

Role of Open Source Software in Digital India

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Abstract

This paper lays down philosophy for using **Open Source Software** [1] for Digital India. It goes without saying that computer network is essential for every step towards Digital India. It comprises of **computer hardware** [2] that includes servers, terminal equipment, communication channels, user end equipment like personal computers and mobile phones, smart phones etc; **computer software** [3] that includes server operating systems, web page servers, database servers, e-mail servers, file transfer servers, numerous web applications and so on. Many companies develop software for various applications. They sell it for commercial purposes to earn profit. However, most of them **do not provide source code to the user**. As such the user remains dependent on that company for maintenance, modification and upgrades of such software. It leads to slavery. This kind of software is called **Proprietary Software**. The idea of Free and Open Source software was initiated by **Richard Matthew Stallman** [4], an American national, in early 1980's. He started Free and Open Source Software Foundation. He also started GNU

(GNU's Not Unix) project to replace proprietary Unix Operating System with free software. Since source code is available, such software is free of virus and malware. In 1991, Linus Torvads [5], added **Operating System** to the GNU project. This resulted in open source software called Linux. Any software where user is free to study the software, make changes if he so desires, use it the way he wants and is free to share copies with anyone, is called Free and Open Source Software. This brings down the cost, enhances quality and gives freedom to its users. Therefore, for **Digital India** to be a reality, Open Source Software is recommended wherever possible. Proprietary software should be used only where inescapable.

Keywords: digital India; open source; operating system; computer program; programming language; free and open source software; FOSS; AICTE; network; communication media; compiler; GNU; Linux; Richard; Mathew; Stallman; Linus; Torvalds; email system; development centre; mandatory use of open source software

I. INTRODUCTION TO OPEN SOURCE SOFTWARE

This paper lays down a philosophy for using Open Source Software for Digital India. Nothing contained herein belongs to me (the author) in person. Everything is based on information from various text books during my course of teaching, various discussions and the Internet (especially Wikipedia). You may copy and share anything and everything from this paper. Information contained here is of general nature. Many authors are likely to have produced written works of this nature which I may not be aware of. Thanks to one and all known and unknown.

Computer hardware is of value only when we have software ie computer programs that do something for us. Microsoft Word, Power Point, Excel, Media Player etc are some examples. Other examples are COREL for image processing, browsers for Web browsing etc. There are many companies producing such software. In order to run these programs we need another essential software called Operating System such as Windows XP, Windows 8.1 etc. These commercial software packages are sold/distributed in a form where a user, even if he is a programmer, cannot see the instructions inside. He does not have the

freedom to modify the same. So, the program controls the user as per manufacturer's design.

Open Source software is the one which can be studied and modified by a programmer if he so desires and can be distributed freely without any restrictions. Generally, such software can be downloaded free of cost from the developer's websites. Users have freedom to use, copy, study, and change the software in any way. Users may seek paid technical support if they so desire. Companies may also charge for additional cost for added features. However, the source code is available.

II. WORKING OF A COMPUTER SYSTEM

A. **General.** A digital system requires network of computers. We are aware of Internet which is network of networks. A network comprises of the following:-

- 1) **Hardware.** Comprises of computers and terminal equipment. Equipment connected to ends/terminals of a communication medium is called terminal equipment.
- 2) **Software.** System software is a must for managing system resources. Application software performs specific task for users.

3) **Communication Media.** It is used for interconnecting servers, servers to user devices and other peripherals. Example of communication media are: Optical fibers, microwave systems, radio, satellite, local cable for telephone connections etc.

B. Hardware. Hardware comprises of electronic circuits. A key element of all computer hardware is a processor. A processor is designed to execute/run a set of instructions. This set of instructions is defined by the manufacturer and may be unique for each category of processors. All computer programs are written using these basic instructions. Physically, each instruction is a combination of high and low voltages on a set of wires connected to the processor. Processors, being electronic circuits, understand only high and low voltages. Mathematically we call them 1's and 0's.

C. Software.

1) **Computer Program.** In order to carry out a specific task, instructions from Instruction Set of the processor are arranged in an appropriate sequence. This sequence of instructions is called a computer program.

2) **Programming Language.** Since humans have difficulty in writing large programs using processor instructions comprising of 1's and 0's, we write instructions in some human understandable language and save them in storage media. Such languages are called computer languages or programming languages. However, the machine language remains a combination of high and low voltages.

3) **Source Code.** A program written in accordance with the rules of a programming language is called **source code**. It is generally written using text editors and saved in the form of text files.

4) **Assemblers and Compilers.** Another program, called assembler or compiler, converts the instructions from source code into machine language ie sets of 1's and 0's. The output of a given source code when converted into instructions of a processor comprising of 1's and 0's is called compiled or assembled code.

5) **Running the Computer Programs.** Compiled code is loaded in computer memory called Random Access Memory(RAM). Processor is intimated the starting address of a

program from where it reads and executes the instructions one by one automatically.

6) **Computer Software.** A set of programs such as source code, compiled code, editor, assembler, compiler and many such programs along with their documentation are termed as computer software. There are two broad categories of software:-

i. **Proprietary Software** [6].

Many companies develop software for various applications. They sell it for commercial purposes to earn profit. However, most of them **do not provide source code to the user**. As such, the user remains dependent on that company for maintenance, modification and upgrades of such software. It leads to slavery. Such software is to be used like a book. The user cannot share its copies. Therefore, the user has to pay for each copy. This kind of software is called Proprietary Software. Since, the source code is not provided to the user, companies can embed locking code inside their programs. They may also embed malware. Such nefarious

activities can also be performed by embedding virus/malware through upgrades.

ii. **Free and Open Source Software** [7].

- In this case the **source code is available to the user**. The user can study the same, modify and distribute copies to his friends with full **freedom**.
- The user may modify the same himself or could get it modified from any programmer.
- The idea was initiated by **Richard Matthew Stallman** (known by his initials as rms), an American national, in early 1980's. He started Free and Open Source Software Foundation. He also started GNU project to replace proprietary Unix Operating System with free software. **Operating System** is a set of programs that provides essential features for computer resource management such as managing loaded programs, memory management, hard disk management, device management etc. Lot of development was done. However, an important piece of

operating system called kernel which is the central part of the operating system was missing.

- In 1991, in Helsinki (the capital of Finland), **Linus Torvalds** began a project that later became the Linux Kernel. He started by developing device drivers and hard-drive access, and by September had a basic design that he called Version 0.01. **This kernel, which is called Linux, was afterwards combined with the GNU system to produce a complete free operating system.** It is presently known as **Linux (GNU Linux** to be more precise as Linus Torvalds provided only operating system. Remaining programs and utilities were provided by **GNU Project**). Torvalds had also used GNU compiler and other free and open source programs for his work.

D. **Communication Media and Terminal Equipment.**

Detailed discussion of communication media is beyond the

scope of this paper. However, most of the terminal equipment itself is based on microcontrollers. Microcontrollers are complete computers on chip. They have their own built in processor, RAM, program memory and program ie software. They run only one preloaded software application throughout their life time. Keyboard, mouse, hard disk, LAN cards, switches, routers, multiplexers etc have their own microcontrollers. Microwave ovens, automatic washing machines etc are all based on microcontrollers. **In all these devices, the software is proprietary.**

III. **DIGITAL INDIA [8]**

A. **Simple View.** In the present era, almost all of us who are educated are using computers, mobile phones and smart phones for the purpose of information sharing and business. We are now well aware of online shopping, banking, air, train and bus reservations, social web-sites and so on. Numerous mobile phone applications are already in use. All this is based on digital networks. In a nutshell, all digital networks require computers with LAN cards (ie Hardware), server

operating systems (software), communication media (wired and wireless) and web applications.

B. Vision and Scope. Scope would have to be visualized in terms of the following three key areas:-

- Digital Infrastructure as a Utility to Every Citizen
- Governance & Services on Demand
- Digital Empowerment to Citizens

C. Implementation.

- i. **Infrastructure.** Infrastructure in the form of servers with server software, networks with terminal equipment and end user equipment would be required.
- ii. **Self-Dependence.** Self-dependence in terms of hardware and software must be planned as long term perspective.

IV. IT INFRASTRUCTURE FOR DIGITAL INDIA

A. Communication Networks. BSNL [9] is already providing voice and data communications. This will have to be expanded wherever required. Services from other companies may be integrated.

B. Servers.

1) **Hardware.** Indigenous hardware must be developed under “**Make in India**” initiative. India must become self-sufficient in terms of hardware.

2) **Software.**

- i. **Operating System.** Open Source software must be used. Proprietary software may be used where inescapable.
- ii. **Applications.** Must be based on Open Source Software.
- iii. **Email Systems.** We must have our own email systems based on open source software.
- iv. **Development Centres.** Various in-house agencies must be tasked to develop software based on open source.
- v. **Policy.** Laws governing **mandatory use of Open Source Software** in India must be passed by the parliament.
- vi. Use of Open Source Software must be a binding on all states, universities, colleges and other government organisations. Use of proprietary software should be optional.
- vii. Only those companies should be allowed to do business in India which provide Open Source Software.

C. **User Equipment.** Development of PCs, Laptops, Tabs, Mobile phones, Smart Phones etc must be started in India. They should all be based on Open Source Software.

D. **Policy.**

- 1) Long term as well as short term policy must be clearly laid down by the government.
- 2) Subsidy may be given to Indian companies.
- 3) Due attention must be paid to technology transfers.
- 4) AICTE (Government of India, All India Council for Technical Education) must lay down that **Open Source Software** is mandatory in all educational institutions. Curriculum must be modified at all levels accordingly.
- 5) Research work must lead to workable solutions.

V. Options

If we consider extremes, India may land into two situations:-

- 1) **Digitally Slave India.** This would be the situation when we import hardware and use proprietary software. Some political parties,

politicians and/or officials may pass rules and regulations for their personal benefits to get kickbacks or alternate favours.

- 2) **Digitally Free India.** This would be the situation when we manufacture our own hardware and use Open Source Software. We may have to live with old technology for some time but it would make the country strong in the long run.

None of the above options can be applied blindly. Therefore, a via media would be the appropriate solution.

VI. Recommendations

- For success of Digital India we should buy hardware manufactured in India. Import hardware only where inescapable.
- AICTE (Government of India, All India Council for Technical Education) must lay down that Open Source Software is mandatory in all educational institutions. Other proprietary software, such as Microsoft products may be used only where essentially required by an organisation. Funds for purchase of proprietary software must be restricted. For example, why should we pay for Microsoft Windows, Microsoft Office etc when Linux Desktop and Server

operating system with “Libre Office” is available as free and open source. We do not have to even pay for these products.

- In house development and production of computer hardware.
- All servers must be based on Open Source Software.
- All PCs must be based on Open Source Software.
- Open Source Software must be taught in schools and colleges.

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