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An Achievable Computing Solution for Schools

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ABSTRACT

Currently in New Zealand primary and secondary schools struggle to fund IT education programs. Schools can rarely afford to establish and maintain an effective up-to-date computer infrastructure.

We hypothesise that many schools are unable to meet their syllabus requirements because of this inability to fund and support adequate computer systems. We intend to research schools' IT requirements, wants, needs and capabilities with a view to offering a low cost alternative to the prevalent Microsoft Systems used in most schools today.

This paper will present the results of the research and propose a low cost viable Linux based solution. In addition we will present a community-based model that combines the resources of technical institutes, businesses and schools with benefits for all participants.

Keywords

Linux, schools, community, co-operative model, practical opportunities, web support.

1. INTRODUCTION

On the question of providing adequate Information Technology (IT) facilities, schools are faced with a dilemma. On one hand the Ministry of Education is demanding more IT education for our children. On the other hand schools appear to be under-funded by Government in this area, and are always seeking alternative funding sources. IT equipment and software are expensive and complex and schools need either well trained staff to design, install and administer their systems, or enough cash to use expensive commercial services.

The stability issues and difficulty in using and supporting modern Microsoft operating can be problematic These platforms also demand increasing amounts of storage capacity, computer memory and processing power. All these factors present a challenge to our schools. How can they provide for their IT requirements with little cash and without detailed technical skills?

This paper will examine the reality of IT implementations in schools and assess what the needs are of this sector. From there we will present a model that addresses the major issues. Further we will propose a model of providing this level of support by organising Community involvement that will present a win-win situation for all involved.

2. DISCUSSION

If a typical business were to computerise their operations and provide just 20 computer stations and a server they might expect a bill of around $147,000. Why so much? Allow around $2000 per PC, $7000 for a server,

$1500 per user for software, $10,000 for networking, $1000 per PC for furniture and ergonomic aids, $500 per user for training, $30,000 for specialised labour (all rough estimations based on experience, but serve to illustrate a level of unavoidable costs). To write this off over three years alone that's over $49,00 per year plus operating costs for technical support. Realistic operating costs would add around $20,000 making the system cost at least $69,000 per year. Leasing options cannot be substantially cheaper as leasing companies would have to recover this cost plus margin. How much money can a school make available to fund its IT requirements?

A school will have different needs and incomes, and unique opportunities for cost reduction and avoidance. For example, academic discounts, Net Day (a community effort to provide the network cabling for schools), donated equipment and donated parent service all help to reduce the costs. The survey seeks to establish just what level of capability and funding primary and intermediate schools do have, and finds some varied results.

There is some opinion that if the Ministry wants schools to have this level of capability, then the Government should fund it, and that anything a school does to use the lesser options is just letting the Ministry off the hook. Unfortunately this principled approach is unlikely to attract the level of funding required, and there remains the problem of providing the education opportunities for our children today.

Our initial perceptions were that schools have insufficient funding, operated IT on the good will of technically inclined staff and parents and had poor quality systems for backup, virus protection, internet access, e-mail and the like. This raises major concerns for the schools that are developing extended IT systems. Many of these have been unable to implement adequate disaster recovery protection and lack the capability to recover from even a minor system failure.

If ongoing use of IT by school children is to be encouraged, it is imperative that anguish and frustration is minimised during their IT experience. Even if the teaching systems are not very modern, consistent and error-free operation is a worthy goal.

In short, the aim for Primary Schools is to deliver their IT experience consistently, reliably and for the lowest possible cost.

3. HYPOTHESIS

The survey was intended to test the hypotheses:

1. That Primary and Intermediate Schools require significantly more computer equipment and support services to reach their educational goals.
2. That current levels of funding are inadequate to that purpose.

These hypotheses were tested to establish the current level of IT implementation, funding and skills in primary and intermediate schools.

4. SURVEY METHODOLOGY

A written survey was sent to schools to allow them time to assemble the diverse information required. The survey questions were developed to determine demographic, funding and IT capability information.

We approached 53 of the 159 Primary and Intermediate schools in the greater Wellington region via telephone (mainly schools in the extended Hutt Valley region). Each school was asked to commit to completing a written survey within 1 week and return it by facsimile. This method produced a return level of 68%. 36 survey returns were received.

5. SURVEY RESULTS

The following represents a summary of the more relevant statistics generated from the survey.

The average school had 285 students, 15 teaching staff, 4 of whom have some technical computer skills. 86% expressed the need for further technical training for, on average, 5.5 staff. This shows a significant demand for technical training.

There is an average of 28 (a median of 20) computers per school, with an average of more than one printer for every two computers. Three schools had very high computer numbers (73, 80, 135) which skewed the average. After removing these 3 outliers the average reduced to 20 computers per school. The high proportion of printers per PC shows that very poor use is being made of printers on networks, and thus the schools must be running with excessively high operating costs in this area.

All schools reported using computers as a general research tool for students, all had Internet access, but only 70% had the Internet available on the local area network. As only 80% had a network in place, this leaves 10% of schools with the capacity to share Internet access, but using it in standalone mode. 44% of those with Internet access had a higher speed external network connection (cable modem, ADSL etc), and the rest appeared to be using a single modem connection. If 56% of schools are using only a modem for Internet connection, their capacity for simultaneous multiple use

is very restricted, thereby limiting their ability provide general research facilities.

Reporting on funding levels and sources was generally confused and poorly represented in the survey. We can say that 71% of schools felt that funding was inadequate for IT syllabus purposes. The funding shortfall was communicated in a variety of ways, but generally with an average of at least 30%, and possibly much higher. As a consequence this result (30%) lacks the desired level of objectivity and verification is required. Nevertheless there is strong evidence that IT methods currently in use in schools requires significantly more funding to reach their educational goals.

Annual IT Expenditure

	Average	Median
Hardware	$7,800	$5,000
Staff Training	$2,763	$2,000
Professional Support	$2,333	$1,500
Software	$1,460	$1,500

For annual expenditure computer Hardware is the major area (average $7800, median $5000) software is the lowest expense (average $1460, median $1500). This is interesting as the primary learning interface is provided through the software, yet schools spend the least on it. There appears to be a significant level of expenditure on professional support services. Total average expenditure is $14,356.

Of the 36 schools, 66% identified that they had at least one server. Of those with servers 33% (8) are using workgroup technology, not server technology. We can conclude from this that only 44% of schools use true server technology. This is of concern in a sector where the sharing of data and resources are key to a consistent and reliable service delivery. 28% of those with servers had no system for taking backups.

16% of schools report no virus protection. Of those that do, only 34% have protection that was updated this year, 34% was last year's or older, and the remainder did not know how current their protection was. The degree of coverage of this protection was not requested.

In industry, current virus protection and regular backups are considered essential to a professional system. The protection these afford is designed to reduce the risks of loss and minimise downtime. These should be integral features of a school's IT system. These systems involve significant expense and skills to set up and maintain.

5.1 Discussion of Costs and General Difficulties

Most schools reported income and donations providing around 3 new personal computers per year. If schools 'write-off' or plan for total obsolescence of computer equipment within 5 years (compared with 3 years typical in industry), then such replacement rates at best support only a total inventory of 5 times that in desktop equipment. This does not include breakage, normal repair costs and providing the computers for the infrastructure i.e. servers, hubs, internet gateway. As the current average number of PCs per school is over 20, this situation is not sustainable.

A few schools (6% of those approached) are already operating comprehensive suites of modern computers with solid infrastructure and Internet access. This paper is not addressing these schools, though it would be a useful to know how they achieved this. Initial indications show that this has been achieved through significant levels of sponsorship, parents who are specialists in the IT industry, and dedicated staff. Some have achieved this through leasing arrangements, joint funding of common resources between schools. However the typical school funding regime would not normally allow such sophistication, as well as support software licences, systems maintenance, consumables and staff training.

6. PROPOSAL

Given the clear requirements for lower cost and lower maintenance computing, alternatives to the current (predominantly Microsoft) systems need to be found. A viable alternative has emerged. Linux based systems are gaining international acknowledgement as industry-strength solutions that are largely free or inexpensive, operationally stable, and have a significantly lower hardware requirement than the alternatives. The original criticisms of Linux are fading as increasing numbers of support options become available. More graphical tools make Linux easier to manage. The open-source code method Linux employs is allowing it to be more responsive to market demands, more accessible for technical repair and more robust than its proprietary opposition. The adoption of Linux by common computer retailers and the burgeoning growth in Linux/Unix competent support staff look to further reduce the support costs and make available support contracts for those companies who wish to outsource this function (Raymond, 2000).

In the current US court case Microsoft vs the US Department of Justice, Microsoft pitches Linux as a major threat to its market position. The exponential growth of Linux deployment and the inability of the Linux movement to be bought-out should ensure that Linux (and other freeware Unix variants) are here to stay.

It is important to realise that no company or collective owns Linux. It is an open-source code endeavour actively supported by many thousands of programmers world wide. The best of the improvements make it into new releases of the core of Linux (the kernel) through the progenitor of the Linux product, Linus Torvalds. There are several notable companies that issue the current Kernel version with comprehensive families of supporting utilities and applications. These companies (eg. Redhat, Caldera) charge only a nominal amount for these products and are themselves gaining significant investments from the mainstream computing companies (Ricadela, 2000).

There are many free or inexpensive software tools, utilities and user applications available for Linux, a large proportion of which are functionality equivalent or superior to their commercial counterparts.

There is considerable conflicting information publicised about the relative costs of ownership of Microsoft and Linux solutions. At one end of the spectrum Microsoft claims this at 26% lower than Unix (the family of products of which Linux is the low-end version), on the result of an early 1995 study (BRG, 1997). This result bears less relevance today due to a number of factors:

1. Linux is substantially simpler than Unix and has lower support/complexity requirements. Linux is not mentioned in the survey at all.
2. There has been (and continues to be) rapid growth in easy GUI Linux system utilities, putting ongoing system maintenance and management back into the reach of the ordinary user.
3. By using the support resources we propose, the initial configuration and implementation skills requirements will be significantly reduced, thus reducing the initial costs component.
4. BRG's calculations were based on reported maintenance effort at industry average rates. This bears little relevance to Linux as most of the work will be DIY or with local enthusiasts. This sort of labour pool is not recommended for (or by) Microsoft for its NT product line.
5. Using Linux schools can use a much lower specification of hardware to support their needs than would be possible in an equivalent Microsoft operating system / server configuration.

Members of the Linux community claim Linux to have a substantially lower Total Cost of Ownership than NT, but without large company resources behind them have thus far been unable to produce conclusive evidence.

Linux solutions have the reputation for virtually crash free operation and excellent crash-recovery. Resources (time/money) are not wasted on preventing or repairing system crashes.

"Fewer People will complain because the servers are more stable than Windows NT. Linux, FreeBSD, and BSDI UNIX outperform Windows NT by a wide margin on limited hardware..." (Petreley, 1998)

"...a UNIX system's uptime can be measured in years. NT, however, cannot boast such periods of uninterrupted service. Even if one could eliminate the "Blue Screen of Death," NT is hampered by its own design and use of difficult-to-recreate proprietary binary configuration files, for instance the NT registry." (Kirch, 1998)

Other alternatives such as Novell have similar operating requirements to Microsoft NT. The main difficulties are: the significant up-front cost of the operating systems, the generally higher hardware requirements, the professional services normally required in the design and installation, and a shortage of Novell qualified professionals.

6.1 The Linux Solution Model

The Linux operating system features, associated freeware Linux applications, and utilities, presents the opportunity to provide a significant part of a School's computing infrastructure with less software and hardware costs. The objective we have chosen is to allow a school to get more reliable and professionally designed IT implemented for their funding dollar, not to reduce the funding requirement.

A modular approach can be employed to provide Linux based units in some or all of the following roles:

1. File/Printer/Storage/Backup servers
2. Communications servers (for shared and secure Internet access, supporting e-mail and web browsing)
3. Desktop systems (for areas not requiring full Microsoft-compatible multimedia applications)
4. Speciality systems, like Library management and internal web servers.

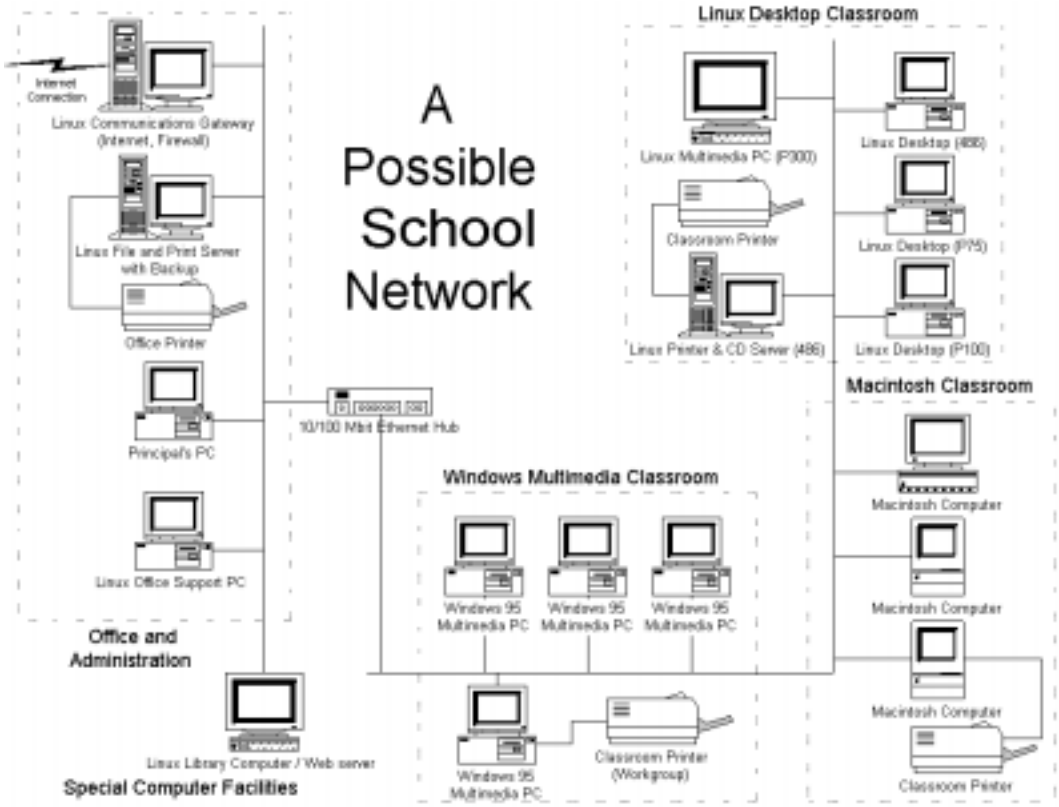
These units can integrate with existing Microsoft or Novell solutions already in place, or provide low-cost and low maintenance alternatives.

Linux provides the same security and firewall capability as used in many ISPs today, and is supporting a over half the web-servers worldwide (often in conjunction with a free application called Apache) (Shipley, 1999). Internet access and e-mail services can be made generally available over a network in a reasonably secure manner. A variety of Internet access methods can be assessed for inclusion in communications servers. These may include cable, satellite and ISDN as higher capacity alternatives to the predominant modem connections (Figure 1).

Freeware or shareware, Linux software applications can be selected to support all the roles required to operate a school as a business, as a computer facility, and for teaching in standard areas like office automation. Current offerings are similar in functionality and presentation to the popular applications in the market and for the level of usage they will receive (in schools)may be considered equivalent. Many of these applications have the support of major industry participants (for example IBM teamed up with Apache in June, 1998) and are porting their leading applications to the Linux platform (such as Netscape and Corel).

Existing multimedia systems can be retained and integrated in the network. These are generally based on more powerful PC platforms, using Microsoft or Apple Macintosh operating systems and have specific multimedia teaching applications that may not work on the Linux platform (through a Windows emulator program). Through the use of the generic TCP/IP network protocol and free products like Samba or MARS these disparate devices can communicate and share services and data. Some applications may be supported under various emulation packages on a Linux system, though at this stage it is safer not to rely on them.

Figure 1. A Possible School Network.



6.2 CIT Involvement

The Information Technology department at CIT proposes to develop the following resources on a publicly accessible web service:

1. System design support
2. Recommended operating systems
3. Recommended software applications
4. Detailed installation instructions
5. Detailed recommendations for configuration and design
6. Support resources such as discussion groups, FAQ, links to world wide resources.
7. CD distribution services for a software suite and documentation

8. Standard operational procedures documentation (backups, viruses, user management etc)
9. Supporting training documentation.

Using this resource a school may adopt whatever parts of a standard configuration they require, with all the significant design work and documentation templates already developed. Resources of this nature would enable confident teaching staff or parents to complete the installation and commissioning work. This sort of design work and specific documentation is a significant value-add to the generic Linux supporting documentation found elsewhere.

There are many other support resources available. The response of the Linux community to requests for assistance is legendary (Henderson, 1999) - both rapid, and free. The nature of the Linux product and community should ensure this remains the case for many years.

Once this configuration has proven itself it may be suitable to up-size the model to offer this service to colleges and other training institutions.

6.3 The Co-operative Community model

This intended web resource presents a number of opportunities for Polytechnics to operate in the wider community, integrating activities with their academic teaching programme.

In essence the community involvement model involves:

1. Local companies donate older server equipment, collected at the polytechnic. At present this would comprise low Pentium PCs and networking and backup hardware.
2. Students assemble and test equipment. This may be integrated as practical experience into a number of courses such as HE100, HS200, WX100, electronics
3. Students prepare and implement school installations as student projects. Integrate this into PM200/SI200 and degree modules.
4. Students revisit schools for maintenance and review activities. Integrate this activity into diploma, advanced diploma and degree levels.
5. Polytechnic facilitates the forming of company/ school relationships for the donation of equipment

There are many branding and advertising opportunities for the hosting Polytechnics, the donating companies and the schools involved. These can come in the form of stickers, logos, and editorial in magazines, newspapers and other media. Sample material for this purpose could be provided on the web site, along with sample project plans and schedules.

Significant expenditure is still required. The model is designed to reduce costs and facilitate schools to achieve their goals with existing financial resources. Not all hardware and software can be provided through donation and it is unlikely that all schools would be fortunate enough to receive donated equipment whenever needed. In any event several high-ticket items such as large hard drives, tape backup units and media, specialised communications hardware, server memory and quality printers would need to be purchased as it makes sense to have critical computing elements using reliable hardware.

It is intended to be provide high performance multimedia PCs.. These should be purchased by the school as part of their normal yearly expenses. Leading edge animation and teaching products will have much higher demands than may be fulfilled through donated hardware.

Many of the older PCs disposed of by businesses are still useable as Linux workstations - for low-end

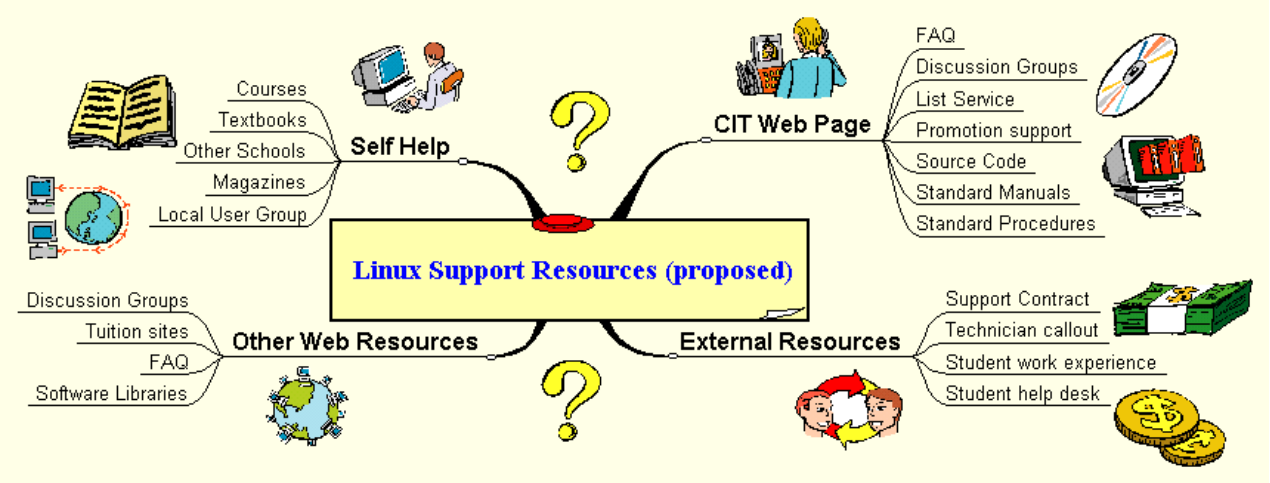


Figure 2. Possibilities for Linux Support Resources.

multimedia use or to populate a computer laboratory for formal teaching. CIT can serve (via its web site) as an introduction agency to match companies with surplus equipment with schools that need it. The process of building a 'standard' Linux workstation will be on the CIT web site, and local polytechnics may wish to offer student projects or work experience in support of this.

This model benefits everyone involved. Due to the synergy between the tertiary academic year and the primary school teaching year a reasonable standard of support will be available for most of the time the systems are in use. With simple development of the documentation provided, schools can document their systems to a professional standard and obtain outside support if they need it.

However, nothing is guaranteed, and CIT cannot guarantee to provide any on-going computer support.

There is an opportunity for enterprising polytechnic students to run a pay-per-use help desk or other paid support ventures, some of which may create permanent jobs supporting schools.

This polytechnic-run process would ideally operate after a Net Day has configured the school with network cabling and hubs.

7. SUMMARY

In the face of a well defined need for inexpensive and reliable IT infrastructure in New Zealand Primary Schools, Linux looks like it could meet the requirements. An international open-source code movement, burgeoning support resources and the emergence of ported mainstream products fuel the explosive growth of this freeware operating system.

CIT aims to aid the introduction of Linux to schools by developing a detailed design and support resource to take away some of the uncertainty and mystique that surrounds UNIX-derived operating systems. With specific advice, detailed installation and support scripts, recommended product configurations, and a variety of other support resources primary schools should be able to develop a professional-grade system and provide reliable facilities to their students for little cost.

We have also suggested a model of community involvement between local firms, polytechnics and schools that should be able to provide educational opportunities for polytechnic students, whilst simplifying the process for the schools. This process has several good public relations and good-will opportunities, and once the system has progressed into secondary schools, may allow polytechnics to gain a larger share of the graduating secondary students.

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