Doing Physics with Free/Open-Source Software

Allister Levi C. Sanchez
Department of Physics
Mindanao State University - Iligan Institute of Technology
9200 Iligan City, Philippines
allister@physics.msuiit.edu.ph

Abstract

Computers are an important part of physics research and education. The prohibitively expensive software licenses pose a real problem for educational and research institutions. The solution however is quite simple: use free and open source software (FOSS). This paper introduces Linux and other FOSS with special emphasis to physics research and education.

1. Introduction

The development of physics research and physics education is now closely related with the availability of computers. Computing tools are important parts of present and future physics studies. Many schools and universities, however, due to meager financial resources, resort to the use of unlicensed software. The software piracy rate in the Philippines is 71% in 2004 [1]. The recent nationwide crackdown on the use of unlicensed software gives urgency to the problem faced by many users, including those in the physics community.

2. What is free/open-source software?

Loosely speaking "free" could mean as in "free beer" (that is, price) but could also mean as in "free speech" (that is, liberty). The Free Software Foundation (FSF) defines "free software" as a matter of liberty, not price [2]. According to the FSF, free software is a matter of the user's freedom to run, copy, distribute, study, change and improve the software. More precisely, it refers to four kinds of freedom for the users of the software:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.
- The freedom to redistribute copies so you can help your neighbor (freedom 2).
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.

A program is free software if users have all these freedoms. These freedoms may seem unimportant to ordinary end-users who simply use software but these principles actually have significant impact particularly on the economics of software usage and development.

There are different types of free software depending on how it is released to the public: free, open source, copylefted, public domain, to mention a few. Figure 1 shows the different categories of free and proprietary software.

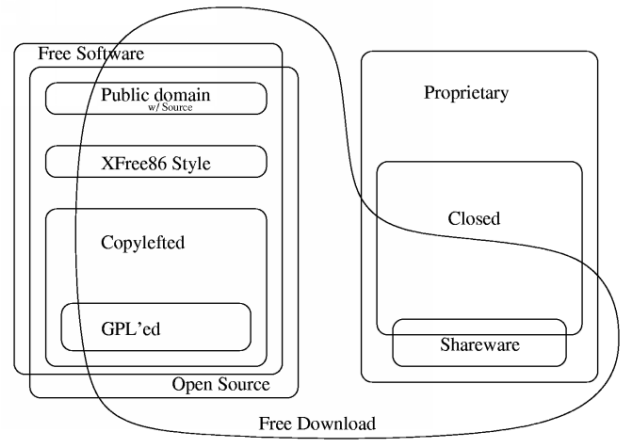

Figure 1. Categories of free software.

3. The case for using free software

Although the concept of free software is more about freedom than price, it is quite pervasive in the FOSS community to distribute software at minimal monetary expense if not totally free of charge by allowing electronic transfers via the Internet. This is analogous to the free transfer of ideas as practiced of the scientific community. It is worth noting that the Internet, invented by a physicist at CERN, grew and became widely used in this tradition.

There exist strong (both philosophical as well as practical) arguments for the use of FOSS in schools and universities (see for example refs. [3] and [4]). Here are some:

- FOSS can cost less to acquire and run than proprietary software.
- FOSS can ease the burden of software license management.
- FOSS can be robust and secure.
- FOSS can help discourage software piracy.
- FOSS can be a useful teaching tool in ways proprietary software can't match.

In the context of physics research and education in the Philippines, the above arguments translate into advantages that can help us overcome a part of our financial constraints and pursue the goals we want to achieve.

It is also important to note that many of the current advances in next-generation computing, such as the Grid [5], are being done using FOSS. Using FOSS will therefore, in a way, familiarize students with the tools of the future.

4. The Linux operating system

The most popular example of a free software is the Linux operating system. It is a UNIX-like operating system originally written by Linus Torvalds and improved with the collaborative effort of many programmers worldwide. Strictly speaking, Linux is just the kernel – the heart of an operating system (see the diagram in Figure 2). By combining it with thousands of other free software, people are able to create different "distributions" – complete operating systems ready for doing productive work. Figure 3 shows the Linux-based desktop used for writing this report. It shows a text editor, a PDF-file viewer, a web browser, a file manager, and a command-line terminal running simultaneously. The following Linux distributions have been known for their user-friendly graphical environments (not an exhaustive list as there are many):

- SUSE Linux [6]
- Ubuntu / Kubuntu Linux [7]
- Mandriva Linux [8]

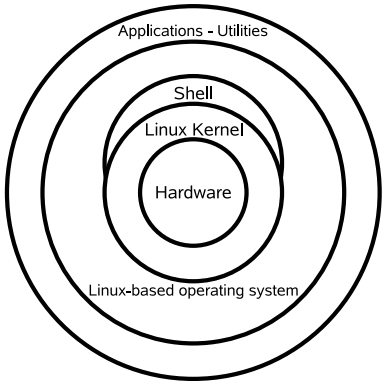

Figure 2. A complete Linux system.

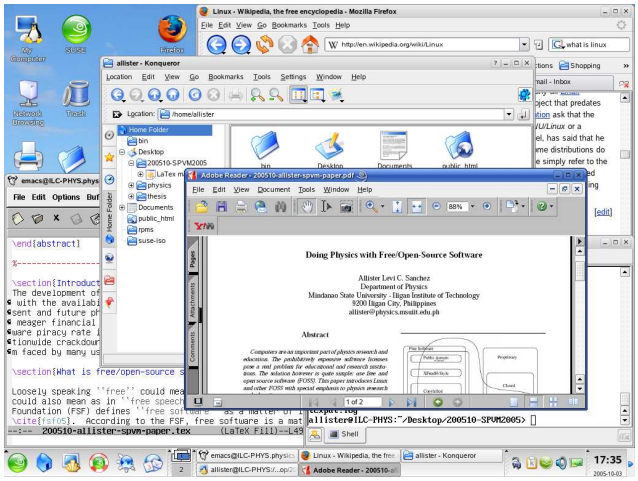

Figure 3. Snapshot of a Linux-based desktop.

- Linspire [9]
- Mepis [10]

User-friendliness depends on personal taste, though, and it is highly recommended to try two or three distributions before selecting one for your use.

For network servers, the following distributions are also popular:

- Fedora Core [11]
- Debian Linux [12]
- Slackware Linux [13]

You may try to download several of these distribution from various FTP (file transfer protocol) sites worldwide.

5. Free physics software

There are many FOSS easily available from the Internet. Here are some useful FOSS for physics education and research (a more complete list is very long):

- ROOT [14], an object-oriented data analysis framework.
- Geant4 [15], a toolkit for realistic simulation of physics experiments.
- Elmer [16], finite element solver for multiphysical problems.
- LON-CAPA (LearningOnline with Computer-Assisted Personalized Approach) [17], a full-featured web-based course management system.
- Globus Toolkit [18], a software toolkit used for building grids.
- Physlets [19], small flexible Java applets designed for science education.
- GNU C Compiler [20], a complete suite of developer tools for creating your own programs.

6. Summary

We have presented an introduction to the use of free and open source software for physics education and research. We hope that Filipino physicists will introduce and encourage the use of FOSS in their respective schools, universities and in their research work.

References

[1] Second Annual BSA and IDC Global Software Piracy Study, May 2005. http://www.bsa.org/globalstudy/upload/2005-Global-Study-English.pdf.

[2] The Free Software Definition, Free Software Foundation, http://www.fsf.org/licensing/essays/free-sw.html.

[3] Dan Kegel, "The Case for Linux in Universities", Presentation at the 2002 Southern California Linux Expo. http://www.kegel.com/linux/edu/case.html.

[4] Richard Stallman, "Why schools should use exclusively free software". http://www.gnu.org/philosophy/schools.html.

[5] Grid Café. http://gridcafe.web.cern.ch/gridcafe/.

[6] http://www.opensuse.org

[7] http://www.ubuntu.com

[8] http://www.mandriva.com

[9] http://www.linspire.com

[10] http://www.mepis.org

[11] http://fedora.redhat.com

[12] http://www.debian.org

[13] http://www.slackware.com

[14] Rene Brun and Fons Rademakers, "ROOT - An Object Oriented Data Analysis Framework", Proc. AIHENP'96 Workshop, Lausanne, Sept. 1996, Nucl. Inst. & Meth. in Phys. Res. A 389 (1997) 81-86. See also http://root.cern.ch/.

[15] Geant4 Collaboration (S. Agostinelli et al.), Nucl. Instr. & Meth. in Phys. Res. A 506 (2003) 250-303. See also http://geant4.cern.ch/geant4/.

[16] Elmer - Finite Element Software for Multiphysical Problems, http://www.csc.fi/elmer/.

[17] LON-CAPA, http://www.lon-capa.org/.

[18] Ian Foster, "Globus Toolkit Version 4: Software for Service-Oriented Systems", IFIP International Conference on Network and Parallel Computing, Springer-Verlag LNCS 3779, 2005, pp 2-13. See also http://www.globus.org/.

[19] Physlets, http://webphysics.davidson.edu/Applets/Applets.html. See also http://natsim.net/en.html.

[20] http://gcc.gnu.org