Open Source in Education: an overview

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1 Introduction

Open Source is not just about computer programming in the same way the Internet is not just about network infrastructure. Its core principles are about the freedom to use, distribute and modify computer software freely, something which significantly changes the approach to developing, implementing and using Information Communications Technology. Open Source applications are the most widely used applications for running Internet services, such as web sites and mail servers. With the development of School connectivity, Open Source is now also important to schools, as they move away from providing soley stand-alone and local area network functionality.
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This short paper explains what Open Source is and highlights its benefits and current weaknesses. It discusses its potential in education before concluding by indicating future work that could done in exploiting Open Source to deliver suitable ICT solutions for the next stage of the National Grid for Learning (NGfL).

2 What is Open Source?

2.1 History

Open Source is a relatively recent term use to describe a long establish tradition in computing, where computer programmers have allowed for the free use and modification of their code. It is really all about free speech, rather than simply free software, however the latter aspect has made it very attractive for people in education. This type of software has been available since the 1950's and 60's, but was never really became available for the mass-user market as this dominated by the big commercial providers from the early 1980's. The maturing Internet in the late 1990's has changed that, allowing Open Source applications to become widely available and distributed in commercial, educational and home-user markets.

2.2 Licenses

The license is important, as it defines how the software can be used and distributed. There are now a number of Open Source licenses, the most popular is the Gnu Public License (GPL), which promotes the notion of copyleft, where everyone has permission to run, copy and modify the program, distribute the modified code, but they do not have permission to add restrictions of their own. The main benefit here is that modified versions of the software is will also be freely available.
There are other licenses, such as the Mozilla license (set up by Netscape) and the Artistic License (used for the Perl programming language). The Department for Education and Employment (DfEE) has a Public Source, Public Ware (PSPW) license that it uses with suppliers to enable reuse amoungst different divisions within the organisation.

2.3 Scope of Software

The area of Internet Services is area in which Microsoft and other large software companies are weakest and where Open Source applications thrive[1] This is because the Internet is based on open standards[2] and is an area that thrives on innovation. This is why Open Source is now becoming of increasing interest to schools, although other areas such as Application Service Provision (ASP) and local area network integration are where Open Source applications are beginning to flourish. It is possible that for any general computing function, an Open Source alternative can usually be found. There are a number of sites such as Tucows[3] that are databases of Open Source software.

[1] For example Apache, the Open Source web server has 62% market share, against Microsoft's IIS 20% and Netscape's NES at 7%

[2] Standards as defined by the Internet Engineering Task Force (IETF), something that doesn't really exist

[3] Interestingly enough, one of the UK mirror for Tucows is hosted by Research Machines

2.4 Development Process

Open Source development projects are usually started because of demand to meet a functional requirement, possibly for a single site or for a more of a widespread problm. This process of defining and managing Open Source development is becoming more organised with a number of websites providing coordination and skills brokering[4]. The developers are typically geographically disperate and primarily use the Internet for communication. The project will normally have web site and mailing list, copies of the software for download, documentation and Frenquently-Asked Questions (FAQs). The project will also involve a number of active users, who through the policy of 'release-early, release-often' will be engaged in the development process, locating bugs and suggesting feature enhancements.
This approach to software development is suprisingly successful[5]. The *Halloween Documents*[6] indicate from internal memorandums that Microsoft's main concern is not the Open Source software itself, but the approach used in the development and the overall quality that this produces.

2.5 Linux

The most notable example of Open Source software is the Linux operating system. Started by Linus Torvalds in 1990 as a tool for teaching operating system design, it quickly became popular amoungst other computer scientists. As the number of developers grew, so did the number of users, forming a community that continues to develop a rich, versatile operating system now highly regarded in all sectors of Information Technology.

One of the misconceptions about Open Source is that is all about Linux. The Linux operating system is a cornerstone of Open Source applications, because it is Open Source itself, however there are an increasing number of applications for Windows and MacOS, as there are also other Open Source operating systems such as FreeBSD.

A typical Linux installation CD from one of the main distributors (such as Red Hat, SuSE, Debian or Caldera) is made up of less than 1% of the operating system itself, the majority is made up of quality-assured Open Source applications. This allows users to construct server, router, workstation or custom configurations, selecting different options during the installation. Once installed, other Open Source applications can be easily added,

[4] Such as sourceforge.org
[5] Eric Raymond's Cathedral and the Bazaar[?] provides further reading on this area
[6] http://www.tuxedo.org/ esr/writings/

from other CD's or downloaded.

3 Benefits

There are a number of key benefits of Open Source software:

- **Application Quality.** Primarily because of the development process, mature Open Source software is of a high quality and is usually the choice of technical staff, especially for Internet services. This is the main reason for the ongoing success of Open Source, not that it doesn't cost anything.

- **Interoperability.** Open Source applications rarely use propretiary file types, but follow working Internet guidlines and standards, as outlined in Request for Comments (RFC's). Also, many Open Source applications have been written for the purpose of integration, usually originated by people who had specific problems to solve. A notable example is Samba, a server application that supports Microsoft's Server Message Block (SMB) networking protocol on other operating systems, such Linux or Solaris. This is one of the reasons why Linux is so useful, as it can support a wide range of networking protocols and filesystem types that make it work in nearly all network environments. A Linux server can simultaneously support file sharing for Windows, MacOS, RiscOS and other UNIX clients all on the same network.

- **Support.** The main support model for Open Source software is different and does not soley rely on support contracts with suppliers and call centres. It is much more peer-based, with the use mailing lists, web sites, FAQs and HOWTOs to provide support from both developers and more experience users. To use this support model effectively does require some experience, but is highly effective and can be less frustraiting that traditional methods. However, telephone and onsite support are now available for those users who require it, providing by companies such as Linuxcare.

- **Flexibility.** Unlike closed source software, it is far easier to change to a different application with Open Source software. Firstly, there is no contractual obligation to a specific supplier and you are no tied to their development timetable. In many cases, if there is functionality that you wish to add to an application you can in most cases find that it has already been developed by someone else.

4 Difficulties

There are a number of potential problems with using Open Source software, most of which eminate from the way in which manufacturers of hardware and software have done business over the last twenty years. There is still a great amount of hardware secrecy, making it difficult for developers to write drivers and appliations for new equipment. There is also the growing threat of software patenting in Europe[1]. This could restrict the development of Open Source alternatives, especially if the same approach and algorithms need to be used.

- **Packaging** For the uninitiated, installing and configuring Open Source software can be a little on the technical side. Downloading software, then installing on a local system does take some practice, especially for less popular software. This is however changing, with the use of graphical package managers and easy to run Linux installers, as well as preconfigured hardware solutions.

- **Primarily Server Applications** Open Source development is more mature in the server application area and arguably produces industry leaders in many aspects. The desktop area, including productivity tools, communications clients and desktop windowing systems is no so developed. Recent releases of the latest Gnome and KDE desktops for Linux are viable Windows alternatives, as are office applications like Star Office, ThinkFree and AnyWhere Office.

- **Less Development in Uninteresting Areas** Much Open Source development is directed at cutting edge applications, say for web development and new technologies, rather than office-based systems. Although the desktop area is currently seeing greater development, positive action may need to be taken to attract developers to educational applications.

- **Market Share** In many areas of IT, Open Source still has only a small market share and despite its growth, many IT Managers and Coordinators will only adopt Open Source software if they feel that this is the way the whole market is going. Open Source is not backed by large marketing campaigns, and is not an area covered by many IT professionals as part of their education and training.

5 Open Source and Managed Services

Rather than the software itself, it is the cultural differences between current solutions and those derived from Open Source that are the most marked. Many of the Open Source implementations carried out so far (see Appendix 1 - Case Studies) rely on individuals or groups inside the organisation being prepared to undertake development and support themselves and, most significantly, to be held accountable for the performance and reliability of the system.

While this seems at odds with the development of NGfL Managed Services, potentially Open Souce solutions can be offered effectively in this way at a cheaper overall cost. The high reliability of Open Source server platforms and the ability to remotely manage them should be the basis for a good Managed Service solution. There are currently no Open Source Managed Service solutions available from suppliers, indeed none of the main educational suppliers have made any indication that they would use this use of software in this area. With suppliers moving away from relying on income from hardware and software sales and instead developing a service-orientated business model, non-revenue Open Source software can be accommodated. However, Open Source companies have arrived only recently and hence there are barriers to them obtaining Managed Service supplier status.

6 Future Work in Education

As part of the development of Internet services for schools, Open Source software is already being used and this will continue to grow. Becta should undertake further work in the following areas:

- **Procurement.** Currently many specifications for education ICT procurements do not allow for Open Source solutions to be tendered. For example, many would state a requirement for a specific application or operating system. Although this may be done to ensure compatability with existing infrastructure, it also takes place due to a lack of awareness of Open Source solutions.

- **Piloting.** Although the Case Studies (see Appendix) have indicated that Open Source is an option for many schools, further pilots managed directly by Becta would provide the basis for opening up contacts with Open Source-based companies and developers and encourage their participation in the education sector. This in effect would be similar to the role Becta had three years ago with the Internet Service Providers (ISPs). The piloting could be done alongside the proposed NGfL Managed Services pilots or as part of Becta's Technology R&D Small Scale Technology Pilots (SSTPs). Piloting would also allow analysis of how administrators and users apapted to the Open Source approach to support.

- **Content.** Although Open Source development has centred around software, the same approach could also be used for the development of educational content and associated online delivery mechanisms. Becta's Contributory Database is an example of a potential mechanism for providing Open Source content, although further work would need to be done in setting up a suitable license for use by contributing teachers and those downloading material. Further work would look at small-scale piloting and working with content providers in determining a suitable framework for development.

There is irrefutable evidence that Open Source software already plays a significant role in the provision of Internet services in education, information on which needs to be disseminated to a wider audience, both educational suppliers and users.

7 Conclusions

The issues around Open Source go beyond software programming, it is more about the approach to ICT solutions for schools. The Open Source approach currently offers the best solutions for Internet Service Providers, and in this area of educational ICT it is beginning to have an impact. In other areas, such as desktop tools the picture is less certain although it is having an effect on the current providers. The prescence of Open Source applications and solutions would ensure that there is viable competition to current software and suppliers in education, helping to achieve good quality services and best value for educational customers.

A Case Studies

A.1 Educational Institutions

A.1.1 Powys LEA

Powys LEA's is probably the largest school sector Open Source implementation in Europe and involves the provision of electronic mail and cacheing services to all schools in the authority. Given the geography, sparse population and the lack of telecommunications services, that a large percentage of pupils already have electronic mail accounts is a strong endorsement of the Open Source approach.

Open Source software has been used to build servers for each school to enhance the performance and functionality provided by the telecommunications link. These links use PSTN, EPS9 and ISDN circuits, with the router functionality built into the servers. The servers also run Exim (mail server), Apache (web server), Squid (cache) and mars/nwe (Novell/IPX networking) to support filesharing on the Windows clients.

All the systems in the LEA can be administered from the centre using a web-based monitoring and alerting system.

A.1.2 Portland, Oregon

The Multnomah Educational Service District (MESD) acts as a broadband ISP for a number schools in the Portland area, providing T1[7] connectivity and Internet services such as mail, web hosting, filtering and cacheing. Many of these services are run on Open Source applications, as a growing number of services running locally in the schools. These are supported on Linux servers which can be remotely managed by MESD and the school system administrator. They commonly run cacheing, web and mail servers, but are also beginning to used a LAN servers offering file sharing, print spooling and user/group management.

One of the school districts, Riverdale, is also using desktop Linux machines running a range of Open Source software, both as PC and thin-clients. Much of the development work in Portland is based on a community approach, with monthly Linux clinics, an active mailing list, the support of the Portland Linux User Group (PLUG) and a central technical role played a number of key figures. The work in Portland[8] is reflected in a number

[7] Around 1.5Mbps

[8] Further information can be found at http://linux.riverdale.k12.or.us

of areas of the US, although as in the UK it has no profile with the main educational resellers.

A.1.3 Stonar School, Melksham

Stonar School has over 100 client machines which are mainly Acorn's running RiscOS 4. They are using a Acorn server to provide file sharing functionality, but have recently installed a Linux server running on a Dell server to provide Internet functionality. This is run using a Navaho server(see below) and provides email, web hosting (Intranet) and cacheing functionality. The system administration is entirely web-based and can be access from off-site. Because of the location of the school, they can currently only get PSTN connectivity at less than 56Kbps, however the cacheing means that users can have useable web access. While the site is in transisition from RiscOS to Linux, they have split the server functionality and have chosen to use a *packaged* Open Source solution. As the expertise on site increases it is likely that they will be able to develop the system further, including onto the desktop.

A.1.4 Silcoats School, Wakefield

Unlike Stonar School, their system is mainly Windows 95/8 clients and is support inhouse. However they also have only a 56Kbps modem connection currently and are using Linux-based servers to run Open Source server applications. These include squid (cacheing), squid-guard (filtering), Samba (file-sharing) and Apache (web hosting).

With their local expertise, they have constructed a very sound and manageable network, although it should be noted that have to get significantly involved with applications such as Samba in order to provide the functionality required. They rightly point out, they would have had the same issues with running a NT fileserver, as the problems related to SMB networking, not the Open Source implementation.

The use of the Open Source squid-guard application has also allowed the school to configure the system for their specific security policy and also be build in a network usage monitoring tool for the system administrator. This is an effective system for a school network environment.

A.1.5 Felsted School, Essex

Felsted School is another independant school that has followed the Open Source route to provide an extensive range of IT services. With around 800

pupils, the school network supports over 300 machines, ranging from BBC B's to recent PC's. The majority of client hardware is recycled 486, early Pentium and Acorn RISC architechture which act as dumb clients running the X window system, obtaining resources from one of two servers. All of the various clients provide a common email, web and office system interface (using pine, Netscape and Star Office).
The servers are running FreeBSD (rather than Linux) and support all of the standard Internet services, with Internet access currently being supported by 128k ISDN access. While many schools would not be able to support a network of this magnitude, the approach of using X-terminal clients on refurbished hardware enables low pupil-computer ratios to be reached.

A.2 Commercial Organisations

A.2.1 Redhat

Redhat are the largest and most successful of the Linux distributors and are putting much into developing Open Source in different ICT markets. They currently offer Linux free to all schools in the UK, and have set up a pilot school in Manchester. They now have a European office based in the UK.

A.2.2 SuSE

SuSE is the largest European Linux distributor and also have a UK prescence. They are also looking to develop their schools market and currently have a dedicated education development officer and a successful mailing list.

A.2.3 Equiinet

Equiinet are primarily a hardware manufacturer who a background in network equipment. Their Netpilot product is a 'thin server' than uses Open Source software to provide Internet services, such as cacheing and web hosting, but they have developed a web-based interface for all the administrative functions. This has been done in such a way that users cannot get access to the Linux operating system underneath, in effect creating a black-box.
By packaging Open Source tools in this way customers loose many of the benefits, as they are reliant on Equiinet for upgrades and changes, as they would with normal traditional software. While changes and updates can happen quickly for most applications, Netpilot users would have to wait for Equiinet to port and check their versions before they are released to customers. There is also a initial cost overhead, but the packaging makes it

a accessible product for smaller schools or those with no technical support. The Netpilot is now being resold by a number of the leading educational resellers, and has attracted significant interest in the last year.

A.2.4 Navaho

Navaho offer a similar solution to Equiinet, that they have a bundled, web-based package running on a Linux server, however their software is even further removed from being Open Source. They have their origins in providing server functionality for RiscOS, but changed to Linux two years ago. They tend not use many of the mainstream Open Source applications (such as the Apache web server), but have ported their original code from RiscOS. Therefore only the OS (Linux) is Open Source, making therefore removing many of the advantages that the platform could bring. This type of approach provides advantages over existing LAN-focussed solutions, however it does not allow community development or the other Open Source bebefits.

References

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[6] Williams, M., (1999), “Linux in Education”, NAACE Newsletter, May 1999 (in two parts).