

Bridging the Digital Divide - A Blueprint for deploying Linux in Tamilnadu Schools

V. Venkataramanan

Photonics Research Ontario

60 St. George Street, Suite 331, Toronto, M5S 1A7. Canada.

Introduction

The necessity of providing computing infrastructure to schools can never be overstated. It is often the cost that is a single most influencing factor in providing computers to schools in a developing economy like India (Tamilnadu). When it comes to economy, Linux is the undisputable choice for the schools. However, this is not the only deciding factor. Here we present a blueprint for deploying Linux Servers/Clients in Tamilnadu schools.

Primary Considerations

The following are the basic consideration in designing this blueprint:

Versatility: The chosen platform (hardware/software combination) should be able to handle all the tasks in education; from simple word processing to complex programming.

Economic: This is an important consideration in developing countries. A large initial budget will never get the project started.

Scalability: There should be an option to easily scale up the services in future. It is then imperative that a larger cost should be spent on non-recurrent investment and in hardware that do not obsolete soon.

Robustness: The systems should be crash proof leaving more time for constructive tasks, there should be minimal administrative tasks for the teachers. Time spent on viruses and worms is not worth anything.

Flexibility: Should be able to handle cross-operating system tasks. Should be possible to develop unique tools for the situation, rather than adapting to what is available.

Longevity: Documents and programs created through school projects should survive a fair amount of time, without version conflicts.

Open Learning Tools: These are indispensable in the learning process. It is better to teach the students to create tools for themselves rather than giving them black boxes with hoods shut.

Localized tools: Availability/possibility of local language interface is an important consideration in education through native language.

These design considerations obviously prompt us to choose Linux as the operating system of choice.

Why Linux?

Linux is the fastest growing operating system for the past few years and this growth is estimated to sustain. Linux scales efficiently from a stand-alone desktop to supercomputers. Among the modern operating systems, Linux has the minimum hardware requirement. It has

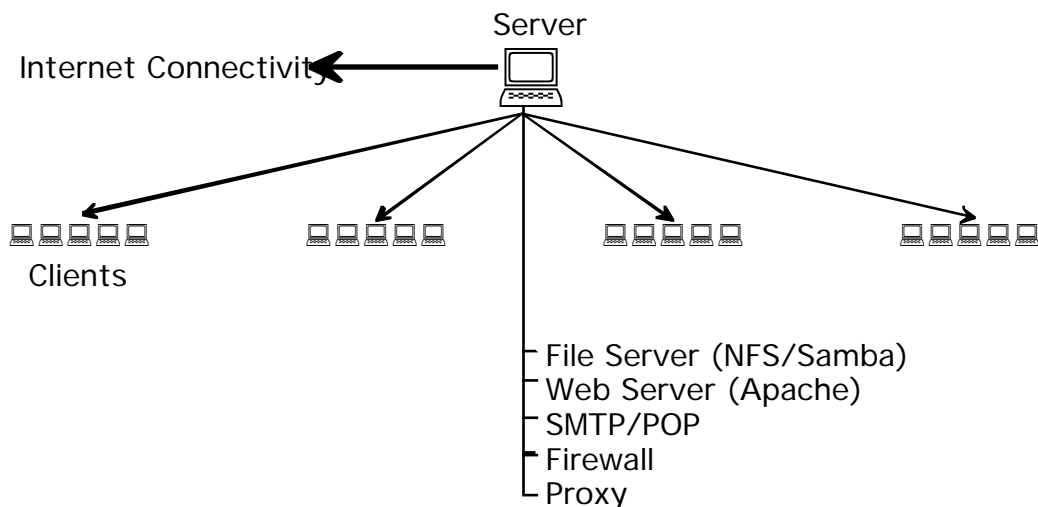
very strong network capabilities and security. So, by choosing Linux for schools we invest in superior technology and growing job potentials. More than half of the internet is run on Linux based servers and the majority of emails are routed across the globe by open source programs such as Sendmail. These programs have proven both flexible and robust. As a desktop operating system Linux is fast becoming easy to use with both GNOME and KDE environments. A variety of office suites are now available for Linux, such as StarOffice and KOffice. These are superior in technology and flexible in interoperability.

Linux is an ideal learning platform on programming. Compilers and tools for several programming languages come pre-packaged with it. These include C, C++, Fortran, Perl, Python, Tcl. There are choices for databases like MySQL and PostgreSQL. The Linux kernel and most of the programs that run on it are open source and provide excellent opportunities for the student to learn what is under the hood. All kinds of uses, modifications and redistributions of the sources are legal with Linux.

Complete GUI desktops (KDE and GNOME) are available localized in Tamil. This should be the single great motivating factor in native language learning and should motivate students to develop software for local applications.

Hardware

The proposed architecture of the school network is shown in Fig. 1.



Each school should be running a server; something like a Pentium III at 1 GHz or better, with 126 MB RAM and 20 GB hard disk and anywhere between 10 to 25 clients (diskless workstations). While this is estimated as an optimum configuration, it is also possible to drive about 20 diskless clients with a Pentium MMX at 333 MHz. The server will host the primary file server (NFS), a firewall, internet connectivity and may be a Samba server (for Microsoft Windows connectivity, if the school already has few computers running on Microsoft's operating systems.). The diskless clients can be anything up a 486 MHz processor with mean memory and a standard monitor. One of the important aspects of this configuration is that it never becomes obsolete. When the requirements increase, it is only necessary to spend improving the server. The same clients will get benefited with server upgrades.

Multimedia is an essential tool for learning. As such it is recommended that the server is equipped with a larger size monitor (at least 17 inch and at best 21 inch), sound card and speakers. This will facilitate multimedia based demonstration tools easily available from the internet on anything from oceanography to astronomy.

Irrespective of the outside connectivity speed (internet) the students can still experience a fast intranet with a secondary NIC card in the server connected to say, a 100base hub. There are several tailor-made configurations for schools available such as those from the Linux Terminal Server Project (LTSP). Excellent installation and configuration documentation are available through these several Linux school projects.

Software

Choice of Linux as the platform provides unique opportunity to teach both command and GUI based operations at the same time. The curriculum should principally begin with an old-fashioned UNIX style-learning scheme, but within about 5 classes should branch out to simultaneous GUI and Command operations. This approach is expected to have several advantages. For example, the student will learn the power and flexibility of command-based operation, while appreciating the indispensability of GUI in multimedia applications. Also this will stretch the imagination of the students to appreciate what goes beneath the icons as they operate, an indispensable learning necessity.

An intimidating task is to choose the appropriate software from the plethora of available choices. Distributions like RedHat, Mandrake and Debian are the obvious choices in terms of ease of installation and use and the availability of wide support base. These companies also have special assistance programs for schools. In addition to C++, modern programming languages like Python, Ruby and QT should be taught. Languages that are obsolete, such as BASIC, COBOL and PASCAL should be given up in favour of modern computing languages. A typical software configuration should include GNOME based Nautilus, Evolution, and GIMP and/or KDE with most of the packages, StarOffice or Abiword/Gnumeric, WINE, etc. All development packages should be included for the students to experiment.

Tamil localization packages for KDE and GNOME should be used in the classroom. As of now, it is possible to do file management, user management, task scheduling, internet browsing, emailing, etc. with Tamil GUI¹. An average school student under the teacher supervision can handle several localization tasks such as GUI translation, documentation, etc. Curriculum can be developed to include such open experiments as a part of course evaluation. This unique opportunity can speed up the learning, as the students will feel proud to be the developers.

Administration

Each student should be provided with a unique login and a minimal disk quota to save his classroom work. This, incidentally, will give them unique internet email address. The students should be denied access to mount floppies in the clients. At the end of the classroom session, the teacher should mount floppies for the students and provide them access to have backup storage in their floppies.

An essential part of network system administration is to prevent malicious use of the computers. While this may seem an intimidating task, there are several easy tools to configure the firewalls and user rules. It is also possible to easily detect and deny web sites with inappropriate content with these filters. In terms of security open sources are proven to be more reliable than the closed source programs. Virus and worm attacks on Linux operating system are insignificant compared to those on Microsoft's.

At each district level the teacher (system administrators) should be provided initiation that will include hands-on experience in conducting daily chores of system administration. Several of the resources (such as documentation and configuration scripts) can be pooled at the state level website. It is also possible to enlist the support of local Linux user groups, who can assist in early stages of the project.

Support

One of the greatest strengths of Linux is the availability of the entire user base as the supporting staff. There is always someone willing to answer, explain and share the experience. There are several Linux in Schools projects, including those in developing countries such as Thailand and Mexico. Learning from their experience should ease the growing pains. It is also possible to get reciprocal school-to-school cooperation with developed communities to make this experience more enjoyable and extend this as a cultural exchange process.

As outlined above, the local Linux user groups should be strongly encouraged to interact with the schools. It is possible to identify and enlist a couple of experienced local Linux gurus as administration consultants.

For all Tamil interface issues, members of Tamil Linux community will be there to assist. Until the momentum is gathered some of the NRI Linux community can volunteer in providing free CDs and even assistance in securing recycled computers or recycled computer main boards/processors. As an initial offer tamillinux.org volunteer group will be pleased to offer a set of Linux CDs, bundled with Tamil localized tools for any school that contact them directly by email. They will also assist in identifying a local Linux volunteer who can assist in setting up the school server and clients.

Total Cost of Ownership

Finally, let us try to construct model Linux School and analyze the Total Cost of Ownership (TCO). The recommended configuration for the server is indicated in Table 1.

The analysis street price of this computer is about 20,000 - 30,000 Indian Rupees. It is also possible to configure a fast server with dual (old) processors.

The minimal configuration of the clients is as follows;

- Intel 486 or equivalent
- 32 MB RAM
- 15" monitor,
- Mouse, Keyboard,
- Ethernet card

Optimum Configuration	Minimum Configuration
Pentium III @ 1 GHz 128 MB SDRAM 20 GB Hard Disk Floppy Drive, CD-ROM drive, 17" monitor SoundCard, Speakers Mouse, Keyboard, 2 X 100 base Ethernet cards	Pentium MMX @ 333 MHz 128 MB RAM 20 GB Hard disk, Floppy Drive, CD-ROM drive, 15" monitor SoundCard, Speakers, Mouse, Keyboard, 2 X 100 base Ethernet cards

Table 1: Recommendation Configuration for the Server

As this configuration is obsolete years ago, it is not possible to get these new. The only option is to procure recycled machines. We undertook several enquiries in cities such as Chennai and Bangalore and concluded that it is possible to get a 486 or first generation Pentium boxes including used monitors for about 6,000 Indian Rupees. It is also possible to seek donations from industries and individuals.

So, the total cost of ownership is estimated as shown in Table 2:

Resource	Minimal Requirement	Estimated Price (Indian Rupees)
Server (Optimum)	PIII, 128 MB RAM, 20 GB HDD, 2 NICs, 17" Monitor	30,000/ 20,000
Server (Minimum)	MMX333, 128 MB RAM, 20 GB HDD, 2 NICs, 17" Monitor	
10 Clients	486, 32 MB RAM, 15" monitor	60,000
Network hardware (Hub, Cables,...)	100 Base switchable, 12 port.	8,000
Installation /Overhead		2,000
Total		1,00,000 (or) 90,000

Table 2 Estimaton Total Cost of Ownership

This analysis is expected to provide a moderate overestimate of the costs. As outlined above it is possible to acquire several recycled computers for clients. The state government can facilitate this by allowing the companies to write off an estimated street value of these machines in corporate tax statements. Alternatively, schools can seek in-kind donations from companies or individuals towards this project. No donation will be small for this project, discarded hardware components can be recycled efficiently with diskless clients. Old hard drives can be used as secondary storage or backup devices.

The hardware configuration for the server is once again slightly over-specified. The purpose is to provide an upper estimate. Even a MMX 333 MHz, based computer can efficiently drive up to 20 diskless clients. One should also view the investment as totally non-recurrent as the diskless clients will never become obsolete. This configuration is also easily scalable; all diskless clients will get benefited when the server is upgraded. As and when resources become available, they can be easily added to strengthen the overall network without any modification of the configuration.

We have totally excluded the cost of the software and support. Linux operating system that comes bundled with anything from a simple text editor to an Apache Web server is freely downloadable from the internet. As an initial incentive, the volunteers at tamillinux.org are promising to provide a set of Linux CDs for any school that contacts them for the next two years.

Sources for support

There are several corporations and organizations that help schools set Linux School projects. Intel has a program to donate Celeron processors to schools setting up Linux Servers². RedHat supports the schools by training teachers and answering administration related questions³. Sun Microsystems has a free licensing program for its StarOffice suite⁴. The tamillinux.org volunteer community promises to donate a CD set with Tamil localization tools included and will gladly answer any questions regarding setting up a working Tamil Linux server.

Perhaps the most important support comes from the schools themselves⁵⁻⁷. There are several internet based school communities that help each other in terms of setting up servers and clients, designing curriculum, negotiating donations, etc. Besides these communities also develop edutainment tools on Linux platforms^{8,9}.

The Learning Experience

The hardware/network requirements are minimal. The software is free of cost and the support comes free. These factors will essentially help scaling the target size. Each student will get a unique email address and each school a community web site. Free compilers and open source are invaluable in learning. Interacting with other school communities, both in the neighborhood and globally will provide a rich learning experience. Reciprocally, the students will venture to develop software unique to the local communities and in the long run will contribute to the whole open source community. Linux help make the tools rather than providing simple black boxes. This is an aspect of unique benefit to the developing economies and student community.

It should be emphasized to the students that they are a part of a large experiment and this whole Linux school projects is a learning experiment. If the students are properly motivated and impressed upon that every one of them is a beta tester for the hardware configuration, for software choice, for documentation, for Tamil localization, they are sure to respond positively.

References

1. <http://www.tamillinux.org>
2. Intel has such program in the United States, See for example, <http://k12tsp.org/application.htm>
3. RedHat supports the K12LTSP project. It also has online resources for setting up Linux servers for schools. See, <http://www.redhat.com/opensourcenow/intro.html>
4. http://www.sun.com/products-n-solutions/edu/products_solutions/software/desktop_applications.html
5. K-12 Linux Project <http://k12linux.org/contents.html>
6. <http://www.schoolforge.net>
7. Thailand has a very successful SchoolNet project through which about 4550 schools are connected with Linux networks. <http://www.school.net.th/index.php3>
8. A Louisiana based Linux consulting company provides copyright free audio and text books for schools: <http://freecourse.sourceforge.net/>. They also have edutainment tools on issues like global warming.
9. Free Computing Curriculum Project: <http://freecourse.sourceforge.net/>