

*Sun Ray 1 Enterprise Appliance
Overview and Technical Brief*



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Sun Ray 1 Enterprise Appliance Overview and Technical Brief



Introduction

Managing information systems efficiently has never been more difficult, or more essential for success. Today, CIOs face the conflicting goals of controlling expenditures while delivering better support to users. As the total cost of ownership (TCO) for desktop systems escalates, managers are seeking ways to reduce purchase and upgrade costs, and to cut the larger expenses of administration and maintenance. Despite this need for greater economy, savings can't be traded for a loss of functionality and performance — unrestricted access to high performance enterprise applications remains a critical requirement.

The Sun Ray enterprise system is Sun Microsystem's newest solution for the low-cost enterprise desktop. Based on a fundamentally new architecture that Sun calls the *Sun Ray Hot Desk architecture*, the Sun Ray enterprise system provides a very low cost, zero-administration desktop appliance for the enterprise workgroup environments. The Sun Ray 1 enterprise appliance requires no desktop administration, is centrally managed, and provides an exceptional user experience. In addition, the Sun Ray enterprise system leverages the shared resources and the inherent reliability, availability, and scalability of Sun servers to deliver enterprise computing performance to the desktop with economics unmatched by general-purpose computing platforms.

The Sun Ray enterprise system offers many compelling advantages to users and administrators. The Sun Ray 1 enterprise appliance is completely stateless, with all data and processing located on the server. This, combined with a



unique smart card interface, provides users with instant access to their user environment from any Sun Ray 1 enterprise appliance within the workgroup, and prevents data loss even if a unit fails. If a failure does occur, a replacement can simply be plugged in, or the user can move to another Sun Ray 1 enterprise appliance and continue working. Users experience less downtime and better productivity, with the Sun Ray 1 enterprise appliance's "instant on-line" feature and an exact return to their desktop environment. Access to multiple platforms (Solaris, Microsoft Windows NT 4.0 TSE, and other UNIX® applications) from a single desktop, including cut and paste between applications, further boosts user productivity. Finally, Sun Ray 1 enterprise appliance users gain a more comfortable work environment, with a fanless, noise-free enclosure and sharp, 24-bit color images.

The Sun Ray enterprise system's user benefits are accompanied by a cost of ownership that is far lower than conventional desktops. Some costs are eliminated entirely because the Sun Ray 1 enterprise appliance requires zero maintenance and no upgrades. System administration is simplified because only one copy of the operating system (on the server) is required, and all application client processes and services run on the server, eliminating software distribution problems and reducing purchasing and licensing costs. Most existing applications run without modification, so adopting the Sun Ray enterprise system entails no new training for users and requires no rewriting or porting of applications. Finally, sharing desktops is practical and secure with the Sun Ray enterprise system — data and applications are securely held on the server, with nothing stored on the Sun Ray 1 enterprise appliance. And multiple users (agents working different shifts, flexible office environments, or job sharing employees, for instance) can easily share desktops, each finding their customized workspace in the same state as when they left, with no danger of corrupting one another's files.

Sun Ray enterprise systems deliver what enterprises demand — dramatically lower total cost of ownership, centralized management, and access to their existing applications, with no loss of functionality or performance.

The Sun Ray enterprise system design is based on a fundamentally new approach — the Sun Ray Hot Desk technology. Designed with the needs of enterprises in mind, this new technology offers many benefits over previous approaches, including better mobility for users, simplified administration, and far greater economy than dedicated PCs or workstations.

Sun Ray Hot Desk Architecture

System architectures have evolved over time, from mainframes, to isolated PCs and PC LANs, and finally to the distributed three-tier architectures of today. Distributed computing brings power and flexibility to the desktop while gaining centralized control of back-end data and applications, but historically has required fully-functional desktops to perform application and user interface processing. These “fat clients” need lots of resources, are difficult to interchange, and their administration and maintenance costs are high.

Modern three-tier architectures have gone one step further, moving applications back to centralized servers, and leaving only the user interface on the client. Applications are downloaded across the network onto “thin” clients for execution. This increased centralization simplifies administration and reduces demands on the client. However, client systems still require resources to execute applications, and upgrades will likely be needed as future applications increase in size and complexity.

The Sun Ray enterprise system implements the *Sun Ray Hot Desk architecture*, the next logical step in an evolutionary process toward more economical and secure computing environments. This new approach removes everything from the desktop except the resources needed for the human interface — input from the keyboard, mouse, and voice; and output to the display and audio (see Figure 1). All computing is performed on one or more centralized, shared machines. Everything that previously ran on the user’s own desktop — window system, user applications, mail clients, etc. — now runs in a session on the server. The Sun Ray 1 enterprise appliance display provides a composite view of all currently active applications, with input/output between the user and the servers carried over a simple, dedicated, interconnection fabric.

Because applications execute independently of the location of input and output, this architecture allows a user to access his/her unique session from any Sun Ray 1 enterprise appliance within the workgroup. By re-directing input and output, a user’s session environment can be moved from one physical enterprise appliance to another instantaneously.

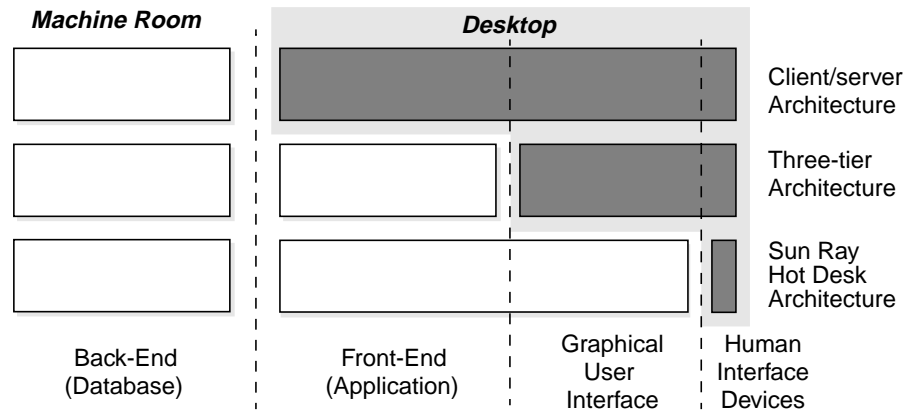


Figure 1 Sun Ray Hot Desk architecture repartitions the functionality between the desktop and the machine room, leaving only the human interface appliance on the user's desktop.

The Sun Ray Hot Desk architecture retains many of the desirable features of previous approaches without their attendant drawbacks. It provides the cost of ownership and administrative benefits of three-tier, thin-client computing without reducing functionality. It provides the applications, performance, and resources of distributed architectures while significantly reducing acquisition costs, administration, and desktop maintenance. By leveraging shared resources, the Sun Ray enterprise system delivers server-class performance to a desktop appliance that never needs upgrades or maintenance. The completely stateless nature of the desktop appliance enables easy mobility, with users accessing their unique session from any desktop connected to the Sun Ray server. By defining a new way of delivering services to the desktop, Sun's Hot Desk architecture offers substantially greater levels of functionality at a significantly lower overall cost than other approaches.

The Sun Ray Enterprise System Product Description

The Sun Ray enterprise system include three primary components: the *Sun Ray 1 enterprise appliance*, a *Sun server* with the Solaris™ (SPARC™ Platform Edition) Operating Environment, running the *Sun Ray enterprise server software*, and a *dedicated interconnect* (see Figure 2).

The Sun Ray 1 enterprise appliances are small, stateless, “plug and work” appliances that include a smart card reader, 10/100 Mbit ethernet connection, four USB ports for connecting peripherals, and audio and video I/O. The Sun Ray 1 enterprise appliance connects to a display device, keyboard and mouse, and will support other local peripherals (such as a printer or scanner) with later releases of the Sun Ray enterprise server software. The Sun Ray enterprise server software runs on a Sun server, and hosts the user sessions run by Sun Ray 1 enterprise appliance users. The interconnect is a dedicated 10 or 100Mbit ethernet communications channel that connects the enterprise appliances with the Sun Ray enterprise server.

No client software is stored or executed on the Sun Ray 1 enterprise appliance— all applications run unchanged on the server, utilizing its CPU and memory. Output is rendered to a *virtual frame buffer* on the server and then transmitted via the interconnect to an attached Sun Ray 1 enterprise appliance. Similarly, all input (keystrokes, mouse clicks, etc.) is transmitted from the enterprise appliance through the interconnect, and on to the appropriate client application running on the server.

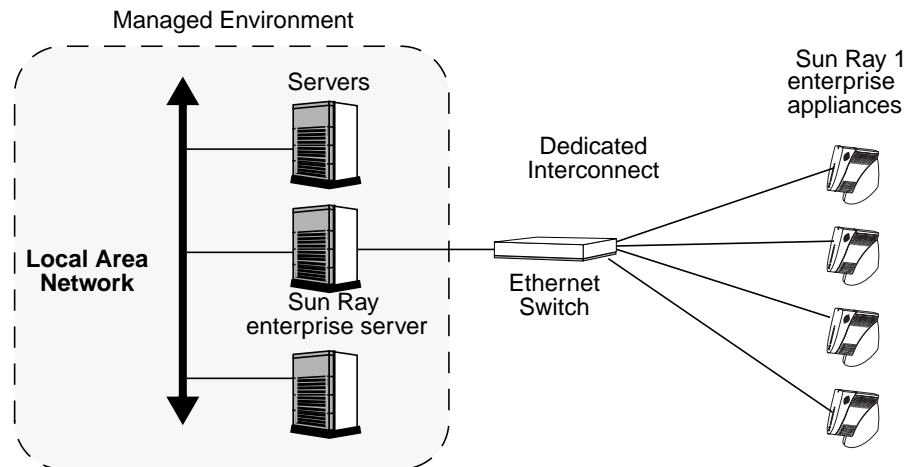


Figure 2 High-level schematic of Sun Ray enterprise system components.



Hardware Architecture

Several recent computing trends make the Sun Ray Hot Desk technology practical today. Servers are more powerful and more economical than ever before, with the cost per unit of performance on parity with desktop systems. When combined with state-of-the-art operating environments like Solaris, today's servers can easily provide the requisite multi-user support and the high levels of performance and scalability called for by such architectures. In addition, high speed networking (100 Mbps or better) is now widely available at a low cost, making inexpensive, dedicated interconnects feasible.

Sun Ray 1 Enterprise Appliance

The Sun Ray 1 enterprise appliance is a small, fanless device that connects to a display device, keyboard and mouse (see Figure 3). Its function is to process all input and output for the user, and to manage communication with the shared Sun Ray enterprise server.

Sun Ray 1 enterprise appliance supports graphics resolutions of up to 1280 x 1024 with 24-bit color and a vertical refresh rate of up to 76 Hz, enabling outstanding display quality. Peripheral I/O is provided through four USB ports, and a 10/100BaseT Ethernet interface provides access to the dedicated interconnect. Multimedia ready, Sun Ray 1 enterprise appliance offers stereo audio out and mono input, and standard composite video input for video conferencing applications.

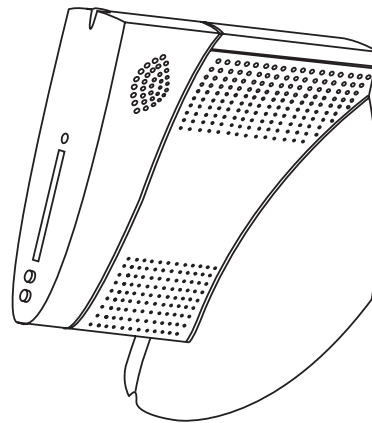


Figure 3 The Sun Ray 1 enterprise appliance.

The Sun Ray 1 enterprise appliance ships in a “headless” configuration with a Sun Type 6 USB keyboard and USB mouse. Current Sun 17-inch, 19-inch, and 21-inch monitors and Sun’s 18-inch flat panel display are supported, as are selected earlier generations of Sun 17-inch and 20-inch monitors. In addition, the Sun Ray 1 enterprise appliance is designed to work with standard VGA monitors commonly used with personal computers, enabling flexible configurations and allowing organizations to leverage their existing IT investments.

Feature	Specification
Enclosure	Slimline desktop box 180 mm H x 50 mm W x 180 mm D
Graphics	24-bit, up to 1280 x 1024 @ 76 Hz
Interconnect	10/100BaseT
Supported Input Devices and Peripheral I/O	4 powered USB ports Type 6 USB keyboard and “Crossbow” USB mouse Sun Microphone II (optional) Sun Camera (optional, no I/O card required)
Audio	16bit stereo audio In/Out, microphone, headphone
Composite Video Input	NTSC/PAL
Energy Management	Energy star compliant
smart card Reader	ISO-7816-1 compliant

Table 1 Sun Ray 1 enterprise appliance features and specifications.

The Sun Ray 1 enterprise appliance’s design affords considerable benefits:

- Its stateless nature prevents loss of work if a Sun Ray 1 enterprise appliance fails — a replacement unit can simply be plugged in, or the user can move to another Sun Ray 1 enterprise appliance, and continue working uninterrupted. This statelessness also allows easy session mobility, as users can access their unique session from any enterprise appliance within the workgroup.
- Individual Sun Ray 1 enterprise appliances do not require any setup or configuration, making units instantly replaceable.
- Sun Ray 1 enterprise appliances become fully functional in less than 10 seconds after plug-in (essentially, the time required for monitor warm-up), reducing down-time and lost productivity of users.



- No local rendering is performed within the enterprise appliance, eliminating problems with missing local fonts and providing consistent output.
- No computation occurs on the Sun Ray 1 enterprise appliance, reducing resource bottlenecks common to low-end desktop systems.
- There are no user-serviceable parts on the desktop, simplifying maintenance. A small number of failure and fault diagnostics are handled through simple on-screen display graphical icons.
- The fanless Sun Ray 1 enterprise appliance is noise-free, yet offers high-quality graphics and multimedia capabilities.
- The dedicated interconnect utilizes standard Ethernet networking technologies and components, resulting in a low-cost dedicated network.

The Sun Ray Hot Desk architecture has a unique benefit in that the Sun Ray 1 enterprise appliance only needs to deliver services at a performance level set by “human bandwidth.” Once the Sun Ray 1 enterprise appliance is capable of meeting the input/output requirements set by the limits of human perception, a faster processor or more memory will not provide any additional benefit to the user. Thus, the Sun Ray 1 enterprise appliance represents a one-time acquisition cost, as there is no need to upgrade to faster components or more memory.

Smart Card Reader

The Sun Ray 1 enterprise appliance includes a built-in smart card reader that conforms to the ISO-7816-1 standard. The size of an ID badge or credit card, smart cards provide easy and instant authentication of users. Sites using compatible smart cards are able to deploy and integrate them, if desired, with the Sun Ray enterprise system’s authentication system. The Sun Ray enterprise system’s default authentication policy does not require a smart card, however, and at the initial release, smart cards are not shipped with the product.

Firmware

Each Sun Ray 1 enterprise appliance includes 512 KB of Flash EPROM that contains the system firmware. This system firmware handles Power-On Self Test (POST), communication with the service providers, authentication, on-screen displays, audio and video control, and local device drivers.

The Sun Ray 1 enterprise appliance firmware can be securely updated via the network interface, providing convenient, centralized administration.

Interconnect

Sun Ray enterprise systems employ a dedicated interconnect for communication between the Sun Ray 1 enterprise appliances and the Sun Ray enterprise servers. Based on Fast Ethernet (100BaseT) technology, the Sun Ray enterprise system leverages commodity network components and standard protocols, thereby avoiding the expense of engineering, manufacturing, and supporting a proprietary interconnect. Despite their use of Fast Ethernet technology, Sun Ray 1 enterprise appliances are not directly connected to the local area network, which reduces network administration costs.

Based on the Hot Desk technology, the Sun Ray enterprise server communicates to Sun Ray 1 enterprise appliances over a low-cost, high quality-of-service interconnect. The Hot Desk technology assumes a dedicated connection between the Sun Ray 1 enterprise appliance and server, to provide a defined quality of service in terms of latency, bandwidth, and congestion-induced loss on the link. Such an unmanaged, dedicated interconnect also reduces costs and maintenance. No higher level services such as NIS, NFS, or SMTP are required and no complex network management is necessary.

Sun Ray 1 enterprise appliances can connect directly to servers via unmanaged Gigabit/Fast Ethernet switches. All network equipment must support autonegotiation — Sun Ray 1 enterprise appliances have no means to manually configure link parameters. Switches must also have good internal bandwidth and reasonable cross-traffic conflict resolution.

Two basic interconnect approaches exist: switched 100 Mbps Ethernet and direct connections from server to desktop using crossover Ethernet cables.

- *Switched 100 Mbps Ethernet*

Switched 100 Mbps Ethernet, with a Gigabit link from the server to the switch, is the preferred interconnect configuration because it provides the highest performance and best reliability (Figure 4). A 100 Mbps switched Ethernet configuration provides sufficient bandwidth for the most demanding bandwidth-intensive applications and enables quality of service expectations to be met for each desktop. The use of gigabit fiber cable also enables a greater distance between the server and the Sun Ray 1 enterprise appliances.



Switched 10 Mbps Ethernet, with a 100 Mbps link to the Sun Ray enterprise server, is also supported but is not recommended for general use. (Shared 10 Mbps Ethernet is not supported.) 10 Mbps is insufficient for audio or video, and graphics performance may occasionally suffer. However, 10 Mbps switched Ethernet may provide acceptable performance if Sun Ray 1 enterprise appliance displays are configured for lower resolution, graphics use is minimal, and audio and video are not used.

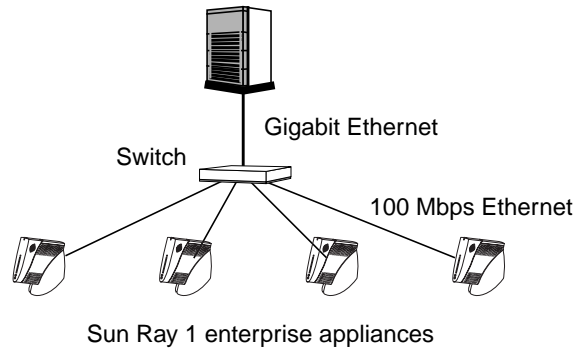


Figure 4 The preferred interconnect configuration includes switched 100 Mbps Ethernet with a Gigabit Ethernet link from the switch to the server.

- *Direct Connection from Server to Desktop*

Sun Ray 1 enterprise appliances can be directly connected to the network interface on the server using crossover Ethernet cables (Figure 5). This configuration is useful for configurations of one to eight users, or for test and demonstration purposes. Such arrangements can serve only a limited number of Sun Ray 1 enterprise appliances, because there must be one Ethernet port on the server dedicated to each desktop.

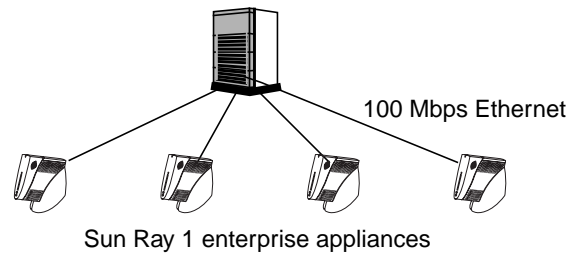


Figure 5 Small configurations can employ direct Ethernet connections from the server to the Sun Ray 1 enterprise appliances.

Architectural Scalability

The Sun Ray Hot Desk architecture is highly scalable and supports configurations from a few desktops to hundreds of desktops per server. Scalability for Sun Ray enterprise systems is determined by application load, network bandwidth, and server memory and CPU resources.

Typically, each Sun Ray 1 enterprise appliance requires between 10 and 20 MB of server memory, with each 300 MHz CPU on the server able to support from 25 to 65 desktops, depending on application load. Fortunately, scaling systems to meet growing performance requirements is a Sun specialty — Sun Enterprise™ servers are among the most scalable computer systems available today. They range from the entry-level Enterprise 5S to the Sun Enterprise 10000 (Starfire™) server, which can accommodate a maximum of 64 GB of memory and up to 64 high-performance UltraSPARC™ processors. Memory and CPUs can be steadily added until a server's maximum configuration is reached, at which point the server can be upgraded to a larger model. For even larger configurations, multiple servers can be configured for maximum performance and availability.

In addition to memory and CPU scalability, network scalability is also important when considering the performance of configurations deploying Sun Ray 1 enterprise appliances. Using switched ethernet, additional users can be added without incurring any network conflicts or congestion. Additional Fast Ethernet ports can be added to the server running the Sun Ray enterprise server software to raise the total bandwidth of the interconnect as needed.



The Role of the Solaris Server

Any Sun server running the Solaris 2.6 or Solaris 7 Operating Environment can be used as a Sun Ray enterprise server. The Sun Ray enterprise server runs the Sun Ray enterprise server software, that manages connections to the Sun Ray 1 enterprise appliances and performs enterprise appliance-specific administration functions. In addition, the Sun Ray enterprise server hosts user client sessions, and may also host other applications, depending on capacity. Applications that used to run on an individual's desktop — the window system, mail clients, Web browsers, and other user application clients and services — run on servers in the Sun Ray enterprise environment. They take advantage of the server's memory and CPU resources, and exploit the server's superior administration and security features.

By centralizing and sharing the system's computational resources, enterprises gain enormous cost savings while providing users with higher levels of performance. Additional resources, such as memory or extra processors, can be added to a Sun Ray enterprise server and automatically made available to all Sun Ray 1 enterprise appliances. Adding redundancy to the servers through disk mirroring, redundant hot-standby hardware components, or clustering — techniques which aren't cost-effective at the desktop level — bring even greater reliability and availability to the desktop. As a result, Sun Ray 1 enterprise appliance users experience the higher performance and resources of centralized servers, and also benefit from the greater reliability and availability of those machines.

In addition to the Sun Ray enterprise server, applications hosted on other servers on the network can be accessed by users attached via the Sun Ray 1 enterprise appliances. This can include applications running on other versions of UNIX, applications running under Windows NT 4.0 TSE (accessed via the Citrix MetaFrame technology) and legacy applications accessed via 3270 gateways and emulation software.

Sun Enterprise Servers and Solaris Operating Environment

Because computation takes place on servers, Sun Ray enterprise system performance is a function of server performance. And with Sun Enterprise servers running the Solaris Operating Environment, Sun Ray enterprise system users can get all of the performance and scalability they need.

Sun Enterprise servers lead the industry in offering some of the most powerful, scalable, and reliable systems available today. Sun's family of servers provide scalable, symmetric multiprocessing capabilities, featuring from one to 64 high-performance UltraSPARC processors, up to 64 GB of physical memory, and up to 20 TB of disk storage, providing performance for peak demands as well as virtually unlimited growth. For the highest levels of availability, Sun servers also support clustering technology that can produce high levels of availability.

The power of Sun's servers is further enhanced by the Solaris Operating Environment, the premiere environment for enterprise network computing. Designed with the needs of enterprises in mind, the Solaris 7 Operating Environment features full 64-bit processing, mainframe-class reliability, superior scalability, and unprecedented performance. The operating environment has significant enhancements to support multi-user environments, and is uniquely suited to the Sun Ray enterprise system's new generation of time sharing.

Software Architecture

Any server running the Solaris 2.6 or 2.7 Operating Environment can host the Sun Ray enterprise server software. This software provides Sun Ray enterprise system management and administration, including authentication of users and redirection of input and output to the Sun Ray 1 enterprise appliances. Administrative functions such as managing authentication policies and setting user privileges are also included in the Sun Ray enterprise server software.

All Sun Ray enterprise server software resides on the servers — nothing is stored on or downloaded to the Sun Ray 1 enterprise appliances. Sun Ray enterprise server software can be distributed among multiple servers, allowing load balancing and providing increased levels of availability to users.

Sun Ray Enterprise Server Software

Some features described below may not be available in the initial release of the Sun Ray enterprise system product. Additional functionality will be added in subsequent software releases; no changes or modifications to the Sun Ray 1 enterprise appliance will be required.

The Sun Ray enterprise server software hosts several functions needed to maintain and manage a network of Sun Ray 1 enterprise appliances:



- Authentication Manager — Recognizes and validates Sun Ray 1 enterprise appliance users
- Session Manager — Maps a user session on a server to a physical Sun Ray 1 enterprise appliance and binds/unbinds related services to and from specific Sun Ray 1 enterprise appliances
- Virtual device drivers — Translate from higher-level rendering APIs such as X11 to the Sun Ray Hot Desk interface and handle all input and output for the Sun Ray 1 enterprise appliances
- Peripheral device support — Manages remote peripherals attached directly to Sun Ray 1 enterprise appliances
- Administration Tool — Provides user management and usage monitoring

An example of the interaction of the Sun Ray enterprise server software components is illustrated in Figure 6:

1. A user inserts a smart card. If smart card authentication is not being used, the user logs in at the Sun Ray 1 enterprise appliance.
2. The Sun Ray 1 enterprise appliance sends an event to the Authentication Manager running on the server. This message includes a unique token number — either the serial number of the smart card or the MAC address of the Sun Ray 1 enterprise appliance.
3. The Authentication Manager chooses the current authentication policy and exchanges messages with the Sun Ray 1 enterprise appliance to complete authentication. If authentication succeeds, the Authentication Manager maps the user to a session ID and sends the ID to the Session Manager.

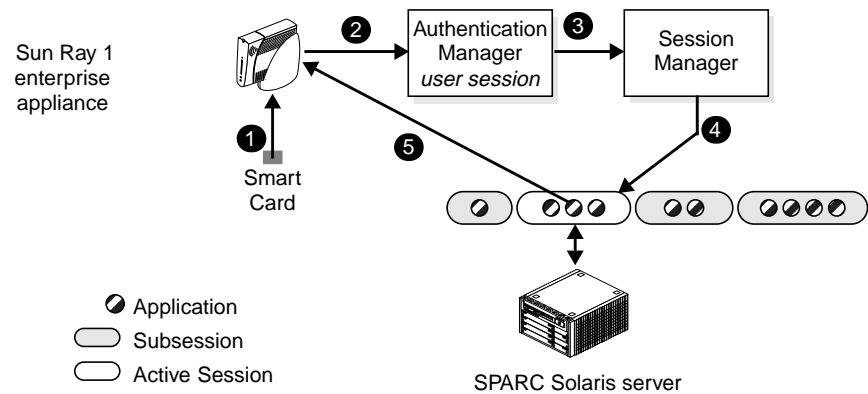


Figure 6 The Authentication Manager and Session Manager work together to validate users and map a user's currently active session to a particular Sun Ray 1 enterprise appliance.

4. The Session Manager locates the user's currently active subsession. Once the session has been identified, the Session Manager directs all of the associated services to the Sun Ray 1 enterprise appliance upon which the user is currently authenticated.
5. When the user is finished (e.g., the smart card is removed or the user logs out), the Authentication Manager is notified and the chosen policy is executed. Depending on the policy, the user may be logged off and all associated services killed. Or, the session may be kept alive with all services disconnected from their display.

Authentication Manager

The Authentication Manager's principal duty is to implement the chosen policies for authenticating users' Sun Ray 1 enterprise appliances. When a user is successfully authenticated, this software maps the individual to a specific abstraction maintained by the system and notifies the Session Manager of the new connection. Similarly, the Authentication Manager notifies the Session Manager of disconnection events as they occur.

The Sun Ray 1 enterprise appliance contacts the Authentication Manager each time a user at a Sun Ray 1 enterprise appliance attempts to access the system.



The Authentication Manager provides an extensible framework that permits the creation of arbitrary authentication policies, all without requiring any modification to the Sun Ray 1 enterprise appliance. Administrators may modify policies or create new ones, enabling a flexible security solution that can be tailored to meet an organization's specific needs. Two authentication policies are defined in the first release of the Sun Ray enterprise server software:

- *Zero Administration (default policy)*

The default policy, in effect when the Sun Ray enterprise server software is initially installed, requires no administration. Smart cards are optional, but fully supported. If smart cards are used, the serial number from the card is used as a unique, identifying token number. Otherwise the MAC address of the Sun Ray 1 enterprise appliance is used as the default.

The first time a token number is sent (i.e., the first time a smart card is inserted or a Sun Ray 1 enterprise appliance is powered on), the user token is automatically accepted. A new CDE session is started, and the user is prompted for a login and password as with any other Solaris system.

Although smart cards are optional, they act as a "bookmark" for a particular session and enable easy mobility. During an active session, a smart card can be removed from one desktop and inserted into a different desktop. The Authentication Manager uses the token number of the smart card to map the user to their currently active session, and work can continue uninterrupted; all applications are still running and the user environment is recreated exactly as it was left. If smart cards are not used, a user needs to log out of one desktop and then log in to another (which is identical to workstation environments today). Sun Ray enterprise system users can still use any Sun Ray 1 enterprise appliance within a workgroup, but a smart card is required to *automatically* reconnect to an active session.

- *Registered*

The registered authentication policy affords a higher level of security, as all tokens must be registered before they will be accepted by the Authentication Manager. Administrators may choose a distributed or a centralized registration policy. With a distributed policy, users accessing the system with a new token number are sent to a registration screen to complete self-registration before being authenticated. A centralized policy provides greater security, as the registration program runs only at a single location, such as a badging station or site security

officer's station. As with the zero administration policy, any user would also need a Solaris login and password to complete the Sun Ray enterprise system authentication process.

Additional authentication policies may be included in later releases. For example, in a future software release a challenge/response policy will be combined with the registered authentication policy. Under this policy, users would need to enter a valid, registered smart card and complete a full challenge/response transaction in addition to requiring a Solaris login name and password to be successfully authenticated. A Software Development Kit (SDK) will also be made available so that additional authentication mechanisms can be developed to meet individual customer needs.

Session Manager

The Session Manager manages all running user sessions. A user session encompasses one or more applications running on a particular server. For example, one subsession may contain a word processor and a spreadsheet application running on an Windows NT server.

When the Session Manager is informed of a user connection event by the Authentication Manager, it notifies the applications within the user's session to perform all input/output operations with the indicated Sun Ray 1 enterprise appliance. Similarly, when a disconnect event occurs, the Session Manager signals all applications in the user's session to cease I/O with the Sun Ray 1 enterprise appliance and enter a quiescent state.

As with the Authentication Manager, the Session Manager must be active at all times for the Sun Ray enterprise system to function properly.

Virtual Device Drivers

All output to the Sun Ray 1 enterprise appliances is accomplished through the use of *virtual device drivers* that reside on the server. The virtual device drivers translate between higher-level rendering APIs such as X11 and the Sun Ray Hot Desk interface (Figure 7). A virtual device driver is needed for each supported rendering API.

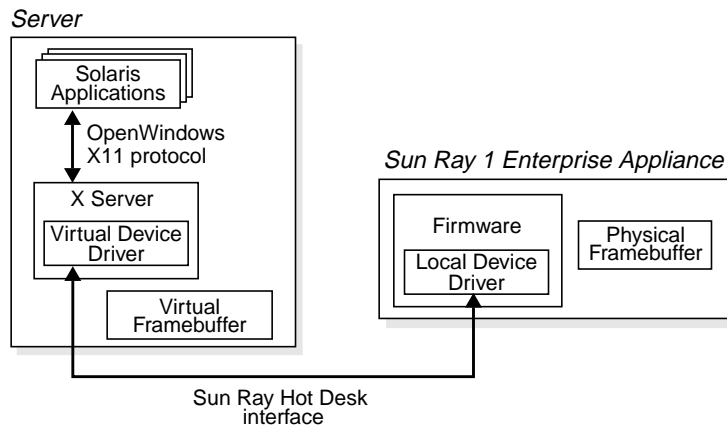


Figure 7 The virtual device driver translates between higher-level rendering APIs and the Sun Ray Hot Desk interface.

The virtual device driver maintains a copy of the currently active subsession's display in a memory-based virtual framebuffer on the server. All display rendering is performed on the server, and pixels are sent by the virtual device driver to the display in a standardized format. Keyboard and mouse events are sent from the desktop back to the virtual device driver on the server, translated to the higher-level API, and then sent on to the application. Each rendering API's virtual device driver must also convert any 8-bit pseudo color visuals into the 24-bit values required by the Sun Ray 1 enterprise appliance.

Unaccelerated (software-only) 3D graphics rendering is supported with the Sun Ray enterprise system through the OpenGL API. However accelerated 3D rendering is not supported, as only the framebuffer on the Sun Ray 1 enterprise appliance is used. (Accelerated framebuffers on the server cannot be used by applications destined for Sun Ray 1 enterprise appliances.)

Peripheral Device Support

Sun Ray 1 enterprise appliance users have two ways to access peripherals: they can access network peripherals that are accessible through the Sun Ray enterprise server (like any other Solaris user), or they can use local peripherals connected directly to a Sun Ray 1 enterprise appliance. Local peripherals attach through Universal Serial Bus (USB) ports on the Sun Ray 1 enterprise

appliance, with the device driver for these peripherals residing on the servers. At the Sun Ray enterprise product's initial release, Sun will provide USB drivers for the keyboard and mouse. Additional drivers for common USB peripherals, such as printers and serial devices, will be provided after the initial release. A Software Development Kit (SDK) will also be made available so that users can create new device drivers for additional USB peripherals.

The Remote Device Manager, a component of the Sun Ray enterprise server software, manages connections to remote devices, and handles the association between a device driver on the server and USB operations on the Sun Ray 1 enterprise appliance.

Legacy Solaris devices that are accessed directly through the `/dev` name space (like `/dev/audio/*` and `/dev/term/*`) are supported through device emulation. When a new session is created, pseudo devices are dynamically created for those devices which the user has permission to access. To the services that use them, these dynamically created pseudo devices behave just like the devices they emulate.

Administration Tools

Every effort has been made to reduce the administration burden for the Sun Ray enterprise system. For example, reasonable defaults are provided so that most Sun Ray enterprise systems will function correctly after installation without additional configuration. However, some administration is still required. Sun Ray enterprise server administration software includes tools for managing the chosen authentication policy, altering desktop device settings, and monitoring the state of the Sun Ray 1 enterprise appliances.

All Sun Ray enterprise server administration tools are accessible through browser-based graphical user interfaces (GUIs) as well as command line interfaces.

Administrative data is stored in the Sun Directory Service (Sun's LDAP server) and the Sun WebServer™ software is used to provide GUI access.

Microsoft Windows NT Access

In many organizations, users require access to popular productivity applications running on Windows NT servers. Using optional software from Citrix Systems, Sun Ray1 enterprise appliances support the display of



Windows applications running natively under Windows NT 4.0 Terminal Server Edition (TSE). This requires the installation of Citrix MetaFrame software on an available Windows NT TSE server and corresponding Citrix ICA client software on the Solaris server running the Sun Ray enterprise server software. Windows applications can redirect their output, using MetaFrame, to the Solaris server (Figure 10). Because Citrix ICA clients use the X11/OpenWindows™ interface, the Windows user interface is rendered to the virtual device driver and then to the Sun Ray 1 enterprise appliance like any other X-based application. This approach provides high performance access to Windows applications that can only come from native execution, along with the same economy and ease of administration enjoyed by Sun Ray 1 enterprise appliance users running Solaris applications.

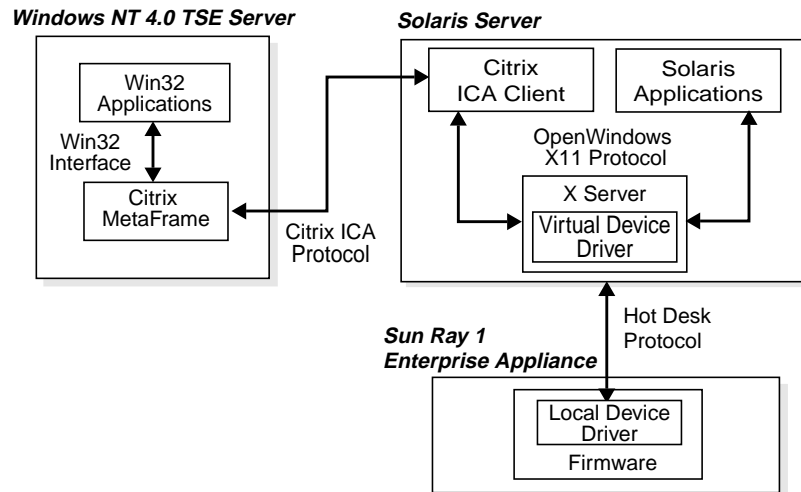


Figure 8 Optional software from Citrix Systems is used to display Windows applications on Sun Ray 1 enterprise appliances.

Typical Configurations

Two typical configurations are described here. The first, applicable for small workgroups, uses a Fast Ethernet (100BaseT) shared network for the dedicated interconnect. The second example, suitable for larger departmental configurations, utilizes a large-scale Gigabit Ethernet/Fast Ethernet switched network to provide the high bandwidth needed by a large number of users.

Small Workgroup Configuration

Small workgroups consisting of approximately 5 to 50 desktops can be satisfactorily served by using a low-cost Fast Ethernet (100BaseT) shared network as the dedicated interconnect. The Sun Ray enterprise server connects to one or more small 100BaseT switches which in turn connect to the Sun Ray 1 enterprise appliances (see Figure 9).

As shown in Figure 9, the combination of an entry-level Ultra™ 10S server with two Fast Ethernet ports and two low-cost 100BaseT switches can easily support 12 users. In this example, each 100 Mbps link from the Ultra 10S server carries the traffic for six Sun Ray 1 enterprise appliances. Because user traffic is generally bursty in nature and not all users are typically active at any given time, this configuration supplies ample bandwidth for most applications.

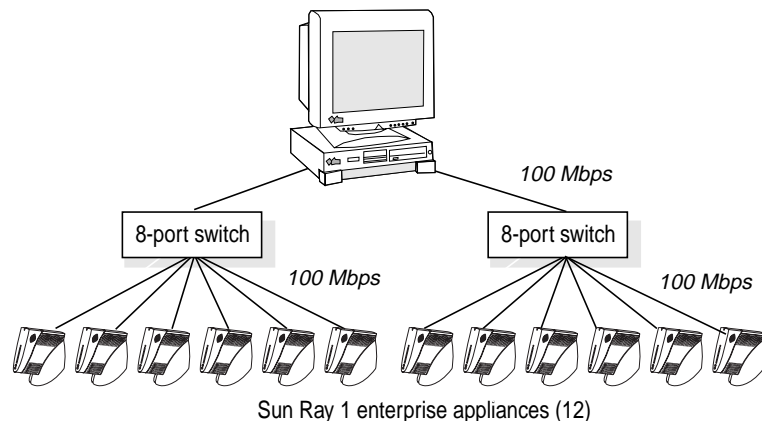


Figure 9 Shared 100BaseT switches can be used as the dedicated interconnect for small workgroup configurations.



Initial hardware purchase price is only one part of the cost equation — software costs and ongoing administration and maintenance expenses typically account for an even larger part of an enterprise desktop's total cost of ownership — and in this regard, a Sun Ray enterprise system solution can produce dramatic savings.

In a traditional configuration, software must be purchased, licensed, and installed on each desktop. With the Sun Ray enterprise system, only one copy of the operating system software is required. In the example shown here, the organization would save by purchasing, installing, and managing only one copy — rather than twelve additional copies — of the operating system software. Furthermore, with the Sun Ray enterprise system all application software is installed on the central server rather than on the distributed desktops, greatly simplifying installation and administration costs.

Additional cost savings are achieved through the Sun Ray 1 enterprise appliance's greatly simplified administration and maintenance, as compared to traditional architectures. Many administration costs are a function of the total number of network nodes, and with the Sun Ray enterprise system this number is reduced to only the server running the Sun Ray enterprise server software. Sun Ray 1 enterprise appliances communicate over a simple, unmanaged interconnect and are not visible to the network, decreasing network complexity and associated administration costs. Maintenance is also simplified, as Sun Ray 1 enterprise appliances are completely stateless and interchangeable, contain no user-serviceable parts, and can be brought on-line without a complex installation or configuration process—by simply plugging them in. Furthermore, the Sun Ray 1 enterprise appliances will never need hardware upgrades, eliminating incremental costs, so that the total cost of the desktop is fixed over its lifetime.

Departmental Configuration

For departmental groups consisting of 100 to 1000 desktops, a large-scale Gigabit Ethernet/Fast Ethernet switched network is more suitable for the dedicated interconnect. In this configuration, a Sun Ray enterprise server with multiple Gigabit Ethernet cards connects to a set of 100BaseT switches, which in turn branch out to the Sun Ray 1 enterprise appliances (Figure 10). The 100BaseT switches must be able to perform layer-2 switching, and must include IGMP multicast snooping to reduce the flow of multicast traffic to unwanted ports.

As shown in Figure 10, a Sun Enterprise 4500 server equipped with seven Gigabit Ethernet ports can support up to 500 users. Each link from the server to the switch is 1 Gbps, while each link from the switch to the desktops is 100 Mbps. In this example, each Gigabit link carries the traffic for 72 desktops communicating at 100 Mbps, so there is a multiplexing factor of approximately one to seven. Given the typically bursty nature of communication, this configuration will deliver acceptable quality of service for most applications.

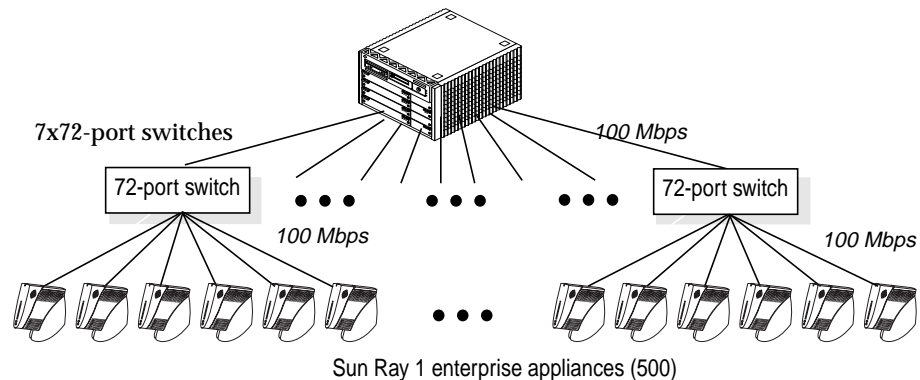


Figure 10 Larger, departmental configurations utilize a switched Gigabit Ethernet/Fast Ethernet interconnection fabric.

As with the workgroup configuration, the initial hardware purchase price is only one part of the total cost of ownership. Software costs and continuing administration and maintenance expenses typically account for an even larger part of the TCO of an enterprise desktop. Like the workgroup configuration, this configuration benefits from tremendous savings in software purchasing and licensing, and greatly reduced administration and maintenance costs as compared to traditional architectures. The result is a low-cost enterprise desktop that never needs upgrades.



Summary

Sun's highly innovative approach to desktop computing addresses the urgent business need of reducing costs without giving up functionality or performance. Sun's Sun Ray Hot Desk technology simplifies enterprise desktop management by centralizing it at a single location where it can be more easily and economically managed. Because they never require upgrades, and because they more efficiently share expensive resources, the Sun Ray enterprise system keeps the total cost of ownership lower than other desktop computing solutions — with no compromises in performance or functionality.

The Sun Ray 1 enterprise appliance is yet another important solution in a long line of innovative products from the leader in enterprise networking solutions. For over fifteen years, Sun has maintained a history of innovation in computing and networking technology. Today, IT managers adopting the Sun Ray enterprise system can capitalize on Sun's experience and expertise and gain a truly low-cost solution that delivers both high performance and full functionality, secure in the knowledge that they Sun Ray 1 enterprise appliance may well be the last desktop system they will ever buy.

For More Information

Sun Microsystems posts complete information on Sun's hardware and software products and service offerings in the form of data sheets, specifications, and white papers on its Internet Web page at <http://www.sun.com/>.





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