towards Open Source Software adoption and dissemination

tOSSad

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Methodology, Implementation Report and Tutorial to Build a F/OSS Laboratory

D12

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Version control

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Name	Role	Date
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1. Introduction and Goals

1.1. tOSSad Project

tOSSad is a Coordination Action-project funded by FP6-IST. The project consortium consists of 19 partners from 15 European countries. The project started on February, 2005 and will run for two years.

The tOSSad project aims at improving the outcomes of the F/OSS communities throughout Europe through supporting the coordination and networking of these communities by means of state-of-the-art studies, national program initiations, usability cases, curriculum development and implementation of collaborative information portal and web based groupware.

The main objective of the tOSSad project is to start integrating and exploiting already formed methodologies, strategies, skills and technologies in F/OSS domain in order to help governmental bodies, educational institutions and SMEs (Small and Medium Enterprises) to share research results, establish synergies, build partnerships and possibly innovate in an enlarged Europe.

As an FP6-IST project, tOSSad is structured in the following 6 work packages:

- WP1: F/OSS Study
- WP2: F/OSS National Programs
- WP3: F/OSS Usability Study
- WP4: F/OSS Curriculum Development
- WP5: Dissemination and Exploitation
- WP6: Management and Coordination Activities

1.2. Work Package 4: F/OSS Curriculum Development

The main goal of tOSSad work package 4 is to develop and revise F/OSS training standards and help develop infrastructure and standard training documents. The outcomes are intended to be in a standard form in intermediary education and training applicable to schools and universities. The number of institutions adopting and supporting the F/OSS curriculum will define the success of this workpackage.

WP4 will produce the following deliverables:

- D11: 1st F/OSS Curriculum Workshop Report
- D12: Methodology, Implementation Report and Tutorial to Build a F/OSS Laboratory

- D16: 2nd F/OSS Curriculum Workshop Report
- D22: F/OSS Curriculum Report

All of the deliverables mentioned above will be released under a CreativeCommons 3.0 (http://creativecommons.org/licenses) license and will be publicly available at the tOSSad website.

As a general policy, all the efforts needed to release the various deliverables, are divided into “tasks”. Referring to WP4, here are the list of related tasks:

- Task 4.1: Organizing two workshops and a training program on “F/OSS in education”; the first workshop will study and discuss the various curriculum plans worldwide, the second will discuss the developed curriculum. The workshops could be held with other tOSSad workshops and/or attached to other F/OSS events. Particular care will be taken in choosing the invited audience, and policy makers will be invited whenever possible
- Task 4.2: Evaluating the needs of industry to enhance qualifications in F/OSS, based on the societal objectives to improve F/OSS adoption; Local industries, including SMEs, will be contacted and interviewed, in order to assess their orientation toward F/OSS and to define which skills are needed in their use of F/OSS. The results of this task will be used to develop F/OSS curricula and courses
- Task 4.3: Determining the best F/OSS training methods, be they classroom based learning or e-learning (distance learning). This task will be developed by surveying and recommending pedagogic processes and methodologies for training in F/OSS. These recommendations will inform the nature and design of the proposed standards and curriculum
- Task 4.4: Developing and revising F/OSS education and training standards and helping to form the infrastructure and the standardization of training documents. This task will build on the results of tasks 1, 2 and 3, and will produce one or more proposed curricula and course programs
- Task 4.5: Exchanging of information about curricular aspects of F/OSS and their further development

1.3. The Deliverable 12: Methodology, Implementation and Tutorial to Build a F/OSS Laboratory

This report discusses the methodology for building a F/OSS laboratory for different kinds of F/OSS curriculum and gives a step-by-step tutorial for the implementation of the proposed approaches.

Use of laboratories have been advocated by many different curriculum committees for some time, but, as with any other pedagogical device, the “adopt first, analyze later” approach may lead to unwanted results. Adding a laboratory to a curriculum does not automatically make it a better program, but may make it worse unless there is a clear vision as to the goals that will be achieved by the adoption of a laboratory to a curriculum.

A well designed and implemented laboratory will provide students with an environment supporting a wide variety of investigation, organizational, creative and communicative skills development.

Laboratory activities help students enhance their performances by providing the following:

- Making the material studied, operational
- Allowing the student to ascertain that the material is understood
- Providing instant feedback to the student
- Stimulating experimentation with the material
- Raising questions for further lectures and study
- Offering the student the opportunity to discover solutions to problems

In this report, a number methodologies and approaches in the implementation of laboratories supporting the F/OSS curriculum will be discussed and a summary of issues will be provided.

2. Methodology and Approach

The design for the F/OSS laboratory supporting the F/OSS curriculum has many attributes. In this section, a discussion of all these following attributes are given:

- Curriculum type
- Laboratory model
- Laboratory activity types
- Infrastructure model

2.1 Curriculum Type

The first and the foremost attribute defines what kind of curriculum the laboratory is designed for. The tOSSad project is directed at K12s and universities as the target groups; the laboratory differs in these two distinct curriculum:

- F/OSS Laboratory for K12
- F/OSS Laboratory for universities with CSE department
- F/OSS Laboratory for universities with non-major CSE

2.2 Laboratory Model

The second attribute is in the laboratory model to be applied. Due to the nature of the methodologies apparent in computer science studies, a rich variety of possible models exist in F/OSS laboratories:

- Closed Session: This refers to a model in which an instructor is available to provide immediate feedback about the laboratory activities.
- Open Session: This refers to a model in which the laboratory activities are completed by the students without the supervision or immediate access to assistance.
- Scheduled Session: A scheduled laboratory session is defined to take place at a specific time and within a fixed duration. Scheduled sessions are best used to facilitate team work amongst groups of students.
- Unscheduled Session: In contrast with a scheduled session, an assistant is available for an extended period of time and students are free to show up during that time.
- Structured: In the structured model, activities are provided through a detailed, step by step fashion.
- Unstructured: Open-ended assignments are given by many instructors.

These models may be grouped as closed versus opened, scheduled versus unscheduled and structured versus unstructured. A complete laboratory model will consist of one choice from each of the model groups.

2.3 Laboratory Activity Types

There have been various types of laboratory activities enlisted by many authors. The ones related with the F/OSS laboratory and their goals are identified as follows:

- Discovery Labs: Broadening the curriculum through lab activities.
- Improvement Labs: Developing skills at analysis and comparative techniques.
- Comparison Labs: Analytic and cooperative skills.
- Reinforcement Labs: Increasing retention of concepts.
- Exploratory Labs: Exploring the breadth of the discipline.
- Skills Labs: Achieving proficiency with the basic tools and techniques of the discipline.
- Methodology Labs: Methodologies for solving problems in the discipline.

A laboratory curriculum is a blend of these types.

2.4 Infrastructure Types

Establishing an effective infrastructure for the laboratory is an important aspect of the process. There are many types of infrastructure that can be identified. In this report we emphasize three significant setups; the thin clients approach, the conventional set-up and the mixed approach, where a combination of thin-client and conventional approach is used.

Understanding the basic differences between thin client networks and typical local-area or wide-area networks (LANs and WANs) is necessary to investigate the different uses that each system may have for educational settings.

- Thin Clients: In this approach, there is but one central server and all clients are stripped of their hardware except for the CPU, RAM, display card, monitor, network card, keyboard and mouse. All of the processing is done by the central server; users log on to clients (or terminals) and run programs on the central server. With a thin client network, all of the computing power resides on the central server (or servers), not the individual computer. Individual workstations act as remote terminals for these powerful central computers. Because the actual processing and storing of software and files occurs only on the server, the workstations are not dependent on the CPU or the memory capacity of individual computers; instead they need only provide the basic ability to receive input, transmit it to the server, and display the results. These workstations can therefore be simpler (or “thinner”) than full-capacity computers. Rather than employing full-capacity computers, a thin client network can make use of specialized devices (referred to herein as “thin clients”, or “thin client terminals”) that are both simpler and less expensive than full-capacity computers, and rely on the server for access to applications and other services. Full-capacity computers can also be set up to run as thin client terminals (or “workstations”) and the user can switch between using it as a workstation or as an individual computer. Older and less powerful computers can thus be used as functional thin client workstations. In this infrastructure the server is the key part, so almost all hardware maintenance, software installations, memory or hardware upgrades occur on the server.

  This approach is implemented though the use of the LTSP (Linux Terminal Server Project) in this particular case. The LTSP is an open source project that provides fast high quality computing simultaneously to many people from a single central server. The advantages of this approach and the LTSP can be identified as:

  - Low cost: The terminal computer need to have minimal hardware, and the processing power needed by the central server is only modest. There is an option of using recycled computers as clients.
  - Low cost of software maintenance: All software is stored on a single server with a standard re-storable set-up. Systems can be maintained remotely.
  - Security: All resources including the file system, process management and Internet access can be controlled through the central server.
  - Educational value: It is possible to load a rich range of Open Source software, with high educational value, to offer programming experience, Web site creation, use of databases, creative graphics, may be accomplished without the worry of licenses. In the Linux environment inappropriate software (for example inappropriate games) can be excluded.

- Tried and Tested Technology: The LTSP software has thousand of installations worldwide and is widely used in education and in primary schools in the US. In France the Ministry of Education has adopted a similar system based on server equipment from Sun Computers for providing computer power in schools.
- Ease of support: Open Source software is supported by a world wide network of enthusiasts who may often provide faster and better support than commercial software providers, and do so, usually, without charge.

- Conventional set-up: The alternative to the thin client approach is the conventional one where the laboratory consists of regular computers and a central server (not necessarily). In this set-up, all of the clients work independently. In this case, all computers should be configured individually and the required software should be installed on clients. By this means, students study locally. There may still be a central server that serves files, print, identity management and Internet connection sharing services.

  All computer processing occurs on the individual computer, powered by the computer's central processing unit (CPU) and using software stored on the computer's hard drive. In a LAN, these individual machines are linked together into a network that connects them to the Internet and to central servers where files can be centrally stored, typically at the discretion of the individual user. The most important part of the system is the individual computer. We can compare this alternative to the thin client approach in the following manner:

  - User satisfaction: The thin client approach, in some cases, may fall short of satisfying the user as it limits the hands on experience and the lack of hardware may cause bottlenecks. Also, the level of control is not primitive enough for students. This may show itself as a problem for more advanced students wanting to have more control of their installations.
  - Limited types of services: The bottom line is, thin clients are batch environments. The restrictions employed limits the services, both quantitatively and qualitatively.
  - Cost: In some cases, the thin-client approach may prove more costly, especially in establishing the lab. If there is a lack of experience in setting up the LTSP, the time and effort needed for the laboratory establishment and administration may prove costly.

- Mixed Set-up: In this configuration, a set-up which is a mixture of the thin client approach and the conventional set-up is established. This approach tries to benefit from the two approaches listed above, specifically in situations where computing power is essential for the laboratory students. This infrastructure type is ideal for F/OSS laboratories servicing major or non-major CSE curricula. In this set-up, the network is set up as both a thin-client network and a local area network. In this case, all computers in the laboratory boot from the the central server, as in the thin-client approach, however, during operation, users' home directories are mounted to the central server over the thin-client network. All applications run from the local computer. The advantages and disadvantages of this approach can be identified as:
  - Computational power: Running applications from the local computer yields higher performance when compared to the thin-client approach. This is a significant advantage where computational power is crucial. This also increases user satisfaction.
  - Cost: This approach might lead to higher set-up costs than the thin-client approach, although the maintenance costs will still be relatively low. Please refer to the cost tables in each curriculum type.

In this report all three of the above set-ups have been considered. However, the mixed-approach is not considered for the K12 curriculum type; the advantages this approach brings are not beneficial for K12 F/OSS laboratories.

3. A F/OSS Lab for K12

The tOSSad project includes activities for developing a F/OSS curriculum for K12 educational institutions.

3.1 Hardware Specification

The laboratory should first be equipped with the necessary hardware to function. In this section, the hardware specifications of a F/OSS laboratory for 20 students is given.

Both the conventional and the thin-client approaches for infrastructure have been considered here. Table 3.1 gives the hardware specification and an estimated cost for the implementation.

Table 3.1 Hardware Specification and Estimated Cost for Thin Client Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	2	400
Main board	Dual Xeon Board	1	208
Display Card	16Mb AGP	1	12
Network Card	Gigabit Ethernet	2	256
RAM	2 GB DDR 400	1	210
SCSI Controller	Ultra320	1	32
Storage	146 Gb U320	1	375
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case	1	25
Terminals			
CPU	AMD Sempron 2200+	20	700
Main board	AMD 64-Bit Main board	20	900
RAM	256 Mb DDR400	20	250
Display Card	16 Mb Graphics Card	20	240
Audio	Audio Card	20	300
Display	15” Monitor	20	1400
Networking	Gigabit Network Card	20	1800
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100

Item Type	Item	Quantity	Cost in Euro
Networking			
Switch	24 Port Gigabit Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
TOTAL COST			**7.868**

Table 3.2 gives the hardware specification and estimated costs for the conventional approach.

Table 3.2 Hardware Specification and Estimated Cost for Conventional Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	1	200
Main board	Xeon Board	1	150
Display Card	16Mb AGP	1	12
Network Card	10/100 Ethernet	2	256
RAM	2 GB DDR 400	1	210
SCSI Controller	Ultra320	1	32
Storage	72Gb U320	1	150
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case	1	25
Terminals			
CPU	AMD Sempron 3000+	20	1600
Main board	AMD 64-Bit Main board	20	900
RAM	512 Mb DDR400	20	500
Display Card	16 Mb Graphics Card	20	300
Storage	80 GB SATA	20	1200
Audio	Audio Card	20	200
Networking	10/100Network Card	20	800
Display	15” Monitor	20	1400
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100
Networking			

Item Type	Item	Quantity	Cost in Euro
Switch	24 Port 10/100 Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
TOTAL COST			**8.725**

3.2 Software Specification

The software for use in the F/OSS lab for universities with CSE departments have been selected with respect to the TOSSAD K12 F/OSS curriculum. All of the software items are F/OSS products, therefore no cost indications are necessary for them. Table 3.3 gives a list of selected software. It should be noted that In the thin-client approach, only 1 copy of each software product will be needed, whereas in the conventional approach, 20+1 copies would exist.

Table 3.3 Software List

Name of the software	Web Site	Description	Application
OpenOffice.org	http://www.openoffice.org	The Open Source office software for scientific text processing, database applications, graphics creation.	Lab reports Calculation of results Creation of simple charts
LyX	http://www.lyx.org	A scientific text processor software, making use of LaTeX properties. Full support of mathematical expressions and all Postscript output from scientific programs.	Lab reports with the equations, and output of all X11 science software
Xfig	http://xfig.org	Vector drawing program with a large and extendable parts library.	Preparation of schematic drawings (experimentand setups) for lab reports
Grace	http://plasmagate. weizmann.ac.il/Grace/	Data analysis program	Plots diagrams of every complexity. Good software for creating regression and line fit

Name of the software	Web Site	Description	Application
GIMP	http://www.gimp.org	Graphics program to analyze images	Image analysis (length, angle)
ImageJ	http://rsb.info.nih.gov/ij/	Image analysis program	Analysis of intensity distribution in an image
Xdrawchem	http://xdrawchem.sourceforge.net/	Program to draw chemical structures	Report on chemistry lab exercises
OpenRasmol	http://www.openrasmol.org	Program to visualise 3d molecules	Chemistry classroom use and creating images for reports
Feynman	http://www.physics.odu.edu/~musatov/	A program to create Feynman graphs	Particle physics teaching
Ghemical	http://www.uku.fi/~thassine/ghemical/	A molecular modeling software package	Chemistry teaching in high schools
Gcompris	http://gcompris.net/	A software package for the kids	For elementary schools. Many different applications around elementary schools teaching
KDE Edu	http://edu.kde.org/	The KDE Education project	Many educational software packages mainly focusing on lower level education
Bloodshed Dev C++	http://www.bloodshed.net/devcpp.html	Programming environment for beginners	Software for learning programming languages
Eclipse	http://www.eclipse.org	Multi-language integrated programming environment	Software for advanced programming languages and software engineering study
MySQL	http://www.mysql.org	Relational Database Management System	Software for database and systems studies

4. A F/OSS Lab for Universities with CSE Department

The tOSSad project includes activities for developing a F/OSS curriculum for universities with CSE departments.

4.1 Hardware Specification

The laboratory should first be equipped with all of the necessary hardware to function. In this section, the hardware specifications of a F/OSS laboratory for 20 students has been given.

The conventional and the thin-client approaches are considered here. Table 4.1 gives the hardware specification and cost for the implementation.

Table 4.1 Hardware Specification and Cost for Thin Client Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 3.2 Ghz	2	400
Main board	Dual Xeon Board	1	208
Display Card	16Mb AGP	1	12
Network Card	Gigabit Ethernet	2	256
RAM	2 GB DDR 400	1	210
SCSI Controller	Ultra320	1	32
Storage	146 Gb U320	1	375
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 2200+	20	700
Main board	AMD 64-Bit Main board	20	900
RAM	256 Mb DDR400	20	250
Display Card	16 Mb Graphics Card	20	240
Audio	Audio Card		300
Display	15” Monitor	20	1400
Networking	Gigabit Network Card	20	1800
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100

Item Type	Item	Quantity	Cost in Euro
Networking			
Switch	24 Port Gigabit Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**8.218**

Table 4.2 gives the hardware specification and costs for the conventional approach.

Table 4.2 Hardware Specification and Cost for Conventional Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	1	200
Main board	Dual Xeon Board	1	150
Display Card	16Mb AGP	1	12
Network Card	10/100 Ethernet	2	256
RAM	2 GB DDR 400	2	210
SCSI Controller	Ultra320	1	32
Storage	72Gb U320	1	150
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 3000+	20	1600
Main board	AMD 64-Bit Main board	20	900
RAM	512 Mb DDR400	20	500
Display Card	16 Mb Graphics Card	20	300
Storage	80 GB SATA	20	1200
Audio	Audio Card	20	200
Networking	10/100Network Card	20	800
Display	15” Monitor	20	1400
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100

Item Type	Item	Quantity	Cost in Euro
Networking			
Switch	24 Port 10/100 Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**9.075**

Table 4.3 gives the hardware specification and costs for the mixed approach.

Table 4.3 Hardware Specification and Cost for Conventional Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	2	400
Main board	Dual Xeon Board	1	150
Display Card	16Mb AGP	1	12
Network Card	10/100 Ethernet	2	256
RAM	4 GB DDR 400	2	420
SCSI Controller	Ultra320	1	32
Storage	72Gb U320	1	150
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 3000+	20	1600
Main board	AMD 64-Bit Main board	20	900
RAM	512 Mb DDR400	20	500
Display Card	16 Mb Graphics Card	20	300
Storage	80 GB SATA	20	1200
Audio	Audio Card	20	200
Networking	10/100Network Card	20	800
Display	15” Monitor	20	1400
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100

Item Type	Item	Quantity	Cost in Euro
Networking			
Switch	24 Port 10/100 Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**9.485**

4.2 Software Specification

The software for use in the F/OSS lab have been selected with respect to the tOSSad F/OSS curriculum for universities with CSE/CS departments. All of the software items are F/OSS products themselves, therefore no cost indications are necessary for them. Table 4.4 gives a list of selected software. It should be noted that the number of copies of software needed for each laboratory set-up varies according to the the software and the network set-up.

Moreover, in most distributions, mentioned software packages come precompiled and ready to install. It's highly recommended to check whether these packages exist before downloading.

Table 4.4 Software List

Type of software	Software product	Download link
Office packages	OpenOffice.org	http://openoffice.org
	KOffice	http://www.koffice.org/
Graphics	GIMP	http://www.gimp.org/
Programming environments	Dev C++	http://sourceforge.net/projects/dev-cpp
	KDevelop	http://www.kdevelop.org/
	gcc	http://gcc.gnu.org/
	PERL	http://www.perl.com/download.csp
	Python	http://www.python.org/download/download_linux.html
	FreePascal	http://www.freepascal.org/download.html
	Java	http://java.sun.com
	PHP	http://ww.php.net
Databases	mySQL	http://www.mysql.com/
	PostgreSQL	http://www.postgresql.org

Type of software	Software product	Download link
Web-design	NVU	http://www.nvu.com/
Internet	FireFox	http://www.mozilla.org/
	Opera	http://www.opera.com/
	Mozilla	http://www.mozilla.org/
Tools for computer simulation	OpenCascade	http://www.opencascade.org/
CAD	PowerCAD	http://powercad.sourceforge.net/
Systems of distance learning	StudIP	Http://www.studip.de
	eXe	http://eduforge.org/projects/exe
	UNI Open Platform	http://uni-open-platform.fernuni-hagen.de
	CommSy	http://www.commsy.de
	Moodle	http://www.moodle.org

5. A F/OSS Lab for Universities with Non-major CSE Studies

The tOSSad project includes activities for developing a F/OSS curriculum for universities with non-major CSE studies.

5.1 Hardware Specification

The laboratory should first be equipped with all of the necessary hardware to function. In this section, the hardware specifications of a F/OSS laboratory for 20 students has been given.

Both the conventional and the thin-client approaches for infrastructure have been considered here. Table 5.1 gives the hardware specification and cost for the implementation.

Table 5.1 Hardware Specification and Cost for Thin Client Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 3.2 Ghz	2	400
Main board	Dual Xeon Board	1	208
Display Card	16Mb AGP	1	12
Network Card	Gigabit Ethernet	2	256
RAM	2 GB DDR 400	1	210
SCSI Controller	Ultra320	1	32
Storage	146 Gb U320	1	375
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 2200+	20	700
Main board	AMD 64-Bit Main board	20	900
RAM	256 Mb DDR400	20	250
Display Card	16 Mb Graphics Card	20	240
Audio	Audio Card		300
Display	15” Monitor	20	1400
Networking	Gigabit Network Card	20	1800
Input	Keyboard & Mouse	20	100

Item Type	Item	Quantity	Cost in Euro
UPS		1	200
Speakers	Stereo Speakers	20	100
Networking			
Switch	24 Port Gigabit Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**8.218**

Table 5.2 gives the hardware specification and costs for the conventional approach.

Table 5.2 Hardware Specification and Cost for Conventional Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	1	200
Main board	Dual Xeon Board	1	150
Display Card	16Mb AGP	1	12
Network Card	10/100 Ethernet	2	256
RAM	2 GB DDR 400	2	210
SCSI Controller	Ultra320	1	32
Storage	72Gb U320	1	150
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 3000+	20	1600
Main board	AMD 64-Bit Main board	20	900
RAM	512 Mb DDR400	20	500
Display Card	16 Mb Graphics Card	20	300
Storage	80 GB SATA	20	1200
Audio	Audio Card	20	200
Networking	10/100Network Card	20	800

Item Type	Item	Quantity	Cost in Euro
Display	15” Monitor	20	1400
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100
Networking			
Switch	24 Port 10/100 Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**9.075**

Table 5.3 gives the hardware specification and costs for the mixed approach.

Table 5.3 Hardware Specification and Cost for Conventional Approach

Item Type	Item	Quantity	Cost in Euro
Central Server			
CPU	Xeon 2.8 Ghz	2	400
Main board	Dual Xeon Board	1	150
Display Card	16Mb AGP	1	12
Network Card	10/100 Ethernet	2	256
RAM	4 GB DDR 400	2	420
SCSI Controller	Ultra320	1	32
Storage	72Gb U320	1	150
DVD-ROM	16X DVD ROM	1	15
Display	15” Monitor	1	70
UPS		1	90
Backup	Backup Tape Driver	1	140
Input	Keyboard & Mouse	1	5
Case	Server Case		25
Terminals			
CPU	AMD Sempron 3000+	20	1600
Main board	AMD 64-Bit Main board	20	900
RAM	512 Mb DDR400	20	500
Display Card	16 Mb Graphics Card	20	300
Storage	80 GB SATA	20	1200
Audio	Audio Card	20	200
Networking	10/100Network Card	20	800
Display	15” Monitor	20	1400

Item Type	Item	Quantity	Cost in Euro
Input	Keyboard & Mouse	20	100
UPS		1	200
Speakers	Stereo Speakers	20	100
Networking			
Switch	24 Port 10/100 Switch	1	100
Cabling	CAT5 UTP		
Accessories			
Printer	B&W Laser Printer	1	40
Data Projector	1024x768 LCD Projector	1	350
TOTAL COST			**9.485**

5.2 Software Specification

The software for use in the F/OSS CSE lab have been selected with respect to the tOSSad F/OSS curriculum for universities with major CSE studies. All of the software items are F/OSS products themselves, therefore no cost indications are necessary for them. Table 5.4 gives a list of selected software.

Table 5.4 Software List

Genre	Product Name
Operating System	Debian Linux
Desktop	GNOME
Office Productivity	OpenOffice.org
Web Browser	Mozilla Firefox
E-Mail Client	Mozilla Thunderbird
Multimedia Player	MPlayer
Instant Messaging Client	Gabber
Development Environment	Eclipse
Graphics Editing	Gimp
Connectivity	LTSP (only for the thin client approach)
DBSM	MySQL
Web Server	Apache

The choice of Debian Linux is significant. The Debian Linux distribution incorporates a project called the SkoleLinux (formerly known as DebianEdu), which aims at improving Debian for educational purposes.

Skolelinux offers several ready-to-run services in its default installation:

- Centralized user catalogue. Use of the same username and password for all services and on all machines in the network.
- Centralized storage. Regardless of which machine in the network you use, you have access to your own files. You receive your own desktop with your own configuration.
- Thin client solution. The applications are run on a thin client server, which is a reasonably fast server. The image is drawn on the thin client. This enables you to reuse old computers and run new software on them. Additionally, the use of thin clients eases administration, as the thin client server is the only machine needing software updates and maintenance.
- Backups are done on a daily basis.
- Printers can be shared and made available on the network.
- A proxy server caches files downloaded from the Internet, for a faster internet surfing experience.

More information on the SkoleLinux project along with the software packages can be found at http://www.skolelinux.org.

6. Tutorial

In this section, a tutorial for the implementation of the F/OSS laboratory is given. The tutorial includes common elements for the three different laboratories given in the previous sections. Unless specified, the information is valid for all of the three laboratories.

Constructional Design and Seatings

The layout of the laboratory is often constricted by the physical size or shape of the room. The placement of the equipment and furniture is often predetermined by the placement of the physical network or power supply. The size or shape of the room itself often determines the labs configuration. Most labs exist in older buildings where traditional classrooms were modified to support a collection of computers. These are situations where space and money require the lab designer to be creative in making the space a computer "classroom" addressing the needs of the learner. In new schools the lab designer can embrace the new "classroom" approach to technology.

Even if a lab has all the latest equipment and software, the arrangement of furniture in the room has a big impact on the instructional potential of the lab. The first thing to consider is to not overcrowd the lab. Another important factor is the floor area, as no style of seating can cope with a limited floor area. The table 6.1 gives the floor area and maximum number of pupils for different laboratories.

Table 6.1 – Capacity and Floor Area for F/OSS Laboratories

	K-12 F/OSS Lab	**CSE F/OSS Lab**	**Non-Major CSE F/OSS Lab**
Maximum number of pupils	30	20	20
Minimum Floor Area	110 m^2	90 m^2	90 m^2

Technology classrooms often ignore many of the basic premises of good teaching practice. Effective classrooms are arranged so that students have unrestricted visual and auditory access to the teacher and the various media which the teacher uses to present their respective curriculum. Traditional computer labs often restrict the view of both the teacher and their chosen mode of presentation by arranging the furniture and actual computers in the line of sight of the learner. The modern design of benching for the laboratories are **U-shaped**. This gives a better vision of the instructor (if present), the board and the data projector. Also, the desktop should be kept as clear as possible by recessing the terminals. Lighting is another important issue. The choice should be fluorescent based sources. The lights should be adjustable and should provide good viewing of the data projector while still lighting the rest of the room.

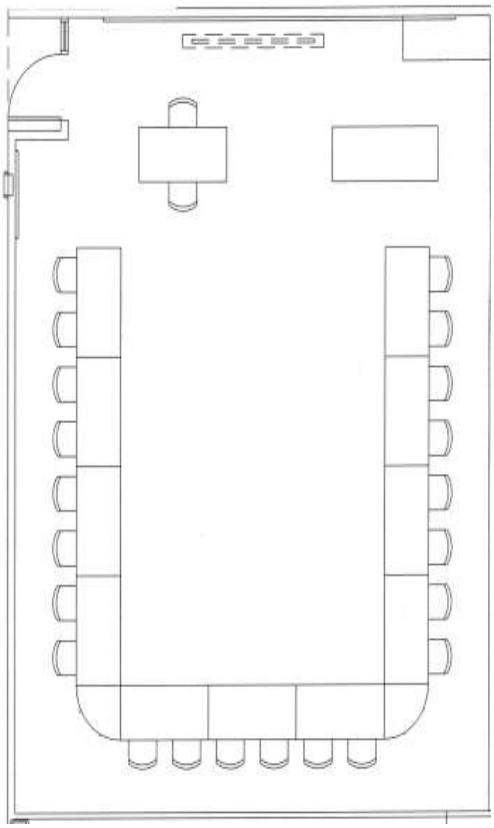

Figure 6.1 – A U-Shaped Laboratory

Ergonomic Considerations

Ergonomics is synonymous with human factors. It means the science of fitting the workplace to the worker rather than vice versa. It is the study of people in their working environment, especially of their physical interaction with their equipment. The finest technology equipment in the world will be of little benefit if it is not coordinated with a facility's environmental characteristics, interior design and furniture.

We know that students take naturally to computers, but what we do not know is, while stimulating students' minds, what computer stations are doing to their bodies. A considerable amount of interest has been shown by faculty, staff and students in having workstations evaluated to prevent the development of repetitive strain injury (RSI) disorders such as carpal tunnel syndrome. RSI occurs when excessive use of muscles, tendons and joints results in discomfort and increased pressure on nerves. RSI can be prevented by controlling some of the components that contribute to these problems.

Workstations should be adjustable, with independent height adjustments for keyboards and monitors. Independent adjustable keyboard surfaces at the workstation generally range in height from 58 to 71 cm above the floor, and the monitor platform height from 68 to 81 cm above the floor. Height adjustments should be convenient and easy to make. In general, space for the user's legs and feet under the work surface should be at least 68 cm deep and 68 cm wide.

Detachable keyboards are a fundamental requirement for an ergonomically acceptable workstation. When a person is sitting at the keyboard, he or she should be able to look straight ahead and see the center of the monitor. The keyboard should be directly in front of the operator to prevent a user from twisting his or her wrists to the left or right. The wrists should be as straight as possible when the fingers are resting at the home position on the keyboard. As little as a 3cm difference can cause significant physical problems for the user.

Furniture should be able to accommodate the 5th-percentile female through to the 95th-percentile male dimensions. These percentiles represent all but the smallest 5 percent of females and the largest 95 percent of males. The scale of the furniture must be consistent with the age group. Furniture with flexibility is necessary for freedom of choice, choice to arrange or rearrange, as well as to expand or reduce. To accomplish this, furniture should be adjustable, or there should be a selection of furnishings to choose from.

Generally, seat height should range from 40 to 50 cm above the floor, so that you can place your feet firmly on the floor or a support surface. Additionally, the seat should be at least 45 cm wide, 40 cm deep, and the front edge of the seat should be rounded downward. When adjusting chair height or the height for the keyboard, arms should hang comfortably at the side with the forearms at a 90-degree angle from the body.

Power and Cooling Considerations

The main equipment room should be cooled all year around to 24-25 degrees. The smallest of systems will require approximately 5,000 BTU with larger systems requiring up to 40,000 BTU cooling capacity. Provide 4 amps per workstation and 1 amp per network device. The servers should have two 20-amp circuits for the first two racks and one 20-amp circuit for every two racks thereafter. All electrical system must be connected to an UPS. UPS serves the benefits of the laboratory in two ways; first it keeps the hardware secure from hazards that may occur because of fluctuations in the electrical voltage; second it gives sufficient time to shut down servers and the workstations properly before a complete electrical black-out. The specifications for the UPS depends on many factors including the number and the power consumption of the hardware to be served.

Networking, Cabling and Internet Access

There seems to be a misunderstanding in schools as to the importance of a well-designed network and an installation that follows the design. Most of the cabling installations are done based on an assumption that data access is the same as telephone access - run a wire, put in a jack and plug in a computer. This can result in an installation that may have to be rewired in three to five years.

Designing and installing a cabling infrastructure that is future-proof is difficult. A cabling infrastructure is expected to support telecommunications connectivity for approximately 15 years. With this in mind, it does not pay to cut corners or use old design practices and technology. Since the cabling backbone is the main

artery of information flow it is important to plan the design thoroughly and invest in long-term solutions. The building wiring infrastructure that is selected may be the most critical decision made; it is hard to reach design overkill for infrastructure.

The types of cable most often used in installations are Category 5, fiber optic or a combination of both. Currently, the most common choice of cable for LANs is Category 5 unshielded twisted pair (UTP). Historically, the primary reason for using this cable has been cost. Since copper cables are limited to 100-meter runs, multiple wiring closets are needed for many installations. Also, the wires should run through protective channellings, either attached to the wall, or stuck to the floor.

Figure 6.2 – A Sample Cable Channel

An important concept to remember is that while equipment is contemporary, the infrastructure should last a long time; investing in good network and power cabling always pays back.

The distance between the network switch and both the workstations and the server should be equal. It is important to protect the network switch; it should be located in a cabinet or some such place.

Server Setup

The physical setup of the server has the following considerations:

- The server should be placed such that only the administrator, instructor or facilitator of the laboratory has access to it. A typical solution is locating the server in a locked cupboard or room.
- The server should be placed such that the administrator, instructor or facilitator has convenient and easy access in order to track problems with the network as quickly as possible.

The software setup of the server will vary according to your selection of networking approach. If you have selected to implement a thin-client approach, the configuration should be for the LTSP, otherwise you must install and setup a linux network with the recommended Debian distribution.

If you choose to implement the thin client approach, please use Appendix A –

Setting Up an LTSP network. If you choose to implement the stand-alone approach, please use Appendix B – Debian Server Configuration for a Linux Network.

Clients Setup

The client setup also varies with your selection of infrastructure. If you have selected to implement the thin-client approach, please use Appendix A for instructions on how to setup the clients. If you have selected to implement the stand-alone approach, please use Appendix B with instructions on how to set-up a debian Linux based network.

Accessories Setup

We have previously listed a printer for purchasing. This printer should be connected to the server. In both thin-clients and stand-alone approaches, it is possible to use the server as a print server. The instructions to set up a print server are located in the respective appendices.

We have also indicated a data projector. This projector should be connected to the server. Most modern data projectors require no configuration to be made, as they simple plug-in to the monitor connection of the video cards. There are also VGA hubs available enabling the use of the data projector and the monitor at the same time. These devices also require no specific configuration.

Choice of Laboratory Models

In the previous chapters, brief definitions and descriptions of the most widely used laboratory models have been given. In conjunction with the F/OSS curriculum being developed within the tOSSad project, a “closed”, “structured”, and a “scheduled” model is recommended. It is also helpful for students to have unstructured, unscheduled and open models available, as a side option.

Laboratory Activities

Laboratory activities differ by the F/OSS curriculum being applied. The table 6.2 gives a brief set of laboratory activities for each curriculum type.

	K-12	Major CSE	Non-Major CSE
Activities	OS Principles Productivity Multimedia	OS Principles Development Administration Networking Security Engineering Tools	OS Principles Administration Networking Security Productivity

Appendix A. Setting Up an LTSP Network

You can use the following URLs to reach the latest LTSP package and documentation:

http://www.ltsp.org/download/

http://www.ltsp.org/documentation/index.php

In this section we present the installation steps for LTSP. Please refer to the above links for detailed installation documentation. Please note that this tutorial is for the 4.1 version of the LTSP (latest in time of writing).

Steps for LTSP server installation:

1. Download the latest release of the ltsp-utils RPM package from http://www.ltps.org/download.
2. Install the downloaded package using the rpm command.
3. Run the ltspadmin command to manage the LTSP client packages.
4. Choose Install/Update from the menu.
5. The ltspadmin will display a configuration screen, configure “source for downloading packages”, “LTSP client tree root directory”, and your http and ftp proxies if needed.
6. The next screen will display the available package repository.
7. Choose the packages you want to install. You can select all packages by pressing A.
8. After your selection is completed, the ltspadmin will download and install the selected packages.
9. We need to configure the four basic services, DHCP, TFTP, NFS, and XDMCP to run LTSP. Run ltspcfg from the command line.
10. The configuration screen has several options, here is a summary of what they serve:
    - Runlevel: Traditionally, runlevel 5 is used for LTSP systems. So NFS and XDMCP should be configured to serve in runlevel 5.
    - Interface Selection: If you have more than one network interface, you need to specify which one of them is connected to the clients.
    - DHCP Configuration: You'll be able to create the dhcpd.conf configuration file, and enable dhcpd to run at startup time
    - TFTP Configuration: TFTP is used by the thin client to download the Linux kernel. The tftpd service needs to be enabled on the server, to serve up the kernel.
    - Pormapper Configuration: The Portmapper is used by RPC services. Each RPC service, such as NFS.
    - NFS Configuration: This menu item will take care of configuring NFS to start at boot time. The configuration file is /etc/exports and its creating is described later in this section.

- XDMCP Configuration: XDMCP is the "X Display Manager Control Protocol". The X server sends an XDMCP query to the Display manager on the server, to get a login prompt.
- Create /etc/hosts entries: To be simple, configure the mapping of IP addresses and host names in the `/etc/hosts` file.
- Create /etc/hosts.allow entries: Some services use a layer of security known as tcpwrappers . This is configured through the /etc/hosts.allow file.
- Create the /etc/exports file: The configuration of each workstation is directed by entries in the lts.conf file. For fairly modern workstations with a PCI bus, it shouldn't require any additional entries in the lts.conf file. But, the file still needs to exist.

11. The next step is to configure the LTSP server for workstation specific information. There are three files you need to modify: /etc/dhcpd.conf, /etc/hosts, /opt/ltsp/i386/etc/lts.conf. Please refer to the LTSP documentation for details on configuring these files.
12. Check the current configuration settings from ltspconfig by pressing S from the main menu.

Steps for LTSP workstation installation:

1. There are two popular options for booting the workstation. Etherboot, and PXE
   - If your network card has PXE built in it, you can use it to load the kernel into the memory
   - Etherboot is a software package for creating ROM images that can download code over an Ethernet network to be executed on an x86 computer. Many network adapters have a socket where a ROM chip can be installed. Etherboot is code that can be put in such a ROM.
2. After booting, your workstation will be ready to use.

Appendix B. Debian Server Configuration for a Linux Network

You can use the following URLs to reach the latest Debian installation documentation:

http://www.aboutdebian.com/install31.htm

http://www.debian.org/releases/stable/installmanual

Here we present a simple step-by-step tutorial on installing Debian. Please the refer to the above link for a detailed documentation.

1. Download the latest stable Debian release from http://www.aboutdebian.com/install31.htm. There are several options there, downloading using HTTP/FTP, BitTorrent Network or purchasing the installation CDs. Choose the one that suits you most.
2. Insert Debian CD 1, and boot your system.
3. Select your regional settings like, language, region and keyboard layout.
4. Configure your TCP/IP settings.
5. Partition your hard drive. This might be a complicated process when done manually. Please refer to the Debian documentation for details on this configuration item.
6. The installer will format your partitions and your computer will reboot.
7. After rebooting, select your timezone.
8. Create your root account and select a password.
9. Create one non-root account and select a password.
10. At this step, the installer will scan the CD for available packages to install. Choose desired packages and proceed. For more information on availbale packages, refer to the Debian installation manuals.
11. The installer will install and configure selected packages.
12. After installing, your system will reboot, and your Debian installation will be working.

Appendix C. Resources

There exists endless possibilities in creating an F/OSS laboratory and selecting software for it. In this document, a clear-cut how-to like approach is given, whereas in this appendix, the resources listed are to enhance the laboratory .

Project/Product Name	URL	Description
Debian-edu distribution (Formerly SkoleLinux)	http://www.skolelinux.org	Distribution for educational purposes
debian jr.	http://www.us.debian.org/devel/debian-jr/	A distribution created for childs
edubuntu	http://www.edubuntu.org/	A distribution for education
richtech	http://richtech.ca/seul/	Educational applications index
linuxforkids	http://www.linuxforkids.org/	Children related Linux applications
k12os	http://k12os.org/	News, links and articles in open source in education
KDE educational	http://edu.kde.org/	Educational software for K desktop environment
Sourceforge	Http://www.sourceforge.net	The biggest collection of open source projects.
Open Source Education Foundation	http://www.osef.org/	Software for K12 F/OSS laboratories.
Schoolforge	http://opensourceschools.org/	Education F/OSS software
KDE Edutainment Project	http://edu.kde.org/	The KDE Edutainment Project is a project designed to create free educational software based around KDE, the K Desktop Environment.

References

tOSSad Description of Work, 2005.

Knox, D. Wolz, U.; Joyce, D.; Koffman; E., Krone; Laribi, J.; Meyers, A.; Paul, J; Proulx, V. K.; Reek, K. A. "Use of Laboratories in Computer Science education guidelines for good practice." *Report of the Working* Group on Computing Laboratories. SIGCSE Bulletin. 28, Special Issue (1996): 167-181.

“Avoiding potholes on the way to the future. Educational Technology Planning Concerns”, American School & University (1998), v70 n6 pT4(4).

Fekete, A. and Greening, A.: Designing Closed Laboratories for a Computer Science Course, *Proceedings of the 27th SIGCSE Technical Symposium on Computer Science Education* (SIGCSE 96), Philadelphia, (February 96): 295-299.

Roberge, J. and Candice, S.: Embedding Laboratories within the Computer Science Curriculum, *SIGCSE Bulletin*, 23(1), (1991): 6-10.

Parker, B.C. and McGregor, J.D.: A Goal-Oriented Approach to Laboratory Development and Implementation, *Proceedings of the 26th SIGCSE Technical Symposium on Computer Science Education* (SIGCSE 95), Nashville, (March 95): 92-96.

Kumar, A. (2003). "Effect of Closed Labs in Computer Science I: An Assessment," in Proceedings of the Eight Annual Consortium for Computing Sciences in Colleges Northeast Conference, *The Journal of Computing Sciences in Colleges* 18(5), May 2003, pp 40-48.

Linux Terminal Server Project Documentation, http://www.ltsp.org/documentation/index.php.

Installing Debian, http://www.aboutdebian.com/install31.htm.