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Evolution versus Revolution as a Strategy for Thin Client Acceptance: Case Study

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ABSTRACT

Thin Clients have evolved from simple text based CRT dumb terminal devices in the 1960s, into a sophisticated architecture encompassing hardware, software, networks and protocols. However despite this recent evolution the Thin Client model has yet to re-emerge as a relevant design in an IT industry where Fat Clients (desktops and laptops) thrive. This paper describes two case studies performed within the Dublin Institute of Technology School of Computing, focused on the issue of student acceptance of this technology. The first case study provides a dedicated single service Thin Client implementation, while the second case study adopts a process of coexistence with Fat Clients in addition to providing new services to users. This paper examines both approaches as strategies for the integration of Thin Client technology into a Higher Level Educational Institute and through our data analysis demonstrates that while co-existence improves acceptance there are clearly additional factors to be resolved.

Key Words: Thin Clients, Virtualisation, RDP, Fat Client, Terminal Services

1. Introduction

The Thin Client model *[1]* offers users the ability to access centralized resources including full graphical desktops from remotely located, low cost, stateless devices. However, while there are many examples of successful deployments of Thin Clients *[2] [3] [4] [5]*, the fact that they are not ubiquitously deployed implies there are clearly unresolved issues concerning their acceptance. The motivation behind this paper was to review the issue of acceptance based on two case studies which focused on Thin Client deployment within an Educational Institute. The aim of the Thin Client deployment was to evaluate the practicalities of achieving an increase in the flexibility of our computer laboratories, achieve greater cost savings associated with resource centralization and achieve lower power consumption of computer laboratories.

1.1 Research Aim

The aim of this paper is to evaluate the methods used to gain user acceptance of Thin Clients within an environment where the Fat Client model held dominance. Over a four year period, two Thin Client case studies were run within the Dublin Institute of Technology School of Computing with the explicit aim of integrating Thin Clients into one of the computer laboratories. The following data points are used to evaluate each case study:

1) Login events on the Thin Clients.
2) Reservation of the Thin Client facility.
3) The cost of maintaining the service.

1.2 Paper Structure

In section 2 we review the technology and key issues of Thin Clients. Sections 3 and 4 provide details of the two case studies discussing their design, evaluating the results, and providing critical analysis. Section 5 is an analysis of both case

studies together, before providing a conclusion in section 6 and identifying future work in section 7. This paper is targeted at professionals within educational institutes seeking ways to realize the benefits of thin client computing while maintaining the support and acceptance of users.

2. Background

The concept of Thin Client computing has evolved from a dumb mainframe terminal to a complete architectural infrastructure *[6]* including specialized hardware devices, remote display client software and numerous network protocols such as X, ALP, ICA, RDP, AIP, and VNC. In the area of protocol performance analysis, there is a growing body of research *[7][8][9]* that includes the evaluation of the user experience *[10]*.

2.1 Why use Thin Client?

The cost benefits of the Thin Client model are defined by Jern *[11]* as:

1) Reduced cost of software maintenance
2) Zero cost of software distribution
3) Zero cost of local software support

These benefits are expanded by Golick *[6]* as follows:

4) The ability to leverage existing desktop hardware and software
5) Interface portability. (session mobility)
6) Faster *Mean Time to Repair* (MTTR).
7) Capacity planning

In the article "*An Inefficient Truth*" Plan *[12]* reveals a series of "truths" supported by a number of case studies directed at the growing costs of Information and Communication Technologies. One such case study is of *Reed Managed Services* where 4,500 PCs were replaced with Thin Clients, and a centralized blade server providing server based virtualized desktops. Savings are reported as follows:

1) 5.4 million kWh reduction,
2) 2,800 tonnes of CO_2 saved annually
3) Servers reduced by a factor of 20
4) IT budget cut by a fifth

2.2 Thin Clients & Fat Clients

Thin Client technology has evolved in sophistication and capability since the middle of the 1990s, however the "thickness" (the amount of software and administration required on the access device) of the client is a source of distinction for many vendors *[13][8]*. Regardless of "thickness", Thin Clients require less configuration and support when compared to Fat Clients (your typical PC). In the early 1990s Gartner provided a client-server reference design shown in Figure 1. This design provides clarity for the terms "thin" and "fat" clients by viewing applications in terms of the level data access, application and presentation logic present on the server and client sides of the network.

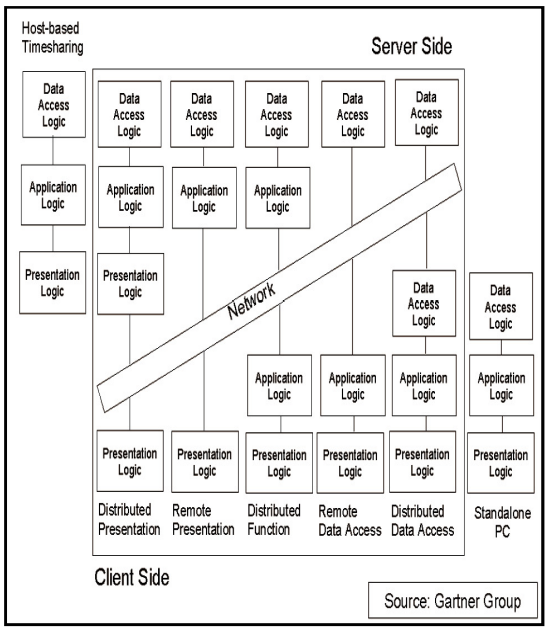

Figure 1. Gartner Group client/server reference designs.

2.3 Services on the Network

The demand for network based services such as email, social networking and the World Wide Web has driven bandwidth and connectivity requirements to higher and higher levels of reliability and performance *[14]*. As we progress to an "*always on*" network infrastructure the arguments focused against Thin Clients based on required connectivity are less relevant. The move from Fat Client to Thin Client is however often resisted as individuals find themselves uncomfortable with the lack of choice provided as the

transition is made as observed by Wong et al.*[2]*. It would seem that no matter how well documented the benefits of Thin Clients may be *[15]*. There is always resistance when the process is presented as a revolution.

3. Case Study 1: Thin Client Revolution

This case study commenced in 2005 and focused on the provisioning of graphical Unix desktops using SunRay Thin Clients. This deployment sought to offer new services to students and introduced Thin Clients for the first time to both students and staff.

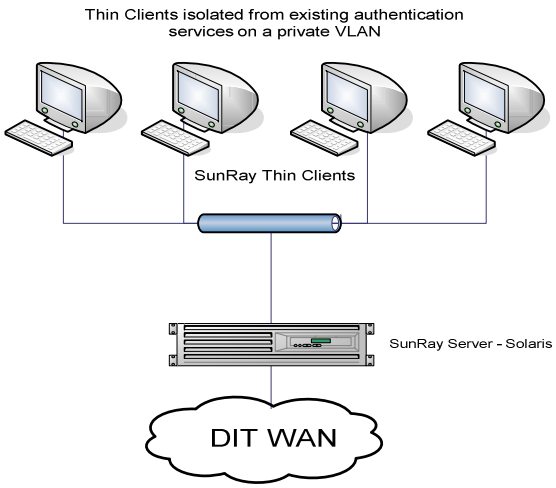

Figure 2. Case Study 1 Revolution

3.1 Design

The initial design shown in Figure 2 allowed students within this new Thin Client lab access to the latest version of Solaris using a full screen graphical environment as opposed to an SSH command-line Unix shell which was the traditional method from existing computing laboratories. The key components within the design are:

a) The service is on a private network
b) New authentication process used.
c) Devices were all in the same location
d) Service provided was a Solaris desktop
e) Graphical desktops running on Linux servers also accessible.

The use of an alternative authentication process for accessing the Solaris desktop environment was required as the Solaris authentication requirements could not be met by the existing Windows Active Directory domain in the School of Computing. While it is possible to integrate Unix based and Windows-based authentication services, this was not a trivial matter and could potentially cause service disruption to students.

3.2 Results

The data gathered for the first case study was evaluated under three headings.

1) Login events on the Thin Clients
2) Reservation of the Thin Client facility
3) The cost of maintaining the service

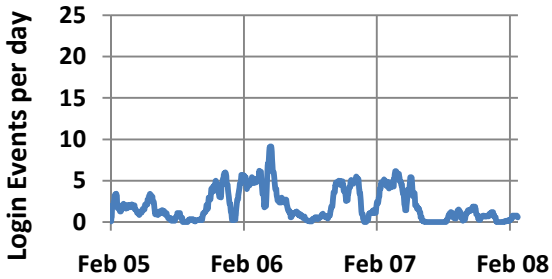

Figure 3. 2005-2008 User Login Events

Login events on the Thin Clients:
The usage pattern of the thin client lab remained disappointingly low (between 1 and 10 login events per day) throughout this case study as shown in Figure 3.

Reservation of the Thin Client Facility:
Each laboratory may be reserved by staff for the supervision of students as part of course work. The hourly reservations for this laboratory were reduced as a result of the introduction of Thin Clients with only 1 to 2 hours being reserved per day.

The Cost of Maintaining the Service:
Cost savings were identified in the following areas:

a) Time spent performing system upgrades and hardware maintenance was reduced to virtually zero as no upgrades were required.
b) A single software image was maintained at the central server location and changes were made available instantly to all users.

c) No upgrade costs were incurred on the thin clients or server hardware. All systems have remained in place throughout both case studies. The devices in this lab are now 8 years old and are fulfilling the same role today as they did when first installed.
d) The thin client lab is a low power consumption environment due to the inherent energy efficiency of the thin client hardware over existing PCs. This can provide up to 95% energy savings when compared to traditional PCs [12].

3.3 Analysis

This first case study is described as a revolution, as it attempted to replace existing services with new services. It did not address the existing needs serviced by the existing Fat Clients, but rather selected a service which matched the capabilities of the Thin Clients themselves, which was to provide graphical Unix desktops. It was believed that the new service offered would gain acceptance with students and staff as it provided something not previously available, however this was evidently not the case. Thin Clients did deliver on lower total cost of ownership but there was a clear lack of acceptance from students. The Thin Client lab became yet another example of Thin Client technology failing to penetrate a PC dominant model, however the reasons for this lack of acceptance was potentially inherent in the implementation of the case study and not due to failings in the technology itself. Clearly a second case study was required.

4. Case Study 2: Thin Client Evolution

The second case study is a modification of the basic implementation of the first case study with changes focused on increasing student acceptance of the thin client facility. Removing the Unix centric nature of the existing service was central to the design of this case study. With recent advances in virtualisation technology it was decided that additional services could be easily and cheaply offered to the thin client environment. Figure 4 identifies the key components within the design.

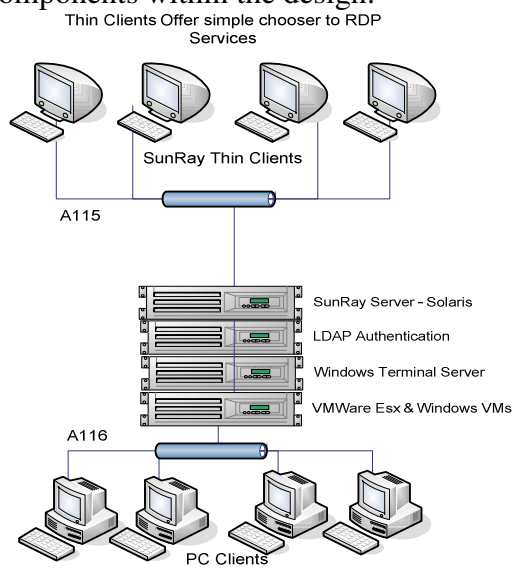

Figure 4. Case Study 2 Evolution

4.1 Design

The most important addition to the second case study was the provisioning of additional services which were similar to those available in PC labs. This was to ensure that students could use this facility and have an experience on par with the PC labs. A new domain was created where Unix and Windows shared a common authentication process. Students could now also access services within the new domain from any of the laboratories, not just the Thin Client devices. The new services provided were as follows:

a) A general purpose Windows Terminal Server with mounted storage for all students and staff.
b) Module specific Windows Terminal Servers for courses where there were specific software requirements not common to all students.
c) Individual Virtualized desktops for students in specific modules where administration rights were required.

All services were made available from both the Thin Client and PC labs as they were available over the Remote Desktop Protocol RDP.

4.2 Results

The data gathered for the second case study was evaluated under same three headings as per case study 1.

1) Login events on the Thin Clients
2) Reservation of the Thin Client facility.
3) The cost of maintaining the service.

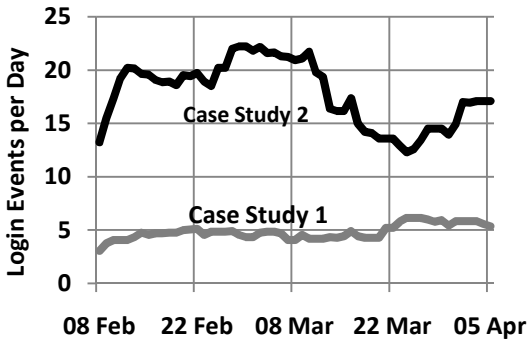

Figure 5. User Login Event Comparison

Login events on the Thin Clients:
As shown in Figure 5 there was a significant increase in the activity of the Thin Client facility. The graph shows a comparison of activity during the same time period for the two case studies. To smooth out the graph a simple moving average was perform on the data.

SMA= (L_M+L_(M+1)+ …L_(M+13))/14

Reservation of the Thin Client Facility:
The changes to the Thin Client facility were announced at the start of the second academic semester as a *PC upgrade* and the number of room bookings increased immediately as shown in Figure 6.

The Cost of Maintaining the Service:
All of the benefits observed from the first case study were retained within this case study. The addition of terminal services reduced the reliance of students on Fat Clients installations. Students are now using virtual machines and terminal servers on a regular basis from all labs.

4.3 Analysis

This second case study is described as an evolution, as it seeks to identify and retain the best traits from both the Fat and Thin Client infrastructures. Thin Clients are shown to be capable of providing services equally well to both Windows and Unix users. The introduction of virtualisation to the infrastructure allowed new services to be developed and used from Thin and Fat clients. As a result there was a definite increase in the use of the Thin Client facilities. Data was gathered from the same period over both case studies to eliminate any bias which might occur due to module schedule differences at different time periods during the year. The timing and method used to announce the changes was critical to the increase in acceptance. The service is currently operating as a dual purpose facility offering both the Windows PC experience and the Unix experience. The announcement of the systems as a PC upgrade removed some of the barriers which existed for users who did not feel familiar with a Unix environment. In fact most users are not aware that they are using Thin Clients.

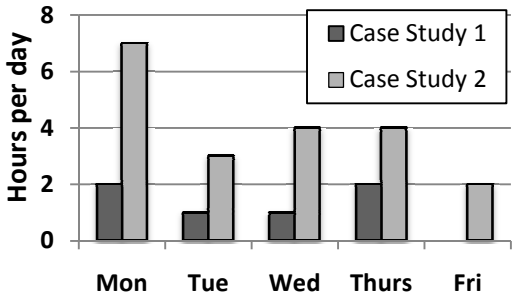

Figure 6. Thin Client Room Reservations

5. Critical Analysis

These two case studies demonstrate that it is possible to obtain the total cost of ownership benefits using a Thin Client model, but the method used to introduce the alternative architecture has a dramatic affect on user acceptance. Without acceptance users will continue to use existing PC laboratories and ignore Thin Clients. The most conclusive result from these case studies is that while the second case study demonstrated significant increase in acceptance and use, the PC environments are still the system of choice for students, as shown in Figure 7. In this graph we show the highest use PC laboratory and an average use PC

laboratory. Thin Client use is still less than one third of the use of the busiest computer laboratory.

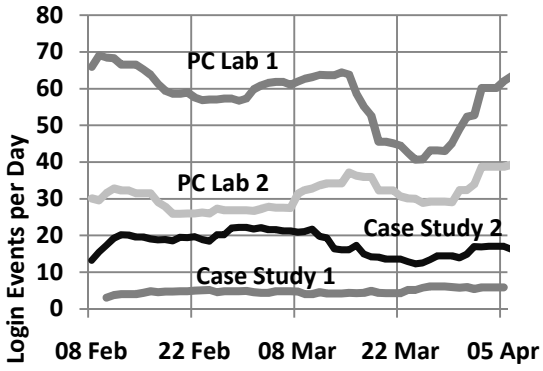

Figure 7. Comparison of all Computer Labs

6. Conclusion

In similar studies the focus is often on measuring the reduced total cost of ownership of the Thin Client solution [12] but rarely is there a focus on co-existence and the measurement of user acceptance. These two case studies provide data centric analysis of acceptance and have shown that given a choice, students will continue to use familiar PC systems as opposed to Thin Clients. The design modifications in the second case study which provided additional services to both the Fat Clients and the Thin Clients are the next stage in the evolution of Thin Client integration strategy within the DIT. It is only by offering additional services to the students and focusing on how to enhance the user experience that the issue of acceptance can be addressed.

7. Future Work

Additional case studies are planned where the thin client is located physically adjacent to existing PC deployments. Efforts will be made to eliminate any obvious distinction between the two technologies to remove bias from the experimental results. Additional services could also be offered which would encourage students to be more mobile between computer facilities.

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