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Thin client networking

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What is a thin client network?

A thin client network is a server based network where the majority, if not all, of the processing is done by the server rather than by the individual client machine(s). Software applications and programs are held and run on the server, and displayed on the client machine. The term thin is derived from the small or 'thin' amount of processing done on the client and this is opposed to a 'fat' client where most of the processing is carried out on the client machine.

Traditionally the thin client network architecture was typified by a powerful server connected to a series of 'dumb terminals' with limited functionality. However, there are a number of system architectures which can be described as thin client; ranging from the server/dumb terminal approach above at one end of the spectrum, to many high specification Personal Computers linked to a central server at the other, with several network solutions in between. A fuller description can be found under the section 'What types of thin client network are there?' below.

How does a thin client network work?

A thin client network typically includes

- One or more computers to operate as a server. These computers tend to be of a much higher specification and more powerful than the other computers on the network.
- Further information on servers and client server networks can be found in the following Becta documents
 - '*Client-Server Networks an overview*' - see the Tools section on the Ipas site

<http://ipas.ngfl.gov.uk>

- *'Managing servers and server capacities in schools'*
http://www.becta.org.uk/page_documents/research/infosht05.pdf
- An Operating System that supports Thin Client computing, eg Windows 2003 Server, Windows NT Terminal Server Edition (NT TSE), Linux, UNIX, Mac OS 9/ Mac OS X.
- Centralised server software to control which commands are executed and where they are executed (ie at the client machine, or at the server). There is a wide range of commercially available and free server software which incorporate features specific to the requirements of a thin client server computer (eg remote client management), as well as more generic server features like load balancing and failover mechanisms which are discussed in more detail below. Server software is produced by the companies who manufacture the operating system as well as companies who specialise in server software.

Where are thin client networks used?

A thin client network can be used anywhere but they have been widely adopted in organisations with multiple sites; banks and estate agents often use thin client solutions; where the operatives use a computer with limited functionality, linked to a central server. Thin client solutions are particularly suited to support remote working.

Birmingham Central Library has recently installed a thin client network for public use. This allows them some control over how they permit the public to use their network. The public can use standard software packages for word processing, spreadsheets/finance, drawing, and can gain access to the internet; however, the system does not permit the use of disk drives (preventing the introduction of computer viruses), and does not permit downloading of software - again preventing potential viruses. The individual client machines are easy to maintain as there is less to be tampered with. Details of where to find this case study can be found in Further Information section of this paper.

Many schools have used a full or partial thin client solution (a partial solution is taken to mean a mixed network environment where there are some computers functioning as networked PCs with other computers being used as thin client machines). Notable school examples include Hobbs Mill Wood Primary School which was the first UK school to implement its thin client solution using Microsoft Windows Server 2003, Millbourne Lodge Junior School which installed a new school network with new equipment as well as incorporating its old PCs into the thin client network and Bicester Community College, a large 11-18 school which also allows students access to the college network over the internet, so enabling home working. Details of these case studies can be found in the Further Information section of this paper.

What are the advantages and disadvantages of a thin client network?

Some of the advantages of thin client networking in certain circumstances can be major disadvantages in others. As with any network solution, it is important to have a clear idea of requirements.

Advantages

- Manageability
 - Installation and upgrading of software is considerably easier. It is only necessary to upgrade the software on the server rather than on each individual computer on the network.
 - Monitoring the software on the network is also easier as there is only one machine to monitor (the server computer) rather than all the machines on a

network. This is also advantageous when trying to carry out software audit and provides some consistency across the network.

- **Security**
 - It is more difficult to introduce viruses to a thin client network as there are less points of entry to the network; it is usually not possible to download software from the internet to the client machine; client machines do not have operable disk drives so viruses cannot be introduced through virus infected disks. This is particularly useful in a school environment when you wish to restrict pupil's use of disks brought from home.
 - Additional server software can limit the execution of email attached documents and therefore significantly reduce the threat of computer viruses.
 - Terminals do not store data so if they are stolen, it is only the equipment which needs to be replaced rather than the data.
 - Schools have reported that thin client terminals are considered less desirable to thieves than PCs and therefore less likely to be stolen.
- **Administrator control**
 - Users cannot load their own applications or change configuration settings without the administrator's permission. This in turn helps to prevent unauthorised use of software or the introduction of unlicensed software to the network.
- **Hardware cost**
 - Thin client computers tend to be less expensive than PCs on a network. Furthermore, as thin client machines have fewer movable parts, they are less prone to breakdown, damage or disrepair and therefore have greater longevity. The longer term costs of thin client machines should be lower than those for a fat client network. However, this cost saving is countered by the fact that the server computers used to service a thin client network are invariably more expensive as they need to be of a higher specification. Typically thin client network servers need to have greater processing speeds, greater memory capacity and more storage to be able to deal with the higher amounts of processing required.
- **Ease of upgrade/reduction of downtime**
 - It is relatively easy to add another terminal to the network and software to be installed on the terminal can often be done remotely from a central location. Faulty units can simply be replaced without the need to diagnose faults at the machine.
- **Energy saving**
 - Thin client terminals use considerably less energy than PCs because they perform very little processing on the client machine. Various studies have shown that a thin client machine can use as little as 10 - 20 watts of electricity an hour compared to up to 280 watts an hour on a PC, eg see study <http://www.thinclient.net/power/intro-f.htm>.
- Facilitates 'hot-desking' or working across various sites.

Disadvantages

- **Inflexibility**
 - What you see is what you get. If a particular application or add on has not been installed on the server, it is not possible for a user to download it to the client machine. This is a particular disadvantage for downloading software from the internet, or trying to install plug-ins or software upgrades. The system administrator needs to be very proactive in anticipating what users will require especially for upgrades to commonly used tools (eg Acrobat Reader, Flash plug-ins, the various Media players etc). For users used to using stand-alone PCs and being able to download software as they require it, it can be frustrating to need to

seek the help of the system administrator or network manager to perform these tasks.

- Reliance on the server
 - It is absolutely vital that the network server is robust and very reliable. If the network server fails on a thin client network, all terminals on the network are unusable until the network is restored. On a traditional server based network, only access to network resources (shared peripherals devices, shared files) is lost in this event so applications on an individual machine will still continue to work when the network goes down.
 - It is very important that the network and servers are configured optimally and that suitable server options are in place. Such options might include
 - Failover mechanisms - failover is a mode of operation where some parts of a network system (eg a processor, server, network, or database) are carried out by another system component if the main component becomes unavailable (through breakdown or failure).
 - Load balancing - is dividing the amount of work that a computer has to do between two or more computers so that more work gets done in the same amount of time. Load balancing can be implemented with hardware, software, or a combination of both.
 - Clustering - is using several computers (and/or other devices) to form one server system. Typically each computer has responsibility for defined tasks. A common cluster configuration in schools might be a file server, an application server, a proxy server, a cache server and a mail server. This ensures that should one server malfunction, the tasks associated with the other servers will continue. An additional backup server may be considered as a complement to the usual backup solution.
- Bandwidth issues
 - Like any network, the amount of available bandwidth for any user will depend on the number of other users on the network. As thin client requires practically all processing to be carried out on the server, there is considerably more network traffic as all processing commands and resulting actions need to be transmitted across the network.
- Lack of disk drives
 - It is not possible to use floppy disks or CDs on the client machine with a true thin client solution.
- Use of peripheral devices
 - This can be limited. Some thin client devices now come with a variety of ports to allow peripheral devices to join the network, though most do not. Therefore integration of devices such as digital cameras or video equipment may not be possible.
- Poor multimedia performance
 - Graphics intensive applications or multimedia programs which require high levels of processing may not work well on thin client networks because processing is performed by the server and is shared with the rest of the network. Recent advances in both processing technology and server technology have helped alleviate this to some extent, but there still remain some problematic areas eg real time applications by their very nature will encounter latency on a thin client network.

There are specific products on the market which enhance multimedia performance. These products give access to the media player locally (at the client machine) whilst running other applications at the server. For example, certain Windows Based Terminals (see below) have the ability to run more multimedia

rich programs, as typically they will have more processing power on the client machine.

What types of thin client network are there?

As mentioned above, there is a range of 'thinness', from a true thin client at one end of the spectrum where only mouse clicks and graphics are processed on the client machine with all other processes being carried out by the server; to a network architecture where much of the processing is undertaken on the client machine but with some of the client machine's functionality disabled

Ultra thin client

The user has a keyboard, mouse and a monitor. The client machine only processes keyboard input and screen output. All remaining processes are carried out by a designated server. These have the added advantage of saving space as there is no 'box' containing the hard disk, expansion cards, disk drives, memory cards etc.

Certain terminals now use smart card technology to log the user onto the machine and to store a user's settings eg the Sun Ray range from Sun Microsystems.

Windows Based Terminals (WBT)

There are terminals which are designed to complement the Windows operating system and Windows products. There are two types

1. Those with Windows Based Terminal Standard where the Windows environment is displayed on the desktop through the use of Microsoft Remote Desktop Protocol (RDP) or the Citrix Independent Computing Architecture (ICA) display protocols. See below 'What are the protocols relating to thin client?'
2. Those which use a proprietary client operating environment with support for Citrix ICA to display Windows applications (eg Linux with Tarantella).

Notable providers of WBT are NCD, Wyse, Neoware and Compaq.

Also falling within the category of Windows Based Terminal is a PC configured for thin client networking.

The key features of these machines is that they permit certain processes, eg multimedia applications to be run on the client machine rather than executing them on the server.

Internet terminals

As the name suggests these are terminals with embedded internet browser support. Internet Terminals are more expensive than Windows Based Terminals as they (internet terminals) have more functionality.

Low spec PC solution

Because client machines in a thin client environment undertake very little processing, older and lower specification PCs can be used as thin client terminals. This approach can be used effectively in a school environment to increase and enhance computer provision without the costs associated with either a complete upgrade or change to a complete thin client solution. Instead of disposing of old computers and monitors, they can be recycled and linked to a thin client network to undertake less demanding capacity computer tasks (eg word processing).

This particular use should not be underestimated. As previously mentioned, there will be the additional costs associated with the server and network administration but there is very little cost associated with the terminals themselves.

Tubby clients

Tubby clients are PCs with their own operating system and some applications which are run on the client rather than the server, but which can also connect to the thin client network via software installed on the client machine. This allows newer applications that may not run on the client machine (eg because it has a legacy operating system) to be run from the server via a thin client connection.

It could also permit the use of earlier versions of applications to run on a server with an earlier operating system, even though the client machine may be running the latest version of the software.

This would be particularly useful to schools not wanting to lose the availability of older, but regularly used, software.

Disabled PC solution

Using standard PCs to perform a thin client role with floppy disk and CD drives disabled to prevent their use. This is not a particularly good use of resource if used as a long term solution; but could be useful in a mixed environment where there is a thin client network as well as a standard network. This would enable some flexibility as the disabled PC could be used as a thin client machine; or if required, re-enabled to work on the standard network or as a stand-alone PC.

Blade PC architecture

An emerging technology is the blade server which is sometimes referred to as a *high-density server* and is typically used for clustering.

A Blade PC architecture uses PCs as individual servers as well as maintaining their PC function. These Blade PCs are held in a central location. A *manager server* controls these individual Blade PCs and manages load balancing between them. The users monitor, keyboard, mouse and other peripherals connect to a connection device on the desktop which in turn connects to the PC Blade chassis via a standard network cable connection (Cat-5).

This is currently an expensive solution, which requires a very experienced network manager to maintain the system. It may not be particularly suited to schools at the current time.

What are the protocols relating to thin client networks?

Citrix ICA protocol is a client-server protocol that allows a client device to connect to a Citrix WinFrame or Metaframe server. It also permits a variety of operating systems servers (eg Unix, or Novell) to access and run Windows applications.

Microsoft RDP protocol is a client-server protocol that allows a client device to connect to a Microsoft Terminal Server.

The dominance of Windows as an operating system and Citrix as server software has meant that other server software and applications have tended to conform to one of these two protocols. The emergence of Microsoft's Windows Server 2003 has meant that Citrix software is no longer required to run Windows applications on non Windows network devices.

What issues should I consider when choosing a thin client network?

How significant is cost as a factor for your decision?

The Total Cost of Ownership (TCO) of a thin client solution varies. Several analysts indicate that, in a business context, the TCO of thin client is cheaper than a networked PC solution - with figures varying between 20% and 35% cheaper; but these figures do depend on a number of other factors.

1. There are cost advantages when implementing a thin client network solution from scratch.
2. Replacing an existing network system and moving to a thin client solution may not be cost effective in the long term especially if the existing network is effectively implemented.
3. Adding to an existing system may require more work as there may be issues of compatibility and interoperability between client machines and servers, especially if the existing set up requires machines to be modified to act as thin clients. This may be time consuming and may require professional support.

Other factors like size of network, number and experience of network staff, and software used can affect the TCO. The upheaval of moving from one system to another is often not quantified in terms of financial cost; cost alone may not be the best criteria for deciding whether to implement a Thin client network.

What do you want the thin client network to do?

Will there be much 'high level' processing (multimedia/databases/computer aided design)? These types of activity are not well suited to a thin client network.

How much access you want users to have to the physical system?

Do you want to allow

- use of CD's and disks?
- use of peripheral devices?
- use of downloaded software and plug-ins?

If so, thin client may not be the solution.

Do you have a systems administrator on site?

While nearly all secondary schools have a full time system administrator or network manager, only about 30% of primary schools have one. In nearly 40% of primary schools, maintenance of the school IT system is carried out by a member of the teaching staff.

The initial setting up of a thin client network infrastructure in a primary school will have implications in terms of added workload, and may well need to be done by an outside agency which will have a cost implication.

How big is the site?

With a thin client solution, software upgrades to client machines can be achieved remotely from the server (this can be done to a certain extent on networked PCs if individual machines are running the same software). This saves a technician needing to go to every PC on the network to either manually install a piece of software or implement an upgrade, or when undertaking a software audit. On a small network where all the client machines are in the same room this is not so important.

On larger sites or where machines are dispersed over a number of areas, a thin client solution can improve network management.

How many computers will there be on the network?

A thin client solution becomes more cost effective as the number of machines added increases (less maintenance, less software installation etc). For smaller networks, as may be found in primary schools, the additional costs of a thin client solution, eg a more powerful (and therefore expensive) server combined with the additional administrative/ technical overhead may be prohibitive.

How able are you to modify the physical architecture?

Are you likely to want to add new machines? How easy is it to build on the network to get more sophisticated solutions? Adding additional machines to a thin client network is relatively easy, as is installation and upgrading of software. If you anticipate frequent changes to your system, thin client may have some advantages over traditional network architecture.

Will the software and applications you want to use be compatible with a thin client configuration?

As with any change or update to a computer system, you will need to check compatibility with existing software and applications being used in the school. Software may have been designed with a specific operating system in mind; some software may be upgradeable to the new system and may already work within a thin client environment. However, if there are compatibility issues, schools will need to determine how much of a problem this is. A 'tubby client' solution may offer a partial solution in some cases. Many schools use software run from CD-ROMs which would not be possible with thin client machines; but may be possible with a 'tubby client' solution.

How much online learning and teaching is anticipated?

Increasingly, educational applications will require content to be downloaded through the school internet/ broadband connection (or even over the LAN from a local content engine or examination server). This content or information may be compressed and perhaps encrypted, which would require each device to process the files locally on each terminal. In these cases, a tubby or fat client may be better suited than a thin client.

What are the implementation issues?

Data security

Will the thin client system be developed in isolation from the rest of your data sources, eg will the school's information management system be incorporated into the network? And if so, what security measures need to be put into place to prevent unauthorised access to that information?

Software licensing

What are the software licensing cost implications? Certain software licences are calculated on an estimated use basis. Others are on a per machine basis which may have cost implications in a thin client network. The issues around software licensing can be complex and should be investigated thoroughly. Links to Becta advice can be found in the Further Information section of this paper.

Compatibility with home equipment and the use of laptops

In a school environment, students and staff will often expect some compatibility with the computer equipment and software they have at home. Thin clients do not tend to permit students to save their work to floppy disk or CDs, nor do they permit users to upload work onto the school network; this may be an issue. In a thin client network, teachers wanting to use their own laptops to access the school network may need some technical support from the system administrator.

Remote access

Some consideration may be given to allowing students and staff to access the school network remotely via the internet from home. This is the approach at Parrs Wood Technology College in Manchester which offers computers to students via a loan scheme. Low cost reconditioned computers have been used, which connect to the school's network as thin clients. Student

access to the internet is filtered through the school. All school software can be accessed from the students' home. The school is able to upgrade the students' thin client machine remotely if necessary. See 'Case Studies' in the Further Information section of this paper.

Supplier support

Will your supplier give you support only in the initial phases or will support be ongoing? Will the supplier also install and set up your network for you?

User training

As with any new computer system, you need to consider whether staff will need specific training and if so how long the training will take. Will there need to be additional training for students? In both cases there may well be time and cost implications.

Further Information

<http://www.thinplanet.com/>

<http://www.sun.com/hw/sunray/whitepapers.html>

http://www.sun.com/products/sunray/whitepapers/SunRay_WP042403.pdf

Becta information

Technical papers

<http://www.becta.org.uk/technicalpapers>

- 'Appliance servers'

Software licensing

'How to choose between software licences'

http://www.ictadvice.org.uk/index.php?section=ap&cat=004006&rid=1005&pagenum=1&NextStar_t=1

'How to license electronic materials'

<http://www.ictadvice.org.uk/index.php?section=ap&cat=004006&rid=429>

'Becta Microsoft licensing negotiations'

http://www.becta.org.uk/corporate/press_out.cfm?id=3098

Expert Technology seminars

Becta Expert Technology Seminar - Thin Clients in Education - 22 March 2001

http://www.becta.org.uk/corporate/corporate.cfm?section=7_1&id=2584

Case studies

Birmingham Libraries Thin Client Deployment: A case study

<http://www.becta.org.uk/etseminars/presentations/2003-04-30/8/slides/slides.pdf>

from the Becta Expert Technology Seminar on Application Content development and deployment
- April 2003

http://www.becta.org.uk/etseminars/presentations/index.cfm?seminar_id=12&id=2608

Parrs Wood Technology College

- presentation by Samantha Wells, assistant Headteacher, at Becta Expert Technology Seminar -

Home School Links - March 2002

http://www.becta.org.uk/page_documents/corporate/events/parrswood.pdf

- article from e-Learning Foundation Best practice in Home School links

<http://www.e-learningfoundation.com/uploads/Innovation%20in%20home-school%20links.pdf>

Hobbs Hill Wood Primary

Case study of Hobbs Hill Wood Primary; the first school in the UK to deploy Microsoft Server 2003 for its thin client solution.

<http://www.microsoft.com/uk/casestudies/caseStudy.asp?CaseStudyID=826>

Bicester Community College

<http://www.itcasestudies.com/case/edu17.html>

General

<http://www.itworks.be/rescenter.php?topic=thin&tab=info>

Article: Time to go thin again? - March 2002

<http://www.computerweekly.com/Article110605.htm>

Article: Thin clients: Behind the numbers - April 1997

<http://www.byte.com/art/9704/sec6/art3.htm>

Article: Sharp skill for thin clients

<http://www.computerweekly.com/Article123135.htm> - July 2003

Article: Maxspeed Revs Thin-Client Notebook - October 2003

<http://www.eweek.com/article2/0,4149,1356623,00.asp>

Websites related to thin client software/ hardware mentioned in this paper

Citrix <http://www.citrix.com/>

Linux <http://www.linux.org/>

Microsoft <http://www.microsoft.com/>

Neoware <http://www.neoware.com/>

Wyse <http://www.wyse.com/>