Thin Client Pilot

Executive Summary

This pilot study is a preliminary look into the potential use of thin clients in high use areas with low computer processing demand at UEA. By starting with simple deployments means that more challenging setups can be addressed at a later stage, post confirmation of the reduction in power estimated, with less cost involved. In this pilot library catalogue points and print stations have been used as test cases.

The recordings show that there is an operational power saving between a thin client device and a fat client desktop arrangement for providing UEA printer stations and library catalogue points. By incorporating the implementation cost and scale of these operations it is not considered financially viable to implement library catalogue points with a thin client deployment. However by replacing the print stations with thin client devices operating like a fat client (with the Operating System processed locally on the device) the pilot shows that £7,688.51 can be saved over 5 years in operation and 22,428.96Kg of carbon can be saved. Additionally, the current print stations can be moved to users who could utilise their power and capacity more effectively and efficiently.

In light of this pilot, further work has been recommended to revisit the situation for library catalogue points when UEA has a virtual server infrastructure. It is also recommended that consideration be given to replacing the print stations with thin clients capable of locally running an operating system as per the pilot.

Introduction

Recent activities in sustainable computing have given more impetus to considering wider use of thin clients in HE, for example the desktop infrastructure of the new Queen Margaret University (QMU) campus is based almost totally around thin clients. Other projects such as the Bradford University ITS4SEA: Integrating thin-client systems for secure e-Assessment project and the Coventry University Location Independent Working project have also investigated and successfully implemented thin clients. With this in mind the SISP project at UEA has considered the potential use of thin clients across campus.

At the start of this project it was always stated that any changes made for sustainability should not be made if they have a significant detrimental effect on the performance of services or provisions for our users. With this in mind when planning the pilot, it was decided that any thin client rollout would have to be in a low risk area, where there were other fallbacks should it fail and the technical demands were low. If thin clients cannot adequately provide solutions for low processing demand services, then they will not be able to meet the needs of our higher power demand services.

In the UEA library there are some student print stations and library catalogue only workstations which with their single application (either for printing or library catalogue searches) were considered sensible starting points for trialling thin clients with minimum risk to services. UEA currently has 37 centrally managed print stations and 10 Library catalogue access points.

Methodology

On floor zero of the library there was a set of four catalogue stations monitored, three of these were swapped out with one each of the thin client devices selected for testing. The remaining workstations remained as fat clients in order to provide a control for comparative analysis.

On floor one of the library there was a set of four print stations monitored, again three of these were swapped out with one each of the selected thin client devices and the remaining workstation remaining as controls.

The pilot was to be run for six weeks during semester time (04/11/2009 – 11/12/2009) when undergraduate student demand for these services is high, particularly for printing towards the end of the pilot when coursework deadlines were due. Power consumption measurements were taken once every 24 hours.

The two types of workstation under investigation were configured as below:

The Library catalogue machines had a remote desktop connection through Windows Terminal Services 2008 to a modified Windows XP desktop professional with IE7 & Office viewers for Word, Excel & PowerPoint and Adobe pdf Reader as well as the standard media viewers. This matched the desktop setup prior to the pilot.

The print stations only had a web based system for releasing print jobs from queues and so a Windows Terminal Server was not required and the desktop ran locally from the client. It is appreciated that this is not a “true” thin client implementation due to the client end processing.

A range of thin client equipment was employed for this pilot in order to evaluate the best device for our purposes. It was not assumed that all thin clients would perform identically. The three devices used were:

- WYSE C90LE
- Dell FX160
- HP T5730

The full technical specifications of these can be found at the end of this section. One of each type of machine was used as a print station and as a library catalogue only station.

To measure power consumption a simple Maplin plug in power monitor was used. One was applied to each thin client and the control machine. On Mondays the data readout cumulative figures were divided by three because the units were not reset during the weekend as they were on week days.

The monitors used provide a range of readings including: watts, voltage and amps of the instant draw, and also high/low watts and average KWh over a period of time. The KWh figures are used for this analysis to be consistent with other power studies in the SISP project and to include the power draw over time rather than just points in time during the pilot.

Additionally, the power consumption of the terminal server Blade was also measured from its HP ILO (Intel Lights On) management page which shows average power, maximum power and minimum power readings over a 24hr period. Implementation of this pilot was quite straightforward:

1. Back End Server was setup
2. Desktop packages arranged
3. Fat clients swapped out for thin clients
4. Monitoring & recording started

Thin clients involved

Dell Thin Client

- 2 x Dell OptiPlex FX 160 Intel Atom 230
- 1.6GHz, 533MHz, 512KB
- 1024MB 667MHz Non ECC DDR2 SDRAM
- XPe SP2 OS

HP Thin Client

- 2 x HP T5730
- 1GHZ Processor
- 1GB RAM
- WES 2009 OS

Wyse Thin Client

- 2 x Wyse C90LE C Class (C90LE):
- VIA ULV 1GHz processor
- 1GB RAM DDR2
- XPe SP3 OS

Dell Control Fat Client

Print Station Machine

- Dell Optiplex 745:
- Intel Core 2 CPU 6400 2.13GHz Processor
- 2GB RAM DDR2
- XP SP2 OS

Library Catalogue Machine

- Dell Optiplex 755:
- Intel Core 2 Duo E4600 2.4GHz Processor
- 2GB RAM DDR2
- XP SP2 OS

Recordings & Observations: print stations

Diagram 1 shows a clear saving by all thin clients from the previously used fat (marked as control on the graph)clients, but whilst the HP & Dell thin clients are similar in consumption, the WYSE machine shows further savings of 0.2 KWh over each day.

There is an unexplained peak in the WYSE consumption which shows one day of a gain of 0.5KWh but this is considered to be an anomaly, more likely to be a error in the monitors than a blip in the client machine due to the fact it does not do anything but print from a web based system.

The average value of the WYSE thin client consumption is ~ 0.62KWh per day less than that of the current fat clients used (see table 1).

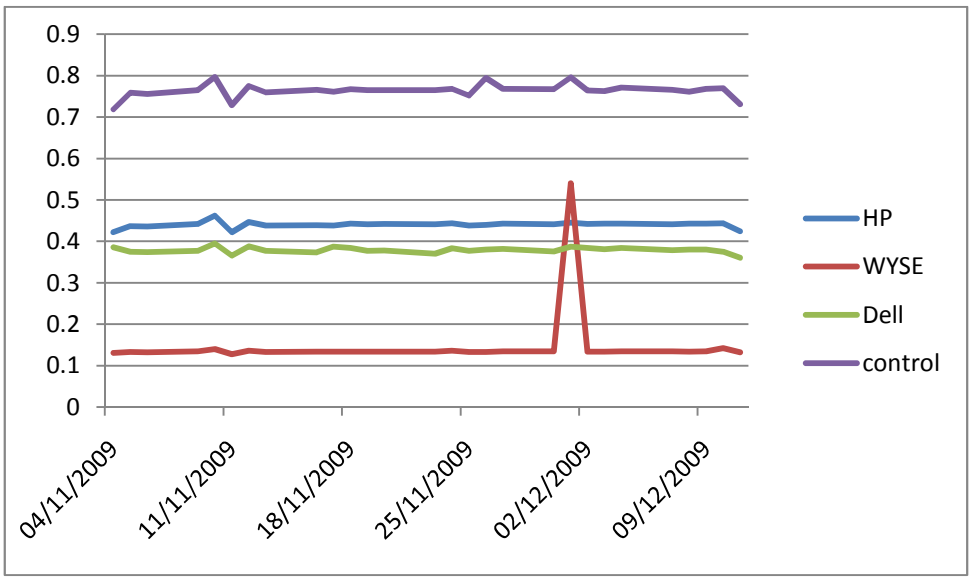

Diagram 1. Consumption (KWh) of the different thin clients per day as print stations.

By extrapolating these recording out over a projected life time of the devices it can be established what the sustainable benefits are and if any related fiscal savings can be made by replacing print stations in the piloted setup. Please note that prices quoted in these calculations were correct at the time of writing and exclusive of VAT.

	Average KWh
HP	0.44
WYSE	0.15
Dell	0.37
Control	0.76

Table 1. Average daily KWh consumption recorded for each type of thin client tested over the duration of the pilot.

Fiscal Implications		
	Thin clients	*Fat Clients*
Cost to purchase 37 units	£14,985.00	£18,500.00
Cost to purchase HP Blade	-	
Cost to implement	£14,985.00	£18,500.00

Table 2. Financial costs of implementing fat & thin clients as print stations (running the OS locally) at UEA.

There are 37 centrally managed student print stations on the UEA campus. By utilising the figures in tables 1 & 2, the following calculations in table 3 have been made about the annual ownership cost by year and over the lifetime of the hardware, if all central print stations were replaced. UEA's current desktop replenishment lifecycle is 5 years. It is assumed for the purpose of these sums that this would be the same for a thin client. However it is probable that due to the low usage and integrated component nature of many thin clients, these could be used for longer as long as they are still fit for purpose. In this situation; student printing.

It should be noted that table 2 shows no costs for an HP Blade. This is due to the "untrue" implementation of thin clients in the position of print stations whereby the flexibility of the clients' trialled enabled desktops to be installed locally.

To install 37 WYSE thin client print stations, setup as per the pilot, it would cost £3,515 less than if using fat clients. Given the locally installed desktops on print stations in the pilot, an HP Blade isn't required for back end infrastructure, so this cost is zero.

Cost of equipment based on replenishment cycle		
	Thin clients	*Fat Clients*
Equipment Life Span (years)	5	5
Cost of 37 units per year	£2,997.00	£3,700.00
Cost of Blade per year	-	
Total cost of implementation by each year of use	£2,997.00	£3,700.00

Table3. Lifetime ownership costs of thin and fat clients if used for print stations.

The next step is to consider the operational costs of the two solutions. This is shown in table 4 and utilises the average daily consumption figures (noted in table 1) for costing over a year, and for the expected lifetime of the client.

Operational and Implementation Costs for 37 Print Stations			
	Thin clients	*Fat Clients*	*Difference (Fat-Thin)*
Energy costs to run per year (KWh)	2,026	10,264	8,238
Energy cost for 5yr lifetime of setup (KWh)	10,129	51,319	41,190
Unit cost per KWH	£0.10	£0.10	
Fiscal cost of operation per year	£207	£1,047	840
Fiscal cost of operation for 5yr lifetime	£1,033	£5,235	4,201
Implementation Cost + operation cost per year	£3,204	£4,747	1,543
Implementation Cost + operation cost for 5yr life time	£16,018	£23,735	£7,715

Table 4. Operational costs of thin & fat clients as print stations for the duration of client operating life and savings thin clients can make over fat.

Also in table 4, the combined implementation and operation cost for each solution is shown. This demonstrates a financial saving of ~£7,5k over the whole life of the 37 clients.

From a sustainable perspective, carbon savings can also be calculated. Based on an emissions factor of 0.54Kg carbon for each KWh of power utilised, table 5 details the difference between thin & fat clients.

Carbon Implications			
	Thin clients	*Fat Clients*	*Difference (Fat-Thin)*
Carbon Emissions factor (Kg CO2 per KWh)			0.54
Energy Carbon Production per year (annual KWH * EF)	1,084.79	5,570.58	4,485.79
Energy Carbon Production over lifetime (life KWh * EF)	5,423.95	27,852.90	22,428.96

Table 5. Carbon Emissions from the print stations as either fat or thin clients and the difference between the two.

Table five shows that a thin client implementation would produce over 22,000Kg of carbon less than fat clients over the lifetime of the print stations. That means the total savings of using thin clients over fat client set up as per the pilot are financially: £7,688.51, in energy reduction: 41,535.11KWh and in carbon reduction 22,428.96Kg over 5 years.

Recordings & Observations: library catalogue stations

Diagram 2 shows the power consumption of each thin client in comparison to the old fat client when implemented at library catalogue stations. These desktops with minimal services are designed to be quick access for students.

Again the WYSE thin client out performs the Dell & HP clients with a consistently lower consumption whilst performing the same duties throughout the whole pilot duration.

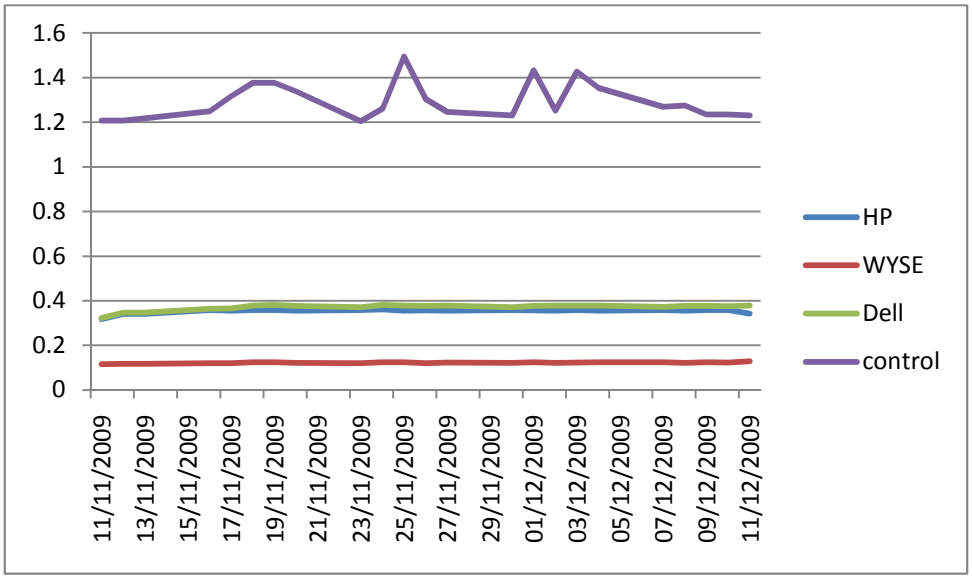

Diagram 2. Consumption (KWh) per day of the different thin clients as library catalogue points.

Additionally all thin clients show a smoother energy draw over time, with less peaks and troughs than the control machine. This is recognised as more efficient energy usage of power supplies as fewer peaks & troughs mean that the power factor of a supply is higher (closer to 1). This efficiency principle is backed up with the use of harmonic filters on large supplies where the efficiency savings are even greater.

Whilst the HP client marginally outperformed the Dell, the best average saving of 1.17KWh (table 6) on the old machines was delivered by the WYSE thin client. This concurs with the best client for the print stations.

	Average KWh
HP	0.35
WYSE	0.12
Dell	0.37
Control	1.29

Table 6. Average daily KWh consumption for each type of thin client tested over the duration of the pilot.

By extrapolating these recordings out over a projected life time of the devices it can be established what the sustainable benefits are and if any related fiscal savings can be made by replacing the current 10 library catalogue stations in the piloted setup. Please note that prices quoted in these calculations were correct at the time of writing and exclusive of VAT and that in the same vein as the print stations the UEA desktop replenishment policy is 5 years.

Fiscal Purchase Costs		
	Thin clients	*Fat Clients*
Cost to purchase 10 units	£4,050.00	£4,750.00
Cost to purchase HP Blade	£4,000.00	
Cost to implement	£8,050.00	£4,750.00

Table 7. *Financial costs of implementing fat & thin clients as library catalogue points at UEA*

Table 7 shows that to implement library catalogue stations with a thin client infrastructure would cost £3,300 more than the current setup with fat clients. This is an opposite outcome to that of the print stations due to the extra cost of the server. Table 8 shows these costs over the lifetime of the clients and by year, and demonstrates that for each year of a thin client deployment it would cost almost twice as much as a fat client rollout, before operational costs.

Cost of equipment based on replenishment cycle		
	Thin clients	*Fat Clients*
Equipment Life Span (years)	5	5
Cost of 10 units per year	£810.00	£950.00
Cost of Blade per year	£800.00	
Total cost of implementation by each year of use	£1,610.00	£950.00

Table 8. Lifetime ownership costs of thin and fat clients if used for library catalogue points

Operationally table 9 shows us that thin clients are cheaper to run, including the cost of the HP Blade dedicated to the service of 10 clients. This is the same outcome as the print stations.

Operational and Implementation Costs for 10 Library Catalogue Stations			
	Thin clients	Fat Clients	Difference (Fat-Thin)
Energy costs to run per year (KWh)	438	4,708.50	4,270.50
Energy cost for 5YR lifetime of setup	2,190.00	23,542.50	21,352.50
Unit cost per KWH	£0.10	£0.10	
Fiscal cost of operation per year	£44.68	£480.27	435.59
Fiscal cost of operation for 5yr lifetime	£223.38	£2,401.34	2,177.96
Implementation Cost + operation cost per year	£1,654.68	£1,430.27	-224.41
Implementation Cost + operation cost for 5yr lifetime	£8,273.38	£7,151.34	-1,122.05

Table 9. *Operational costs of thin & fat clients as library catalogue points for the duration of client operating life and savings thin clients can make over fat.*

Of the 506.9KWh per year consumption costs, ~60KWh per year are attributable to the HP Blade (based on the average daily measurements taken in this pilot).

But also in table 9, negative values in total cost difference show that fat clients are still cheaper over their lifetime than thin clients when implemented as library catalogue stations. This demonstrates that the operational financial savings are not enough to offset the implementation cost for thin clients to replace fat ones for this purpose. An extra ~£1.1k is required to setup & run 10 thin client library stations over 5 years.

Carbon Implications (Kg)			
	Thin clients	*Fat Clients*	*Difference (Fat-Thin)*
Energy Carbon Emissions factor (kg per KWh)			0.54
Energy Carbon Production per year (annual KWh * EF)	273.73	2,548.59	2,274.86
Energy Carbon Production over lifetime (life KWh * EF)	1,368.64	12,742.94	11,374.30

Table 10. Carbon Emissions from the library catalogue points as either fat or thin clients and the difference between the two.

However, the reduced operational cost has a related carbon saving as shown in table 10. A decision would have to be made which addresses balancing between an extra financial cost of ~£1.1k and a reduced carbon production of 11.3K Kg of carbon over 5 years against the financial saving and an extra 11.3K Kg of carbon to UEA's carbon footprint.

When HEFCE's strategy to allocation research funds based on energy sources and usage is initiated this balance may need to be readdressed subject to the fiscal cost compared to the research funds lost.

It should be noted that the additional HP Blade terminal server required for this deployment also had its power consumption recorded and on average, never went more than 4w over the idle consumption (Diagram 3). This is factored into the investment costs in tables 6-10 above.

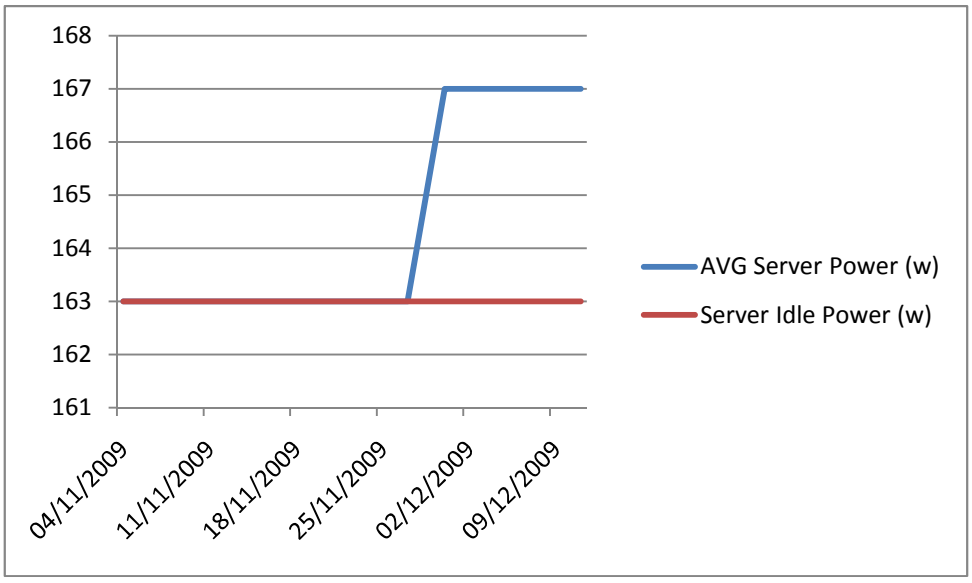

Diagram 3. Terminal Server power draw during pilot duration

During the pilot UEA did not have a virtual server infrastructure. Although this scenario would make cost of ownership calculations more complex, it would also reduce the cost as more than one server could be on a Blade (subject to volume of terminal server connections).

Power Management of a Fat Client savings compared to Thin Client Savings.

At the time of planning this pilot it was noted that the savings of a thin client implementation would need to be offset by means of savings created by power managing a fat client.

However, the library print stations can not be power managed by the current PowerMan software due to software inoperability on wake up, and the library catalogue points also are not power managed because of the way that they have been configured.

Conclusions & Recommendations

A key requirement, as stated earlier, is that thin clients should only be deployed where they are fit for purpose, i.e. by using them there is no detriment to services offered including performance. Confirmation that this requirement has been met was provided by the fact that there were no user complaints about the service or any unscheduled down time of the thin clients throughout the whole duration of the pilot.

An interesting point to note is that the control client for the library catalogue stations with a remote desktop consumes on average 0.53 KWh per day more than a fat client as a print station which had its operating system installed locally (the false thin client implementation).

What has not been taken into account within the remit of this pilot are the unknown carbon costs of client manufacture & transport and also that of the heat BTU. Further work would have to be undertaken to collect figures for analysis.

Further work to explore the use of thin clients to support higher processing requirements could also be explored.

Based on the results of this pilot, it could be recommended to Information Services management that investment in 37 WYSE thin clients to replace student print stations should be made for the purpose of reducing the university's energy bill and carbon footprint.

Over 5 years this offers financial savings of over £4,500 and a reduction in carbon production of 6000 Kg. Although this does not offer such a large financial saving as to recoup investment monies within the expected life of the clients, it is a way to spend less to deliver the same service.

Before this can be implemented, the university should also consider the in-house support required for thin clients and physical security arrangements of the hardware. This is necessary due to the different technical knowledge required for supporting a thin client infrastructure, and because the physical devices are significantly smaller than a fat desktop and therefore much easier to steal.

In regards to the library catalogues, this is less clear cut as to the strategic decision the university should take. Although the trialled deployment did deliver the service and reduce carbon production, it does cost more financially. It is recommended that this is reconsidered once UEA has a virtual server infrastructure which should reduce the implementation and maintenance cost of the thin client deployment.

When this happens it should also be remembered that the library catalogue stations do have a slightly higher maintenance overhead in terms of setup for the terminal services server. This maintenance overhead has not been quantified within the remit of this pilot but would not change the outcome for library catalogue points.

Once the recommended further work is complete then more formal recommendations can be made for potentially deploying thin clients around campus.