Bharat Operating System Solutions: An Initiative Towards Freedom

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Abstract
There has been a gradual increase in numbers of open source (OS) projects in the recent times and they are becoming more and more in number as the commercial sector is making big contributions in these projects so as to make profits from their investments. This is made possible by the development of indigenous projects by various IT giants, local companies, small and medium scale IT industry and government sector. These private and public sectors are investing in FOSS (Free and Open Source Software) projects to fulfil their routine needs by customising the traditional FOSS projects like LINUX to suit their own domestic environment. One such effort is the customized version of LINUX called Bharat Operating System Solutions popularly known as BOSS. This is an initiative taken by Government of India to launch its own operating system parallel to the world wide famous operating system known as Windows. Providing support in different languages used/spoken across the country (India), BOSS is a very user friendly GUI based operating system. The incredible India is a land of different cultures, religions and languages. Almost every state in India has its own language. With this point of view BOSS becomes very important in the country because of its multilingual support for different states and hence different languages in the country. To conclude the development of BOSS is going to prove a milestone in the FOSS development era which has already started in the country.

Keywords
Bharat Operating System Solutions (BOSS), Free and open source software (FOSS), Open Source software (OSS), FOSS in India.

I. Introduction

A. Background and Motivation

Bharat Operating System Solutions (BOSS), a free and open source Linux distribution was developed by the National Resource Centre for Free and Open Source Software (NRCFOSS) of India. The latest version is 6.0. BOSS is considered as India's own PC operating system. It is described as the most significant product to come out of the Indian software industry in decades. The Govt. of India has approved BOSS for adoption and implementation on mass scale. It was developed at C-DAC, Chennai INDIA. The Centre for Development of Advanced Computing popularly known as C-DAC is the premier R&D organization of the Department of Electronics and Information Technology (DeitY), Ministry of Communications & Information Technology (MCIT). The aim of this organization is to carry out research & development in the field of Information Technology, Electronics and related areas.
Linux foundation has certified BOSS for compliance with the Linux Standard Base standard. Till March 2015 BOSS has seen six (Wikipedia, 2015) major versions (Table 1).

Table 1: Various Versions of BOSS Adapted From (Wikipedia, 2015)

Version	Code Name	Date of Release
BOSS GNU/Linux Evaluation	Sethu	-
BOSS GNU/Linux v1.0	Tarang	10/01/2007
BOSS GNU/Linux v2.0	Anant	17/09/2007
BOSS GNU/Linux Server	-	01/01/2008
BOSS GNU/Linux v3.0	Tejas	04/09/2008
BOSS GNU/Linux v4.0	Savir	02/08/2012
BOSS GNU/Linux v5.0	Anokha	23/12/2013
BOSS GNU/Linux v6.0	Anoop	04/03/2015

BOSS is available in various languages which are spoken across the country. These languages are Assamese, Bengali, Bodo, Gujarati, Hindi, Kannada, Kashmiri, Konkani, Maithili, Malayalam, Manipuri, Marathi, Odia, Punjabi, Tamil, Telugu, Urdu, Arabic, Persian, Sanskrit. The languages not supported by BOSS are Nepali, Sindhi, Dogri(Pahari).

B. Research Objectives

The aim of this paper is to throw light on the situation pertaining to the implementation of BOSS in government and business sector in India in the present scenario, focusing on different applications/ areas. The current expectations as well as the experience from the previous implementations in the recent years are taken into account. Also, the future prospects for the developments are presented and discussed. To understand and examine the value of BOSS and its influence on the professional world the various government bodies like public administrations, education sectors etc. are taken as subjects for analysis.
In order to achieve this, first of all BOSS OS will be introduced followed by some important FOSS licenses. After this, the research method will be taken up, results will be presented. Discussion will summarise the findings then.

II. Bharat Operating System Solutions

A. Features

Following are the features of BOSS (C-DAC, 2012)

1. User Friendly Graphical Installer
2. Indian version of OpenOffice – BharateeyaOO
3. 3D Desktop
4. Auto detecting of devices
5. Better usability for digital cameras, printers, scanners, Bluetooth, TV tuner.
6. Auto mounts of all Hard disk partitions
7. Localization support for desktop in 22 Indian languages
8. Smart Common Input Method
9. Migration tool - Bulk document converter
10. Internet tools – Pidgin, Iceweasel, X-chat
11. Multimedia support.

B. Licenses

BOSS license falls under the category of free software licenses (mainly GPL).

A FOSS license may be defined as a license that attempts to bestow the type of rights, privileges, and obligations related to the definition of FOSS. It has been argued that most software licenses are there to cart off your freedom to change or share the software. On the contrary, the FOSS licence ensures that the software is free for all the users by ensuring your freedom to change and share the software (Lee, 1999).

To use software in fact the user purchases the license for that software along with the software itself. Software that is available for use may be obtained by a single person or an enterprise. There are many different FOSS licenses available and their number is continuously growing. Each license specifies different constraints attached to the various software components. There exist various external references which are there that explain and describe a number of different licenses that are presently in use with FOSS (Laurent, 2004; Rosen, 2005; Fontana, 2008; OSI, 2014). There are four general categories in which software licenses may be grouped into (Table 1). FOSS licenses are categorized as permissive, reciprocal, and propagating; all propagating licenses are also reciprocal, but the reverse may not be true i.e. most of the reciprocal licenses are not propagating. In case of commercial software, Terms of Service (TOS) and End-User License Agreement (EULA) are proprietary and do not provide the rights of source code availability, copying, modification, and distribution (Alspaugh et al., 2011).

Table 2: Types of Software Licenses Adapted from (Alspaugh et al., 2011)

License Type	Also known as	Examples
Permissive	Academic	Apache, BSD, MIT
Reciprocal	Copyleft	MPL, LGPL
Propagating	Strong Copyleft	GPL, AGPL
Proprietary		CTL, EULAs, TOSs

C. BOSS Variants

The BOSS has been able to mark its presence in the different areas in the software industry offering a variety of software solutions. The following is the list showing its few variants useful to different parts of society ([Online] Available: https://www.bosslinux.in, 2015).

1. BOSS Desktop

There is an integrated search facility available with BOSS Desktop which is helpful in switching windows launching applications and opening recent documents and settings. The integrated search allows you to look for different applications in easier and faster way on your system. What you need to do is just to type in your query into the Dash home and the system will determine that which categories of applications are relevant to your search criteria thus returning the best results as per your expectations.

2. EduBOSS

EduBOSS is designed for schools. It is available with a set of features which suit the Primary and Secondary school environment. It is a complete usable operating system in itself carrying graphical user interface and console applications. It is capable of routine tasks and comes with additional utilities which are very useful. It is a unique operating system in itself which has proved to be very useful in providing teaching and learning aids in schools.

EduBOSS is designed and developed keeping in mind the power and flexibility of a free and open operating system which is available free of cost for everyone. This power and flexibility is brought right to the doorsteps of education community which is enjoyed by the children at the grass root level. EduBOSS is accompanied by rational design decisions. It is armed with actual understanding of challenges that are faced by education system and various technologies at the time of trying to implement something new. The components and features of EduBOSS are as follows:

(i). Fotowall

It is a creative tool that allows you to personalize the photos and pictures in the desired layout. With the help of this feature you can add pictures and then later on can resize etc. the pictures to develop your own composition or collage

(ii). GCompris

It is an educational software package which is specially designed for kids between the ages ranging from 2 to 10 for carrying out variety of activities. The various activities include arithmetic science, games, computer discovery, reading practices and so on.

(iii). TuxPaint

It is a general purpose drawing tool. When using TuxPaint the sound effects and a cartoon character keep the user aware of the surrounding and entertain them with charming visual effects and audio

(iv). Kalzium

It is a full featured application which is based on chemistry. It includes a number of features including Periodic Table of Elements, chemical equation solver, chemical reference, and 3D molecule viewer.

(v). Geogebra

It is a dynamic program based on Geometric applications. It can be used to do constructions with points, vectors, segments etc. These geometric shapes can then be modified dynamically afterwards.

(vi. Gbrainy

It is a platform where memory can be trained for something specific. Here one can check logical and arithmetical capabilities. There are available many sorts of different exercises with different levels of difficulty.

3. Advanced Server

The architecture supported by the BOSS Advanced server is Intel and AMD x86-64 architecture. It is bundled with web server, proxy server, database server, mail server, network server, file server, SMS server and LDAP server. The various administrative tools available with it are: Webmin, Gadmin, PHP myadmin, PHP LDAP admin and PG admin.

(i). Webmin

This administrative tool is used for system administration. It has a web based interface. It helps to create user accounts, file sharing, DNS, Apache and much more.

(ii). Gadmin
It is GUI based tool. It is for using server administration tools with ease.

(iii). PHP myadmin
It provides a suitable visual front end to the MySQL databases by making use of an Apache/PHP frontend.

(iv). PHP LDAP admin
It is a web-based LDAP administration interface which is used to manage LDAP server.

4. BOSS MOOL
The purpose of MOOL (Minimalistic Object Oriented Linux) is to redesign the Linux kernel so as to reduce coupling and increase maintainability by means of OO (Object Oriented) abstractions.

5. Switching to BOSS
Switching from the conventional proprietary/closed source software to BOSS is not that easy especially when people are used to their routine software applications (proprietary) which provide extensive support and documentation. The change-over to BOSS is greatly influenced by human and technological factors. Due to the kind of change involved resistance from the people/employees is quite obvious and needs to be dealt with and overcome. Rather than compelling people to change to new software, they should be encouraged instead to adapt to the awaiting changes for the betterment of the environment they belong to. This leads to the increased acceptance level and decreases the problems which may be the result of outcome of this expected migration. It needs a proper communication and able leadership among the two sides i.e. between technocrats and commercial sector for a successful shift. If we talk of the factors which are on technology side then two terms emerge as successful candidates, these are reliability and usability. When we think of replacing software, such as e-mail and office applications/programs the features which are similar on two sides i.e. closed source software and open source software, help in strengthening the same thinking as an employer/entrepreneur and increases the confidence level as an employee/user. In the present scenario BOSS is capable of providing a strong foundation to any organization/ business/educational institution provided it is led by a strongly managed well organized migration project. To talk about such migration the following options can be considered.

In case of office applications i.e. when we want to process the text or want some manipulation of numerical data with the help of some mathematical formulas, we have Libreoffice 4.3. As far as the open source application is concerned in this field, it serves this purpose and is counterpart of MS-Office. This open application is capable of serving various kinds of needs like word processing, presentation making, spreadsheet manipulation and database management.

BOSS allows us to manage our e-mail accounts through a unique software called Evolution. It has numerous features including secure network connections encrypted with SSL, TLS, STARTTLS and many more.

Now, we can look for an open source web browser. One such well known candidate which qualifies as a reliable web browser is called Mozilla's Firefox. It is equipped with such features which make it more secure and it also provides greater privacy. It is capable of preventing pop-ups, viruses and spywares that leads to a protected surfing environment and more secure downloads. It can be customized to greater extent. It has also enhanced security features including protection from online identity theft.

What about image editing? The use of GIMP (GNU Image Manipulation Program) is one of the possible alternatives as FOSS as compared to the costly image processing and image editing software. There is a large collection of tutorials that are available world-wide on the internet, wikiHow is one such place devoted to this category of information. It is an application which allows variety of functions ranging from paint program to an expert quality photo retouching program, a mass production image renderer, or even an image format converter.

Another software known as Bulk Document Converter lets us to convert documents from one format to another. The various conversions which are possible are - doc to pdf, doc to html etc.

Now, we can talk about some software which is more or less meant for entertainment purpose. We are talking about software which is used for playing videos and audios for some serious business or just for pass-time. Such software is a media which is capable of recognizing numerous formats. One such software is known as VLC media player. VLC is a free and open source cross-platform multimedia player and framework that plays most multimedia files as well as DVDs, Audio CDs, VCDs, and various streaming protocols.

Computer games are excellent source of entertainment. Games are not only used for entertainment instead they are also capable of providing information and knowledge. The games like Chess are wonderful source for testing your power of brain in different ways. Such games are available in BOSS also. Apart from this BOSS comes with loads of games including Sudoku, shoot-em-ups, alien-arena , Civilization V , Fortunes , Dota 2 and many more that will keep you busy for hours.

III. Research Methodology
This study examines the BOSS's adoption in government and private sector in India. The scope is limited to this country and its government bodies and various companies/concerns/enterprises. The data collection is done mainly from existing surveys, BOSS studies and internet articles in a mixed fashion. The research methodology/method used in the present study is explanatory (Tellis, 1997). The study is conducted in explanatory fashion because of the nature of data collection used in the present study.

IV. Results and Findings
Estimation of use of FOSS is a difficult task. Whether we are talking in terms of international or national context this determination remains an uphill task. The reason behind this bitter pill is that FOSS is generally free of cost and secondly, downloads from the internet are not the only source for getting such kind of software and hence its use. If we look at BOSS (BOSS GNU/Linux is a Desktop and Server Linux Operating System) the scenario is somewhat different. It is a Government initiative. It is derived from Debian Linux. As it is developed by C-DAC so it can be downloaded free of cost from its website. No doubt it is FOSS based OS and there is no restriction on its use still the main source of this software remains the website. But, it does not mean that it cannot be obtained by any other means. The department/agency which has developed the software has itself installed the software in different Government offices, organizations and institutions. The Indian Government itself is instrumental in the installation and smooth functioning of the software (BOSS) across different states of the country. Besides BOSS, C-DAC has also developed Bharateeya Open Office that also supports Indian languages.

A. BOSS in India

BOSS is operational in various states across the country. Some of them in which BOSS is operational are Punjab, Haryana, Tamil Nadu, Chhattisgarh, Tripura, Kerala, and Pondicherry (DeitY, 2015).

A worth talking example of use of FOSS in India is Tamil Nadu (Richter et al., 2009). It is the federal state of India which is located in the south of the country. As far as the economic conditions of the state are concerned it is one of the prosperous states of the country contributing a large share to India's GDP. As per the census (2011), it is found to be the most urbanized (49%) state of the country (Wikipedia, 2014). It accounts for 9.6% of urban population while comprising only 6% of India's total population. It has a network of about 113 industrial parks and estates which offer developed plots with supporting infrastructure (ASSOCHAM, 2013). It has been ranked first by the Economic Freedom Rankings for the States of India (Gill, 2010). As far as monetary gains from the software export are concerned, Tamil Nadu is one of the leading software exporters of the country (STPI, 2012).

The Government of Tamil Nadu uses BOSS for official use (DIT, 2011; "The Hindu" March 18, 2014) instead of the conventional operating system MS-Windows. It has some special features: It includes well known FOSS programs; all the tools that are available as a part of software are in Indian languages with software supported in both Tamil and Hindi languages. These features are very important because if we look at facts and figures we find that among 22 constitutionally recognized Indian languages only 10.35% of the total population of the country is familiar with English (Wikipedia, 2015). Keeping these statistics in mind it is extremely important to be able to use this operating system software in official language of state and the country. It could be made possible because FOSS solutions are available with source code thus allowing customizations which made it possible for developers/users to implement previously unsupported languages. This offered not only economic benefits but also allowed the software to be accessible to more and more people. Among various reasons the license fees was one of the reasons that greatly influenced decision of the government to switch to FOSS because of the fact that open source platform cost as much as the cost of the hardware on which it runs. Tamil Nadu is just one of the numerous examples where BOSS is successfully running in the country.

If we talk about Haryana then in this state alone 58000 nodes are already having BOSS as OS. If we look at Punjab then we come across the fact that 1400 schools of the state have already implemented BOSS. In Chandigarh also (a Union Territory, also capital of Punjab and Haryana) about 85 schools are using BOSS. In a National research project BOSS is being used. DRDL Hyderabad is also making use of BOSS.

It has also been decided to setup Centre of Excellence for Mobile Internet Devices based on BOSS Linux. BOSS support centre network has already been established. BOSS support Centres have been setup at various C-DAC Centres. Franchisees have also been used as part of the support centre network. In addition to this, a National Help Desk facility has also been constituted at C-DAC Chennai that is responsible for providing the additional layer of support. Many national institutions have chosen BOSS as an optimistic solution to proprietary applications with a view to have more stable platform. Nationwide awareness and promotional drives have been conducted to strengthen the roots of BOSS Linux in the country. More than 250 colleges in the country have BOSS Linux installed in their labs for the students. To establish favourable environment for BOSS Linux efforts are already on by getting the vendors on board in the country (DeitY, 2015).

As far as the business model for BOSS Linux is concerned, it has been chosen to be service and support. This strategy that is chosen for its promotion is very vital for it. According to this model license for BOSS is free while service and support for it are charged. The revenue is generated from training, custom development, post-sales support, branding and consulting instead of software licensing fees. The fee charged may be the subscription fee that is charged on the basis of per node/desktop per year. The other mode is the lump sum fee that is charged once for a period of time for providing the on-site support. C-DAC has tied with different vendors to provide technology support for the various users across the country. This support is for preloaded BOSS Linux laptops and desktops that are available with least price (DeitY, 2015). Apart from the above savings which are directly coming from BOSS there are indirect savings also which the Government is having as a result of adoption of BOSS by the various Government institutions/ departments/offices/organizations/agencies.

B. Discussion

If we look at the motivation for implementation of BOSS in the country we find that the cost/expense in terms of licence fees is one of the most common factor or the driving force behind this change. In general, in the developing countries like India the license fees are normally higher and wages are lower, comparatively. Furthermore, the total amount of money spent on various activities related to IT operations normally remain within the country thus resulting to the benefit to local and national IT industry in general.

One of the main reasons (apart from the cost issues) for the adoption of BOSS is the liberty i.e. independence from software manufacturers/ proprietary issues and self governance. Countries like India find open source platforms as a great opportunity to bring better access to digital world in the country. In India there are numerous languages. The official language of the country and the official languages of the states are all different depending upon the language of the natives of a particular state. As BOSS has been customized to support different languages so, it has proved to be a motivating factor for migration to BOSS in the country.

As we already know the migration to BOSS is due to cost savings and to have increased flexibility. The same holds true in case of education sector in India where the switch is due to the same reason so that more and more computers can be provided to the students and at the same time to have greater life span of the hardware being used. Other reasons include special educational programs that can be introduced at various levels to help increase employment opportunities which can be made available under FOSS licenses. This software movement is useful in many ways as one of its aspects can be that the people who are involved in teaching profession can share study material among each other and also with other professions using open content platforms. There is no doubt that software activities are increasingly growing in the various parts of the country, but still there is very marginal but so called successful progress in the country.

Value creation is one of the aspects as far as BOSS is concerned for most of the locations in the country where it has been implemented. No doubt costs are saved in using this open source based alternative, but it is not only the factor that is a matter of concern. Other factors such as high degree of flexibility, reliability and innovation capabilities become the motivation factor for carrying out this open source based initiative.

V. Conclusion

It can be said that BOSS seems to have attained maturity during the recent years as evident from its level of development in the past few years. It has proved itself as a valuable alternative to various important applications including office applications and operating systems. Various state governments and public sector institutions have chosen it as a possible alternative to closed source software due to different and varying reasons including low cost, being reliable and flexible, with innovative trends and freedom from manufacturers. Also, it has already been seen that migration to open source alternatives has proved to be fruitful and rewarding leading to stable solutions. Now, we can say that this success is not only limited to servers and supercomputers any longer but also includes desktop environments and applications used by masses for their routine use.

A. Limitations

Due to the fact that data is collected using mixed approach so the information cannot be considered as always accurate. Most of the data and information that was collected as a part of this research was based on articles, news reports, web sites and other such means which may be considered as unsatisfactory means of providing unbiased, authentic and accurate information. The scope is further limited by the fact that out of large pool of activities associated with BOSS only few of them were considered and included in the study. Apart from this, in this study only the success stories have been included. But, the hundred percent success of BOSS is more or less a myth as it has been observed that Government's OS BOSS is dying a slow death due to lack of patronage. So, if not failures, there are at least some setbacks which the BOSS is facing. These stories of a sort of partial failure of BOSS to emerge as a market leader (as it was expected that it will become an alternative to MS-Windows in India) have not been mentioned here in the study undertaken. Although, the study strongly favours open source environment as a result of the success the BOSS has achieved that have been mentioned, still it cannot be generalised for various variants of BOSS because of the missing facts such as its low rate of success in the present scenario.

B. Scope for Future Research

Overview of the BOSS Linux usage in India was presented by this study. Useful BOSS projects were discussed which became successful and have proved to be able to become milestone in the long journey that BOSS has yet to cover in the country to enable itself so that its presence can be felt substantially. Although, various points leading to the success of different cases were discussed, but still some important points may be missing related to their success. Also, not all the success stories were included in the current study. So, this is one of the important points which can be considered for carrying out further research in this regard. The other side of the picture is not taken into account in the present study. As it is said that Government's OS BOSS is dying a slow death due to lack of patronage (Aggarwal and Alawadhi, 2014). These cases can be taken up to have complete analysis of impact of BOSS on India.

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