Linux Thin Clients at the Footscray Library

computerbank

A Demonstration Low Cost Public Access Network

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Overview

Note: The views in this paper are those of the Author, Contributors, and Computerbank Victoria; they do not necessarily represent the views of the Footscray Library or the Maribyrnong City Council.

Footscray Library, the main library in the City of Maribyrnong Library network, provides public computer access to its patrons via 16 Microsoft Windows based computers. Changes in the technological landscape presented new opportunities to enhance and provide additional computer services to the library's patrons in a cost effective way. Kylie Davies (Victorian Branch Coordinator of Computerbank Australia Incorporated) met with Lloyd Brady (Team Leader, Library Information and Technology Services, Maribyrnong City Council) in February 2004 to discuss the implementation of a Linux thin client network at the library on a trial basis.

A proposal for this trial was developed and a strategy for implementation was agreed upon. One of the motives of this trial was to determine the appropriateness of a Linux thin client approach in a multi user environment, thus enabling Computerbank to explore the suitability of this approach to provide future IT services to groups interested in public access network solutions.

On the 5th of May 2004, a demonstration Linux thin client network was implemented at the public access Internet area for an initial period of *3* months.

This document reports our observations and experiences from the trial. It is to be considered an interim report at this stage; an updated version of the report will be compiled at the conclusion of the trial.

We suggest interested parties visit the library and use this system in order to make their own observations and draw their own conclusions. Comments, suggestions and queries relating to this project are welcome, and can be directed to Kylie Davies at Computerbank Victoria (CBV).

For those unfamiliar with the term “Linux thin client network”, it is simply the sharing of a single Linux desktop, simultaneously amongst multiple workstations in a networked multi-user environment. For more information regarding a Linux thin client network (eg implementation, hardware or software), please contact Ed Chan or Kylie Davies at CBV .

Executive Summary

After six weeks of continuous operation, comments and reports from staff at the Library indicate that the Linux thin client network is reliable and well used by library patrons. Our own observations confirm this.

An important aspect to the trial was to assess whether the Linux desktop can be used successfully by non-Linux users for “everyday basic computing” use. The reports and observations already collected are a good indication that this goal has been achieved.

By writing this report we hope to contribute our experience to others looking to provide or extend public access computer facilities using cost effective IT strategies similar to the one used in this trial.

Many Thanks

This project would not be possible if it had not have been for the co-operation and kind assistance of the staff at the Footscray Library; their patience, cheerfulness and positive outlook from the very start was fantastic.

Many thanks to all the staff, volunteers and Work for the Dole participants at Computerbank Victoria (CBV) who have helped along the way with tasks such as the initial development of the proposal, setup, transport and building of thin clients and test servers.

Thanks especially to the two people who supported the project in every way; Lloyd Brady, Footscray Library IT systems officer, who provided us with very valuable feedback and support on numerous occasions, and Kylie Davies, of CBV, who helped with a lot of the organisation behind this effort.

A big thanks to Robin van Spaandonk, who provided a lot of technical feedback on the system operations. We had endless discussions about the operational aspects of the network. From many of these discussions (sometimes over several days), we came away with what was required, and we went about seeking and providing the solution.

Finally, it is important to note that without the efforts of the GNU/Linux free and open source software community (special mention *MandrakeSoft*) and its developers to provide the project with the tools and ability to do the job, this project would not have got off the ground.

Objectives of the Trial

The primary objective of this trial is to determine if a Linux thin client setup can operate adequately in a “real world” environment as a way of providing “low cost and effective” public access computing facilities to community groups and/or schools.

By “real world,” we mean ordinary users of personal computers, not technically savvy or interested users. The main concern of the user, in this context, is to use a computer as a tool. The user would like to be able to use a computer as effortlessly as possible as a means to achieve a certain set of tasks within a limited time frame. The users we refer to have limited inclination to learn or tackle anything new or unfamiliar while performing these tasks.

By “effective” we mean providing the applications that would satisfy the computing needs of an “average user” in a community group setting such as a library environment.

The minimum requirements for the trial included the ability for users to access a full featured web browser with multi-language capability (Arabic, Chinese, Vietnamese), the ability to perform word processing (inter-changeable formats with MS Word) and spreadsheet (inter-changeable formats with MS Excel) tasks, and the ability to print from applications.

The system also needed to have the ability for patrons to read (open) and save their data to floppy disks. This feature was seen as particularly important as it is the most practical way for users to store and retrieve their data on public access computers.

By “low cost”, we mean low cost in relation to acquiring the hardware and the software. “Low cost” also refers to the on-going maintenance effort required to support the continuous operation of the implementation. An appendix detailing the cost of the hardware and software is included at the end of the report.

A secondary objective of the trial is to use it as an opportunity to make any necessary changes to refine the system from a usability and an operational view point.

Note: It is important to note that the Linux thin client network provided to Footscray Library is intended to complement the existing Windows network by providing additional capacity.

Operational Environment

The Linux thin client network operates alongside 16 Windows based PCs as part of the library's public access network; providing Internet access and PC based applications to library patrons. Its primary role is to provide “quick 15 minute” access terminals to the general public; there is no requirement for bookings in advance. Hours of operation are Monday to Friday 10 am – 7.55 pm, Saturday 10 am – 4.55 pm, and, Sunday 2 pm – 4.55 pm.

The hardware environment consists of four Pentium 166 MHz PCs acting as Linux thin clients linked to an AMD Duron 900 MHz acting as the Linux thin client server. The machines are connected via 100 Mbit network interface cards and a 100 Mbit switch.

The software environment is designed for use by the “general public access user” and is a Mandrake Linux 9.2 distribution (operating under the GPL license scheme) that has been customised to have restricted menu options and modified login processes.

In order to meet the operating needs of the Footscray Library's public access area, the following changes were made to the standard Mandrake Linux KDE desktop environment:

- Automatic shutdown of the server and thin clients at predetermined times. Just before the library's closing times, the server sends “shutdown” commands to the thin clients. After the thin clients have shut down, the server shuts itself down and powers off. If patrons are using the system before it is due to be shut down at the library's closing time, a screen message will appear *advising* users to save their work and log off. At the end of the day, library staff are only required to “power-off” the thin clients.

- Use of the floppy drive on the thin clients. We have provided a system that allows users access to the floppy drive on the thin clients for data retrieval/storage purposes.

- Automatic refresh of the user's home directories at the beginning of each user session. Home directories are automatically re-built from a “master copy” during each login process. This feature addresses some of the privacy issues surrounding a “shared” terminal in a public access area and restores the next user session to a previous “clean” state.

- Password-less logon. A user does not enter a password to login to use the system.

- Linking each terminal to a specific user. In order to overcome the problems caused by two or more users logging on with same user-id, we have implemented a “one user one terminal” logon policy. This policy is enforced at the software level.

- Disabling of the Alt+Ctrl+Backspace and Alt+Ctrl+F1 to F6 keys on the thin client terminal. A user operating a thin client cannot access a login prompt by pressing (intentionally or unintentionally) these combination of keys as they have been disabled.

- Time limits on user sessions. We provided a system whereby each user session has a predetermined amount of time (2 hours).

- Heavily customised desktop menus that only enable access to the applications deemed to be required by users. In particular, access to console/shell applications were removed from all menus.

In setting up the thin client network we did not adopt the Linux Terminal Server Project (LTSP) [1] model. The CBV model involved modifying the thin client server in order to accept logins (XDMCP requests) from terminals which have their own base Linux OS installed on their local hard disk.

This design, while not as technically elegant as the LTSP model, did provide us with immense flexibility in that we can now turn any modern Linux desktop distribution into a thin client server. It was also easier to troubleshoot as we did not have to grapple with the issues surrounding network booting, or mounting the file system over Network File System (NFS) and swapping across the network.

The approach we took to implementing the thin client network is also simpler to understand - we wanted our thin client networks to be deployed and maintained by a broad range of people with varying levels of Linux skills.

Observations from 5th May to 10th June 2004

The system went "live" (open to the public) at approximately 10.30am on Wednesday the 5th of May, 2004. The following sections document our observations and experiences from the first six weeks of operation.

Breakdown of Application Use

From our casual observations, the breakdown of application use in this type of environment is:

- Web Browsing (includes web mail) - 85 %
- Word Processing and printing of documents - 15%

Most users of the system use the terminals as "quick ad hoc" access to the Internet. Even though the terminals have an official 15 minute limit, users tend to stay on for much longer. In general this means that users can stay on the computer until a queue forms. During very busy periods (eg. immediately after school and on the weekends) the "15 minute" rule is rigidly policed and enforced.

As there are some differences in functionality provided by these and the 16 Microsoft Windows PCs that the library provides, a sign was displayed on the desks housing the Linux thin client terminals specifying what they can and cannot do. As a result, most users of the Linux thin client network use it with the right sort of expectation.

System Usability

Familiarity of application interfaces
Users like familiarity and will associate an application with a familiar brand or name. For example "Google" is associated with the Internet. We provided *two* web browsers on the desktop, Konqueror and Mozilla. Initially, we provided a Google icon on the desktop to use the Konqueror web browser. This proved to be a mistake as Konqueror did not display some web pages similar to Internet Explorer (IE) and a number of users noted the difference. This difference was a constant source of queries to the staff. The Mozilla web browser seemed to work more like IE. After we changed the Google Icon to use the Mozilla web browser, we reduced user queries in this area by a large amount.

Remote Floppy drive use

This proved to be a major problem for us in the early days of operation. The lack of user familiarity with the Linux floppy disk mount and unmount procedure, plus the fact that the floppy drive was mounted across the network on a system that was not designed to use a floppy disk, led to

problems of reliability.

We revisited the implementation for the remote floppy disk drive and came up with a more reliable solution towards the end of the second week. This proved to work, as we noticed the problems reported by both the users and the system log files had dropped away.
In addition we provided a brief "how to" *icon* on the desktop in an attempt to educate our user population with regards to its use. However we noted that users tended to "attempt first and (maybe) read the docs" later.

Multi-Language Web browsing

The municipality of Maribyrnong has a large population where English is not their first language. We provided a web browser (Mozilla) with multi language capability (Chinese, Vietnamese and Arabic) and this has proved popular. In addition, Amharic fonts were installed on the system.

CBV is currently conducting research with the intention of providing more and better language capability for Linux web browsers.

Session limits

Originally we had a limit of *2* hours for each user session with a warning message to be displayed *5* minutes before a session was due to end. When the user session time limit had expired, the system would automatically terminate it. We disabled this feature as we discovered that most of the users did not log off their sessions after they had finished with it. The next user would then continue to use the previous session and not get the full 2 hours of a new session.

Reported Problems During the First Six Weeks of Operation

1. The remote floppy drive implementation
   We used a Network Block Device (NBD) server/client implementation. Until we sorted out the problems with the remote floppy drive (towards the end of the second week), it proved to be unreliable and only worked well occasionally. Once we solved the problems with the remote floppy drive, we dramatically reduced the problem count.

2. Terminals hanging
   We had 2 reports of user sessions hanging or looping, thereby preventing the user from logging on. Investigations have linked this to the remote-floppy drive problems. Since the introduction of changes to the remote floppy drive implementation, we have had no further problem reports. We are monitoring this area closely.

3. Thin client terminal failed to boot
   The thin client terminals boot a base Linux kernel with an X Server application. On one occasion, we had a problem with inodes on the ext2 file system getting out of sync. In order to overcome this shortcoming, we provided the library with floppy disks that will automatically boot and perform a file system check and repair on the ext2 file system.

Note: We have changed the file system used on our “development” thin clients to the more robust Reiserfs file system.

Project Focus

During the 3 month period leading up to the implementation date, we worked to ensure that the system would meet the basic needs identified by the library.

During this time we identified the areas that we would need to concentrate on (usability, floppy disk use, system stabilty and security) in order to ensure the best chance of success for the project.

We used the trial as an opportunity to uncover any bugs or usability issues in our Linux thin client implementation. During implementation we made a number of changes to our thin client model.

The section below details our approaches to implementing the project.

Pre-Implementation Project Focus

During the three months prior to the implementation date, we spent considerable effort in researching user needs, customising the system, and, acceptance testing the system.

During this time we had considerable input from the Library's Information Systems Officer, Lloyd Brady, as to the type of applications, desktop features and languages required. We also spent time at the site observing existing computer utilisation (without being intrusive) in order to gain an appreciation of the environment that the thin client would operate (very public and busy; ie high profile and high pressure).

Our intention was to provide the minimum necessary “Linux Desktop System” to satisfy the latent demand[2] that we knew existed in the system and to ensure this would work in a stable, uniform and consistent manner.

It was not our intention to showcase the varied and many Linux applications available to the general public; this is the role best played by a computer magazine or a Linux user group. We resisted the temptation to provide too many applications that would end up presenting the “general user” with a confusing array of choices.

Post Implementation Project Focus

With any new system, be it Microsoft Windows, Apple Mac, or Linux, the support given immediately after the initial implementation period is critical [3]. This point cannot be stressed enough; the acceptance of any new and unfamiliar system is more likely when support is on-site and at hand.

In the first two weeks after implementation, CBV had someone on-site [4] answering questions, taking note of problems and generally establishing a rapport with staff and users. It is often a fine

balancing act between being overbearing and intrusive and being helpful and supportive.

In addition, we conducted many staff training sessions (duration of one hour) which covered system operation basics, problem resolution for the most common problems encountered, and problem reporting. We hope to provide more training as time goes on. Staff were provided with single page "HOW-TOs" to handle the most frequently encountered problems and questions. A note book was also provided for the purpose of reporting problems with the system.

When a problem was reported, it was followed up with the member of staff concerned. The note book was invaluable for looking at what went wrong and when. On the whole our efforts in this area *were* very well received and this was reflected in the growing confidence and acceptance by members of the staff to this new and unfamiliar thing known as a Linux thin client network.

Being on-site gave us first hand experience on how the project was going. We were able to address system and usability problems as they arose. The most urgent "operational" problems or annoyances were addressed within the first two weeks.

System Operation

Apart from configuration of printing services, we encountered no problems during the initial setup of the system. This section reports on the system operation.

System Stability and Availability

In a centralised or server-centric model of computing, the stability of the system is crucial; if the system crashes or performs poorly (perhaps as the result of a single user's actions), then all users on the system are similarly affected. In the initial stages of the system's operation, this very much occupied our thinking . However over the past six weeks, the robustness of the Linux system to continue to operate and serve other users despite the occurrence of some “rogue” tasks [5].

Apart from 1 system failure [6] which resulted in the system being unavailable to users, the system has been operating continuously, each day, everyday, since the initial implementation.

This system failure resulted in the development and implementation of a disaster recovery plan (DRP) for the Linux thin client network. The DRP consists of a backup server that has an identical set of software. In the event of a hardware failure, the backup server is “plugged in” and switched on to perform its required role.

We tested the DRP on the 21st of May, 2004. During this test, after a successful “5 minute changeover,” the thin client network operated for a day on the DRP machine [7]. The DRP system continued to function as per normal. On the next day of operation, we switched back to the “production machine.”

We also have several replacement thin clients on “stand by” if the requirement to use them arises. In addition to a DRP machine to ensure continuity of operation, we have an identical system installed on a separate partition on each of the machines. In the event of any software corruption, we can boot off these “backup” partitions and resume normal operations to the public.

System Performance

There have been no reported issues with system performance. Despite the fact the system is utilised fully (all terminals in use), snapshots (using the “top” command) report the system idle (at between 50-70%) during these times . Even with 4 users on the system, the swap space is seldom used. The above suggests we have sufficient capacity (under “normal” workload) to run an additional 2 terminals if required or needed.

It is interesting to note on the day we switch over to the DRP machine (a significantly more powerful machine [8]), users did not notice any significant performance gain. This tend to suggests that the performance improvement was not at a level that is noticeable under the existing

workload. Put it another way, the current setup was fast enough for the users not to notice when a faster setup was introduced.

System Expandability and Ease of Upgrade

The nature of a “centralised” model of computing allows for new terminals to be added to the system with relative ease. It is as simple as plugging in another Linux thin client terminal.

Upgrading the system (hardware or software) only requires an upgrade at the server end of the system, ie, all changes are performed on the server end.

Centralising all the applications on the server essentially means all the thin client terminals are removed from the future software and hardware upgrade cycle [9]. The reader can draw their own conclusions in this area of potential cost savings both from the hardware and software point of view.

Conclusions

When we first embarked on the project, the magnitude and significance of this project did not escape us. We have been given a fantastic opportunity to do a trial in a public place, using an approach (server-centric) and an operating system platform (Linux) that is not common place among ordinary PC users.

The continuous use of Linux thin client network at the library has demonstrated that it is possible for the "general user" to use a Linux system productively to meet basic computing needs. We often have to pinch ourselves when we see all 4 terminals being occupied while other patrons wait their turn to use the system - a Linux desktop system.

Even after six weeks of operation, the results and feedback we have received from this demonstration have exceeded our expectations.

We hope the success of this trial will encourage IT decision makers to look closely at this model as an alternative for the provision of IT services within community spaces. Those wishing to reduce costs or make their computing dollars go further may also be interested in our approach.

References

[1] LTSP is a fantastic project; in the early days we benefited from their documentation to help us better understand thin clients and X terminals.

[2] We had observed (three months before) from the library's own booking system, that there were queues of sometimes 15-20 deep against the Windows PC computers and the “queue depth” continue to exist throughout the day. From this observation we concluded that there was “latent” demand for public Internet access in the existing system.

[3] The amount of support given initially seemed high, especially during the first week. One of our problems being a different member of staff on the desk each day; we did not have the opportunity to train them all in the one go. So it was “hands on” to ensure a smooth operation everyday.

[4] In the first week, we had someone on-site for at least 40 -60 % of the operational time; this decreased to 10–20% in the second week and over the longer term was reduced to a visit (of 30 minutes) every three days. As the system became a “part of the furniture,” it was virtually “hands off.”

[5] Always seemed to occur when there are lots of children around, ie 3 year olds. They make excellent stress testers for any system.

[6] Hard disk failure; outage of 1 hour.

[7] During the DRP exercise we “upgraded” from an AMD900 to XP2600. It was a simple exercise of plugging in the new server. The thin client network was left untouched.

[8] Production machine specification: AMD Duron 900 MHz, 512 MB RAM, capacity 5-6 thin clients; DRP machine specification: AMD XP2600, dual channel memory Ultra 400 motherboard with 1 GB RAM, capacity 10-12 thin clients. Both machines have had floppy drive removed and run “headless”.

[9] At least in the foreseeable future anyway.

Appendix A: The Costs Involved (in $AUD , prices as at April 2004)

Hardware Requirements

Linux thin client server (production machine)

AMD 900 MHz Duron processor
512 MB RAM
40 GB Hard Disk
Intel eepro100 network card (x2).

Estimate cost: $380.00

Linux thin client server (DRP machine)

AMD XP2600 with Nvidia dual channel memory
Ultra 400 motherboard
1 GB RAM
40 GB Hard Disk
2 case fans
Intel eepro100 network cards (x2)
CD-ROM.

Estimate cost: $700.00

Linux thin client terminals (each)

P166 MHz processor
32 MB RAM
540 MB Hard Disk (used only 250Mb to install base Linux OS and X Server)
Intel eepro100 network card
Compaq S3 Video cards with keyboard and mouse

Estimate cost: $30.00 each

17 inch Dell and IBM monitors ($70.00 – 80.00 each).

We deployed 4 thin client terminals.

Network switch (100 Mbit)

8 Port (approximately $70.00)

Network Cables

Depending on length ($5 - $8.00)

Note: We used a lot of second hand components in this setup. Many of the components are available at CBV. The new items we needed to purchase were the DRP machine, the 40 GB hard disks and power supplies. We used “cheap” $2.00 Video cards on the server and cases from our “recycling bin”, and we changed the power supply to reflect the needs of the motherboards.

Software Requirements

All the software provided came from the free Mandrake 9.2 Linux download edition. See www.mandrakesoft.com for more information. We were able to customise the login process, management of home user directories, and the desktop to suit the needs of the project.

Note: For this project, we spent a fair amount of effort customising the software to meet the operational needs of the library environment. However, for a normal desktop environment such as our own training facility at CBV, the amount of customising is not as high.

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Version 1.2, November 2002

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