Applying Open Source Software in a Development Context: Expectations and Experiences.

Case study of a University in Uganda

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1. Introduction

Over the past three years the issue of Free and Open Source Software (FOSS[1]) for development in Less Developed Countries (LDC's) is receiving more and more attention. Where in the beginning the benefits of OSS for lower developed countries was only stressed by small groups of idealists like Richard Stallman (Williams, 2002), now it is moving into the hands of the large international organizations like the World Bank (Dravis, 2003) and the United Nations. In the e-Commerce and Development Report that was released at the end of 2003, it was stated that FOSS is expected to dramatically affect the evolving Information and Communication Technology landscape for developing countries. UNCTAD believes that FOSS is here to stay and developing countries should benefit from this trend and start to recognize the importance of FOSS for their ICT policies (UNCTAD, 2003).

Leading organizations in the software and ICT consulting industry have embraced OSS at a rapid speed. IBM is now the major champion of Open Source Software, and in 2002 IBM announced the receipt of over USD 1 billion in revenue from the sale of Linux-based software, hardware and services. Other technology leaders, including Hewlett-Packard, Motorola, Dell, Oracle, Intel and Sun Microsystems, have also made major commitments to FOSS (UNCTAD, 2003). The major player objecting the Open Source Software paradigm at the moment is Microsoft.

The advantages of FOSS are diverse, but the most often quoted benefit in relation to the developing world is the reduction of purchase and license costs of the software. Software and licenses are paid in hard currency and put an extra burden on the, often disastrous, financial situation of developing countries. Other advantages of FOSS are; reduction of vendor lock-in, adherence to open standards, increased transparency, minimizing security risks, increasing technical self

1 The authors are well aware of the paradigmatic differences between free software and open source software. However, it is often difficult to clearly distinguish these differences. We, therefore, prefer to use the term Free and Open Source Software (FOSS) to capture both paradigms.

reliance, and it provides a good starting point for local capacity development (Dravis, 2003). The last advantage is probably the most important benefit of FOSS. Local capacity is needed to understand the technical foundation of the digital divide and start initiatives to bridge it.

In spite of the obvious advantages of FOSS for developing countries, the adoption until now has been low (Reijwoud, Topi, 2004; Reijswoud, 2003; Bruggink, 2003). In Africa, no country other than South Africa, has explicitly mentioned FOSS in their ICT Policy. On the contrary, governments of several of the richer countries on the continent are considering large deals with proprietary software vendors (see: www.FOSSFA.net). At present it seems that FOSS is on the agenda of the donor organizations and international NGO's but not on the agenda of the decision makers in LDC's. Although there are growing number of initiatives to promote FOSS for developing countries in general and Africa in particular (for example, www.fossfa.net, www.eacoss.org), there are very few organizations that consider and actually implement FOSS.

In this article we evaluate the experiences of an organization in Uganda, East Africa, that has decided to migrate its ICT infrastructure to FOSS. The purpose of the evaluation is to make an on-the-ground assessment of the claims about the development potential of FOSS. We, therefore, start the article with an overview of the FOSS and the role it can play in the development of LDC's. Against this background we describe the case study, the progress the organization has made and the problems that were encountered. Finally, we will draw some conclusions on the experiences in the case study and set out an agenda for successful roll-out of FOSS in developing countries, especially in Africa.

2. FOSS for Development – an overview

When we consider FOSS in Africa we have to distinguish multiple levels in order to get a good understanding of the impact of the different initiatives. The implementation and the propagation of FOSS can be performed at micro, meso and macro levels. At the micro level we like to think about individual users that decide for or against FOSS. At the meso level we consider organizations that take actions to integrate FOSS into their total software infrastructure. Finally, the macro level where IT policies and actions at a national level are considered. We will start with the macro level.

2.1 FOSS from a macro perspective

Governments provide a huge potential for FOSS, not only as a site for implementation of the software, but, more importantly, as propagators of the philosophy behind the FOSS movement.

Over the past 5 years, a growing number of countries are starting to consider FOSS as a serious alternative (www.apc.org). Brazil has been one of the countries that has actively pursued the open source model. It was in Brazil that the first law regarding the use of FOSS in the world was passed in March 2000. Brazil is one of the countries where policies regarding adoption of FOSS have been successful, notably in the states of Rio Grande do Sul and Pernambuco. Also, the Brazilian Navy has been using FOSS since 2002.
(http://www.pernambuco.com/tecnologia/arquivo/softlivre1.html)

In Africa, the South African government is one of the forefront players. In the wake of the developments, the South African government released a policy framework

document in September 2002 by the Open Source Work Group of the Government Information Officers' Council (GITOC) (see for details and discussion about FOSS in South Africa: www.oss.gov.za). The GITOC Policy document (GITOC, 2002) recommends that government "explicitly" supports the adoption of open source software as part of its e-government strategy after a comprehensive study of the advantages and pitfalls of FOSS for government requirements. Next to adopting FOSS software GITOC also recommends that the government promotes the further development of FOSS in South Africa. There is a huge potential role for South Africa's SME industry in the production and implementation of FOSS as well as in setting up user training infrastructures. At the same time, the FOSS approach does represent a powerful opportunity for South African companies to bridge the technological gap at an acceptable cost.

Some *success factors* need to considered in order to tap this potential:

1. *Implementation should produce value*: Value is related to economic value, that is , the reduction of costs and saving of foreign currency; and social value, that is, a wider access to information and computer training.
2. *Adequate capacity to implement, use and maintain*: There need to have enough trained people to support and use the FOSS solution. Training of users and developers should be a high priority.
3. *Policy support for a FOSS strategy*: Support for FOSS needs to expand to all key players at governmental level, departmental level, IT professionals and computer users in general.

The South African government's Department of Communication has already begun the move to Open Source by adopting Linux as their operating system. The government plans to save 3 billion Rand a year (approximately €383 million), increase spending on software that stays in their country, and increase programming skills inside the country. South Africa reports that its small-scale introductions have already saved them 10 million Rand (approximately €1.27 million).

Other countries are following. Worldwide, similar moves are discussed by Taiwan, China, Peru, the UK, France and Germany[2].

2.2 FOSS from a meso perspective

The International Institute for Communication and Development (IICD – www.iicd.org), a Dutch Non Governmental Organization (NGO) promoting the use of ICT's in developing countries, investigated the use of FOSS in organizations in three countries in Africa: Uganda, Tanzania and Burkina Faso (Bruggink, 2003). The objective of the research was to find out how, where and why organizations from all kind of sectors use FOSS, what problems can be observed and what opportunities for development are available. The findings of the research show that FOSS in Africa is being used, but it is not yet very widespread. FOSS is mostly found at the server side of Internet Service Providers (ISP's) and is sometimes used by government and educational institutions. This means that Open Source operating systems, mainly Linux and derivatives, web servers, email servers and files servers are found where the day to day computer users do not see them. Large and hierarchical organizations that have migrated completely from proprietary software to FOSS (server side and user side) have not been found. Most of the

2 Bundesrechnungshof fordert Einsatz von Open Source, 25.02.2002, http://www.heise.de/newsticker/data/anw-25.02.02-004

organizations that are using FOSS are relatively small organizations. When the three countries are compared, it is concluded that Tanzanian organizations show most initiatives, while in Burkina Faso organizations do not show interest to move away from proprietary software.

The research of the IICD highlighted several reasons why organizations in Africa do not take up the challenge of FOSS. In the first place, there are some false perceptions on FOSS. Many organizations believe indeed that FOSS is Linux only and that FOSS is not user friendly and is only suitable for the ICT specialist. Secondly, there is limited access to FOSS. Most of the FOSS is distributed through the Internet and with the scarce and/or low bandwidth Internet connections, the access to FOSS is limited as a by product. Software companies, including FOSS companies, see little market potential in Africa (outside South Africa) and so the availability of software is low. This is also reflected in the amount of resellers of FOSS. Finally, there is little expertise available to provide training and support for FOSS and eventually consultancy in migration processes.

In section 3 we will further elaborate on an example of the implementation of FOSS in Uganda.

2.3 FOSS from a micro perspective

Most of the FOSS initiatives are small scale projects of individual people or small organizations. A growing number of individuals throughout the African continent are becoming aware of the potential of FOSS from a strategic point of view. Together with relevant advantages from an economic and technical point of view, with its lower costs, more flexibility, availability of robust and reliable technology, lower dependence on software vendors, FOSS does in fact represent a most important opportunity for changing the position of Africa as whole within the information society.

At user level, and for many individuals in Africa, the challenges of FOSS provide new opportunities for development, both at personal and community level. Now that most countries in Africa are connected to the Internet, individual FOSS initiatives, which rely on it, are finally thriving. An initiative with good potential that tries to bring together the scattered FOSS society is the Free and Open Source Foundation for Africa (FOSSFA – www.fossfa.net). The initiative started as the offspring of an ICT policy and civil society workshop in Addis Ababa, Ethiopia, in February 2003. During the workshop the participants agreed that FOSS is paramount to Africa's progress in the ICT arena. The mission of FOSSFA is, therefore, to promote the use and implementation of FOSS in Africa. Herewith it began to work on a coordinated approach to unite interested individuals and to support open source development, distribution and integration. The Free and Open Source Foundation for Africa envisions a future in which governments and the private sector embrace open source software and enlist local experts in adapting and developing appropriate tools, applications and infrastructures for an African technology renaissance. They foresee South-to-South cooperation in which students from Ghana to Egypt and Kenya to Namibia develop programs that are then adopted by software gurus in Nigeria, South Africa and Uganda in order to narrow the digital divide.

On a similar line a number of Internet mailing lists and user groups are emerging, that focus on bringing together FOSS developers and users in Africa. At the moment there are active groups working in South Africa, Ghana, Kenya, Zambia, Zanzibar, Tanzania, Burkina Faso, and Uganda.

Hosted in South Africa, Internet portals are emerging, that aim at being a starting point for knowledge on FOSS in Africa.

Similarly, at commercial level, an interesting initiative has been launched by DireqLearn (www.direqlearn.org). DireqLearn promotes FOSS and FS as an alternative for the education sector in Africa. By adopting FOSS and FS the company can offer new solutions to the educational sector at low costs.

Finally, even if only to a limited extent, some African Open Source Software development projects have been launched. Most of the projects are situated in South Africa, for reasons connected to the presence of infrastructure. Outside South Africa, a project that is worthy of mention is the RULE (Run Up to-date Linux Everywhere - www.rule-project.org/en/) project. The aim of this project is the creation of a very light Linux distribution for people that cannot afford modern computers systems. In order to achieve the goal, the developers are modifying a standard Red Hat distribution, trying to allow the greatest real functionality with the smallest consumption of CPU and RAM resources. The new distribution is mainly intended for schools and other organizations in developing countries. At present, the RULE project provides a FOSS solution with GPL license that is able to transform 5 year old computer models (Pentium 75MHz, 16 MB RAM, 810 MB Hard disk) into useful machines.

The increasing interest in FOSS is also driving the emergence of FOSS-specific organizations. In several African countries, like Nigeria, Ghana, Uganda and South Africa, specialized software and consulting companies have started up. Meanwhile, young people with a background in computing are embracing the FOSS approach and trying to reform the accepted practice of buying pirated proprietary software. At present, the market share of FOSS is still small and it is a struggle for these specialized companies to survive. However, when the benefits become clear and FOSS is implemented on a larger scale, the capacity to implement the systems shall be ready.

3. Implementing FOSS – a case study

There are hardly any documented large scale organizational implementations of FOSS in developing countries. Where FOSS is implemented, it mostly concerns small donor funded projects or relatively simple organizations. See, for example, the projects described in Dravis (2003). The case study presented here describes a relatively large organization that has made the strategic decision to move away from proprietary software to FOSS.

The goal of the case study is to evaluate whether the high expectations of the use of FOSS for development translate well in a practical situation.

The case study is based on documentation and interviews with the main stakeholders at the university. Since both researchers are employed at the university and participated in the migration project, their views and experiences are also included. We have tried to avoid being subjective.

3.1 Uganda Martyrs University

Uganda Martyrs University is a privately owned university in the central province of Uganda. The university opened its doors in 1993 after the government allowed private universities to exist next to the government owned universities. The main reason was to improve the quality and the capacity of higher education in Uganda.

At the time of writing (February 2005) the university has 2200 students enrolled in full time and part time programs at diploma and degree levels. The main campus of the university is located in Nkozi, 80 km outside the Ugandan capital city, Kampala. The location of the main campus can be characterized as rural. When the university started, there were no telephone connections, no steady water supply and electricity was unreliable. This has changed over the years and now the university is recognized for its good and reliable facilities. The university has a smaller campus in Kampala, where some masters programs are offered in the evenings and several outreach offices are available for students who cannot easily travel to the main campus.

The university employs a full time academic staff of 86 people and an administrative and support staff of 117. With this size Uganda Martyrs University qualifies as a large organization in the private sector of Uganda.

The case study mainly focuses on the Nkozi campus of the university.

3.2 FOSS at Uganda Martyrs University – the initial stages

The FOSS project at Uganda Martyrs University had an informal start in 2001 when foreign assistance was offered to set up a mail server at the main campus. Since there was only a budget available for hardware and no provision for software, it was decided to equip the server with Free and Open Source Software. The mail server was configured with Red Hat Linux 6.0, Sendmail as the mail transfer agent (MTA) and Neomail as the web based mail client. A webserver, to host the local intranet, was configured with SuSE Linux 7.2 and Apache webserver software. When a new systems administrator was hired, he was trained to use and maintain the implemented configurations. The new systems administrator picked up interest in Free and Open Source Software and started to extend FOSS to other parts of the system. In the beginning of 2002, the systems administrator incorporated FOSS for the proxy server (Squid) and the firewall (SuSEFirewall) for Internet access and some other minor applications.

In mid-2002, the project got a new impulse when several guest lecturers from universities and other organizations in Europe started to visit the university for lectures in the then newly started Master of Science in Information Systems program. These lecturers encountered installations of pirated software on most computers of the university and started to question the ICT policy. The university did not happen to have an ICT policy formulated but realized that there was need to take action. This is when the FOSS project started formally. In the course of the academic year 2002-2003 the ICT Department, together with the Office of the Vice Chancellor and the Department of Computer Science and Information Systems, outlined a software policy based on Open Source Software. The software policy was based on two underlying principles:

1. the university wants to optimize access to ICT for students and staff within the limited funds available
2. the university will not support the use of pirated software on university property

The first principle was derived from the mission of the university that promotes the access to information for the university community. The second principle was derived from the Christian values on which the university is based, and states that you shall not steal (not even software). Free and Open Source Software was considered a good alternative to work within the two principles.

In May 2003, the Senate of the university officially agreed on a FOSS policy and

preparations started for a full migration on the server-side as well as the user desktop applications.

3.3 Migrating the Desktops

The major challenge for the university was the migration of the desktop applications. Literature review revealed very little reference material and few success stories. Experiences with similar migration projects in Uganda and the rest of East Africa were not available. The university received help from the FOSS Group of the University of Huddersfield, in the United Kingdom, as a response to a message sent to one of the Linux mail lists. Other than that, the university ICT staff was on their own to plan and execute the most difficult part of the FOSS migration.

At the start of the migration project, all computers in the university were using Microsoft Windows (98, 2000 and XP), the Microsoft Office suite and other common proprietary software applications. One of the first steps in the project was to identify the main applications and their usage, in order to select FOSS alternatives. It was observed that the university staff and students used very few 'exotic' applications. They mostly used the mainstream productivity applications. This made the selection of alternatives relatively straightforward. Table 1 below shows the alternatives that were selected to replace proprietary software.

Task	***Proprietary software***	***Open Source alternative***
Operating system	Windows 9x, 2000, XP	GNU/Linux
Office productivity suite	Microsoft Office	Open Office
Mail client	Microsoft Outlook Express	Kmail, Mozilla Mail
Internet browser	Internet Explorer	Konqueror, Mozilla
Database	Microsoft Access	MySQL/phpMyAdmin
Programming	Wordpad Borland Builder	Kate Eclipse
Statistical analysis	SPSS	Open Office Calc
Webdesign	Microsoft Front Page	Bluefish / NVu

Table 1 – Main Proprietary software used and Open Source Software alternatives selected

Since the operating system would also be migrated, a decision needed to be made on the Linux distribution that would be used as the standard at the university. Several alternative distributions were considered and finally the Knoppix distribution was selected. The main reasons for this decision was that Knoppix is a one-disk, bootable distribution that can also be installed easily. The distribution could be handed out to the students and used as a CD-ROM-bootable program on any available computer (even one with another operating system already installed). Research on the Internet showed us that the Knoppix distribution would work well on older machines, of which the university had quite a lot (Pentium II's). Finally, the Knoppix distribution came already bundled with most of the packages that would provide alternatives for the proprietary software being used at the university.

It was decided that the implementation strategy for the migration would be staged. First, all the computers that have public access (library and computer labs) would

be migrated. Once this was completed, the lecturing staff would be migrated and finally, the administration (financial and student affairs administration units) of the university. This strategy was based on the reasoning that the university's main operations should not be endangered.

The first phase was scheduled to take place during the absence of the students (June-August 2003). An evaluation of the first phase of the migration would be performed before the start of the second phase. The second phase was scheduled for the long vacation (June-August 2004). A time frame for the third phase was not determined.

3.4 Problems encountered during the migration

The project encountered unexpected technical and organizational problems in the first phase that delayed the time frame for the further implementation. The major problems are listed below.

Although several claims were made about the installation of Linux on older machines (Pentium II/Dell), it was not as smooth as these descriptions seemed to suggest. Many of the machines did not have CDROM drives or were not able to boot from the CD for the installation. Bootable floppy disks had to be created to solve this but for about 20% of the older computers the installation failed. There were also problems of maintenance at a later stage for the computers without CDROM drives.

Limited disk space and RAM handicapped the performance of the machines. The machines installed with Linux did not perform much better than similar hardware configurations with Microsoft Windows installed on them. The users, therefore, did not consider this as a as an improvement and this had a very negative impact on their acceptance of the new software.

Although it was anticipated that the GUI (KDE 3.2) would not cause problems for the more experienced Windows users, the slight differences became bigger hurdles than expected. The most common problem was that the Knoppix distribution requires users to mount and unmount their floppy disks. Windows does not require this. After losing information due to (un)mounting improperly, the users started to question and resist the user friendliness of the new systems.

A special problem was caused by the frequent power cuts in Uganda and improper (hard) shutdown. When the Knoppix machines were not switched off properly (through misuse or power cuts), a filesystem failure was created with the result that the operating system was no longer mounted automatically. In order to boot the computer, a root password was needed and the filesystems needed to be repaired. This repair procedure always took a long time since the repair program was checking the entire hard disk. The users were not able to do this themselves and so help from the ICT department was required every time the problem occurred. In the newsgroups it was explained that the problem was caused by the default use of the ext2 filesystem. When the filesystems were converted to ext3 or Reiser, which provide journaling, the problem was solved.

There were some cases where there were no available alternatives for the software being used. Computers had to be installed with a dual boot system setting Linux as the default option. The same Open Source Software applications had to be installed on both operating systems which meant double work per computer for the ICT staff. Students were still working in Microsoft Windows a lot and so in order to encourage them to choose Linux, Internet (and as a result web based

email) access was restricted to the Linux operating system.

Finally, differences between the file formats of the office applications (Microsoft Office and Open Office) caused a problem. Since the staff and the administration was not yet migrated, the files sent by the students could not be read. With files sent by the staff there were no problems. The use of the Open Office option of automatically saving files into Microsoft Office suite formats was not valued since every time an Open Office document was being saved in these formats, the following worrying message appeared: “Saving in external formats may have caused information loss. Do you still want to close?”. The message was confusing to the users.

3.5 Evaluation of phase I

Although solutions were found for most of the technical problems with the installation of the new FOSS system on the public computers in the university, the evaluation showed that the acceptance of the new systems was not as high as expected.

The mounting and unmounting of floppies disks was the major cause for resistance, especially since forgetting to unmount the disk caused the loss or corruption of files. This problem was overcome by adopting the SuSE Linux 9.1 distribution since it had an auto-mount and unmount feature.

Students, especially the freshers (1st year students), responded very positively to the new systems. Although they had a choice between Windows and Linux (dual boot system), observations in the labs showed that most of them decided to use the Linux side. Among students that had already had some experience with computing in Microsoft Windows, the resistance to the new software was extremely high. Some of the postgraduate students wrote complaint letters to the university management about the use of 'inferior' software and even threatened to strike. The resistance to the use of FOSS remained until that class of students graduated. For the incoming students, a compulsory FOSS computer literacy course was introduced based on a manual (Easy Linux Introductory Guide to Computers) developed by the university. This greatly reduced the resistance. At present there are few problems that the students are experiencing.

On the technical side, the problem of maintaining computers without CDROM drives was solved through the installation of SuSE Linux 9.1. It provided the option to perform installation and upgrading of software through the network. All that was needed was to make sure the computers had a network interface card and a connection point. This saved the technical staff having to carry around and/or keep copies of very many installation CDs and external CDROM units.

Overall, we underestimated the importance of awareness creation of the underlying motives of the university to move to FOSS. The explanation of these reasons needs to be taken extremely seriously to secure commitment of the users. We also underestimated the need to have existing continuous and constantly available support to ease the users into the new system. This meant that even with the introduction of the improved system that performed the auto (un)mounting for the users, they already had a mental block and were still somewhat reluctant to trust the system. The university has embarked on an active promotion of the ideas behind FOSS.

3.6 Phase II – the staff

The second phase, the large scale migration of the staff computers, was planned for the period June-August 2004 but was delayed due to the problems in the first phase. In order to keep the migration on track it was decided to concentrate on the new computers only. All new computers that were purchased were installed with FOSS. Since almost all computers that the university was purchasing came pre-installed with Microsoft Windows operating system, a dual boot system was installed with Linux as a default option of the two.

Some of the computers needed to continue to operate on Microsoft Windows because certain applications were being used that have no satisfactory FOSS alternative. Some of these applications are listed in table 2 below.

Task	*Proprietary software*	*Open Source alternative*
Financial application	Tally	-
Architectural design	Vector Works	-
Wordprocessing	Corel Word Perfect	-

Table 2 – Applications without satisfactory and/or compatible FOSS alternatives

The staff of the ICT department went around the university to install FOSS applications for Microsoft Windows platform on the staff computers. This was needed to support the format of documents that the students were sending to the staff. The staff was also informed that no support would be given to illegal proprietary software. Unfortunately, no member of staff, other than the staff in the department of Computer Science and Information Systems and the staff of the ICT department, allowed their 'personal computer' to be migrated to Linux. Only official work computers were migrated.

For the installations that were done on the university property being used by the staff, it was rare to find them using the FOSS alternatives that were provided for them. The few who tried using these alternatives had lots of complaints about the software not being able to perform the kind of tasks that they wanted.

3.7 Evaluation of phase II

The second phase turned out to be even more difficult than the first phase. Although there were relatively few technical problems, the high level of resistance of the staff at the university virtually stalled the project.

The biggest problem in the whole project and especially in the second phase, is the acceptance of the new software by the staff. The users of Microsoft Windows find it difficult to switch to the new system. They feel that they are migrating to an inferior system and, as a result, small differences are turned into big problems, for example, the fact that the settings for the page layout are in a different location for Open Office makes them feel that the new package is inferior to the well-know Microsoft Office Suite. Arguments that the location of the page characteristics in Open Office display a more logical user-interface design are not accepted. The migration team concluded that the differences in the user interface were underestimated and too little information was provided on the reasons and consequences of the migration to get full user commitment. When introducing a new software environment – even when the differences are small – several training workshops highlighting the reasons and consequences of the changes should be planned.

The project also underestimated the number of Corel Word Perfect users and the problem of migrating their documents. Open Office can handle Microsoft Office files well, but there is no facility for Word Perfect files. The fact that these files could not be read in Open Office is used as a reason not to migrate regardless of the varying number of documents that the users have available in Word Perfect formats. The ICT department is looking at ways to handle this problem. Some considerations at the moment include encouraging the staff to use Corel Word Perfect as a document reader only and to adopt Open Office for creating and editing newer documents. The other consideration is to get document converters that shall create PDF versions of the older documents that the staff may need to keep as archives.

At the moment we observe a growing divide between the staff and the students in terms of the software used. Staff tends to continue to use proprietary software while students move more on the open source software side.

4. Lessons learned – critical analysis

The migration at Uganda Martyrs University allowed us to draw some important lessons about a large scale migration to FOSS.

Installation of FOSS on the server-side proved to be a big technical challenge. There was little hands-on guidance and support available to help the system administrators in the university. In a country where the university was the first organization to migrate, there was no possibility to hire local technical experts to assist the staff on-site. Hiring support on the international market was considered unfeasible due to financial limitations (the daily fee of international consultants is in most cases higher than a monthly salary of the local staff). On-line support by the FOSS community proved to be too unreliable and often not applicable for the situation at the university. Therefore, the staff of the ICT department had to rely on their own research and much of the implementation was done through trial-and-error. The speed of the migration was, therefore, slow and demanded a lot of patience from the users. On some occasions email and the Internet connection were down for several days.

Whereas Microsoft software applications provide a standard environment for the desktops, FOSS leaves more room for choice. Advantages and disadvantages of the different FOSS desktop applications are not well documented. At the university, this led to changing standards. Where Konqueror was the first choice for web browsing, this was later changed to Mozilla when it became clear that Konqueror had problems with viewing some commonly visited pages on the intranet and Internet that contained javascripts. Recently, we observe a change from Bluefish to NVu for building web pages. These changing standards are confusing for most users. These changes seem to be mostly appreciated by the technical staff and the students in computer science and information technology. As far as end users go, therefore, it would be helpful to pick standard well developed packages taking into consideration the users possible future needs. End-users would want to spend most of their time being productive rather than learning the computer environment. However, there are no guarantees because new FOSS projects are starting up everywhere and a better alternative might be developed.

The introduction and the roll-out of the migration project at the university revealed that continuous information to the users is needed. Their commitment and support of the project is essential for success. The approach at the university was a top-down approach with a presentation for management and senate, an initiation

workshop, a mid semester workshop for all staff and individual support for all users. This approach was not enough. Although the resistance to the changes seemed to diminish after the workshop and presentations, it proved to come back quickly, and stronger than before. Small problems were magnified. The fact that the migration team was composed of technical personnel, but with strong support from the top management of the university and the Vice Chancellor as champion did not guarantee complete success.

The migration of the students before the migration of the staff seems to have been disadvantageous. The expectation that the staff would support new software and request for installation of FOSS on their machines turned out to be a miscalculation. Instead, several staff pushed students into using proprietary software formats, for example, when handing in assignments. Documents saved in Open Office format were not accepted. From our experiences it may be a wise option to get staff acceptance and migrate them before any attempts to migrate the students.

The migration team is contemplating on an approach to migrate the rest of the university. If this migration is not completed, there might be a quick return to the original situation.

5. Conclusions and research agenda

In spite of the high expectations of the policy makers about the development potential of FOSS, the reality of implementing FOSS in a developing country is difficult. The route to the implementation of FOSS is one with a lot of hurdles. Some of these hurdles are general and some are specific to developing countries.

At a general level we observe that there is a strong resistance to change to FOSS applications. Many users start a migration with the idea that they are confronted by an imperative of the 'technical people' to use 'inferior software'. Their judgment is solely based on the experiences that they have with the desktop applications. On the server-side where the migration is driven by the technical staff, the clear advantages are a strong motivator for the change to FOSS.

On the desktop the portability of files between FOSS and proprietary software is still a problem. Until this issue is solved, desktop migration will remain difficult. It is high time that proprietary software producers are forced to adhere to international standards or to completely open up their own standards.

The need for education material for FOSS is high. The material currently available is mostly very technical and not understandable for the general users. Availability of student material, for example on Linux, Open Office, MySQL/PHPMyAdmin, GIMP and Bluefish as replacements for the proprietary tools may greatly improve the use of FOSS tools.

In the context of the developing countries the need for appropriate support in implementing FOSS is high. Experiences at Uganda Martyrs University show that the help received from the international mailing list community was little since the questions posted were considered basic and not challenging to members on the list. On the other side, the discussions in the mailing lists were too difficult and not (yet) applicable to the situation at hand. It seemed difficult to bridge the knowledge gap, and implementers felt isolated in their problems. In order to support the migration in developing countries international organizations like the World Bank or UNCTAD need to consider setting up a support center that deals with the questions of the system administrators and users in these countries.

Another specific problem in the context of the developing countries is the feeling that the access to the 'good' tools from the West is denied. A question that was often asked was: “Why are the people in the West not using these [FOSS] programs when you are saying they are so good?”. This argument is difficult to counter until there are success stories available from Western organizations. The situation gets even worse when the international organizations that promote the use of FOSS in developing countries only accept files in proprietary software formats (.doc, .xls, . ppt), have webservers that run on proprietary software and websites that can only be browsed optimally with Microsoft Internet Explorer.

Finally, the market of pirated software in developing countries is well organized and institutionalized. Pirated software is readily available from every street corner at very low prices, and support for installation often accompanies the sales. Many of the new computers that are bought in Uganda, for example, have full installations of pirated software. The ones that have valid licenses cost more than the individual is willing to part with. This applies to both servers as well as desktop computers. Why would anybody want to install something else?

At present the development potential of FOSS for developing countries is still a theoretical potential. At the practical level more research, more support and a changed attitude of the organizations in developed countries is needed. Research should focus on the development of better tools to bridge the compatibility problems. More support is paramount to the success of the acceptance of FOSS in developing countries. Support should focus on practical help with the implementation of FOSS, but also for lecturers who want to use FOSS applications in their courses. More educational material, preferably published under the Open Content license, could act as a catalyst in an environment where the need for textbooks is extremely high. Finally, organizations working with developing countries should set an example by adopting FOSS as a standard in their organization. As long as organizations in the developing world need to communicate with their counterparts in the developed world by proprietary software standards and proprietary tools, the development potential of FOSS will be considered a myth and never a real possibility.

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