

FreeBSD and Linux: What they Can Do for Schools

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About the Author.

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Abstract

Free UNIX-compatible operating systems such as FreeBSD and Linux can be of enormous benefit to schools.

These operating systems have an established place as servers in the IT industry. While their traditional role has been in Internet infrastructure, they are also being used to replace Novell and Microsoft file servers.

Recent developments in graphical user interfaces now make them a viable proposition for the desktop.

Surprisingly, price may not be the only benefit to schools: an educational computing environment may actually favour using a UNIX-compatible operating system instead of Windows or Mac OS.

Introduction: FreeBSD and Linux

This paper will discuss the suitability and benefits of installing FreeBSD or Linux as a server or desktop operating system at your school.

Microsoft² Windows, Novell NetWare, FreeBSD and Linux are computer operating systems. They run on Intel based personal computers³. What makes FreeBSD and Linux different is that they are free, and UNIX-compatible.

These systems⁴ have a lot to offer schools. For at least half a decade they have been widely adopted by networking professionals as servers for the “back office” of the Internet. New graphical user interfaces make them “user friendly”; a term not previously associated with UNIX. Fundamental design strengths can save administrators a lot of headaches, too.

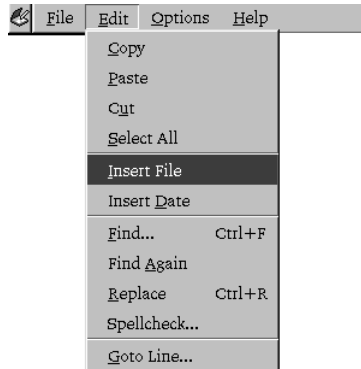


Figure 1: FreeBSD and Linux come with user friendly interfaces.

In fact, for more than ten years an ever increasing line up of UNIX and UNIX-compatible operating systems have been available for standard PC hardware. Some are commercial products. But FreeBSD, Linux, and large amount of software written for them are free for download from the internet.

From now on, I'll use the term “Unix” to refer to all the versions of UNIX-compatible systems both free and commercial.

Compaq, Dell, Fujitsu and IBM now ship servers and desktops with Linux preinstalled. Apple's new OS X shares much of its codebase with FreeBSD. IBM is rumoured to be porting Linux to its S/390 mainframe. Oracle has ported their database to Linux. IBM has followed suit with their DB2 database and Lotus Notes. Adobe is doing the same with their FrameMaker desktop publishing application. Yahoo use FreeBSD servers to power their website.

The University of Technology, Sydney, has just installed two shiny new computer labs – both running Linux. The University of Sydney makes extensive use of boot images to alternate its computing labs between FreeBSD, Linux, and Windows NT. The University of New England asks its new computing science students to install Linux, not Windows, on their home PCs.

The picture is clear: In universities and industry, FreeBSD and Linux are now mainstream operating systems.

² All trade names are the properties of their respective owners.

³ Some versions of BSD and Linux run on Macintosh, Sun SPARC, Compaq Alpha, and others.

⁴ FreeBSD and Linux are different “flavours” of Unix. The advantages of each are subtle enough to be left to intermediate and advanced users.

School Computing

How does this relate to [Australian] schools today? Let's examine the status quo:

Like just about everywhere else, schools seem to have a lot more computers and networks around than they did only a few years ago⁵. A rural high school will probably have biggest network in the town, and school staff struggle with the technical issues of networking.

In certain private schools a "laptop" program is in place: every student is expected to own their own laptop. This is unusual; typically schools have Windows or Macintosh desktops clustered in groups of around two to twenty.

Most schools have installed campus-wide Ethernet cabling, or are seriously considering it. Workstations are networked for access to a shared printer, and hopefully the Internet.

Larger schools which have the luxury of an enthusiastic computer coordinator will often have an Apple, Novell or Windows NT file server. Five or ten "accounts" might be set up on this file server corresponding perhaps to class-teacher groups.

Fewer schools have servers set up so that every student and teacher has their own individual account.

If no file server is present, students save their work on to floppy disk or to the local hard drive. This has fairly obvious implications for security, ease of access and seating arrangements.

Although not uncommon in Universities, very few secondary schools use Unix for file serving.

Personal Computers?

Personal computers were designed to be just that – *personal*. This is important, since unlike commercial and home use, desktops in a school environment are not personal at all: they can see up to perhaps ten *different* users each day⁶. As an example, Windows-98 desktops in our library have each collected over 400 user profiles in an eight month period.

Few would argue that Windows-98 was meant for this! The problem of school computers being used in a non-personal way can not be emphasised enough. We are using software and operating systems for something they were never designed to do, and I'd estimate this issue is the root cause of 80% of my frustration as a school computer coordinator.

The "Zero Administration" tools often help, however they always come with unwanted limitations, as anyone who has used them for a period of time knows. Application software rarely takes full advantage of their features.

The Unix Alternative

Unix was conceived when there were no such things as *personal* computers. Everyone shared the one computer. The structures set up to make this work, such as file-level access permissions, user accounts, and home directories are all still there. These structures let individual users read and write files only where they should and prevent interference with system "control panels".

Features called NFS and NIS⁷ let home directories and passwords can reside on a single server.

⁵ My own school has about 120 desktops available to 1450 students. This is reasonably typical for a Government School in NSW.

⁶ The senior executive staff in a school often have their "own" PC. They are a significant exception to this.

⁷ Network File System and Network Information System.

Windows NT and Novell both offer competition to NFS/NIS and in some ways surpass it. However, they fall back on a critical issue – while the servers may be designed for multiple users, the desktops are not.

Let's use an example. You log into your PC running Windows-98, fire up your favourite email client, enter all the settings and collect your mail. Where are all your mail settings saved? Somewhere in the C:\ drive, of course. Now, unless you sit at exactly the same desktop the next day, you'll have to type in all those preferences again⁸.

On the other hand, if those PCs were running Unix and NFS/NIS all your email folders – preferences, in boxes, out boxes, the lot, would be saved in *your* home directory on the server. Thus, in some ways Unix desktops are inherently suited to a networked educational environment.

Software for Unix

Although Unix does not force the same sort of distinction between a server and a client as does Windows NT or Novell, we will still use the headings “server” and “client” to look at available software.

Server Software

Providing services to networked computers is where Unix truly sparkles. Much of the best software is free *and* stable. In the two and a half years I have been running FreeBSD servers, I have seen only three system freezes.

The design features of Unix means that, in many cases, server software can run considerably faster than a commercial competitor on Windows NT or Novell NetWare. The most heavily used FTP site in the world, ftp.cdrom.com, uses a single FreeBSD server to move over 1400 Gigabytes of data a day.

Here is a quick rundown of some of the best known software for Unix servers:

Email: Sendmail is the defacto standard Internet mail server. Most Unix systems come with a basic setup pre-installed and configured. The most recent version has powerful anti-spam capabilities. While Sendmail is the most popular, there are others. Microsoft reputedly uses one of Sendmail's free competitors, Qmail, along with over 1000 FreeBSD machines to drive their Hotmail web site.

Web serving: Apache is the most popular web server on the Internet, period. It is included free with all FreeBSD and Linux distributions. There are also commercial servers such as Zeus and IBM's Websphere.

Caching Proxy Server: One of the best and fastest proxy server is Squid. This free product is widely used by commercial ISPs, including Ozemail and Bigpond.

NFS file-serving: The most common file serving protocol for Unix is called Network File System or NFS. It is commonly used in conjunction with an authentication service called Network Information Service or NIS. Every decent version of Unix now ships with an NFS/NIS server. An NFS/NIS client for Windows, called PC-NFS is sold by Sun Microsystems.

Windows file serving: Samba is a set of programs that lets a Unix computer do a reasonably good emulation of a Windows NT file server. While short on some of the most advanced Windows-NT features, it has much more than a school is ever likely to need. I personally use Samba to provide network log-ons, file-serving, print spooling and roving profiles for over forty Windows PCs and over 1600 registered users. Until recently, my Samba server was a desktop quality Celeron

⁸ Windows administrators may know that *roving profiles* can help. However, a lot of software does not take advantage of roving profiles.

with 64 Mb of RAM. The system is far from overloaded. All my users can access their home directory on the server as well as several shared folders. Setting up shared folders that only one group, say teachers, can access is fairly simple. Samba is by now quite a mature product – and to a large extent an Australian product to boot!



Sysop on 'Hermione' (X)

Figure 2: Samba has much of the functionality of Windows-NT Server. Windows users can mount their home directory as a network drive.

Apple file serving: Netatalk is a set of programs that lets a Unix look like a Mac fileserver. Mac users can access their home directory and Unix print queues from the chooser.



Figure 3: This user has their home directory mounted on a Macintosh desktop.

Database Servicing: Several high quality SQL database management systems are available, and IBM's DB2 and Oracle are available for Linux.

Domain Name Server: A DNS server is an essential part of any intranet, although it is quite difficult for a novice to configure. Telstra's Bigpond use FreeBSD for their DNS servers.

Security and Stability: In the Unix world, operating system crashes, susceptibility to cracking attacks, or viruses are called bugs. Period. The good news is that bugs of this kind are rare. One of the lesser known advantages of the FreeBSD and Linux development community is that bugs are often fixed within days or hours of being discovered. Unix servers often run for years without needing to be rebooted.

Administration: Both FreeBSD and Linux have graphical tools to perform basic system administration, such as adding a new user. However, knowledge of the command line interface is needed to automate mundane tasks, such as importing 1500 users and giving them new accounts. The ability to write scripts to perform repetitive, mundane tasks has always been one of the stand-out features of Unix. On the other hand, the command line interface presents a significant hurdle to the novice administrator.

Desktop Software

A major barrier to the adoption of FreeBSD and Linux on the desktop has been the lack of a user friendly graphical user interface. While GUIs have been around for a while now, earlier versions were targeted towards technical users. In the last two years this has all changed – for the better!

Here is a quick description of some of the “desktop” or “end user” software for FreeBSD and Linux:

Graphical User Interfaces: FreeBSD and Linux haven't always had great GUIs. However, two great desktop interfaces are now available: KDE and Gnome. Although they still lack some of the polish of Windows or Mac OS, better internals make them easier to program. Both have made significant progress in the last eighteen months and are now ready for mainstream use. They come with the usual accessories such

as graphical file managers, trash cans, mail clients, calculators, games etc.

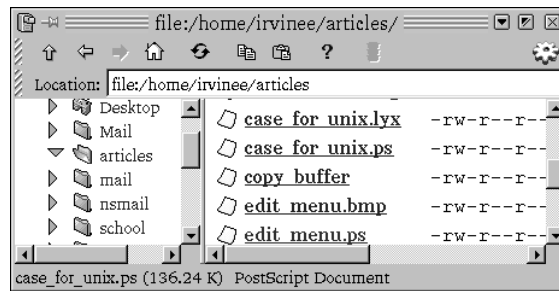


Figure 4: Graphical file managers like this one in the KDE desktop free end users from the Unix command line.

Office Software: Applixware and StarOffice are powerful “Office” packages that go far beyond the normal requirements of students and teachers. Sun Microsystems is currently distributing StarOffice for free. Applixware is priced at about \$US 100.00. Corel’s Wordperfect has been available on Linux for several years.

Web Browsing: Netscape Communicator started out on Unix. However, not all the plug-ins that Windows users take for granted are available yet.

Graphics: The Gnu Image Manipulation Program, or “The Gimp” is a powerful Adobe-Photoshop like bitmap program. While a little opaque to the beginner, it is free.

Programming Environment: While nothing quite as easy as Visual Basic or Hypercard are available yet, C, C++, Java, Python, and Perl programming environments are pretty much standard components. Perl is an excellent introductory programming language for senior students. C-Forge (Code-Forge) is a GUI/Integrated Development Environment. See <http://www.codeforge.com/download.html>

A secure OS: FreeBSD and Linux workstations are virtually immune to viruses. File level permissions make it difficult for students to meddle with settings⁹ or to save files outside their home directory. Disk quotas mean students can’t take more than their fair share.

Dual Boot: Most readers might balk at the prospect of deleting Windows from their hard drive so they can install FreeBSD or Linux. In fact, both come with a feature that allows the user to boot multiple operating systems. I now set up all new PCs at my school to dual boot FreeBSD and Windows¹⁰.

Barriers

Schools are surprisingly conservative places. FreeBSD or Linux on every server and ever desktop is not yet on anyone’s horizon. The poor situation of staff training is also of concern, and is unlikely to change; Teachers with anything more than the most basic IT skills will have them only because of significant personal investment. This personal investment naturally magnifies the reluctance to change.

Very few computing teachers and computer administrators in schools have any experience whatsoever with the Unix command line¹¹. While perhaps not so

⁹ As with *any* operating system, a user with physical access to a machine can always do some sort of damage if they want to.

¹⁰ A dual booting system can be a little quirky to set up – and unfortunately this is the sort of system that novices always want. Caldera Linux sell a version that is bundled with a commercial partitioning program.

¹¹ The command line interpreter in Unix is called the “Shell”. Thus, the Unix equivalent of an MS-DOS batch file is called a “Shell Script”.

important for desktop use, it is still an important part (indeed, a strength) of server administration. The psychological magnitude of this can not be over estimated.

With networking, lack of head office support¹² means that computer administrators and principals are often bombarded with advice from vendors, but in no position to competently evaluate issues that are more properly the domain of engineers.

FreeBSD and Linux enthusiasts are always quick to point out that their systems are much more stable than Windows. This is true for them: a competent administrator of these systems can make their systems close to perfect. However, CD distributions of FreeBSD and Linux *always* require some sort of modification to work perfectly in a networked environment¹³.

The user database and filesystem access is based on a fairly old and simple model. It is not yet fully Directory orientated like Novell or Windows 2000. Unless you have a huge organisation with many different levels of administration, this is not that much of a problem. Its simple approach is in some ways an advantage. However, expect those with a vested interest in promoting Novell or Windows 2000 to make this issue much bigger than it really is.

When properly configured, server software is in many ways clearly superior to its Windows or Novell rivals, but the truth is that desktop “end user” software still has a way to catch up to commercial platforms. The gap is closing fast – but the gap is still there. Some of the graphical and multimedia software from Macromedia and Adobe has no equivalent for FreeBSD and Linux.

Lack of support: This is perceived problem. The real truth is that FreeBSD and Linux mailing lists offer some of the best support available – at any price. There is also commercial support available – at commercial prices.

Recommendations

So what should you do?

The first thing to do is get hold of a Linux or FreeBSD CD and actually install it on a desktop. As well, I’d strongly recommend you purchase one of the Linux or FreeBSD textbooks in the bibliography.

If you are developing a school network, a good point to aim for first is might be setting up a Linux or FreeBSD system as a DNS, Web, and proxy server. This will make your network a true “Intranet”. Since Unix is far less resource intensive than Windows-NT or Novell, it will work just fine on a Pentium level machine with 32 Mb of RAM. While this might be intimidating for the Unix newbie¹⁴, it is a “bread and butter” job for a moderately experienced consultant. A volunteer from a local user group might even do it for free.

Linux or FreeBSD? As you might have guessed by now, my personal experience is that FreeBSD is the pick of the pack for configurability and reliability. Being a little more server orientated, it is targeted toward the “Unix literate”. Some distributions of Linux, such as Caldera and Corel, have the desktop end user in mind, and are easier for the novice to install.

Conclusion

Peter Moon of the Australian Financial Review has this to say about Linux:

“One thing is obvious: Any enterprise that employs full time IT staff should be telling them to get familiar with the alternative operating system now. It is just too plausible to ignore. But more than that, it is

¹² In NSW, Government schools are supported by a District Technology Adviser. It is worth noting that these advisers are classified as “clerks” and require no technical qualifications.

¹³ Red Hat Linux 6.0 shipped with print spooler that did not work “over the network”. A recent version of Caldera Linux shipped with a broken NIS control panel. These are not insignificant flaws.

¹⁴ It took me quite a few late nights the first time around!

credible enough, even as a desktop alternative to Windows, that it positively deserves support.” (Moon, 1999)

FreeBSD and Linux are dependable descendants of the UNIX operating system. They run very well on standard PC hardware, and are widely used by the Internet industry. For many network server tasks, such as email, web-serving, and file serving, they not only represent the most economical solution, they also represent the *most reliable* solution.

They are a popular choice in Industry and Universities. Some secondary schools and districts are starting to follow suit. With the help of consultant, a fully functional network server can be implemented for many thousands less than if a conventional Novell or Windows-NT solution was used.

While these operating systems are not much harder¹⁵ than Windows to install on the desktop, the downside is that the server software such as web-servers difficult to configure. A consultant is recommended for all but the most adventurous.

While it had traditionally been seen as a server or technical operating system, recent developments in graphical user interfaces and end user software make Unix a viable choice for the desktop, too. The fact was built from the ground up as a multi-user system makes Unix particularly suitable for school use, where the concept of a *personal* computer is actually a misnomer.

The time is now ripe for FreeBSD and Linux to be seriously considered as desktop operating systems for schools.

¹⁵ Believe it or not, I find Caldera Linux *much* easier to install than Windows-95 on a modern PC.

Links:

BUGS – The BSD User Group of Sydney. <http://www.bugs.au.FreeBSD.org/>

Everything Linux – an Australian store for FreeBSD and Linux books, CD-ROMs etc. – <http://www.everythinglinux.com.au/>

FreeBSD Project Home Page – <http://www.au.FreeBSD.org/>

Gnome – A graphical user interface for Unix – <http://www.gnome.org/>

KDE – Another graphical user interface for Unix - <http://www.kde.org/>

King George's School in Hong Kong use FreeBSD for all their server needs. Largely set up by students. <http://www.kgv.edu.hk>

Linux Home Page – <http://www.linux.org/>

LUV – The Lunux Users of Victoria. <http://www.luv.org/>

Schools offered free system software.

http://news.bbc.co.uk/hi/english/education/newsid_603000/603893.stm

Slashdot is a popular Open Source news site – <http://slashdot.org/>

SLUG – The Sydney Linux Users Group. <http://www.lug.org.au/>

Sun Microsystems has been a leader in networking Unix systems. It's Solaris operating system is now free. <http://www.sun.com/>

VicFUG – The FreeBSD User Group of Victoria.

<http://www.vicfug.au.FreeBSD.org/>

Xavier College in Gawler, SA, have upgraded their file servers to Linux.

<http://www.xavier.sa.edu.au>

Bibliography

Moon, P. 1999. The Australian Financial Review. 15/12/1999.