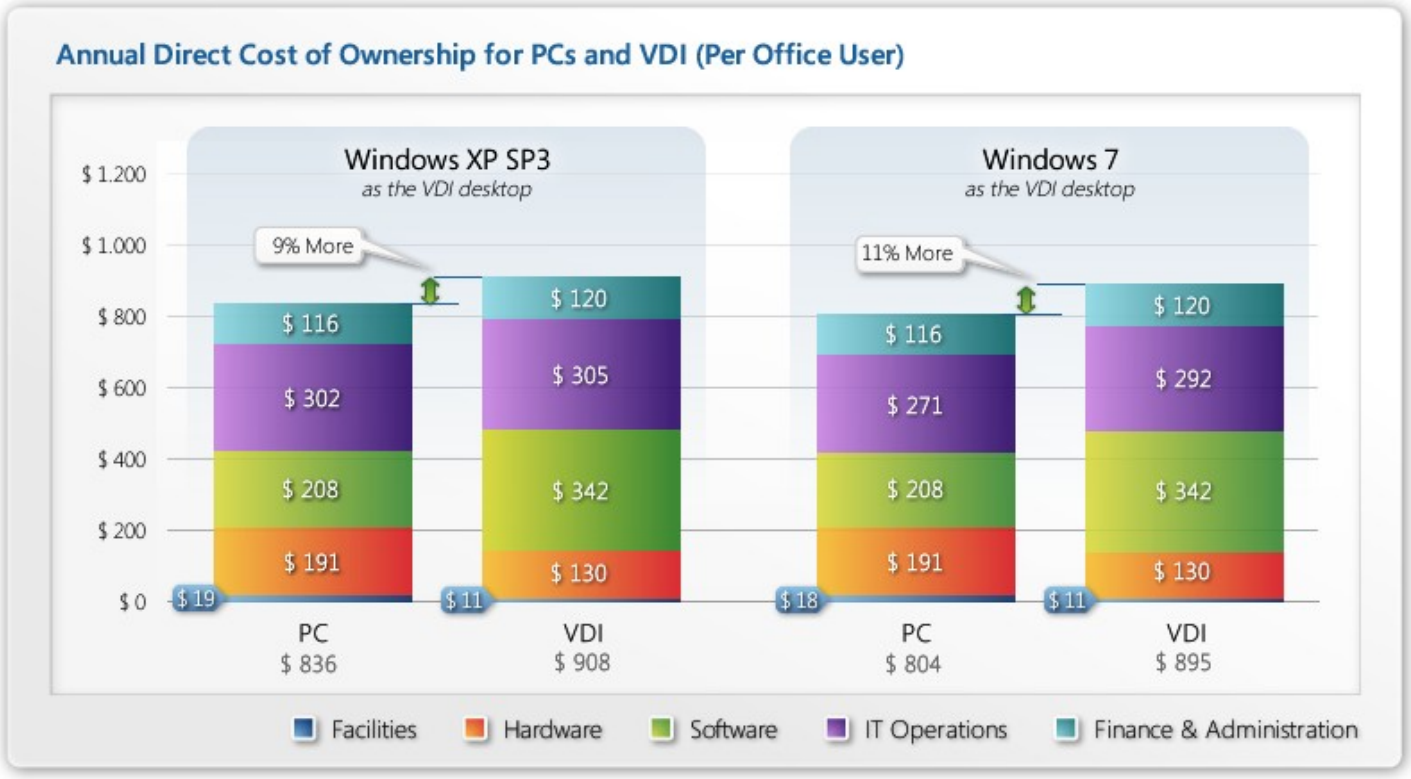
Cost reductions were primarily driven by:

(1) Low VDI end-point costs – thin clients are inexpensive and have a longer service life, easily offsetting the new server, storage and network costs
(2) Low service desk costs – the ability to remotely re-initialize a failed virtual PC offsets the need for most desk-side support visits

Cost increases resulted from:

(1) Additional licensing costs associated with virtualization, management and desktop software from VMware and Microsoft®
(2) More demanding desktop engineering requirements due to the complexity of designing and managing the VDI environment

The table below summarizes the annual direct costs of ownership for PCs and VDI per office worker, with Windows® XP SP3 and Windows 7 as the desktop operating systems.



Key Findings

- VDI reduces hardware costs by 32% but increases software costs by 64%, cancelling any savings
- VDI redistributes IT labor costs, but total labor costs are almost identical in the PC environment
- Users that move from a well-managed PC to VDI complained about a diminished user experience

CONCLUSION

We believe VDI is an innovative technology that can deliver significant value in specific use cases, such as for shift-based task workers and for contractors. However, for the office worker, the value driver will not be TCO reductions. Microsoft recommends that each organization evaluate its use cases and drivers for VDI to ensure the best choice of technology for their users and IT organizations.

Introduction

If organizations made IT decisions exclusively on the basis of Total Cost of Ownership (TCO), they would choose a pencil and paper over computers. Instead, organizations make decisions based on value. They gather business requirements, map requirements to IT architectures, then determine the most cost-effective way to deliver the service.

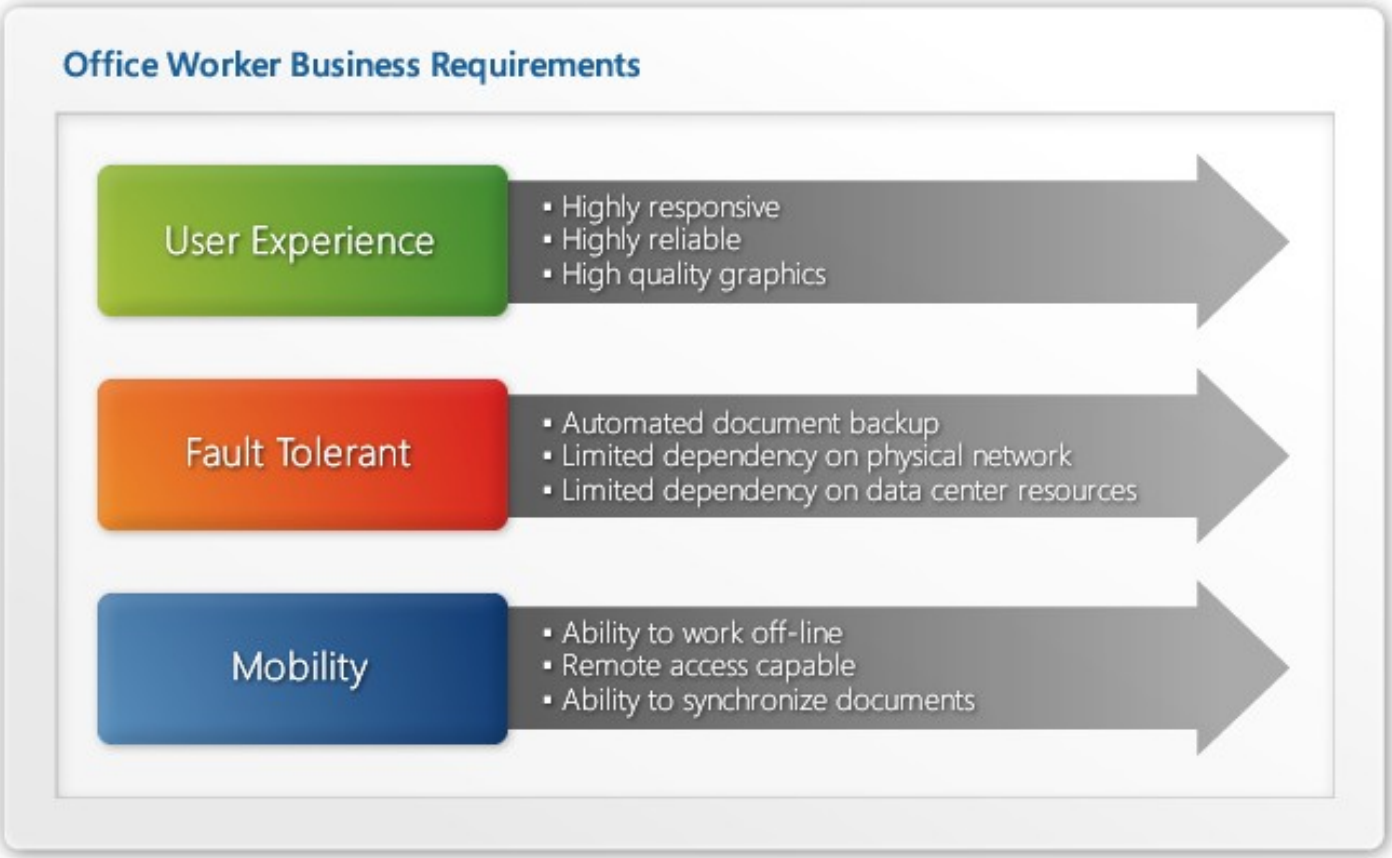
PCs and a Virtual Desktop Infrastructure (VDI) have different value propositions. Each technology has its strengths and weaknesses, and aligns to different business requirements. PCs provide the best user experience, while VDI is more flexible. Either environment can have lower TCO depending on business requirements, use cases, management tools, IT maturity and IT architecture.

This paper focuses on full-time office workers. They often represent the majority of users, and with the exception of the mobile worker, are the most complex to manage. In order to normalize the non-technical variables, our model assumes a well-managed company in the United States that is supported by a mature IT organization. Other use cases and business scenarios are out of scope for this paper, and each would have its own value proposition.

Who is an Office Worker? Office workers provide key support functions for organizations, are moderately paid, and have a high turnover cost. Examples include employees that work in accounting, procurement, marketing, and could include specialists like financial traders and software developers.

Applications: Office workers use a mix of Line-of-Business (LOB) applications and local applications, including web browsers, e-mail clients, spreadsheets, word processors, and presentation software. They generate peaks and valleys in IT resource consumption, and many of the applications require high graphics resolutions and refresh rates.

The diagram on the following page summarizes office worker requirements.



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PC Advantages: Office workers need reliable IT resources, and their productivity suffers when IT system performance is poor or fails. Because PCs tend to be stand-alone, they protect users from competing for shared computing resources. A PC infrastructure increases reliability by reducing dependencies on servers and networks.

Today's PCs have graphics processors that provide high screen resolution and refresh rates, with little impact on the CPU. When mobility is required, a notebook PC is used to provide IT resources for meetings and off-sites. So, from a business perspective, a PC is better aligned to the office workers' requirements.

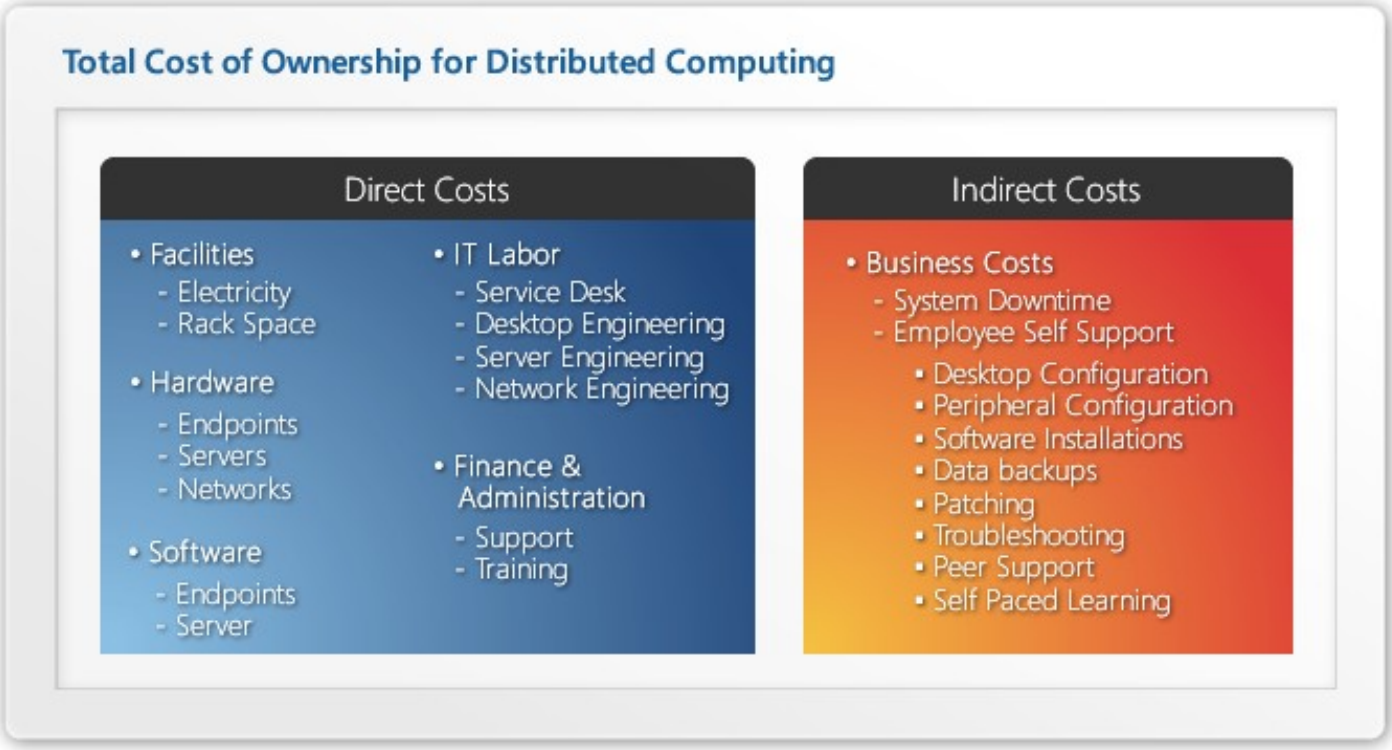
VDI in Contrast: A VDI environment, on the other hand, can provide only some of these capabilities – but at higher cost for office workers. To compensate for peaks and valleys in usage, and the surge associated with all the users starting their machines at the same time, a VDI system requires additional server capacity – that means higher costs, and lower systems utilization.

In order to provide superior graphics performance, more expensive thin clients with local graphics processors may be required. Because virtual machine graphics are processed on the servers, and screen changes are transmitted to the thin clients, more network bandwidth is required, increasing costs. Off-line computing for VDI is still in experimental stages, and the technologies are not ready for production.

The majority of this paper is devoted to providing comparative TCO benchmarks between VDI and PCs. There is no industry standard TCO model. Every vendor, consulting firm, and analyst firm creates their own model, and this study is no exception. This paper is based on a hybrid of best practices of existing models.

TCO: Annual Total Cost of Ownership equals the capital and operational costs of an IT service divided by the number of years in service. *Direct costs* are budgeted, *Indirect costs* are not. CIOs typically focus on direct costs since they appear in their budgets, and therefore this paper focuses on direct costs. However, indirect costs are also important since they reflect the amount of business resources consumed by the computing environment. In a poorly managed environment, these costs can easily exceed the direct costs in the IT budget.

The TCO model used in this project has been expanded to track specific costs associated with a VDI environment. The chart below provides a summary.



Direct costs in this model are financially quantified; indirect costs are presented instead as time spent by office workers to perform self support tasks. We recommend that each organization evaluate if they are interested in tracking indirect costs, and if so, determine the value of their Office Worker's time, and hence arrive at indirect costs that are unique to their environment.

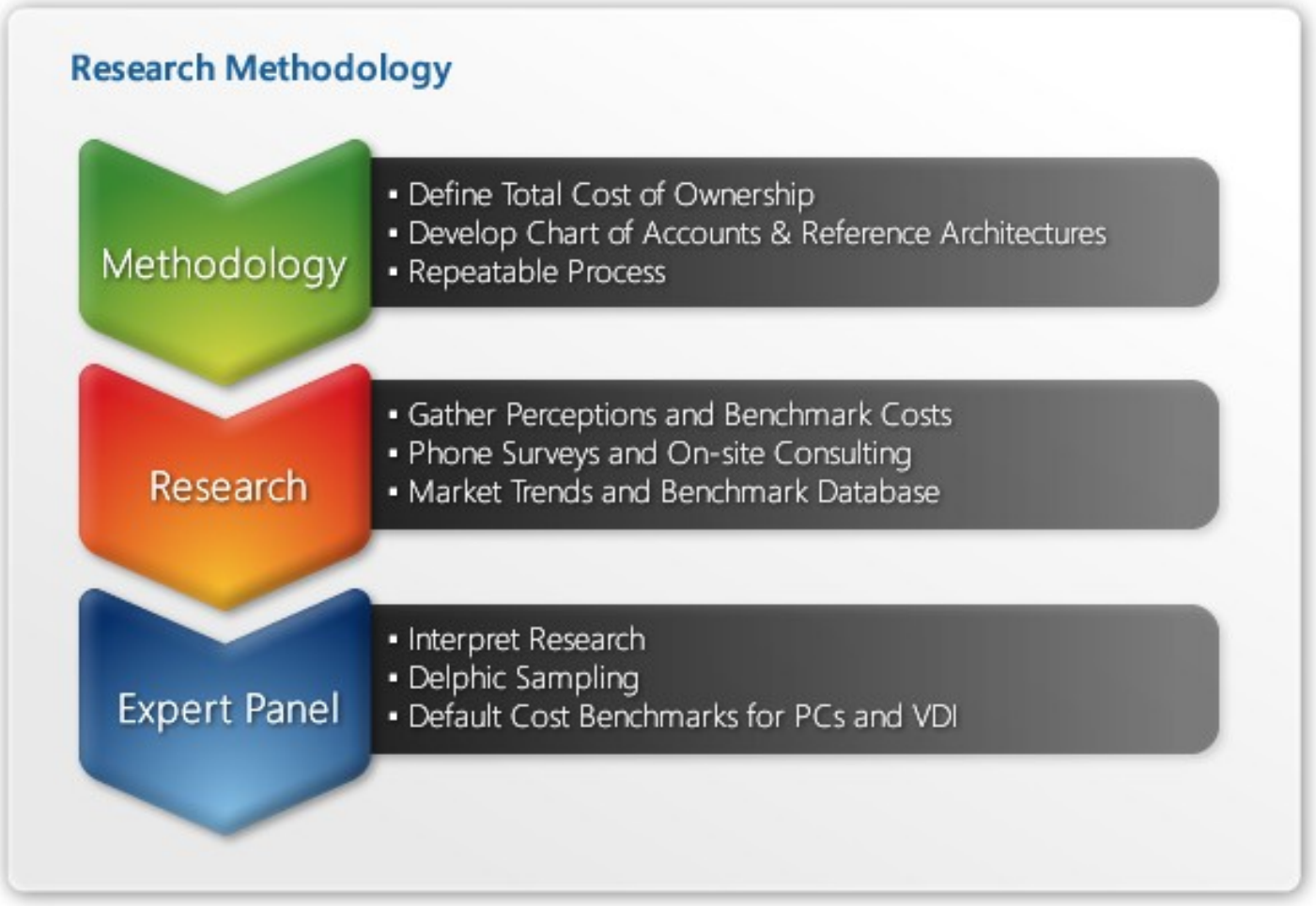
IT Maturity or Infrastructure Optimization typically plays more of role in TCO benchmarks than the choice of technologies or architectures. Many poorly managed organizations fail to realize this and look to a new technology to reduce costs. In almost all cases, the organization would be better off implementing IT best practices with their technologies rather than changing architectures.

Research Approach: Several data collection and validation techniques were used to generate this paper:

- Surveys determined why organizations opted to deploy VDI, and the benefits they anticipated
- On-site benchmarking engagements were used to capture business drivers and cost metrics
- Baseline data was created by an experienced VDI Systems Integrator
- An expert panel analyzed the data and determined TCO metrics

The research portfolio was created over a period of six months, and the expert panel evaluated the results in January of 2010.

The diagram below describes the research process.

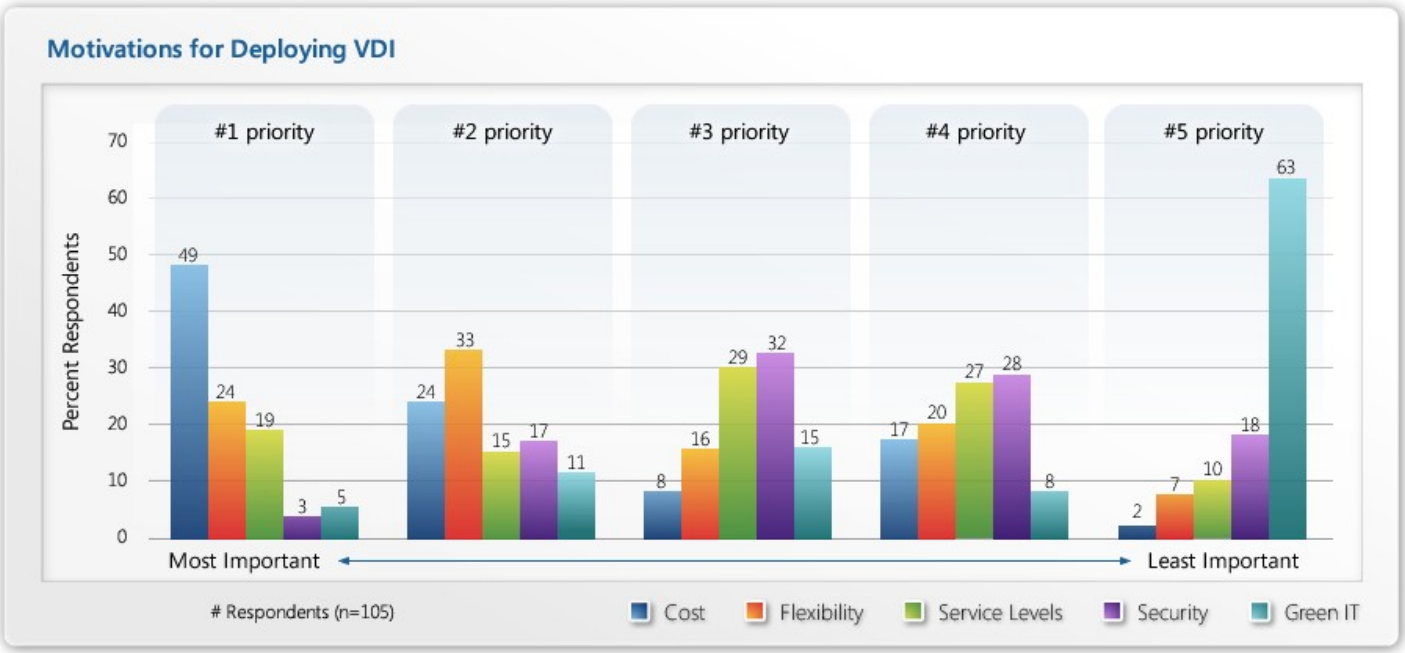


The metrics in the following sections reflect the opinions of the panel and survey participants.

VDI motivations and perceptions

One hundred five organizations were polled on their motivations for deploying VDI. All participants were from the United States, had at least 500 VDI users, and were from the financial services, government, manufacturing and retail industries. For the most part, the organizations appeared to be running large pilots, and some were in the process of increasing the size of their deployments. The reader should keep this in mind when reviewing the data. The majority of the organizations answered the questions based on what they expected to receive from their VDI deployments rather than what they had already received. Their opinions are based on perceptions of their currently deployed environment and not on benchmarking.

The chart below summarizes the motivations for deploying VDI. In the survey, each participant was asked to consider five motivators, and stack rank them from most to least important.



Cost: *Capital and Operational Expenses (Hardware, Software and IT Labor).*

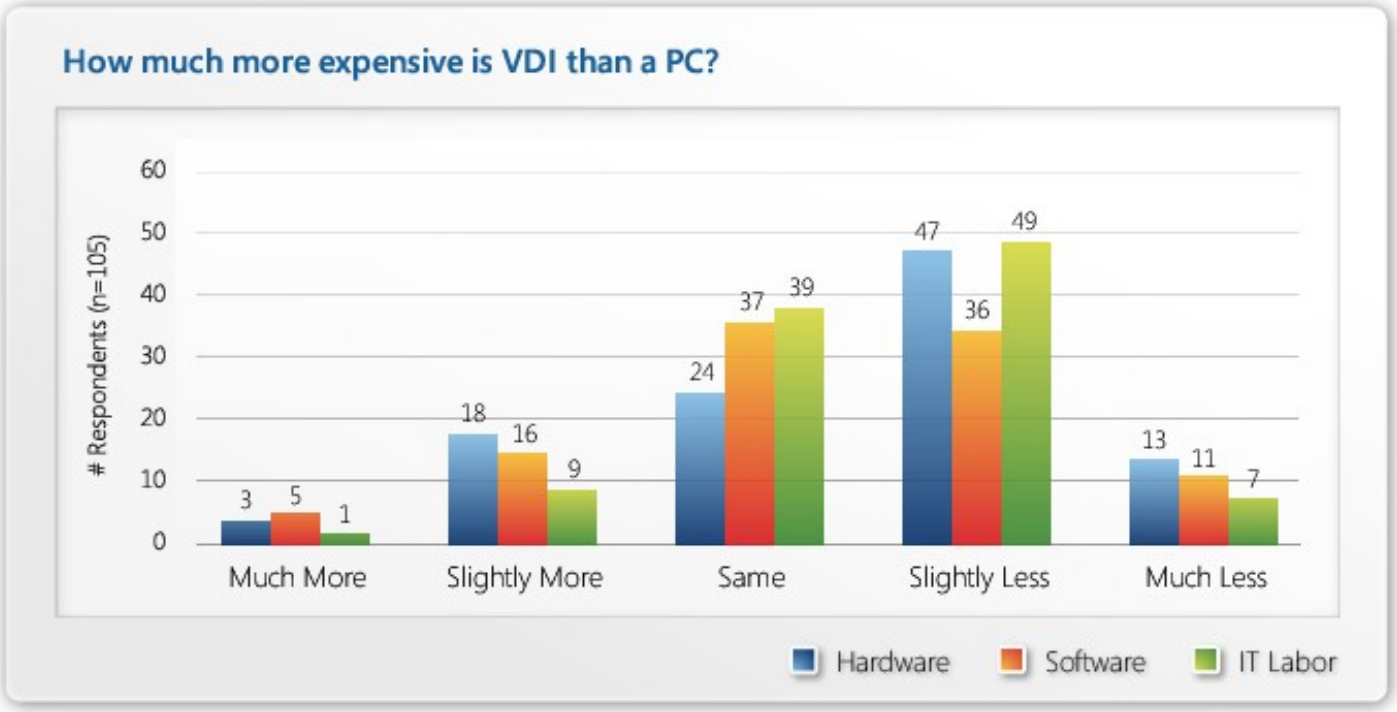
Flexibility: *Time and effort to reconfigure the environment in response to changing business requirements.*

Service Levels: *The quality of services provided to the business.*

Security: *The protection of intellectual property and knowledge assets.*

Green IT: *Power consumption, CO2 emissions and disposal of hi-tech waste.*

The chart below represents the participants' perceptions about the costs associated with the two technologies, by rating how much more expensive VDI was as compared to a PC.



Participants believed that they already were, or soon would be realizing cost benefits as they progressed from pilot to full deployment. However, expectations were modest, with mild savings expected in hardware, software and IT Labor.

Benchmarking studies later in this report were used to compare perceptions to reality.

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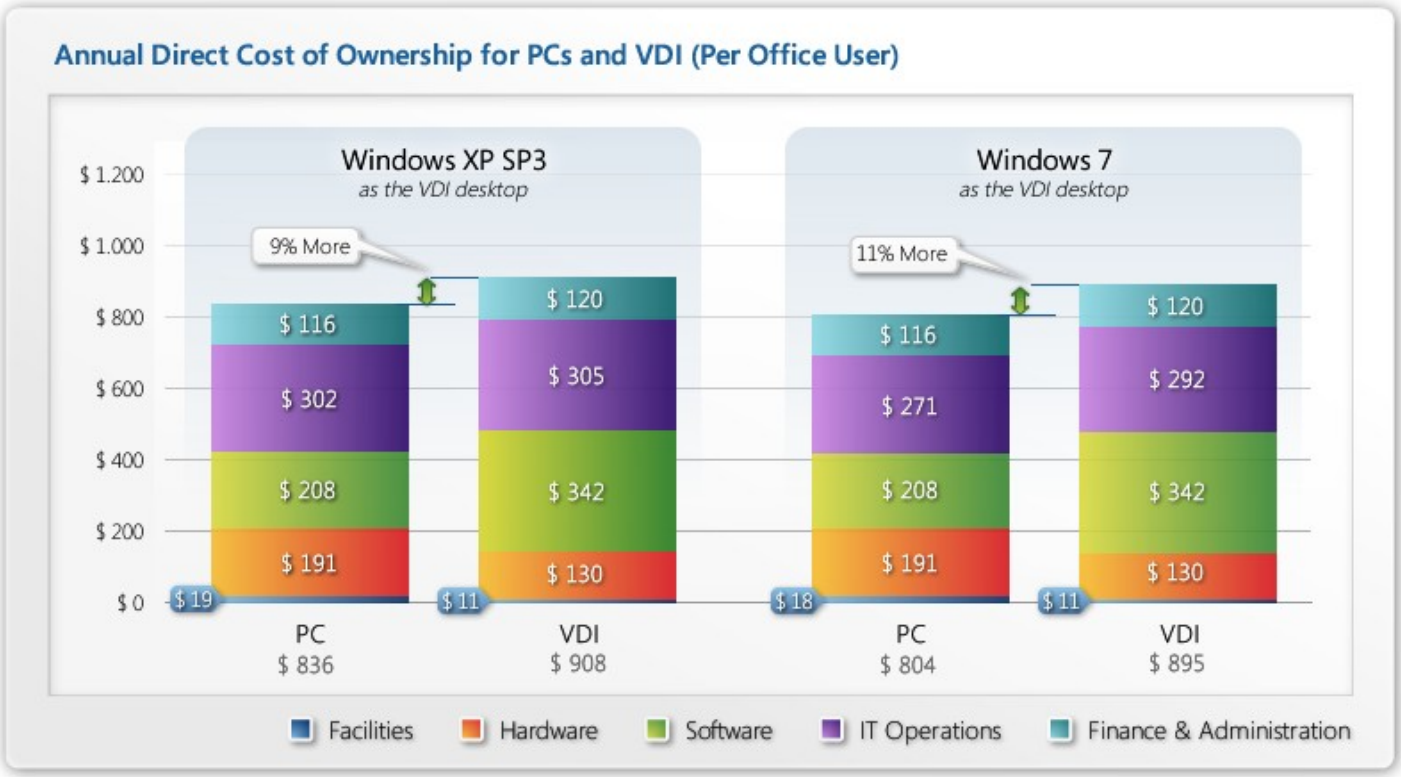
Total Cost of Ownership (TCO) Findings

TCO consists of all direct and indirect costs over the lifespan of the asset or IT service. This section provides cost estimates for Windows XP and Windows 7 PC environment versus a VDI environment for a Rationalized Office worker organization. These estimates were generated from benchmark data collected on-site at four deployed organizations. Because of non-disclosure agreements, the actual benchmark data is not provided. An overview of these organizations can be found in Appendix D.

The chart below summarizes the annual direct cost of ownership for PCs and VDI per office worker.



A full definition for Rationalized can be found in Appendix A, but the short definition is that the organization uses best practices to reduce management costs and to improve service levels. Few organizations have an IT department finely tuned enough to qualify as Rationalized. The modeled office worker scenario assumes users that spend up to 75% of their workday working with personal productivity software and line of business applications. Rationalized was chosen for this exercise since this level of IT Maturity yielded the most effective VDI implementations among the organizations benchmarked.

The majority of today's VDI organizations are using Windows XP, but are expected to upgrade their images to Windows 7 within one year. Listed below are key points to be taken from the table.

- VDI with Windows 7 is 11% more expensive than Windows 7 PCs for office workers
- VDI with Windows XP is 9% more expensive than Windows XP PCs for office workers
- Total PC and VDI labor costs are similar, but costs are accrued to different support teams
- Higher software costs make VDI more expensive than PCs

The following sections drill down and provide the logic for these metrics.

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Facilities cost

Facilities costs include moving a portion of the distributed computing environment from offices into the data center. These costs are not large compared to hardware, software and IT labor, but they do contribute to the bigger picture. These added costs also offset some of the savings in electricity generated through the use of thin clients.

DATA CENTER COSTS

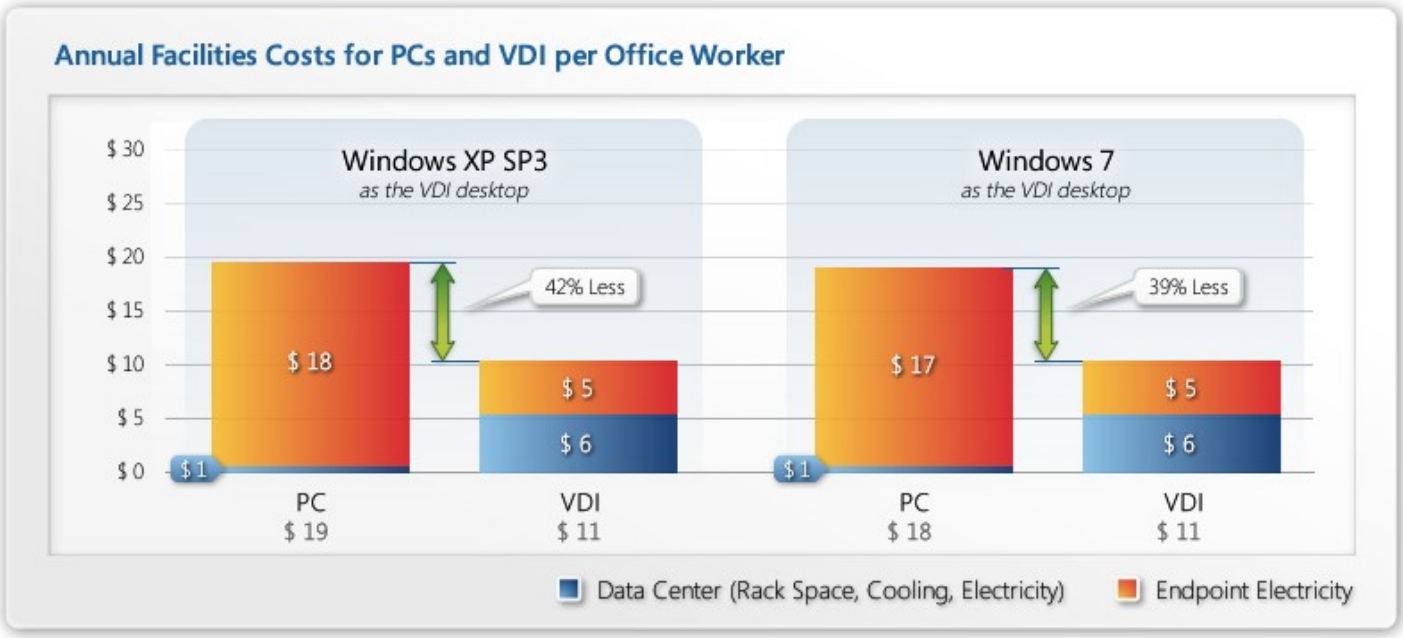
- Rack Space/Floor Space ($50 per square foot)
- Cooling (included in Floor Space Costs)
- Electricity (9 cents per KWh for 8,760 hours per year)

ENDPOINT COSTS

- Electricity (9 cents per KWh for 1,920 hours per year)
  - 66 watts per PC
  - 9 watts per thin client
  - 16 watts per flat panel display

The wattage for equipment reflects "run rates" as opposed to "power supply output," and was based on average consumption rates across the benchmarked organizations. In each of the benchmark studies, equipment power consumption was either taken from product documentation or from the Environmental Protection Agency (EPA) website.

The chart below summarizes the facilities costs for PCs and VDI.



All four company participants in our benchmark studies used Windows XP for both their PCs and VDI clients. After reviewing new power management features for Windows 7, the panel predicted that PCs would receive a small cost reduction because of improved standby, hibernation and group policy management.

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Hardware costs

Hardware costs accounted for 14 percent of the direct costs for VDI, and were split evenly between endpoints and data center hardware. In the PC environment, hardware accounted for 23 percent of direct costs, with nearly all the savings attributed to endpoints. This validates the perception in the survey research that VDI reduces hardware costs.

In both systems, endpoints dominated the cost equation. In the VDI environment, the lower cost of thin clients, coupled with their 7-year lifecycle, easily offset new spending in servers, storage and network hardware. In the PC environment, costs were higher since PCs are more expensive than thin clients, and have a 4-year service life. Data center hardware costs for a PC environment are small, consisting only of systems management servers for managing the environment. When spread across a large number of users, the costs were less than $1 per user.

Hardware spending is directly related to system performance and the quality of the user experience. Costs can be decreased in the VDI environment by loading servers more heavily, and in the PC environment by extending the hardware refresh cycle past 4 years. However, both actions reduce system performance, the user experience and productivity. Before evaluating cost metrics, it is necessary to review the assumptions behind them. The list below provides assumptions for business requirements, support infrastructure and the PC and VDI environments.

BUSINESS

- 2,500 office workers
- Peak hours 9am to 5pm, M-F
- Employees work on endpoints 80% of workday
- Employees spend most of their time in personal productivity applications
- Each office worker has their own PC / thin client, not shared with other workers

INFRASTRUCTURE

- PCs and VDI VMs are managed by Microsoft System Center Configuration Manager (SCCM)
- Employee documents are stored locally, on file shares and on SharePoint®
- SCCM server hardware has a 4-year lifecycle

PC

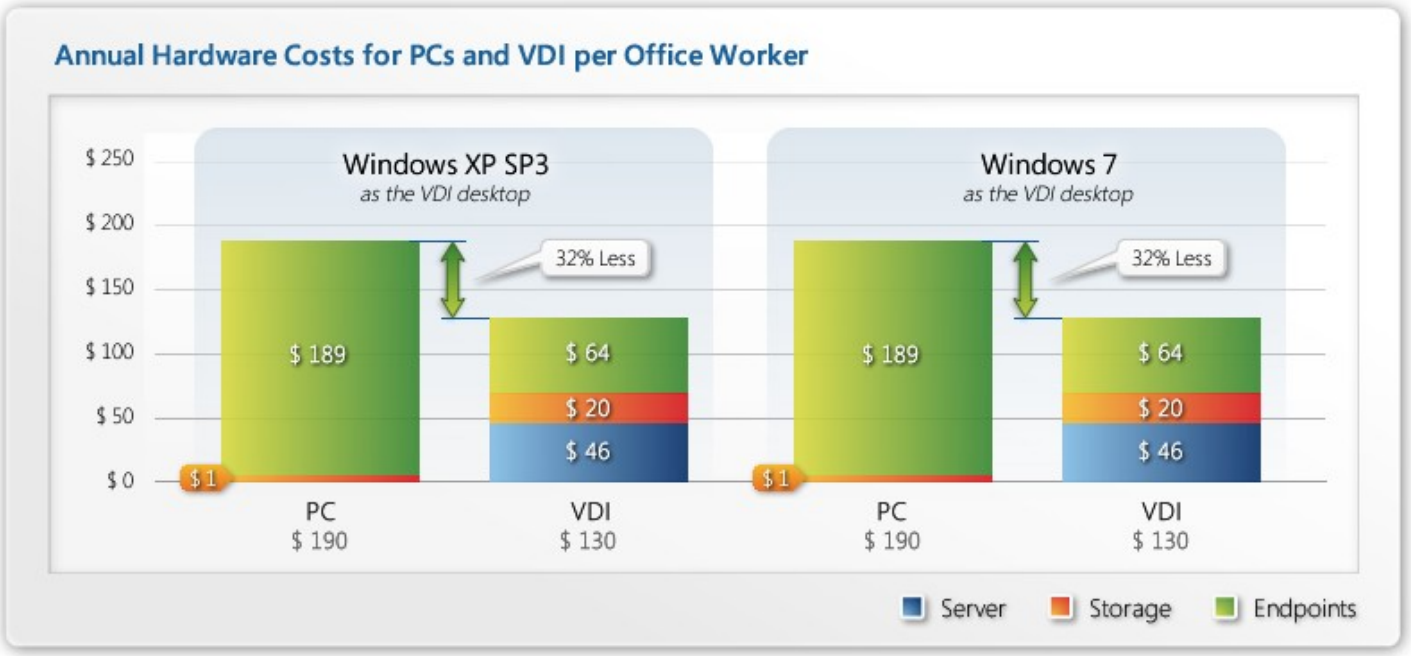
- PCs and flat panel displays cost $750
- PCs are Core 2 Duo, have 2 GBs RAM, 160 GB hard drives, Nvidia graphics
- PCs are replaced every 4 years through a rotating refresh cycle
- PC warranties match lifecycle

VDI

- Thin Clients and flat panels cost $450
- Wyse TCX is used to improve graphics performance
- Thin Clients are replaced every 7 years through a rotating refresh cycle
- Server and storage is replaced every 4 years

There are three hardware cost components in the TCO model; the charts below show roll-up costs for servers, storage and endpoints. Endpoint and systems management cost profiles are straightforward and will not be broken down further. The remainder of this section will focus on VDI capacity planning, server and storage cost metrics, and the assumptions used to generate these metrics.

The chart below summarizes the annual hardware costs for PCs and VDI per office worker.



Office workers are demanding, and their productivity is influenced by the performance of IT systems. If more performance is required, more hardware can be brought on-line. The challenge is in striking the right balance between performance and cost. There are four potential performance bottlenecks in a VDI system: the microprocessor, memory, disk and graphics.

Microprocessors: Some VDI vendors claim 8 to 12 users can share a CPU core. This may be true if the processor is an AMD Opteron or Intel Nehalem Xeon and the users are task workers. However, this assumption is not valid for older processors, or if the users are office workers. In the four benchmarking studies, organizations used both AMD and Intel, and new and old processors. Core loadings ranged from 1 to 8 users per core, and performance varied accordingly. In this analysis, 6 users per core were used on an Intel Nehalem processor. This was seen as the minimal acceptable configuration for an office worker.

Memory: The minimal memory configuration for Windows XP and Windows 7 is 1 GB. Logically, more memory equals a better user experience. In this analysis, 1 GB of physical memory was allocated for each active VM, and it was assumed that using memory over commit technology would allow each user to have the equivalent of 1.2 GB. In the four benchmarking studies, memory allocation ranged from 1 GB - 1.5 GB.

Storage costs: These varied considerably in the four benchmarking studies. Some organizations went with entry-level SANs, and other used cutting-edge equipment in mirrored configurations. The metrics in this analysis assume an entry level configuration from EMC.

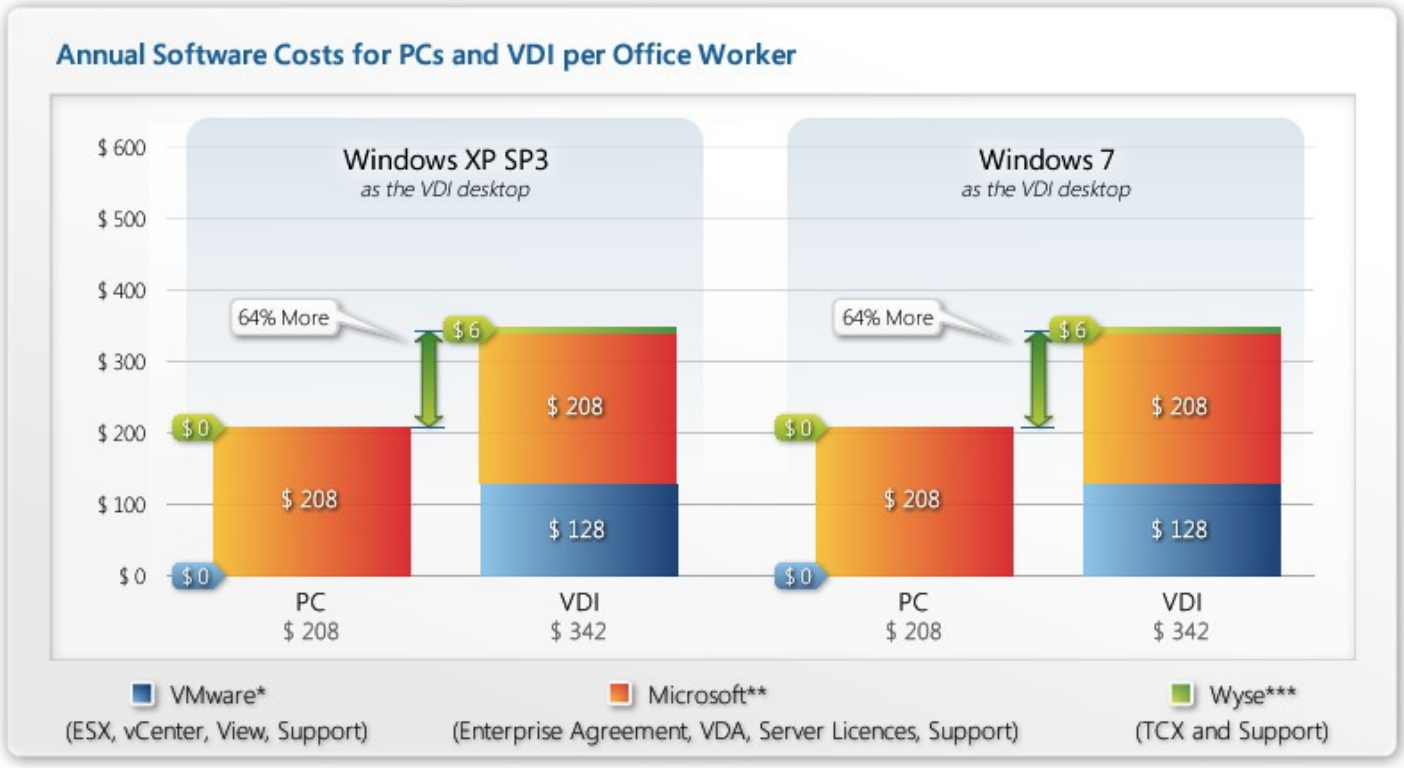
Graphics: Only one of the benchmarked organizations used local graphics processing on their thin clients, which was added in response to user complaints about video performance. The other IT organizations had minimal numbers of office workers or were not responding to user complaints. This analysis assumes that most office workers will require this capability, and Wyse TCX was used as the default configuration.

Software costs

Software costs account for 38 percent of VDI costs and 25 percent for PCs. The addition of virtualization and management software licensing from Microsoft and VMware easily overtake the hardware savings associated with VDI. In the survey research, participants mistakenly felt that they could reduce software spending. Instead, they would need to purchase the same client software as in their PC environment, in addition to investing in the VDI components.

There were significant variations in software costs in the four benchmarking studies: some had Enterprise Agreements (EAs); some were paying for Microsoft VECD (now called Microsoft Virtual Desktop Access (VDA)) licensing and others were not; 3 of the organizations were running VMware and the fourth used a Microsoft/Citrix solution. Below is a middle of the road model for software costs. It does not match any of the four organizations exactly, but does capture the trends. The software costs for Windows XP and Windows 7 are considered the same.

The chart below summarizes the annual software costs for PCs and VDI per office worker.



*Source: VMware website

**Source: Microsoft

***Source: Wyse reseller

The metrics used in this analysis are based on advertised MSRP off the Internet. In the benchmarks, each organization had a different pricing model depending on their industry, history, size and relationships with their software vendors.

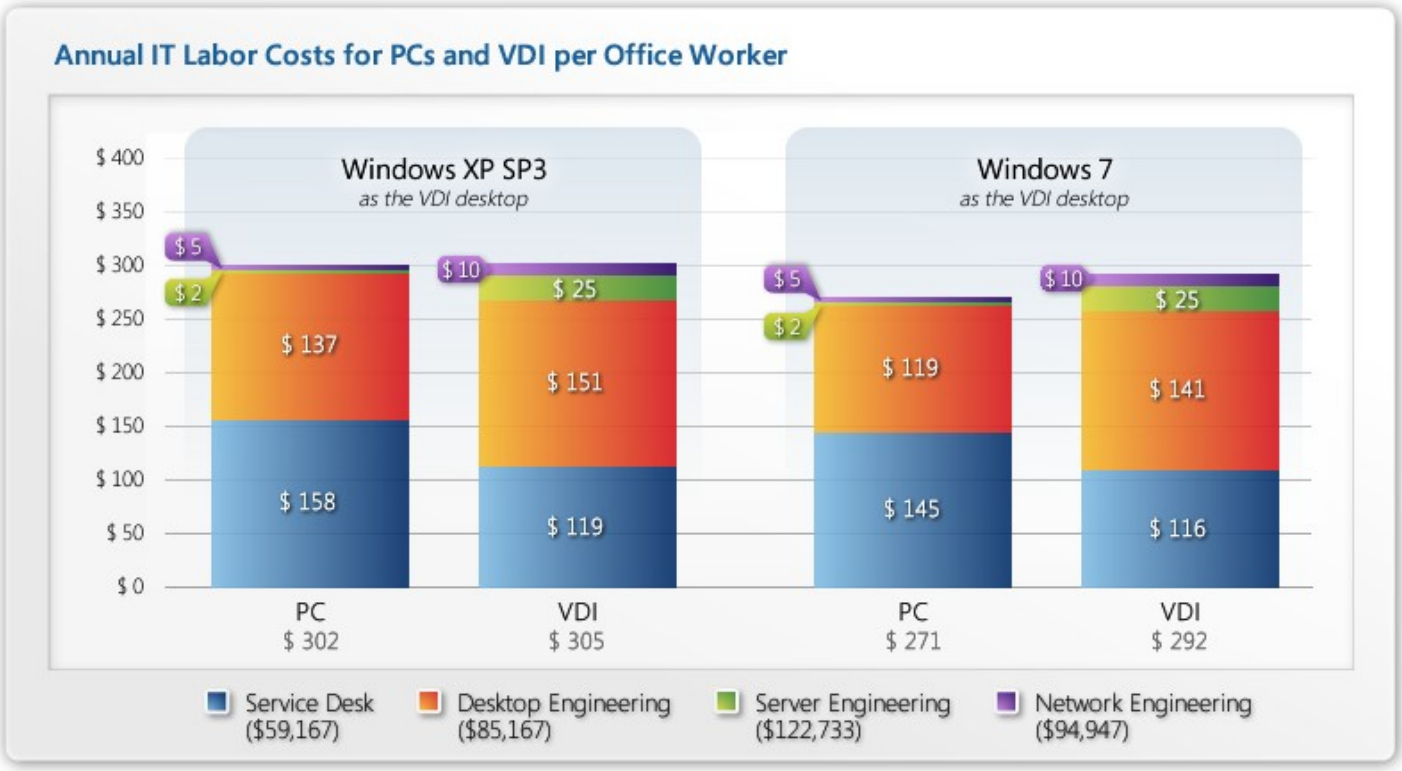
IT labor costs

For a 2,500 user office worker environment, IT labor is more or less a wash. In certain areas, like service desk, VDI does help reduces costs. However, VDI's complexity forces up engineering costs. Service desk costs include telephone and desk-side support labor. These costs are variable and track to the number of users. Engineering costs include systems engineering, maintenance, and escalated support. With the exception of escalated support, engineering costs are more or less fixed — the more users, the lower the cost per user. In the survey research, most participants expected cost reductions in this area, but in reality, the observed outcome is a transfer of costs from service desk to engineering.

Like hardware and software, labor costs varied between organizations for a number of reasons. The two most notable were salary rates and IT maturity. One organization was in an extremely expensive labor market, and the other three were in the Midwest where salaries were lower. Infrastructure Optimization also played a role with two Basic and two Rationalized organizations. Appendix B provides definitions for the best practices used to evaluate Infrastructure Optimization in the Microsoft model. Challenging the panel further, each of the 4 organizations used different organizational structures; tasks that were performed by one team in an organization were performed by a different team in another organization.

The following sections are based on the panel's interpretation of the data and its projection for a Rationalized organization. The salary rates used were the straight averages of the four organizations.

Below is a chart with high level metrics. The dollar figure listed after the position category is the annual burdened salary using a rate of 28 percent for the added costs of an employee beyond salary (e.g. benefits).



A drill down by task for Service Desk and Desktop Engineering can be found in Appendix C.

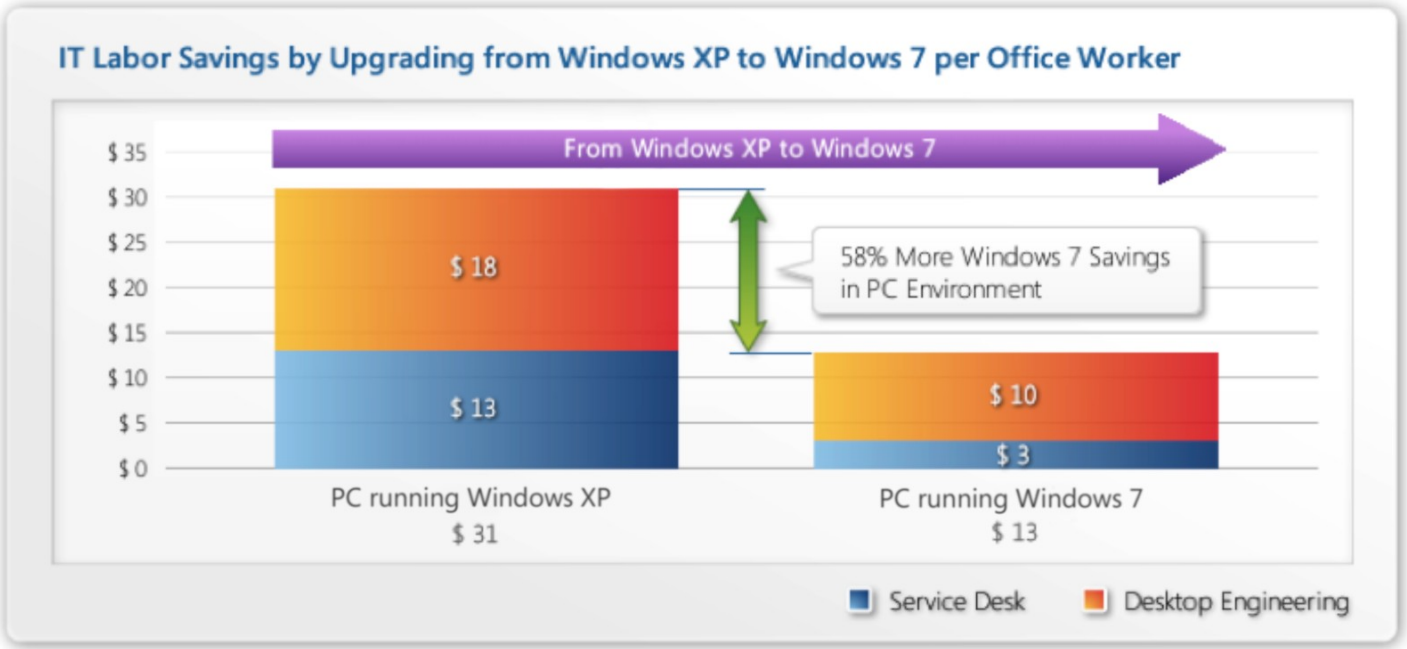
Based on interviews with Service Desk managers, VDI had the greatest impact on costs by eliminating large numbers of desk-side support visits. Instead of sending a technician to a user's PC, the support team was able to re-initialize a machine remotely. The simplicity of the thin client architecture also reduced costs by not having a hard drive; there was one less component that could fail. Also, when a replacement was needed, the thin client could be replaced by the user or office staff by simply plugging in a new part.

Desktop Engineering costs went up in the VDI environment for several reasons. First, a complex VDI infrastructure replaced a simple PC infrastructure, adding to the time needed to develop and deploy the architecture. Second, new tasks were added to job roles, including broker management and orchestration. Lastly, VDI teams spent more time monitoring systems and handling escalated support calls compared to a PC environment. The extra monitoring for VDI systems is to prevent performance bottlenecks at the network, storage and server level. Escalated support calls increased for VDI since user issues are often related to the physical network, storage or servers. These systems require more senior resources for troubleshooting compared to what is available at the service desk. These are not issues for the PC environment, where there is minimal dependence on infrastructure and resources are isolated.

Data center personnel have virtually no involvement in a PC environment. In a VDI environment, this team is involved with managing server hardware, hypervisors, SANs and network capacity planning. The cost across a large environment is relatively small, but it does offset more of the service desk costs associated with VDI.

Although all four benchmarked organizations were running Windows XP, Microsoft asked the panel to generate metrics for Windows 7. Microsoft believes that few organizations would implement Windows XP in new deployments since it is now two versions behind Microsoft's new operating system. In order to generate the metrics, the panel received a briefing from Microsoft on Windows 7, including lists of new features, expected impacts, and default cost metrics. Based on this input, the panel felt that Windows 7 would have the most impact in a PC environment and much less impact in a VDI environment. All cost savings occur at the Service Desk and in Desktop Engineering, while Server and Network Engineering are unaffected.

The chart below summarizes the panel's projections.



When IT tasks are evaluated, VDI under Windows XP receives many Windows 7s benefits. The three primary Windows 7 benefit areas are OS Troubleshooting, Endpoint Deployment and Patching.

OS Troubleshooting: Windows 7 is more stable than Windows XP. However, in a virtualized environment a Windows XP virtual machine can be re-initialized easily. Benefit goes from $7 to $0.

Endpoint Deployment: In a PC environment a user image is deployed with the PC. Windows 7 provides tools that reduce this cost. In a VDI environment the endpoint is separated away from the image. Benefit goes from $7 to $0.

Patching: Windows 7 requires less patching than Windows XP. However, in a virtualized environment patching is much easier. The benefit goes from $6 to $3.

When building a business case for Windows 7 in a VDI environment, the majority of the benefits will need to come from an improved user experience, application compatibility and security.

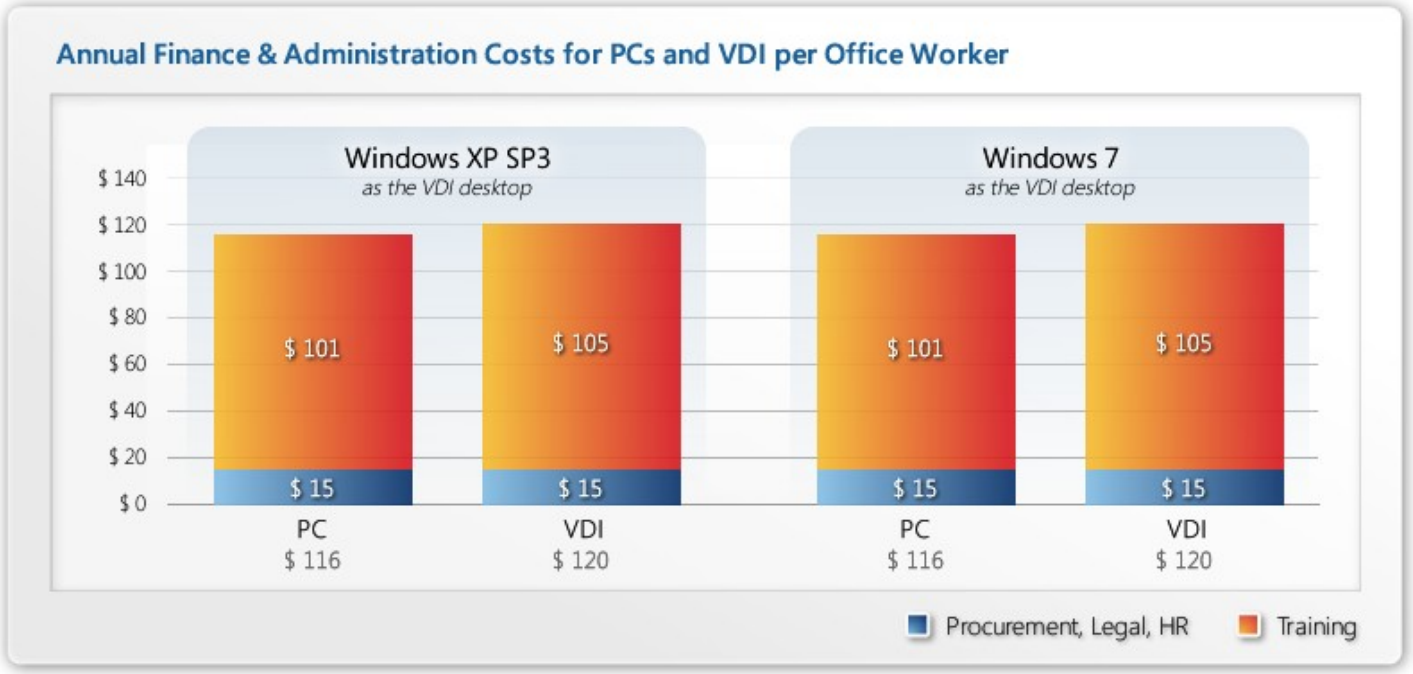
Finance and administration costs

There is very little difference in Finance and Administration costs between PC and VDI environments. Costs in this category include procurement, legal and HR support, and user and IT training. There is also no difference between Windows XP and Windows 7.

Procurement, Legal and Support tasks were either performed by dedicated staff on the IT payroll, or there was a charge back system in place where the IT department "purchased" these services from other departments in the organization.

User training budgets varied greatly between organizations. This model assumes an average cost of $100 per user per year. Most organizations spend more on IT training for their technical personnel, but these costs are distributed across the entire user base and have a small impact on TCO. Because VDI is more complex than a PC environment, IT training increased from $1 to $5 per user.

The chart below summarizes the annual finance and administration costs for PCs and VDI per office worker.



Business costs

Business cost is defined as the value of lost productivity that occurs when users perform self-support activities. These activities include configuring hardware and software, connecting to printers, time on the phone with service desk, helping peers with their issues, learning new software, installing software, patching and other tasks. These costs are considered indirect costs since they are not budgeted and do not impact the IT budget. In many cases, indirect costs exceed direct costs. A TCO calculation includes indirect costs.

Indirect costs were very difficult to measure in this research, and the expert panel was not able to come to consensus on metrics for this paper. Two of the benchmarked organizations reported a surge in business costs resulting from the VDI deployments. Users found the system hard to use and spent considerable time doing tasks that would be routine in a PC environment. For example, many users reported spending considerable time fiddling with the equipment to add printers or to transfer documents with USB keys. They often involved peers in these processes, which resulted in multiple employees being taken away from their normal jobs. However, the VDI systems were new, not all the bugs had been worked out and the CIOs/CTOs felt that this situation was temporary and that things would stabilize once the VDI systems had been in production for a year or more. Once stabilized, they felt that VDI and PCs would have similar business costs. Another organization used VDI for offshore contractors. In this case, it was not possible to get any feedback from the contractors and even if it were, there was no PC data to make a comparison. The last organization was almost exclusively a task worker scenario where users used a small number of Line of Business (LOB) applications. They were not permitted to add printers or to use USB keys. This system had also been in production for a long period of time and had stabilized. These users reported lower business costs than their office workers using PCs. However, work habits between task workers and office workers are so different, the comparison is not valid.

For this reason, the expert panel was unwilling to assign a business cost metric to the VDI environment. However, the author of this paper believes that even after these environments stabilize with advanced technologies like Wyse TCX, business costs will likely be higher. The thin client model is more complicated and more things can go wrong. Also, new employees that are familiar with PCs will start using the VDI system and will need assistance from their peers to make the transition.

Depending on how well managed a PC environment is, users typically spend between 40 and 100 hours per year on self support activities. In a Basic desktop environment, some of the IT costs are transferred to the business users as they are forced to provide their own IT services. In a well-managed Rationalized environment, best practices are used to automate IT services on behalf of users. We believe that VDI users will spend 10% to 20% more time on self support than in a PC environment at the same IT maturity level.

Conclusions

Office workers depend on IT systems to do their jobs. When systems don't perform, it negatively impacts productivity, job satisfaction, and an organization's performance and competiveness.

VDI is an emerging technology that is highly flexible and can be used to protect intellectual property. However, many office workers will find the VDI user experience inadequate. The results will be reduced productivity, increased business costs and less good will toward the IT department.

VDI is infinitely configurable. Performance and the user experience can easily be improved by adding more hardware and software. However, closing the gap to the level of the PC experience raises costs, making VDI on par or more expensive at lower performance levels. Unless the benefits of improved flexibility and security offset these costs, organizations will receive more value from PCs for office workers.

VDI hardware costs are significantly lower than the PC environment when thin clients are used on a 7-year refresh cycle – the additional cost of server, storage and network hardware do not offset the cost differential. Service desk costs are also lower because of the ability to re-initialize failed virtual machines remotely, and the avoidance of desk-side support visits. However, additional VDI software costs exceed the savings in hardware.

Additional virtualization and management software licensing from Microsoft and VMware provide the majority of the cost increases. Although service desk costs are lower for VDI, engineering costs go up because the IT staff must now design, deploy, monitor, troubleshoot and manage a much more complex system than a PC environment. IT labor costs are more or less even between the two environments.

While other cost categories such as facilities costs (electricity), finance and administration and business costs are part of the TCO model, their impact is small compared to hardware, software and IT Labor.

While VDI has higher TCO than PCs for office workers, it can deliver superior value in other use cases. One area that shows great promise is shift-based task workers working in different time zones. These workers generally use server-based applications that avoid the peaks and valleys associated with office workers. The shift work also aligns to a VDI strength by being able to reallocate computing resources on-demand, which can significantly reduce the cost profile for a task worker. There are also many advantages to using VDI for contractors, eliminating the need to provide a PC plus additional protection of corporate IP and corporate computing resources.

In the case studies used to generate this paper, some of the organizations had chosen a VDI solution purely for the flexibility or the security, and were willing to pay substantially more per user to get this capability. PCs could not meet these business requirements no matter what the price point. In these cases, the IT department conceded that the user experience had dropped, but that the new capabilities exceeded the value of the productivity losses.

VDI is a new technology, and vendors such as VMware, Citrix, and Microsoft are improving their products. In time, new or improved products may be better able to close the user experience gap. If they can provide a "Good Enough" user experience at an attractive price point, they will be in a better position to challenge the traditional PC in the office worker scenario.

Appendix A: Infrastructure Optimization

IT Maturity plays a role in IT labor costs. Organizations that leverage best practices are able to improve service levels while reducing costs. To help customers evaluate their own IT Maturity, Microsoft created the Infrastructure Optimization model. This model has four levels, Basic, Standardized, Rationalized and Dynamic. Each level is determined by the use of best practices. Basic is a chaotic and reactive organization with few (if any) programmatic best practices; Standardized is an organization with standard but uncoordinated processes in place; Rationalized is an organization with optimized processes and beneficial use of automation and integration to extend those best practices across the organization. Most IT departments are at the Basic and Standardized level. A small number, maybe 10% are Rationalized. Few if any organizations have attained the Dynamic level. Because of the complexity of a VDI environment, the assumption was that an organization would be Rationalized before implementing VDI.

Prior to this research project there was no Infrastructure Optimization model for VDI. Lawrence Associates, in conjunction with Entisys and Microsoft, identified key management processes that improved service levels and reduced cost.

The chart below describes VDI Infrastructure Optimization for Basic, Standard and Rationalized.

VDI Infrastructure Optimization Defined by Best Practices

Basic	Standardized	Rationalized
• Best Practices None	• Best Practices (1) Desktop change management (6) SAN storage (7)Active/passive clustering (9) Network redundancy (11) Hardware graphics acceleration	• Best Practices (1) Desktop change management (2) Pooled images/broker (3) Application virtualization (4) Smart load balancing (5) Dedicated infrastructure (6) SAN Storage (7,8) Multi-node clustering (9) Network redundancy (10) Rule based monitoring/control (11) Hardware graphics acceleration (12) Live migration (13) RPC tunneling

PC Infrastructure Optimization Defined by Best Practices

Basic	Standardized	Rationalized
• Best Practices None	• Best Practices (1) Automated patch management (2) Standardized images (3) Minimal Windows versions (5) PC firewalls (6) Automated Anti-virus (10) Automated Software Distribution	• Best Practices (1) Automated patch management (2) Standardized images (3) Minimal Windows versions (4) Automated asset management (5) PC firewalls (6) Automated Anti-virus (7) No Admin rights on PCs (8) L1 Lockdown (9) L2 Lockdown (10) Automated Software Distribution (11) Network Access Control

VDI Best Practices

1. Desktop Change Management

By enforcing a desktop change management process that includes service request forms, an approval process, testing regimen, task scheduling and a communication plan an organization can reduce costs, improve service levels, and reduce security risk by ensuring that changes to policies, processes, and technology are evaluated for efficiency and organizational impact.

2. Pooled Images/Broker

VDI storage per GB is more expensive than a hard drive on a PC and must be optimized. By maintaining a reference image for each OS in use, and then storing profile information and state information separately, organizations can reduce storage by 10 GB per VDI client. IT management costs are also reduced since patching and image updates can be performed once, rather than once for each client image. Dynamic thin images require the use of a broker to assign users to a VDI server and pair them with their user profiles and applications.

3. Application Virtualization

Application virtualization separates an application from client image, improving stability and reducing maintenance costs. There are two implementations of this technology. One solution virtualizes the application separately on an application server and presents the application through the image. The other solution runs the application locally on the image that is being run on the server.

4. Smart Load Balancing

Round robin DNS provide load balancing by ensuring that each server provides the same number of sessions. What is not taken into account is the amount of resources being consumed by each client session. Smart load balancing uses monitoring agents to track user behavior, processor utilization, memory utilization, network traffic and disk activity for each session. Smart load balancing forwards a session based on available resources instead of round robin DNS.

5. Dedicated Infrastructure

VDI images are typically virtualized with servers that provide security and networking services, such as domain controllers, certificate servers, DHCP servers, DNS servers and WINS servers. In order to improve security and optimize network traffic, a high speed virtual network with dedicated NICs should be used to create a VLAN for the VDI images and supporting infrastructure.

6. Storage Area Networks (SAN)

SANs are expensive, but provide high performance and unsurpassed reliability compared to locally attached storage or network attached storage. Although expensive, SANs are extremely efficient since they virtualize storage and provide a high return on assets. Since VDIs share storage with among client images and the server, a SAN is often the best solution to reducing this bottleneck.

7. Active/Passive Clustering

Server clustering involves duplicated physical server hardware and shared storage. System state is captured so that the load of a failed server can be transferred to the back-up unit. Single node clustering is fault tolerant but allows an expensive asset to go unused until needed. Multi-node clustering exceeds the capabilities of this best practice and is used in more mature organizations.

8. Multi-node Clustering

A single-node cluster uses two servers, one that is active and another that is on standby. In a single-node cluster, only 50% of the hardware is used at one time. In a multi-node cluster, 4 or more servers work as a team to carry the full workload of 3 servers. In the 4-node example, if one server fails, its workload is divided among the other 3 servers in the group, bringing them to full capacity. In a 4-node cluster, 4 servers provide the protection of 6 single-node servers, increasing ROA.

9. Network Redundancy

Unlike a PC that is local and can continue to operate if the network is down, a VDI client cannot. The network is a single point of failure for VDI and must be redundant. The network must have alternate routes for traffic and redundant hubs, switches, gateways, routers and bridges.

10. Rule based Monitoring and Control

Many vendors provide agents that can be run on hardware and software to monitor key metrics. The agents forward the metrics back to a management database where administrators are provided with a dashboard that shows the health of the clients, software, servers and networks.

11. Hardware Graphics Acceleration

Some users make extensive use of graphics for simulations, modeling and videos. These users will be dissatisfied with session based VDI. If a PC supports hardware virtualization, an image can be streamed and cached to the local PC. The PC can have a full OS, stripped OS, or boot OS to support the hypervisor.

12. Live Image Migration

A large server farm must be flexible in order to allow for new equipment, decommissioning of old equipment, upgrades, replacements and reconfigurations. If users are on the VDI system 7x24, these changes must be made without disrupting the users. In larger VDI environments, state information must be captured for active sessions and moved to duplicate systems during the change process. This must be done without disrupting the users.

13. RPC Tunneling

Using an RDP client requires that port 3389 be opened on a firewall when users connect over the Internet. Some firms may be reluctant to open this port for security reasons. Some vendors provide and encrypted RPC connection over https through a web browser, which eliminates the need for the RDP client and the requirement to open the port.

PC Management Best Practices

1. Automated Patch Management

PC images are monitored for compliance with required security patches. If PCs are out of compliance, automated systems push patches to the clients.

2. Standardized Images

Organization has minimized the number of client images to reduce testing and support costs. Only applications that are deployed to the entire organization are incorporated into the image. Non-standard user applications and personal customization are handled through profiles and automated software distribution systems.

3. Minimal Versions of Windows

Organization has standardized on one version of Windows, or may be in transition to standardization and using two versions of Windows through Managed Diversity. In a Managed Diversity, all new PCs receive the new OS while older PCs are allowed to remain on the legacy OS. Organization pays less to manage two OSs simultaneously, compared to the one-time cost of upgrading to the latest Windows version.

4. Automated Asset Management

Organization has automated asset management to track PC hardware and software. The inventory is stored in a centralized database and used for managing the environment. Automated software distribution systems are integrated with asset management systems to ensure users get the correct version of applications to minimize application and OS conflicts.

5. PC Firewalls

Each PC is protected by a firewall with port and application exceptions set by a group policy delivered through a directory. Users are prevented from opening ports or creating application exemptions. PC firewalls are most critical on notebook PCs that are operating on public networks.

6. Automated Anti-Virus

All PC images are protected by an anti-virus application that is tied to an automated system that ensures profiles are kept up to date.

7. No Admin Rights on PCs

Some applications require administrative rights to function. Organizations that have implemented this best practice have replaced all applications that require administrative rights with ones that will operate with user permissions. This allows administrators to do the L1 and L2 lockdown best practices.

8. L1 Lockdown

Group policies implemented through a directory are used to configure the user PC. Since users do not have administrator rights, they are not able to alter configuration settings. The result is a more stable PC and few calls to the service desk.

9. L2 Lockdown

Group policies implemented through a directory are used to prevent users from installing applications. Instead, automated software distribution systems are used to deploy software based on group policies. The result is a more stable PC and few calls to the service desk.

10. Automated Software Distribution

Automated software distribution is used to install applications on PC images. Distribution is based on hardware/software inventories and group membership.

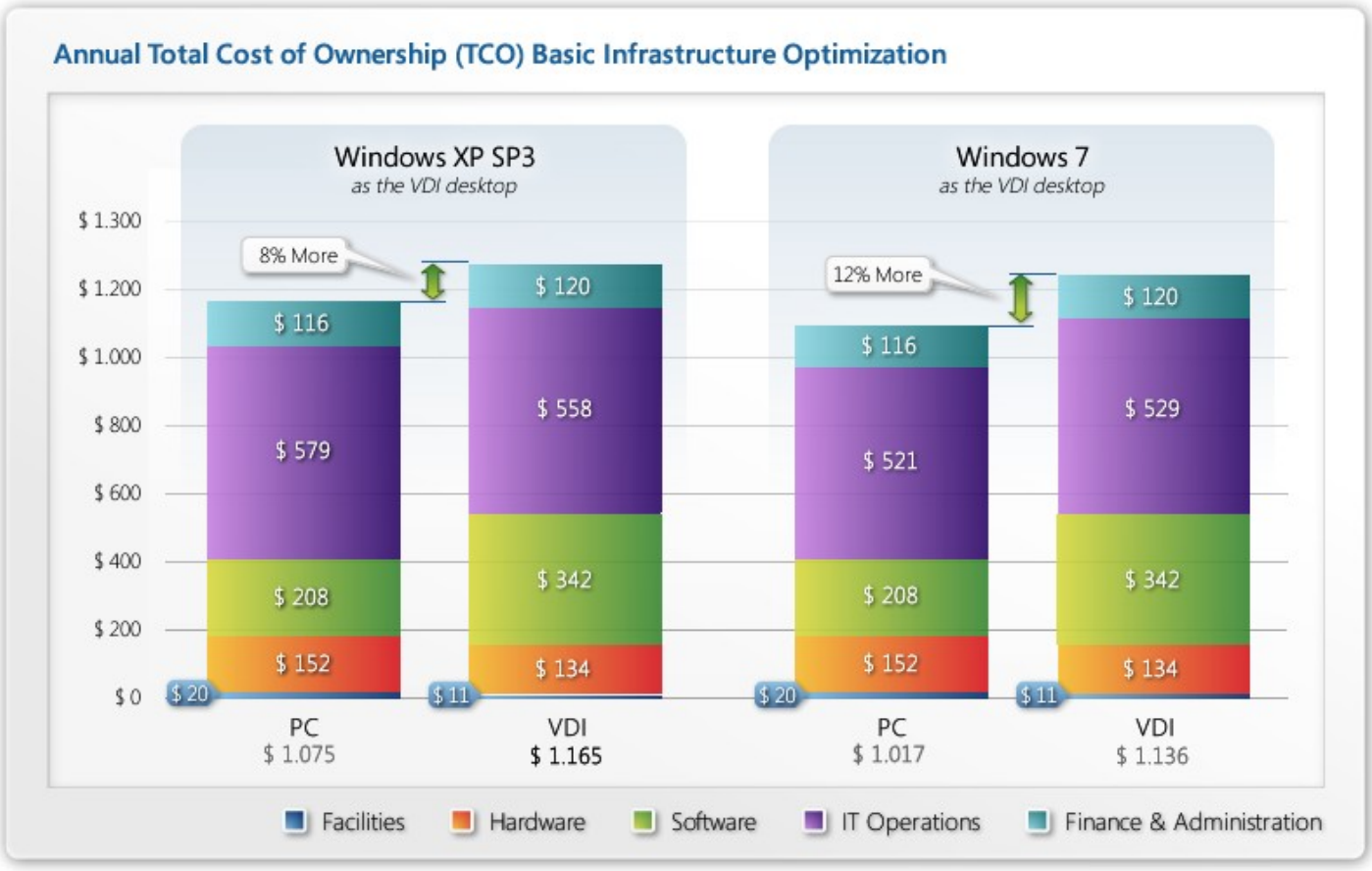
11. Network Access Control

PCs that connect to a network are evaluated for compliance to security compliance. PCs that do not comply are placed in quarantine and prevented from damaging other IT assets.

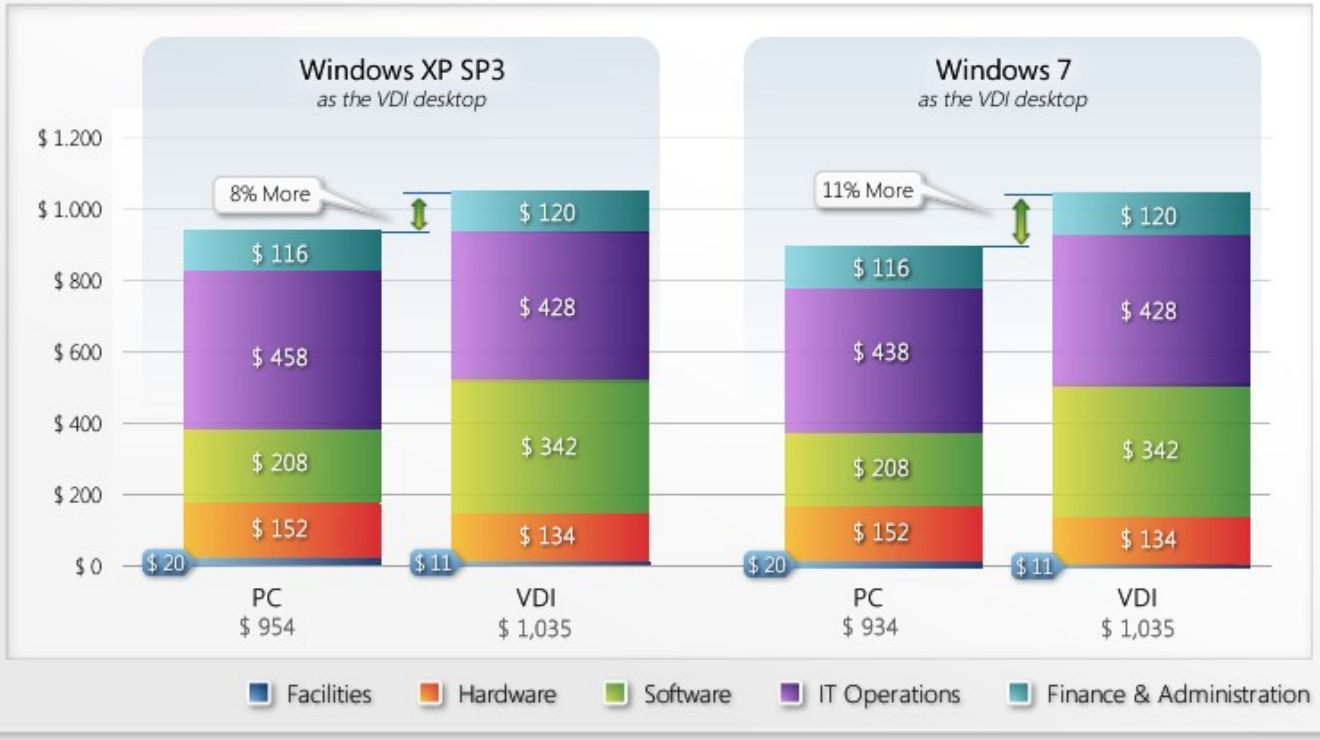
Appendix B: Infrastructure Optimization cost tables

Infrastructure Optimization improves service levels and reduces IT labor costs. In some situations, additional spending in hardware and software is required to implement best practices to increase the Infrastructure Optimization level. The models below are for Basic, Standard and Rationalized for Windows XP and 7, VDI and PC.

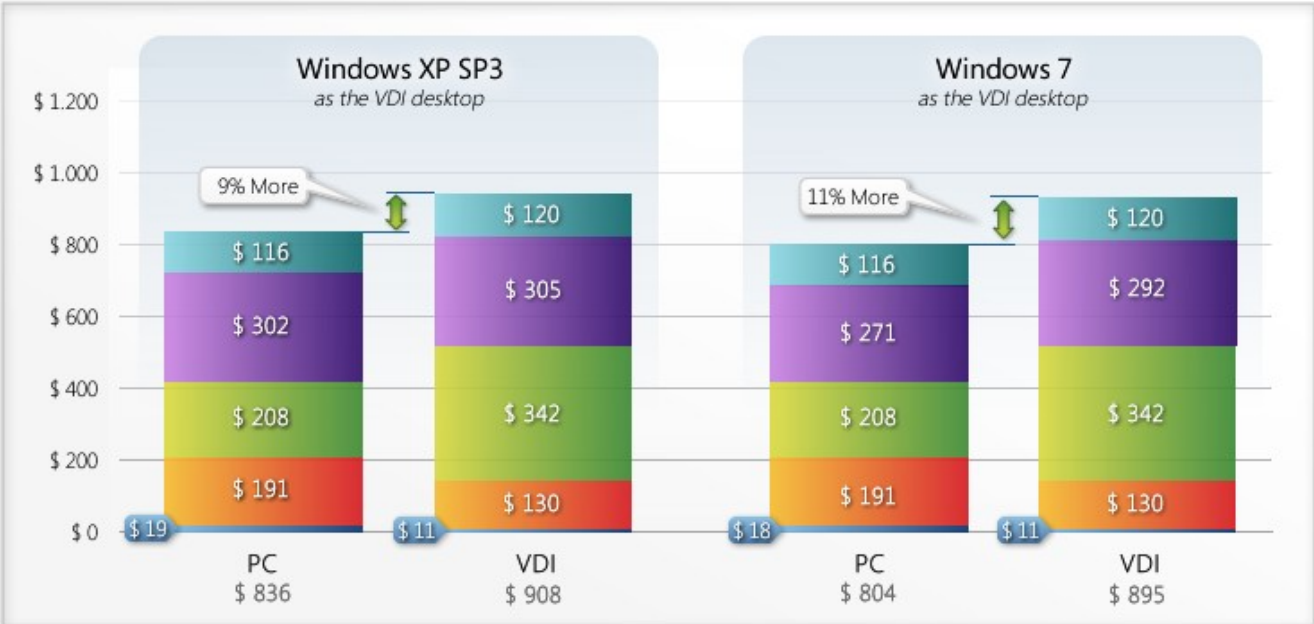
One of the assumptions in the model is that Rationalized organizations place more value on the user experience and operate on shorter hardware refresh cycles. This further increases hardware costs for the Rationalized environment.



Annual Total Cost of Ownership (TCO) Standardized Infrastructure Optimization

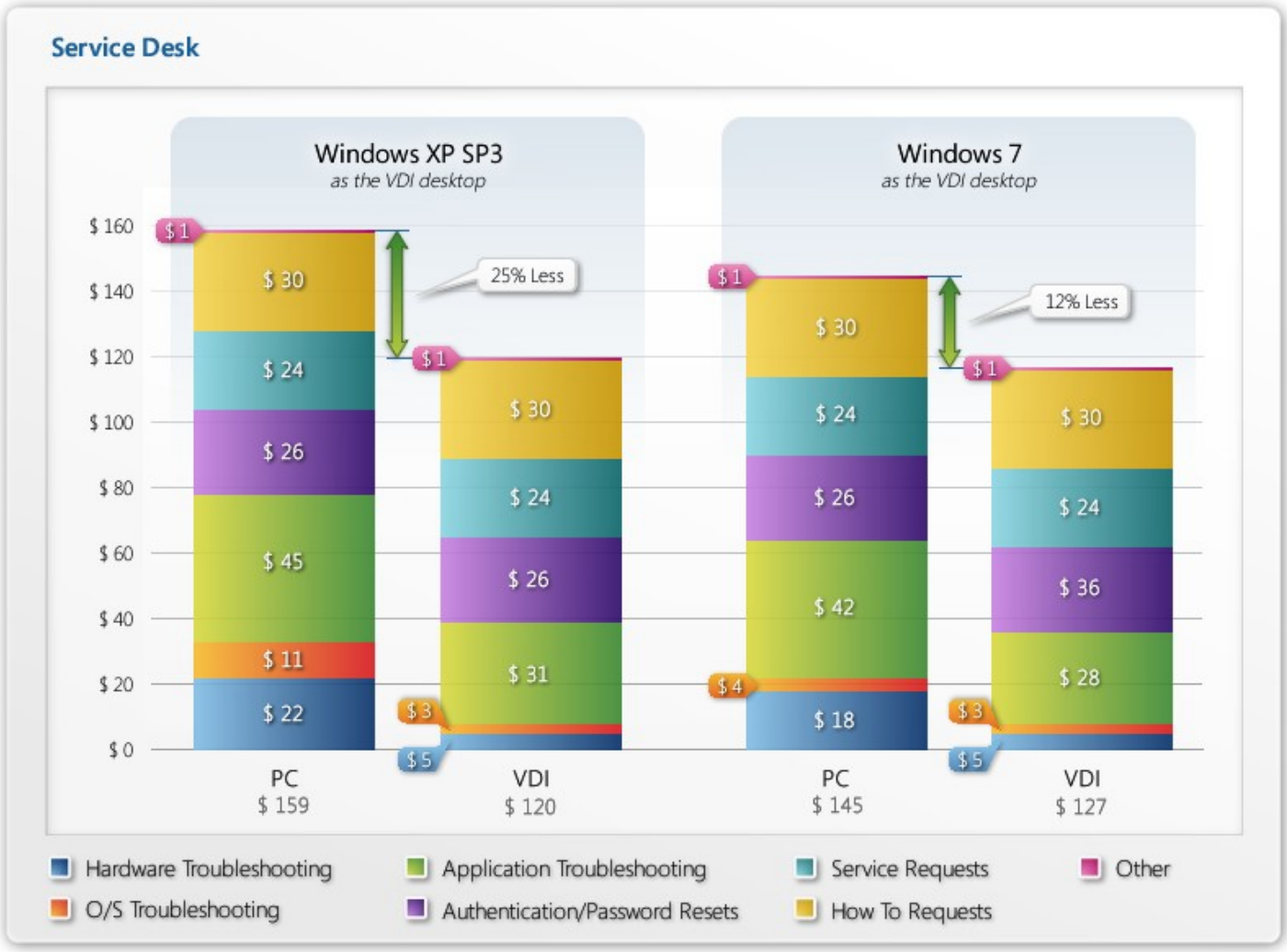


Annual Total Cost of Ownership (TCO) Rationalized Infrastructure Optimization



Appendix C: Service desk and desktop engineering

The tables below provide additional details on Service Desk and Desktop Engineering costs for Traditional PCs and VDI desktops for Windows XP and Windows 7.



Of the 6 service desk categories, VDI is expected to reduce costs in the three troubleshooting categories. The other cost categories are tied to users and remain unchanged between virtualized and non-virtualized environments. The use of thin clients with their simpler design and lack of hard drives are expected to provide significant savings over PCs.

Windows is not more reliable in a virtualized environment. However, if the OS fails it is much easier to re-initialize it compared to re-imaging a PC. The VDI environment makes extensive use of application virtualization in the Rationalized environment, which reduces costs. While application virtualization is not a requirement for a Rationalized PC environment, it is an option.

The assumption in the model is that PCs retain locally-installed applications. Because of the more streamlined troubleshooting process, VDI is expected to reduce service desk costs by 25% in a Windows XP environment. It should be noted that migrating from Windows XP to Windows 7 is expected to result in a 9% service desk cost reduction in the traditional PC environment. A migration to Windows 7 will reduce the potential pool of benefits that VDI can tap into.

Because it's everybody's business

While service desk costs are expected to decline under VDI, desktop engineering costs are expected to increase by 9% because of the complexity of the VDI environment. Program management is expected to increase by $4. Tier-3 support increases since the engineering team will spend more time supporting the service desk on issues concerning the virtualized environment. Since VDI systems are significantly impacted by server utilization, storage loading and network traffic, constant performance monitoring will be required.

Because it's everybody's business

Appendix D: Overview of the Benchmarking

Organizations with high value VDI implementations deploy it in use cases where flexibility and security are more important than a high-end user experience. The 4 benchmarking studies were no exception. This section summarizes their motivations, deployments and results.

HEALTHCARE CUSTOMER

Five hospitals deployed VDI to nursing stations, which operate around the clock 365 days per year. Work is done in shifts, and applications are used for patient records, scheduling and inventories. Applications were client server-based with minimal graphics requirements. VDI was attractive for 3 reasons:

- Wireless thin clients could be deployed inexpensively and quickly
- Nurses did not require the computing power of PC for their applications
- VDI provided better personalization and performance than Terminal Services

This organization was well run in both its PC and VDI environments. VDI was less expensive than PCs to operate for the nursing stations, and provided a satisfactory user experience.

UTILITIES CUSTOMER

A utility in the U.S. needed to quickly overhaul its computing environment to address issues with the user experience. VDI was seen as a work-around for refreshing the existing PC infrastructure. VDI was given to all employees that did not require a notebook PC. VDI was attractive for 2 reasons:

- Thin clients can be deployed more quickly than PCs
- VDI would provide a better user experience than the existing PC infrastructure

This organization was in pilot during the benchmark and was getting mixed results. User complaints were common and the VDI team was experimenting with higher-end thin clients to address performance issues.

BANKING CUSTOMER

A Midwest bank wanted to reduce its vulnerability to natural disasters, and use this as a selling point for new products and services. VDI would be used in the bank branches and for task workers. Two mirrored data centers were used for redundancy. VDI was attractive for 3 reasons:

- Branches could function even if facilities and PCs were destroyed
- Branch desk-side support visits could be reduced
- Customer identity information would stored at HQ, not branches

This organization had excellent processes and a savvy IT staff. VDI was partially deployed and getting mixed reviews from users. Costs were high because of the high redundancy levels built into the design.

RETAIL CUSTOMER

A large retailer was deploying VDI to offshore application developers. VDI was attractive for 2 reasons:

- No requirement for IT equipment to be sent overseas
- Developers could work on code without pulling it over a WAN link

This organization had been in production for 3 months and business requirements were being met. Lower hardware costs had offset higher software costs, making this solution financially attractive.

Appendix E: Profiles and commentary

Bill Barna, Principal – Lawrence Associates LLC

Bill Barna is a Principal Consultant at Lawrence Associates LLC and leads a consulting team providing benchmarking services to Microsoft and other technology firms. He has over 20 years experience in IT, 10 years experience in benchmarking and has authored dozens of articles and papers on the value of IT investments. He has an MBA from Southern Methodist University and a certificate in benchmarking from Stanford University. He has done graduate studies in innovation, energy management and computer science.

Mr. Barna began his IT career working for the U.S. Department of State serving at U.S. embassies in Saudi Arabia, Lebanon and Germany. In 1997 he began consulting and worked for KPMG Peat Marwick and Microsoft Consulting Services (MCS). He worked with Active Directory and Systems Management Server.

In 2003, Barna transferred to the Windows Server® product team and led a research team that focused on the costs of deploying and operating Microsoft technologies. He worked closely with analyst firms and academia to help develop Microsoft's IT Maturity model (Infrastructure Optimization). Barna returned to consulting in 2006 and worked for Wipro Consulting Services and Lawrence Associates conducting research, performing benchmarks and authoring papers. He is the primary author of this paper.

Bill Barna's VDI Research Commentary

VDI is a disruptive technology using Clayton Christensen's definition in the "Innovator's dilemma".[1] *A disruptive technology "creates a new (and unexpected) market by applying a different set of values". Organizations that see VDI as a cost reduction tool are missing the true value of the technology. VDI value comes from its ability to provide desktops on-demand across geographies. Organizations can use this flexibility to create new business processes that improve operations, mitigate risk, or increase revenues.*

The organizations benchmarked in this research have developed innovative ways to leverage flexibility. Although Non Disclosure Agreements (NDA) prevent Lawrence Associates from sharing details on these business processes, all found value above and beyond TCO reductions. Some were able to work with business leaders to develop new products and services that increased revenue and customer loyalty. Others adopted "Follow-the-Sun" models to create on-demand workforces. Still others used VDI to protect intellectual property. If more benchmark studies had been done, additional innovative uses would have been uncovered.

VDI is an emerging technology. The user experience may not be a good fit for today's Office worker, but innovation should change that in the future. IT organizations should watch VDI developments carefully, and look for ways to align it to their business. Costs should always be a secondary consideration.

TCO benchmarking is tricky and is a mix of art and science. There are dozens of variables influencing cost structures that have nothing to do with the technology. In reality it is impossible to come up with a set of benchmarks that fit all organizations. TCO studies are more valuable when they provide the reader with the tools needed to evaluate their own environments. This includes how to identify and prioritize business requirements, creating lists of what to measure, and insights on how the data should trend under different inputs.

When reading this report, the reader should focus less on the absolute numbers and more on the concepts. Each organization's mileage will vary greatly.

[1] http://en.wikipedia.org/wiki/Disruptive_technology

Len Bergstrom, Founder – Information Technology (IT) Measurement Services

Len Bergstrom is known in the industry as the original founder of IT Measurement Services. He joined Real Decisions Corporation (RDC) in 1976 as one of its first associates and became president at the beginning of 1992. He was a central figure in the design, development and delivery of comparative benchmark in the data center, network and distributed computing arenas and a pioneer in establishing the market-based competitiveness of outsourcing arrangements. As RDC president, he was responsible for planning the overall business strategies of the company as well as managing the corporate relationship with the NYNEX parent company.

Mr. Bergstrom was instrumental in the acquisition of Real Decisions by Gartner in December of 1993. At the start of his Gartner tenure, he was responsible for the introduction of measurement services internationally. This multifaceted global role involved conducting briefing tours, managing major client assignments, coordinating distributors in Europe, South America, Asia-Pacific and Africa and being the central measurement relationship manager for dozens of Fortune 100 accounts. At Gartner he was also involved with the development of new Total Cost of Ownership (TCO) models many driven by alliances with key industry leaders. Alliance activity included exploring methodologies and databases to address innovation in addition to the better defined efficiency and effectiveness dimensions. Mr. Bergstrom is an expert on performance management systems and has assisted firms in designing measurement programs that link IT activities to enterprise results and demonstrate the business value of IT.

During the past 30+ years, Mr. Bergstrom has delivered presentations to industry conferences and published articles and is quoted in major trade magazines. Today, Mr. Bergstrom is an independent consultant who concentrates on a variety of projects for both vendors and users of IT measurement services. He holds a Bachelor of Arts degree from Yale University.

Len Bergstom's VDI Research Commentary

Based on the information made available for the assessment, the case study research conforms to the TCO benchmark standards in the industry indicate a number of interesting results detailed by Lawrence Associates including that PCs generally provide a much richer user experience than VDI and critical employees such as office workers can be dramatically impacted by a poor user experience. On the other hand, VDI provides the mobility and security that prove both to be cost efficient and user effective in specific environments. The benchmarking team did a good job of analyzing the results and explaining the various cost drivers at each company and their concomitant impact on TCO.

The results of all the case studies are specific to the client situation and in no way represents this analyst's opinion that TCO reductions will necessarily always be gained upon the use of VDI or PCs. TCO benchmark results must always be viewed from the perspective of the fact that performance is relative to both the business requirements supported (in terms of workload and complexity) as well as the way the business / IT organization elect to run the business (service / support / security / maturity). The case studies all contain good examples of why business and technical drivers influence the results.

Additional research / data points will definitely increase our knowledge and insight into the best use of VDI. If undertaken successfully, the longer term goal of efforts such as the creation of a dashboard of drivers that would impact PC / VDI TCO (both positively and negatively) might result in the construction of a "decision model" to help determine the optimal use of each environment for prospective clients. The research performed here presents a good starting point to start the foundation for accomplishing this ambitious objective.

Bill Kirwin, VP Research and Business Development - Cohesive Knowledge Solutions

Mr. Kirwin is an IT industry veteran with over 30 years experience in IT management, industry analysis, sales, marketing and support. In his 20 years as VP Research at Gartner, Bill provided thought leadership in personal computing, IT financial, operations and management key issues. He created the concepts of Total Cost of Ownership (TCO) and Enterprise Personality Profile (EPP) and applied it to IT user and supplier markets. He founded Gartner Software, Gartner Press and the Managing Distributed Computing practice area and was instrumental in developing Gartner Measurement consulting services.

Currently Bill is VP Research and Business Development at Cohesive Knowledge Solutions, a leading knowledge worker productivity training company that helps enterprises get control of email, info management and meetings. He continues to focus on research and writing about knowledge worker behavior and the cultural impact of information technology. Bill is a Certified TCO Expert and Alinean Value Selling consultant.

Mr. Kirwin serves as a board member to several corporations and non-profit organizations. He is a graduate of Southern Connecticut State University.

Bill Kirwin's Research Commentary

Over the past 25 years TCO has been established as an industry standard methodology to assess IT costs. It is universally recognized by IT users, IT providers and industry analysts as a useful tool to determine the delta between one set of IT assets, practices and services and another. This can be done within a single enterprise or across a broad range of companies that are facing a significant change of assets, practices or services. There are subtle differences in the TCO approach across these scenarios. In the first instance the single enterprise retains a high percentage of consistency in variables like industry; workforce (e.g., task v knowledge worker), IT strategy (e.g., centralized v decentralized) and a full chart of accounts of direct and indirect costs can and should be applied. In the second scenario, typically two technologies are compared across a broad set of industries, workforces and IT strategies. This requires an approach that must standardize on many variables to control factors that would obfuscate small and subtle technology variables in the bottom line. This study did a good job of isolating these factors and focusing on the often small technology TCO differences. These small differences can turn into large costs when multiplied over many units over several years. One unique consideration is the indirect costs. My recommendation was to treat the Indirect Costs as a separate category in the TCO. The primary reason for this is that the Indirect Costs are significant and significantly different across platforms and would overshadow differences in direct costs in the bottom line. A secondary reason is that Indirect Costs remain controversial to IT decision makers and should therefore be isolated as a separate analysis. In this study, they are expressed in hours due to the large variation in end user hourly costs.

A final observation is that in most enterprises VDI is still an emerging deployment and is relatively immature. We will undoubtedly see new management challenges, technologies and practices rise as this platform becomes more mainstream.

Tom Pisello, Chief Executive Officer – Alinean

Tom Pisello has built his 20-year career with a single-minded vision: helping companies prove and improve the business value from IT investments.

Tom's latest endeavor, Alinean (http://www.alinean.com), was founded in 2001 to develop software, methodologies and tools for accurately evaluating, presenting and measuring the value of IT investments using benchmarking and ROI analysis; particularly helping vendors use business value selling to streamline the justification of new investments and assuring true value delivery. Alinean has exclusive partnership with leading IT industry analyst firm IDC, and customers including Oracle, SAP, Microsoft, IBM, HP, Intel, BellSouth and Dell, many of the world's leading consultancies and CIOs.

Tom's pioneering ROI and TCO experience began in 1993 with Interpose, a company he founded to develop the first automated ROI and TCO analysis software for CIOs and IT vendors. Interpose was acquired by Gartner in 1998 and formed the foundation for Gartner's Measurement, ROI and TCO software solutions. Tom served Gartner as managing VP and was instrumental in the software becoming the industry standard for TCO assessment.

Tom is a serial entrepreneur having served as a founding member or advisor for several technology start-ups including Full Armor Corporation, Connotate Technologies, Digital Owl, PuertaBella.com, OurBeginning.com and Spiral-Up Interactive.

Tom is a regular contributor to Computer World, CIO Decisions, TechTarget, IT Business Edge, CIOInsight and other leading IT publications. He holds several software patents and is a featured speaker at major IT and management conferences. He has written several key e-books on ROI and TCO analysis; including "Return on Investment For Information Technology Providers: Using ROI as a Selling and Management Tool" and "IT Value Chain Management - Maximizing the ROI from IT Investments."

Tom Pisello's VDI Research Commentary

VDI, because of its architecture and capabilities, can help most organizations create a best-in-class managed PC environment. For those organizations with less than stellar PC management today, implementing VDI can help standardize and secure the environment, generating net total cost savings. However, these organizations must be sure they can adequately implement and support the more complex datacenter IT infrastructure needed to support VDI.

For best-in-class managed PC environments who can best implement VDI, most of the savings in desktop administration, application and image management, security, help desk and desk-side support have already been realized. In these environments, additional net core IT savings will rarely be realized with VDI.

For enabling specific workgroups such as task workers, flexible work environments like virtual call centers, and follow-the-sun development groups, VDI can provide not only savings, but significant business benefits, making the case more attractive. The decision is based on business goals, and TCO savings is then not the deciding factor.

Michael Strohl, President & CEO - Entisys Solutions, Inc.

Michael Strohl joined Entisys in 1994, bringing 10 years of operations management experience and training from UPS along with his degree in Business Administration and Marketing from San Francisco State University. Mike worked early on as Vice President of Sales, helping develop key partnerships and establishing Entisys as one of Northern California's top technology consulting organizations. Under Mike's direction, Entisys has grown to become the leader within the mid-tier, enterprise and government space with partnerships and accreditations from the industry's top manufacturers such as Citrix Platinum Partner, VMware Premier Enterprise Partner, Novell Platinum Partner, and Microsoft Gold Partner.

In 2002, Mike was promoted to President and CEO of Entisys Solutions. Since that point, Entisys has increased in revenue by over a 1000%; being well positioned to continue a strong and stable growth. As recent as January 1st, 2008, Mike's decision to acquire with Agile360 has established this organization as the top Citrix and VMware and Microsoft partner in the western region of the United States. Among the key vertical industries that are served are biotechnology, government, finance, healthcare, entertainment, manufacturing, retail and high tech. This union enables the new company to combine the resources of two equally talented organizations, giving the power to provide clients an even larger scope of services and best practices, from a larger pool of experts, with a larger geographical footprint.

He is most proud of his team's success in recruiting and developing one of the industry's strongest technical and sales teams by instilling the values of integrity, constant communication, teamwork and a sense of doing what is right for the client; resulting in a high level of customer loyalty- valuing relationships above all. With Mike's vision and passion for this organization and his care and concern for the people that work at Entisys Solutions and Agile360, the future is bright.

Michael Strohl's VDI Research Commentary

From my perspective many organizations create risk when selecting a VDI Solution. Instead of focusing on strategic goals, organizations focus on tactical needs for an individual or department. This prevents them from taking advantage of scale, the "sweet spot" for any virtualized solution. VDI should be a platform decision. Organizations should take a broad view of their computing environment and determine what use cases would benefit from VDI. If there is sufficient demand, one infrastructure should be developed for the entire organization. By doing this, organizations will prevent the creation of multiple tactical systems that are not able to leverage the full value of a virtualized environment.

This report has made the case that VDI is not a good fit for the Office worker. While the benchmarking studies uncovered issues with user satisfaction, this may not have been the fault of the technology. Better planning up front could have mitigated this risk. Many organizations make the mistake of treating desktops like servers by evaluating workloads. Organizations should instead evaluate user behavior and minimal performance thresholds. A VDI software vendor should be chosen by its ability to provide the business requirements based on user behavior. Different VDI software vendors have different competencies in this area. Vendors that have their roots in server workloads may struggle to provide the same quality user experience as a firm that has been delivering user desktops.

VDI is new and risky. The key to success is to develop a strategic plan, have a deep understanding of the user community and then choose the software vendor that is best aligned to business requirements.