Sun Ray™ 1 Enterprise Appliance Deployment in the University, School, and Library

Customer Guidelines and Case Studies

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Table of Contents

Executive Summary

This document includes information intended to help plan and prepare to deploy Sun Ray™ 1 enterprise appliances in schools and libraries. It contains general information on the interconnection fabric, servers, applications, and smart cards — all useful during the planning phase. It also describes the experience gained while deploying Sun Ray 1 enterprise appliances at three sites in education and library markets. For each site, background information, customer motivation and requirements, detailed technical information on the Sun Ray 1 enterprise system solution, results, and future plans are discussed.

The installations described include:

- Electronic Information Network (EIN), a collaborative project by the Carnegie Library in Pittsburgh and other libraries in Pennsylvania, deployed approximately 200 Sun Ray 1 enterprise appliances. At the main library site, a Sun Enterprise™ 4500 server supports 84 enterprise appliances, while branch libraries are outfitted with Sun's Ultra™ 10 servers each driving up to 10 enterprise appliances. Library patrons use these enterprise appliances to browse the Web, access the library card catalog, and search external databases. EIN previously used fat-client PCs and struggled with support and cost issues. They looked to the Sun Ray 1 enterprise appliances to ease their support burden and lower overall costs. The initial deployment has gone smoothly, and EIN is satisfied with the performance, simplified support, and ease of use the enterprise appliance affords. They plan to add additional units to replace existing PCs, possibly replacing up to 80 percent of their population of nearly 1,500 desktops within the next 12 months.

- Carrollton City schools, a K-12 school district in Georgia, set up a successful pilot program in their elementary school. A Sun Enterprise 450 server currently supports 20 enterprise appliances, which are used by fifth-grade students to browse the Web, run StarOffice™ productivity applications, and access educational software. Smart cards provide secure access to the system and enable easy mobility between enterprise appliances in the school. Because Carrollton City's current PC equipment is relatively new, it is not economically feasible to replace all PCs with enterprise appliances at this time. However, they are impressed with the Sun Ray 1 enterprise appliance performance and easy administration, and foresee adding additional appliances and replacing older PCs over time.
- Danish Technical University (DTU), one of Northern Europe's largest technical universities, deployed 100 Sun Ray 1 enterprise appliances. DTU began looking at the enterprise appliances as a way to replace their aging mix of HP servers, workstations, and X-terminals with a new configuration that provided high performance for users, was reliable, supported open standards, and had greatly simplified administration. The enterprise appliances are serviced by a pair of Sun Enterprise 250 servers and a Sun Enterprise 6500 as a compute server. Users at DTU rely on these appliances to browse the Web, run mathematical and graphics applications, access data warehousing tools, and use office productivity applications. DTU is pleased with the very low maintenance costs and easy system administration, high performance and uptime, flexibility, and ability to interoperate well with other systems on the campus, and they plan to add as many as 180 additional units in the near future.

The experiences at EIN, Carrollton Schools, and DTU show how the Sun Ray 1 enterprise appliance can be successfully deployed in library and education markets. Potential users can learn from these case studies — addressing common issues such as proper sizing and configuration — to successfully implement Sun Ray 1 enterprise appliance installations at their site.

Introduction 1

This paper contains general information on the Sun Ray 1 enterprise appliance, discusses planning considerations and guidelines, and describes the experiences gained deploying Sun Ray 1 enterprise appliances at three different sites in library and education markets. The intention is to provide potential users guidance in planning and deploying Sun Ray 1 enterprise appliances at their own sites.

The sites described in this paper include:

- *Electronic Information Network (EIN)*, a collaborative project by the Carnegie Library in Pittsburgh and other libraries in the surrounding region of Pennsylvania, deployed 200 Sun Ray 1 enterprise appliances in their main library and several branch libraries.
- *Carrollton City schools*, a K-12 school district in Georgia, set up a successful pilot program in their elementary school.
- *Danish Technical University (DTU)*, one of Northern Europe's largest technical universities, deployed 100 enterprise appliances in computer labs and classrooms in their mathematics department.

This paper is based on interviews conducted at the sites as well as through telephone and email. Their IT staff were interviewed to gain their perspective on the deployment of the Sun Ray 1 enterprise appliances, their results, and any future plans. Where possible, end users were also asked to share their experiences working with the enterprise appliances.

Product Description

Sun Ray 1 enterprise appliances are simple, low-cost devices that require no desktop administration. They are centrally managed by, and draw their computing resources from, Sun's powerful server line. Underlying this architecture is Sun's Hot Desk technology, which enables users to instantly access their session from any Sun Ray 1 enterprise appliance in the workgroup.

With the Sun Ray 1 enterprise appliance, users can run the Solaris™ Operating Environment and other UNIX® applications as well as Microsoft Windows NT applications from a single, integrated desktop environment. With properly configured Sun Ray 1 enterprise servers, appliance users should experience a high level of interactive responsiveness and performance, in line with that available from powerful UNIX workstations.

Three components comprise the Sun Ray 1 enterprise system: (1) the enterprise appliance, (2) a Sun™ server running the Solaris Operating Environment and the Sun Ray 1 enterprise server software, and (3) a dedicated interconnect (see Figure 1). All processing occurs on a central server, with the desktop appliance used only for input and output. A dedicated interconnect is used to provide the bandwidth needed for acceptable quality of service.

For a more detailed product description, please refer to the *Sun Ray 1 Enterprise Appliance Overview and Technical Brief*.

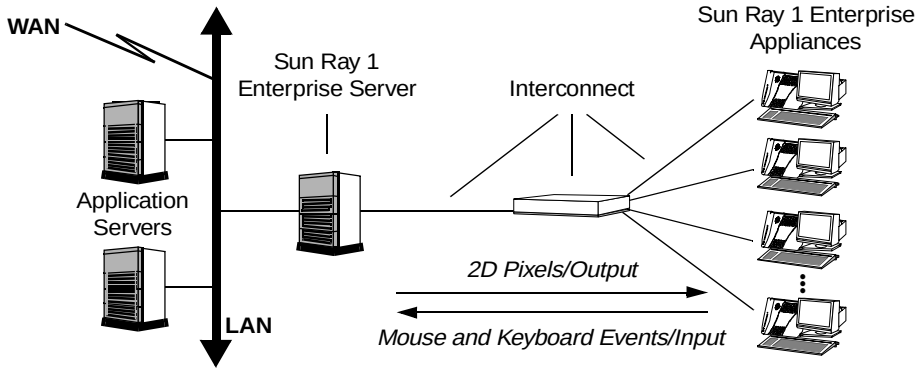

Figure 1 The enterprise appliance, a Sun server, and a dedicated interconnect are the three components that comprise the Sun Ray 1 enterprise system.

Key Benefits for Education and Library Markets

Schools and libraries share many characteristics, including distributed desktops in classrooms and labs, a need for security, easy access for multiple users, and requirements for reliable and low-cost desktops. Most sites also face the challenge of maintaining a growing number of PCs spread across one or more locations.

The Sun Ray 1 enterprise appliances are an ideal match for many school and library sites, providing numerous benefits for administrators and end users. The enterprise appliance is a reliable and easy-to-use desktop, and for K-12 sites this means teachers can focus on their students and not be distracted by common PC problems. User's can't accidentally — or intentionally — introduce a virus, change the configuration, or otherwise damage the desktop as they can with PC clients. System administrators gain increased security and greater control over the user environment, because storage and applications remain centralized. Users can easily and securely share desktops — nothing is stored locally on the individual appliances, so there is no danger of changing someone else's environment or corrupting another's files.

The Sun Ray 1 enterprise appliances also deliver Sun's innovative Hot Desk technology, which enables users to instantly access their own personal desktop and work-in-progress from anywhere in the workgroup. Smart cards, similar in size to a credit card, can be used to provide secure access to the system and enable easy mobility. Users can withdraw their smart card to stop mid-sentence in an application, and then continue where they left off by simply re-inserting the smart card into any unit in the same workgroup. This functionality is especially attractive to K-12 schools and higher education sites, as it allows students to easily and conveniently continue their work on any available station in the workgroup. Libraries are also interested in the potential uses of smart cards, and are considering them as replacements for traditional library cards.

Higher education markets benefit from the flexibility of accessing multiple applications and environments from a single desktop. The Sun Ray 1 enterprise appliance's support for open standards allows it to easily integrate into diverse, heterogeneous network environments. Users also benefit from the inherent performance and reliability of powerful Sun servers, and they enjoy a more comfortable work environment with the Sun Ray 1 appliance's fanless, noise-free enclosure and sharp, 24-bit color images.

Virtually all library and education sites are concerned about expenses, and the Sun Ray 1 enterprise appliance is an attractive solution with a total cost of ownership that should prove far lower than conventional PC desktops. Support costs are dramatically reduced because the Sun Ray 1 enterprise appliance requires zero administration. The long term cost of ownership is further enhanced as the desktop appliance, which comes with a five-year warranty, never requires upgrades. All configuration is performed on a centralized server, simplifying administration and eliminating the need to physically configure each unit. Software upgrades are streamlined, with updates performed on the server and automatically made available to all desktops. Dealing with failed units is also easier, as replacement units require no configuration and are simply plugged in.

Trends and Technologies

Recent trends in the industry are creating new opportunities for a low-cost, low-maintenance desktop like the Sun Ray 1 enterprise appliance. For example, the education industry is starting to move towards a service provider model, driven by demands for low-cost, simplified access to customized educational content and applications. The SchoolTone Alliance Program, a joint effort by Sun and leading K-12 service providers and portal companies, is working to create high-quality portals that provide affordable and easy-to-access Internet content, communication tools, and applications targeting K-12 schools. By adopting a service provider model — and paying transaction or monthly usage fees instead of purchasing, upgrading, and maintaining software — schools have the potential to save millions in licensing and administration fees. The Sun Ray 1 enterprise appliances fits well in this scenario, giving schools a low-cost desktop that is easy to install, maintain, and use. The combination of the enterprise appliance and the service provider model can help schools save money and eliminate the heavy burden of supporting PCs for IT staff and teachers.

New technologies are also driving dramatic changes in higher education. Digital libraries, distributed learning, virtual classrooms, multimedia — these technologies have led to significantly increased expectations from the worldwide education community. Students expect Web-based registration, online digital library privileges, smart cards, and a host of services delivered over the network. And university administrators need cost-effective ways to manage student records, human resources, financial data, and physical facilities. With ever-shrinking budgets and growing demands on their

computing infrastructure, administrators require a flexible, affordable environment that extends their programs and services for their students. And the Sun Ray 1 enterprise appliance, with its high-performance and low-cost, is the perfect fit for these needs.

Similarly, library patrons are increasingly sophisticated, demand quick access to library database searches, and require fast and easy access to the Internet. Libraries must offer new services to continue to meet the needs of their patrons. Like many schools and higher universities, libraries generally face limited budgets to implement their computing infrastructure and can also benefit from the low-cost, easy-to-use Sun Ray 1 enterprise appliance.

Planning Considerations and Guidelines 2

Careful planning is important for any IT investment. Required functionality, present and future goals, and training and support needs should all be considered. Planning helps ensure that a site realizes the functionality and performance they require, and designs an infrastructure that can grow as needs change.

This chapter contains information on the interconnection fabric, Sun Ray 1 enterprise servers, software applications, and smart cards. These topics were relevant to the three sites interviewed for this paper, and will typically be of interest to others in library and education markets.

Interconnection Fabric

The Sun Ray 1 enterprise appliance relies on a dedicated interconnect to provide low latency and quality of service on a consistent basis. Requiring a dedicated interconnect simplifies installation and deployment since installation scripts and Sun Ray 1 enterprise server software take over the task of address management. Administrators assign network addresses to only servers; addresses are automatically and transparently assigned to each desktop. Automatic address management is a significant benefit to school and library administrators, as the number of IP addresses that must be assigned and managed to support a workgroup of Sun Ray 1 enterprise appliances is drastically lower than with individual networked PCs or workstations.

Commodity Ethernet networking equipment is used for the dedicated interconnect, keeping costs low. Switches used for the private interconnect must meet certain qualifications in auto-negotiation, internal bandwidth, buffering and latency. Hubs are not recommended because individual ports share the total bandwidth, and so may not provide adequate performance for each enterprise appliance.

Most well-behaved modern switches work within the Sun Ray 1 enterprise system environment. To see if a particular model of switch has been tested, check the following Web site:

`http://www.sun.com/io_technologies/sunray/network/index.html`

Bandwidth Requirements

Because the interconnection fabric is a shared resource, it must be designed to absorb peak traffic patterns so that users don't adversely affect one another. Sufficient bandwidth must exist at a number of essential points within the interconnection framework, as illustrated in Figure 2.

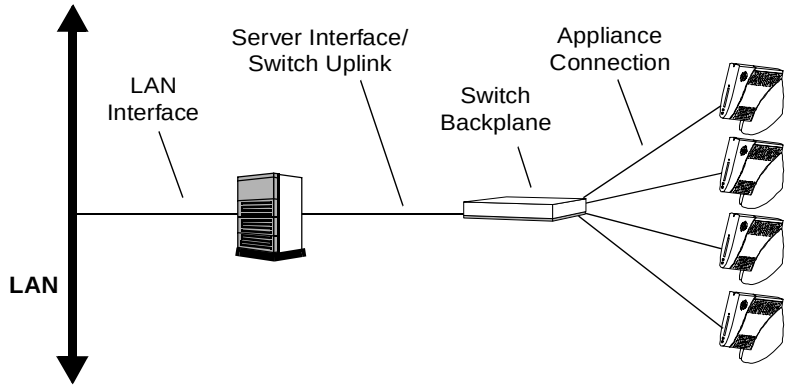

Figure 2 Potential choke-points for interconnect bandwidth

- *Appliance Connection*
  Configuring appropriate interconnect bandwidth starts with an assessment of both application requirements and usage patterns for appliance users. Connections to appliances must be consistent with expected peak usage patterns.

Interconnect traffic to a given appliance is primarily a function of the number of pixels being updated to the screen — a user displaying dynamic video has very different requirements than a user performing data entry. Display of digital video consumes more bandwidth than most applications (up to 30 Mbps depending on the nature of the video) since it requires a relatively large number of pixel updates. Most applications have interconnect bandwidth requirements which are considerably lower.

The Sun Ray 1 enterprise appliance supports both 10 Mbps and 100 Mbps operation. Though 10 Mbps switches can be used for small workgroup deployments with low-bandwidth needs, 100 Mbps switches are recommended as they provide room for growth at a very low additional cost.

- *Switch Backplane*

  Switches must provide adequate internal bandwidth to support the aggregate needs of the ports they provide. For example, a switch with four Gigabit Ethernet ports and an internal backplane which runs at only 1.2 Gigabits per second will not scale to serve the capacity advertised by its ports.

- *Server Interface/Switch Uplink*

  Sufficient bandwidth must be configured in both server interconnect interfaces and switch uplink connections to support the aggregate bandwidth of the attached appliances under peak load conditions. For example, if a school has a large number of appliances or has applications requiring high levels of bandwidth, one or more Gigabit links between the server and the switches can help ensure adequate bandwidth. Conversely, sites with only a few appliances and low bandwidth applications may require only a 100 Mbit connection for the server uplink. As more appliances or downstream switches are added, or as applications or usage patterns change, server uplink requirements may need to be reevaluated.

- *LAN Interface*

  It is important to understand an application's LAN usage profile in addition to the impact the application places on the dedicated interconnect. Administrators must confirm that sufficient bandwidth exists on the external local area network to support the peak loads of any applications that will use the LAN.

Topologies

Determining the appropriate Sun Ray 1 enterprise appliance topology is a function of simultaneous usage patterns and applications used by the workgroup, as well as the total number of expected appliances. Several possibilities exist for designing the interconnection fabric.

- *Direct Wired*

  Small workgroups can be supported by directly connecting the enterprise appliances to a server equipped with multiple Ethernet or Fast Ethernet ports. For example, a small branch library requiring only eight appliances could be supported by a server configured with two Sun Quad FastEthernet™ cards and UTP crossover cables. This topology eliminates the cost of network components (switches) completely, but is ultimately limited by the number of network interfaces that can be deployed on a single enterprise server.

- *Switched*

  For most sites, switched topologies are preferred for their scalability and flexibility. Switched topologies can allow entire buildings and even groups of buildings to participate as a single Hot Desk workgroup. For example, if a school is configured in this manner, students have instant access to their desktop environment by inserting a smart card in any appliance connected to the same server.

  Sites with existing networks running on Cat-5 wiring can typically reuse their wiring infrastructure for an easy migration to the private interconnect required by the Sun Ray 1 enterprise system. As an example, consider a hypothetical site whose current LAN is implemented using Ethernet hubs and Cat-5 wiring to each workstation. A private interconnect can be implemented by replacing the Ethernet hubs with switches and connecting the enterprise appliances to the existing Cat-5 connections.

  For more detailed information on designing switched topologies, including considerations on nesting versus cascading multiple switches, refer to the white paper, *Deploying the Sun Ray 1 Hot Desk Architecture.*

Virtual Networks

Virtual local area networks (VLANs) are not officially supported for use as the dedicated interconnect. VLANs are implemented by various switch vendors and work by appearing to provide multiple separate networks across the switch backplane. Unfortunately VLANs generally imply a sharing of backplane bandwidth with other “networks” and are not a true dedicated interconnect. Because enterprise appliances would not be on an isolated and private interconnect, traffic on other VLANs could adversely affect the bandwidth and latency of the switch, resulting in degraded performance for users.

Sun Ray 1 Enterprise Servers

Application performance in a Sun Ray 1 enterprise system environment is directly dependent on the servers that provide computational resources. Sun Enterprise servers provide scalable, symmetric multiprocessing capabilities, and lead the industry in offering some of the most powerful and reliable systems available today. From one to 64 high-performance UltraSPARC™ processors can be configured along with up to 64 GB of physical memory and up to 20 TB of disk storage, providing the necessary performance for peak demands as well as virtually unlimited growth.

The power of Sun’s servers is further enhanced by the Solaris Operating Environment. Solaris features full 64-bit processing, mainframe-class reliability, superior scalability, and unprecedented performance. Solaris has significant functionality that enhances multi-user environments, and is the foundation of the Sun Ray 1 enterprise system.

Dedicated or Shared Servers

Sun Ray 1 enterprise servers need not be dedicated to serving enterprise appliances and can be used for other purposes if capacity allows. For example, a server running Sun Ray 1 enterprise server software might also provide database services or act as a Web server. This may be particularly useful at smaller sites, eliminating the need to purchase and maintain a second server and providing a cost-effective total solution.

Whether the Sun Ray 1 enterprise server is dedicated to serving enterprise appliances or is shared with other applications, responsiveness and interactivity for the appliances is directly dependent on having sufficient resources. Servers should be sized carefully to avoid degrading interactive performance for desktop appliance users. As a general rule, computationally-intensive tasks should not be run on the Sun Ray 1 enterprise server unless it has been specifically configured for that purpose.

Sizing Sun Ray 1 Enterprise Servers

Sun Ray 1 enterprise servers provide the computational resources for the attached desktop appliances. They must be configured correctly with sufficient CPU and memory resources to ensure a high level of interactivity and satisfy the needs of the end users. Minimal configurations should be avoided since interactivity can suffer as soon as initial demands are exceeded. Maximal configurations can result in lower levels of resource utilization and a higher per-seat cost.

Initially, server configurations should be sized to exceed the minimum needs of the workgroup and allow for anticipated growth for one or two years. Needs for additional appliances should be forecast along with potential requirements for new applications — particularly applications that are computationally-intensive or require greater amounts of network bandwidth.

Some schools and libraries may prefer to start with a small initial deployment of enterprise appliances, trying the new technology and gradually replacing their existing desktops. The Sun Ray 1 enterprise system architecture and Sun's scalable line of servers make this a feasible and attractive model. Sites can add appliances and easily scale the performance of their servers by adding additional CPUs or more memory. Network bandwidth can also be increased by adding additional switches or utilizing additional Ethernet interfaces on the server.

Refer to the Sun white paper *Sizing Sun Ray 1 Enterprise Server* for detailed information on correctly sizing servers. The white paper *Assessing Scalability of the Sun Ray 1 Enterprise Appliance* contains additional information on scalability.

Reliability and Configuring for Resiliency

Reliability is an important issue for school and library environments. Mission-critical applications are typically associated with large corporations and applications such as on-line banking. But, to a teacher, the classroom is also a mission-critical environment. Teachers have classes at regularly-scheduled times. To use technology in the classroom, teachers must have confidence that it's going to work when they need it. Libraries face similar reliability concerns, and require desktop appliances that they can count on to provide services to their patrons.

The Sun Ray 1 enterprise appliance is stateless and has no moving parts, which contributes to making it a reliable device. Should a failure occur, users with smart cards can move to another appliance, with no interruption in their work. A hardware failure in an appliance is easily remedied by plugging in a new appliance.

Because all of the enterprise appliances in a workgroup depend on a single server, its availability is critical. Sun servers provide high levels of reliability, and include features such as redundant power supplies and the ability to configure around a failed component upon re-boot. Servers can be configured with extra processors or memory to allow it to continue operation at an expected level of service until a failed component can be replaced.

Application Environment Considerations

The Sun Ray 1 enterprise system provides application support for both the Solaris Operating Environment and UNIX along with optional access to Windows NT applications. Most existing multi-user applications are able to run without modification.

- *Multimedia Applications*

  Whether viewing a Web-based news broadcast, listening to a recorded speech, or using educational software, multimedia capabilities have become a basic requirement for desktop computing environments in library and education markets. The Sun Ray 1 enterprise appliance tightly integrates audio and video support, enabling most multimedia applications to run with little or no modification.

Sun Ray 1 enterprise appliances provide good performance for video playback, as long as the server is configured correctly to meet the demands of the environment. Multimedia applications usually involve computationally-intensive operations like software decompression of video. Adequate CPU processing power must be provided if multiple video sessions are running concurrently. Because video playback can be very CPU and bandwidth intensive, one can easily overtax the server if it has inadequate processing power.

For more information on sizing Sun Ray 1 enterprise servers for multimedia, refer to the *Digital Media on the Sun Ray 1 Enterprise Appliance* technical Whitepaper.

- *Microsoft Windows NT Support*

  The Sun Ray 1 enterprise system supports the display of applications running on Windows NT servers with the addition of MetaFrame software from Citrix Systems.The Citrix MetaFrame™ software is installed on the Windows NT servers, and the corresponding Citrix ICA client software is installed on a Sun Ray 1 enterprise server. The Windows NT server can redirect output from Windows applications to Citrix clients running on the Sun system, which are then displayed on the enterprise appliance.

  Although Windows NT applications are supported, the Sun Ray 1 enterprise system is not intended for sites where these applications are the primary requirement. Scalability issues with the Citrix software can result in degraded performance when large numbers of Windows NT applications are running simultaneously.

  As an example, an engineering department that primarily runs Solaris applications and occasionally needs to access a Microsoft Windows productivity tool like Excel or PowerPoint is a good candidate for the Sun Ray 1 enterprise system. A large secretarial pool running only Microsoft Windows NT applications is not a good candidate, because the Citrix software does not scale well.

- *2D and 3D Applications*

  Both 2D and 3D applications run in the Sun Ray 1 enterprise system. However, since 3D applications display to a 2D virtual frame buffer on the Sun Ray 1 enterprise server, their performance is limited to that provided by software rendering. Because the server CPU is used as the computational

resource, servers must be sized appropriately. This is most likely a concern for higher education markets that may need to run 3D modeling and graphics applications.

- *Other Application Considerations*

  Hot Desk technology changes nothing in the way that applications are executed, and most well-behaved applications run without modification. However, by virtue of its shared-resource architecture, the Sun Ray 1 architecture can expose less well-behaved applications that might have gone unnoticed in a single-user environment. In particular, applications that make assumptions about available hardware resources or assume a single-user computing environment may fail to run in a Hot Desk environment. For example, applications which use the IP address to identify a user (a practice common in conferencing applications), assume exclusive file access to generically-named files, or that “hardwire” the X11 display variable, will not work correctly.

Smart Cards

Smart cards enable users to move quickly and easily between Sun Ray 1 enterprise appliances. If a user starts a Sun Ray 1 enterprise appliance session with a smart card, they can remove it and re-insert it into any other enterprise appliance connected to the same Sun Ray 1 enterprise server. The active session “follows” the user, providing instantaneous access to the user’s environment, including all open applications and work-in-progress. Education sites appreciate this easy mobility and instant access that smart cards provide to students. Students working on a project don’t need to save everything when the bell rings, and they can quickly resume work right where they left by re-inserting their card in any appliance in the same workgroup.

Each Sun Ray 1 enterprise appliance contains an ISO-7816 compliant smart card reader. Smart cards are optional, however, and are not shipped with the Sun Ray 1 enterprise appliance. If a site prefers not to use smart cards, users can login from the keyboard to start a session, but they forfeit the instant access and easy mobility between appliances that smart cards afford.

Smart cards are similar in size to a credit card. But unlike credit cards, which contain magnetic stripes, they have integrated circuitry to identify users. Schools and libraries presently using identification cards won’t necessarily

need to choose between smart cards and their current cards. Smart cards can be manufactured as hybrid cards — with bar codes and magnetic stripes — so they can co-exist with current magnetic stripe readers.

For more detailed information, refer to the white paper *Using Smart Cards With the Sun Ray 1 Enterprise Appliance*, available on Sun's Web site.

Ordering and Customizing Smart Cards

Smart cards are purchased separately; they are not included with the Sun Ray 1 enterprise system. The first release of the Sun Ray 1 enterprise appliance supports the Schlumberger MicroPayflex smart card, which can be purchased directly from Sun Microsystems or from Schlumberger Limited.

Users and ISVs can order smart cards through the Solaris Ready program. Cards bearing Sun artwork may be ordered through SunStore℠ — Sun's electronic storefront (`http://sunstore.sun.com`). Sites that require customization or want to order large numbers of cards can do so directly from Schlumberger. Cards ordered from this supplier can be plain or customized with logos and photographs.

Case Study: EIN 3

The Electronic Information Network (EIN), a collaborative project by the Carnegie Library in Pittsburgh and other libraries in Pennsylvania, deployed approximately 200 Sun Ray 1 enterprise appliances. Library patrons use these enterprise appliances to browse the Web, access the library card catalog, and search external databases.

EIN previously used fat-client PCs and struggled with support and cost issues. They looked to the Sun Ray 1 enterprise appliances to ease their support burden and lower overall costs. The initial deployment has gone smoothly, and EIN is satisfied with the performance, simplified support, and ease of use. They plan to add additional units to replace existing PCs, possibly replacing up to 80 percent of their population of nearly 1,500 desktops within the next 12 months.

Background Information

EIN is a collaborative project of the Allegheny County Library Association, Carnegie Library of Pittsburgh, and the Commission on the Future of Libraries in Allegheny County. Their mission is to use advanced technology to supply information access to public libraries, schools, and museums throughout the region in Pennsylvania.

By linking the libraries of Allegheny County, EIN aids both residents and member libraries. Residents benefit by receiving equal access to the most up-to-date information for their education, employment, enjoyment, and health. Libraries derive benefit from EIN's collaborative efforts, gaining cost-effective

access to electronic tools that enhance planning, management, communication and resource building. EIN's future plans to create a seamless information highway between schools and libraries will benefit students by removing barriers that prevent them from linking their activities between institutions.

Over 70 member libraries are networked by EIN's system. Each member institution provides publicly-accessible computer stations that allow patrons to peruse the library card catalog, search external databases, and browse the World Wide Web. Currently, both Sun Ray 1 enterprise appliances and "fat-client" personal computers are used to run the Netscape Navigator™ program and provide the user interface to search applications running on a centralized server.

Support and Cost Issues

Before adopting the Sun Ray 1 enterprise appliances, EIN was exclusively a PC shop, and administration and support problems plagued EIN's distributed, PC-based architecture. Bob Namestka, Chief Technology Officer of EIN, explains, "We have a relatively small support staff, and we were spending an inordinate amount of time repairing PCs and reloading disk drives. We just had to find a better way to give the public libraries the capability that they needed on the desktop without the support nightmare that we were going through."

EIN struggled with PC desktop failures, especially at remote sites. Elbie Yaworsky, Director of EIN, discusses the extent of the problem, "EIN had at least 2% of its desktops in repair every week. And for a thousand plus desktops, that's just an enormous workload." The limited technical expertise at the remote sites compounded the problem. For each failure, a member of the technical staff had to drive out to the site to pick up the PC, return to a central lab to perform repairs or reload software, and then deliver the PC back to the site. Turnaround time was measured in days or weeks. Software upgrades presented similar challenges, requiring someone to physically visit each site when new features or functions were added.

Yaworsky explains the negative effect on his organization, "We were so overwhelmed with the repairs at the desktop that we had a hard time focusing on new solutions."

EIN began considering alternatives to fat-client PCs as a way to ease their support burden and lower overall costs. Namestka summarizes their thinking, “First and foremost, we had to figure out how to lower our total cost of support, and ultimately ownership of the desktops. We had to find new ways for libraries to acquire additional seats for lower cost, and we wanted to have zero administration on the desktop so that we could use our limited staff proactively, as opposed to always having to put out fires.” He continues, “Integral to the total cost of ownership is not just the initial purchase price but the ongoing support and maintenance that’s required of those devices. We were spending an inordinate amount of time supporting traditional desktop platforms.”

After deciding to look for alternatives to their distributed fat-client architecture, EIN investigated the available options. Namestka explains, “We took a look at some of the so-called thin clients from Microsoft and their supporting vendors. And we found out that the way they do their software licensing on those devices didn’t lend itself to the kind of cost of ownership model that we were after.”

About this time, Sun offered EIN an opportunity to participate in an early-access project with the Sun Ray 1 enterprise appliance.

Sun Ray 1 Enterprise Appliance Solution

EIN began deploying its first Sun Ray 1 enterprise appliances in August 1999 at its central site, the Carnegie Library of Pittsburgh. Currently, they have deployed close to 200 enterprise appliances at this main site and at multiple branch libraries. The Sun Ray 1 enterprise appliances sit side-by-side with the personal computers, and patrons have the choice of either desktop. Library patrons retain all the same functionality — they can browse the Web, access the library card catalog, and search external databases from either platform.

At the main Carnegie Library site, a Sun Enterprise 4500 with six 400 MHz UltraSPARC processors and six gigabytes of memory currently supports 84 Sun Ray 1 enterprise appliances (see Figure 3). Four 4-GB internal disk drives and a Sun StorEdge™ D1000 disk array with four 9-GB drives provide disk storage. The Sun StorEdge Volume Manager™ system is used to implement striping and mirroring for increased I/O throughput and improved availability. Switched 100 Mbit Ethernet is delivered to each desktop appliance, while the

server utilizes a Gigabit Ethernet connection. In addition to serving the enterprise appliances, the Sun Enterprise 4500 server handles user authentication and is also a Web server for EIN.

PCs, Windows NT servers, a DEC VAX server, and a pair of DEC Alpha 8400 servers are also located at this main site. The PCs provide the same functionality as the enterprise appliances: Web browsing and access to library applications. The Windows NT servers run Cyber Patrol Web filtering software, provide network services to the PC clients, and are used as DNS, proxy, Web, SQL, print and application servers. The DEC VAX is currently used as the site's mail server. The pair of DEC Alpha 8400s run the DRA classic application that is used by patrons to search library databases.

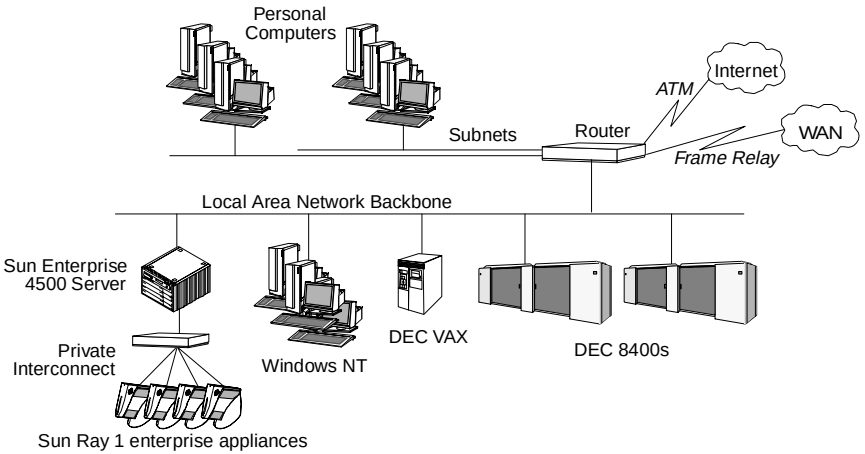

Figure 3 Logical network architecture — main Carnegie Library site.

At branch libraries, Sun's Ultra 10 servers drive up to 10 enterprise appliances (see Figure 4). Library patrons use these appliances to browse the Web and access the library search applications and the proprietary database running on

the Dec Alpha 8400s physically housed in the main library site. A Frame Relay wide area network (WAN) connects the 70 branch libraries in the county with the main Carnegie Library site.

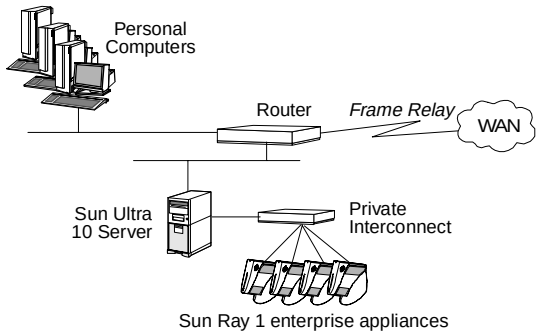

Figure 4 Logical network architecture — branch library sites.

Network Configuration Details

At the Carnegie Library, two Cisco routers and multiple switches implement the local area network and provide connectivity to the Internet and EIN's WAN (see Figure 5). A Cisco 7206 router acts as a firewall and provides access to the Internet over a 10 Mbit ATM connection, while a Cisco 7505 router connects to the 70-location EIN wide area network via a 45 Mbit Frame Relay link. A Cisco Catalyst 5500 switch maintains Gigabit connections to multiple Cisco 3500-series switches and supplies 13 virtual local area networks (VLANs) throughout the Carnegie Library site. One VLAN is reserved for the exclusive use of the Sun Enterprise 4500 server and the Sun Ray 1 enterprise appliances as their private interconnect.

The Sun Enterprise 4500 server is situated on two networks — the local area backbone and the private interconnect with the enterprise appliances — and therefore requires two Ethernet connections, both of which are Gigabit links in this configuration, to supply adequate bandwidth. Each Sun Ray 1 enterprise appliance connects to the private VLAN through a Cisco 3500-series switch

with a 100 Mbit connection. PCs also connect to the Cisco 3500-series switches with 100 Mbit connections, but use a separate VLAN from the enterprise appliances.

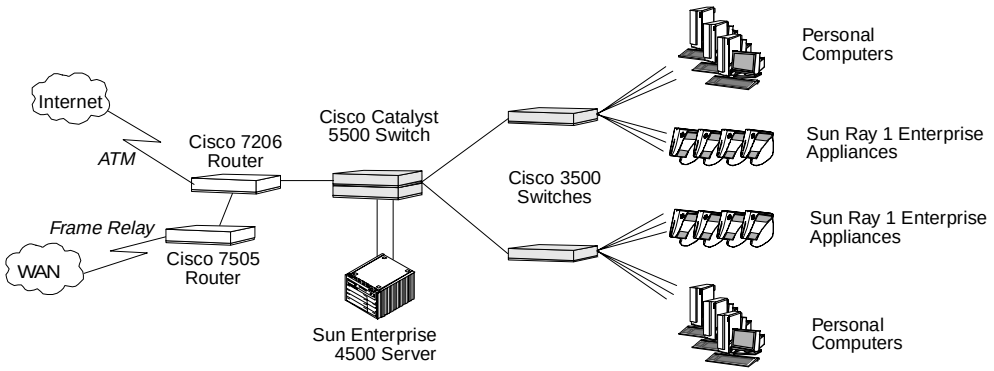

Figure 5 Network configuration detail — main library site

Although VLANs are not an officially supported configuration, EIN had the equipment and the networking expertise in-house and decided to deploy their private interconnect using this technology. Sites choosing to use VLANS must be aware that Sun cannot guarantee the performance of this configuration, and does not support its use with Sun Ray 1 enterprise appliances.

Implementation

EIN experienced a relatively smooth deployment of the Sun Ray 1 enterprise appliances, with only a few minor implementation issues. During the early days of the installation, EIN experienced some problems with Sun Ray 1 enterprise appliances occasionally freezing and having to be reset by an administrator. This problem was traced to users starting too many Web browsing sessions and not closing them down when finished. Unfortunately, this type of user behavior can be expected in an environment where library patron experience and expertise varies greatly, and must be handled cleanly. A patch was delivered which solved the problem, and this problem has not resurfaced.

Reliability and availability haven't been a problem for EIN, but they are a major concern. Keeping the enterprise appliances available for library patron use is high priority, particularly as increased numbers of appliances are

deployed throughout the libraries. As a result, EIN is currently investigating high availability options and configuration alternatives that add redundancy and resiliency to the Sun Ray 1 enterprise system as a whole.

Results

Library patrons demand the quick display of information, and EIN is pleased with the performance they see. Yaworsky states, “The performance has been a great surprise. The Sun Ray 1 enterprise appliance outperforms the existing PCs we have within our network.” Yaworsky then adds that customer use is a sure sign of success. “Within days, customers find out which performs better, and they move to the better performing device. The customer load has definitely shifted to the Sun Ray 1 enterprise appliance.”

According to Namestka, the deployment has gone smoothly, and the Sun Ray 1 enterprise appliances have fulfilled their promise of support and functionality. As Namestka puts it, “the Sun Ray 1 enterprise appliances have released us from the administrative nightmare that we’ve experienced with traditional desktop computing.” He adds words of praise for Sun’s role in the pilot program, “Sun has been very responsive to our needs in terms of delivery, support, help, answering questions. No matter what it is, we can pick up the phone and get an answer.”

Andrea Clarkson, Help Desk Manager at EIN, is also pleased with the simplified support and ease of use the Sun Ray 1 enterprise appliance provides. She sums up her experience with the Sun Ray 1 enterprise appliances, “They’re much easier to maintain, and they’re much faster, too. It’s been an easy transition for the patrons, with very little training needed. Overall, the enterprise appliances are a much more solid piece of machinery, and that’s definitely improving our work flow.”

Future Plans

EIN has an ambitious vision for the future, and the Sun Ray 1 enterprise appliance is key to their plans. The ability to manage significantly fewer devices — namely only the servers — is an enabling architecture that allows EIN to realize their vision of delivering information to all libraries and schools in a cost-effective, manageable fashion. Once removed from the burden of PC administration, EIN’s staff can concentrate on providing information access and other new opportunities to library patrons and students.

Short-term goals include adding Sun Ray 1 enterprise appliances to the central library site and deploying appliances at additional branch libraries. According to Namestka, EIN could replace up to 80 percent of their population of nearly 1,500 desktops with Sun Ray 1 enterprise appliances within the next 12 months. They are also interested in replacing library cards with smart cards, allowing libraries to offer new types of premium services to patrons, perhaps printing and faxing or running StarOffice productivity applications. They view the high-performance Sun Ray 1 enterprise appliance as ideal for delivering new high-end digital library solutions to customers.

EIN also plans further expansion into the K-12 schools in the surrounding region. The applied research and development group at EIN is developing new applications using Java™ technology, and one project is currently in a pilot program at a local K-12 school. This project implements an information portal for students, providing easy access to the information they need. With the Sun Ray 1 enterprise appliances and technology developed by EIN, students will be able to start work on a desktop appliance at school, bundle up the files they are currently using, and later continue their work on an appliance in any one of the regional libraries. Another way that Sun is helping EIN make good on their vision of integrating schools and libraries.

EIN is back on track with their mission of connecting libraries and schools with a seamless information highway, and Yaworsky is clear on their direction, “The Sun Ray 1 enterprise appliance will be our device of choice for the future.”

Case Study: Carrollton City Schools 4

Carrollton City schools, a K-12 school district in Georgia, set up a successful pilot program in their elementary school. A Sun Enterprise 450 server currently supports 20 enterprise appliances, which are used to browse the Web, run StarOffice productivity applications, and access educational software. The success of the pilot program has raised interest in deploying additional units in the school district. Carrollton City school administrators are impressed with the Sun Ray 1 enterprise appliance performance and easy administration, and foresee adding additional appliances and replacing older PCs over time.

Background Information

Just 35 miles from Atlanta, the Carrollton City schools are part of a progressive district strongly committed to providing quality education. Instructional technology — the use of technology to provide or enhance education — has long been a key part of their program. Today, Carrollton teachers employ instructional technology across the entire curriculum and across all grade levels as they seek to prepare students for an increasingly sophisticated and demanding world.

The district has recognized that the Internet and World Wide Web provide a wealth of educational opportunities for their students. The Web is ideal for student and teacher research, and also provides access to tools and applications which can be integrated into classroom learning experiences or used for supplemental activities. The Internet also facilitates fast and easy communication across the country and around the world, enabling students to

communicate in ways unimaginable just a few years ago. Finally, Web-based applications provide students with a common interface, expanding the opportunities for instruction from the school directly into their homes.

Dr. O.P. Cooper, Assistant Superintendent for Technology in the Carrollton City School District, sums up their philosophy, “Instructional technology is vitally important to us in Carrollton City schools, has been in the past, and we know it’s going to be increasingly important in future years.” Looking ahead, Cooper expands on his continuing commitment, “We’re always looking for new things that will enhance what our students do in the classroom. We believe it’s very important in the coming years to move our computing to a Web-based environment.”

Current Implementation

The Carrollton City school district includes three schools, all located on one 250-acre campus. A fiber-optic network connects the schools and enables communication among the more than 1,200 PCs in classrooms, library media centers, and computer labs. The PCs are all still relatively new, so there are no plans to immediately replace them. Dr. Cooper anticipates that for financial reasons they will remain in use for at least 2 more years. Even though the PCs were delivering the needed functionality, he wanted to actively investigate other solutions that were lower cost and easier to administer.

The PCs, scattered across the large campus, are a great resource but raise many support concerns. Like many school districts, Carrollton City has limited resources for technical support. Routine tasks such as installing or upgrading computers and software require administrators to physically visit each system, taking up valuable time of the technical specialists and limiting their effectiveness.

Dr. Cooper feels fortunate that his support resources in terms of personnel are superior to many K-12 schools, where teachers are often needed to perform administrative tasks on classroom PCs. As Cooper explains, “It’s very important for us to remove the classroom teacher as much as possible from the day-to-day administration of a network or maintaining PCs. We want the teacher to concentrate on helping the students to be better with math and reading and social studies and science. If they’re worrying about the PCs, it’s taking away from their effectiveness in the classroom.”

For Carrollton City, having computers that are easy to use helps teachers integrate the technology into their curriculum. Having computers that are easy to administer enables their technical specialists to accomplish far more for the teachers and students.

Low-Cost Desktops Seen as the Answer

As Carrollton City schools looked to the future, they needed a solution that would address their support concerns, keep total cost of ownership under control, and grow with them. They began considering alternatives to fat-client PCs to address these issues and enable them to move toward their vision of a Web-based environment.

Cooper explained their thinking, “We were faced with a situation where we had a lot of legacy equipment. We were trying to decide whether to continue using it or invest in new equipment. At that point, we looked very strongly at a thin client solution based on Citrix and Windows NT servers. When we looked at the costs and the resources we would have to provide to make it work like we wanted, it wasn’t going to be cost-effective.” He adds, “We just weren’t that comfortable with the big server farm that was needed given the scalability and reliability issues with NT.”

Sun’s proven performance and reliability prompted Carrollton City schools to turn to Sun for their next generation desktop solution. Cooper explains, “In Carrollton City schools, we’ve used Sun products for a number of years to run our Web server, mail server, DNS, and Internet applications, and we’ve been very pleased with the reliability and the stability of those products.” He adds, “We like the Sun platform because the throughput is very strong and the machines are extremely reliable.”

Sun Ray 1 Enterprise Appliance Pilot Program

The Carrollton City school district has recently begun a pilot program with the Sun Ray 1 enterprise appliance in their elementary school. A Sun Enterprise 450 server currently serves 20 desktop appliances. Four enterprise appliances are located in the library media center, and four classrooms contain the remaining 16 appliances.

Approximately 75 fifth-grade students currently use the Sun Ray 1 enterprise appliances to access Netscape Navigator, StarOffice productivity applications, and LearningStation.com educational software. Each student has a smart card, which provides secure access to the system and enables easy mobility between any Sun Ray 1 enterprise appliance on the campus.

Configured for Performance and Growth

A Sun Enterprise 450 server, configured with two 300 MHz UltraSPARC processors and one gigabyte of memory, currently supports 20 Sun Ray 1 enterprise appliances (see Figure 6). The larger-than-needed Sun Enterprise 450 server is sized for future expansion. Two 18-GB hot-swap UltraSCSI-3 drives store system files and user home directories, and are mirrored for increased availability using Solstice DiskSuite™. The server utilizes two 100 Mbit network interfaces plus an additional Gigabit Ethernet interface for network connectivity.

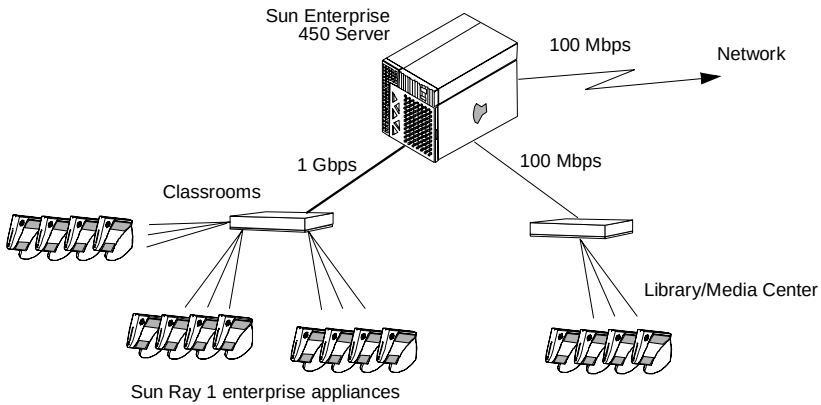

Figure 6 Carrollton City school district logical network architecture

Two 3COM 3300-series Ethernet switches implement the private interconnect. These 24-port switches supply 100 Mbit Ethernet bandwidth to each enterprise appliance, ensuring sufficient bandwidth for user applications. Two separate switches are needed because the enterprise appliances are located in two separate wings of the large elementary school. One switch connects the four enterprise appliances in the media center to the server with a 100 Mbit connection. The other switch connects the 16 classroom appliances to the server

with a Gigabit connection. The server is also connected to the campus-wide network, providing communication with other systems in the district and the Internet.

Scalability Provides Room to Grow

Sun's proven scalability was an important factor, increasing Carrollton City schools' confidence as they implemented their new solution and began migrating additional users to the system. Cooper describes Sun's reputation, "Sun servers are known for their scalability, certainly. And for us it's an important part of our transition to the Sun Ray 1 enterprise appliance environment. As we move to the Sun Ray 1 enterprise appliance platform, we will be able to scale the server as needed to handle the additional users as they come on-line. With Sun servers, we know that they will grow with us over time."

As Carrollton City adds additional enterprise appliances, it is easy to scale the performance of both the server and the network. Two additional processors can be added to the Sun Enterprise 450 server, and its memory can be increased to a maximum of 4 GB. Network bandwidth can also be increased by adding additional switches or utilizing additional Ethernet interfaces on the server.

Network Configuration Details

In the Carrollton City school district, the elementary school (where the Sun Ray 1 enterprise appliances are located) is connected to the high school, junior high school, and administration building via an Ethernet network. Multiple 3COM switches implement their local area network (see Figure 7). A pair of 3COM 3500 switches housed in the high school is at the center of the network infrastructure, connecting via Gigabit Ethernet fiber links to additional 3COM Corebuilder 3500 switches at each of the buildings. At each site, these 3COM 3500 switches connect to multiple stacks of 3COM 3300 switches, which in turn connect to personal computers and other server machines.

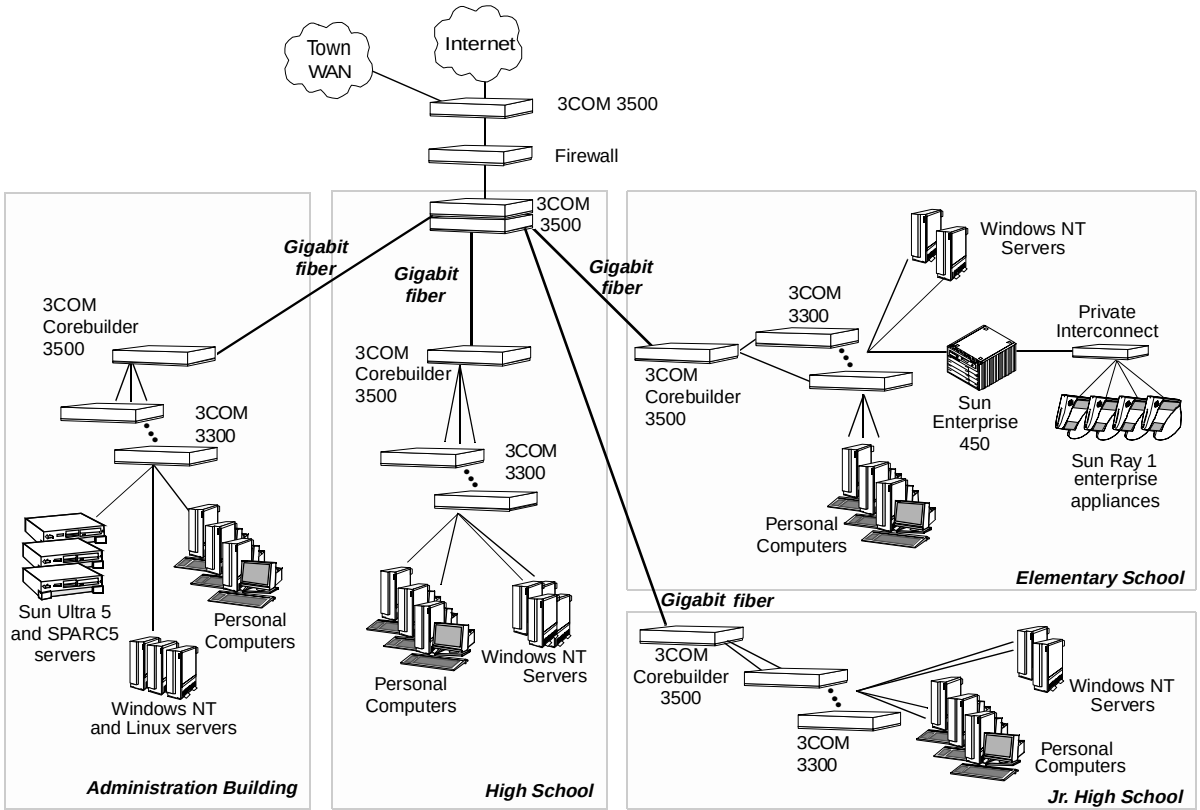

Figure 7 Carrollton City school district detailed network architecture.

The school administration building contains Sun's Ultra 5, Sun's SPARCstation™ 5, Microsoft Windows NT, and Linux-based servers which are utilized by the Sun Ray 1 enterprise appliances and other machines throughout the network. Two of Sun's Ultra 5 servers are mail and proxy servers, the SPARCstation 5 machine is the site's DNS and Web server, a Windows NT server handles user authentication, and the Linux-based servers run calendar applications and network analysis tools and host the teacher Web pages.

Connectivity to the Internet and the town's wide area network is provided by the central core of 3COM 3500 switches located at the high school. These switches connect to a firewall, which provides security for the site's network infrastructure, and then to another 3COM 3500 switch. This final switch has two external interfaces, one for the Internet and the other for the town WAN.

Implementation

The installation of the Sun Ray 1 enterprise appliances at Carrollton City elementary school went very smoothly. Carrollton City experienced a few minor issues with enterprise appliances not working correctly at the very beginning of the pilot program, but these were all due to pre-release software and were quickly fixed. Their experience has shown the product to be very stable in classroom use, and they are pleased with the performance and reliability of the enterprise appliance. According to Dr. Cooper and his IT staff, the experience has been very positive overall.

Results

The Sun Ray 1 enterprise appliance provides Carrollton City schools with a lower-cost, easy-to-use desktop solution that enables them to implement their vision of a Web-based environment for learning. Sun's reliability ensures that students and teachers can work where and when they need to, and the combined scalability and flexibility of Sun servers and the Sun Ray 1 enterprise appliance architecture provide a system that can grow along with their needs.

Students are excited about working on the Sun Ray 1 enterprise appliances, and much of the appeal is in the smart card. When asked what they like best, one student was quick to reply, "I like where you can just put your card in real quick and it just pops up." Another student points out that when you're browsing the Internet, the enterprise appliances are better because with the smart card "it saves all your stuff. With the others [PCs], you have to start all over" because you don't have your personal session (with your personal bookmarks and navigation history) saved. Although they don't explicitly name the Hot Desk technology, this is what is making it easier for them to get their work done.

Teachers also are pleased with the Sun Ray 1 enterprise appliances in their classrooms. One teacher confirmed that students love the appliances, and think the smart cards are "cool." She specifically appreciates that "students can go to

any computer, in any classroom, and continue their work. The smart card makes it convenient." Another teacher points out that students prefer the enterprise appliances over the PCs in the classroom, "If I've asked them to research something, they'll choose the Sun Ray 1 enterprise appliances because it's faster. They don't have to login. They just put their card in and they're ready to go."

Everyone involved with the pilot program at Carrollton City elementary school — school administrators, technical specialists, students and teachers — is pleased with the results. Because the desktop appliance is easy to use, requires zero administration, comes with a five year warranty, and never needs to be upgraded, school administrators look forward to reduced support costs and a lower total cost of ownership. Technical specialists appreciate the simplified administration and easy installation, with new units simply removed from the box, plugged into the network and powered on. Students enjoy the smart cards and Hot Desk technology, enabling them to pause their work on one desktop appliance and then continue later on another in the workgroup with no interruption and no problems saving and transporting their work. And thanks to the reliability and ease of use, teachers can concentrate on what they do best — working with students, not worrying about computers.

Future Plans

Carrollton City is pleased with the success of their pilot program at this time, and plans to continue with the program. Their current PC equipment is relatively new, so it is not economically feasible for them to replace them all with enterprise appliances at this time. But they foresee adding additional appliances and possibly replacing older PCs over time.

Carrollton City continues to investigate other opportunities to deploy Sun Ray 1 enterprise appliances in the elementary school where the existing pilot program is in place, as well as at their middle school and high school.

Case Study: DTU 5

Danish Technical University (DTU) deployed 100 Sun Ray 1 enterprise appliances in its Mathematics department, for use browsing the Web, running mathematical and graphics applications, accessing data warehousing tools, and using office productivity applications. DTU chose the enterprise appliances as a way to replace their aging mix of HP servers, workstations, and X-terminals with a new configuration that provided high performance for users, was reliable, supported open standards, and had greatly simplified administration. DTU is pleased with the Sun Ray 1 enterprise appliance implementation, and plans to add additional units in the near future.

Background Information

DTU is the leading center of engineering education and research in Denmark, and is one of Northern Europe's largest technical universities. DTU offers studies in many engineering disciplines, including chemistry, electronics, mathematics, and mechanics.

Historically, DTU is known for H.C. Ørsted's studies of electromagnetism and Niels Bohr's pioneering work in nuclear physics. DTU continues this tradition of technical excellence, educating new generations of engineers and researchers. Today, approximately 6,000 students are enrolled in bachelor and master degree programs, with an additional 625 students working towards their Ph.D's. The university employs a teaching and research staff of approximately 1,250 and has another 650 employees on its technical and administrative staff.

DTU is committed to providing a first-rate technical education for its students. Leaders at DTU believe that the basic purpose of a research university is to obtain and pass on knowledge. They recognize that technology is an essential component of a superior engineering education, and part of their mission statement outlines their commitment to ensuring that staff and students have access to state-of-the art equipment.

Previous Equipment Needed Upgrade

The aging computer lab in the DTU mathematics department was far from state-of-the-art, containing a mix of seven-year-old HP workstations, servers, and X-terminals with only 66 seats for students. Approximately half of these units were located in auditoriums and used as part of class instruction. The remaining units were used by students for class exercises and lab work. Students used standard UNIX-system-based applications such as Mathematica and MatLab for mathematical analysis, statistics, and other related course work.

The mixed X-terminal solution had served DTU's math lab well, but the equipment was now old and slow. In addition, technical staff at DTU needed up-to-date software development tools, particularly for Java technology. It was time to replace the aging equipment with a new solution.

DTU wanted to continue to provide access to the same applications, while expanding the number of available seats. High performance for running demanding mathematical applications was important, as was high availability that would allow students to complete their assignments on time.

Administrators had low cost and simplified administration as primary requirements of the new solution. They aimed to replace their complicated mix of multiple servers, workstation, and X-terminals with a simpler configuration that required less attention from system administrators. Support for open standards was an additional prerequisite for DTU. Their new solution had to integrate easily into their existing network and interoperate with other servers and workstations currently in use.

Sun Seen as a Leader

As a prestigious center of engineering education and research, it is imperative to DTU that they provide students with access to leading technology. And DTU viewed Sun as a leader in technology, a company with a vision for the future. DTU was already familiar with Sun's high-performance servers. They appreciated their high levels of reliability, as well as their performance and scalability. In addition, they liked the support for Java technology and other software development tools available on the Sun platform. And they were particularly impressed with Sun's new desktop platform — the Sun Ray 1 enterprise appliance — with its innovative architecture, Hot Desk technology, and use of smart cards.

Sun's on-going commitment to open standards was also significant to DTU's choice of vendors. Professor Henrik Madsen, a key player in researching and selecting the new infrastructure for the math department's computer lab, explains, "One of the main reasons for buying from Sun is that we feel that they are among the companies which really represent open standards." He continues, "We want to buy the best computer equipment and the best software solutions. We want to be able to mix it. And we are able to do that with Sun today."

Sun Ray 1 Enterprise Appliance Solution

In August 1999, 100 Sun Ray 1 enterprise appliances were successfully deployed at DTU in four computer labs and three classroom auditoriums. Two Sun Enterprise 250 servers, each configured with two 400-MHz processors and 2 GB of memory, provide service for the 100 desktop appliances (see Figure 8). Switched 100 Mbit Ethernet is delivered to each desktop appliance while the servers both utilize Gigabit Ethernet connections, providing a high quality of service to users.

A Sun Enterprise 6500 server, configured with 24 400-MHz processors and 24 GB of memory, is connected to the local area network and operates as a compute server for the Sun Ray 1 enterprise appliances. The Sun Enterprise 6500 server also acts as a primary file server, with two Sun StorEdge D1000 disk arrays configured with sixteen 18-GB disks. Servers in other labs at the university also contain home directories, which are automatically made available via NFS when a student logs in to an enterprise appliance. Linux servers located in the labs provide students with access to removable media like floppy and Zip drives.

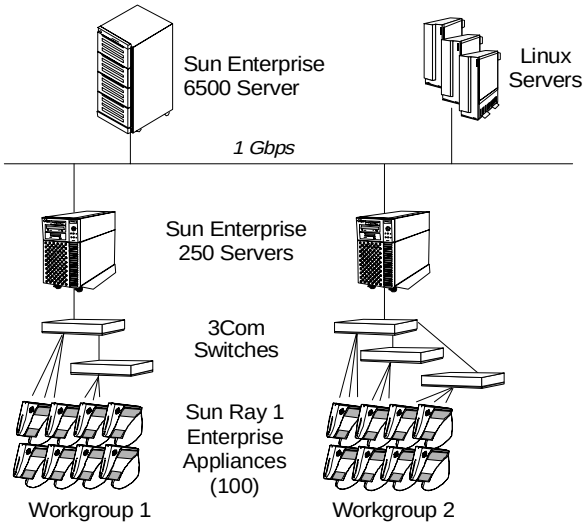

Figure 8 Logical network architecture of DTU's computer lab.

Users at DTU rely on the Sun Ray 1 enterprise appliances for a wide variety of applications. Students and other users employ the appliances to access the World Wide Web, running browsers as well as chat sessions and Internet radio and television applications. For their course work, mathematical applications such as Mathematica and MatLab are used. Office productivity tools, including Applix and StarOffice software, data warehousing tools like SAS and SPlus, and assorted graphics applications are also accessed with the enterprise appliances.

Network Configuration Details

The private interconnect is implemented using five 24-port stackable 10/100 Mbps switches (3Com SuperStack II Model 3300) with a total of four high-speed Gigabit modules (see Figure 9). The Sun Enterprise 250 server in the first workgroup connects to a 3300 switch using a Gigabit link.[1] This first switch is

1. This configuration features two Gigabit Ethernet cards in each Sun Enterprise 250 server. One Gigabit Ethernet card is used to connect to the local area network, while the other connects to the switch and the attached enterprise appliances. However, the Sun Enterprise 250 server is qualified to run only one Gigabit Ethernet card, and this configuration is therefore not officially supported by Sun.Other sites interested in a similar configuration should consider deploying a server that supports two (or more) Gigabit Ethernet cards.

connected to a second via a built-in connector at the rear of the switch, called the matrix port, which provides 1 Gbps of interswitch communication bandwidth. This configuration services approximately 40 enterprise appliances with 100 Mpbs bandwidth to the desktop.

Another Sun Enterprise 250 server in the second workgroup also connects to a 3300 switch using a Gigabit link. As in the previous configuration, this switch is connected to a second via the matrix ports. A third switch is then connected using a Gigabit connection, with this configuration servicing approximately 60 appliances.

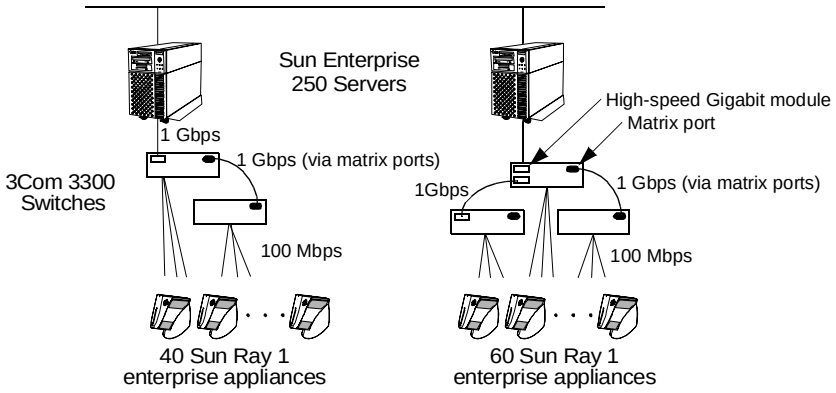

Figure 9 Detailed private network architecture at DTU

The Sun Enterprise 250 servers and the Sun Enterprise 6500 server are all connected to the local area network backbone with Gigabit Ethernet connections to ensure adequate bandwidth. All other existing servers at DTU are also connected to the backbone, providing Sun Ray 1 enterprise users with full access to these servers as well. High-speed Internet access is also available through the local area network, connecting Sun Ray 1 enterprise appliance users to the World Wide Web.

Implementation

The installation of the Sun Ray 1 enterprise appliances at DTU went very smoothly. According to the service engineers, “We installed all our equipment: application server (E6500), Sun Ray 1 servers (two E250s), and the Sun Ray 1

enterprise appliances, but the switches were late. When the switches finally arrived, the cables were plugged in and Whooh! All 100 Sun Ray 1 enterprise appliances were up and running! Great!”

There were a few minor issues early in the deployment, all of which have been fixed by patches. Initially, some enterprise appliances would hang and required a reboot of the server. Also, users on the Sun Ray 1 enterprise appliances had problems logging on to other servers on the network backbone. Again, these problems were all quickly resolved and have not occurred since the patches were installed. When Professor Madsen was recently asked if there were any on-going administration issues or other problems, he positively stated, “Not at all with the Sun Ray 1 enterprise appliances and the Sun servers. But we have spent a huge amount of time setting up a few Linux servers!!”

The Sun service engineers relate that their decision to have a separate application server for the Sun Ray 1 enterprise appliances has worked out well. “Our experience is that the choice of not running any applications on the Sun Ray 1 central servers and having all applications running on application servers is a good choice. It makes it possible to make some good menus on the Sun Ray 1 enterprise appliances that, transparently to the user, run the applications on different application servers on the backbone.”

Results

The Sun Ray 1 enterprise appliances have successfully fulfilled the needs of DTU. According to Professor Madsen, the new enterprise appliances have delivered on their promise and he gives high marks to their very low maintenance costs and easy system administration, high performance, and uptime. DTU had sought an open solution, and they are pleased with the Sun Ray 1 enterprise appliance system, citing its flexibility and ability to interoperate well with other systems on the campus.

Administrators and teachers aren’t the only ones happy with the new arrangements. Users now have better performance for their demanding applications, which run on the high-performance Sun Enterprise 6500 server. Professor Madsen credits the Sun Ray 1 architecture, which leverages the shared resources and the inherent reliability, availability, and scalability of Sun servers to deliver enterprise computing performance to the desktop. In addition to better performance, this architecture allows DTU to more effectively upgrade and scale the performance as needed on the centralized servers, and have all users automatically benefit at each desktop appliance.

Users gain access to powerful, scalable, and reliable servers while the university benefits with economics unmatched by general-purpose computing platforms.

Future Plans

DTU intends to expand their deployment of Sun Ray 1 enterprise appliances, with plans for up to 180 additional appliances in the near future. Part of this expansion will include equipping all auditoriums in the physics and mathematics departments with a Sun Ray 1 enterprise appliance and video projector, allowing entire classes to follow along as instructors use advanced applications and software-based demonstrations to reinforce complex topics. DTU is also interested in adopting smart card use, as they recognize the potential for secure access and increased mobility for students and other users.

When asked what advice he could offer his colleagues at other universities, Professor Madsen responds with a strong recommendation for the Sun Ray 1 enterprise appliance, “I think they should take a look at a system where the administration is very low, where researchers can spend their time on the research and not on computer maintenance, and where the investment can be protected.” He continues, “I’m sure that the future belongs to a system like the Sun Ray 1 enterprise appliance.”

The Sun Ray 1 enterprise appliance brings leading technology to the desktop at DTU. This highly innovative approach to desktop computing addresses DTU’s pressing need for simplified administration and low-cost maintenance without compromising performance. Sun’s Hot Desk technology simplifies desktop management by centralizing it at a single location where it can be more easily and economically managed. Because the enterprise appliances never require upgrades and they efficiently share expensive resources, the Sun Ray 1 enterprise system keeps the total cost of ownership low.

DTU has a long history of technical excellence as the leading center of engineering education and research in Denmark. For over fifteen years, Sun has also maintained a history of innovation in computing and networking and technology. Together, DTU and Sun’s creative solutions are preparing the next generation of engineering and research leaders.

Summary 6

The Sun Ray 1 enterprise appliance pilot program at Carrollton City schools and the deployments at EIN and DTU have all been successful. Both EIN and DTU have expressed plans to add additional enterprise appliances to their current deployment in the near future. While Carrollton City school district hasn't made specific plans to purchase additional appliances at this time (they just recently purchased new PCs for the entire school), they report a positive experience with their pilot program and continue to investigate opportunities to deploy enterprise appliances in their middle and high schools as well as their elementary school.

Administrators at these sites have been impressed with the promise of a low-cost, very low administration desktop computing environment. The expected low total cost of ownership, five-year warranty and desktop appliance that never requires an upgrade appeal to financial officers. IT staff appreciate the ability to centralize and confine administration to essentially only the servers, allowing limited personnel resources to be used more effectively. Education and library customers can leverage a zero-administration desktop that is trivial to install and can simply be replaced if it fails, freeing teachers and librarians from administrative duties on the desktops in their classrooms and libraries.

As the three case studies detailed in this paper indicate, the Sun Ray 1 enterprise appliances are an ideal match for many customers in library and education markets. These markets typically require a low-cost desktop that is reliable and easy to maintain. Generally, education and library sites have limited IT staff to administer their many distributed desktops. Teachers and librarians don't usually have the training to fix things when they break — nor

should this be expected as part of their job. The centrally-administered Sun Ray 1 enterprise system with its zero-administration desktop is therefore a good fit for these environments.

References

An index for many of the Sun Ray 1 enterprise appliance papers can be found at *http://www.sun.com/products/sunray1/whitepapers/index.html*

Look for these and other Sun technology white papers:

Sun Ray 1 Enterprise Appliance Overview and Technical Brief, White Paper, Sun Microsystems.

Assessing Scalability of the Sun Ray 1 Enterprise Appliance, White Paper, Sun Microsystems.

Deploying the Sun Ray 1 Hot Desk Architecture, White Paper, Sun Microsystems.

Digital Media on the Sun Ray 1 Enterprise Appliance, White Paper, Sun Microsystems.

Using Smart Cards With the Sun Ray 1 Enterprise Appliance, Customer Brief, Sun Microsystems.

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Printed in USA