Is thin-client becoming the new paradigm in networking technologies? A research paper.

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ABSTRACT

This research paper focuses on the thin-client networking. It strongly supports the idea that this type of network is going to become the new paradigm in networking because of these benefits of social and economical impacts: a) savings in upgrading software, b) savings in recycling old hardware, c) ubiquity: have communication access through the network at any time and everywhere, d) security, e) vast content of data and information, f) fastest application deployment, among others. Gives two examples of successful applications of thin-client networking in libraries: a) State University of New York at Stony Brook and b) at the The Tulsa City-County Library System in Oklahoma and its 22 branches. And reviews superficially some of the major products and companies dealing with thin-client networking, it includes a directory. Remarkable is the section of Glossary where the reader can go to look up and certainly find every new term.

INTRODUCTION

OBJECTIVES

The particular topic chosen was thin-client networking [see Glossary]. We intend to give the reader a clear and brief, but substantive introduction to the advantages and disadvantages, and trends of the so called "new paradigm" of thin-client networking and some successful applications to libraries. Is thin-client becoming the new paradigm in networking? This is the major topic this paper will try to answer in a more issued-oriented content than in a technical-oriented.

METHODOLOGY

These are the terms used as strategies for retrieving information as sources for the paper:

a) Thin-client server

b) Server-client server

c) Client or clients

d) Network

e) Library or libraries

f) Thin

g) Trends

h) Networking

i) Directions

j) Research

As a value added to a better understanding of this paper, we appended at the end an interesting and comprehensive Glossary section, so the expert or neophytes reader can go over some technical terms which are linked by calls.

1. PURPOSE OF STUDY

By the end of 1996 Jim Kurose synthesized the last thirty years of networking and communication as to provide valuable guidance for future research in an article titled: "Future Directions in Networking Research". He mentioned 7 lessons learned during that period of time and that have to be taken into account as a basis for the next 5 to 10 years of research: 1) importance of the "right" service architecture [see Glossary], 2) multiservice network architectures, 3) insufficient bandwidth [see Glossary], 4)

importance of scalability and interoperability, 5) reliability, 6) security, and 7) evaluation methodology.

The first one is the cornerstone for this paper. He states:

"Importance of the "right" service architecture. The startling success of Internet applications such as the WWW [see Glossary], and Internet [see Glossary] audio illustrate the importance and potential of rapid, widespread network application deployment. This quick deployment was possible because these applications were built at the "edges" of the network, utilizing existing services. Difficulties in adding new telephone-based services, which require modification of the subnet [see Glossary] services, which require modification of subnet infrastructure, provide counterpoint. Thus defining a minimal but sufficient set of subnet services to allow future, yet-to-be-discovered applications to be built and deployed is critical research issue. What are the right subnet services for future applications that are likely to require mobile, real-time, and group communication? [1] Four years later and as a Nostradamus prediction this is what our society is facing: an ever crescendo demand for optimization of communications ways via computer networks, mobile computing, mobile networking, wireless networks and the like.

Thus, we try to state clearly that the object of information technology –in the way of networking technologies-- research is society, not technology itself. To what David Clark in his article "Strategic Directions in Networks and Telecommunications", also in 1996 and with a futuristic vision enunciates: "the future is driven by societal choices from available technologies. Our job, as the research community, is to enlarge the space of technical possibilities in a way that creates new choices that are value to society. The

choices we make in the research we do will drive the future through creation of these possibilities." [2] He also refers to some of the trends of the moment similar to the mentioned above, but in a more technical language which is not intended in this paper, issues like: 1) computers in the network, b) protocols and network architecture, c) partitioning functionality, d) reliability, e) scalability, f) fundamental limits, g) the centrality of the application, h) the network research process, and i) research in new applications.

And what all of this has to do with thin-client networking? When studying a problem it may be suggested that we dig into the strategic research issues of it, not only the problem per se. Also it is advised we link our very particular problem with the biggest category it belongs to, as to have a well balanced picture of the most general and particular, our particular tree and the whole forest it belongs to. Hence, society is claiming from information technology world: bigger benefits of computing use, true value for what they pay, mobility, global reach and communication; to communicate, to trade, to be productive at work, school, home, and in other milieus, to be educated, to have fun, etc. More of the same. So, what we can say of this is we need to find the new technologies that absorb the old ones and improve them and advance them far beyond this universe we live in.

By saying so, when new technologies arrive to market, society, the current ones begin to tremble because of this bothersome advent. Why? Because their lives seem threatened, the new comers are cutting and bleeding edge knives, want to cut and make bleed whatever comes on their way.

Thin-client networking is considered a newer technology compared with its counterpart fat-client [see Glossary] one. The arrival of thin-client it has not been quite easy and simple. Its concepts, research, applications and products are not quite well stated or implemented because our society is ruled by markets, where all companies in the world are fighting to find, place and maintain their markets, shares and niches, so the development of thin-client is the development of a whole new market where not all of the current actors are taking a piece of the share.

By keeping that in mind we must be aware that most of our findings in this paper describe an open fight among companies which develop thin-client networking software, hardware, architectures, conceptual models, etc., hence, it is not so easy to have the sharpest picture of this so fuzzy and blurred subject.

2. BACKGROUND

Andrew C. White in a 1998 article states: “while much of the marketing of thin-client technology is focused on current corporate interest in reducing the total cost of ownership of computer support, the basic concepts and implementations of thin-client architecture date back to the 1970.” [3] On the other hand Jerry Golick in a 1999 article notes: “the groundwork for thin-client networking was laid in the early 1990s when the Gartner Group introduced its now-famous reference designs for client-server systems”. [4] [See Graph 1. below to see Gartner Group reference design, taken from Golick, p. 33]

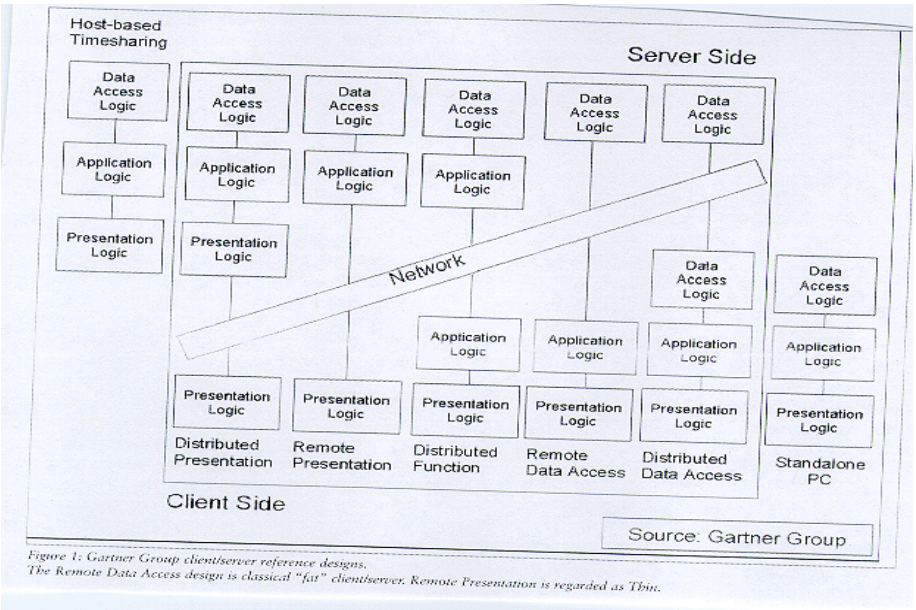


Figure 1: Gartner Group client/server reference designs.
The Remote Data Access design is classical "fat" client/server. Remote Presentation is regarded as Thin.

Graph. 1. Figure 1. Gartner Group client/server reference designs. The Remote Data Access design is classical "fat" client/server. Remote Presentation is regarded as Thin..

I agree with White in the way that thin-client networking upraised in 1970. Sheehan seconds us too by saying: "The thin client story has its roots in client/server technology. In the beginning was the mainframe, a powerful computer for its day with access limited to a few elite programmers." [5] So, the mainframe computer [see Glossary] was a kind of "server" or host [see Glossary] of those days and all the peripherals such as terminals, printers and others connected to it were the sort of "clients". All the processing was made in the mainframe computer called "dumb" because it did not process numbers or graphics, only text. For online communications the mainframe serving as a host had a modem [see Glossary] connected to it and a telephone line, that is how remote computers could reach it. The 1980s brought the minicomputers and then the PC and with them the ever-ascending graphical revolution –it is not free mankind has to "clonize" everything from nature and capture the images as real as possible. LANs, WANs, and MANs made its way, the client-server computing [see

Glossary], its architecture came along; it was the time for fat cows, every single PC no matter if it were a client began the kitchen's long run, becoming fatter and fatter, glutton of eating and eating too much software, packets for this packets for that, upgrading this, and not happy of being fat, definitively at the end replaced in the desk of honor by another bigger glutton. But the modern version of thin clients came to put PC world on diet.

3. DEFINITION OF THIN-CLIENT NETWORKING

What is then a thin client? The corporation Automation Control Products gives us the answer to this FAQ:

"A thin client is a computer with no hard drive or other moving parts that can lead t machine failure. Thin clients operate on a mainframe paradigm. All instructions and sessions come directly from a central, secure server. Each thin client realizes its own NT [see Glossary] session and operates independently from the other thin clients. Because thin clients have no hard drives, there is no loss of data if a local thin client gets damaged or has a local power failure. [6]

That is the clearest and sharpest definition we can give of the term, it is more likely any corporation developing and/or selling thin client products will have a definition as clear as this. But we mentioned before that all about this is a fight of fat-clients versus thin-clients and/or vice versa. A whole industry came up in the early 1990s bearing the new flag called Network Computer or Computing (NC), the new computer architecture named to overthrow the PC establishment. That is why we think Golick set the advent of thin clients in the early 1990s, because of NC.

For example Steven J. Bell throws these darts right to the target: “Depending on what you read, the network computer is:

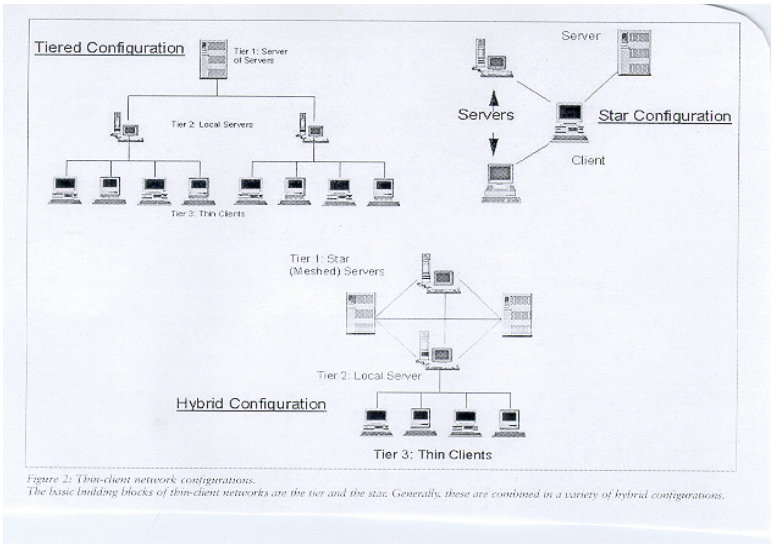
- computing’s fourth wave –the next logical evolution form mainframe to mini to PC to network computer
- an unwelcome return to the “dumb terminal” model of centralized computing
- a simplification of computing that will save companies millions of dollars in software upgrades and hardware maintenance
- a plot by Microsoft’s competitors to circumvent Microsoft’s control on the Internet
- the catalyst that finally makes computers as common as televisions and telephones for consumers. [7]

And here is where the war of terms among thin-client companies begins. Golick gives his definition:

> “a thin-client system is defined as a cooperative processing environment that primarily implements applications based on remote and distributed presentation designs. This environment that primarily morphed into a distributed function design through the use of applets [see Glossary] as required. As with any client-server system, the primary intent is to provide a single system image to the user. Also note that there is no need for a network computer in this definition. Network, or diskless, computers, might be used in a thin-client network, but they are not required. Thin-client networking is not about what you have, but how you use what you’ve got.” [8]

There is no much discussion about this, both opinions come from the academic and research community, the problem is that the market is a devastating whirlpool which sweeps everything; market fights may get confused even the most savvy one, besides, Bells' statements come from 1996, while Golick's from 1999. Golick himself states: "Fortunately, we can leave these less-than-illuminating discussions behind. Thin-client networking is no longer focused on hardware, but rather on architecture –the architecture of building seamless network applications to maximize the networker's ability to manage the network while at the same time preserving the autonomy of end users to select the most suitable mix of hardware and software to meet their requirements." [9]

How are the configurations in thin-client networking? They can be Tiered, Star or Hybrid (a mixture of Tiered and Star). Graph 2. below can give you a better idea:



Graph. 2. Thin-client network configurations. The basic building blocks of thin –client networks are the tier and the star. Generally these are combined in a variety of hybrid configurations. [Source: Galick, p. 37]

4. ADVANTAGES AND DISADVANTAGES OF THIN-CLIENT NETWORKING

ADVANTAGES

It is the intention of this paper to support the idea that thin-client networking has more advantages than disadvantages.

- Lower support and distribution costs. Since the applications mostly run on servers, there are fewer machines to configure.
- Interface portability. User profiles and interface specifications can be maintained via a server process. This means that as the end user logs onto the system, his or her interface profile is downloaded in real time. The implication is now that the user's personal interface is now available from any piece of hardware.
- Faster Mean Time To Repair. (MTTR see Glossary). Today, the failure of desktop hardware can be catastrophic to the individual user. While some files may be kept on the corporate or departmental server, many of them are stored locally. These must be recovered before the user can continue to work. In the worst case, the entire local station may have to be rebuilt, reconfigured and restored. This is not the case in a thin-client network. All personal files can be kept on a back-office servers. In the event of an end-user machine failure, simply replace the old machine with a new one, log on and continue to work. This reduced MTTR also implies a lower cost of outage when these failures occur.
- Capacity planning. Networkers will be able to perform better capacity planning in thin-client environment. It will be possible to measure and evaluate the actual

work being performed. This data may be plotted so that trends can be predicted. [10]

- Hardware Flexibility. Because the majority of processing in a thin client network occurs at the main server, workstation power is less important than in a client/server network, this avoids constant updating of hardware.
- Great to WANs [see Glossary]. Thin client networks are called “thin client” because the amount of data transferred over the network is considerably smaller compared to client/server networks. This reduced data transfer is optimal for WANs. Because WANs rely on transferring data between geographically different locations via communications lines, having reduced network traffic improves overall network performance”. [11]

DISADVANTAGES

Basically their disadvantages fall on the rooted fight between fat-client mainstream and thin-client, where the market share of fat-clients do not want to or it is investing or opening to the advantages of thin-clients. Thin-clients by now are focused on corporations or big non profit organizations and not in small businesses or individuals, but the trend is to become the revolution the PC used to be, the NetTop. Another disadvantage is when the server goes down will affect many clients, though much emphasis is made on its robustness as to not let that happen.

5. TRANSITION FROM FAT TO THIN-CLIENT NETWORKING

There are several issues that have to be taken into consideration by networking managers to a smooth migration from fat to thin-client networking. Vicky Harris considers this: “The drive to put overweight clients on a reducing regimen has yielded new devices and architectures that offer creative solutions to the issues of narrow bandwidth, deployment to remote users, complex administration, and high ownership costs. The first step on the road to thinness is a careful evaluation of business, user, and application requirements to determine which architecture –or hybrid—can deliver the best combination of manageability, access, performance, and security” [11] Although there are some applications on the academic and library environments, this transition is mostly taking place in the corporate environment. These are the most remarkable:

POSITIVE ISSUES

- Thin-client networking will leverage the existing infrastructure of the organization, which means that new applications can be deployed in the existing desktop hardware/software environment. The hardware costs may not be reduced, but the current infrastructure will last longer which means savings on the long run.

POLITICAL ISSUES

- The technical support specialists who have fat-client product certification may feel threatened their jobs and they certificates already earned if the desktop environment becomes simplified.

6. THIN-CLIENT NETWORKING APPLIED TO LIBRARIES

We found two remarkable examples of thin-client networking applied to libraries.

1. State University of New York at Stony Brook. In 1998 they implemented a thin-client network to provide public Internet access for over 22, 000 faculty, staff and students, in addition to the local community. By extension they networked the University Libraries as well. The products selected were: Microsoft's Windows-Based Terminal (WBT) from Boundless, Pentium-based servers from DEC and WinFrame from Citrix [see next section below to find out about companies]. [12]
2. The Tulsa City-County Library System in Oklahoma has 22 branches linked to a central library. The system installed a thin-client network to launch their databases on CD-ROM from the central library and to be accessed from the branches. The product chosen was Citrix WinFrame. [13]

7. PRODUCTS AND COMPANIES

PRODUCTS:

This is a brief list of products and companies, to consult the companies go to the subsection of companies below and directory and enter their web sites to know more about their products:

PRODUCT	**COMPANY**
1. MaxSpeed Super VGA MaxStation	Max Speed Corp. [14]
2. Citrix Extranet VPN [see Glossary]	Citrix Systems, Inc. [15]
3. Citrix Nfuse	Citrix Systems, Inc. [16]
4. Wyse 320Ole, Winterm 8360SE and WinCat	Wyse Technology [17]

Nota Bene: The major product and company in the market is Citrix and to which corporation you think it belongs to? Right, to Bill Gate's realms.

WEB RESOURCES:

NETWORK COMPUTERS

Sun Microsystems JavaStations-- http://www.sun.com/javasystems/krups

IBM Network Station-- http://www.pc.ibm.com/networkstation/products

NCD Explora-- http://www.ncd.com/pexp/pexp.html

Neoware NeoStations-- http://www.neoware.com/neostation_info.html

Acorn Corporate NC-- http://www.acorn.com/acorn/products/nc/corpnc.html

WINDOWS TERMINALS

Wyse Winterm-- http://www.wyse.com/winterm/

Tektronix ThinStream-- http://www.tek.com/VND/Products/ThinStream/

Boundless Viewpoint-- http://www.boundless.com/network/

NCD Thinstar-- http://www.ncd.com/thinstar/thinstar.html

Neoware @workstation-- http://www.neoware.com/@workstation_info.html

SERVER PRODUCTS

Microsoft Windows NT 4.0, Terminal Server Edition

http://www.microsoft.com/ntserver/basics/TerminalServer/default.asp

Citrix WinFrame (for Microsoft Windows NT 3.X servers)

http://www.citrix.com/products/winframe.asp

Citrix MetaFrame (for WinFrame and for Microsoft Windows NT 4.0, Terminal Server Edition)

http://www.citrix.com/products/metaframe.asp

GENERAL INFORMATION:

NC World online magazine (no longer publishing new material as of July 1998, but with valuable archives still available)

http://www.ncworldmag.com

DIRECTORY:

Boundless Technologies
100 Marcus Blvd.
Hauppauge, NY 11788-3762
Phone: 800/231-5445
http://www.boundless.com

CITRIX SYSTEMS, INC.
6400 Northweast 6th Way
Fort Lauderdale, FL 33309-
Phone: 954/267-3000
http://www.citrix.com

DIGITAL EQUIPMENT CORPORATION
111 Powdermill Rd
Maynard, MA 01754-1418
Phone: 978/493-5111
http://www.digital.com

EXUDUS TECHNOLOGIES
11130 NE 33rd Pl # 250
Bellevue, WA 98004-1400
Phone: 425/803-5400
http://www.exodustech.com

Insignia Solutions
41300 Cristy St.
Fremont, CA 94538-3115
Phone: 51/360-3700
http://www.insignia.com

MaxSpeed Corporation
Palo Alto, Calif.

Phone: 800-877-7998

http://www.maxspeed.com

OPERA SOFTWARE

Z.A. de Courtaboeuf 12,

Avenue des Tropiques 91943

Les Ulis Cedex, France

Phone: 011-33-1-69-29-39-39

http://www.prologue-software.com

SUN MICROSYSTEMS, INC.

901 San Antonio Rd.

Palo Alto, CA 94303

Phone: 408/276-1211

http://www.sun.com

8. TRENDS

We will make a checklist of things that seem to be the trendy issues on thin-client networking:

- ✓ Golick suggests us that the market is asking for a thin-client personal productivity suite that can maintain compatibility with the Microsoft file formats and offer a reasonable level of performance; the claim society makes to the information technology as mentioned before. [18]
- ✓ The converge of digital technologies such a voice, video and data will drive the requirement for a wide variety of thin devices. We are beginning to see indications of this in the next generation of cell phones, TV set-top boxes and even video game consoles. The rapid acceptance of ultra-light devices such as the Palm Pilot and Windows CE palmtops is further evidence of this trend. [19]

- ✓ As the Java language, object brokers and the Internet continue to evolve and mature, they will collectively form an infrastructure where new functionality can be dynamically delivered as required. This may give birth to the concept of "just in time" applications. [20]
- ✓ Academic software and interactive programs are easily run on thin clients configured with a monitor, network connection, a browsing engine and about 64 MB of memory. Thin client computers have become a driving force behind changing "desktops" to "Net-tops." [21]

9. CONCLUSION

Is thin-client becoming the new paradigm in networking? Let us see. Bell declares: "The NC approach is to create a completely new desktop computing environment. Shipped void of hard, floppy, or CD drives, the machine is totally dependent on the server computer for its operating system, software, and storage. The vision is modeled on the telephone or cable system in which the user's device merely connects to a powerful communication infrastructure. Remodeling the computer landscape includes a move to software based on Java [see Glossary] programs delivered by a central server. Interpretation: No Windows; No Microsoft software. [22]

We really consider thin-client networking despite of the market fights, the disputes of terms and despite certain things like this, is really becoming a new paradigm.

Major technologies are just pulling the others aside, i.e. satellites capture signals in the outer space and from that central flying headquarters repeater channels here down on Earth just get chunks of signal (data, information) and the ones who can afford it rent waves on the radio spectrum, signals and all types of data coming from those gigantic "server-like" source. Another example is television cable be via wires or wireless: there's a central headquarters which transmits the signals. Thin-client technologies are really moving fast, the inferred goals from this short and too thoughtful study are too overthrow PCs in the next 10 years since and to reduce the new NetTop to half or third the price of the current PC prices; more daring, the goal is to introduce one or many anorexic and skinny devices like people can afford radios or TV. We will see.

10. REREERENCES

[1] Kurose, Jim. (1996). Future Directions in Networking Research. ACM Computing Surveys, 28 (4es), http://www.acm.org/pubs/citations/journals/surveys/1996-28-4es/a214/Future. Retrieved online on 11/12/00 at: http://www.acm.org/dl/.

[2] Clark, David, Pasquale, Joseph, Et Al. (1996). Strategic Directions in Networking and Telecommunications. ACM Computing Surveys, 28 (4), p. 680. Retrieved online on 11/12/00 at: http://www.acm.org/dl/ .

[3] White, Andrew C. (1998). Toasting the Thin Client as a Viable Solution to Public Web Access. Computers in Libraries, 18 (10), p. 20. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[4] Golick, Jerry. Network Computing in the New Thin-Client Age. Mixed Media. Networker 3, 1 (March 1999), p. 33. Retrieved online on 11/12/00 at: http://www.acm.org/dl/.

[5] Sheehan, Mark. (1998). Thin Clients and Network Centric Computing. Online, 22 (6), p. 89 Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[6] Automation Control Products. Thin Client Technologies. FAQs about thin clients. Retrieved on 11/12/00 available at: http://www.acpthinclient.com/faq/index.shtml.

[7] Bell, Steven J. Computers Great-Less Filling. An Online Searcher Looks at Network Computers. Online (Weston, Conn.), 21 (May-June 1997), p. 52. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[8] Galick, p. 34.

[9] Idem, p. 33.

[10] Idem, p. 35.

[11] Kleaveland, Bruce. Thin Client and Internet Computing. Health Management Technology, 21 (11), (Nov 2000), p. 20. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[11] Harris, Vicky. (1997). Networking on Diet: Thin-client/server Computing. Managing Office Technology, 42 (10), p. 41. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[12] White, p. 20-21.

[13] Turner, Anna. (1997). Thin Client Architecture for Networking CD-ROMs in a Medium-sized Public Library System. Computers in Libraries, 17 (8), 73-75. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html.

[14] Byrne, Jason. (1998). MaxSpeed Takes New tack on Thin-client Networking. Government Computer News, 17 (3), 1-2. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html.

[15] Wagner, Mitch. Citrix Adds VPN Functions to Thin-Client Line – Early Customer Uses Tools to Connect with International Partners. Internetweek, 828, (Sep 11, 2000), p. 13. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html.

[16] Cox, John. Citrix Aims to Make Thin-Client Transactions Safer. Network World. 17 (37), p. 16. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html.

[17] Cox, John. Wyse Technology Redefines Thin Client Product Line. Network World. 17 (14) (Apr. 3, 2000), p. 10. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html. See also on this same company: Cox, John. Wyse Expands Thin Client Line. Network World, 17 (39), p. 188. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html. And McDougall. Wyse Technology's Thin Client Offer Full Net Access. Informationweek. 780, (Apr. 3, 2000), p. 113. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html.

[18] Golick, p. 39.

[19] Idem, p. 39-40.

[20] Idem, p. 40.

[21] Crocco, Jim. (1999). Introducing Thin Client Computing. Media & Methods, 36 (2), 15. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

[22] Bell, p. 53

BIBLIOGRAPHY

Automation Control Products. Thin Client Technologies. FAQs about thin clients. Retrieved on 11/12/00 available at: http://www.acpthinclient.com/faq/index.shtml .

Bell, Steven J. Computers Great-Less Filling. An Online Searcher Looks at Network Computers. Online (Weston, Conn.), 21 (May-June 1997), p. 52. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

Byrne, Jason. (1998). MaxSpeed Takes New tack on Thin-client Networking. Government Computer News, 17 (3), 1-2. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Chellis, James, Perkins, Charles and Strebe, Matthew. (2000). MCSE: Networking Essentials Study Guide. 3rd. ed. San Francisco: SYBEX, Inc.

Clark, David, Pasquale, Joseph, Et Al. (1996). Strategic Directions in Networking and Telecommunications. ACM Computing Surveys, 28 (4), p. 680. Retrieved online on 11/12/00 at: http://www.acm.org/dl/ .

Cox, John. Citrix Aims to Make Thin-Client Transactions Safer. Network World. 17 (37), p. 16. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Cox, John. Wyse Technology Redefines Thin Client Product Line. Network World. 17 (14) (Apr. 3, 2000), p. 10. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Cox, John. Wyse Expands Thin Client Line. Network World, 17 (39), p. 188. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Crocco, Jim. (1999). Introducing Thin Client Computing. Media & Methods, 36 (2), 15. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

Golick, Jerry. Network Computing in the New Thin-Client Age. Mixed Media. Networker 3, 1 (March 1999), p. 33. Retrieved online on 11/12/00 at: http://www.acm.org/dl/ .

Harris, Vicky. (1997). Networking on Diet: Thin-client/server Computing. Managing Office Technology, 42 (10), p. 41. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

Kleaveland, Bruce. Thin Client and Internet Computing. Health Management Technology, 21 (11), (Nov 2000), p. 20. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html

Kurose, Jim. (1996). Future Directions in Networking Research. ACM Computing Surveys, 28 (4es), http://www.acm.org/pubs/citations/journals/surveys/1996-28-4es/a214/Future. Retrieved online on 11/12/00 at: http://www.acm.org/dl/ .

McDougall. Wyse Technology's Thin Client Offer Full Net Access. Informationweek. 780, (Apr. 3, 2000), p. 113. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Sheehan, Mark. (1998). Thin Clients and Network Centric Computing. Online, 22

Turner, Anna. (1997). Thin Client Architecture for Networking CD-ROMs in a Medium-sized Public Library System. Computers in Libraries, 17 (8), 73-75. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

Wagner, Mitch. Citrix Adds VPN Functions to Thin-Client Line – Early Customer Uses Tools to Connect with International Partners. Internetweek, 828, (Sep 11, 2000), p. 13. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

White, Andrew C. (1998). Toasting the Thin Client as a Viable Solution to Public Web Access. Computers in Libraries, 18 (10), p. 20. Retrieved online on 11/12/00 at: http://ublib.buffalo.edu/libraries/e-resources/subject.html .

12. GLOSSARY.

APPLET. A little application. An applet can be a utility or other simple program. On the World Wide Web, there are many applets written in Java language which are attached to HTML documents. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

ARCHITECTURE. The design of a computer, software, or network. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

ASP. APPLICATION SERVICE PROVIDER. An Application Service Provider ("ASP") is a company that offers access to applications (such as software) and related services via the Internet that would otherwise be located on a company's own computers. Sometimes referred to as "apps-on-tap," ASP services are expected to become an important alternative, not only for smaller companies and individuals with small technology budgets, but also for larger companies as a form of outsourcing (Source: http://www.asp.com/Define.htm) **.** ASP has other meanings under the same acronyms but not as meant in here: 1.Association of Shareware Professionals. A trade association for shareware authors. Members submit shareware, which is tested and checked for viruses, then distributed on CDs. See also Association of Shareware Professionals 2.Active Server Page. A specification for a Web page that is dynamically created by the Web

server and contains both HTML and scripting code. With ASP, programs can be run on a web server in a similar way to CGI scripts, but ASP uses the ActiveX scripting engine to support either VBScript or JScript. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

ASYNCHRONOUS TRANSFER MODE (ATM). A network transfer method that transmits data in 53-byte packets called cells. ATM is most frequently used on WANs but it is sometimes used for LANs and MANs. ATM can reach speeds of up to 2.488 gigabits per second. ATM is frequently called cell relay. (Chellis, p. 569).

BANDWITH. In network communication, the amount of data that can be sent across a wire in a given time. Each communication that passes along the wire decreases the amount of available bandwith. (Chellis, Glossary).

CLIENT-SERVER ARCHITECTURE. A network architecture in which clients request data, programs, and services from servers. The servers then provide the data, program, and services to the clients. Applications written for the client-server architecture typically have different components for the server and for the client. Client-server architecture allows clients to exploit the processing power of the server. (Chellis, Glossary).

CLIENT-SERVER NETWORK. A server-centric network in which some network resources are stored on a file server, while processing power is distributed among workstations and the file server. (Chellis, Glossary).

DEDICATED SERVER. A computer that functions only as a server and is not used as a client or work station. (Chellis, Glossary).

FAT CLIENT. In a client/server environment, a client that does most or all of the processing leaving little or none that must be done by the server. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

HOST. 1.A computer connected to a network, that provides data and services to other computers.Services may include data storage, file transfer, data processing, e-mail, bulletin board services, World Wide Web, etc. 2.A multiuser computer that has terminals attached to it. . (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

HUB. A network connectivity device that brings media segments together in a central location. The hub is the central controlling device in some star networks. The two main types are active hubs and passive hubs. (Chellis, p. 568).

INTERNET. The biggest internet [short for internetwork, see in this glossary] in the world.This worldwide information highway is comprised of thousands of interconnected computer networks, and reaches millions of people in many different countries. The Internet was originally developed for the United States military, and then became used for government, academic and commercial research and communications. The Internet is made up of large backbone networks (such as MILNET, NSFNET, and CREN), and smaller networks that link to them.The U.S.National Science Foundation maintains a major part of the backbone (NSFNET). (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

INTERNETWORK. Two or more independent networks that are connected and get maintain independent utilities. Internetworks are joined by interconnectivity devices. (Chellis, Glossary).

JAVA. A cross-platform programming language from Sun Microsystems that can be used to create animations and interactive features on World Wide Web pages. Java programs are embedded into HTML documents. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

LOCAL AREA NETWORK (LAN). It is a number of computers connected to each other by cable in a single location, usually a single floor of a building or all the computers in a small company. (Chellis, p.6).

MAINFRAME COMPUTER. A "mainframe" originally meant the cabinet containing the central processor unit of a very large computer. After minicomputers became available, the word mainframe came to refer to the large computer itself. The older computers used many large vacuum tubes and generated a lot of heat, thus requiring specially air-conditioned rooms. A single computer might have hundreds of users at a time. Today, because the large vacuum tubes have given way to transistors, a desktop personal computer can have as much power as a mainframe computer that once filled a whole room. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

MODEM. A peripheral device that connects computers to each other for sending communications via the telephone lines. The modem modulates the digital data of computers into analog signals to send over the telephone lines, then demodulates back into digital signals to be read by the computer on the other end; thus the name "modem" for modulator/demodulator. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

METROPOLITAN AREA NETWORK (MAN). A network larger than a LAN, where each message is rooted through the network independently. (Chellis, Glossary).

MTTR . The entry we mean here is Mean Time To Repair. The average amount of time needed to repair a failed unit. But also can mean, Time To Recovery. The average amount of time a functional unit will spend in corrective maintenance over a given period of time. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

NETWORK. A group of computers and various devices (such as printers and routers) that are joined together on a common network transmission medium. (Chellis, Glossary).

NT. (NETWORK TERMINATION). 1.Network Termination. A device that connects a customer's telephone to an ISDN line. 2.Windows NT. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

OPTICAL FIBER. Glass filament cable that conveys signals using light rather than electricity. (Chellis, Glossary).

PROTOCOLS. The specifications that define procedures used by computers when they transmit and receive data. In other words, the rules by which computers communicate. (Chellis, Glossary).

STAND-ALONE ENVIRONMENT. Computers operating without connection to network. (Chellis, Glossary).

SUBNET. A part of a network, which has the same network address as other parts of the network but a unique subnet number.

(High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

THIN CLIENT. A simple client machine or program that performs very little processing.In this client/server arrangement, most of the application processing is done in the (fat) server. For example, a thin client may supply only the graphical interface.The advantage of a thin client is simpler hardware and simpler maintenance; the maintenance for applications is done on the server. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

TOPOLOGY. A type of network connection or cabling system. Networks are usually configured in bus, ring, star, or mesh topology. (Chellis, Glossary).

VIRTUAL PRIVATE NETWORK (VPN). A network which has the appearance and functionality of a dedicated line, but which is really like a private network within a public one, because it is still controlled by the telephone company, and its backbone trunks are used by all customers.

WIDE AREA NETWORK (WAN). A network typically spanning multiple cities. (Chellis, p. 576).

WIRELESS COMMUNICATION. In computer networking, this term refers to networks that are connected by radio rather than by wires. Wireless communications are enabled by packet radio, spread spectrum, cellular technology, satellites, and microwave towers, and can be used for voice, data, video, and images. Sometimes wireless networks can interconnect with regular computer networks. (High-Tech Dictionary, http://www.computeruser.com/resources/dictionary/).

WORLD WIDE WEB (WWW). The collection of computers on the internet running HTTP (Hypertext Transfer Protocol) servers. The WWW allows for text and graphics to

have hyperlinks connecting users to other servers. By using a Web browser, such as Netscape or Internet Explorer, a user can cross-link from one server to another at the click of a button. (Chellis, Glossary).