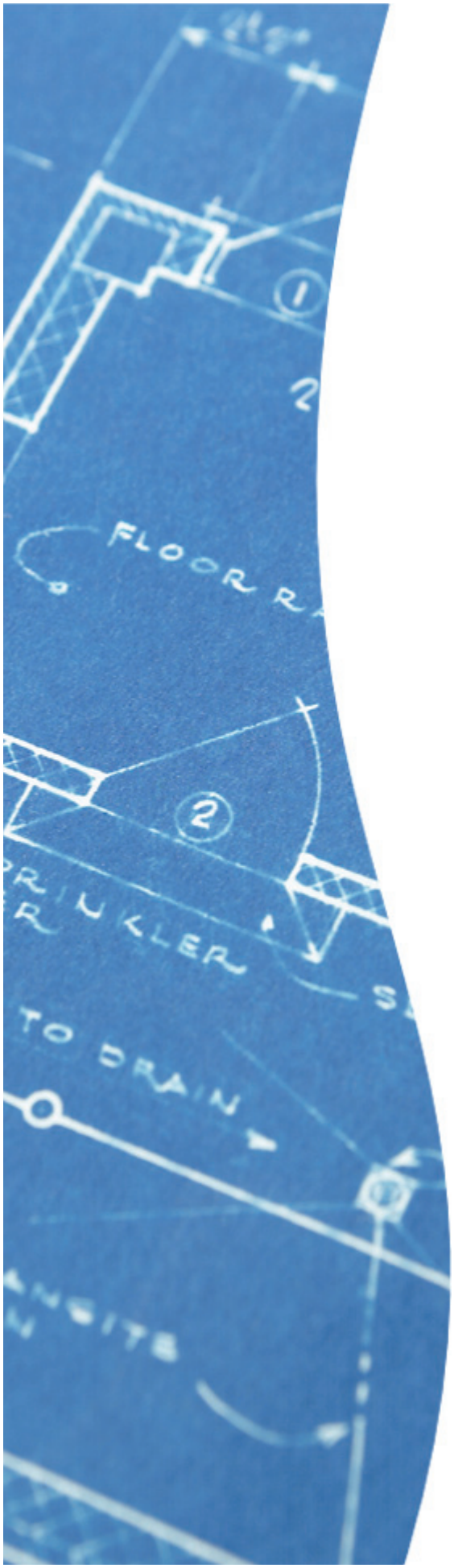

THE MANAGED DESKTOP FACTORY

Sun™ Virtual Desktop Infrastructure Software as a Service

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Chapter 1
Introduction

IT organizations are constantly provisioning office workplaces to make services and applications available to users. Doing so requires state-of-the-art IT environments that are:

- Flexible—Adding and deleting users, changing configurations, providing new IT applications and services, and moving an office from one country to another must be possible in the age of global economics.
- Accessible—Accessing data and functionality from the office workplace, home, or while traveling is essential for many users. Simple remote email access is no longer sufficient.
- Adaptable—Handling specific user needs is paramount. For example, the optimal office environment for a call center agent differs significantly from an environment suited to a software developer, sales representative, or secretary. In addition, IT departments must be able to handle changing user roles.
- Secure—Securing the IT infrastructure and safeguarding access to corporate intellectual property is essential to the business. Access must be granted only to authorized personnel, and IT systems must be able to defend against viruses and malicious data, and cope with data loss in the event problems arise.
- Available—Keeping IT services running at agreed upon service times and levels is key to minimizing lost productivity and lost revenue.
- Powerful—Supporting demanding modern office software requires adequate compute power and network bandwidth. IT infrastructures must be able to handle typical day to day and peak demand. While many organizations replace or add systems whenever workloads rise, more efficient mechanisms for adding compute power are needed.
- Prepared for future developments—Avoiding technology lock-in is important as technology continues to evolve. IT infrastructures must be able to work with a variety of operating systems, and support new services and access methods as developments emerge.
- Easy to operate—Connecting company data and business processes is the job of IT systems. Powerful, flexible, end-to-end services must be available. Unfortunately, complex services often lead to time-consuming operations and high risk for failures, and are difficult to operate.
- Cost-effective—Staying within budget is imperative in today's global economy. IT services are now a commodity, and competition is fierce among service providers. While delivering service quality is challenging, companies and users are not willing to pay more for provided services.

Sun™ Virtual Desktop Infrastructure Software

IT organizations with a large and sprawling desktop client community struggle with complex and ineffective desktop management strategies. Traditionally, all applications run directly on a local desktop. Every machine must be modified when software installations or upgrades are required, making it difficult to keep track of the number, kind, and version of applications in use.

Just as server virtualization revolutionized how IT managers think about compute power and resource management in the datacenter, desktop virtualization is changing the office landscape. Desktop virtualization enables some or all of the applications—including the desktop environment—to be moved off individual desktops and centralized on dedicated application tier servers in the datacenter. As a result, organizations are better able to take advantage of client device independence, provide true mobility for workers, streamline management, and keep information secure.

Sun™ Virtual Desktop Infrastructure Software is a compelling new architecture for providing office desktop environments and IT services to users. It delivers applications and full desktop environments to clients using a server-based computing model. All the intelligence—compute power, storage, software, and administration—is concentrated in the datacenter. Web browsers running on Sun Ray™ ultra-thin clients, PCs, or mobile devices provide access to services and applications running in the datacenter.

The Managed Desktop Factory

Today, many operational datacenter practices are based on Information Technology Infrastructure Library (ITIL) processes and best practices. By using the Sun Virtual Desktop Infrastructure Software, organizations can create IT infrastructure that delivers standardized, ready to use, high quality desktop environments and applications on an as needed basis—with consistency.

Sun Virtual Desktop Infrastructure Software shifts compute power and disk space, as well as operational workloads and skills, from distributed office environments into the datacenter. As a result, most technical and administrative tasks take place in the datacenter, with logistical work (parts replacement) remaining in user offices. This paradigm shifting approach fosters improved service quality, greater flexibility, and more security at a significantly lower cost per user. The business case for this approach is evident and impressive.

This Sun BluePrints™ article suggests an operational model for a desktop environment that is based on the Sun Virtual Desktop Infrastructure Software. Using ITIL as a foundation, the concept presented illustrates opportunities for optimizing operations and describe the next steps toward industrializing IT services—the managed desktop factory.

- Chapter 2 describes the Sun Virtual Desktop Infrastructure Software architecture, laying the foundation for later discussions on operating solutions.
- Chapter 3 discusses the operation of a managed desktop factory, describing roles, responsibilities, and empirical data on operational tasks and efforts.
- Chapter 4 examines the managed desktop factory from a service management and business perspective, including service and business models, financial aspects, and ideas on how services can be offered using pay-per-desktop and utility models.
- Chapter 5 provides a list of references.
- Appendix A defines important terms used throughout this document.

Chapter 2

An Overview of the Sun Virtual Desktop Infrastructure Software

This chapter discusses the motivations and market characteristics that are driving desktop virtualization, and provides an overview of the Sun Virtual Desktop Infrastructure Software architecture.

The Case for Virtual Desktops

According to a Forrester Research report[1], moving from desktop PCs to a virtual desktop infrastructure is motivated by the key pain points in traditional environments—the need to improve client system manageability and security. Such concerns stem from the one-to-one relationship between workplaces and devices, and the difficulty involved when systems are in the field and out of direct control of IT organizations.

"It's a completely different trend. While server virtualization is about saving money and consolidation, on the desktop it's much more about isolation, about being able to do different things on the same machine."

Quote by Tom Bittman, a vice president and distinguished analyst at Gartner, Inc., from "Moving beyond server virtualization", Network World, January 9, 2006, http://networkworld.com/news/2006/010906-virtualization.html

- Security—As more companies take advantage of the Internet and networked environments, and more laptops connect to corporate local area networks (LANs), security concerns rise. In addition, employees that work from home often connect to corporate networks with virtual private network (VPN) connections that give stay at home workers full network access to corporate intranets. While IT organizations can set security policies and install virus scanners for remote systems, enforcing their use is often difficult.
- Management—Desktop PC environments are filled with multiple generations of operating systems and many applications. Keeping administrative efforts in the realm of operating staff, and strictly limiting user rights in desktop environments, is the primary way to keep management efforts under control. Doing so is difficult when users have physical access to systems and are granted rights to handle self-support in an effort to lower maintenance costs. Desktop virtualization makes it possible to reduce the dependence on specific hardware and operating system configurations and to gain the possibility of centralized manageability. The workplace can be used for different user roles, such as power users or knowledge workers. With virtualization techniques, it is relatively easy to provide different environments for different roles.
- Cost—Companies look for ways to spend the least amount of money possible while still fulfilling business demands—they also try to use available budget to create as much business value as possible. In this context, business value not only means value that can be measured in monetary terms, but also flexibility, usability, functionality, and agility, as well as the technical values of availability, reliability, performance, and security.

1. *Desktop Virtualization Is The Future Of The Corporate PC*, David Friedlander and Simon Yates, Forrester Research, January 5, 2006, http://www.sun.com/software/vmware/forrester_rr.pdf

Market Evaluation

Companies strive to deliver desktop workplaces to employees that are fast, secure, and personalized with the applications needed to perform work. Traditional fat client desktops, consisting of a personal computer running an operating system and locally hosted applications, have several disadvantages:

- Complex client management
- Security only as good as the weakest client system
- One inflexible, dedicated PC assigned to each dedicated worker

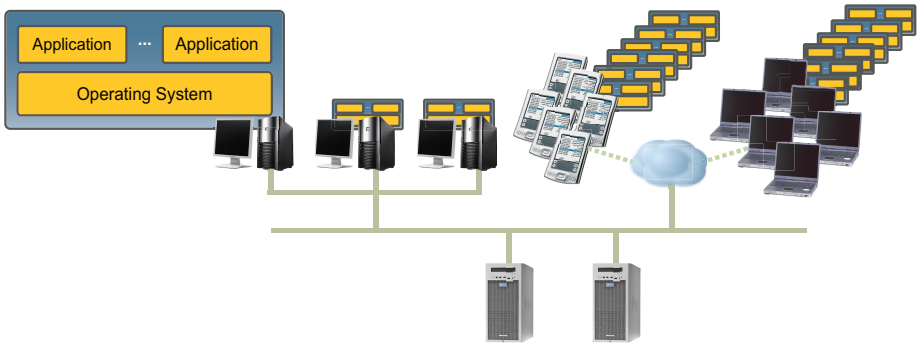

Figure 2-1. In a traditional fat client architecture, each desktop runs its own copies of environments and applications, increasing management complexity as the number of systems grows

With the cost of PC systems remaining relatively inexpensive when compared to datacenter servers, organizations continue to cope with the disadvantages of fat client solutions. In many environments, some services have moved into the datacenter, such as collaborative disk space and a few key server-based applications. Now, organizations can take advantage of several trends that can help reduce the management burden and create more cost-effective environments.

Centralization

In a centralized environment, distributed operating systems and applications move into the datacenter. Typically, datacenter-class servers are used to host applications and services, with thin clients residing at the desktop for user access. Because datacenter hardware tends to be more expensive than traditional PC desktops, organizations must often find ways to finance the move to a centralized approach.

Isolation

Isolation techniques move an application into a dedicated environment with clear control points for transferring data. Such an approach offers improved security and reduced complexity than typical deployment architectures. Security checks and security policy enforcement are easier to perform in an isolated and controlled environment in

which all systems run the same desktop and applications. Because only the dedicated environment must be checked and maintained in the event of changes or incidents, management complexity is reduced.

Virtualization

Virtualization is defined in many ways. *The Rise of the Virtual Machine and the Real Impact It Will Have* defines virtualization as "a loose definition that applies to technologies that allow software applications to view computing resources, typically server hardware or storage systems, as either many smaller units (partitioning) or multiple units grouped together to appear as one larger system (clustering). Virtualization essentially allows software to decouple from the physical hardware. The end result is that IT departments are able to optimize their operations by flexibly adding, subtracting, mixing, and matching hardware and software resources to enhance efficiency and reliability."[1]

1. *The Rise Of The Virtual Machine And The Real Impact It Will Have* , Tim Klasell, Jeffrey Peck, Thomas Weisel Partners.

Building on that general definition, Forrester Research defines desktop virtualization as "a PC environment where some or all components of the system, including operating systems and applications, execute in a protected environment, isolated from the underlying hardware and software platform. The virtualization layer controls interactions between the virtual environment and the rest of the system."[2]

2, 3. *Desktop Virtualization is the Future of the Corporate PC*, David Friedlander and Simon Yates, Forrester Research, January 5, 2006, http://www.sun.com/software/vmware/forrester_rr.pdf.

Virtualization is a key technique that makes it possible to improve datacenter hardware capacity utilization. That is why it is now possible to fund the move of desktop environments into the datacenter. According to Forrester Research, desktop virtualization techniques can be divided into several categories:[3]

- Server-based computing virtualizes multiple application instances on a single server operating system and gives users remote access to those applications.
- Virtual systems run the entire operating system and application instances on a host system. Desktop clients establish a connection and present the virtual system to users. No other software is executed on the local system.
- Other forms of virtualization exist, such as blade PCs and application sandboxing. However, these techniques often fail to deliver the full power of virtualization. Blade PCs move the system from the desktop and into the datacenter on more expensive hardware, providing limited capacity utilization benefits. Application sandboxing only enables isolation on the desktop fat client—without centralization, management complexity remains. The combination of both methods makes it possible to utilize the full power of the concept. For example, connector software provides a bridge between access technologies and a virtualization back-end, and assists with the management and assignment of virtual desktop environments running on virtual machines to users of display client devices.

Sun Virtual Desktop Infrastructure Software Concepts and Architecture

Sun Virtual Desktop Infrastructure Software can help organizations move applications and operating systems off personal computers and consolidate them on servers in the datacenter. It offers a highly secure platform for accessing virtualized Microsoft Windows or other operating system desktop environments and applications from a wide variety of client devices using high-performance display protocols. When combined with VMware Infrastructure 3 software, desktops can be consolidated onto servers in the datacenter, with each user owning a dedicated virtual machine that is customized for use and isolated from other users.

Sun Virtual Desktop Infrastructure Software consists of the Sun Ray Software and the Sun Secure Global Desktop Software for providing access to virtualized desktops via ultra-thin Sun Ray devices, PCs, or other client devices running a Java™ technology-based browser (Figure 2-2).

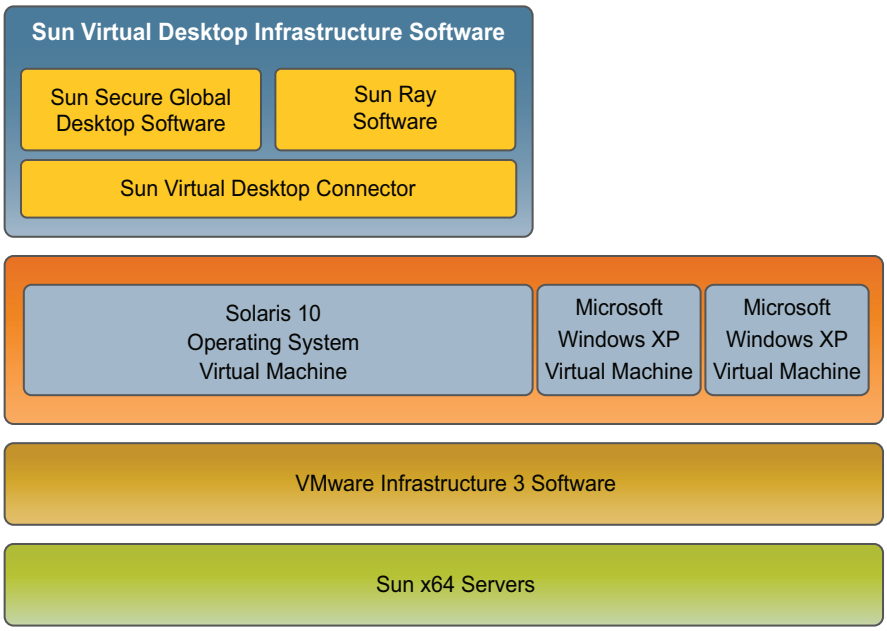

Figure 2-2. The Sun Virtual Desktop Infrastructure Software architecture

Sun Ray™ Software

Sun Ray Software gives users access to applications and services from any location using Sun Ray compatible thin client devices. Since these ultra-thin clients do not contain any local processing or storage resources, these functions are performed centrally on servers in the datacenter. In essence, Sun Ray Software acts as a broadcaster, delivering customized content to each Run Ray client on the network. It provides user authentication and encryption between servers and clients, as well as

user session management. Fully stateless connectivity to Sun Ray clients means users can move from one device to another and resume a desktop session—instantly picking up where right they left off.

Sun Secure Global Desktop Software

Sun Secure Global Desktop Software gives organizations the ability to centralize applications in the datacenter. Operating systems, applications, and data no longer reside on private desktop or laptop computers. Environments and applications run on dedicated systems in the datacenter and are displayed on client devices, providing anytime, anywhere access from any device. Organizations can publish most Microsoft Windows, UNIX®, midrange, or mainframe applications to any network-attached client, including PCs, Macintosh computers, laptops, wireless devices, and more.

Sun Virtual Desktop Connector Software

Sun Virtual Desktop Connector software offers a highly secure platform for accessing virtualized Microsoft Windows desktop environments from client devices. Easy to install and configure, the software eliminates guesswork by including pre-made scripts that let client devices access virtual desktops through Sun Secure Global Desktop or Sun Ray software. Both the dynamic and static assignment of desktops to users is supported.

The system uses a three-tiered architecture (Figure 2-3).

- The virtualization layer hosts multiple virtual Microsoft Windows desktops running on one or multiple VMware ESX servers. VMware VirtualCenter software orchestrates the VMware ESX servers.
- The client access layer contains the Sun Virtual Desktop Connector software, a session broker for intelligent and automated virtual machine administration and assignment. The service communicates with the VMware VirtualCenter software or directly with VMware ESX servers.
- The desktop layer consists of Sun Ray Software and/or Sun Secure Global Desktop Software. Both components communicate with the Sun Virtual Desktop Connector software and publish virtual desktops to clients in the right layer. Multiple instances are possible for maximum horizontal scaling.

Users connect to the system via the access layer using a device connected to the Internet. Sun Virtual Desktop Infrastructure Connector software associates all users directly to the assigned (static or dynamic) virtual machines. If users move to a new location or switch to a Sun Ray client from a Web browser, the same assigned virtual machines can be accessed.

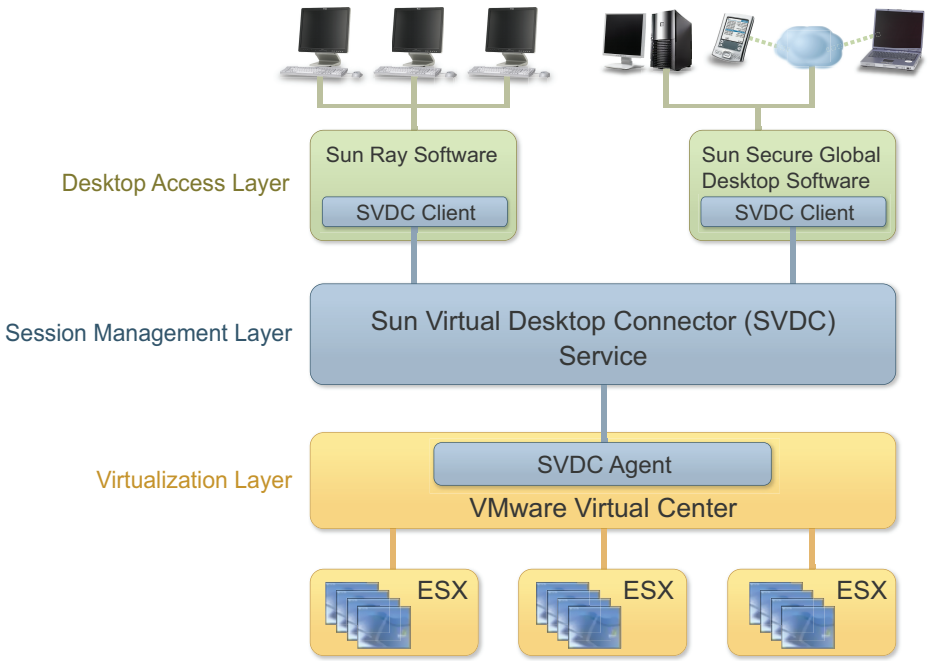

Figure 2-3. Sun Virtual Desktop Connector gives users access to Microsoft Windows desktop environments that are running in virtual machines

Sun Virtual Desktop Infrastructure Software Building Block Architecture

Figure 2-4 depicts the Sun Virtual Desktop Infrastructure Software building block architecture. Key components include:

- *Desktop virtualization*
  Although few solutions for desktop virtualization exist on the market today, those based on VMware ESX are becoming popular and gaining acceptance. Sun's solution takes advantage of this proven technology to create an end-to-end solution.

- *Session broker*
  The session broker is a core component that controls the entire desktop virtualization environment. It is also the key interface between the virtualization back-end servers hosted in the central datacenter and the thin clients used by users. The session broker consists of the Sun Ray Connector for Windows OS and the Sun Virtual Desktop Connector software. Note that the Sun Secure Global Desktop software can be integrated for fat client PC connectivity. As a central control function, the session broker takes care of the entire lifecycle management of all virtual instances—the login and authentication process, assignment and administration of virtual machine resources, the logout process, and the release of corresponding virtual machine resources.

- *Ultra-thin clients*
  Sun Ray 2 Virtual Display Clients and Sun Ray 270 Virtual Display Clients with an integrated display provide sophisticated desktop front-ends to users. A variety of third-party products based on Sun technology, such as portable laptops with wireless LAN (WLAN) technology, can be used to handle different user requirements.

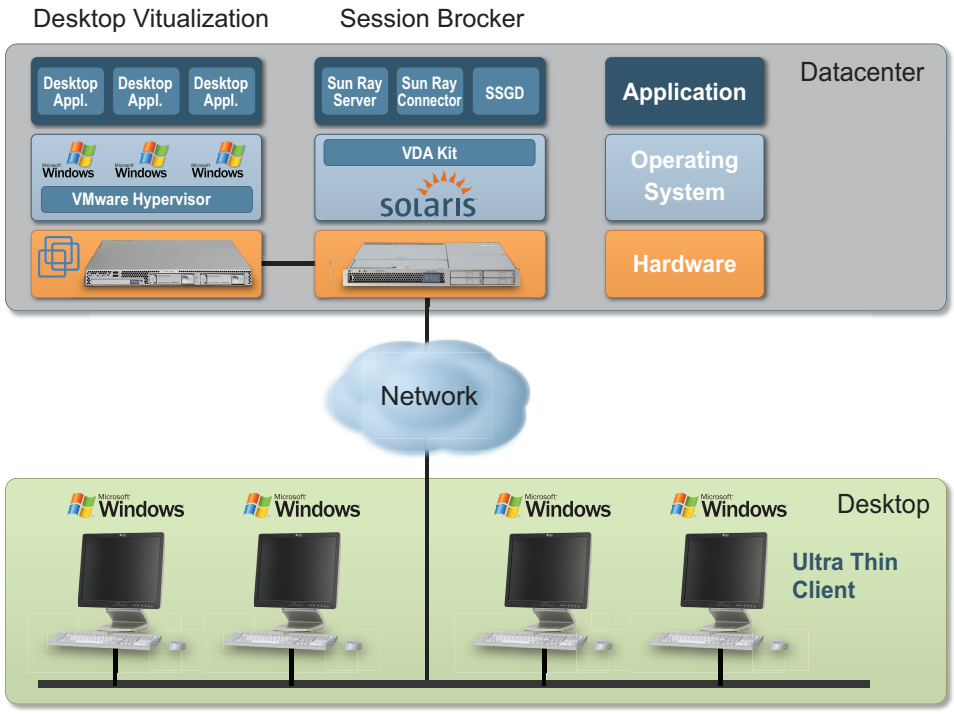

Figure 2-4. Sun Virtual Desktop Infrastructure Software building block architecture

Migrating to Sun Virtual Desktop Infrastructure Software

When migrating from existing environments to solutions based on Sun Virtual Desktop Infrastructure Software, enterprises must migrate applications and clients. The following sections provide an overview of these processes, and do not represent a complete installation and migration plan.

Application Migration

When enterprises use a server-based computing model, all users access a single instance of an application. To make this work, the application must be able to handle multiple users. Because some applications do not offer multiuser support, organizations must test applications with load conditions that simulate expected workloads. These issues are eliminated when Sun Virtual Desktop Infrastructure Software is deployed. In the Sun environment, a dedicated operating system instance is available to each user. Dedicated application instances run on these operating system

instances, without modification or knowledge of the underlying environment. IT organizations simply build and maintain a golden image of the software stack.

Client Migration

When deploying Sun Virtual Desktop Infrastructure Software, enterprises can replace fat clients with Sun Ray clients to reduce maintenance and operational costs. Sun Ray clients are stateless devices that require little or no administration, and typically consume only 4 Watts of electricity when operating—approximately five percent of the power consumed by a typical PC system.

Enterprises with existing installations of fat clients can utilize Sun Secure Global Desktop Software to give these clients access to applications and services. The software delivers a graphical session from a UNIX or Microsoft Windows server to local fat clients over the network. As a result, PCs can be used until a failure or end of lease term occurs, and replaced with a thin client. Best practices suggest developing a standard, restricted operating system installation for recycled PCs. The operating system installation must only run the Sun Secure Global Desktop Software client or a Web browser. Other applications are not needed—all functionality is delivered to clients by the software over the network.

Chapter 3

Operating a Managed Desktop Factory

This chapter describes the work to be done to operate a managed desktop factory. Doing so is a major shift from traditional desktop management concepts, using new technology and moving most operational tasks into the datacenter. While transitioning to a managed desktop factory that uses ITIL best practices often requires an investment in time and money, changes tend to occur infrequently once the architecture and operational processes are put in place. In short, setting up a new production line is complex. But once it is up and running, it continues to run and provide a state-of-the-art way to build modern devices and services.

Roles and Responsibilities

ITIL processes and best practices detail the methodology of organizing a datacenter. Of particular interest to managed desktop environments are service operations. Three team roles are key, and can be performed by one or more staff members, depending on the size of the IT organization.

- The user help desk builds a front line of support for users. It receives and qualifies user calls, solves issues whenever possible with a known repair or workaround, or escalates problems to a second level of support services. Staff members must be skilled in guest operating systems and user applications.
- The service desk operates the managed desktop factory and acts as a second level of support. It is responsible for incident management and administrative tasks to help ensure service availability. Staff members must be trained to handle issues related to VMware ESX, the Solaris™ Operating System, guest operating systems, Sun Ray Software, Sun Secure Global Desktop software, storage area networks (SANs), and Oracle database technology.
- The project office maintains golden images of the software and develops the environment based on changes received from service transition processes. Staff members must be skilled in VMware ESX and guest operating systems.

Note – User help desk and project office are not ITIL terms. These terms are used for brevity and to provide a clear view of the different responsibilities of first and second level support. Traditional ITIL deployments include a service that operates the desktop environment, and another that operates the datacenter service. With a managed desktop factory, desktop services are delivered by the datacenter. Because users can consume a great deal of support time, giving users access to datacenter staff is not ideal. Establishing a first level of support for user requests, such as a help desk, can mitigate cost and productivity concerns.

Process Design

Few organizations have all ITIL processes implemented. In fact, many enterprises have partially implemented process stacks in the field, with the focus on service operation processes. While the full stack of ITIL processes—service design, service strategy, service transition, and service operation—are important, this document highlights release and capacity management efforts and related special tasks for managed desktops.

Release Management

In a managed desktop environment, release management focuses on the release of golden images and the virtualization software stack. A new release of a golden image can include additional applications, new versions of applications, new or patched versions of guest operating systems, security updates, and more. When a golden image is changed, the working desktop environment for all users is changed automatically. As a result, a release management policy is recommended to help ensure quality and reduce the likelihood of problems. Expensive test systems are not required. A standard desktop can be used, with special images assigned only to developers.

The virtualization stack includes the software needed to deploy running application images to clients, such as VMware ESX, Sun Ray Software, and Sun Secure Global Desktop Software. While new releases of the virtualization stack tend to be rare, test environments must be in place to perform quality checks before deployment.

Capacity Management

System performance is key to user satisfaction, and capacity characteristics must be watched in order to fulfill expectations. Performance analysis looks at how fast an application runs, determines why it runs the way it does, and finds ways to improve performance. In a managed desktop environment, the major factor affecting capacity is the number of desktop workplaces to be supported.

Assume CW represents the number of concurrent workplaces, and TW is the total number of workplaces. A linear dependence exists between CW and the number of systems needed for VMware ESX desktop virtualization. In addition, there is a linear dependence between TW and storage capacity requirements. As a result, capacity management for these resources is straightforward.

More effort is needed to make a correlation between CW and the VMware software and Sun Ray Software infrastructure. Application performance depends on several hardware and software factors. Considering system and application views of performance can help. System performance can be measured using system monitoring tools, such as Sun Management Center, or Solaris Operating System tools, such as vmstat, mpstat, iostat, lockstat, netstat, and sar, or third-party analysis tools. Application performance can be measured using the VMware VirtualCenter tools supplied with the VMware software.

System Management Tools

System management refers to the administration of distributed computer systems. System management tools provide a centralized approach to automating day-to-day operations and monitoring. A variety of off-the-shelf system management tools are available, including Altiris, BMC Patrol, CA Unicenter Network and Systems Management (NSM), HP OpenView, IBM Tivoli, Sun xVM Ops Center, and Sun Management Center software. Key functions of typical system management tools include:

- *Performance management tools*—software that monitors the performance and availability of the hardware and software in the environment. Resource utilization statistics are reported to aid in performance tuning efforts.
- *Incident management tools*—software that monitors events and other vital information about the operating system and applications running on systems in the environment.

System management tools provide the ability to look at different scopes or areas of interest, including:

- Host operating system—Because the solution presented in this document is built on Sun servers running the Solaris Operating System, Sun Management Center is a preferred tool for performing in-depth monitoring and management of enterprise servers and operating systems.
- Guest operating systems—Selecting the right tool for monitoring and managing guest operating systems depends on the environment in use. Enterprises running Linux or the Solaris Operating System can use Sun Management Center software. Other tools must be used for Microsoft Windows environments. Leaving the guest operating system unmanaged is not unrealistic, and can free staff and budget resources. For example, monitoring all guest operating system instances requires a license for the management tool for each workplace in use. Administrators must parameterize agents and handle a large number of events. Since traditional desktops typically are not managed, it is not unreasonable to leave guest operating systems alone unless cost-effective solutions can be found.
- Virtualization software stack—In a managed desktop environment running the Sun Virtual Desktop Infrastructure Software, it can be important to monitor the VMware ESX, Sun Ray Software, and Oracle Database software. Sun Ray Software and Oracle Database software monitoring can be performed using Sun Management Center software. VMware ESX can be monitored using VMware supplied tools.

Technical Building Blocks and Operational Tasks

From an operational standpoint, several components create the core of a managed desktop factory—server hardware and operating systems, network services, file systems, clustering software, networking hardware, storage systems and configuration, databases, Sun Ray Software, and VMware ESX software. Together, these components comprise the assembly line of the managed desktop factory. Table 3-1 defines the key tasks that must be undertaken for these components.

Table 3-1. Operational tasks for managed desktop factory building block components

Monitoring and Reporting	• Monitoring of devices, platforms, operating systems, and services • Measurement of key performance indicators (KPIs) • Delivery of data and reports for other processes
Reactive Administration Tasks (Incident Management)	• Incident isolation • Reactive patching • Break and fix
Proactive Administration Tasks	• Change management • Release management • Performance management • Capacity management • Proactive patching • Asset management

The following sections discuss the tasks and estimated operational efforts for each component. In many cases, the tasks do not differ from standard operation. Differences that exist are highlighted. Key notes include:

- A fundamental difference from standard operation is that many components can be regarded as largely static, including operating systems, storage area networks, networks, and databases. As a result, fewer changes to these components are likely to be required compared to a standard environment.
- Software patching is a significant proactive task.
- The number of reactive administration tasks depends on the quality of the products in use and chosen maintenance service levels.
- A second level support function for incident isolation is recommended. Incident isolation is intended to isolate the area of the managed desktop factory that is causing the issue. A broad knowledge of the components and their interaction is required.

Asset Overview

Table 3-2 lists the assets that typically comprise the foundation of a managed desktop factory.

Table 3-2. Managed desktop factory assets

Asset Type	Asset	Comments
Servers	x86 or x64 servers with AMD Opteron™ or Intel® processors	Run VMware ESX and VMware VirtualCenter software
	x86, x64, or SPARC® processor-based servers	Run Sun Ray Software
Storage Area Network	Fibre Channel switch	Storage area network recommended; network attached storage or direct attached storage also supported
	RAID controller	Storage area network recommended; network attached storage or direct attached storage also supported
	Fibre Channel disk modules	Storage area network recommended; network attached storage or direct attached storage also supported
Internet Protocol (IP) Networks	Ethernet switches	
Clients	Sun Ray clients	
Operating System	Solaris Operating System	Runs Sun software
	Microsoft Windows 2003 Server	Runs VMware VirtualCenter software
	Microsoft Windows XP or other user applications	Runs applications for users
VMware Software	VMware ESX	Provides a platform for virtual machines
	VMware VirtualCenter software	Manages VMware ESX
Sun Software	Sun Ray Software	Provides user desktop access to Sun Ray clients
	Sun Secure Global Desktop Software	Provides user desktop access via a Web browser
	Sun Virtual Desktop Connector software	Connects Sun Ray Software and Sun Secure Global Desktop Software to VMware ESX
Database Software	Database software	Used by VMware VirtualCenter software

Servers and Operating Systems

Industry-standard servers that can handle 24x7 operation are recommended as the hardware platforms for a managed desktop factory deployment. Servers are needed as platforms for Sun Ray Software, Oracle databases, VMware ESX, VMware VirtualCenter software, network services, and administration consoles. Servers running VMware ESX create virtual platforms for Microsoft Windows XP operating environment instances, and VMware VirtualCenter software runs on Microsoft Windows environments. All other servers run the Solaris Operating System.

- Operating system clustering is not necessary for most software components. Database server clustering can be performed at the operating system or database level.
- Two network services are required for operation. The Domain Name Service (DNS) is needed for VMware ESX operation. The Dynamic Host Configuration Protocol (DHCP) is used by the Sun Ray Software.

Monitoring and Reporting

When the Solaris Operating System and Microsoft Windows environments run on industry-standard Sun servers, Simple Network Management Protocol (SNMP) based tools, like Sun Management Center software, can be utilized. Since no specific requirements for monitoring exist, standard datacenter tools and processes can be used. Servers running VMware ESX can be monitored at the hardware level (depending on the platform) or the Linux operating system level.

Reactive and Proactive Tasks

In general, platforms can be regarded as static. As a result, the number of required changes tends to be less than typical servers. If more compute power is needed, new servers can be added rather than reconfiguring existing servers. In addition, platform administration can follow standard processes. Processes and tools for patch management are a necessity to support twice yearly proactive patching of systems, as well as emergency patching tasks.

IP Networks

Network management consists of several tasks. Depending on the services included, these tasks can be handled by users (user office network) or third-parties (network service providers). All network components are standard network elements and are considered static. Changes are necessary only when factory capacity is increased. Tasks include:

- Monitoring and management of internal networks of the managed desktop factory
- Monitoring and management of the network to users and user offices
- Service management of the wide area network (WAN) service provider, if a WAN connection to user offices is required

Storage Area Networks

It is recommended that storage area networks use highly standardized and homogeneous components—one type of disk, controller, and SAN switch. Fibre Channel disks are preferred and provide a high mean time between failure (MTBF). RAID-5 or higher technology is suggested for storage systems. Furthermore, SANs can be considered static. New components can be added as capacity demands rise, rather than changing existing configurations.

Depending on the details of the implemented architecture, the SAN provides a number of logical unit numbers (LUNs) that contain a directory for every user. Each directory contains configuration files, a swap file, and a file for each user drive (C:) in use. Files for users in each user profile type are expected to be similar.

- The static nature of the SAN means that monitoring tasks can be reduced to checking for SNMP traps.
- Major reactive and proactive tasks consist of incident management, the initiation and control of maintenance services, performance checks, redistribution of images for optimal load balancing, and firmware updates.

Databases

VMware VirtualCenter software utilizes databases, such as Oracle Database, for operation. Databases can be considered static. Because the database is critical for the operation of the managed desktop factory, it is recommended that the database be clustered at the database or operating system level. All database instances are identical in terms of structure and administration. Typically, database administration is not needed during standard operation, and standard database monitoring and management concepts apply.

VMware ESX

VMware ESX is a software component that runs on the Red Hat Enterprise Linux environment and provides the platform for user operating system images. One instance of VMware ESX is installed per machine, with all servers configured identically.

- Monitoring is performed on two levels. Hardware monitoring is handled by an SNMP agent in the VMware ESX environment. VMware ESX monitoring is achieved using the VMware VirtualCenter software.
- Administration tasks consist of patching the VMware ESX software as needed. It is recommended that patching be performed using scripts or patch management tools.

VMware VirtualCenter Software

VMware VirtualCenter software is the primary management and administration tool for VMware ESX environments, and supports performance and capacity monitoring. VMware VirtualCenter software is used for the following tasks:

- Central administration of all virtual machine images
- Distribution of operating system image templates (golden images) to users
- Provisioning of new virtual machines using standardized operating system image templates, including testing and change management
- Monitoring of individual usage of virtual machines and system resources
- Creation of incidents and tasks based on alarms or signals from the virtual machine or schedules
- Creation of configuration and performance reports for performance optimization
- Provisioning high availability functionality, including the ability to automatically restart sessions on other VMware ESX servers in the group in the event of a failure
- Functionality for moving live sessions from one VMware ESX server to another using VMware VMotion software for maintenance and change management purposes

The VMware VirtualCenter software runs on the Microsoft Windows 2003 Server environment. It can be helpful to run the Microsoft Windows operating system instance on a VMware ESX server. Doing so enables VMware VirtualCenter software to be restarted easily on a spare machine, and lets more Solaris Operating System or Microsoft Windows administration servers run on one physical server. In addition to standard VMware software installation processes, the Pano Logic Virtual Desktop Solution (VDS) service must be configured for interaction with Sun Ray Software, if used.

Monitoring and Administration

Several items relating to monitoring and administration tasks must be considered:

- Monitoring must be performed with standard agents.
- Since VMware VirtualCenter software runs on Microsoft Windows with a graphical user interface, a Microsoft Windows helper host is needed for display redirection for remote management.
- Efforts for patching the Microsoft Windows binary must be taken into account.
- Administrative access must be configured. Up to 48 VMware ESX servers establish a group in terms of administration and high availability. These servers are operated by a single VMware VirtualCenter software instance. Administrators must not be granted Microsoft Windows administration rights. An access concept

is recommended for administrators that is based on active directory or identity management.

- VMware VirtualCenter software uses an internal database that is typically managed directly by the software. Direct database management is not required.
- All instances of VMware VirtualCenter software must be configured identically.

Sun Ray Servers

Sun Ray servers run the Sun Ray Software and deliver images that reside on VMware ESX servers to users with Sun Rays clients. Sun Ray servers have several characteristics:

- Configuration—a standard kiosk mode configuration is used. All Sun Ray servers include a Remote Desktop Protocol (RDP) connector. Several servers are connected together to form an application cluster. No users work on Sun Ray servers. As a result, Lightweight Directory Access Protocol (LDAP) or identity management-based user management is required.
- Monitoring—Since a Sun Ray Software instance is a standard UNIX process that creates a log file, monitoring can be established using standard methods. Monitoring of single user sessions is not required.
- Management—Sun Ray Software tools provide a graphical user interface and command line interface for managing configuration data. These tools are used to create, delete, modify, assign, and reassign profiles. Profile creation is performed during managed desktop factory implementation. Thereafter, management tasks tend to focus on incident and patch management. It is recommended that all Sun Ray servers be identical in terms of hardware configuration, structure, and administration.

Sun Secure Global Desktop Software

Users can also access desktop environments and applications via the Sun Secure Global Desktop software. This software gives users remote access to a Microsoft Windows or other operating system session via a Web browser. The Sun Secure Global Desktop software can be used in addition to the Sun Ray Software, and creates additional access flexibility for mobile users. It can also be used as a tool for migrating from existing fat client environments to thin client solutions.

The Sun Secure Global Desktop software employs the same back-end infrastructure as the Sun Ray Software, and requires similar monitoring and management tasks.

- Monitoring of UNIX processes, but not user sessions
- Application clustering
- No user management required
- Near static environment once the implementation phase is complete

Impact of Failures

Table 3-3 provides an overview of the impact of failures on managed desktop factory components. Information in the table can aid discussions regarding reaction times for service contracts and administrators, and hardware architecture. Because Sun Virtual Desktop Infrastructure Software is a datacenter-class application, companies can use established techniques, including clustering, separate fire compartments, and Solaris JumpStart™ software, to build a robust environment without a single point of failure.

Table 3-3. The impact of failures on managed desktop factory components

Component	Impact of Failures	Recommendation
IP Switch	• Used for user sessions and administration access • If a switch fails, users cannot work • Remote administration no longer possible	• Solution 1: Keep a cold standby/spare part for every rack for manual replacement; inexpensive solution with nontrivial downtime • Solution 2: Maintain a redundant network; more expensive solution with less downtime
DHCP Server, DNS Server	• Failure leads to a complete blackout	• Operate DHCP and DNS in failsafe mode • Does not add to administration efforts
SAN Switch	• User workplaces that use the disks fail	• Solution 1: Keep a cold standby as suggested for IP switches • Solution 2: Define privileged users; manually shift users and restart on remaining SAN components • Solution 3: Use redundant switches
SAN Disk	• Impact depends on RAID level in use • Suitable RAID levels result in no impact	• Use an appropriate RAID level on storage devices
Full SAN System	• Sessions abort • Unsaved data is lost	• Solution 1: Implement appropriate backup and restore functions • Solution 2: Deploy a redundant SAN
Database	• System states freeze • Existing sessions work • New sessions cannot be initiated	• Solution 1: Cluster at the operating system level • Solution 2: Cluster at the database level (recommended) • Proper cluster function mitigates the impact of failures
Sun Ray Software	• Sessions abort • Microsoft Windows instances remain active but are eventually disconnected • After a short while, users get a new login screen from another Sun Ray server within the same availability group	• Use provided Sun Ray application clustering • No extra effort necessary
Sun Secure Global Desktop Software	• Users lose connections • Users are presented with a link for a new login • Microsoft Windows instances run	• Use provided application clustering • No extra effort necessary
VMware ESX	• Failure of one VMware ESX server results in session termination and display of a blue screen for users on the system • When restarted, fsck is run • Unsaved data is lost	• Behavior is typically acceptable • VMware VirtualCenter software controls VMware ESX servers and the virtual machines • If a server fails, the virtual machines are restarted automatically on a remaining VMware ESX server (if configured)
VMware VirtualCenter Software	• System states freeze • Existing sessions work • New sessions cannot be initiated	• It is recommended to run VMware VirtualCenter software in a private VMware ESX server environment • Restart of VMware VirtualCenter software on a different machine is easy • Failures typically are not noticed by all users • Existing sessions are not affected • It is recommended to have at least one hot standby machine per rack • Alternatively, use Microsoft Windows clustering

Managing the User Space

In the context of the managed desktop factory, IT organizations must operate and maintain two domains:

- Sun Virtual Desktop Infrastructure Software domain — Sun Virtual Desktop Infrastructure Software provides the infrastructure that gives users access to desktop environment and application images. In this datacenter-centric domain, administrators keep track of the kind of images provided. Any kind of application or service can be supported. The domain is generic and can be standardized.
- Golden image and user space domain — This user-centric domain provides services that are similar to those in a traditional fat client distributed environment. Administrators must think about guest operating systems and applications maintained in a golden image, as well as identity management, user help desk functionality, and more. The domain is customized to support business tasks and priorities.

Because these two domains are so different, the logical conclusion is to have different IT teams handle them. Internal teams or outsourced services, like Sun[SM] Managed Services, can be employed. It is recommended to build an organizational structure that includes a user help desk for first level user support, and a service desk for second level support for Sun Virtual Desktop Infrastructure Software operations.

Several jobs and services are required for managing the user space in both domains. Because the Sun Virtual Desktop Infrastructure Software domain provides indirect services, it is recommended that users not be able to make requests of the service desk and use the help desk instead.

Potential tasks and services for managing the user space in the Sun Virtual Desktop Infrastructure Software domain include backup, data restoration, and the restoration of a personalized image from a golden image. Potential tasks and services for managing the user space in the image domain include:

- Handling of service requests and the user help desk
- User and identity management
- Application support
- Image creation and maintenance

User to Image Mapping

A golden image is a virtual machine template that is used to create new virtual desktops through the cloning mechanism provided by the VMware software. Virtual desktops can be static or dynamic. Static virtual desktops are assigned to a specific user, and the user is always connected to, and only uses, that virtual desktop. Dynamic virtual desktops are created dynamically and assigned upon request to users. After a user finishes using a dynamically assigned virtual desktop, the desktop reverts to a

clean state and is returned to an available pool. The key is for administrators to create user roles based on duties performed, and map these roles to pools of dynamic or static images. Doing so provides a flexible way to supply user environments with different configurations to various job functions within the enterprise. Because thin clients are stateless, users can move from place to place, or role to role, and automatically and transparently access an adjusted desktop. More information on this topic can be found in the *Sun Virtual Desktop Access Kit for VMware* Sun BluePrints article located at http://sun.com/blueprints/0307/820-1325.html

General Datacenter Services

Operating a managed desktop factory requires the use of several standard services, including:

- The hardware used in the infrastructure is designed to be operated in an industry-standard environment with power, cooling, access control, and other features. Service levels can range from the use of a single rack in an open and shared room, to dedicated, restricted access rooms with several fire compartments or remote disaster recovery sites.
- Datacenter power and cooling must be provided at industry-standard rates.
- Smart hand services can be made available when needed.
- Datacenters must be capable of connecting to user office sites, with a choice of network providers.
- Backup and recovery services tend to be provided as a routine part of datacenter operation. Detailed methods and strategies can vary based on targeted service levels. The amount of data to be backed up depends on factory implementation and the number of different golden images used in the environment.
- Configuration data and operating system and software libraries must be backed up separately from user data. Only user data is intended to be included in regular backup cycles. Ideally, only one image with all supporting static data needs to be stored per golden image.
- Backup strategies and frequencies must be considered relative to old environments. Standard PC environments often are not covered by datacenter backup solutions. When comparing current solutions with the managed desktop factory approach, existing methodologies can be taken into account when deciding on new procedures.
- Disaster recovery mechanisms need to consider the type of disasters and failures that are possible, and the service levels required. Today, most office environments are not protected against disasters. However, it is important to consider that any remaining portion of a factory infrastructure that is usable after a catastrophic event often can be configured to service a privileged group of users.

Sun Virtual Desktop Infrastructure Software and Security

Security is a major design goal of the Sun Virtual Desktop Infrastructure Software architecture. Common security features provided by the solution include:

- Authentication—The software supports LDAP-based user authentication and role-based access controls, and is two-factor authentication compatible.
- Encryption—The software supports the Alleged RC4 (ARC4) protocol for Sun Ray client traffic, the Secure Sockets Layer (SSL) protocol for secure remote access, a secure shell (SSH) for secure communication between systems, and the Transport Layer Security protocol for directory server traffic encryption.
- Data protection—By design, a network delivered desktop solution tends to be more secure than a traditional distributed PC-based solution. There is less risk of data loss since data is not distributed on local desktop hard drives. It is centralized in the datacenter and can be encrypted easily. Most importantly, network delivered desktops can help solve the dreaded “stolen laptop” problem, where confidential corporate data is lost or stolen from a portable computer.
- Layer security—Internal and perimeter firewalls can be used to prevent unauthorized traffic between deployment architecture tiers.
- Endpoint security—Sun Virtual Desktop Infrastructure Software lets desktop environments be hosted in the datacenter, enabling centralized management of desktop profiles and resources. However, security risks associated with network endpoints—desktops, laptops, and personal digital assistants (PDAs)—persist. Use of the Sun Virtual Desktop Infrastructure Software can help shield the enterprise infrastructure from risks associated with remote fat clients. If fat clients are used in the office or at remote locations, it is recommended that enterprises put standard security software and processes in place.

Chapter 4
The Managed Desktop Factory as a Service

This chapter focuses on how a managed desktop factory can be operated from a business perspective. When looking at the parameters to be considered, it is clear that one size does not fit all. However, creating the right solution for a specific set of needs is not complex—and operating a managed desktop factory and establishing a business model is not more difficult than older approaches. In the end, complexity can be condensed into a clear and easy to understand pricing model.

Service Management

Wikipedia defines IT Service Management (ITSM) as "a discipline for managing information technology (IT) systems, philosophically centered on the customer's perspective of IT's contribution to the business. ITSM stands in deliberate contrast to technology-centered approaches to IT management and business interaction[1]. Similarly, the OGC states that "Service management aims to achieve common understanding between the customer and provider through managing service level expectations and delivering and supporting desired results."[2]

1. See http://en.wikipedia.org/wiki/IT_Service Management
2. See http://www.ogc.gov.uk/delivery_lifecycle_co-ordinating_service_management.asp

The idea is to abstract technology, software, and assets and take the viewpoint of customers. Organizations wonder what delivers IT, and the value of IT to their enterprise. The benefit for IT providers that use this technique is improved communications with customers. In addition, a service view supports different pricing models, such as pay for resources, pay for service usage, and more. The following sections examine the ITSM concepts relevant to managed desktop environments.

Service Catalog

The Service catalog lists the services provided to customers. Each service listed in the catalog includes at least a service description, a service-level agreement, and associated costs. A properly conceived and constructed service catalog is paramount to ITSM success. It must be aligned with business priorities and customer expectations. Several best practices can be used to create an effective service catalog for managed desktop environments.

- Find the right granularity of service.
- Consider user profiles and cost. While all inclusive services sounds like a smart idea, and look simple to implement, service details often are overlooked. Different user profiles, such as sales, developers, and call center agents, require access to different resources, service levels, and resolution time frames in order to be effective. For example, sales staff often require printers as standard equipment, while call center agents can work without them. Organizations must decide if a single printer service, including hardware, device drivers, toner, paper, technical support, and incident resolution is required, or if customized printer services are

desirable. Similarly, developers need administrative access to golden images, while a call center agent needs an image that provides access to a problem ticket and resolution system. Both situations can be handled by one or more services.

- Include service attributes if needed by every user. If only one group needs an attribute, consider making it a separate service.
- Make attributes that are cost factors, such as hard disk space, separate services. Doing so makes it clear to users where costs come from and elevates awareness. Keep in mind that the higher the level of granularity, the more likely services are to become complex and difficult to manage, thereby increasing costs.
- Define a comprehensive list of services. Potential services for a managed desktop service catalog include personalized images, shared images, fat client workplaces, thin client workplaces, and color printer access.

Key Performance Indicators

What cannot be measured cannot be managed. Measurements are not the entire solution, but do provide an important tool that supports the daily tasks of service-level managers. Key Performance Indicators (KPIs) are metrics that are used to quantify objectives and determine the strategic performance of an IT organization. KPIs are used to create reports for service-level and quality managers, so that they can determine how to goal service delivery performance. In the well-known plan, do, check, and act methodology, KPIs fall in the check phase. Table 4-1 provides an idea of the metrics to consider in a managed desktop environment.

Table 4-1. Suggested Key Performance Indicators for a managed desktop environment

KPI	Description
%AVA	Service availability
#CW	Number of concurrent workplaces in use (average)
#TW	Total number of workplaces
%HDU	Hard disk space used by an image (average)
#TTR	Time to repair a failed component (in minutes)
#CUHD	Total number of user help desk calls
#CSD	Total number of service desk calls
#RT	Resolution time (average)

Service-Level Agreements

A service-level agreement (SLA) formally defines the level of service provided. It is an agreement between the consumer and the provider of a service. It records the common understanding about the level of service to be achieved, such as priorities, responsibilities, guaranteed values, coverage times, availability, and more. It is recommended that each SLA specify a metric for measuring fulfillment, and that the

metric consist of one or more KPIs. With SLAs, organizations can turn to reports and determine quality of service rather than relying on subjective evaluations.

Consider a managed desktop environment with two services: a personalized image service and a thin client workplace service. Table 4-2 details several example SLAs that can be defined for these services.

Table 4-2. Example service-level agreements

Service-Level Agreement	Service-Level Agreement Details
Personalized Image Service—Provides personalized images to users	
Image Count and Availability	• 99.9 percent image availability • 1,000 initial images with support for up to 1,500 images • Provisioning of new images upon request, no later than next business day
Hours of Coverage	• Monday through Friday (5x24)
Measurement	• Image availability measured with a test client at the customer site with a dedicated test image
Reporting	• SLAs are measured and reported on a quarterly basis
Charges	• Customer agrees to pay a specified amount per personalized image, provided as a monthly service charge
Disk Space Service—Assigns disk space to a personalized image for arbitrary use	
Capacity and Availability	• 3 GB initial size • Data growth of 1 GB within one business day of request • 99.9 percent availability • Weekly full backups, daily incremental backups • Data restored within one business day of request
Hours of Coverage	• Monday through Friday (5x24)
Measurement	• Availability measured with a test client at the customer site with a dedicated test image
Reporting	• SLAs are measured and reported on a quarterly basis
Charges	• Customer agrees to pay a specified amount per gigabyte of storage space used on a monthly basis
Thin Client Replacement and Provisioning Service—Provides break and fix services for thin client devices	
Capacity and Availability	• Initial provisioning of 800 thin client workplaces • Replacement of a thin client workplace within one business day of the request • Provisioning of a new thin client workplace within one business week of the request
Hours of Coverage	• Monday through Friday, 8:00 am to 5:00 pm
Measurement	• Measured by tickets submitted, no automatic technical measurement
Reporting	• SLAs are measured and reported on a quarterly basis
Charges	• Customer agrees to pay a specified basis fee, as well as a specified cost per client replacement and a specified cost per new client

It is important to note the following points:

- Fine-grained charging algorithms can be based on usage with an on-demand model.
- Because it is possible to access a personalized image from an arbitrary thin client, it makes sense to agree to an image availability of 99.9 percent, with replacement of a thin client taking place the next business day.

The Managed Desktop Factory as a Business Model

Business models depend on unique organizational situations and user requirements. As a result, a managed desktop factory can be implemented in various ways: as part of an in-house IT solution, as a hosted, full service offering, or a combination of both approaches. Consequently, enterprises must consider several key questions when defining a managed desktop environment.

- What are the different ways to offer and buy managed desktop factory services?
- What is needed for a complete service offering?
- What are the major cost factors?
- What financial options are available?
- How can accounting be realized?

Managed desktop factories can be used by a wide range of companies, including those that want to:

- Offer standardized desktop environments to other companies (business-to-business)
- Provide standardized desktop environments to end users (business-to-enterprise)
- Find a replacement for office IT and build a managed desktop factory

Typical user scenarios include:

- Small and medium enterprises struggling with in-house solutions (buy-in)
- Call centers (buy-in or build to suit)
- Telecommunications and network providers (business-to-business and business-to-enterprise)
- Government agencies (buy-in or build to suit)
- Banks and shops with sensitive data that must be stored in central datacenter repositories and users in a public environment (buy-in or build to suit)
- Public environments, such as schools, universities, and hospitals

Major Advantages

A managed desktop factory provides several advantages to users that make business justification straightforward, including:

- Significant cost savings in terms of people, energy consumption, software licenses, and more
- Ability to simply use technology without understanding the underlying details
- An easy to use environment that eliminates the need for IT experts in the office
- Flexibility that lets users access systems and services from any location with WAN access, and focus on individual job functions and core competencies
- Security measures, including central datacenter storage, ID cards, and more
- Ability to share high quality components with other users
- Easy maintenance and simple replacement of Sun Ray client devices
- Improved service quality and datacenter service levels
- Comfort and compatibility of a native Microsoft Windows environment

Selecting a Business Model

No two enterprises have the same set of requirements. As a result, it is important for companies to look at a variety of characteristics before deciding whether to build or buy a managed desktop solution.

- Define the scope of services to be provided. Understand what is in scope, and what is out of scope.
- Determine if portions of the existing infrastructure, assets, and services can be used in the new environment. Consider related technical, financial, and legal constraints.
- Define service-level agreements.
- Decide whether to build or buy a solution. Consider whether it makes sense to create the new environment with existing resources, or purchase parts or complete solutions from a service provider. Many companies now buy services, and pay-per-use and utility models are gaining in popularity due to the flexibility and simplicity such solutions provide to organizations.

Understanding Cost Factors

Whether an enterprise builds or buys a managed desktop solution, it is important to understand the cost factors associated with service building blocks and complete service offerings. Table 4-3 lists the major cost factors for creating a managed desktop factory service.

Table 4-3. Major cost factors for creating a managed desktop environment

Setup and One-Time Costs	Ongoing Costs
• Planning and project management • Performing pilot installations and testing golden images on proposed solutions • Ordering hardware and software assets, including management tools and components • Setting up the environment and preparing the datacenter for factory installation • Setting up the factory, including installation, connection to the network, and testing • Setting up the management infrastructure • Setting up remote management connections • Migrating existing data and users to the new system	• Administration of operating systems, storage systems, and switches • Network operations and services (WAN) • Database and application operations • Maintenance contracts • Service operations management • Help desk and single point of contact operations • Datacenter real estate, power, and cooling • Datacenter smart hand devices and storage • Advanced datacenter services, such as backup and restore

In addition, provisioning and maintaining golden images with user management, user help desk functions, and the management of applications, licenses, and services create further one-time and ongoing costs. If particular security mechanisms must be established for the factory, additional setup, asset, and operational costs are to be expected.

Numerous options can be part of a managed desktop service, and each contributes to cost calculations.

- Provisioning of printers, scanners, and special devices
- Web services, such as mail, calendar, and instant messaging
- Identity and user management

The amount and type of professional and project-based services that are needed depend on how the factory is used and how often changes and enhancements are implemented. Work effort and costs must be calculated separately for these tasks.

- Addition or replacement of systems
- Changes to the basic configuration
- Major updates to the operating system or services
- Movement of systems
- Disaster recovery (server restarts and standard maintenance services must be included in everyday tasks)
- Changes to user profiles (Sun Ray clients)

Accounting Models for Costs and Charges

Once an organizations knows what services are included, one-time and monthly costs can be determined. Monthly costs typically rise in a step-wise fashion. One-time costs can be transformed into monthly costs by using leasing models. Discuss what is best for a given scenario. Possible pricing parameters include:

- More or less one-time costs
- Monthly flat fees or very detailed options (often lead to more overhead)
- Contract run time, for a minimum charge or minimum number of desktops
- Number of concurrent users and named users
- Number of offices
- Pricing based on KPIs and fulfillment of SLAs

Determining Total Cost of Ownership

Given the variety of possibilities for implementing a managed desktop factory, it is impossible to generalize total cost of ownership (TCO) and return on investment (ROI). However, the core functionality of a managed desktop factory can provide significant cost savings. These savings result from virtualization techniques that can help improve infrastructure utilization, lower power and cooling costs, and reduce the amount of labor-intensive administration. In addition, a managed desktop factory creates huge potential for optimized workflows. For example, calculations for factories with 2,000, 8,000, and 20,000 seats show a potential for double-digit savings in percentage of TCO over a period of 36 months when compared with typical PC desktop environments. To obtain TCO and ROI estimates for a specific situation, contact Sun Professional Services for an analysis.

Chapter 5
For More Information

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`http://www.sun.com/blueprints/online.html`

Appendix A
Glossary

Availability
A measure of the total time that data, applications, and services are available from a system.

Cluster
Two or more interconnected systems or domains that share a cluster file system and are configured together to run failover, parallel, or scalable services.

DAS
Direct attached storage.

DHCP
Dynamic Host Configuration Protocol.

DNS
Domain Name Service.

Domain Name Service
A distributed name and address lookup mechanism used to translate domain names to IP addresses.

Dynamic Host Configuration Protocol
A framework for passing configuration information to hosts and managing IP addresses.

Golden image or master
An operating system image that is used as a template for operating system instances for users belonging to a particular user group. Also known as an operating system template in the VMware environment.

Internet Protocol
A set of protocols developed by the United States Department of Defense to communicate between dissimilar computers across networks.

IP
Internet Protocol.

IT
Information technology.

ITIL
Information Technology Infrastructure Library.

ITSM
Information Technology Service Management.

Key Performance Indicators
Metrics that are used to quantify objectives and determine the strategic performance of an IT organization.

KPIs
Key performance indicators.

LAN
Local Area Network.

LDAP
Lightweight Directory Access Protocol.

Lightweight Directory Access Protocol
A standard, extensible directory access protocol used by LDAP naming service clients and servers to communicate with each other.

Load balancing
The process of distributing application service loads across systems to increase performance.

Local area network
A network topology that provides a means to connect systems within a limited distance.

MTBF
Mean time between failure.

NAS
Network attached storage.

RAID
Redundant array of independent (or inexpensive) disks. A technique for aggregating a set of disk drives and making them appear to be a single logical disk drive to an application. Different RAID levels provide different capacity, performance, availability, and cost characteristics.

RAID-5
RAID level 5, or striping with distributed parity. Both data and parity are distributed across disks. No single disk can compromise the integrity of the data. RAID-5 optimizes performance, reliability, and cost.

SAN
Storage area network.

Service-level agreement
A guarantee of the service level provided by a computing environment to a user or set of users.

Simple Network Management Protocol
The standard network management protocol used in TCP/IP networks.

SLA
Service-level agreement.

SNMP
Simple Network Management Protocol.

SPOF
Single point of failure.

Sun Management Center
Software that provides a powerful, easy-to-use platform for administrative and management operations. Providing a single point of management for all Sun systems, Sun Management Center can help system administrators to perform remote system configuration, monitor performance, and isolate hardware and software faults.

Sun Ray Software
Software that gives users access to applications and services from any location using Sun Ray compatible thin client devices.

Sun Secure Global Desktop Software
Software that delivers secure, universal, and portable access to applications, data, and services to users. Users can interact with familiar collections of applications using familiar

devices, and uniform services can be received from a fixed office at the enterprise, or any location around the globe that is accessible to the Internet or telephone network.

Sun Virtual Desktop Connector software
A brokering service that integrates with VMware Infrastructure 3 software to deliver desktop environments running in virtual machines to users.

Switch
A networking device that isolates network traffic to the segments and devices for which the traffic is intended.

VDI
Virtual Desktop Infrastructure.

Virtual Desktop Infrastructure Software
Software that delivers applications and full desktop environments to clients using a server-based computing model. Users access applications and desktop environments that are hosted on centralized datacenter servers over the network.

VPN
Virtual private network.

WAN
Wide area network.

Wide area network
A network topology that provides a means to connect systems that are distributed over a large geographic area via telephone, fibre optic, or satellite links.

WLAN
Wireless LAN, or wireless local area network.

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