Thin Client @ School™

A Guide to Enriching Education Through Affordable Technology

National Semiconductor®

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Introduction

Students today have instant access to the world from within their schools. Computers and communications technology have transformed educational institutions by connecting students to the vast learning resources of the world. To ensure access to new technology for students and teachers, school administrators must invest in networks, computers, software, training, and support staff. The challenges are many: finding funds to acquire and support technology, training teachers, maintaining equipment, and securing equipment and data.

Most schools have a patchwork of technology pieced together from many sources. It is supported by a few information services staff or technology coordinators, and the teachers and students who use it. School districts need a comprehensive, scaleable solution that builds on their existing investment and presents a clear path to the future. One solution is to reduce time and money spent on individual desktop computers by migrating to a shared thin-client computing environment. The idea behind thin-client computing is simple: centralize computing power, storage, applications, and data on “servers” (powerful computers) and provide users with a simple “client” device that is easy to install and requires no hands-on maintenance. The client connects to the server through the network to run applications, access files, print, and perform services available to ordinary computers.

This guide provides schools with information to implement a thin-client solution that is manageable and affordable, one where teachers can rely on information technology as a tool to support learning. The guide introduces the concepts behind a thin-client environment and its advantages for schools. Next, it provides a path to implementation and a review of technology costs. The focus of this guide is on Windows®-based terminals as thin clients, although many of the principles and concepts are applicable to other server-based computing solutions. The guide is written for the school district technology champions and decision makers: technology directors and coordinators, business services managers, curriculum coordinators, superintendents, assistant superintendents, principals, teachers, even school board members. It is for the people who will choose the technology path for tomorrow.

Why Do Schools Need Thin Clients?

To the person using the device, thin clients look and act like ordinary computers, but they are less expensive, faster, more durable, and easier to maintain. The thin client is a simple terminal used to access the power and applications on the server. It operates as fast as the server and network allow, with no desktop hardware upgrades needed. The system administrator updates and maintains the clients by managing the server and its resources. A school district can migrate to a thin-client solution using existing networks,

servers, and desktop computers, building on their investment to control costs and expand access to more students.

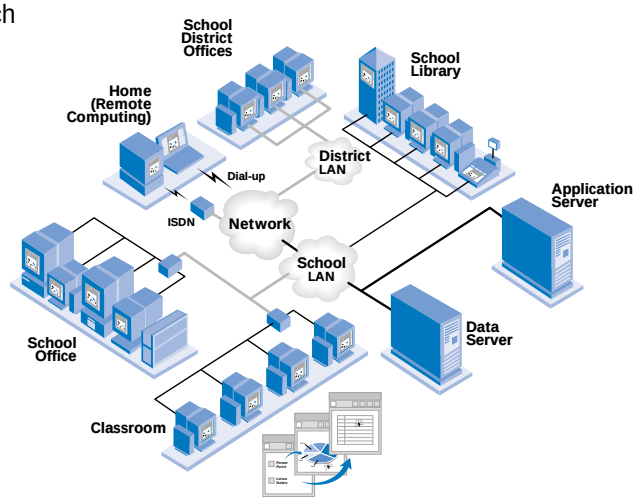
- **Increases Reliability and Consistency of Technology**

How often have educators planned a lesson using computers, and spent most of the time troubleshooting technical problems? How many students have lost work because a floppy disk disappeared or they forgot where they saved a file? How much work is lost when a hard disk crashes?

The general trend in computing is toward networking to manage applications and resources through log-ins and permissions. This approach reduces maintenance on individual machines and can be used to create a consistent look and feel for users. Thin clients take this idea to the next level—all of the computing power and data is stored on the server rather than the individual machine. Only key strokes, mouse clicks, and screen images travel the network to the desktop. When a teacher or student "logs in", the server provides them with their "desktop configuration". They see only the applications they use, and the system administrator controls the settings for a consistent look and feel. It no longer matters which thin client is used or who used the device during a previous session. Users can even access their "desktop" from home or other remote locations. Since the server handles all computing and memory demands, almost any computer can function as a thin client. Schools can connect 286 PC's and higher, or even with Macintosh® LCIII's (68030) and higher, to the thin-client network and run up-to-date software.

However, certain devices are designed specifically to be thin clients, and these "native" thin-client hardware devices offer particular advantages. They cost less because they do not need a hard disk or require much memory (RAM). The small, sealed case design contains few, if any, moveable parts that can break down and no vulnerable openings such as floppy drives or CD-ROM drives. An optimized thin client will function without failure more than twice as long as a typical computer. The low cost and ease of installation means that if a failure does occur, the failed device can be replaced quickly and easily. No data is lost, because it resides on the server. Teachers who are new to technology will feel more comfortable using computing devices that are reliable and dependable.

Thin Clients



No matter where the user logs on, the view is the same.

• Lowers Cost of Technology Over Time

How often do educators interrupt one another with technical problems? Does your technology staff have time to plan and improve services, or are they constantly putting out fires? How long does it take to bring every computer up-to-date with the latest software? How many resources go unused because educators are frustrated with failures?

Like many businesses, most school districts only factor part of the cost of technology into their budgets; they neglect to include the human resources it takes to keep technology operating. In the Consortium for School Networking guide "Taking TCO to the Classroom" it is estimated that when all the costs associated with installing, maintaining and troubleshooting a personal computer in the school environment are considered, the annual cost of operating the computer can be as high as the purchase price.

When an organization recognizes the true costs of technology, it can modify the computing environment to take control of costs. By reducing the number of hours needed for technology support and time lost when users troubleshoot or can't fix a problem, the total cost of the technology is affected.

In a thin-client environment, services are centralized on a server rather than distributed to desktops throughout a school or district. As such, the time and cost needed to maintain and support thin clients is dramatically lower than a standard computing environment. New applications and upgrades are loaded only once onto the server, and become instantly available on all devices, regardless of age, platform or hardware configuration. There is no need to touch the desktop devices to install software or upgrade hardware. The clients have few moving parts to breakdown and users cannot change settings or install conflicting applications. With fewer configurations and less internal hardware, troubleshooting is much easier for support staff and users.

A thin-client solution uses the standard network infrastructure adopted by the majority of schools. Most schools have some combination of Ethernet-capable wiring, servers, desktop computers, and versions of software products for each computer platform, and they have plans to expand access throughout the campus. Unlike fat clients, which send large packets of data across the network, thin clients only send keystrokes and screen shots. They actually require less bandwidth than fat client solutions, although the reliability of the network becomes more critical.

A school district could begin to migrate to thin-client computing by connecting a single computer lab in a single school or starting with administrative computers, which perform a particular function. But true cost savings come from economies of scale, particularly in the area of support. With a sufficient network

connection, a school district could maintain servers for all schools in one location. They could train and hire system administrators with appropriate expertise to plan and manage their technology investment. By centralizing training, maintenance, and purchasing, districts achieve the lowest cost per user.

- **Secure Data and Equipment**

When were the administrative computers last backed up? What would be lost if the computers were stolen or infected with a virus? If a teacher or administrator's hard disk crashed and the data was lost, could the information be recovered?

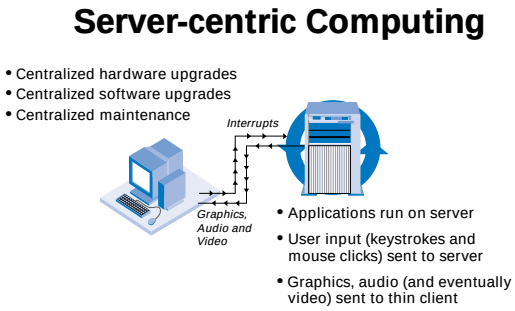
By concentrating data, applications, and processing power on servers, the thin-client environment reduces security risks of data loss and equipment theft. Most organizations only backup servers, because a backup of the information resources of individual desktop devices is too costly. With thin clients, servers are the only devices storing data, and they can be secured in rooms with alarms and limited access. True thin-client devices have little intrinsic value. If they are stolen, the hardware is easily replaced and none of the data lost.

What Are the Ingredients of a Thin-Client Solution?

Thin clients are the next step in the evolution of computers. Building on the lessons of the past, thin clients create a robust computing environment that will support the expanding needs of educational organizations. The first computers were massive "mainframes" that users accessed through "dumb terminals"—a simple monitor and keyboard using text commands. Mainframes computed over slow networks using proprietary software. Personal computers freed computing power from the backroom and made it available at every desk with an easy to understand "graphical user interface" (GUI). Advancements in network technology made it possible to send larger and larger packets of information across networks at faster rates, and personal computers were networked to share resources and move data. They now functioned as both individual computers and clients of servers. However, the desktop control that made personal computers so appealing also made them a challenge to support, and it reduced their ability to talk to one another. Thin clients simplify management and allow multiple platform computers to share resources seamlessly. Like a mainframe, they rely on a server, where resources and maintenance can be centralized, but they also have an easy to use GUI interface and the latest software like a personal computer.

The four basic ingredients in a thin-client solution should be familiar to anyone who has designed a centralized computing environment:

- Network infrastructure
- Server
- Thin-client device (including monitor, keyboard, mouse)
- Software



The network infrastructure—the pipeline between the server and the client—is the most critical element of the thin-client environment. If it is slow or inefficient, all of the users will be affected. If it works well, the network will be essentially transparent to them. With e-rate and other programs, most schools are on their way to developing a network capable of supporting a thin-client environment. A school should start with a good wiring infrastructure to support 10 MB connections to the classroom. Unlike fat clients, which access the network to download program files and data files, thin clients only exchange small packets of information over the network. High-speed connections are only necessary between the servers. Network reliability will be critical, as inefficiencies that were tolerable or went unnoticed before will be apparent. However, removing slow protocols and improving the network in support of thin clients will result in a more manageable and faster network for all connected devices.

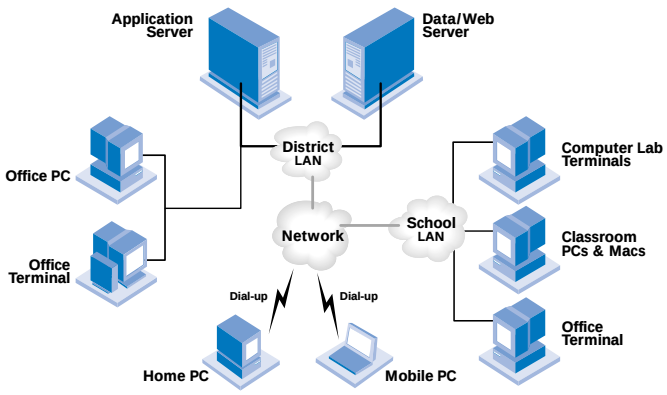
The workhorse of the thin client environment is the application server, a computer that is robust and modular with a high fault tolerance. It should have best-of-class processing power, 8-24 MB of memory per simultaneous user, 64 MB for the operating system, and a plan for daily backups. The application server requires two essential pieces of software: Microsoft® Windows NT server 4.0, Terminal Server Edition, or Terminal Services in Windows 2000, and Citrix® MetaFrame™, using the thin-client protocol based on Independent Computing Architecture (ICA®). Citrix also offers the Remote Management System (RMS) utility to help size, audit, and maintain the server. The application server may work with other servers, networked together to form a server farm. These additional servers, used for data storage, web hosting, email, and other services, should be located as close to the application server as possible to reduce network traffic.

Any user device connected to a server is a client and clients connected to the server via the thin-client protocol can be called thin clients. Almost any new or legacy computer can be connected and run as a thin client. Also, a computer can function both in the traditional mode and as a thin client when a user logs in to the thin-client server for particular applications. However, the term thin client also describes a particular

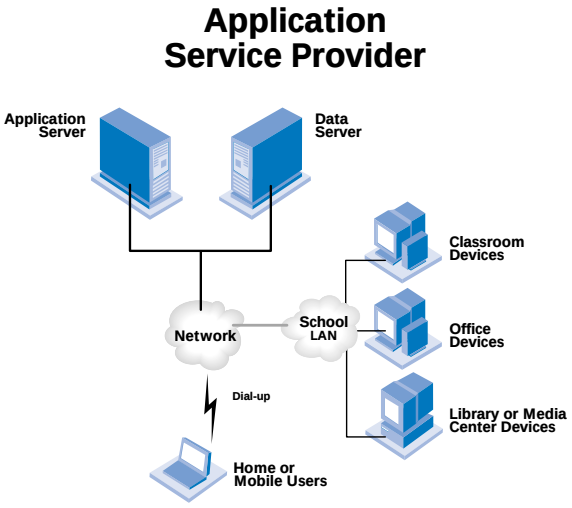
type of hardware device optimized for use in this environment. A thin client is smaller than a typical desktop computer (about the size of a thick textbook) because it contains fewer parts: a processor capable of processing graphics, Ethernet network interface capability, a video subsystem, and enough memory (about 2 MB) to run the software to connect to the server. It does not need a hard drive, modem, floppy drive or CD-ROM drive. Thin clients can be purchased in a sealed case without openings. These thin clients last longer, use less energy, and upgrades to the device can be downloaded from the manufacturer's web site. Some thin clients come complete with monitor, keyboard and mouse.

Many software applications can be used in a thin-client environment. Most productivity software will run on thin clients, and graphic intensive or specialized applications will become available, as they are web-enabled or optimized for network use. An organization might start a thin-client solution with productivity software, and migrate to instructional and more specialized applications. Some fat clients can be used to access graphic- and sound-intensive applications and for trying new applications. As part of the implementation process, a systems integrator should test compatibility of applications and determine network needs. Software licenses should cover an adequate number of simultaneous users.

School District Network Using Thin Clients



An alternative to purchasing and supporting all four ingredients in a thin-client solution is to employ the services of an "Application Service Provider" (ASP). The school or district owns thin clients and networks, and rents applications and server space from the ASP. For an annual fee per user, the school can subscribe to a variety of software applications (instructional and productivity) and educational content resources through the ASP. The ASP owns, tests, upgrades, and maintains software applications and server equipment. The ASP centralizes the cost and complexity of managing and delivering applications and serves those applications over secure Internet connections to classroom and school computers. Costs are lower than a more traditional computing environment, and there is less initial investment.



What Can Schools Do with Thin Clients?

Thin clients offer schools a reliable and secure solution to escalating technology ownership costs. They optimize network utilization, provide access to applications from older computers (Windows, Macintosh, or Unix®), keep data secure and uncorrupted, and provide technology staff with more control. However, there are unique features that enhance the educational environment as well.

- **Shadowing**

Shadowing allows certain users access to another user's desktop in real time. For example, an educator can take control of a student's desktop and show them how to solve a problem without going to the student's actual workstation. (This is especially useful in distance learning.) Shadowing can also be used for staff development or mentoring. If an educator is stuck or lost, a trainer can access the desktop remotely and show the educator how to solve the problem. Although a few applications on the market offer similar features, the thin-client software performs this function at the server rather than the desktop, reducing the computing and network resources required.

With an ASP configuration, only the system administrator can shadow (still helpful for training purposes), but teachers can monitor how long a user has been using an application to keep students on task.

- **Machine Independence**

Because the desktop configuration is based on the user log-in, not the device, it doesn't matter which device you use to access the server. A student will see the same icons, buttons, and have access to the same applications whether viewing their lessons in the library, on a classroom device, or from their home computer. Educators also have an identical "user interface" (UI) whether checking e-mail in the teacher's lounge, entering grades from their desk, or planning lessons at home. Student information and student work stored on a centralized district server could be instantly available when a student moves to a new school in the same district.

- **User Groups Based on Needs**

User groups can be defined according to privileges and applications set by the local system administrator. Schools can use these definitions to promote successful applications and curriculum plans by making them

available to appropriate groups when they log in. For example, when the state approves a curriculum application and a district adopts it, the new program can be added easily to the menu of applications for all appropriate educators. Media specialists and curriculum development staff could develop grade-level appropriate packages for teachers, offering them several choices that have been tested and are supported with curriculum materials.

Designing a Thin-Client Environment

Although businesses have successfully deployed thin clients as a solution to the escalating cost of ownership, the concept is still somewhat new to educational organizations and educational software applications. As school districts begin to formalize their technology planning, they will find that successful technology implementation requires a good team and a good plan.

Who Should Be Involved?

By centralizing computing power in application servers and a high capacity network, a district will save money on maintenance and desktop purchases in the long term. The planning group should have representatives of all stakeholders to create buy-in for the project, as well as experienced computer users and thin-client installers to set realistic goals and solve problems. The planning team may include the following members.

- School representatives will be essential to define the needs of the system-principal, technology coordinator, teachers, students, parents, or volunteers.
- District representatives can provide technical support, funding, and voice district curriculum requirements. This should include the staff members who decide what applications are installed and available-network manager, business manager, facilities manager, or curriculum and instruction manager.
- A systems integrator, consultant, or Value Added Reseller (VAR) with experience in designing and implementing thin-client networks is necessary.
- Community supporters may volunteer as members of a technology team to assist in planning or raise funds for technology purchases.

Consider these qualifications when selecting a VAR:

- At least two years of experience with thin-client installations
- Authorized Citrix partner
- Staff members who have both Microsoft Certified System Engineer and Citrix Certified Administrator credentials
- References (preferably another educational institution)
- Location or negotiate travel expenses to make sure that they can be onsite when needed
- Require documentation as part of the finished project

Once your team is assembled, define the goals you have for your technology implementation. For example:

- Improve the reliability and functionality of computing and telecommunications to improve student learning
- Improve student learning by increasing access to technology for every student and training for every educator
- Involve all educators at our school in using technology to enhance their curriculum and improve student learning
- Lower the total cost of ownership of technology in the district while expanding access without hiring more support staff

Roles and Responsibilities

As the pieces are assembled, issues may arise regarding application compatibility, server functions, network bandwidth, electrical or facilities issues, or the functioning of the thin clients. Establishing clear roles and responsibilities will help your team work together and resolve problems quickly.

• Project Management

The school or district most likely handles project management. The person responsible for this function may also be involved with others. As the key contact for the integrator and other members of the team, this person ensures that the school or district's needs are met and that all parties communicate.

• Integrator or VAR

Depending on the scope of work defined, the integrator assists at several levels. They may provide support with planning, design, and evaluating existing equipment. They will be the primary contact with thin-client equipment and software vendors. Their experience will be important in identifying the best combination of products for the system and for the project-testing phase. They bring the pieces together in a phased installation and commit to the project until all equipment is working to the team's satisfaction. On-going support contracts and training may be provided.

• System Administration

System administration for the servers requires specialized training to configure user groups, add new users, add applications, and develop a backup and restoration process. The integrator should offer clear documentation and appropriate training. (If the school district uses an ASP, they will train someone to handle simple administrative tasks at the site.)

- **Network Administration**

Either a district staff member or someone at the school site is responsible for the health and maintenance of the network supporting the thin clients and servers. The network administrator should work with the integrator to establish diagnostic tests, operational thresholds, and capacity planning measures.

- **Teacher or Educator**

A technology champion or technology-savvy teacher should be selected to work closely with the team: determining needs, testing the set up, selecting user groups, and communicating success and advantages to colleagues. Choosing the right person is critical to the success of the project, as he or she is the liaison to the rest of the school.

Steps to a Thin-Client Installation

1. Analyze environment.

The first decision for the planning team will be to determine which parts of the network to migrate to thin clients based on strategic goals, upgrade plans, and availability of software. The environment includes the existing network, servers, legacy computers, and current software applications. The VAR or systems integrator should review and test the existing network to verify that it matches documentation, to identify weaknesses, and to set performance benchmarks. Upgrades and further testing may be necessary. Working with the project manager, the integrator should review the current network, servers, and computers to determine how to integrate a new system into the existing one and which equipment should be replaced, retired, or retained.

The location of the servers should be determined. In general, the application server should be close to data servers with high-speed connections between them. Districts might locate servers for all schools at the district office for security and maintenance reasons. A safe, secure location should have appropriate heating, air conditioning, and ventilation, as well as locks and alarms.

Outcome: Network plan and documentation.

2. Analyze requirements and determine needs.

The equipment requirements depend on who will use the network and how. First, define the primary groups of users and the applications they use. Students may each have a unique log-in with permissions set based on grade level, course work or other group attributes. Some applications work better than others on thin clients; determine where fat clients will be needed for access to specialized software.

• **Sample User Group**

Does the school have current network licenses for all applications, covering the expected number of workstations? Does this list include every application that is loaded on every computer currently? The school may decide to migrate some users to thin clients first, based on the applications they use. The applications available to thin clients are controlled at the server and only designated staff can make changes and additions. The system administrator should work with teachers and users to develop a process for adding applications that they will feel comfortable with. Several traditional computers should be available for teachers to load and test new applications to be considered for the thin-client environment. By standardizing on applications, school districts can save money on licensing and support.

Group	Quantity	Applications (list software by title)
Teachers	40	• Office Applications • Grading Application • Calendar Program • E-mail • Internet Browser
6-8 Students	800	• Word Processing • Presentation Software • Spreadsheet • Internet Browser • Database • Graphic Design, Image Processing • Encyclopedia, other Reference Programs • Other Educational Software
Other Staff	10	• Office Applications • Student Records • Calendar Program • E-mail • Internet Browser

To estimate the amount of bandwidth necessary, determine how the groups will use the applications.

- How many applications will users run concurrently?
- How many concurrent users will be logged in at a time?
- What are the minimums and maximums of these numbers?
- Other questions from the VAR or integrator.

Increasingly, schools must show measurable outcomes. While it may be impossible to correlate thin client use with a change in test scores, there are ways to measure and track changes in system use. Servers can be set up to provide data about which applications are being accessed, by which groups, and for how long. Work with the integrator to configure the system to give you the information you need.

Outcome: System requirements and software application list.

3. Define the scope of work and determine equipment needs and budget.

The integrator will develop a scope of work, timeline, equipment list, and a budget for the project. The scope of work might include:

- Facilities upgrade (electrical, Ethernet wiring, network closet build-out, etc.)
- Network upgrades
- Server testing and configuration
- Application testing, installation, and configuration
- Thin-client installation
- Verification and testing

An equipment list and budget should include the quantity, description, price, and the estimated life of each item. The integrator or VAR can help determine the life span estimate. You can also use your own experience with products and information gathered on the web and in industry magazines.

Sample Worksheet for a Middle School with 800 Students

SERVERS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
1		Application Server		
1		Database Server		
1		Web Server		
SOFTWARE				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
1		Citrix MetaFrame		
1		Microsoft NT, Terminal Server Edition, 4.0		
1		Citrix, Remote Management Server		
3		Security		
3		Backup and Restore		
50 user		Office		
50 user		Student Records		
50 user		Calendar Application		
280 user		Word Processing		
280 user		E-mail Client		
280 user		Internet Browser		
280 user		Educational Software		
Multi-user licenses should support all clients who will access applications. Plan to upgrade software every 1 to 2 years.				
WORKSTATIONS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
80		Desktop Computers		
200		Thin Clients		
280		Monitors		
PERIPHERALS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
40		Laserjet Printer		
10		Scanner		
10		Digital Camera		

SAFETY/SECURITY IMPROVEMENTS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
1		Mounting Rack for Closet		
1		Motion Sensor Alarm		
1		Raised Floor in Closet		
		HVAC Improvements		
Total Capital Costs				

4. Test applications in lab or on location to determine compatibility and bandwidth needs.

The integrator should have copies of all software that will be loaded on the server for testing to verify that the applications are compatible and have sufficient bandwidth to function. Even an experienced VAR may be surprised by the graphic-intensive applications used by schools, compared to those used in business installations. Many applications written for Windows 3.1 or later, and even for DOS, are compatible with the thin-client protocol, however, some will run better than others will. Check with other educational institutions, ASPs, and industry web sites to determine which applications work best. Revise the application list as needed.

Outcome: Revise equipment list, software list as necessary.

5. Server set up, configuration, and testing.

Servers are set up with server and application software either offsite or on location. They should be tested in a controlled environment on a non-critical part of the network. When configuring the server, the integrator sets permissions for user groups, based on the profiles determined in step 2. It is probably best to start with a few groups and generic IDs until teachers, students, and staff are used to the system. Groups can be defined in more detail later. For example, library and media specialists might have a user group for testing applications and content. They could then develop specialized groups based on discipline or grade level to assist teachers in adopting reviewed content and applications. By providing students with unique IDs, they will be able to carry their desktop profile with them from school to school and grade to grade within the district.

Outcome: Working servers.

Depending on the scope of your project, the equipment list might also include network components, furniture, and wiring materials. The budget should also include installation and consulting costs of the project.

Outcome: Scope of work, timeline, equipment list, and budget.

6. Test clients in a phased approach.

Because all of the applications and settings are determined at the server, installing thin clients should be as simple as plugging them in and booting them up. Slow response, application view problems, and other issues will most likely require network or server adjustments. It is best to start small to thoroughly test a few clients with configured servers. Use e-mail lists and other methods to encourage communication of problems so that they can be resolved quickly. Representative teachers and students can put the setup through its paces before full implementation. Gradually add more clients to test scalability and network throughput. A single thin-client environment may have anywhere from 30 to 3000 thin clients.

Outcome: Working thin clients.

7. Full installation on site.

Once the clients and servers are installed, invite team members to test the system again. Test all of the applications and user configurations, simulating actual classroom situations. The team members can practice troubleshooting the system and develop processes for maintenance, backup, and system configuration.

Outcome: Full installation of thin-client environment.

8. On-going analysis.

An unveiling event can bring closure and recognition to the project and acknowledge those involved. The VAR should provide final documentation with training or a recommendation for training. With the new system, technical staff who spent their time troubleshooting desktop problems will learn new planning skills for monitoring network performance to prevent breakdowns and traffic jams. Remote management software can be used to run diagnostics and set benchmarks for service. The software also identifies signaling thresholds to prompt a review of the service before users notice problems.

Outcome: Visibility for the project, network documentation and technology plan.

To the users, thin clients will appear to operate just like desktop computers. Additional features such as shadowing, location independence, and remote support can be introduced to the users when they are comfortable with the system. The team members should set expectations for educators and students who use the system.

Steps to an Application Service Provider Solution

If you are planning to use an ASP, the steps to implementation will be somewhat simpler. You may or may not need an integrator, depending on your setup. The school or district installs and maintains the thin clients and network, and chooses an ASP. The service provider does the rest. The planning team may consist

of the project manager, network administrator, local system administrator (if one exists), teacher or educator, principal, and a consultant or integrator to help set up.

1. Determine what services are needed.

To determine whether an ASP is the correct choice, the project manager should review the applications currently used by the school district and work with educators to determine future needs, then choose an ASP with an appropriate offering of service. The ASP will have tested the applications and offer service bundles with both software and educational resources. They may offer customization based on a district's previous purchases or specialized needs. For the most part, expect to purchase an existing package. Look for an ASP that specializes in the educational market.

Because your organization will depend on the quality of service from the ASP, set performance levels in the contract. Arrange a service level agreement which guarantees uptime, help desk response, a plan to remedy problems, and software upgrades. The ASP should have a good security plan to protect data and applications.

Outcome: ASP selected.

2. Analyze network and desktop device requirements and determine needs.

Based on the ASP's specifications, determine what upgrades will be needed to your current environment. Most ASPs require a LAN for clients and a T-1 or other high-speed WAN connection. You may need to hire a consultant or specialist to review and test the existing network to verify existing documentation, to identify weaknesses, and to set performance benchmarks. The project manager should review current computers to determine which should be retained, and which replaced or retired. Upgrades and further testing may be necessary.

Outcome: System requirements.

3. Define the scope of work and determine equipment needs and budget.

The majority of the work will be upgrading the network to meet bandwidth needs identified by the ASP, and installing thin clients. For network upgrades or installation, the consultant will develop a scope of work, timeline, equipment list, and a budget for the project. The scope of work might include:

- Facilities upgrade (electrical, Ethernet wiring, network closet build out, etc.)
- Network upgrades
- Thin-client installation
- Verification and testing

The sample equipment list will be simplified from the previous example. Instead of application upgrades and server equipment, the budget should include a line item for the annual ASP subscription fee.

Sample Worksheet for a Middle School with 800 Students Using an ASP

ADMINISTRATION & SOFTWARE				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
280 users		Student Subscriptions		
40 users		Teacher Subscriptions		
10 users		Administrator Subscriptions		
WORKSTATIONS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
80		Desktop Computers		
200		Thin Clients		
280		Monitors		
PERIPHERALS				
Units	**Life**	**Description**	**Price Per Unit**	**Total**
40		Laserjet Printer		
10		Scanner		
10		Digital Camera		
Total Capital Costs				

The equipment list might also include network components, furniture, and wiring materials. The budget should include installation and consulting costs of the project.

Outcome: Scope of work, timeline, equipment list, and budget.

4. Test clients in a phased approach.

Because the ASP provides the applications and determines settings, installing thin clients should be as simple as plugging in and booting up. Slow response, application view problems, and other issues will be either network related or problems for the ASP to resolve. It is best to start small with a few clients, and add more to test scalability and network throughput.

Outcome: Working clients.

5. Full installation on site.

Once the clients are installed, invite all team members to test the system again. Test all of the applications and user configurations, simulating classroom situations.

Outcome: Full installation of thin-client environment.

6. On-going management.

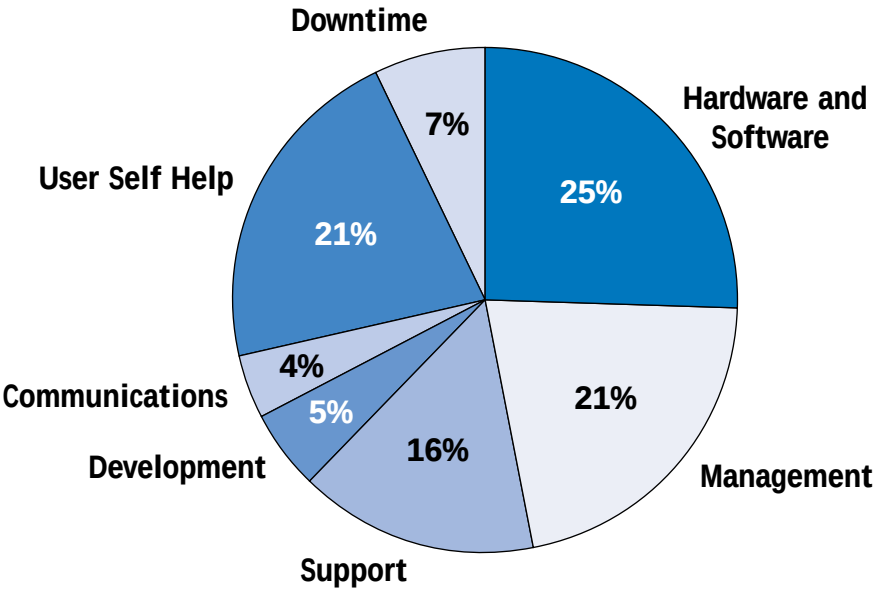
Although server maintenance and upgrades will be handled remotely by the ASP, the network connections will remain the responsibility of the school or district. Network and system administration staff who once spent their time troubleshooting desktop problems will need to learn new skills for monitoring the network to prevent breakdowns and traffic jams. They will also work with the ASP to plan for upgrades or expand services as needed.

Outcome: Network documentation and technology plan.

Determining the Cost

An administrator's first question about new technology is usually "how much will this cost?" The second one is "how does it fit with what I already have?" A third question should be asked as well: "who will support it?" The current model of individually supported desktop computers is not scalable. When schools expand from a controlled computer lab environment to computers in every classroom at a ratio of 4 students per device, the cost for support and training will skyrocket. Most school technology budgets only account for the acquisition of hardware and software, about 25 percent of the lifetime cost of technology. Other cost areas include management, support, development (planning and research), and communication. Few organizations (commercial and educational alike) measure the cost of user self-help (users training themselves or asking each other for informal training) or downtime. The actual cost breakdown looks like this:

School District Technology Costs



Source: http://www.microsoft.com/education/planning/implement/tco/h_page2.asp

Studies of school district technology spending show that they have not yet accounted for the soft costs such as user self help and downtime described above.

Instructional Technology Spending by US School Districts

AVERAGE DOLLARS PER STUDENT						
Category	**1997-98**	**100%**	**1998-99**	**100%**	**1999-00**	**100%**
Hardware	$58.48	50%	$59.39	40.3%	$48.86	35.3%
Software	$11.34	10%	$11.39	7.7%	$12.10	8.7%
Supplies	$5.00	4%	$5.30	3.6%	$5.58	4.0%
Training	$6.66	6%	$11.70	7.9%	$11.85	8.6%
Service/Support	$5.85	5%	$12.20	8.3%	$12.26	8.9%
Internet	$2.34	2%	$11.03	7.5%	$7.52	5.4%
Networks	$24.31	21%	$29.11	19.7%	$29.76	21.5%
Other	$2.64	2%	$7.36	5.0%	$10.55	7.6%
Total	**$116.62**		**$147.48**		**$138.48**	

Source for 1997-98 data: Rebecca Quick, "Paying the Price," Wall Street Journal, Nov. 17, 1997, p. R4.
Source for 1998-1999 data: 1999 QED's 1999-00 Technology Purchasing Forecast (preliminary).

In order to improve access to computers in classrooms, schools need to make better use of their current investments and reduce the cost for support. Thin clients may be the most cost-effective solution to educational computing today. Because they build on existing resources: Ethernet wiring, network components, servers, applications, and even older computers, organizations can migrate to thin clients without committing their technology dollars to a single solution. Thin clients reduce maintenance, simplify upgrades, and improve security. Troubleshooting is more manageable because resources exist in one location: the server. If a problem with a client does occur, the tech support person or system administrator can shadow the user, diagnose, and either fix the problem remotely or replace the failed device easily.

Zona Research estimates that organizations will save 54-57 percent of their system administration costs over five years with a thin-client solution vs. a traditional computing approach. The cost advantages occur in the following areas:

- As older, less reliable desktop computers are retired, they are replaced with low-maintenance thin clients.
- Installation of thin-client devices is a matter of plugging them in—no need to install software, change settings, or add hardware such as memory or Ethernet cards.
- Fewer, more specialized staff can support far more clients.
- Thin clients require fewer upgrades and can be upgraded remotely without touching each device or opening the case and to install new hardware.
- With fewer moving parts and no open slots, the device itself lasts at least twice as long as a typical PC.
- Reliable computing devices with a consistent look and feel will encourage more educators and staff to integrate them into their curriculum and daily work.
- With regular backups of servers, all data is recoverable and secure.
- Travel expenses and travel time of support staff are essentially eliminated through the use of remote management tools, shadowing, and local server maintenance.
- Software costs can be reduced through site licensing, concurrent licensing, and standardization. Usage can be tracked to determine whether applications should be upgraded or eliminated.

Determining the cost of a thin-client technology plan, and selling the project to a school board and administrators, requires thinking ahead three to five years as well as a thorough review of all technology-

related costs. The first year investment to purchase new devices, network systems, servers, and software may not result in savings from existing technology budgets. However, as the school district expands access to technology and as maintenance costs are absorbed, the savings will become significant. To determine the difference in spending, estimate the cost of a thin-client solution versus a traditional solution over five years. In a traditional computing environment, the budget will include installation, maintenance, and software upgrades for each individual machine, as well as for the server and the network.

SERVERS, WORKSTATIONS, AND OTHER HARDWARE				
Units	**Description**	**Year 2**	**Year 3**	**Year 4**
1	Application Server			
1	Database Server			
1	Web Server			
80	PCs			
200	Thin Clients			
280	Monitors			
40	Laserjet Printer			
10	Scanner			
10	Digital Camera			
SOFTWARE				
Units	**Description**	**Year 2**	**Year 3**	**Year 4**
1	Citrix MetaFrame			
1	Microsoft NT, Terminal Server Edition, 4.0			
1	Citrix, Remote Management Server			
3	Security			
3	Backup and Restore			
30 user	Office			
30 user	Student Records			
30 user	Calendar Application			
280 user	Word Processing			
280 user	E-mail Client			
280 user	Internet Browser			
280 user	Educational Software			

When determining operating costs, a traditional PC environment requires travel time and support for each workstation at each site.

ADDITIONAL BUDGET ITEMS		
Line Item	**Traditional Environment**	**Thin-Client Environment**
Installation	Hardware and software installation, upgrades, expansions for servers and all PCs at all sites.	Hardware and software installation, upgrades, expansions for servers. Thin-client installation.
Management	Network, system, and storage administration, management contracts, and other related tasks. Backup, inventory, and tracking of site-based PCs and servers.	Network, system, and storage administration, management contracts, and other related tasks.
Support	PC help desk, training, travel expenses, district and school site maintenance, support contracts.	System help desk, training, maintenance, support contracts.
Development	Review and testing of applications for all platforms, PC specifications, and combinations of applications; customized software.	Review and testing of applications, customized software.
Communications	Leased lines, modem lines, server access.	Leased lines, modem lines, server access.
Training	Certification courses for tech staff, training for educators, troubleshooting for school site staff, conferences, and subscriptions.	Certification courses for tech staff, training for educators, conferences, and subscriptions.

A total cost analysis for technology will come as a surprise for many organizations. First, most school districts do not provide support at the desktop level. Teachers either spend their own time managing computers, students provide volunteer support, or computers go unused. Second, most classrooms still don't have a significant number of computers in them. The downtime and user self help costs for a computer lab are barely noticeable. However, without a management solution, districts will experience a dramatic rise in support costs when devices are deployed throughout the school. A thin-client environment helps an organization rein in costs and keep them under control. To further control costs, an ASP offers a predetermined expense for maintenance, support, upgrades, and new software costs through subscription fees.

What to Expect

Thin Client Philosophies

Planning, promoting, and managing a thin-client environment may require a shift in computing philosophy. It will be important for the technology staff to ease school district staff members using thin clients through the change.

- *Centralization* is the keyword for thin clients. Keep the applications, data, management, and security risk in a single, secure location that can be controlled.
- *Service* must balance centralization. Unless users receive quick response to their requests for changes, they will be unwilling to give up control of computers in their classroom. They must be assured through good service and effective communication that their needs will be met.
- *Reliability* has to back up service claims. As educators get used to thin clients working the same way from day to day, they will begin to integrate them into their daily routine and their classroom projects.

Future of Computing in Education

The introduction of networks and computers transformed the business office in ways that no one predicted. While computers have been used in educational business offices and some classrooms, they have not yet been fully integrated into the learning process. The complexity of the machines, the capital investment needed for widespread access, and the lack of educational resources have prevented their potential from being realized. The convergence of community, business, and government support for technology is producing a sea change in education. The thin-client model offers educational organizations a realistic and cost effective way to manage technology and make it available to teachers and students. These are the individuals who will transform the educational process to advance learning in the information age.

Online Information about Thin Clients

http://www.bocavision.com

The Boca Research site covers server-based computing and offers solutions specifically for business and education customers. Other sections include products, support, resellers, and contact.

http://www.boundless.com

Boundless Technologies Inc. manufactures Windows-based terminals, text terminals, and provides server-based computing solutions. Their web site provides product information, contacts for resellers, company information, and press releases.

http://www.citrix.com

The main sections of the Citrix web site include product information, the Worldwide Channel with links to service providers, technical support, links to training and certification programs, a demo room, and company information. The technical support section includes a searchable knowledge base organized by date and topic.

http://www.compaq.com/products/thinclients/

Compaq has recently added thin clients to their product line and the web site offers quick specs, a product summary, and a white paper perspective on Windows-based Terminals, PCs, and NCs.

http://www.computerworld.com

The Computerworld, Resource Center, Quick Study section provides links to *Computerworld* news articles, books, reports and research, vendors, and a quick overview of selected technology.

http://www.ed.gov/Technology/

The U.S. Department of Education web site has a technology section with the latest information about federal government programs, initiatives, and goals.

http://www.pc.ibm.com/us/networkstation/

IBM offers full service and information on their thin client products. The thin client (Network Station™) section of the web site covers products, how to buy, support, software, solutions, promotions, news, and other features.

http://www.mcom.fr/hp/thinclient/

The home page for Hewlett-Packard thin clients contains information about thin clients, thin-client solutions, products, press releases, and thin-client support. The information about thin clients is a good introduction to server-based computing. The thin-client section also links to the server and enterprise areas of the HP site.

http://www.learningstation.com/

Learningstation.com (LSC) is an Application Service Provider specializing in K-12 education. LSC offers a managed and maintained library of applications for PCs, Macintosh systems, and thin-client devices for use across the school's network and over the Internet. The web site includes the following sections: our technology, demo, members, corporate profile, tech partners, press releases, site tour, download, and contact. "Our Technology" is a white paper describing thin clients and how they can be used in educational settings.

http://www.microsoft.com/education/k12/

The Microsoft education web site includes these sections: articles & events, classroom resources, technical resources, training, planning, and school stories. There are case studies of schools with thin-client environments and a Total Cost of Ownership analysis in the articles section.

http://www.national.com/thinclient@school

The National Semiconductor thin-client information site is designed for educators. In addition to information about design, purchasing, quality, and the company, it includes a school pilot program, information about the benefits of thin-client technology, and resources for educators.

http://www.televideoinc.com

TeleVideo Inc., specializes in the development and manufacturing of Windows-based and network terminals. Products, partners, support, and company information are the main sections of their thin-client web site. The products section includes technology white papers, a project evaluation form, and stories about TeleClient implementations.

http://www.thinplanet.com/

Thin Planet is an independent, on-line resource center for thin-client and server-based technologies. The site sections include news, products, partners, sites, training, events, opinion, tech, and community. Most sections are searchable by manufacturer, product, or application. The sites section points to case studies of various thin-client and server-based environments. The community section includes bulletin boards, job postings, and user group information.

http://www.wyse.com

The main sections of the Wyse Technology web site include Winterm™ thin clients, Wyse solutions, Wyse partners, and service and support. The home page covers the latest thin-client and server-based computing news with brief summaries and event listings. Service and support covers everything from online warranty registration and Return Merchandise Authorizations (RMA) to a searchable knowledge base.

Glossary

Application server: A server dedicated to running applications for thin clients.

Application Service Provider (ASP): A company that rents applications and powerful servers via thin clients. Organizations subscribe to the services of the ASP.

Client/server network: A network of computers where one or more computers (servers) store the resources accessed by users through other computers (clients).

Client: A device on a network used to access resources on a server. Also called a *workstation, a desktop computer*, a *networked PC*, or a *terminal.*

Desktop: Usually refers to the primary screen on a computer with a graphical user interface (GUI). It is a metaphorical office desk with file folders, a trashcan, and other graphics. It can also be a synonym for a client *(desktop computer).*

Desktop configuration: The appearance of the user interface—the color of the background, the location of the icons—as determined through preferences and desktop controls. On a client/server network, the server can send a different desktop configuration to a client depending on which user has logged in.

Dumb terminal: A text-based video display and keyboard used to access data and applications from a mainframe or host computer.

Ethernet: A network architecture standard defined by a physical network medium and its method of placing data. See IEEE 802.3.

Fat client: A client computer on a network designed to operate with or without access to the server. Internal memory and processing power are used to run applications, and to store information.

Floppy disk drive: An internal or external drive that reads data off of a floppy disk, a writeable and readable disk that can be removed from the drive.

Graphical User Interface (GUI): Displays designed with graphical elements such as color and icons to convey information to users.

Hard disk: A magnetic disk used to store data. Most hard disks are permanently housed in hard drives which read and write to the storage medium, although some hard disks are removable.

Local Area Network (LAN): A network within a limited geographical area. LAN can describe a network of computers in a classroom, a school wing, or even a school site.

Login: Identification through a username and password. A user will log on to a computer network with their username and password, and the network provides appropriate access to assigned resources.

Mainframe: A highly reliable, powerful host computer that can be accessed via terminals. Often used for mission critical services.

MB: Abbreviation for megabyte when used to measure memory.

Protocol: A formalized set of rules that computers use to communicate. The rules define procedures, conventions, and methods used to transmit data.

Server: A computer on a network used to store resources, run applications, host web pages, support printing, or provide any other services that can be centralized.

Server farm: Several servers connected together to provide services to the network and clients. Servers within a server farm can be configured to back one another up in case of failure and to balance the load of users to improve performance.

System: The whole operating system created by the parts—software, servers, clients, network, etc.

Systems integrator: A company or individual who provides complete systems solutions. They evaluate needs, contact vendors and purchase equipment, install, test, and verify a computer system.

Thin Client: A client device on a network designed to access a server for all of its functions.

User Interface (UI): Text, graphics, sound, or other conventions that allow humans to interact with machines.

Username: Unique or group identification for users on a network. Unique usernames can be assigned to individuals to offer specialized services and single access to files. Group usernames can be assigned to provide shared access to services and files.

Value Added Reseller (VAR): A company that links component manufacturers and buyers. A VAR provides all of the components necessary for a complete system and also offers technical expertise and installation experience.

Wide Area Network (WAN): A network that spans a geographic area larger than a LAN or LANs connected together to form a WAN.

Workstation: A computer that may be a client on a network or a stand-alone computer.

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