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Breaking through with thin-client technology: a cost effective approach for academic libraries

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BREAKING THROUGH WITH THIN-CLIENT TECHNOLOGIES: A COST EFFECTIVE APPROACH FOR ACADEMIC LIBRARIES

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Illinois Institute of Technology is a private, Ph.D.-granting university focusing on engineering, business, law, architecture, design, and psychology. IIT is located in Chicago, on a campus designed by Mies van der Rohe and has some 6,000 FTE students. The university has three campuses in Chicago and two campuses in the suburbs of the city. IIT's Main Campus, which concentrates programs in engineering and science, is served by the Paul V. Galvin Library.

Introduction

After spending the past two decades learning more about the fundamental shift in the way information is produced and accessed, the reality of the financial management of academic information technology is settling in. We are now at a crossroads. Passage will require institutions to adapt to new opportunities and strategies as economic pressures grow. New strategies must include innovative methods in the development of economic models, outcome assessment, and a true accounting of the cost of owning new technologies.

As Oberlin explained in his CAUSE article, *The Financial Mythology of Information Technology: The New Economics,* "One of the most misunderstood aspects of managing information technology is the attendant economics. The rate of technical advancement is accelerating, demand is intensifying, standards and architectures are changing daily, prices are falling, but total costs are growing." (1996) Oberlin argues that "the principal forces driving the new economics of information technology are: (**1**) its steadily increasing in value, (**2**) academic demand for information technology and computing power is virtually unlimited; (**3**) the per unit price of information technology is declining rapidly; and (**4**) the rising total cost of owning and maintaining these systems. In other words, the potential benefits are truly revolutionary and the demand is insatiable -- but falling prices mislead many to expect cost savings that will never materialize." (Ibid.)

Institutions are trying many strategies to enhance their ability to control IT costs. These include adoption of cost analysis principles, new university funding models, outsourcing of specific tasks, engineering of corporate contracts for purchases, support, and maintenance, etc.

As libraries within academic institutions move their paper-based indexes and abstracts and full text/full image standalone databases systems to online environments, new needs for equipment, training, and operations are emerging. At IIT, the explosion we have witnessed in the number of users and the level of usage (approximately 350,000 Internet/Intranet "hits" every month from library workstations) of such services attest to the success of these new methods of information access. IT has drastically increased the total cost of operating academic libraries. In our university, the demand for these services has risen and the cost of fulfilling such demand has obligated us to acquire more equipment, spend more time working on ways to reallocate monies, and endless hours looking for grants that support IT operations. IT support has become a Catch-22. We need to take a deep look inward at our strategies as we eye technology for solutions that enable us to meet our users expectations as well as our financial bottom line.

Lowering the Total Cost of Ownership (TCO) is one of the many approaches we are exploring to lower the cost of offering online information services to our users.

TCO has many different base elements that vary slightly from one institution to another. Some of these elements include: the actual cost of the hardware and software, user training, the IT maintenance and support staff, the network application support of a client machine, connectivity to the university backbone, contracted technical support and the personnel involved in purchasing, accounting, and inventory. Although we are working on a number of strategies to lower TCO, we find the trend towards network computing, built around the idea of server centric, thin-client technologies to be the most promising.

Thin-Client/Server Computing in Higher Education

Although the critical IT challenges faced by academic institutions rival those of any industry, colleges and universities started to take serious notice of thin-clients when a number of technologically aggressive industries such as FedEx and Komatsu made the trade press headlines with large scale implementations of the technology.

What's a thin-client?

Thin-clients are PC-like devices that embody the idea of the network "appliance" (Tuller, Oblinger, 1998). Although like the PC in appearance (and, hopefully from the user's end, functionality), the thin-client is a clear demarcation from the PC at the technical level. Unlike PCs, thin-clients cannot function without being connected to a server. Thin-clients do not house hard drives or localized operating systems. Applications are either run directly on the server and used via a terminal program, or they are downloaded from the server and executed locally within the thin-client's RAM. The thin-client, however, is far removed from it's cousin the mainframe terminal. Thin-clients utilize Windows and Unix-based graphical applications as a normal PC or workstation, but from the server side, not the client. It is traditional host-based computing with a significant twist: full functionality with not only host-based applications, but also the full array of client/server and PC-based programs – all residing on the server and administered and configured there. The thin-client has evolved from client/server computing as client/server evolved from host-based computing.

Few would disagree with the fact that costs of client/server computing have begun to outpace most organizations' capacities to keep up. PCs are generally underutilized in proportion to their processing and storage power and they are exorbitantly expensive to maintain a point we will outline later. In client-server computing, most applications are developed along the "fat client" model. (Sheehan, 1998). Servers primarily function as repositories for data and shared code, while the client (PCs and workstations) are responsible for much of the processing. As programs have moved from text based to GUI's, the PC has become fatter, and the costs of configuring and maintaining the PC to run a multitude of memory intensive, locally loaded programs have skyrocketed. A typical staff PC running NT Workstation 4.0 at Galvin Library, for example, will be loaded with Microsoft Office 97 suite; WordPerfect, the entire Netscape Communicator suite, the Adobe Acrobat suite for document imaging, and an array of Online Public Access Catalog (OPAC) and Integrated Library System (ILS) software. A typical public area PC will run a current version of the Netscape browser along with a host of plug-in applications and local security programs. Our default configuration for one of these machines is 64MB RAM and a minimum 233 MHz Pentium processor, double the requirements of just a year ago. The average price of a networked PC in the Galvin library, fully configured, networked, and properly licensed for all installed software, is approximately $3,000 out of the box. Adding to this price is an upgrade cycle for both hardware and software that requires an almost constant allocation of resources and time. Public area workstations pose an even larger challenge and, on average they consume twenty-five percent more technical support time than staff PCs because of high volume use and user tampering, which can frustrate even the most experienced of PC technicians. The current client/server conundrum offers some hope towards greater efficiency in this regard. As PC technology improves and software becomes "thicker," upgrade cycles become more relentless, and asset volatility reaches unjustifiably high levels, organizations will be compelled to explore alternatives to the "fat client" general use machine. Sheehan sums up the situation as follows:

> "The same problem occurs everywhere…PCs have to be replaced with bigger, faster, 'thicker' ones. Expensive network connections need to be upgraded to meet the need for speed. Total cost of ownership figures are genuinely frightening." (Sheehan, 1998)

Thin-client technologies offer a new approach, one that moves beyond client/server towards a network centric model, reducing ownership costs and centralizing network resources. We will begin our discussion of thin-client computing with some basic definitions. We will outline the differences between the competing technologies involved in network centric computing and make recommendations as to what we think is appropriate for an academic library environment. We will also go into further detail on the subject of TCO, as all of the advantages of thin-client computing are inextricably linked to the economic issue.

There are two types of thin-clients, each markedly different from the other. Network computers or "NCs" are manufactured by the likes of IBM, Sun, and Acorn Computers. Sun thin-clients, commonly known as JavaStations, are the biggest market leaders in this field. NCs contain RAM, a processor, and input devices. They are connected to the network via an Ethernet port (although alternative configurations such as token ring are also supported to some degree), and boot directly from the server. Once the boot process begins, the server downloads the NCs operating system into the thin-client's RAM. Requested applications are also downloaded in this manner. NCs such as JavaStation run one program at a time. Because of the inherent processor requirements to run a downloaded OS and applications from the server, NCs are heavily equipped out of the box. A typical JavaStation is configured with 32 MB of RAM and must support newer networking standards such as fast Ethernet and ATM in order to run at acceptable speeds as compared to their PC counterpart. In the case of NCs, the "fatter" a thin-client becomes, however, the less it becomes distinguishable from a PC seemingly reverse evolution that is becoming a source of humor for many in the computer industry, especially PC manufacturers.

The second type of thin-client technology the Windows Terminal or, "WT" comes as a result of a strong development push over the last three years by Microsoft and industry partners such as Citrix, the purveyor of the widely popular server-based Winframe products commonly used at many universities today. Windows terminals more closely typify the idea of network centric computing in that they are completely reliant on the server for everything that they do. When booted, a WT notifies the server that is present on the network. No OS download occurs. The WT simply emulates the Windows (NT) environment that is running on the server. The Windows environment and its associated variables that appear is contingent on the user login profile and the published applications available, similar to the "roaming profiles" model used on NT and Windows 95 LANs. Processing on the WT is limited to keystrokes, screen paints, and mouse clicks. The server does the rest. A typical WYSE WT will come pre-configured with four to eight MB RAM, a processor, and input devices. The WT will also house a ROM chip which can contain data such as a static IP address and configuration information for local peripherals such as storage devices and printers. WYSE , Tektronix, and Boundless Technologies are the leading manufacturers of Windows terminals.

Each technology, the NC and the WT, offer advantages and disadvantages. Before embarking on a discussion of the differences, we will begin with the mutual advantages offered by both.

Network Management and Technical Support

The cornerstone of thin-client technology and, its "greatest virtue" (Sheehan, 1998) is of course, the fact that software environments are stored completely on the server side, allowing the kind of centralized control that has been long sought after but by no means perfected by the producers of PC-based network operating systems such as NetWare (ManageWise) and NT (Zero Administration). Thin-clients are essentially "dumb" boxes that serve as access points to the network, not partners with the server as in the client/server model. Because they do not run volatile local operating systems, network administrators can focus their concentration on the server rather than the client. Of course, in a network centric model, the server must be fairly robust, a situation that spawns new support issues. Nonetheless, the larger the number of PC clients on the network (especially PCs that run only a few applications -- a point we will touch on later) the more compelling the case for centralization with thin-clients and its associated management advantages. Asset control becomes manageable when compared to a network dotted with a bewildering array of PC makes and models scattered throughout the organization. In a typical LAN-based, PC-oriented environment, IT managers, on average overestimate their hardware assets by 32 percent. (Wilson, 1998)

Software
Because thin-clients depend completely on the server for their operating systems and applications, updates and upgrades to programs can be done at a single point, eliminating the need for technical support staff to attend to each PC on the network, either directly or through automated (although incredibly complicated) server-to-client downloads. Licensing can also be better maintained, an advantage made all the more critical by the fact that, the average workplace PC contains approximately $405 worth of unlicensed software. (Ibid.)

Security
Although this is a seemingly simple point, it cannot be understated. Thin-clients do not have corruptible operating systems, because they do not contain hard drives. Software (read, viruses) cannot be loaded onto the desktop to wreak havoc. Those few users who may have the need to download software onto the server are limited by environmental constraints as defined by the server administrator. These constraints are far more secure and manageable than anything that can be done on a desktop PC.

Cost
Contrary to what we see in the consumer retail PC market, the average cost of a PC for institutional use has not seen the drastic reduction in price enjoyed by the home user PC makes and models. In 1995, the Galvin library spent approximately $3,300 for a Pentium 75 MHz PC with a 17" VGA monitor and 16MB RAM. In 1998, we spend approximately $3,300 for a 300 MHz Pentium II PC with a 17' monitor and 64MB RAM. System requirements have risen with advances in software, and the upgrade cycle has grown shorter. Although there are cost recovery issues associated with thin-client computing–namely the need for professional level technical staff, along with fat servers -- the costs of NCs and WTs machines are striking when compared to PCs. The following diagram contains a sampling of PC and thin-clients prices as quoted directly from the manufacturers. PC configurations are based on the standard requirements for public area PCs in Galvin library (300-350MHz processor; NT Workstation 4.0; 64 MB RAM; 17" color monitor). Thin-client configurations are based on manufacturers recommendations for PC replacement on a 10BaseT network supporting Windows and Web based applications. 17" monitors are included in the thin-client prices.

PC and WT (Thin-Client) Price sampling as of December 1998
Average Cost of PC: $2464.00
Average Cost of WT: $1125.00

Choices in Thin-Client Technologies
Windows Terminal (WT) and Network Computers (NC) differ in several key areas, each posing its own challenges to the library IT professional. In general, NCs require more computing power on the client side and less on the server side. WTs require very little on the client side, but rely on very "thick" servers. NCs rely on UNIX servers, while WTs utilize run off of the Windows NT server platform, generally in conjunction with the aforementioned Citrix Metaframe product. WTs offer greater flexibility than NCs: PCs of all stripes can be transformed into WTs using the Metaframe product. Citrix claims to have successfully tested it's ICA architecture on

generations old PCs, including 386s, with little or no performance degradation. (Citrix, 1998). Both systems utilize network bandwidth differently, with NCs generally requiring a larger pipe, especially during the slow boot process during which the operating system downloads into the client's memory. Finally, because of their contrasting platforms NCs and WTs require different skill set for network administrators. The following list offers a breakdown of the key differences between the two technologies by category:

NCs		WTs
	Application Support	
Support for Java applets and/or programs written for native NC processor		Support for DOS and 16/32 bit Windows apps
	NOS Support	
UNIX/Java		Windows NT
	Client Hardware	
Specifically manufactured NC device		Specifically manufactured WT device or recycled PC, Apple PC, or UNIX workstation
	Bandwidth Requirements	
Applications and OS downloaded as needed – high bandwidth utilization		Application separated from user interface -- highly efficient bandwidth utilization using ICA
	Systems Staff Expertise	
UNIX/Java – high level of expertise/training		Windows NT (Terminal Server) Citrix Metaframe – high level of expertise/training

At Galvin Library, we have begun a thin-client implementation using Windows Terminals. WTs offer the flexibility we require, in particular for public area PCs and departments where staff members need access to only a limited range of applications, most of which are Web integrated via the library intranet or the Internet at large. In the past, small to mid-sized academic libraries have not been able to seriously consider thin-client technologies because network computing was limited to untried, expensive UNIX platforms such as Java. Network centric computing has been associated with hesitancy, mainly because of the "Java Initiative, and having to embrace a whole new set of applications." (Jacobs, 26.) Most libraries in this class do not require users to have access to specially written Java and UNIX applications beyond what is integrated into Web based services. For these libraries, Web and Windows Online Public Access Catalogs (OPAC), office productivity software suites, browsers, and Integrated Library Systems (ILS) have completed the Windows-centered circle. For example, users who access public area workstations at Galvin library require a browser and it's associated helper applications for full access to a range of library resources. This includes digital collections, electronic reserves, OPAC, and subscription based, Web accessible databases such as Proquest of University Microfilm International and Engineering Information of Elsevier, to name a few. All digital library resources are integrated into the Web environment. Staff also require Web access, as well as a host of Windows programs such as GroupWare, email, document imaging systems, ILS database access (via IP directly to the server), and the standard MS Office suite of applications. All of this takes place within the context of a Windows NT 4.0 desktop environment. The library network has evolved to a Web/Windows environment, mirroring trends in the rest of higher education as well as the corporate world. In the context of this Internet-via-Windows environment, network centric computing based on the WT model offers libraries a leveraged alternative to NCs. A recent article on subject in a leading computer trade magazine summed up the predicted popularity of WT as follows:

> "Windows based terminals are important, according to users and analysts, because unlike early network computers, they were specifically designed to serve the huge installed base of Windows users. Through add on software, they also offer access to non-Windows applications and are *server centric*." (Ibid.)

Indeed, Windows is ubiquitous. Increasingly, libraries are becoming more in step with the corporate world in that applications are being standardized and version control enforced in order to contain software license and support costs. Internet access, platform independent in nature, is generally handled by using a browser written for MS Windows. With some instances of exceptions such as Apple PCs (which can still be used as WTs), Windows 95 and NT are the operating systems of choice for most academic libraries.

There are two components to a network using WT technology: Windows NT Terminal Server 4.0 and Citrix Metaframe. Both are the results of a two-year, joint development project between the two companies. Citrix defines its technology within the context of its integration with Microsoft as "being made possible by two Citrix technologies: Citrix ICA and Citrix MultiWin, the technology licensed by Microsoft to jointly create NT Terminal Server Edition," enabling "multiple users to simultaneously access applications running on a single server." (Citrix, 1998)

Using Metaframe as a base, Citrix defines its interpretation of thin-client computing as follows:

> "Thin-client/server computing requires a multi-user operating system. This allows multiple concurrent users to log on and run applications in separate, protected sessions on a single server. Thin-client/server computing also requires a remote presentation services protocol capable of separating the application's logic from its user interface, thus allowing only keystrokes,

mouse clicks, and screen updates to travel the network. Finally, thin-client/server computing requires centralized application and client management. This type of server-based computing model is especially useful in that it allows enterprises to overcome the critical application deployment challenges of management, access, performance, and security." (Ibid.)

Although Terminal Server can be used without Metaframe, the addition of Citrix's ICA to the model provides some very powerful functionality unavailable by using Terminal Server on it own. Any WT network must support either "Microsoft's Remote Desktop Protocol (RDP) or Independent Computing Architecture (ICA). For network administrators needing flexibility, RDP is quite limited without ICA. Among the differences are:

- Terminal Server supports only IP and offers no method for remote drive mapping. Remote drive mapping is especially important for using attached peripheral devices such as floppy and ZIP drives. ICA supports remote drive mapping and multiple protocols.
- RDP does not allow for object linking and embedding (OLE) cutting and pasting.
- RDP does not allow for seamless windowing.
- RDP does not allow for remote configuration of client machines. ICA allows for server-based distribution of client configurations.
- RDP uses 200K and 300K per connection at peak. ICA, originally developed as a client to server protocol to work over standard telephone lines, makes much better use of bandwidth, peaking between 15K and 20K per connection.
- RDP will not support asynchronous connections. ICA supports synchronous and asynchronous connections.
- Web delivery of applications is not possible without Metaframe. This is especially important if one want to launch applications via HTTP links. It is crucial in Intranet environments.
- RDP does not allow for load balancing. ICA allows for load balancing among different servers, greatly improving processor utilization and allowing for unlimited network growth.
- RDP does not allow for secure, across the wire encryption. ICA includes support for secure encryption.
- RDP does not allow for session shadowing, the ability to monitor sessions from the server. For various administrative and management purposes, this functionality is essential. ICA offers session shadowing under a variety of circumstances.
- Windows Terminal Server and RDP do not support the full range of clients as Metaframe and ICA. These include Apple PCs, JavaStations, DOS machines, X-terminals, etc.

Public access workstations in academic libraries have presented us with management, access, and performance challenges. Deploying the needed applications in the library environment has been complex and time consuming. Library IT staff have to physically distribute applications to every client device, tackle the issues associated with the new version updates, and support the multiple system configurations in a number of branch libraries on different campuses. When some of the older equipment that is not well-suited for high-bandwidth applications shows poor performance, many students simply abandon using a resource the library has already invested thousands of dollars in to facilitate access to textual information. Security has also been a major challenge. Critical applications and data reside on client desktops which increases the risk of unauthorized use, and in turn, the time IT staff have to spend to secure those applications.

Use of thin-client/server computing in academic libraries is not limited to public workstations. It can also be extended to both technical services and circulation departments. Thin-client/server extends access to line-of-business applications to existing devices, from fat clients to a broad range of thin-client devices. It also ensures that users can access 16 and 32 bit Windows-based and Java applications without having to rewrite or record them.

Because all applications are deployed, managed, supported, and executed on the server, the library can utilize much of its older equipment, such as PCs and notebook computers, Windows-based terminals, and Unix workstations. In a thin-client environment, all clients function as thin-clients and all have the ability to access and work in highly graphical, Window-based applications – including, of course, Internet browsing.

The suitability of thin-client technology extends to other parts of the university where customer services such as registration, financial aid, and accounting functions are done. However, as Sheehan noted: "In offices, classrooms and laboratories where PCs are equipped with a variety of software tools and their users frequently push the limitations of the machines – an NC or WT environment may prove too confining and may actually decrease productivity." (Sheehan, 1998) Indeed, departments where users need access to a small number of applications seem best suited for thin-clients. For public area workstations, for example, thin-clients are excellent alternative to top heavy desktop PCs. Many systems librarians agree that the technology has reached the point where the cost benefits, in particular in libraries with dozens or even hundreds of PCs dedicated for public use serve only as Web browsers, WTs are becoming a viable solution. As bandwidth and processor issues are worked out, thin-clients should prove attractive to users whose computing needs are more advanced. Many organizations are beginning to implement thin-clients further up the "user chain." When users realized that they could run their Windows applications over thin-client networks, explained one information manager, it really "opened their eyes. I think thin-clients are going to be pervasive, and they are working well for us for everything but extreme power users." (Wilson, 1998)

After the successful deployment of seven thin-client public access units, two of which were older PCs, IIT library has begun the conversion of many of its public and service desks workstations to a WT environment. And although it is early to predict the total financial savings we will achieve, the picture is getting a bit clearer when we compare the PC solution approach we usually follow to a thin-client one. With the conversion of 40% of the current units, factoring in the average PC life span of three years with regular upgrades, and adding technical staff support time, IIT libraries may reach a total saving of 35-45% per replaced PC. Zona Research has predicted a five-year total cost of ownership reduction of 57% by using a model containing 15 thin-clients and comparing with PCs. (1996) Other predictions by Microsoft and Gartner Group suggesting savings ranges of 22% to 46%, have been cited in recent literature. Thin-client technology is still in its early years, and more time is needed to judge its effect on services and the library budget. However, we believe that our early experiences with the technology, as well as continuing evidence from other sectors of higher education and industry, will show that our cost savings estimates are well within reason.

Conclusion and Recommendations

James Burke noted once that, "Never have so many understood so little about so much." A case in point when IT managers and library directors are faced with the difficult task of delivering technology-dependent services whose value is difficult to quantify and hard to measure. With the acceleration of information technology use in academic libraries, we find ourselves faced with the constant challenge of balancing services, costs, and outcome. The gap between our budgets and the cost of acquiring and maintaining IT is widening year after year. University administrators are puzzled by the falling prices in the home PC market and the IT department's continuing requests for additional monies. We must create new alternative to the spiral costs of desktops. Thin-clients are by no means a panacea, and they pose a host of new problems not unique to network centric computing but certainly more pronounced there. These include the risks associated with single points of network failure; the need for highly trained, technically competent IT staff to manage a server based environment; the high costs of "thick" servers and redundant systems; and, finally, the inevitable political problems associated with re-centralizing control of computing resources in the workplace. We believe, however, that there are workable solutions to these issues and that they do not present significant obstacles to thin-client computing. The management and cost benefits offered by these technologies are compelling, as is the case made by the fact that technology environments are evolving towards platform independent, network centric models. We believe that libraries in particular -- and higher education in general -- should start to pay attention.

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