

A School Without Windows - Draft July 31, 2006

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Chemawawin School in northern Manitoba, Canada, was a K-8 school last year with fifty elderly PCs running various Windows releases. This year, a new building was finished to house a K-12 school with 500 students and it was natural to examine how the curriculum, reflecting widespread use of computers in society, could be integrated into the school. It was decided that

- new equipment should be used with the latest software
- as many seats as possible should be installed in every area
- CDN \$100000 was allocated separate from the cabling costs

Reflecting on various examples, the conclusion came that

- proprietary software licences would eat a big hole in this budget so FLOSS was examined and found suitable. EdUbuntu would be the base.
- thin client/server technology would permit more effective spending on a few powerful servers and many less expensive thin clients
- custom-built multi-seat thin clients in open areas would minimize the average per-seat cost and permit future expansion cheaply
- using gigabit/s networks for the custom thin clients would also reduce cabling costs
- these economies, sale prices and the AMD/Intel price war would permit numerous colour and black and white printers, digital cameras, and scanners to be purchased.

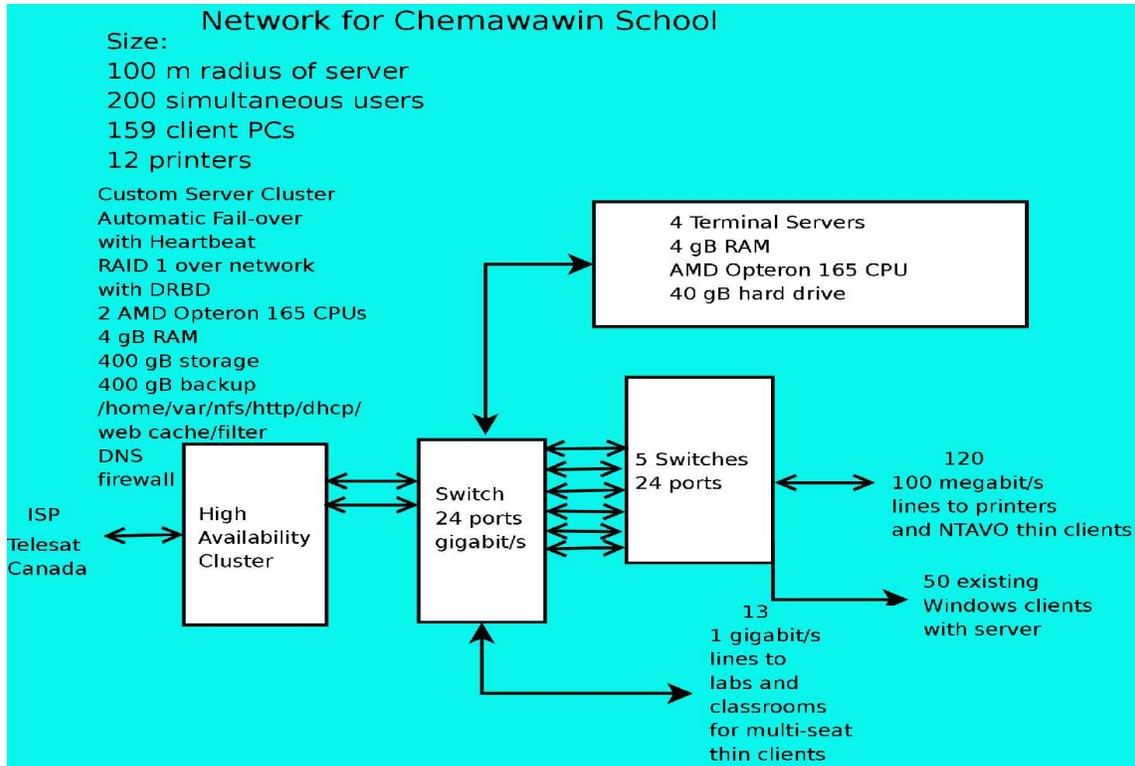
The differences between a Windows solution and GNU/Linux is spectacular. The cost-of-the-box per seat is between \$100 and \$175 with the six-seat thin clients (AMD64 Sempron+256 MB+six video cards+gigabit/s LAN) and the single seat boxes (NTAVO 6020P). Our LCD monitor/USB keyboard/USB mouse combinations cost about \$200 so our per-seat costs for the whole system not including cabling was \$300 to \$375 plus a \$50 share of the server cluster. Windows server and per-seat licence fees would have been near that, so we nearly doubled the number of new seats with this strategy. The new system will have 150 new Linux seats in addition to the 50 old machines, bringing the student/seat ratio from 6:1 last year to about 2.5:1 this year. The ability to have a lab plus multiple seats in each classroom and open area makes it much easier to use computers as tools in the school.

On top of the saving in capital cost, we expect much lower maintenance requirements from using thin clients with few fans and no hard drives. All the work of the system administrator will be done on the six servers of our cluster: two in a fail-over arrangement and four X terminal servers. The existing Windows machines will be able to route from us and share the shade of the firewall, enjoy the web applications and static pages, or boot as thin clients. As users learn the difference between running on AMD64 3200 compared to Pentium III, it is expected these machines may eventually be freed from Windows, too.

Merely using GNU/Linux gives cost savings because there is no licence fee and the system is more reliable and easier to maintain. That savings is further enhanced by making better use of hardware. In a typical system, all computers are replaced every three to five years because newer versions of Windows place ever greater demands on every component. The typical system used workstations having a hard drive with a copy of the operating system and peripheral devices, all of which require maintenance. It is possible to run applications on a central server and merely display data and receive inputs from the client computers. With Windows, there is a per seat licence for this service so there is no saving. With GNU/Linux, we have no per seat licence and the server can handle a greater load. The result is that the client computers are doing a simple task that does not need to change with newer versions of the operating system. The simpler clients can operate with no moving parts and can last longer, too. The savings on licences, the increased life of client computers and the increased reliability give great benefit to schools with much less cost. For the users, the training required is similar to the adoption of a new version of Windows or any other operating system and is rapidly recovered in lower operating costs.

While the best performance of this system is with low-powered thin fanless clients, the lowest cost is with off-the-shelf parts very similar to standard computers except with no hard drive. The reason is that compatible computer parts are commodities competitively produced. The thin clients are specialized devices priced at a premium because of their advantages. We propose to use the larger computer cases to hold multiple interfaces for monitors, keyboards and mice in order to divide the client cost per seat. A typical ATX motherboard can hold six video interfaces for monitors and the USB ports can be expanded to handle the additional mice and keyboards. Whereas a typical special purpose thin client will have a case and power supply costing \$100, these six users can share a single case and power supply. In addition, most thin clients have a 100 megabits/s network

interface while we can choose a motherboard with gigabit/s interface, eliminating the need for one cable per seat and a switch to feed those cables. The available bandwidth per seat is also higher with this arrangement.



Here, then, is a plan for a network in a small school. It can be scaled up by adding more servers or more powerful servers. The total cost of material is about \$600 per seat and software is free, about half the cost of using Windows on each client.

The network is not much different than would be found in a system using that other operating system, but it is now cheaper to use gigabit/s networking than 100 megabits/s because we need fewer switches. One 24 port switch can run a whole school. Also less cabling is needed. We expect higher performance for lower cost this way. At either ends of the cable, things are different. The client computer will load its software from the server at boot time which will take a few tenths of a second at 1 gigabit/s. In a few seconds, users will see a login screen and using a keyboard and mouse enter username and password to log in to the server where the user may run applications and access data, printers and generate responses on the screen in front of him.



The user desktop is fully customizable with a right-click causing a drop down menu for changing what is on the panel at the top, the background, or even adding additional panels. Icons may be created or deleted from the desktop and even multiple desktops may be created. A user can choose whether one click or two are required to activate an icon. Frequently used applications may be accessed more quickly by adding icons.

This system is ideal for schools except in one area, multimedia. If full-screen video is required, a few users can load the server severely. A means to reduce the load on the server for such applications is to run the video application on the client machine, where six users may run video at once and be comfortable. Applications such as browsers and video applications can be made to run on the client by configuring the server to transfer to the client all the necessary files. see <http://www.ltsp.org/documentation/ltsp-4.1/ltsp-4.1-en.html#AEN1683>

Maintenance of this system is also less costly in terms of man-hours because there are fewer computer boxes in the system. The thin clients made from barebones PCs are serviced about once a year for dust bunny suppression and inspection of fans. Decent fans should last five years or more and a stock of spares can be included in the inventory to avoid purchasing delays. Changing a fan involves a few minutes of time on top of the annual cleaning. Because there is only one client machine for six seats, this system is about six times less expensive than the old thick client system even without considering the maintenance of hard drives. A hard drive should last five years so replacements are a small part of maintenance but

replacing the software on the hard drive is a time consuming and risky proposition. Typically, on a large system, the server will be altered to load software that transfers an image of the hard drive as desired for maintenance by PXE. This likely requires shutting down and rebooting every machine in the system. This can be done from the server if the thick clients are set up properly. Complicated scripts customizing each machine with unique identities are necessary because the disc image makes each machine identical as it boots. DHCP and a boot time script can do much of this. If anything goes wrong, two kinds of thin clients may exist in the system... This thin client/server technology avoids this possibility and only the server needs upgrading saving many hours of work each year. With a tightly locked desktop, one system manager may handle a hundred thick clients with Windows, but with the thin client technology and Linux a thousand clients is just as easy to manage as a hundred except for the annual cleaning simply because there is no software to manage on the hard drives of the clients. In Battlefords school division in Saskatchewan, three technicians went from maintaining three hundred Windows PCs to managing thirteen hundred UNIX thin clients using similar technology to our proposal except they used single-seat clients.

Ethical Considerations

Schools without windows are either cost saving devices or attempts to limit stimulation of students to a narrow curriculum. The Windows mentioned in the title is a generic term for a rectangular region of a computer screen used to display information or focus interaction of users with a running process. Windows is a registered trademark of Microsoft corporation with the United States Patent and Trademark Office, even though "The examining attorney will refuse registration of a mark as merely descriptive if it immediately describes an ingredient, quality, characteristic, function, feature, purpose or use of the specified goods or services." This registration is currently being challenged in the courts. Microsoft has been found guilty of many illegal trade practices and is not a corporation with which schools should do business. see <http://toorg.blogspot.com/2006/05/why-microsoft-will-fail.html> Besides ethical grounds, licences to use Windows are overly restrictive and expensive. A suitable operating system for computing in schools is GNU/Linux with a licence that grants the right to use, copy, modify and distribute at no cost. It is a cooperative product of the world and is not owned by any single entity. Windows is also faulty. Many thousands of bugs and malware infect the system. To be usable additional software must be applied to prevent attacks and to restore multiple systems at great cost. GNU/Linux

is known to have a few hundred mostly minor bugs and rarely crashes or requires restarting even when heavily loaded. This article outlines a plan to supply all the needs of students, teachers, administrators and departments of education using only GNU/Linux with much better use of resources.