Free software and open source applications in higher education

HUGO COLL[1], DIANA BRI[2], MIGUEL GARCIA[3], JAIME LLORET[4]
Department of Communications
Polytechnic University of Valencia
Camino de Vera s/n, 46022, Valencia
SPAIN

Abstract: - Since few years ago, the knowledge about free software and open source software has been extended to a bigger percentage of population. One of the groups that can obtain many benefits from this type of software is the university, due to its special characteristics. This paper shows the different meanings of "free software" and the type of licenses that can be used. Later, we will analyse the deep rate of free software in the University in the last two years, as well as the main inputs and benefits of using free software. Finally, we will analyze some alternatives to proprietary software and we will give some migration experiences. We hope that this paper will serve as a state of the art of free software and open source in the Universities.

Key-Words: - Free software, open source, software alternatives, higher education.

1 Introduction

The term *free software* usually leads to puns, due to the existence of more than one meaning of the word *free*. So, in one hand, we have the meaning of free as "free of charge, with no cost". Generally, this meaning is applied to the term *freeware*, software whose author decides to let the use of it to everybody (or to a certain group of users) without paying for it. Sometimes this software is a reduced version of a more powerful application. This selling technique lets try it and explore its possibilities before deciding to buy the extended version. In any case, the source code is not shown to the user, so the application can't be modified or adapted by programmer. On the other hand, we have the meaning of free as freedom. Here, free software means the freedom of the users to execute, copy, study, change and improve the software. Four types of freedom can be classified for the users [1]:

- Freedom 0: It is the freedom to run the program for any purpose.
- Freedom 1: It is the freedom to study how the program works and to adapt it to the user needs.
- The freedom to redistribute copies to any other user.
- The freedom to improve the program and release the improvements to the public, so the whole community obtains benefits.

Finally, there is the open source software. In practical terms it is similar to free software, but its fundamentals are based on different values basically. Open source is a development methodology; free software is a social movement. From the point of view of the free software movement, free software is an ethical imperative because only free software respects the users' freedom. On the other hand, they think that non-free software is a social problem and the solution is to move to the free software [2]. On the contrary, the philosophy of open source is in charge of how to make the software "better" trying to improve it from a practical point of view.

Currently, both free software and open source software are referred as the term FOSS (Free and Open Source Software).

The rest of the paper is structured as follows. Section 2 shows and classifies the types of FOSS licenses in existence. Then, in section 3, we will analyze the advantages and benefits of using free and open source software. After that, the penetration of FOSS in the University of some countries is shown in section 4. In section 5, we will give several free software alternatives to proprietary software and we will analyze some migration experiences. Finally, section 6 gives the conclusions and shows the future works.

2 FOSS licenses

There are many different FOSS licenses, offering several levels of protection to the author according to freedom terms. All of them can be included in one of the two main FOSS licenses types: Copyleft and Open Source. This section gives their main features in order to choose the best one according to the author's environment.

2.1 Copyleft licenses

Copyleft term was used the first time by Li-Chen Wang in 1976 on the source code of Tiny BASIC [3]. It is a general method to make a software program or an application free, furthermore requiring being free all modifications and extended versions of it.

The simplest way to make a software program free is to put it without copyright in the public domain. This allows people to share the software program and its improvements, if they are so minded. But it also allows uncooperative people to convert the program into proprietary software. They can make changes, many or few, and distribute the result as a proprietary product. People who receive the program in that modified form do not have the freedom that was given by the original author [3]. Copyleft allows the author to impose some copyright restrictions, but not all. By using this license, the author protects the open access to source code and the freedom of future works based on it.

The most extended Copyleft license is GNU-GPL (GNU General Public License). This license is used by more than 75% of the free software applications. The last version is GPL3 [4].

2.2 Open Source licenses

This type of license attempts to reconcile the basic freedoms of the free software with the business needs of the companies involved in the creation, distribution and use of free software.

This license allows the free software to maintain the fundamental freedoms (copy, modification, distribution and access to the source), ensuring that the successive distributions will be free. Copyleft license doesn't do it because it is considered that the modified versions of the software program should remain flexible and not required.

The most popular open source licenses are Apache Software License, W3C license, Mozilla Public License and PHP license [5].

3 Inputs and benefits of free software

The use of FOSS has many benefits compared with proprietary software, and it encourages some of the main higher education values.

One of the most visible benefits of the free software is the very low or non-existent cost of the software purchase. Although some licenses allow collecting money for the software, it is unusual [6]. The cases where it is required the payment of some fees is because there is a technical support available. But, many times this support is offered by the forums through the collaboration of many users [7]. The use of FOSS in higher education therefore allows for devoting greater budgetary items to other areas such as Research and Development or to the improvement of the equipment of the laboratories. FOSS lets us to analyze how a software program works and gives us the opportunity to adapt it to the needs of the university community and allows the study of the code by the students. Another advantage of the source code analysis is that any user can collaborate by analyzing potential vulnerabilities as backdoors and programming security flaws. They can be detected and solved, thus obtaining systems more secure and stable than those offered by proprietary software.

On the other hand, employing FOSS reinforces the fundamental value of the University: "share the knowledge"; as one of the functions of the University is the generation of knowledge to benefit the whole society. The use of FOSS entails the creation of code from the University that will be shared worldwide.

4 Rate of penetration of FOSS in the University of some Countries

In this section we are going to analyse the rate of FOSS penetration in the United States of America and in Spain.

4.1 U.S.A.

In 2004, a survey made by the campus computing project [8] showed several expectations about open source. It was expected to play an increasingly important role in their campus IT strategy (more than 62% in the public university and more than 64% in the private university). It was expected that open software will offer a viable alternative for key campus administrative or ERP applications such as student information or campus financial systems (about 30% in the public university and about 26% in the private university).

In reference [9] there is a study which shows that 57% of the Universities of USA used some sort of free software in its infrastructure software (operating system, web server, databases, etc.). The percentage of institutions that have not yet given serious consideration to implement open source applications is 32 %. 25% of them use free software to cover their needs. Figure 1 shows that measurements.

In schools with most limited resources, the use of software without paying licences is an important advantage. Despite of the expect cost reasons, in schools with larger budgets the degree of penetration is greater, reaching 72% of infrastructures and 42% of applications. This is due to these schools have large departments of IT. Figure 2 shows the percentage of utilization of free software in several types of software.

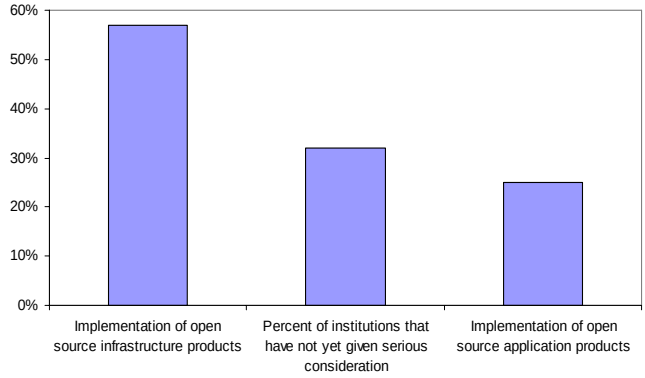

Figure 1. Measurements of open source implementations

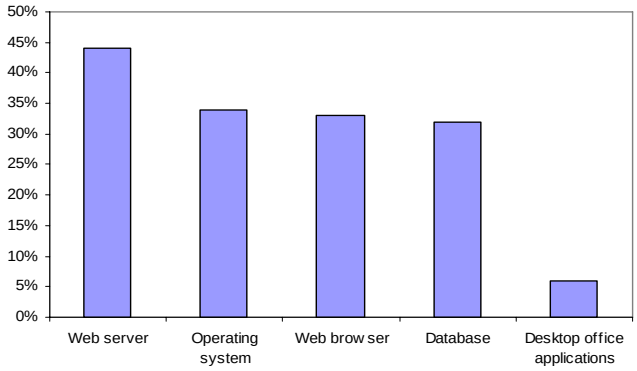

Figure 2. Percentage of utilization of free software

4.2 Spain

In Spain, although until 5 years ago barely existed institutional initiatives for the implementation of free software in the universities, the situation has been changing in the recent years. Thus, in 2007, 10% of the computers in the Universities had installed a free software operating system, compared with 8.9% the previous year, which represents an increase of 12% [10]. Concerning the use of applications, 33% of the software used in the Spanish universities is free, not being this value below 10% in any school. In 2007, 9% of the universities used less than 10% of free software. In both years, the majority of universities have between 11% and 30% of free software. There were more universities between 31% and 50% free software in 2006 than in 2007, but it was because there were an increasing number of universities that employ more than 50% of free software. Figure 3 shows the percentage of universities using free software in their universities in 2006. Figure 4 shows the percentage of universities using free software in their universities in 2007. A comparison between both years is shown in figure 5. In Spanish university Rectors' Conference 2008, they agreed to facilitate the access to free software and open source tools.

5 Analysis of alternatives to proprietary software

There are many free software applications used in higher education. This section gives the most used in the universities.

5.1 Educational platforms

One of the best examples of progress of the Information and Communications Technologies is the use of the educational platforms. They have involved a revolution in the understanding of the education, facilitating access to the materials online, the remote training and allowing permanent contact between the teacher and the student. The most known platforms are Sakai and Moodle, both belonging to the FOSS.

Moodle is a course management system (CMS). It is a free Open Source software package designed using sound pedagogical principles to help educators create effective online learning communities [10]. Moodle has a large and diverse user community with over 400,000 registered users in the official site [11].

Sakai is an online Collaboration and Learning Environment. Sakai is deployed to support teaching and learning. It allows ad hoc group collaboration, support for portfolios and research collaboration [12]. Sakai is a free and open source product that is built and maintained by the Sakai community. Sakai's development model is called "Community Source" because many of the developers creating Sakai are drawn from the "community" of organizations that have adopted and are using Sakai. The Sakai community is actively developing new Sakai tools: Blog tool, shared whiteboard, shared display, multipoint audio, pod-casting, and others.

5.2 Office

This is the most widely used applications. Text processing, spreadsheet, database software are the main ones.

OpenOffice.org is the leading open-source office software suite for word processing, spreadsheets, presentations, graphics, databases and more. It is available in many languages and works on all common computers and in several operative systems. It stores all the data in an international open standard format and it can also read and write files from other common office software packages. It can be downloaded and used completely free of charge for any purpose [13].

5.3 Mathematic software

This type of software has become the most widely covered by the use of FOSS due to its close relationship with the research. Many research groups have developed their own software to meet their needs, and, later, they have made them available to the scientific community.

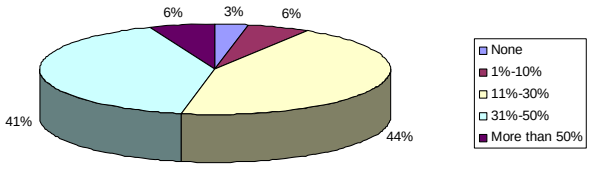

Figure 3: Percentage of universities in 2006

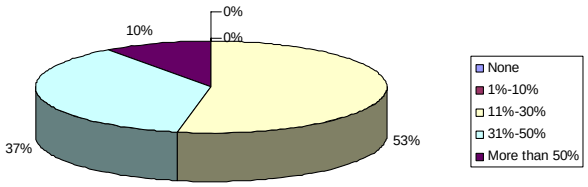

Figure 4: Percentage of universities in 2007

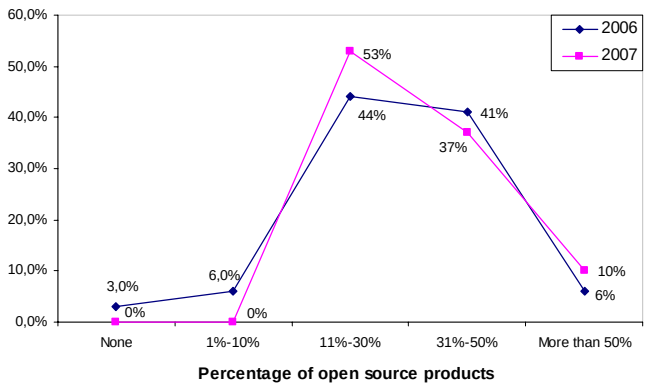

Figure 5: Comparison of percentage of free software used.

GNU Octave is a high-level language, primarily intended for numerical computations. It provides a convenient command line interface for solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with Matlab. It may also be used as a batch-oriented language [14].

Maxima allows to manipulate symbolic and numerical expressions, including differentiation, integration, Taylor series, Laplace transforms, ordinary differential equations, systems of linear equations, polynomials, and so on [15]. Maxima yields high precision numeric results by using exact fractions, arbitrary precision integers, and arbitrarily precision floating point numbers. It can plot functions and data in two and three dimensions. It is the only system based on that effort still publicly available and with an active user community, thanks to its open source nature.

YACAS (the name is an acronym of Yet Another Computer Algebra System.) is an easy to use, general purpose Computer Algebra System [16]. It is a program for symbolic manipulation of mathematical expressions. It uses its own programming language which was designed for symbolic as well as arbitrary-precision numerical computations. The system has a library of scripts that implement many of the symbolic algebra operations. New algorithms can be easily added to the library. YACAS comes with extensive documentation covering the scripting language, the functionality that is already implemented in the system and the algorithms used.

PSPP is a program for statistical analysis of sampled data. It interprets commands in the SPSS language and produces tabular output in ASCII, PostScript, or HTML format. It is intended as a free replacement of the proprietary program, SPSS [17].

5.4 Editing image/audio/video

GIMP is an acronym for GNU Image Manipulation Program. It is a freely distributed program for tasks such as photo retouching, image composition and image authoring [18]. It has many capabilities. It can be used as a simple paint program, an expert quality photo retouching program, an online batch processing system, a mass production image renderer or an image format converter. GIMP is expandable and extensible. It is designed to be augmented with plug-ins and extensions. The advanced scripting interface allows complex image manipulation procedures.

Inkscape is an Open Source vector graphics editor, with capabilities similar to Illustrator, CorelDraw, or Xara X, using the W3C standard Scalable Vector Graphics (SVG) file format [19]. Inkscape supports many advanced SVG features (markers, clones, alpha blending, etc.) and great care is taken in designing a streamlined interface. It is very easy to edit nodes, perform complex path operations, trace bitmaps and much more. They maintain a thriving user and developer community by using open, community-oriented development.

Blender is the free open source 3D content creation suite, available for all major operating systems under the GNU General Public License [20]. Blender has a robust feature set similar in scope and depth to other high-end 3D software such as Softimage, Cinema 4D, 3ds Max, Lightwave and Maya. These features include advanced simulation tools such as rigid body, fluid, and softbody dynamics, modifier based modeling tools, powerful character animation tools and so on.

Kino is a non-linear DV editor for GNU/Linux. It features excellent integration with IEEE-1394 for capture, VTR control, and recording back to the camera. It captures video to disk in Raw DV and AVI format, in both type-1 DV and type-2 DV (separate audio stream) encodings [21].

Cinelerra is a free and open source software non-linear video editing system. Cinelerra also includes a video compositing engine, allowing the user to perform common compositing operations such as keying and mattes [22].

Audacity is a fast multi-track audio editor and recorder for Linux, BSD, Mac OS, and Windows. Supports WAV, AIFF, Ogg, and MP3 formats. Features include envelope editing, mixing, built-in effects and plug-ins [23].

Jahshaka is a video and film compositing, editing and special fx system that uses OpenGL & OpenML hardware rendering to give operators real time interactivity [24].

Rosegarden is a well-rounded audio and MIDI sequencer, score editor, and general-purpose music composition and editing environment. It is an application ideal for composers, musicians, music students, and small studio or home recording environments [25].

Ardour is a digital audio workstation. It can be used to record, edit and mix multi-track audio. You can produce your own CDs, mix video soundtracks, or just experiment with new ideas about music and sound [26]. Ardour capabilities include: multichannel recording, non-destructive editing with unlimited undo/redo, full automation support, a powerful mixer, unlimited tracks/busses/plugins, timecode synchronization, and hardware control from surfaces like the Mackie Control Universal. It is a similar tool to ProTools, Nuendo, Pyramix, or Sequoia.

5.5 Electronics

gEDA is a suite of collaborative software used for electronic design automation [27]. The gEDA project offers a mature suite of free software applications for electronics design, including schematic capture, attribute management, bill of materials generation, netlisting into over 20 netlist formats, analog and digital simulation, and Printed circuit board layout.

Electric is a sophisticated electrical CAD system that can handle many forms of circuit design, including custom IC layout (ASICs), schematic drawing and hardware description language specifications [28].

Kicad is an open source (GPL) software for the creation of electronic schematic diagrams and printed circuit board artwork [29].

6 Migration strategies and experiences

In order to change from proprietary software to FOSS, we have observed some non-written rules:

- Configure the core network with FOSS. This step is probably the most complicated. Data servers, network management, security policies need to be re-programmed to the new configuration.
- Change common applications in workstations to FOSS (Office, web browser, photo editor…), maintaining the operating system (OS) and specific applications.
- Install a free/open source operating system, but maintaining the old one (dual boot). Advanced users will use FOSS OS immediately, but non-initiated users will appreciate the coexistence of both systems. If something gets wrong, they can switch to the other OS.
- Install specific applications for the new OS.
- Delete old OS and applications, so the migration has been completed.

6.1 Open University of Calalonia (UOC)

UOC was one of the earliest institutions in Spain to change to FOSS its entire infrastructure [30].

The experience was successfully. Until now they have offered official studies in free and open source software, which can be continued till master courses. Most of the subjects' documentation is freely available from the web site of the University.

6.2 Catalonian Universities

The Technical University of Catalonia, University of Barcelona, Pompeu Fabra University, University of Lleida and Open University of Catalonia are developing several specific FOSS applications, like a virtual campus or their own Linux distribution. They do not accept the use of proprietary software if they are able to develop on demand applications [31].

6.3 Murcia University

Since 1991, this University offers multiple software courses at no cost to help students and professors to change to FOSS.

Nowadays, most of workstations are based only on FOSS, except specific applications, that are in migration process.

7 Conclusions

Ten years ago, the unique option to consider in universities, for both research and education, was the use of proprietary software. Only the network systems and few applications such as mail managers and web servers employed free software.

In last recent years, FOSS has suffered a development beyond any anticipation, owing mainly to the support of the called "communities of free software": groups of developers working in common and sharing the results of their work with anyone who want use it or is capable of improving it.

Within these groups there are researchers and academics that have adapted existing software to the needs of higher education or have created software programs for their classes.

Nowadays, students and lecturers can resort to open source solutions for almost the entire Universities software needs. We are now, thus, in a changing process towards this type of software, encouraged by reasons of economy, security, control of the software and self-management.

References:

[1] The Free Software Foundation. The Free Software definition. Available at http://www.fsf.org/licensing/essays/free-sw.html

[2] Richard Stallman, Why "Open Source" misses the point of Free Software. Available at http://www.gnu.org/philosophy/open-source-misses-the-point.html.

[3] Li-Chen Wang. Palo Alto Tiny BASIC. Dr. Dobb's Journal of Computer Calisthenics & Orthodontia, Running Light Without Overbyte, Vol 1 No. 5, People's Computer Company, California, May 1976 .

[4] The GNU General Public License. Available at http://www.gnu.org/licenses/gpl-3.0.html.

[5] Open source licenses. Available at http://www.opensource.org/licenses.

[6] Tirole, Jean and Lerner, Josh. The Simple Economics of Open Source. NBER Working Paper No. W7600. March 2000

[7] Karim R. Lakhani, Eric von Hippel. How open source software works: 'free' user-to-user assistance. Research Policy Volume 32, Issue 6, June 2003, Pages 923-943.

[8] The Campus Computing Project. The 2004 National Survey of Information Technology in U.S. Higher Education. October 2004.

[9] Abel, R J. Best Practices in Open Source in Higher Education Study. The State of Open Source Software. Lake Mary, FL. The Alliance for Higher Education Competitiveness, Inc. March, 2006.

[10] J. Uceda, S. Barro, F. Llorens, J. Franco, A. Fernández, S. Fernández, D. Rodeiro, E. Ruzo, UNIVERSITIC2007, Las TIC en el Sistema Universitario Español, CRUE, Madrid, December 2007.

[11] Dougiamas, M., Taylor, P. Interpretive analysis of an internet-based course constructed using a new courseware tool called Moodle 2nd Annual International Conference of the Higher Education Research and Development Society of Australasia (HERDSA), 7 - 10 July 2002, Perth, Western Australia.

[12] Dougiamas, M., Taylor, P. "Moodle: Using Learning Communities to Create an Open Source Course Management System". Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003 (pp. 171-178). Chesapeake, VA: AACE.

[13] Sakai: Collaboration and Learning Environment for Education. Available at http://sakaiproject.org.

[14] Benson, C., Muller-Prove, M., Mzourek, J., Professional usability in open source projects: GNOME, OpenOffice.org, NetBeans. Conference on Human Factors in Computing Systems, Vienna (Austria) 2004.

[15] GNU Octave. Available at http://www.gnu.org/software/octave.

[16] Maxima, a Computer Algebra System. Available at http://maxima.sourceforge.net.

[17] The Yacas Computer Algebra System. Available at http://yacas.sourceforge.net.

[18] PSPP - GNU Project. Available at www.gnu.org/software/pspp/pspp.html.

[19] GIMP - The GNU Image Manipulation Program. Available at http://www.gimp.org.

[20] Inkscape. Open Source Scalable Vector Graphics Editor. Available at http://www.inkscape.org.

[21] Blender home page. Available at http://www.blender.org.

[22] Kino video editor. Available at http://www.kinodv.org.

[23] Cinelerra community version. Available at http://cinelerra.org.

[24] Audacity. Free Audio Editor and Recorder. Available at http://audacity.sourceforge.net.

[25] Jahshaka: Powering the New Hollywood. Available at http://jahshaka.org.

[26] Rosegarden. Music Software for Linux. Available at http://www.rosegardenmusic.com.

[27] Ardour. The new digital audio workstation. Available at http://ardour.org.

[28] gEDA Project Homepage. Available at http://www.geda.seul.org.

[29] Electric – GNU Project. Available at http://www.gnu.org/software/electric/electric.html

[30] Kicad home page. Available at http://www.lis.inpg.fr/realise_au_lis/kicad.

[31] Universitat Oberta de Catalunya. Available at http://www.uoc.edu/masters/oficials/estudis/master_oficial_programari_lliure_estudis.htm.

[32] Els projectes de la CPL. Available at http://www.cpl.upc.edu/publiques/projectes.