

Towards the Deployment of Flexible and Efficient Learning Tools: The Thin Client^{*}

REYNOLDS Gordon GLEESON Michael

(School of Electrical Engineering Systems, Dublin Institute of Technology, Dublin, Ireland)

Abstract: Given today's dynamic and fast paced world of Information Technology (IT), it has become more challenging for an IT manager to provide students with the most flexible and innovative learning environment. The requirement to provide these facilities must be balanced against constraints such as capital spending within budgets, maintenance costs and staffing issues. This paper discusses how a server-centric IT solution, such as thin clients, is capable of meeting these demands in a more efficient manner particularly in relation to Financial Management, Infrastructure Management and Security Management. The flexibility and efficiency of server-centric technology as an education tool is overviewed as experienced by several departments within the Dublin Institute of Technology.

Key words: thin clients, server-centric technology, server-based technology, terminal services

CLC number: TP31 **Document code:** A **Article ID:** 0529-6579 (2007) S2-0145-06

1 Introduction

The requirement to provide an effective Information System creates a number of issues for third level institutions. In the modern computing environment, students and staff expect first rate facilities with leading edge technologies. This is especially the case for technology orientated Schools and Facilities. The requirement to provide these facilities must be balanced against constraints such as capital spending within budgets, maintenance costs and staffing issues.

Regardless of department, staff and students in the Dublin Institute of Technology (DIT) expect to access an increasingly diverse and sophisticated set of software applications in a stable and reliable environment. Against the background of increasing student numbers, the design of a new Information System (IS) must also have the flexibility to offer a single point of authentication, central network storage and be scalable to support future growth.

To different degrees, thin clients and server-centric technologies address these issues and requirements. Thin client technology can offer to reduce management, support and maintenance costs while also enabling a robust environment with high performance and availability^[1]. Added to this are the extra benefits of multiple platform access from any platform and an enhanced user experience^[1].

2 Overview of thin clients and server-centric technology

It is beneficial to begin this paper by defining the terms thin client and the concept of server-centric computing.

A server-centric computing model is a style of networked computer environment which allows for applications and data to be centralised and remotely accessed by a user^[2].

In a server-centric architecture, the majority of processing activities take place on a remote server. All applications are executed from this remote server and data is centrally stored. The primary function of a thin client is to interface between the user and the remote server. That is screen, mouse and keyboard interaction. Therefore, a thin client is any diskless terminal connected over a network to a remote server, which it relies on for applications and data^[3]. A basic thin client/server-centric system is outlined in Figure 1.

Terminal Services is a server-centric architecture developed and distributed by the Microsoft Corporation. The Terminal Server is an installable component for the Windows Server Family which has the ability to provide users with centralised applications and a centralised Windows User Interface^[3]. To date, Terminal Services has been deployed throughout the Dublin Institute of Technology by several departments to evaluate the ben-

*收稿日期: 2007-10-28

作者简介: REYNOLDS Gordon (born in 1977), male, technical officer. E-mail: gordon.reynolds@dit.ie

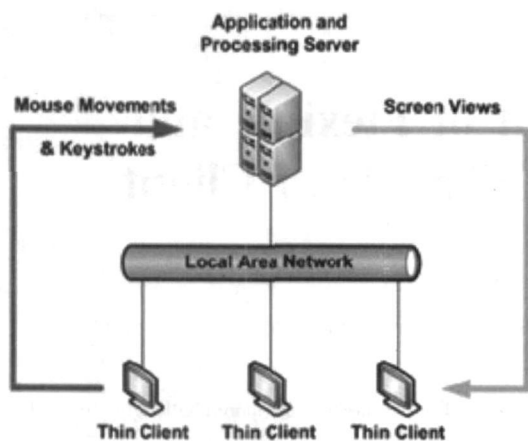


Fig 1 Shows the typical layout of a basic server-centric infrastructure

efits and disadvantages in the use of thin clients

3 Benefits of thin clients and server-centric technology

This section summarises the more significant advantages of a server-centric environment with particular attention given to Financial Benefits, Security Benefits, Deployment Benefits and Infrastructure Benefits.

3.1 Financial Benefits

In this section the financial benefits of a thin client / server-centric environment are considered. This discussion is formed under the categories of (i) Client Acquisition Costs, (ii) Client Maintenance Costs and (iii) the Client life Cycle.

(i) Client Acquisition Costs

The acquisition cost of a thin client is significantly lower than the cost of a PC. This is because thin clients lack onboard memory and storage and are less complex than PCs^[4]. For example, a typical cost of a thin client is 400 (including monitor, keyboard and mouse), which is 53% more cost efficient than DII's tendered standard PC build. However, acquisition costs only play a minor role. Studies by Gartner Inc. show that nearly 80% of total IT costs occur after the purchase of the unit. Nearly half of these costs lie outside the IT department's budget^[5].

(ii) Client Maintenance Costs

According to Wipro^[6], a high number of deployed PC hardware configurations creates a complex environment. Such complex environments contribute to significant hardware-related support costs as well as high software qualification and deployment costs. Since PC manufacturers update and modify their range of available hardware frequently, PC purchasing on an ad-hoc basis will introduce multiple and complex configurations into the environment. Detailed in a report sponsored

by Intel^[6], each additional configuration introduced into a desktop environment can result in a \$12 increase in yearly support costs for every desktop PC. In addition to this, Wipro have outlined that the average support cost per PC increases over time. Figure 2 shows the increase in support cost^[6].

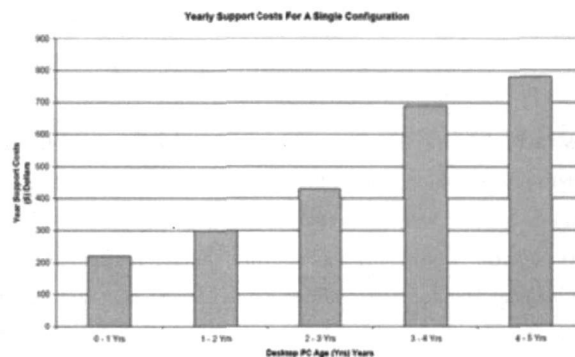


Fig 2 Shows the increase in support costs over time per single PC configuration

It has been shown that server-centric technology is capable of reducing these costs^[7]. Even with multiple hardware platforms, unified configurations can be deployed throughout any infrastructure. Server-centric technology centralises all operating systems, applications and data, thus shifting the majority of support requirements from nodal to central. With a thin client deployment, it is possible to decrease the associated support costs of legacy and ageing PCs (Figure 2) since all application support is central.

(iii) Client Life Cycle

The typical life expectancy of the average PC is between three years and five years^[4]. Since thin clients do not execute the required applications directly, they tend to possess a higher degree of life expectancy, typically ten years and beyond^[4]. This increase in life expectancy is also aided by the fact that thin clients have no moving parts, such as hard disks, and therefore rarely suffer from mechanical failure.

With the use of server-centric technology in a student laboratory environment, it is proposed that a savings of 73% to 91% of IT operating costs can be saved^[7]. However, in practice, the savings is in the range of 51%^[11] as discovered with the recent installation of a thin client laboratory at DII.

3.2 Security Benefits

This section examines the improved security arrangements associated with a server-centric environment. In particular, security concepts relating to (i) Client Hardware, (ii) Client Operating System, (iii) Data Access and (iv) Virus and Malware Protection are discussed.

(i) Client Hardware Security

By the definition outlined in Section 2 thin clients are essentially dumb terminals that possess practically no functionality without the Partnership of a server centric environment. Thin clients are therefore less prone to theft than PCs. In the case of theft no sensitive or business critical data will be lost due to the operational advantages of a server centric computing environment. That is, all the data is processed and stored at the server layer and not on the client.

(ii) Client Operating System Security

In general, the client operating system (OS) of a PC requires regular critical and security updates. This is also true for many applications. Failure to monitor and deploy such patches and service packs can leave an IT infrastructure vulnerable to malicious attacks. To manage such a scenario, expensive network security tools are used to monitor and deploy security updates efficiently. However, operating within a server centric environment does not have such complications associated with it.

In a server centric environment, for example, it is not uncommon to have fifty clients serviced by a single Application Server or Remote Server. Hence, such a system reduces fifty management nodes (clients) to a single management node (server). Such an environment, therefore, significantly reduces the risk of malicious attack and more importantly, reduces the recovery time associated with such an attack.

(iii) Data Access Security

A server centric solution promotes the ideologies of centralisation and single sign-on. One of the key benefits of centralisation is that all data associated with a business, whether non critical, critical or sensitive is centrally stored (logically) across an array of file servers. This significantly increases the simplicity of data protection and restoration. Data no longer exists at the client layer. This enables an IT administrator to confidently secure a complete data set with the use of centralised data protection tools and data back-up utilities.

In addition, due to the very nature of a server centric infrastructure, data accessed on a client never transverse the network. Only screen shots, mouse movements and keystrokes are exchanged between the client and the server. This interaction is typically encrypted by a 128-bit RC4 algorithm. This establishes a foundation for securing data at the point of access⁸.

(iv) Increased Virus and Malware Protection

Malware has become a fact of life for just about ev-

ery organisation with the constant risk of losing thousands or millions of Euros/Dollars in productivity, reputation and revenue from a single event. Table 1 outlines world wide costs, in dollars, from significant virus and malware attacks⁸¹ between 2003 and 2004.

Tab 1 An outline of world wide costs (in dollars) from significant virus and malware attacks

Date	Description	Cost
May 2004	This was the fifth worst month on record for virus, worm and Trojan attacks	16.2 – 19.8 Billion
August 2003	Thousands of systems were hit with the 1 – 2 – 3 Punch of Blaster, Nachi and SoBig F	750 Million
January 2004	MSDoom spread even faster than SoBig F by email	4.5 Billion

Server centric technologies can play an important role in managing virus and malware attacks. One of the single most causes of infection is due to operating systems and applications which have not got their current service packs and security updates installed⁹¹. As previously discussed, a thin client infrastructure simplifies operating system patching. In addition, with a server centric solution, it is possible to deploy thin clients that have Read-Only Memories which have no hard disks. This implies that any virus propagating the network can not permanently write themselves into the clients operating system. Instead, the virus can only exist in the thin clients memory. Hence, when a thin client is rebooted the virus is irradiated and all of the thin clients can then be patched centrally and simultaneously. With the use of thin clients, it is no longer required to visit each client and install critical virus removal tools.

3.3 Deployment Benefits

In this section the deployment benefits are considered. In particular two deployment scenarios are examined: (i) Hardware Deployment and (ii) Software Deployment. To obtain such metrics, several members of the Technical Officer Staff at DIT were interviewed. These results are based upon those interviews.

(i) Hardware Deployment

Table 2 details the important tasks required to achieve a PC deployment in a client based environment. Similarly, Table 3 outlines the tasks required to achieve a thin client deployment for a server centric solution. These tasks are based upon DIT's operational environment.

Tab 2 Tasks Required for a ClientCentric PC Deployment

Process Required	Description
Install PC	The PC is unboxed and physically installed
Prepare Ghost Image	An existing or new Symantec Ghost image is prepared for the PC. Preparation may include security and software updates
Deploy Ghost Image	The Symantec Ghost image is deployed to the required hardware
Configure PC Installation	After the imaging process has completed each PC is manually or automatically configured for specific user or local settings
Commission	The PC is made available for usage

Tab 3 Tasks Required for a ServerCentric Thin ClientDeployment

Process Required	Description
Install Thin Client	The thin client is unboxed and physically installed
Verify Thin Client Configuration	Each thin client is manually or automatically configured for a specific Terminal Server
Commission	The thin client is made available for usage

As shown in Figure 3, when installing PCs the Technical Officers feel that deploying the ghost image accounts for 60% of the time required to complete the total installation. It is also felt that 20% of the time is spent preparing the ghost image. To attach metrics to the time required in the deployment of thin clients, ‘like’ tasks for a thin client deployment was equated with ‘like’ tasks in the PC evaluation, e.g. Install PC = 5% is equated with Install Thin Client. Analysing Figure 3, the deployment of a thin client only requires 20% of the time needed for a PC installation. A server-centric solution, by brief inspection, is therefore capable of offering an 80% savings in time for hardware deployment. Thin client deployment is considered simpler to deploy due to the reduced number of steps or tasks required to achieve deployment.

(ij) Software Deployment

The necessary tasks required to deploy software in a client-based environment are given in Table 4. Likewise, Table 5 specifies the tasks essential to deploy software in a server-based solution. The time it takes to deploy software in both a client-based and server-based solution is compared in Figure 4. The time for the server-based environment was generated by equating ‘like

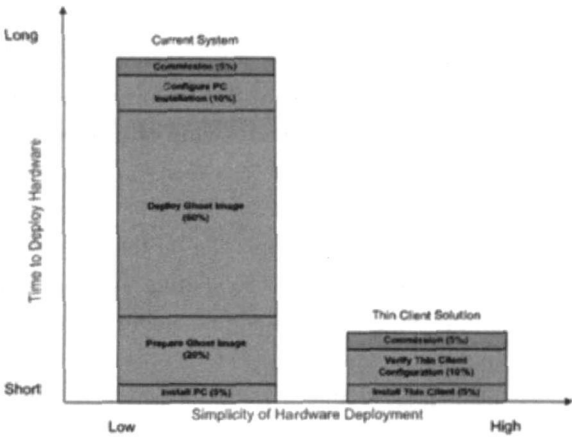


Fig 3 Time required for hardware deployment in both a PC and a server-centric environment

with ‘like’ in the client-based environment, e.g. Install Software = 5% for the client-based solution is equated with Install Software for the server-based solution. As shown in Figure 4, when deploying software in DIT’s client-orientated infrastructure, deploying the ghost image accounts for 50% of the time required to complete the installation. It is also felt that 25% of the time is spent preparing the ghost image.

Tab 4 Tasks Required for a ClientCentric Software Deployment

Process Required	Description
Install Software	The appropriate software is installed on the image PC for evaluation
Evaluate Software Change	Before software deployment, the software installation is checked and verified for integrity
Prepare Ghost Image	A hard drive image is taken in preparation for the software deployment using Symantec Ghost
Deploy Ghost Image	All PCs requiring the appropriate software upgrade are imaged using Symantec Ghost
Configure Installation	After the imaging process has completed, each PC is manually or automatically configured for specific user or local settings
Commission	Once the software deployment process is complete, the PC is commissioned for operation

When considering a thin client solution, the deployment of software only requires 40% of the time needed for deployment in a client-based solution. A server-based solution is therefore capable of offering a 60% savings in time for software deployment.

Tab 5 Tasks Required for a Server Centric Software Deployment

Process Required	Description
Install Software	The appropriate software is installed on a Terminal Server for evaluation.
Evaluate Software Change	Before software deployment, the software installation is checked and verified for integrity.
Deploy Software Change	All Terminal Servers are installed with the appropriate software package.
Configure Installation	After the installation process has completed, user sessions are configured if required for specific user or local settings.
Commission	Once the software deployment process is complete, the software package is made available for users.

learning such as traditional labs, e-learning and m-learning^[10]. A single consistent user interface may be deployed in all such situations.

(i) The Promotion of an Energy Efficient Computing Environment

In today's world there is an important emphasis on energy efficient hardware for a greener environment. Since thin clients have fewer components than PCs, they have a tendency to consume less power. Netvoyager have indicated that the average PC consumes 300 Watts^[11] whereas thin clients, as outlined in several manufacturers datasheets, consume between 35 and 70 Watts. Hence, a thin client can offer a saving of 76.7% to 88.4% on power consumption.

4 Conclusion

This paper considers the modern dynamics of an educational IT infrastructure. In particular, how budget allocations may not meet expected operational requirements and therefore introduces the need to deploy efficient and innovative IT environments. Thin client technology has been identified as such an enabler.

This investigation outlined that with the implementation of a server centric computing solution, significant cost efficiencies are achievable such as a 51% cost savings in a lab deployment. In addition to efficient acquisition costs, a server centric solution also offers savings in many other areas within the IT and business process, for example deployment management, security management and data protection management.

Due to the remote nature of a server centric deployment, it is suggested that a thin client solution can offer an enhancement to a modern educational environment. In particular, it has been found that a server based technology, such as Terminal Services, is capable of adding depth and dimension to m-learning, particularly in relation to software based engineering laboratories such as programming and simulation.

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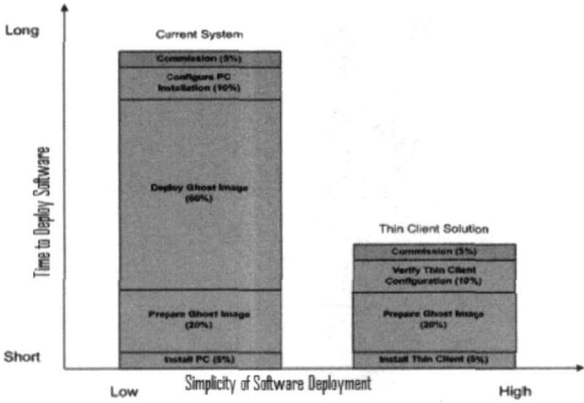


Fig 4 Time required for software deployment in both a PC and a server centric environment

3.4 Infrastructure Benefits

In addition to the previously presented benefits, thin clients provide numerous advantages to the general educational infrastructure such as (i) the Promotion of a Diverse Learning Environment and (ii) the Promotion of an Energy Efficient Computing Environment.

(i) The Promotion of a Diverse Learning Environment

Due to the remote nature of a server centric environment, the client desktop environment may be considered virtual. This is evident since the actual desktop environment and applications do not actually execute on the client. Hence, a user's desktop environment is available across multiple platforms from anywhere at any time^[10]. Essentially, a server centric solution can provide a user with an on-demand streaming of their applications. Such an environment may unify the consistency problem associated with the existing culture of diverse

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