



Framework For Adoption of Open Source Software In e-Governance Systems

April 2015

Version 1.0

**Government of India
Ministry of Communications and Information Technology
Department of Electronics and Information Technology
New Delhi – 110 003**



Metadata of the Document

S. No.	Data elements	Values
1.	Title	Framework for Adoption of Open Source Software in e-Governance Systems
2.	Title Alternative	Framework for OSS Adoption
3.	Document Identifier	Framework for OSS Adoption: 01
4.	Document Version, month, year of release	Version 1.0 (April, 2015)
5.	Present Status	Final
6.	Publisher	Department of Electronics and Information Technology (DeitY), Ministry of Communications & Information Technology (MCIT), Government of India (GoI)
7.	Date of Publishing	April, 2015
8.	Type of Standard Document	Framework
9.	Enforcement Category	Advisory
10.	Creator	DeitY, NIC
11.	Contributor	OTC, NIC
12.	Brief Description	<p>"Framework for Adoption of Open Source Software" suggests a set of recommendations and procedures for promoting, managing and enhancing the adoption of OSS in e-Governance Systems in India.</p> <p>It highlights the impact of adoption of OSS in Government, influencing factors, mutual impact of Open Standards and OSS, establishing enterprise security with OSS, unified software development for all major devices using standards based web browser and use of localisation.</p> <p>The Framework suggests neutral guidelines to select software and the process for induction of OSS solution. The ecosystem suggested to promote the adoption of OSS describes required institutional</p>



S. No.	Data elements	Values
		mechanism, collaboration with key stakeholders like Industry, OSS Communities, Academia, collaborative mechanism, offering of services based on OSS, provisioning of support services on OSS and integration with on-going initiatives.
13.	Target Audience	<ul style="list-style-type: none">• Government Departments and Agencies• Information and Communication Technology (ICT) industry (playing the roles of suppliers, developers, implementers and maintainers, integrators, service-providers) implementing e-Governance projects.• Academia working in e-Governance domain.
14.	Owner of approved Framework	DeitY, MCIT, New Delhi
15.	Subject	Open Source Software
16.	Subject. Category	Adoption Framework
17.	Coverage. Spatial	INDIA
18.	Format	PDF
19.	Language	English
20.	Rights. Copyrights	DeitY, MCIT, New Delhi
21.	Source	Different resources, as indicated in the document
22.	Relation	Policy on Adoption of Open Source Software in Gol



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Executive Summary

Government of India (GoI) is implementing the Digital India programme as an umbrella programme to prepare India for a knowledge based transformation into a digitally empowered society and a knowledge economy. Under the overarching vision of Digital India, GoI aims to make Government services digitally accessible to citizens in their localities and to ensure efficiency, transparency and reliability of such services at affordable costs. To meet this objective, there is a need to set up a commensurate hardware and software infrastructure, which may require significant resources.

Adoption of Open Source Software (OSS) has increased worldwide and has led to innovations in implementation of ICT solutions across businesses and Governments. The use of OSS in the key domains of ICT implementation (like application development, internet connectivity, infrastructure, Data Centre and mobile) has helped widespread adoption of open source technologies across the world. The OSS solutions have matured to a large extent and millions of committed developers are participating in making it conducive to the needs of different areas of ICT implementation. These solutions are now available with the required support services. The increased convergence of computing platforms facilitates the use of OSS together with Open Standards and adoption of web browser as a unified platform for software applications. The socio economic and strategic benefits offered by the adoption of OSS in e-Governance have encouraged several Governments and public agencies, to bring out policy framework / guidelines in this area. Compliance to Open Standards brings the twin benefits of interoperability and easy migration to OSS.

Government of India has been promoting the use of open source technologies and has been keenly encouraging their adoption in the e-Governance movement of the country. Department of Electronics and Information Technology (DeitY), Government of India has formulated The "Policy on Adoption of Open Source Software for Government of India" to enable effective adoption of OSS and encourage the formal adoption and use of Open Source Software (OSS) in Government Organizations. The policy has been approved and notified.

In pursuant to this policy, department is required to publish a policy framework for rapid and effective adoption of OSS covering the prioritization of the application areas and illustrative list of OSS and OSS stack etc. required for various functional areas. This "Framework for Adoption of Open Source Software" has been formulated to promote adoption of OSS in e-Governance Systems in India. It lays down a set of recommendations and procedures for promoting, managing and enhancing the adoption of OSS.

The key objectives of the Framework are to

- (a) Provide guidance to the Govt. departments and agencies in selecting OSS Solutions
- (b) Identify the OSS Stack appropriate to the needs of various government department and agencies
- (c) Enhance & sustain the ecosystem to provide multi-layer support services on OSS for various National & State projects
- (d) Create knowledge-base and build capacity on OSS
- (e) Provisioning the Institutional Mechanism and resources required for promoting OSS on an ongoing basis.



1 Scope & Applicability

Scope	This Framework provides a set of recommendations and procedures for promoting, managing and adopting OSS as a preferred option in e-Governance Systems.
Applicability of this Document	All e-Governance systems.
Need for the Framework	<p>(a) To implement one of the objectives of the National Policy on Information Technology, 2012 i.e. "Adopt Open standards and promote open source and open technologies".</p> <p>(b) To widen the adoption of OSS to cover various National & State projects based on experience, expertise & feedback.</p> <p>(c) To improve the ecosystem of OSS (Support for OSS Tools, Project Planning, Development, Deployment, create community & industry support within the country and Capacity Building).</p> <p>(d) To minimise the informal use of OSS and absorption of OSS technology by limited number of internal experts</p> <p>(e) To mitigate the risks like hidden lock-ins and poor maintainability & sustainability of OSS.</p> <p>(f) To plan and provide the resources (time, funding, man-power and efforts) required to achieve the targets.</p> <p>(g) To reap the maximum socio economic benefits as a result of the adoption of OSS.</p> <p>(h) To improve citizen interface and similarly to establish systems for a better strategic control & ownership of e-Gov projects.</p>
Targeted Stakeholders	<p>(a) Government Departments and Agencies.</p> <p>(b) Information and Communication Technology (ICT) industry (playing the roles of suppliers, developers, implementers and maintainers, integrators, service-providers) implementing e-Governance projects.</p> <p>(c) Academia working in e-Governance domains.</p>
When to use the framework	<p>(a) Development & Implementation of new e-Governance systems.</p> <p>(b) Enhancements & Up-gradation of existing/legacy e-Governance systems.</p>
Nature of Applicability	Advisory
Areas most suited for	(a) Database,



OSS:	<ul style="list-style-type: none">(b) Application/Web Server,(c) Server Operating System,(d) Software defined Networking,(e) Cloud Platform (including Virtualisation and Server Operating System),(f) Desktop Operating System (including Office Productivity Tool),(g) Cross-Platform Application Development (Unified Software Development for Mobile, Tablet, laptop and Desktop).
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This Framework is prepared with a focus mainly on e-Governance Systems. However, other sectors can also use this Framework with benefit. A knowledge base on OSS will be created and shared under this Framework.



2 Overview of OSS

The software solutions developed by various business organisations and communities are deployed or released under various types of licenses and classified as Closed Source Software (CSS) / Proprietary Software, Shareware, Freeware and Open Source Software (OSS).

i. Closed Source Software / Proprietary Software

The conditions or license of CSS/proprietary software typically prohibit the access to / modification of the source code. It restricts the copy, modification, distribution and reuse of the software. The restrictions may be applicable to the whole or part of the software so that the control is with the concerned company. Revenue, profit and IPR drive the development and marketing of the products and solutions.

ii. Shareware

The conditions of license of shareware are almost the same as the CSS license except that executables of the software are made available for restrictive-use free of charge for a specific trial-period.

iii. Freeware

The conditions of license of freeware are almost the same as the shareware except that executables of the software are made available for restrictive-use free of charge permanently.

iv. Open Source Software

OSS is also commonly known as Free and Open Source Software (FOSS), or Free Libre Open Source Software (FLOSS). Here the “Free” refers to “Freedom to use” and not “Free of Charge”; similarly, “Open Source” refers to the “Availability of Source code” for the community / adopter / end-user to study and modify the software and to redistribute copies of either the original or modified software (without having to pay royalties to previous developers). The definitions of Free Software and Open Source are made available by Free Software Foundation¹ and Open Source Initiative² respectively.

There are references which show the synergy between both FOSS & OSS; for example, the reference³ shows “However, the differences in extension of the category are small: nearly all free software is open source, and nearly all open source software is free” and the site⁴ says “They both refer to essentially the same thing”.

Since, Open Standard and Open Hardware along with OSS/FOSS are also being adopted by many countries; the umbrella-term “Open Technology” is widely used. Based on these reasons the term, “Open Source Software” is adopted in this Framework. OSS has matured solutions at par with or better than CSS solutions.

v. Open Source Stack

There are varieties of OSS solutions available for each domain like Web Server, Database Server, Application Server, etc. Identifying, selecting and deploying the right solution is not a simple task. Project teams

1 Free Software Foundation, <http://www.fsf.org>

2 Open Source Initiative (OSI), <http://opensource.org>

3 Categories of Free and Nonfree Software - GNU Project - Free Software Foundation
<http://www.gnu.org/philosophy/categories.html>

4 Debian -- What Does Free Mean? <http://www.debian.org/intro/free>



informally select and use arbitrarily chosen OSS solutions quite often, based on their preference and /or convenience. Such an informal usage of OSS solutions should be avoided to mitigate the risks like hidden lock-ins, poor maintainability of OSS, absorption of OSS technology by limited number of internal experts etc.

The OSS solution (component) needs to be identified for each domain through a set of guidelines. The identified OSS components are to be integrated, tested and offered as pre-configured OSS Stack. Such a stack is to be notified for adoption & reuse with support services in a formal way.

Most of the current e-Gov solutions are based on Java & PHP Technologies. Because of the proliferation of Mobiles & Tablets, Open Web Technology is included along with PHP & Java Technologies in the OSS Stacks listed in the Framework. These OSS Stacks are provisioned with an appropriate support model.

A typical OSS stack is given in <Annexure-I>. The OSS Tool-sets recommended should be given along with the support services at central, regional and state levels. As the Government has limited resources it is difficult to give support for all OSS Technologies chosen without appropriate criteria.

There is no bar in using other OSS Technologies in e-Governance; but the project team has to take care of the support for these technologies. If significant numbers of projects are based on other OSS Technologies then they would be considered in the OSS Stack in future.



3 Preamble

Declining Challenges for Adoption of OSS in Government

Many of the early barriers/ challenges to the use of OSS such as lack of awareness, lack of required skills and training, absence of appropriate business models, absence of standards and interoperability are rapidly reducing. As components of OSS mature, they become easier to use and maintain. A comprehensive list of popular OSS is given in <Annexure-II> “Illustrative List of OSS”. Local firms, user community and developer community offer support and interoperability among different applications with obvious advantages. Alternative business models have emerged which allow OSS contributors to derive revenue for their efforts without charging for the software itself.

Impact of OSS in ICT and non-ICT Domains

OSS framework has a wider perspective than a software development methodology. It not only increases access, ownership and control of ICT, but also provides a Framework for usage and sharing of intellectual capital. The sharing of knowledge spreads, not only through OSS, but also through other related areas like Open Standards, Open Hardware and Product Designs, Open Process, Open ware Course, etc. This is collectively known as Open Technology (OT). In addition to ICT fields, the tradition of sharing of knowledge spreads in many other sectors as Open Medicine, Open Knowledge base, Open Law, Open Science, Open Music, Open Agriculture, etc.

SWOT Analysis of OSS Adoption

OSS adoption also provides many social, economic & strategic benefits described in terms of **S**trengths and **O**pportunities. At the same time, certain precautionary measures are required so as to realise maximum benefits. These measures are explained in terms of **W**eaknesses and **T**hreats. The **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats (SWOT) Analysis of OSS Adoption is outlined below:

Strengths	Weaknesses
Include freedom to use & reuse, cost effectiveness, innovation, enhanced security, better local capacity building, preservation of foreign exchange, minimised piracy, better interoperability, community support, collaborative & distributed approach, enhanced competition, growing & mature developer ecosystems and rapid & effective vulnerability remediation.	Include adhoc use of OSS, adverse impact of legacy systems, limited commercial promotional efforts, dominance of existing marketing forces, high cost of integration and migration, perceived vulnerability due to the openness of source code, lack of OSS Policy / framework, lack of cost effective support services, lack of motivation, lack of capacity building & awareness and lack of awareness on Total Cost of Ownership (TCO).



Opportunities	Threats
Include low barrier to entry, economic opportunities for local industry, better reuse, better suitability, better support from OSS community, wider choices on OSS, ability to drive cross-industry collaboration and forging for new and better solution	Include resistance from the existing market forces, lack of awareness of OSS among decision-makers, inadequate support services, reduced activity of the community, incompatible versions, inadequate skilled-staff

The detailed SWOT Analysis of OSS Adoption along with ways to mitigate weaknesses and threats is given in <Annexure-III> “SWOT Analysis of OSS Adoption”.



4 OSS Current Scenario

i. International Scenario

Open competition from OSS support service providers bring a whole new dimension to the business models of OSS. As per Research Study in 2013 by Yeoman Technology Group and Linux Foundation⁵, Linux usage in Mission-Critical applications has grown drastically to 73% in 2013, mainly due to growth in Cloud / Virtualisation and Big-Data... Netcraft's April 2013 Web Server Survey⁶ shows the combined world market share of Apache and Nginx web-servers as 65%. As per Gartner Survey⁷, August 2012, the market share of Android is 43%. In entertainment sector too, many movie / animation industries⁸ like DreamWorks, Pixar, Weta Digital etc. uses OSS.

In a recent (Goldman Sachs, IDC) 2013-Survey⁹ on common computing platforms (combined market for desktop, laptop, tablet and smart-phone), Linux has more than 40% market.

Gartner¹⁰ report predicted that Google's Android-Linux platform would be installed on more than one billion device by 2014, giving increased dominance to Android; by 2017, shipments of Android devices would "dwarf" those of CSS based PCs and phones.

OSS presents significant opportunities for Government and many initiatives are being taken world-wide for OSS adoption. Led by UNDP and European Union, countries like USA, UK, South Africa, China, Brazil, Malaysia etc. are implementing nationwide policies or legislation promoting OSS. <Annexure-VI> "Adoption of OSS – International Scenario" outlines major initiatives on the adoption of OSS world-wide.

ii. Indian e-Governance Scenario

OSS is adopted in many e-Governance projects executed by various Government Agencies in India. The details of initiatives from some of the public organisations like DeitY, State Governments, NIC and C-DAC are given in the <Annexure-VII> "Adoption of OSS – Indian e-Governance Scenario".

5 Linux use in business, 2013 <http://www.linuxfoundation.org/publications/linux-foundation/linux-adoption-trends-end-user-report-2013>

6 Web Server Survey, 2013 <http://news.netcraft.com/archives/2013/04/02/april-2013-web-server-survey.html>

7 Gartner Report on Worldwide Sales of Mobile Phones, Aug. 2012, <https://www.gartner.com/newsroom/id/2120015>

8 Linux in film production, https://en.wikibooks.org/wiki/Movie_Making_Manual/Linux_in_film_production#Filmmakers

9 IDC, Goldman Sachs Research Report, Dec., 2012 http://seattletimes.com/html/microsoftpri0/2019853243_goldman_sachs_microsoft_os_has_gone_from_more_than.html

10 Gartner Report on Smart-phones and Tablet rise, April, 2013, <http://www.theguardian.com/technology/2013/apr/04/microsoft-smartphones-tablets>



5 Factors Influencing the Adoption of OSS in Government

The factors which influence the adoption of OSS in a positive manner are known as facilitators (indicated with “+”). On the other hand, the factors which negatively influence the adoption of OSS are considered as barriers or inhibitors (indicated with “-”).

The common influencing factors for adoption of OSS in Government Organisations are described below;

Classification of Influencing Factors

I. Economic Level Factors

- (a) Cost Effectiveness (+)
- (b) Preservation of Foreign Exchange (+)
- (c) Enhanced Competition (+)
- (d) Freedom to Use & Reuse (+)
- (e) Help Innovation (+)
- (f) Better Local Capacity Building (+)
- (g) Minimised Piracy (+)
- (h) Low Barrier to entry (+)
- (i) Economic Opportunities for Local Industry (+)
- (j) Better Reuse (+)
- (k) Better Suitability (+)
- (l) Wider choices on OSS (+)

II. Security Level Factors

- (a) Enhancing Security (+)
- (b) Enhancing source code level security without mistrust code (+)

III. Technological Level Factors

- (a) Technological Compatibility based on Standards (+)
- (b) Availability of Device Drivers for OSS Operating Systems (+)
- (c) Relative Advantage of OSS (+)
- (d) Trial ability of OSS (+)
- (e) Availability of OSS stack (+)
- (f) Technological Complexity in OSS usage (-)



- (g) Presence of Proprietary Lock-in (-)
- (h) Freedom to modify and improve (+)

IV. Organisational Level Factors

- (a) Management's Positive Attitudes towards OSS (+)
- (b) Champions of OSS (+)
- (c) Size of Organisation (+)
- (d) Diverse Expertise at Management Level (+)
- (e) Inter-connectedness of Organisation (+)
- (f) Organisational Slack on Resources (+)
- (g) Inclination towards Business Processes Re-engineering (+)
- (h) Availability of Internal Technical Expertise (+)
- (i) Level of Formalisation (-)
- (j) Centralisation on Decision Making (-)
- (k) Availability of Financial Resources (-)
- (l) Outsourcing impact (-)

V. Environmental Level Factors

- (a) Rules for the adoption of OSS (+)
- (b) Provision for Capacity Building (+)
- (c) Availability of Support Services on OSS (+)
- (d) Competitive Pressure (+)
- (e) System Openness (+)
- (f) Past Experience on OSS (+)
- (g) Availability of Internal Collaboration Mechanism (+)

VI. Individual Level Factors

- (a) Level of Organisational Objectives Consensus (+)
- (b) User's Fear on De-skilling of Legacy Expertise (-)

The details of economic factors and security factors are made available in the “Annexure-III SWOT Analysis of OSS Adoption” and Section 10 “Security” respectively. Whereas, some of the influencing factors such as technology factors, organisational factors, environmental factors and individual factors are listed in the “Annexure-IV Common Influencing Factors for the Adoption of OSS”.



Need for Evaluation of Factors

The effects of each factor may vary from country to country; hence, the influence of each factor should be analysed for local environment. Factors having the greatest impact on the adoption of OSS are to be found and given highest priority.

The application context is also to be accounted for analysing the impact of each factor. The production systems is classified based on the strategic importance, into strategic, mission critical, routine-support and experimental / laboratory. The factors with their priority & inter-relationship are to be evaluated with reference to application context through appropriate methodology and metrics.



6 Impact of adoption of OSS in Government

Many Governments worldwide have started adopting innovative solutions offered by OSS in their e-Governance Systems. A recent survey analysis¹¹ says that about 35% of OSS adopters are Government agencies.

i. Reuse of ICT assets

Reuse of ICT Assets is easily facilitated by the adoption of OSS. For example, the use & reuse of OSS Stacks in applications, hosted at data-centres, without additional licensing costs, would bring down a huge amount of expenditure.

Reuse of ICT assets is being mandated by several Governments / their agencies worldwide. For example, UK Government¹², and US-DoD¹³. In the recent survey¹⁴, it was estimated that the annual savings for European Union due to the adoption of OSS is about 450 billion Euro.

The details of benefits due to the adoption of OSS are given in <Annexure-III> “SWOT Analysis of OSS Adoption”.

ii. Huge Employment Generation due to new ICT services

OSS solutions can generate very large employments in the ICT service areas. Small and Medium Enterprises (SME) and Public Sector Units (PSU) from India can be easily engaged in the ICT services based on OSS solutions. Many other groups directly or through the franchisee, with non-ICT backgrounds, can offer on-site services for managing the ERP training, data entry, reports, etc. The service-consumers will be in the order of several millions of citizens.

11 Future of Open Source-2013, Survey Results, Black Bridge and Black Duck Software, 2013, <http://www.blackducksoftware.com/news/releases/seventh-annual-future-open-source-survey-results-show-culture-quality-and-growth>

12 All about Open Source - An Introduction to OSS for Government IT, Version 2.0, April 2012, https://www.gov.uk/Government/uploads/system/uploads/attachment_data/file/78959/All_About_Open_Source_v2_0.pdf

13 Open Technology Development (OTD) - Lessons Learned & Best Practices for Military Software, 16/05/2011, <http://mil-oss.org/otd>

14 Contribution of open source to Europe's economy: Euro 450 billion, <https://joinup.ec.europa.eu/news/contribution-open-source-europes-economy-450-billion-year>



7 Types of OSS Support Models

Generally software support is required for operations and source code level modifications/enhancements. Engagement of vendor for OSS support is also follows similar approach as described below:

a) Operational support for software:

Operational support is a mechanism to run the software with the day-to-day operational requirements; also designing/developing applications based on the software but not involving modification or customisation to the source code.

b) Source code level support:

Source code level support is a mechanism to update or enhance the source code of the software to support additional features, to meet security requirement or fix vulnerabilities and bugs.

For most of the Government applications, operational level support is only required. For most OSS software, operational level support can be availed from multiple vendors within the country.

Government applications rarely require source code level support. Source code support is generally available from the communities/vendors for the respective Open Source Software. Availing the support from the community provides the advantage of staying with the original software distribution. Engaging third parties for source code level support may lead to branching from the software distribution of the mainline community/vendor. To maintain the branched version of the software requires additional effort, technical expertise and resources. Therefore, it is prudent to use community support as that is the practise worldwide.

Governments, in general, prefer to have more number of competing vendors to get quality support services on the chosen OSS as the multiple-support approach offers more flexibility and enhanced competition. The four most common types of OSS source code level support models are out lined below, along with their flexibilities. This helps to select the right support model for the OSS chosen by the Government¹⁵:

iii. Pure Open Source

Selling of “Support and Services” is the main feature of this model. No vendor lock-in exists.

Under this model, the OSS solution is managed / driven mostly by a community / foundation; for example, each of the OSS solutions like Apache-HTTP, PostgreSQL, Drupal, Eclipse is managed by a separate OSS community / foundation. A single edition of the OSS is released & maintained by the OSS Community. In general, there is no branding / marketing / certification of the OSS solution by the community. Multiple competing vendors offer support services / certification on each OSS solution. For example, PostgreSQL is supported by many professional support service companies¹⁶. The Government is not locked in to a single-vendor for availing the support services on the OSS. This approach gives the most flexibility for the

¹⁵ <http://www.openlogic.com/blog/bid/156899/Selecting-Your-Open-Source-Support-Vendors-And-What-Their-Business-Model-Means-to-You>

¹⁶ Professional Support on PostgreSQL http://www.postgresql.org/support/professional_support/



Government since, they can decide at any time to avail the operational support services from any other vendors or through internal experts. Source code level support is community based.

iv. Certified Distribution Model

Selling of “Subscriptions, Solutions and Support” is the main feature of this model. Some level of vendor lock-in exists.

The OSS solution is managed / driven mostly by a single-vendor company under this model. Example is the RHEL Operating System, which is managed / driven by Redhat. Several editions are released and maintained by the single-vendor company. The single-vendor company takes an OSS edition (for example, Fedora) and do additional testing, branding, certification or bundling, and the company releases the certified paid-for-fee edition (for example, RHEL) for the enterprises. There is no provision to have multiple competing vendors to offer support services / certification on the paid-for-fee edition. Only, the single-vendor company or its authorised franchises are allowed to offer support services. Hence the Government is locked in to a single-vendor company for availing the support services. This approach gives lesser flexibility to the Government.

v. Open Core Model

Selling of “Subscriptions” for a Proprietary Version is the main feature of this model. Same level of vendor lock-in, as in CSS, exists in this model.

Under this model, the OSS solution is managed / driven mostly by a single-vendor company. Example is the “Postgres Plus Advanced Server” which is managed / driven by a single-vendor company, EnterpriseDB. The single-vendor company takes the OSS edition (for example, PostgreSQL Community Edition) as a core and creates a separate layer by adding additional functions, testing, branding, certification or bundling; and the single-vendor company releases the additional layer along with the core as a paid-for-fee for the enterprises. The source code of the value added layer is not released under OSS license. Only, the single-vendor company or its authorised franchises are allowed to offer support services on the paid-for-fee edition. Hence the Government is locked in to a single-vendor company. The Open Core model is similar to proprietary software model except that the core is released under OSS license. The use of such model in e-Gov is not generally preferred.

vi. Multiple Licensing Model

In multi license model, the software is made available in two or more licenses with different terms and conditions. Usually the copyright owner of the software releases the software under copyright license which enables creating or deriving proprietary version of the software by copyright owner; while other licences would be based on copy left license which requires any derived work to be released under the same license. The complete control (including copy right to the source code, intellectual rights, trademarks, etc) of the OSS project is held with a single-vendor company. The single-vendor, in general does not allow the modifications to the source base. In case the single-vendor allows such modifications, the contributor has to transfer the copyright to the single-vendor.

Retaining Flexibility

The OSS based application will be given rating using a suitable rating mechanism based on the criticality of the application. The support model will be chosen based on the ratings.



Government needs to ensure continued-support for the open source solution even if a vendor decides to terminate support to it. If multiple vendors compete to offer support services to the open source solution, it is good for the Government since it increases the competition. On the other hand, if a single-vendor company controls the open source solution, then there is more risk of switching to alternative company in order to get the continued-support on the open source solution. Except the “Pure Open Source” model, all other support models, in general, are controlled by single-vendor and hence pose a potential risk.

The major motivation for adopting OSS is to have multiple choices for the software solutions and more competition but without any lock-in. If any support model creates the lock-in under the name of OSS, the major purpose for opting OSS is defeated.



8 OSS Licenses

Basics of OSS Licenses

This section suggests a simple and effective classification and management of OSS solutions based on the category of licenses. The classification terms¹⁷ are commonly used from the point of adopters of OSS.

Based on the conditions / protections available on the OSS solution, the OSS licenses are classified¹⁸ as Highly Liberal, Liberal, Less Protective, Protective and Highly Protective licenses with the restrictions increasing respectively. Legal advice to be sought is also based this level. Liberal type license is also known as Permissive, Non-Viral or Academic license. Protective license type is also known as Reciprocal, Restrictive, or Copy Left license.

All types of protective licenses (like GPL, LGPL, and AGPL) ensure the availability of modified OSS libraries under OSS license. The Liberal licenses (like Public Domain, MIT, BSD, Apache) restrain the release the modified OSS libraries under OSS license.

The OSS with liberal licenses can be used along with other applications / libraries which have OSS licenses or CSS licenses.

Protective licenses (like GPL-v2) allow users to run, copy and modify the software, and distribute the modified software. However, users are not allowed to add their own restrictions. Also the modified software must be released under the same licensing terms.

Less Protective (like LGPL, MPL, EPL) license allows linking an unmodified OSS library to any application / library. Hence the use of unmodified OSS library (with licenses like LGPL, MPL, EPL) does not require the release of the application source to be open. The license obligations of OSS are to be adhered and necessary legal opinion may be sought.

Some public agencies, especially in USA¹⁹ and European Union²⁰, prefer to publish all software developed for any government department, under OSS licence. This model of releasing e-Governance application under OSS license allows the use of all types of OSS licenses (including Protective licenses like GPL / AGPL).

vii. Overview of OSS Licenses

The commonly used OSS licenses are depicted in the following matrix below. In this, the rows indicate different types of licenses and columns indicate different usage

¹⁷ Free And Open Source Software Licensing Primer, by "Shun-ling Chen", Published by IOSN & UNDP-APDIP and Elsevier, 2006, ISBN-13: 978-81-312-0422-1 ; ISBN-10: 81-312-0422-7, <http://www.iosn.net/licensing/foss-licensing-primer/foss-licensing-final.pdf>

¹⁸ OSS Licensing Overview, <http://opensourceforamerica.org/learn-more/oss-licensing-overview/> ; The Mozilla Public License Version 2.0: A Good Middle Ground?, <http://julien.ponge.org/notes/mozilla-public-license-v2-a-good-middleground/>

¹⁹ Open Technology Development (OTD): Lessons Learned & Best Practices for Military Software. 2011-05-16 <http://dodcio.defense.gov/Portals/0/Documents/FOSS/OTD-lessons-learned-military-signed.pdf>

²⁰ Introduction to the EUPL licence <https://joinup.ec.europa.eu/software/page/eupl/introduction-eupl-licence>



Environment for OSS-library Use License Type	OSS-library hosted without modified source	OSS-library hosted with modified source	OSS-library distributed to customer without modified source	OSS-library distributed to customer with modified source
Highly Liberal (Public Domain, MIT)	Violet	Violet	Violet	Violet
Liberal (Apache-v2, BSD(New))	Violet	Violet	Violet	Yellow
Less Protective (LGPLv2, MPL, EPL, LGPLv3)	Violet	Violet	Violet	Blue
Protective (GPLv2, GPLv3)	Violet	Violet	Blue	Blue
Highly Protective (GPL3 Affero)	Blue	Blue	Blue	Blue
Violet denotes the OSS license with less or no restrictions for the particular environment.				Violet
Yellow denotes the OSS license with moderate protection for the particular environment.				Yellow
Blue denotes the OSS license with more protection for the particular environment.				Blue

The detailed description of these licenses and guideline for selecting the appropriate OSS libraries based on OSS licence type can be referred at UNDP Report on OSS Licensing²¹

21 FOSS Licensing <http://www.iosn.net/licensing/foss-licensing-primer/foss-licensing-final.pdf>



9 Interoperability & Open Standards

Open Standards plays an important role in fostering healthy competition, enhancing the interoperability among e-Governance Systems and better communication among all stakeholders.

Open Standard is defined by each country or Public agency. Government of India has brought out “Policy on Open Standards for e-Governance” in November, 2010 to enhance the standardisation activities in India²².

i. OSS and Open Standard

"Open Standard", in general, refers to a technical specification as a result of consensus during formulation and ratification stages.

OSS refers to the implementation of technical specification by a community using Open Source licensing and collaborative contributing model; The licensing and contributing model may vary from one community to another.

Though OSS and Open Standard concepts are similar in terms of availability of specification, cooperative development-model but still there are some differences.

ii. Significance of Open Standards on OSS

Migration from CSS to OSS and vice-versa is made easier by Open Standard. Mandating Open Standards has a complementary effect on OSS systems, introduces increased competition and facilitates better compatibility between CSS & OSS.

The availability of an OSS reference implementation would spur quicker adoption and acceptance of the standards as the implementation of the standard is available for reuse. Examples include HTML5, JavaScript, etc.

²² Policy on Open Standards for e-Governance, <https://egovstandards.gov.in/policy>



10 Security Aspects in OSS

i. Multi-User based OSS System

OSS systems are mostly based on the multi-user, network-ready UNIX model which has a strong security and permission structure. Even then vulnerabilities in applications result in limited security breach in OSS systems. But, availability of the source code for OSS systems helps the developers to discover and fix vulnerabilities.²³ For example, TCP/IP, HTTP, DNS, SMTP & IMAP.

ii. Vulnerability & Bug-Fixes

Since bugs and security vulnerabilities are disclosed in OSS the service-providers can fix bugs and vulnerabilities in OSS source code. Whereas in CSS systems the CSS vendors are involved in bug fixing activities. In general, well-known OSS has potential for faster release-cycle of bug-fixes and the security of OSS is better because the bug and security vulnerabilities are frequently fixed within the respective OSS Community. The security practices are often backed by Commercial support services agencies that also support indemnification; this has a dramatic effect on the roll-out of the systems which are based on OSS.

iii. No Hidden Malicious Code

The security-threats, like hidden back-doors or holes in software, in current ICT infrastructure have encouraged many Government organisations to switch over to OSS. Intentional hiding of security-holes is very rare in OSS and is detectable due to review process. Thus by minimizing security threats, strategic control is far better with the use of OSS.

iv. Establishing Enterprise Security with OSS

OSS Systems tend to be generally more secure and are being used by banks, finance and insurance companies²⁴.

Organisations²⁵ need to ensure that the right level of expertise exists with all types of support providers including in-house experts. Adequate maintenance and support services should be made available for OSS as in the case of CSS, in order to minimise the risk.

A central core group of ethical hackers should continuously look into the vulnerabilities and loop holes of OSS solutions. Support should be taken from communities and Non-Profit Organizations promoting OSS who provide security patches/updates.

The OSS solutions should be tested for security threats by Academic community of Computer Science and the issues if any may be used for student projects to get the solutions.

Other security implications exists both in OSS as well as CSS, like older versions getting outdated and no longer having support from respective communities. Some of the generic security guidelines are as follows:

²³ Why FOSS? - http://en.wikibooks.org/wiki/FOSS_A_General_Introduction/Why_FOSS%3F

²⁴ Wall Street Opens Doors to Open Source Technologies - <http://www.wallstreetandtech.com/it-infrastructure/wall-street-opens-doors-to-open-source-t/217400216>

²⁵ Section 4.1, A Guide to Open Source Software for Australian Government Agencies, Version 2.0, June 2011 - <http://www.finance.gov.au/files/2012/04/AGuidetoOpenSourceSoftware.pdf>



Framework for Adoption of Open Source Software in e-Governance Systems

- (a) Protect network with a strong firewall
- (b) Secured Remote Access
- (c) Securing Data on local desktops, laptops and tablets using encryption
- (d) Securing Wi-Fi access points
- (e) Adopting Best Practice for System Administration
- (f) Secured Internet Access from Intranet through Web Proxy.

The above guidelines are described in <Annexure-V> “Guidelines for Establishing Enterprise security with OSS”.



11 Unified Software Development for Mobile, Tablet & Desktop

Traditionally, e-Governance applications have been developed for desktops and then customised for various types of mobiles & tablets using native approach.

i. Mobile-Native Approach

The native traditional applications were opted in the early years for mobiles; this created native applications for specific mobile platform using its native Software Development Kits (SDKs) & languages. One has to learn different OS, their SDKs & programming-languages if the application is expected to run on different types of mobiles like Android, Apple, Symbian, Window Phone, Blackberry, etc. This approach utilises the native features of the mobiles effectively.

ii. Emergence of Alternative Approaches

The explosion of varieties and types of mobiles, especially smart-phones with HTML5 browser, has challenged native applications adoption. In 2011, there were about 336 million HTML5 capable mobiles sold. As per the report²⁶, Research firm Strategy Analytics forecasts that one billion HTML5 capable mobile devices would be sold in 2013. ABI Research sees more than 2.1 billion mobile devices with HTML5 browsers by 2016. IDC estimates indicate that over 80 percent of all mobile applications would be wholly or partly based on HTML5 by 2015.

Alternative approaches are being explored to simplify the application development process since there has drastically changed due to the emergence of HTML5 based Open Web Technology (OWT) and Cloud Technology.

OWT characteristics are as follows:

- Adherence to Web Standards,
- Wide-adaptability,
- Develop & run the same on all devices,
- Provision of separation of presentation and logic,
- Facility to create rich client with highly scalable thin server,
- In-built methods based on standards to send software updates,
- Provision to exploit the generic and native features of mobiles.

²⁶ What to Expect from HTML5 in 2013, by Fahmida Y. Rashid, December 9, 2012, <http://html5center.sourceforge.net/blog/What-to-Expect-from-HTML5-in-2013>



12 Rapid Application Development Environment for OSS

The manually edited software is highly efficient for building, maintaining and modernising business-critical Web 2.0 applications. However, it is difficult to follow the same process every time as it takes more time to deliver the solution. A Rapid Application Development (RAD) environment with visual, WYSIWYG development studio or a set of reusable drag-and-drop components / templates is required to meet quick delivery schedule.

In general, RAD solutions are used for the development of OSS applications to meet quick delivery schedule.



13 Localisation and OSS

Localisation involves taking a software product and making it linguistically and culturally appropriate for the target country/region where it would be used and distributed. OSS has an advantage in this area because of its open nature. Users are able to modify OSS to meet the localisation requirements of a particular region.

Localised version of any OSS helps in reaching out to the rural population and the people living in remote areas in India, thus bridging the digital divide in the country.

C-DAC has indigenously developed, Bharat Operating System Solution (BOSS), an OSS based OS with Indian language interface. Bharateeya Open Office developed by CDAC supports Indian languages. Industry in India is also aggressively working on localisation efforts. Major South eastern Asian countries like China, Japan and Korea are also actively pursuing OSS localisation.



14 Device Driver

When implementing e-Governance systems, the Device Drivers are available for Windows Operating Systems (OS) as a default. However, Device Drivers are not easily available for GNU / Linux Operating Systems which is also widely-used in Computers and Peripherals deployed in the roll out of e-Governance systems. Users should ensure the availability of device drivers for GNU Linux Operating systems while procuring Computers and associated Peripherals.



15 Procurement Guidelines

Standardised common methodology should be developed for rating OSS against another OSS for Indian scenario as indicated on <Annexure-VIII> "Rating of OSS against other CSS using Business Metrics". A set of guidelines on inclusion of clause related to OSS solutions in procurement should be brought out.

i. Guidelines for Procurement

Some of the important factors, which could be considered for the inclusions in tender terms and conditions while procuring / selecting ICT solutions, are given below: **Preferred Option** - OSS should be considered as a preferred option.

- (a) **Essential functionalities** – To save resources only the required functionalities should be specified, instead of over-specifying the requirements.
- (b) **Customisation Cost** - If the solutions to be acquired need further customisation for adoption, then the factors like cost of customisation, support & maintenance cost, flexibility on engaging competing agencies, legal / licensing obligations, etc. should also be considered.
- (c) **Security** - The security requirements of the solutions should be considered on a case-to-case basis.
- (d) **Survival-ability** – The planned continuity of the solutions with further developments till their life-cycle mitigates the risks related to change over to another solution in future.
- (e) **Compliance with Open Standards** – The compliance on Open Standards should be mandated
- (f) **Transferability / Reuse** – The flexibility of using / reusing the solution in different scenarios (use in conventional systems, virtual machines, cloud systems, emulated systems, etc.), locations (anywhere in 3-tier Government Architecture) and its financial implications should be obtained.. Appropriate structure and guidelines need to be established for shared solutions on e-Governance application between Government / Public agencies through efforts like eGov-AppStore, Mobile-Seva-AppStore.
- (g) **Maturity** - Its adaptability, activity, longevity, services available on it, documentation, integration, security, skill set availability should be considered.
- (h) **Maintenance and support services** - The quality level of support and maintenance services expected to meet the requirements should be specified in the tender specifications as a mandatory condition to mitigate the risks.
- (i) **Lower barriers for SME** - Appropriate steps should be taken to avoid the elimination of firms with good OSS skills and track records from tendering processes based on turn-over conditions. Separate tender conditions (like years of operations, turn-over and number of manpower, number of projects executed) should be set with appropriate lower values for encouraging the participation of SMEs.

The relevant factors are required to be analysed and documented for procuring / selecting ICT solution.



ii. Rating of OSS

If the OSS solution is to be evaluated against CSS solution, then models like (i) Total Cost of Ownership (TCO), (ii) Return on Investment (RoI), (iii) Internal Rate of Return (IRR) could be considered. If required, these models could be analysed to select / customise a suitable model; these are discussed in <Annexure-VIII> "Rating of OSS against other CSS using Business Metrics".

The selection process for selecting a suitable OSS is discussed in <Annexure-IX> "Rating of OSS based on Performance matrix".

iii. Total Cost of Ownership

In general, only the software licensing cost is considered while acquiring CSS or OSS. However, other costs towards search, exit, transition, additional hardware, training etc., are also to be accounted under the Total Cost of Ownership (TCO)²⁷; this gives the overall picture of the savings resulting from the use of OSS. Cost comparison model should address factors like investing money in local IT industry for availing support services instead of acquiring software, enhanced local ecosystem (SMEs, Knowledge base), preservation of foreign exchange, improved negotiating power of entire Government as a single entity, etc. All assumptions should be specified while calculating the TCO. The metrics along with other technical points influence the decision-makers to opt for OSS solution while developing e-Governance systems. The details of TCO are given in <Annexure-VIII> "Rating of OSS against CSS using Business Metrics". Suitable TCO model, after customisation to suit local conditions, should be brought out.

²⁷ Total Cost of Ownership of Open Source software: a report for the UK Cabinet Office submitted by Shaikh, Maha and Cornford, Tony, London School of Economics and Political Science, 2011, <http://eprints.lse.ac.uk/39826/>



16 Stages for induction of OSS Solution

Stages for the induction of OSS solution include the following;

- (a) **Exploration & Testing:** First of all the available set of OSS solutions need to be explored. The required ones may be filtered based on some key parameters such as type of license, functionality, availability, longevity etc., The filtered OSS software solution may be downloaded and installed to make it work as per the instructions given in the documentation. Then it needs to be tested for its functionality, performance, security etc. Finally the tested solutions meeting the benchmarks may be selected for PoC.
- (b) **Proof of Concept (PoC) for confidence building:** For confidence building the facilities and functionalities of the selected OSS solution are required to be shown in some of the Projects. Thus it is required that PoCs are conducted to explore capabilities of these solutions for various project requirements.
- (c) **Training & Hand-holding:** Once the OSS solution is made ready for a project, training should be given to the concerned project teams, so that further development and maintenance becomes easier. User manuals, Technical Documents should be prepared and handed over to the project team. Backup mechanisms, recovery mechanisms should be mentioned clearly.
- (d) **Roll-out in live Systems:** While implementing the tested solution in LIVE systems, proper and routine monitoring should be done. Regular backup of application-data should be taken. The OSS solution should be maintained in the repository.
- (e) **Creating Multiplication Effect:** The OSS solution once implemented in one project should be reused for other similar projects with some customisations as per the project requirement.



17 Proposed Ecosystem for Promotion of OSS

Ecosystem includes Institutional Mechanism, Partnership with Industry, Academia and OSS Community. Support services would be provisioned and collaborative mechanism solutions will be established.

i. Creation of Institutional Mechanism

- (a) Apex Body should drive the OSS initiatives; the stake-holders include DeitY, NIC, CDAC, STQC, Industry representatives, nominated officials from line Ministries of Centre, State Governments and R&D Institutes. Academia and OSS Communities should be linked suitably. The uniform guidelines should be prepared in the consultative mode and it should be adopted by all stakeholders to eliminate duplicate efforts. This would facilitate better interoperability / integration of e-Governance systems.
- (b) The entire program may be sub-divided into few sub-programs and each sub-program may be executed by separate public agencies such that they complement each other. Necessary funds, human-resources and hired-resources should be provided to offer adequate support services, consultancy services on the adoption of OSS through help desk.
- (c) Expert Committees / Specialist Committees should be formed under program implementing agency and they shall be assigned the tasks related to OSS Stack, etc. The Committees would submit the draft reports for obtaining feedback from stakeholders. They would update the drafts and submit to the Apex Body for ratification.
- (d) Key Stakeholders for sustaining the momentum on OSS Adoption would comprise of Senior Management, Project Managers, System-Developer, System-Integrators, Service-Providers, Product-Partners, Technology Experts, End-Users and Consultants; these are outlined in <Annexure-X> "Key Stakeholders of Ecosystem"

The awareness programs on OSS adoption in e-Governance Systems would be offered to the experts from the Ecosystem. Detailed capacity building programs would be offered to System-Developer, System-Integrators, Service-Provider and Technology Experts from Government organisations.

ii. Partnership with Industry (including SMEs)

A forum may be created for the collaboration between Industry (including SMEs) and Government users in order to have better understanding on requirements and capabilities in adopting OSS. Some of the expected services from Industry are;

- (a) Development, Staging and Maintenance of e-Governance applications using OSS Stack
- (b) Publishing information, maintaining knowledge repository & creation of awareness about OSS
- (c) Capacity Building on OSS
- (d) Maintaining repository for each component of OSS Stack
- (e) Creation and Offer of pre-configured, integrated and packaged OSS Stack for use & reuse at data centres



- (f) Supply of hardware with pre-installed OSS operating system & solutions
- (g) Development of particular OSS solution to fill the gaps, if needed.
- (h) Support on achieving strategic objectives of government rather than direct cost benefit

iii. Partnership with OSS Communities in India & Abroad

Government may consider sponsoring the activities of OSS Community. The type of sponsorship may be in any of the forms listed below:

- (a) Creating Repository/Mirror sites of OSS solutions listed in the OSS Stack
- (b) Providing hosting services
- (c) Providing Human Resources / Code/ Documentation contributions
- (d) Subscribing membership
- (e) Sponsorship for the travel of experts from abroad to participate in conferences/workshops/trainings/seminars in India

iv. Engaging Academia

Sponsorships for Student Projects used in e-Governance (Development/ enhancement of OSS solutions/products/Documents).

- (a) Incentives for faculty for managing OSS projects
- (b) Awards for best Open Source Student Project
- (c) Award for Institute – Contribution to OSS
- (d) Awareness / Capacity Building Program on OSS

It is proposed to form Working Groups to enhance OSS course development, e-learning and collaborative learning, application of Open Source methodology and business models for real world scenarios in e-Governance.

The courses will include, philosophy & methodology in OSS, software engineering based on OSS, use of OSS Desktop applications and Linux OS, OSS Servers (including servers for Web, Application, Database, Infrastructure) & OSS Applications based on them, Software Development Solutions; the courses may be at the certificate level, degree level and post-graduate level.

The community approach used by some Indian institutes²⁸ can be considered for the generation of trained manpower.

The working groups should include OSS Technology Experts, Teachers and Academicians.

²⁸ Spoken Tutorial, Indian Institute of Technology, Bombay, Mumbai at <http://spoken-tutorial.org>



v. Collaborative Mechanism

Enhanced Collaborative mechanism (like help desk, knowledge portal, issue tracking system, discussion forums, e-mail support, and telephone) should be established for the adoption of OSS. Preparation of reports, creation of central repository of components of OSS Stack and integration methodologies should be carried out with the support of Industry & Academia for sharing with other stack holders.

vi. Provisioning of Support Services on OSS

The proposed division should provide multi-level support for the adoption of OSS as listed below:

- (a) Help-desk,
- (b) Core-team and domain-consortia as part of in-house experts,
- (c) Hired-resources from Industry,
- (d) System-Partners from Industry (who run the operations),
- (e) Specific-Solution-Partners from Industry (who fix/enhance the source code of the OSS) and
- (f) Technology Domain experts from Community, Academia, R&D Institutes and Government.

In addition to the central mechanism for support services, the Government should take initiatives for setting up OSS Support centres throughout the country. Services from Industry should also be utilised for this purpose.

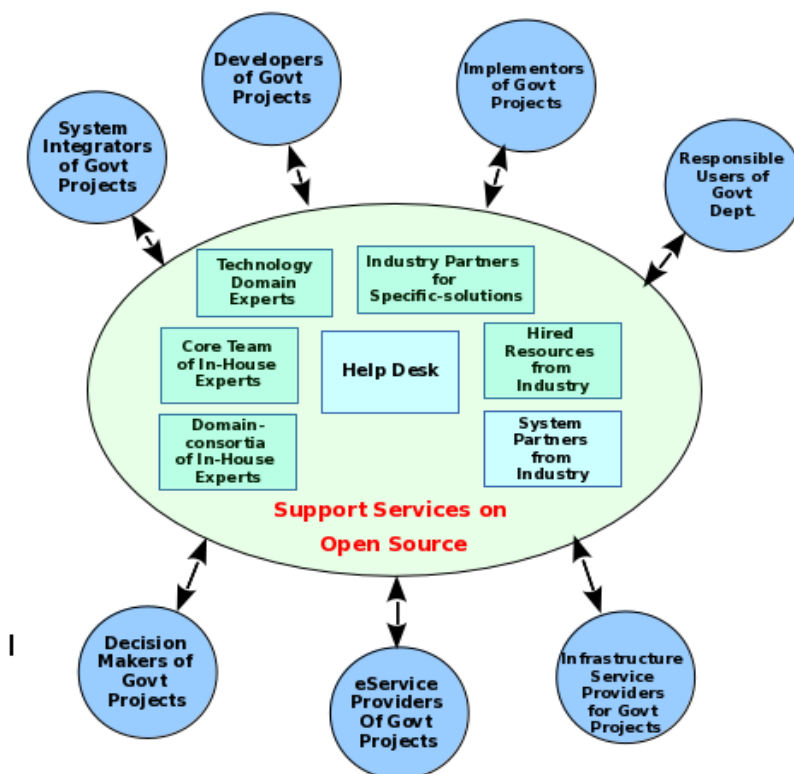
In-House Experts should work on exploration of technology, internal support and domain-consortia forums.

vii. Target Groups for Services on One Stop Solutions on Approved OSS Stacks

The Services can be availed by

- (a) System Integrators of Government Projects
- (b) Developers of Government Projects
- (c) Implementers of Government Projects
- (d) Responsible Users of Government Department
- (e) Decision Makers of Government Projects
- (f) e-Service Providers Of Government Projects

(g) Infrastructure Service Providers for Government Projects



viii. Promotional Mechanism on the Adoption of OSS

- (a) Provisioning of bundled & identified OSS Stack with appropriate fine tuning, hardening and security patches. The stack can be reused in software development, staging and deployment environments on virtual images / clouds available in other locations. The stack should also be provided with support services and source-code level enhancements. This will motivate the e-Governance implementers to come forward for the adoption of OSS.
- (b) Capacity Building for in-house experts and policy makers by way of on-the-job training, class-room training programs and work-shops should be conducted.



18 Summary of Recommendations for Adoption of OSS Framework

This section summarises the recommendations for the adoption of OSS.

i. Recommendations for Implementing Agencies for OSS Framework

- (a) Preference should be given to select OSS libraries which have liberal and less restrictive license model.
- (b) Selecting appropriate OSS stack for development of applications and infrastructure is crucial for performance and sustained support..
- (c) Establish Multi-Level Support Services on the adoption of OSS.
- (d) Provisioning of application development, staging and deployment environments for the reuse of Open Source Stacks with support services.
- (e) Offer services for preferred areas and provide support.
- (f) Continue R&D efforts in OSS in identified thrust areas.
- (g) National repositories/ knowledge banks should be created for OSS solutions, technologies and applications.
- (h) Development of two tool-kits (one tool-kit for rating OSS against another OSS and another tool-kit for rating OSS against CSS) should be brought out.
- (i) Develop a mechanism/tool to rate the OSS based application based on the criticality of the application.
- (j) Transferability of ICT Assets (which facilitate the reuse) with in all levels of Government and public agencies without additional expenses should be considered while procuring them.
- (k) The distribution of the modified source code and executable of the OSS across various units of the single Government entity should be considered as internal distribution.
- (l) Use of OSS in Government Departments along within skill development programs should be encouraged.
- (m) The security of OSS solutions under OSS Stacks should be enhanced by creating a two layered internal & external audit mechanism and retrofitting mechanism under the proposed structure.
- (n) OSS application development with Indian languages interface should be encouraged.
- (o) Simpler & easier Software Development with GUI, Meta-Language and Templates should be provided, as a RAD environment, to achieve faster adoption of OSS in order to meet the quick delivery schedule.
- (p) The guideline on influencing factors for the adoption of OSS should be brought out by customising for Indian Scenario.
- (q) Enforcement guidelines on Open Standards Policy of Government of India should be brought out to



accelerate the adoption of OSS.

- (r) The model used by some Indian Institutes may be considered for creating training and learning materials using the community approach.
- (s) Development of a community engagement model to encourage internal developers to participate in the open source community under the appropriate policies and engage with external developers

ii. Recommendation for E-Governance Project Implementation Teams

- (a) Since many social, economic and strategic benefits are provided by the adoption of OSS, the OSS options should be considered seriously by the e-Gov planners, architects and developers.
- (b) This Framework should be used to expedite the adoption of OSS in e-Governance in India.
- (c) Focus on Preferred areas for adoption.
- (d) Since many socio, economic and strategic benefits are provided by the adoption of OSS, OSS should be considered as a preferred option.
- (e) Preference should be given to “Pure Open Source Model” for availing the support service on OSS.
- (f) Government Agencies and Departments should seek to avoid vendor lock-in to proprietary IT products and services. RFP (Request for Proposal) documents should avoid using vendor specific product/brand names.
- (g) Applications developed by the Government of India should be cross platform and not be locked in to a specific platform.
- (h) For Government funded software research and developments in India, scientists/ researchers should be encouraged to publish their innovations under Open Source and Open Document licenses, except for security reasons.
- (i) Large Projects should be split into smaller Projects for development by different parties/vendors/SMEs and integrated & implemented by the project teams. This will reduce the amount of resources required for the smaller project, encourage SMEs participation, reduce the risks in ICT projects and facilitate the adoption of OSS.
- (j) Open Web Technology should be preferred to develop once and run the same on all devices. Device Specific Development (Desktop, Tablet, Mobile, etc.) should be discouraged.
- (k) Code contribution to OSS community should be encouraged.

iii. Recommendations related to RFP/Procurement

- (a) OSS Solutions should be considered as preferred option in IT procurements by Government of India. In cases where the merits of OSS and CSS are comparable, contracts could be awarded to OSS solutions in recognition of issues like value for money as well as enhanced strategic control, security, reuse, cost saving, knowledge society creation, adherence to Open Standards etc. which are hard to quantify.



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- (b) Vendors must provide justification for exclusion of OSS in their responses to RFPs (Request for Proposals).
- (c) Hardware and peripherals procured by Government Agencies and Departments should have support for Open Source device drivers for ensuring interoperability of systems.



Annexure-I Typical OSS Stacks for Java, PHP and Open Web Technologies

This section lists the recommended Open Source Software Stack for developing and deploying e-Governance Applications. It also includes Open Web Technology (OWT) Stack for development of new projects to work on desktops, varieties of mobiles & tablets.

Legends

“xxxxxxx ^C ”	This notation indicates that the solution/language “xxxxxxx” is a well-accepted “core product”.
	This colour denotes set of Minimal Core OSS solutions for Application Development & Deployment
	This colour denotes set of Minimal Core OSS solutions for Application Development Specific case & for Infrastructure
	This colour denotes set of Additional OSS solutions for Building Mobile Native (OS-Android, iOS, Windows Phone, BlackBerry, Symbian) Applications (Development & Deployment) using HTML, CSS, JavaScript.

Note:

1. The software stack given below is updated in February 2015.
2. “No Discrimination” indicates that the set of tools under this column may be considered as the next best option after the tools in the column marked “Preferred”.



		Functional Areas for Tools	New Projects		Legacy Projects			
			OWT Technology Stack		Java Technology Stack		PHP Technology Stack	
			Preferred	Remarks – No discrimination	Preferred	Remarks – No discrimination	Preferred	Remarks – No discrimination
Minimal Core Solutions	Solutions for Application Development & Deployment	Programming Language Client-side	HTML (5.0), CSS (3.0), JavaScript (1.8.x), JQuery (2.1.x)	HTML (5.0), CSS (3.0), JavaScript (1.8.x), JQuery (2.1.x)	HTML (5.0/4.01), CSS (3.0/2.1), JavaScript (1.8.x), JQuery (2.1.x)			
		Relational Database	PostgreSQL Community Edition ^c (9.4.x)		PostgreSQL Community Edition ^c (9.4.x/8.4)	MariaDB Community Edition (10.0.x)/ MySQL Community Edition ^c (5.6.x)	PostgreSQL Community Edition ^c (9.4.x/8.4)	MariaDB Community Edition (10.0.x) / MySQL Community Edition ^c (5.6.x)
		Web Service Framework	Apache CXF (3.0.x) with Apache Tomcat ^c (7.0.x)	Symfony (2.6.x)	Apache CXF (3.0.x) with Apache Tomcat ^c (7.0.x)		Symfony (2.6.x)	CakePHP (2.6.x)
		Web / HTTP Server	Apache HTTP Server ^c (2.4.x)	Nginx (1.6.x)	Apache HTTP Server (2.4.x/2.2.X)	Nginx (1.6.x)	Apache HTTP Server (2.4.x/2.2.X)	Nginx (1.6.x)
		Programming Language Server-side and Library	Core Java, OpenJDK ^c (1.7)	PHP (5.6.x/5.5.x/5.4.x/5.3.x)	Core Java, OpenJDK ^c (1.7/1.6)		PHP (5.6.x/5.5.x/5.4.x/5.3.x)	PHP (5.6.x/5.5.x/5.4.x/5.3.x)
		Server Side Framework			Apache Wicket Framework (6.x /1.5/1.4) with extensions	Struts (2.3.x) / Spring (4.x)	Symfony (2.6.x) with extensions	- CakePHP (2.6.x)
		Application Server					Apache HTTP Server (2.4.x/2.2.X)	Apache HTTP Server (2.4.x/2.2.X)
	Solutions for only Application Development	IDE	Eclipse ^c (4.x) with extensions	- Netbeans (8.x)	Eclipse ^c (4.4.x) with extensions	- Netbeans (8.x)	Eclipse ^c (4.4.x) with extensions	- Netbeans (8.x)
		Source Code Control	Apache Subversion ^c (1.8.x)	- Git (2.3.x)	Apache Subversion ^c (1.8.x)	- Git (2.3.x)	Apache Subversion ^c (1.8.x)	- Git (2.3.x)
		Documentation	LibreOffice ^c (4.x)	- Openoffice (4.x)	LibreOffice ^c (4.x)	- Openoffice (4.x)	LibreOffice ^c (4.x)	- Openoffice (4.x)
	Solutions for Infrastructure	Server Operating System	CentOS ^c (7.x)	Ubuntu(14.04/12.04/)	CentOS ^c (7.x/6.x/5.x)	Ubuntu(14.04/12.04/)	CentOS ^c (7.x/6.x/5.x)	Ubuntu(14.04/12.04)
		Desktop Operating System	Ubuntu (14.04)	BOSS (5.0) / Fedora (21.x)	Ubuntu (14.04/12.04)	BOSS (5.0) / Fedora (21.x)	Ubuntu (14.04/12.04)	BOSS (5.0) / Fedora (21.x)
		Authentication with Single Sign On	Central Authentication Service (CAS) (4.x/3.5.x)					
Directory Services		OpenLDAP ^c (2.4.x)						



Framework for Adoption of Open Source Software in e-Governance Systems

Solutions for Independent usage	Portal/CMS	Drupal ^C (7.3.x)		Liferay Community Edition (6.x)		Drupal ^C (7.3.x)	Joomla (3.3.x/2.x)	
	Digital Archival Repository	Dspace ^C (5.x)						
	Integrated Library Systems	Koha ^C (3.18)						
	E-learning	Moodle ^C (2.8.x)						
Additional Solutions	Solutions for Application Development & Deployment	Database Replication	SymmetricDS (1.7.16)					
	Building Mobile Native (OS-Android, iOS, Windows Phone, BlackBerry, Symbian)	Apache-Cordova (4.2.x) (PhoneGap)	Apache-Cordova (4.2.x) (PhoneGap)	- Not Applicable	- Not Applicable	- Not Applicable	- Not Applicable	
	Build Tool	Apache Maven (3.2.x)		Apache Maven (3.2.x)		Phing (2.10.x)		
	GIS Server	Geo Server (2.6.x)		Geo Server (2.6.x)		Map server (6.4.x)		
	GIS Desktop	Quantum GIS (2.x)	GRASS GIS (7..x), gvSIG (2.x)	GvSIG (2.x)	Quantum GIS (2.x), GRASS GIS (6.4.x)	Quantum GIS (2.x)	GRASS GIS (7.x), gvSIG (2.x)	
	GIS Database	PostGIS (2.x)		PostGIS (2.x)		PostGIS (2.x)		
	Non-Relational Database	Apache Cassandra (2.x)	- Apache Hbase (0.984) with Hadoop (2.6.0) - Apache CouchDB (1.6.x) (JSON Data Type only)					
	Object Relational Mapping	Hibernate (4.3.x)		Hibernate (4.3.x)		Doctrine (2.4.x)		
	Database Administration	PgAdmin III (1.20.x)		PgAdmin III (1.20.x)	PhpMyAdmin (4.3.x)	PgAdmin III (1.20.x)/phpPgAdmin(5.1.x)	PhpMyAdmin (4.3.x)	
	Database Reporting	Jasper Report (5.6.x) with iReport Designer (5.5.x)	Birt (4.4.x)	Jasper Report (5.6.x) with iReport Designer (5.5.x)	Birt (4.4.x)	MPDF (5.7.x)		
Solutions for Infrastructure	Virtualisation	Xen Server (6.5.x) / Xen Cloud Platform (XCP) (1.6/1.1)						

Cloud Platform

OpenStack (Version)	CloudStack (4.4.x)	OpenStack (Version 2014.2-Juno)	CloudStack (4.4.x)	OpenStack (Version 2014.2-Juno)			
	Video Conference	Apache OpenMeetings (3.0)		Apache OpenMeetings (3.0)		Apache OpenMeetings (3.0)	



Framework for Adoption of Open Source Software in e-Governance Systems

n 201 4.2- Jun o) Apa che Clo udS tac k (4.4 .x)	Solutions for Application Testing	Testing	QUnit (1.17.x) JUnit (4.x) Apache Jmeter (2.12) W3C markup Validators service		QUnit (1.17.x) JUnit (4.x) Apache Jmeter (2.12) W3C markup Validators service		Phpunit (4.x) Apache Jmeter (2.12) W3C markup Validators service	
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Annexure-II Illustrative list of OSS

S. No	Functional Area for Solutions	OSS	
		Preferred	Optional
1.	Java Programming Language Environment	IcedTea	
2.	PHP Programming Language	PHP	
3.	Document type for simple Hyper Text Web Content	HTML 5	HTML 4
4.	Document type for complex Hyper Text Web Content	HTML 5	XHTML 1.1
5.	Cascading Style sheet	CSS 3	CSS 2
6.	Client Side Scripting Library	jQuery	
7.	Java Framework	Apache Wicket	Struts, Spring
8.	PHP Framework	Symfony	CakePHP
9.	Python Framework	Django	
10.	Java Application Server	Apache-Tomcat	Jetty
11.	Java Enterprise Application Server	Apache-TomEE	jBoss (Community Edition)
12.	Web (HTTP) Server	Apache-HTTP	Nginx
13.	PHP Application Server	Apache-HTTP with mod-php	
14.	RDBMS Database Server	PostgreSQL	MariaDB
15.	IDE for Java	Eclipse-JDT	NetBeans
16.	IDE for PHP	Eclipse-PDT	NetBeans
17.	Documentation	LibreOffice	Openoffice
18.	Source Code Control	Apache Subversion	Git
19.	Performance Load Testing	Apache Jmeter	
20.	Java Unit Testing	Junit	
21.	PHP Unit Testing	Phpunit	
22.	PHP CMS	Drupal	Wordpress, Joomla
23.	Java Object Relational Mapping	Hibernate	MyBatis
24.	PHP Object Relational Mapping	Doctrine	Propel
25.	RDBMS Database Administration	PgAdmin	PhpPgAdmin
26.	Virtualisation	Xen Cloud Platform	KVM
27.	Cloud Platform	CloudStack, Meghdoot	OpenStack
28.	Server Operating System	CentOS , BOSS Advanced Server , Debian	Ubuntu Server
29.	Desktop OS	BOSS, Ubuntu ,	



S. No	Functional Area for Solutions	OSS	
		Preferred	Optional
		Debian, Fedora	
30.	Authentication with Single Sign On	Central Authentication Service (CAS)	Shibboleth
31.	Digital Archival Repository	Dspace	
32.	RDBMS Database Replication	SymmetricDS	
33.	Java GIS Server	GeoServer	
34.	PHP GIS Server	UMN MapServer	
35.	GIS Desktop	Quantum GIS	GRASS GIS, gvSIG
36.	Java Build Tool	Apache Maven	Apache Ant
37.	PHP Build Tool	Phing	
38.	Integrated Library Systems	Koha	Evergreen
39.	Video Conference	Apache OpenMeetings	Ekiga
40.	E-learning	Moodle	Sakai
41.	Directory Services	OpenLDAP	
42.	Graphics Applications	GIMP	Dia
43.	Audio/Video Applications	VLC, Movie Player	Rythmbox, Amarok
44.	PDF Reader	Evince	Okular
45.	PDF Creator	Libre Office	Open Office
46.	DVD/CD Burner	Brasero	K3B
47.	File Compression	7Zip, File Roller	Gzip, Tar
48.	Document Scanning	Xsane	Simple-Scan
49.	Vector Image Creation	Inkscape	Libre Office Draw
50.	PDF desktop publishing	Scribus	OpenOffice.org / LibreOffice
51.	Postscript view	GNU GV	Evince
52.	Mail Client	Thunderbird , Icedove	Evolution, Kmail
53.	Address Book	Evolution	KAddressBook
54.	Text Editor	gEdit	Kate
55.	Console Text Editor	Vi , emacs	Vim
56.	Chatting (Audio/Video)	Empathy, Pidgin	Kopete
57.	Image Viewer	Eye of Gnome	Gwenview
58.	File Transfer	Filezilla	Gftp
59.	Printer Management	CUPS	
60.	3D Creations Tools	Blender	K-3d
61.	Remote Management	VNC, RDP Vinagre	grdesktop
62.	Backup Software	Bacula	
63.	Network Monitoring Tools	Nagios	



S. No	Functional Area for Solutions	OSS	
		Preferred	Optional
64.	Antivirus	Clamav	
65.	FTP server	vsftpd	
66.	Email Server	Postfix	Sendmail
67.	Proxy server	Squid	
68.	Web Server Statistics	AWStats	Webalizer
69.	Blog Engine	Wordpress	
70.	Wiki	Mediawiki	
71.	Spatial Database	PostGIS	
72.	Project Management	DotProject	Redmine
73.	Issue tracking System	Trac	MantisBT
74.	Network Security Tool	Nmap	
75.	Calendar	Lightning	
76.	CRMApache Ofbiz		
77.	Diagram Creation	Dia	



Annexure-III SWOT Analysis of OSS Adoption²⁹

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of OSS Adoption are explained in this section.

Strengths

The strengths of adoption of OSS and the potential benefits are highlighted below;

- (a) **Freedom to Use & Reuse** Open Source licenses do not limit or restrict who can use the software, the type of user, or the areas of business in which the software can be used. Therefore, OSS provides a licensing model that enables rapid provisioning of both known and unanticipated users.

Because OSS is free from per user or per instance costs, there is a guaranteed freedom to use. Also re-use is enabled.

- (b) **Cost Effective** Public agencies get great value and the desired RoI (Return on Investment) from OSS based software-solutions.

- (c) **Help Innovation** It is easy to do pilot study and initial roll-outs using OSS with minimal acquisition cycles and associated entry costs. If required, CSS agencies can also be engaged to build value-added capabilities and innovations on top of OSS based software-solutions.

By virtue of their collaborative design, many user-facing OSS based products are intuitive.

Lower barriers to entry, widens participation. OSS is particularly suitable for rapid prototyping and experimentation, where the ability to “test drive” the software with minimal costs and administrative delays is required. CSS suppliers may also provide the same through a ‘proof of concept’ phase at minimal or no cost; but this approach includes lot of restrictions for use in other phases.

- (d) **Better Source Code Level Security** Increased confidence on the software due to the minimised mistrust on the code.

- (e) **Better Local Capacity Building** Increased local capacity building for software development based on OSS which leads to effective participation of local industries.

- (f) **Preservation of Foreign Exchange** Most of the CSS is imported and hence it drains foreign-exchange. The local support service is, in general, used for OSS adoption which will help local economy to grow; at the same time it helps to conserve foreign exchange and reduction of imports.

- (g) **Minimised Piracy** Avoidance of piracy and Intellectual Rights issues which are common with the Proprietary Technology

²⁹ Plone-CMS - Customer Segments - SWOT Analysis, 2008 (<https://plone.org/events/2008C-summit/customer-segments-swot-analysis#Government>)



- (h) **Community Support** Availability of Community Support is a key factor for adoption.
- (i) **Collaborative & Distributed Approach** This approach is used for developing OSS which has better governance structure.
- (j) **Better Interoperability** No vendor monopoly allows use of free and Open Standards. With Data transferability and open data formats, there are greater opportunities to share data across interoperable platforms. Adoption of OSS enhances the interoperability with other e-Governance Solutions because of reuse of recommended software stacks, libraries / components..
- (k) **Enhanced Competition** OSS can be operated and maintained by multiple suppliers encouraging competition and providing an opportunity for SMEs to compete in the Government market. This leads to code sharing cultures, better citizen accessibility, and greater control over IT projects. It reduces dependency on a particular software developer or supplier. It also means diversity of support and services choice.
- (l) **Growing and mature developer ecosystems** The numbers of community-developers and their quality / expertise are increasing for the popular OSS solutions. Hence, proprietary vendors also initiated their own OSS solutions.
- (m) **Rapid and effective vulnerability remediation**³⁰ The reported vulnerabilities are fixed immediately, in general for the popular OSS solutions.

Weaknesses

The weaknesses are existing challenges which are to be considered while adopting OSS; ways to mitigate the weaknesses are also highlighted below;

- (a) **Informal use of OSS** There are varieties of OSS solutions available for each domain area. Identifying, selecting and deploying a solution is not a simple task. No recommended OSS Stacks with ecosystem exist but informal use of Open Technology mainly prevails based on the preference / convenience / exposure of the project teams; this adversely affects
 - (i) Maintainability
 - (ii) Security
 - (iii) Bug-fixing
 - (iv) Interoperability & Sustainability
 - (v) Absorption of Technology by Experts
 - (vi) Lack in level of expertise on identified Technologies
 - (vii) Compliance to Security

³⁰ The Power of Open Source Collaboration Increases Vista EHR Security
<http://osdelivers.blackducksoftware.com/2013/12/02/the-power-of-open-source-collaboration-increases-vista-ehr-security/>



(viii) Sustainability of implementations

(ix) Ecosystem

(x) Related Intellectual Rights and Legal issues

The OSS Stacks are to be identified and notified for the adoption & reuse with support services in a formal way to mitigate the risks of informal use of OSS.

(b) Adverse Impact of legacy systems Mostly legacy infrastructure and expertise are used. Hence, policy makers and technical experts prefer to continue with the legacy systems supplied by the proprietary vendors. At the same time, there is a little awareness among the decision-makers from public agencies regarding the potential benefits of Open Source and ways to overcome the issues faced during the adoption of OSS. Further, Government organisations are locked with long-term (like 5/10 years) conventional contracts / deals on procuring the ICT systems. This gives little choice for the entry of new systems (which may be based on OSS)..

(c) Limited commercial promotional efforts Since the source code of the Open Source solution is available to all, any marketing done by one company to promote that Open Source solution will also benefit all its competitors. This leads to limited commercial efforts from the industry to promote the benefits of Open Source. Hence there is lesser business motivation from the industry. The Government needs to initiate the promotional efforts and awareness on the adoption of OSS. Industry could consider promoting the OSS based on the better quality of their services.

(d) Dominance of existing Marketing Forces In general, major ICT suppliers are preferred over SME (Small and Medium Enterprises) in Government procurements; hence majority (about 80%) of the ICT procurements are done with a few (about 10 or less) business establishments. Most of the major ICT suppliers generally prefer the use of CSS (Closed Source Software) because of their long-term business tie-ups with OEM(Original Equipment Manufacturers) of CSS. Majority of OSS solutions are provided by Small and Medium-sized Enterprises (SMEs) in most of the countries. The vast majority of Government IT work is still carried out by the major ICT suppliers resulting in lesser participation of SMEs.

The existing marketing forces create fear, uncertainty and doubt about new entrants from Open Source model in order to avoid further competition. Hence, entry of new participants from Open Source model needs support from Government to have a level playing field between Open Source and CSS.

(e) High Cost of Integration and Migration Most of the existing proprietary systems poorly inter-operate with other software; this is done mainly to retain the customers.; Cost of switching from existing CSS to other OSS becomes extremely expensive. OSS would require additional developmental efforts to enable integration with an existing proprietary environment. Some OSS never works well with established proprietary products. Hence Government guidelines are required to avoid lock-ins; solutions which offer standards-based interfaces should be preferred.

(f) Security Issues The availability of source code makes the OSS vulnerable to more threats. However, this should be mitigated by using the recommended stable version of OSS with necessary support & updates.

(g) Lack of OSS Policy / Framework In spite of many potential benefits & promises from the Open Source, the Government intervention, through Policy / Framework on OSS (like UK, European Union), is



still needed. The proposed Framework would mitigate the issues due to lack of OSS Policy / Framework.

- (h) Lack of cost effective Support Services** Sometimes, support and maintenance costs outweighs those of the proprietary package and include 'hidden' commitments. Sometimes adequate support may not be available and it becomes biggest weakness of OSS. Support on voluntary community basis alone may be insufficient. A full assessment of the total cost of ownership along with the support service costs from the supplier will help to mitigate this risk.
- (i) Lack of Motivation, Capacity Building and Awareness** Government staff are traditionally trained (and practised) in using CSS programs, the introduction of new programs / software may require staff retraining in order to enable them to use OSS. It is often assumed that OSS requires specialised skills – not necessarily programmers – but usually a systems administrator type of person to configure the application. Institutions change slowly – change takes time and it often makes people nervous.
- (j) Lack of awareness on TCO** The lack of awareness on the total costs associated with the adoption of OSS is another common problem. The provisioning of simplified & customised TCO model would mitigate risks.

Opportunities

The opportunities provided by the adopting OSS and the potential benefits resulting from the opportunities are highlighted below;

- (a) Low Barrier to entry** OSS introduces very low barrier to entry compared to the CSS whose prices are mostly increasing every year. OSS coupled appropriate hardware (whose prices are falling every year) offer a lot of scope for the wide spread adoption in e-Governance systems.
- (b) Economic Opportunities for Local Industry** Hardly few Indian CSS are available and hence their impact on the Indian economic growth is negligible. Whereas, OSS offer many new business opportunities to local industry in the form of offer of support services on OSS, capacity building on OSS, innovation of new products (including OS, Cloud, VM, solutions, Applications) using OSS libraries, development of integrated solutions on desktop, server, embedded, cell phones, set-top boxes, network, open hardware (like 3D printer, robot), etc.; thus OSS provides more growth opportunities to local industries (including SME, start-up companies).
- (c) Wider choices on OSS** There are many competing support-service providers on the OSS solution, in general; this is in contrast to limited choices with the case of CSS where one company along with their partners are offering support services; hence multiple options are available with OSS solution to choose suitable service-agency; this leads to simpler & cost-effective approach in case of switching the support service agency.

Similarly, many OSS competing distributions are also available for core areas like OS (Ubuntu, Debian, BOSS), database (PostgreSQL, MySQL), web server³¹ (Apache, Nginx), application server (Tomcat, JBoss, Jetty), etc.; in case of migration requirement, moving from one OSS solution to another OSS solution is

³¹ September 2012 Web Server Survey: <http://news.netcraft.com/archives/2012/09/10/september-2012-web-server-survey.html>



comparatively easier due to their openness.

- (d) **Ability to drive cross-industry collaboration** it facilitates the cross-industry collaboration through consortia like Linux Foundation, OpenMAMA, etc.
- (e) **Forking** Sometimes forking of OSS solution occurs for good reasons; for example, MariaDB is a community-developed fork from the company controlled MySQL database. Similarly, Proprietary Unix implementations (like SCO, Solaris, IRIX, HPUX) were forked into OSS BSD versions (Open BSD, NetBSD).

Threats

The threats are potential challenges to be considered while adopting OSS and ways to overcome them are highlighted below;

- (a) **Decision-Makers** Slow change of perceptions of decision makers of e-Governance Systems about OSS solutions. License Model, Intellectual Rights Infringements and Legal compliance are often misunderstood. Conducting awareness programs and provisioning of appropriate reports will help to take better decisions.
- (b) **Resistance** The status quo of the established institutions is threatened by the new entry of OSS; hence, fears, uncertainties and doubts (FUD) are created by the established institute to retain their hold on users by creating incompatible solutions (like interfaces, device-drivers, patents) with the established proprietary solutions. This can be minimised by the Policy / Framework on OSS and its enforcement in e-Governance Systems.
- (c) **Support Services** Non-availability of support services with adequate guarantee is a potential threat while adopting OSS. Use of wide variety of OSS solutions for the specific domain area makes it difficult to engage support services. The approved OSS Stacks and provisioning of support services will improve the situation.
- (d) **Activity** Lack of continued development of OSS solution is another threat to be considered. Sometimes, the dependency library may be missing or available only on proprietary model. The approved OSS Stacks will improve the situation.
- (e) **Incompatible Versions** Sometimes there may be mismatch among various libraries of the integrated OSS solution. The approved OSS Stacks will ensure the compatibility.
- (f) **Staff** Sometimes there may be a lack of sufficient number of in-house experts on OSS and need for more skilled staff when OSS is used. There are lesser incentives for the migration to OSS systems. Capacity Building and Policy / Framework on Adoption of OSS will improve the situation.
- (g) **Risk of forking** The forking occurs mainly due to developers who try to create alternative means for their code to play a more significant role than achieved in the base OSS solution. The approved OSS Stacks will reduce the risk.
- (h) **Absence of OSS implementation Agency** This scenario hinders economic and technology opportunities for the industry.



Annexure-IV Common Influencing Factors for the Adoption of OSS

Technological Level Factors

(a) **When to comply of Device Drivers for OSS OS (+)** - The availability of device drivers for the GNU / the Computers and associated peripherals procured would be operational on GNU / Linux OS. Thus availability of device drivers enhances the adoption of OSS.

(b) **Technological Compatibility based on Standards (+)** - Better compatibility / interoperability enhances the chances of adoption of any software. Insisting on adherence to Open Standards & Data Formats (instead of insisting on compatibility with legacy systems) is the better-way for the compatibility.

(c) **Technological Complexity in OSS usage (-)** - Complexity reflects the ease & simplicity of OSS in understanding and usage. More the complexity, lesser the adoption. The provisioning pre-configured & bundled OSS Stacks with adequate support would mitigate the issues due to complexity, if any.

(d) **Relative Advantage of OSS (+)** - OSS has an added advantage due to reliability, scalability, ease of use, functionality and security from virus attacks and spam etc.; this leads to reduced TCO.

(e) **Trialability of OSS (+)** - The degree to which it is possible to use OSS for proof of concepts and experimental studies.

(f) **Presence of Proprietary Lock-in (-)** - The more lock-in with the legacy/new CSS creates more barriers for the adoption. The proposed Framework on OSS would minimise the proprietary lock-ins.

(g) **Freedom to modify and improve (+)** - This makes OSS more suitable for customisation and enhancement as per requirements.

Organisational Level Factors

(a) **Management's Positive Attitudes towards OSS (+)** - The attitudes & support of the Senior Management towards provisioning rules, training, support services, provisioning of additional resources (hired manpower / consultants, hardware and network facilities) for the OSS adoption, considerations on strategic importance are very crucial. Better attitude affects the adoption

(b) **Champions of OSS (+)** - A combination of clear long term plan for training & support services on OSS and availability of champions of OSS in the senior management, in an organisation creates very powerful impact on the adoption.

(c) **Size of Organisation (+)** - The size of the Government organisation indicates the numbers of Government employees working. Large size generally facilitates better adoption. But even smaller size also facilitates if the better awareness is available about the benefits of OSS with the stake-holders. The awareness programs would help the adoption.

(d) **Diverse Expertise at Management Level (+)** - The wide variety of competence of Senior Management towards OSS. More competence means better chances for adoption, in general.



(e) Level of Formalisation (-) - The level of formalism and bureaucracy in the organisation. High level of formalism mostly inhibits the adoption. However, if OSS is accepted as part of formal procedures, then the formalisation facilitates its adoption.

(f) Centralisation on Decision Making (-) - The decision-making power being concentrated with only few experts in the Senior Management affects the adoption negatively, in general, in the initiation phase and positively in the deployment phase. However if these experts are aware of the benefits of OSS, then centralisation also facilitates the adoption by overcoming cultural and structural barriers.

(g) Inter-connectedness of Organisation (+) - The level and depth of connections among various units of the organisation. Better connectedness mostly facilitates the adoption.

(h) Organisational Slack on Resources (+) - The availability of internal resources of the organisation that are not yet assigned with specific works but can devote their time for new works on OSS. The larger the availability, better the chances for the adoption.

(i) Inclination towards Business Processes Re-engineering (+) - More chances for change-procedures / business-processes re-engineering in the organisation offer better adoption.

(j) Availability of Internal Technical Expertise (+) - The technical expertise on OSS available in the organisation impacts the adoption positively. The involvement of in-house experts through collaborations and capacity building through awareness program & training would enhance the expertise of in-house experts.

(k) Availability of Financial Resources (-) - The limited financial resource (shortage of budgets) availability in the Government organisation enhances the adoption. New metrics are required to give more weight-age for the project plan which results in better saving and wider reuse of ICT assets.

(l) Outsourcing impact (-) - The reduction/elimination of in-house experts due to outsourcing would reduce the adoption, in general.

Environmental Level Factors

(a) Rules for the adoption of OSS (+) - The rules facilitate the adoption of Government's OSS policies and guidelines. More rules mean better chances for the adoption. The rules should be applicable to all levels of employees. However, rules with long term contract

(b) Provision for Capacity Building (+) - The level and availability of awareness programs & trainings on OSS for the adopters of OSS are very crucial factors. Better level reduces the barriers for the adoption.

(c) Availability of Support Services on OSS (+) - In case of a bottleneck or failure of a system based on OSS, then it is possible to hold the vendors of OSS; whereas, the project team or champion / mentor has to own the responsibility when the project is based on OSS.

Hence the availability of external support, especially for services such as the installation, configuration and maintenance of OSS, is a very crucial factor. The adopters of OSS are more willing to pay for support.

The proposed Framework on OSS, pre-configured & bundled OSS Stacks and better assured long-term support services with SLA enhances the adoption and minimises the liability on the project team /



champion / mentor.

(d) Competitive Pressure (+) - Early adoption of OSS by the competitors enhances the adoption.

(e) System Openness (+) - Indicates how much the organisation is possibly considering suggestions towards OSS from external environments? Higher the openness, better the chances for the adoption. At the same time, poor adoption of OSS in other external organisations hinders the adoption.

(f) Past Experience on OSS (+) - Success case studies on OSS adoption, past experience of the OSS users / developers and showcasing them create more confidence on OSS.

(g) Availability of Internal Collaboration Mechanism (+) - The availability of collaborative information mechanism within the Government like discussion forum enhances the adoption.

Individual Level Factors

(a) Level of Organisational Objectives Consensus (+) - The level of clear understanding among the adopters of OSS about the organisational objectives, their agreement & motivation. This may require more efforts for the adopters to learn about OSS. Lack of motivation hinders the adoption. Better consensus enhances the adoption. This may require more awareness

(b) User's Fear on De-skilling of Legacy Expertise (-) - The fear of users to become deskilled by losing their expertise in popular legacy proprietary systems while migrating to OSS.

Some users have perception that their work would be under-valued if they use OSS; since most of the project evaluation rating consider more value if more project expenditure; the saving in project expenditures and its impact in reusing the system (based on OSS) without additional cost are not considered in general. Some fear that high level of technical expertise is required for the use of OSS. All these fears create barriers for the adoption. Government rules and promotional drives for OSS reduce the fear and create confidence on OSS.



Annexure-V Guidelines for Establishing Enterprise security with OSS

(a) Protect network with a strong firewall - A security hardened Linux distribution (OSS like Smooth wall) which provides critical hardware firewall operations like port blocking, IP blacklisting, antivirus protection, etc. can be considered; at the same time, it should be easy to use.

(b) Secured Remote Access - Many times, it is required to work through a secured solution (OSS like Open VPN) from remote places with an access to office/data-centre resources. The solution should work on major platforms with localised control and GUI for easy use.

(c) Securing Data on local desktops & laptops using encryption - There is a risk of exploiting the sensitive data residing in local desktops and laptops by unauthorised persons. The common recommended solution is to use encryption solution (OSS like True Crypt) so that even if there is a physical access of the local system by unauthorised persons, the content cannot be used without the required digital key.

(d) Securing Wi-Fi access points - The Wi-Fi access points are required to be protected by using appropriate solution (OSS like WPA2 with RADIUS authentication server) to have safe network for the organisation; the solution allows the authorised users to login easily with username and password while hiding its encryption keys from the end-users.

(e) Adopting Best Practice for System Administration - All users should use strong passwords. Multi-factor strong authentication should be enabled with the combinations of One-Time-Password (OTP), Digital Signature, Finger-Print biometrics, etc. If same authentications are to be repeated in multiple applications, then Single-Sign-On (SSO) authentication solution (like Central Authentication System - CAS) can be used. Only the required services should be invoked in the systems especially at the data-centre; that is, the solution which is not required for running the current system should be turned off. Similarly, monitoring the logs and file folders should be done using appropriate solution (OSS like Mon) for any suspicious activity on regular basis; automated alerts and polls can be activated. Appropriate backup and disaster recovery mechanism (local / remote locations) are to be enabled. Similarly, creations of logfiles at the application level are to be enabled at remote servers.

(f) Secured Internet Access from Intranet through Web Proxy - A web proxy (OSS like Squid) should be made available to route, filter-out & monitor the web access and also to prevent the downloading of mal-ware.



Annexure-VI Adoption of OSS – International Scenario

The initiatives taken by various public agencies / Government world-wide are outlined in this section.

Promotion through Policies - OSS promotion strategies via Government procurement fall into four broad categories³²

- (a) Mandating OSS
- (b) Preferring OSS
- (c) Mandating Open Standards
- (d) Best value

Major International Promotions

European Union Initiatives - European Commission (EC) published a report about avoiding vendor lock-ins in Government ICT systems³³ along with an ICT Procurement Guide based on ICT Standards and Good Practice. It is expected to enable more interoperability, innovation and competition, lowered costs (by more than 1 billion Euros per year), and improve interaction with citizens.

European Commission (Join-up program³⁴) has decided to join hands with Australia (Open Ray program), New Zealand (Open Ray program) and Vietnam (Open Road program) to enhance the software solutions by sharing and reusing. Join-up hosts more than 300 OSS projects directly now and hosts more than 4,000 projects in collaboration with other communities / forges in European Union.

Laws on the adoption of OSS in e-Governance were brought out by European countries like Italy and Iceland.

USA - Department of Defence³⁵ (DoD) has large number of applications based on OSS and has been implementing a roadmap to adopt OSS and Open Standards, as such a move is not only in the US national interest, but also in the interests of US national security. The time-line of the major-events, publications, and code releases in the history of the US Government's adoption of OSS is also available³⁶.

³² UNDP-APDIP - Free/Open Source Software - Government Policy, <http://www.iosn.net/government/foss-government-primer/foss-govt-policy.pdf>

³³ Against Lock-in in ICT Systems, 2013, <http://opensource.com/Government/13/7/against-lock-in-ICT-systems>

³⁴ Sharing and Reusing of OSS, <https://joinup.ec.europa.eu/community/osor/news/australia-new-zealand-vietnam-and-ec-coalesce-platforms-sharing-and-re-use>

³⁵ Open Technology Development - Lessons Learned & Best Practices for Military Software <http://www.oss-institute.org/OTD2011/OTD-lessons-learned-military-FinalV1.pdf>

³⁶ Open Source in the US Government <http://gov-oss.org/>.



France³⁷ - French Government issued a guideline³⁸, to "systematically review" alternatives to CSS when obtaining or developing new versions of applications; it also recommends to build internal expertise on OSS, pooling of resources, collaborating with OSS communities, and contribute back to OSS projects. OSS solutions are widespread in Government organisations; about 15% of country's IT budget is spent on services related to OSS and this trend is increasing. A new law³⁹ on giving priority to OSS in Higher Education and Research was brought out by French Parliament.

The reasons for the major success of France in the adoption of OSS include⁴⁰:

- Smaller OSS companies have effectively organized themselves into alliances and are growing into pure Open Source consortia, which have helped them access the legal expertise to participate in tenders and to better educate policy makers and ICT (information and communications technology) professionals.
- France has the largest Open Source market in Europe and demand for Open Source from public agencies is high.
- The French government actively supports Open Source R&D projects through so-called "competitiveness clusters," which consist of large, medium, and small companies, as well as academics.
- The government at the highest level not only encourages administrations to consider Open Source, but now also allows savings realized through Open Source deployment to be used to invest in in-house OSS expertise and participation in upstream projects.

A conducive infrastructure, adequate tender laws and policies / guidelines, policy makers' support & provisioning of additional resources, awareness among the implementers are available for successful implementation of OSS.

UK - The Government of the United Kingdom⁴¹ wants to create a competitive software market, where OSS and CSS compete on an equal basis; it wants to avoid lock-ins by making long-term commitments to any particular technology, product or supplier; this ensures maximising the future development options and avoid technology lock-in if at all possible. Open Source Procurement Toolkit⁴² is also made available by UK Government.

³⁷ Sharing and Reusing of OSS, <https://joinup.ec.europa.eu/community/osor/news/australia-new-zealand-vietnam-and-ec-coalesce-platforms-sharing-and-re-use>

³⁸ OSS-Guidelines, <https://joinup.ec.europa.eu/news/french-guideline-favours-use-free-and-open-source>

³⁹ Free Software Law for Higher Education in France, July, 2013
<https://joinup.ec.europa.eu/community/osor/news/french-parliament-makes-free-software-law-higher-education>

⁴⁰ Case study of Open Source Policies and Implementation, 2013 Jan, <https://joinup.ec.europa.eu/news/inertia-hindering-governments-profit-open-source-benefits>

⁴¹ UK Government Service Design Manual, 2013, <https://www.gov.uk/service-manual/making-software/choosing-technology>

⁴² UK OSS Procurement Toolkit <https://www.gov.uk/government/publications/open-source-procurement-toolkit>



UNDP Initiatives - UNDP has taken many initiatives for promotion of OSS and bringing many important reports / guidelines on OSS. The International Open Source Network⁴³ (IOSN) is an initiative of UNDP's Asia Pacific Development Information Programme (APDIP) and operates under the principle of "Software Freedom for All" (SFA). Its work includes provision of support and assistance, centre of excellence and information house for OSS in the Asia Pacific region. Through the IOSN/SFA initiative, UNDP provides policy support and advisory services to Government bodies, non-profit organisations and others.

Recognising India's strength in OSS, UNDP/IOSN has selected C-DAC of DeitY, Government of India, as its South Asia node.

China - China brought out office document format known as Uniform Office Format or Unified Office Format (UOF) in 2005 and later RedOffice was implementation was also developed based on UOF.

In the 11th Five Year Plan (2006–2010), OSS policy was announced. The use of foreign software in Government Offices was discouraged; the locally packaged OSS systems are preferred as local software. China brought out its own Linux distribution known as "Red Flag" as an alternative to Windows. As per a paper "The Emergence of Open-Source Software in China⁴⁴", 2007, Red Flag held 30 % of the desktop market in China.

The adoption rate of smart-phone with Android Linux OS is about 90% in 2012. Almost all Super Computer and Cloud Data Centre are based on Linux OS. In 2013, China announced that it is bringing out another Linux OS based on Ubuntu in collaboration with M/s. Canonical, UK.

OS China⁴⁵ is similar to Sourceforge source code hosting service; it hosts about 24,000 projects and many Chinese developers are contributing back. The latest release of the Linux kernel includes about 11,000 contributions from Chinese developers, according to Black Duck's research (2013).

43 IOSN, <http://www.iosn.net/>

44 The Emergence of Open-Source Software in China, <http://www.irrodl.org/index.php/irrodl/article/view/331/762>

45 OS China, <http://oschina.net/>



Annexure-VII Adoption of OSS – Indian e-Governance

Scenario

At present the FOSS movement in India has begun to gain mainstream acceptance and the initiatives taken by Government of India given in this section.

FOSS Cell, DeitY initiatives on FOSS

DeitY established FOSS Cell in year 2004 for promotion of FOSS in the country and has taken number of key initiatives creating an eco-system; the major one is setting up of National Resource Centre for Free & Open Source S/W (NRCFOSS) through C-DAC, Chennai.

Adoption of OSS in e-Governance Projects at Different States

A number of State Governments have started to adopt Linux and Open Source Software as their defacto platforms for e-Governance applications deployment.

Kerala: State Government of Kerala has decided to use OSS for the e-Governance and IT education in the schools. Kerala's draft IT policy focuses on e-Governance, Open Source software and development of technologies. Major proposals in the state include establishment of an International Centre for Free Software and Computing for Development, ITES Training Centre (in Kochi) and extension of Internet to all educational institutions and villages by 2010. Open Standards such as Unicode and Open Document Format and Open Architectures will be followed in e-Governance projects to avoid vendor lock-in. ICFOSS(International Centre for Free and Open Source Software) is an autonomous institution under the Government of Kerala with the objectives of coordinating FOSS initiatives within Kerala.

Tamil Nadu: Tamil Nadu is actively pursuing the implementation of OSS. Electronics Corporation of Tamil Nadu (ELCOT), adopted OSS in May 2006 and the entire ecosystem at ELCOT is build around OSS. Tamilnadu Government can save Rs 200-500 Crores every year through National e-Governance action plan. Some of the OSS solutions that have been developed for the Government include: Anywhere property registration software, Old age pension software with a public interface, Office file management software, and Web-based land recovery administration software. ELCOT has also developed software for the disabled called ORCA based on Ubuntu. ORCA is a text to voice software developed for people who are visually impaired.

Uttaranchal: In a significant move towards promoting e-Governance in India, the Government of the Indian State of Uttaranchal has signed two Memoranda of Understanding (MoU) with IBM, to mark the beginning of a State-wide e-Governance and University Programme initiative. This is the first implementation of IBM's e-Governance framework in India. Based on open-source technologies and Open Standards, IBM's e-Governance framework enables interoperability between new and existing applications.

Assam: The Assam Government has issued an OSS policy to promote use of FOSS in all the Departments and State agencies, bodies and authorities and imparting training on FOSS in schools and colleges. The Government Departments and bodies would ensure that Open Document Format (ODF) is adhered to in creating and storing editable documents, data and information and all applications developed by the



respective Departments adhere to ODF and other Open Standards and are largely independent of Operating Systems and web browsers and any generic hardware procured has support for multiple Operating Systems such as Unix, Linux, Opensolaris and other Open Source platforms.

West Bengal: The IT Department of West Bengal government is choosing Open Source operating systems for its ambitious e-Governance programme in the state. Government has chosen to use Linux for various e-Governance programme involving 277 panchayats in Burdwan district. The IT Department has set up a computing centre which operates exclusively on OSS.

Besides above, other states in India are also showing keen interest in OSS solutions. Union territory of **Pondicherry** was among the first regions to adopt OSS. Many of the Department portals like Commercial Taxes Dept, Transport Department have been developed using OSS.

Haryana Government has signed an agreement with Sun Microsystems to use Sun's Open Standards-based productivity package, StarOffice 7 Office Suite, across all State Government Departments.

Adoption of OSS in e-Governance Projects by NIC, DeitY

Some of the e-Governance projects based on OSS are listed below; most of the projects mentioned below are using **PostgreSQL** as the database.

- JAVA Technology:** eOffice Project , e-Procurement system, Vimanic Pilot Examinations Application for DGCA , Sarathi – Driving License, Vahan – Registration of Vehicles, Common Integrated Police Application (CIPA) , CIPRUS Project, Immigration Visa Foreign Registration Tracking (IVFRT), ePDS, National Minorities Scholarships Project, Multipurpose National Identity Card Software Project, Karnataka Judiciary Department Application, Karnataka Administrative Tribunal, Karnataka Employment Exchange Project, Sevarath Payroll application, TreasuryNet application, CollabCAD, Collabland, TWADNEST, e-District and PDS allotment distribution & monitoring Systems.
- PHP Technology:** District Court Information System Software, e-Courts , Defence Land Records Software Project (Raksha Bhoomi), DC-Suite, Below Poverty Line (BPL) Software Project, NREGA, Online Local Bodies Election of TN, Portal for Rural Development Dept, Specimen Status Monitoring Systems for Forensic Sciences, Utility Maps Web-Interface
- Application Portal based on Drupal :** Central Public Procurement Portal, NIC-OTC, NIC-Pune about 10 Portals, NIC-SDP, Transport Dept. of Arunachal Pradesh, About 50 Portals of various Departments of Karnataka state by NIC-KASC and State Portal based on Drupal – Tamilnadu, Meghalaya, Tripura

Plone Technology: IntraNIC, IntraGov, IntraYojana, IntraMHA, IntraDIT, IntraHealth, IntraPIB, IntraCA, IntraPMO, IntraPOWER, IntraORISSA

OSS Servers at Data-Centres of NIC, DeitY

The following table shows the usage of OSS at Server Level (Including Virtual Machines) in various e-



Governance projects developed, hosted and maintained by NIC at the National Data centres and NIC State Data Centres as on July, 2013.

S.No	Description	Percentage Deployments
1	Linux Physical Servers (including RedHat, CentOS, Debian, Ubuntu, BOSS, SUSE etc.)	32 %
2	Windows Physical Servers	65 %
3	Other OS Physical Servers (including Solaris, IRIX, etc.)	3 %
4	Linux Virtual Machines	69 %
5	Windows Virtual Machines	31 %

Open Technology Centre Project

OTC (<https://portal.otc.nic.in/>) is a Project, sponsored by DeitY, MCIT, Government of India, implemented by Open Technology Group (OTG), NIC. OTC Project is spearheading identification as well as adoption of Open Technology in e-Governance applications and services managed by NIC/NeGP for both State and Central Government Agencies.

Key Technology domains supported by OTC are Drupal CMS/Portal, SymmetricDS Database Replication, Database Migration to PostgreSQL, CAS Single Sign on Solution, Verification Services based on 2D Barcode, Platform independent Digital Signature Certificate, Recommendation and support provisioning of OSS Stack, Bundled OSS Stack for Development, Staging & Deployment ,offering of VM Service, Capacity Building & Hand holding, eForms using HTML5 / Xforms and Performance Tuning of Open Source Application Servers.

OTC has set up collaborative infrastructure (using Portal, Issue Tracking System) for supporting its activities. OTC has evolved a multiple-level support model for the identified OSS Stack.

FOSS initiatives at C-DAC, DeitY

DeitY has taken FOSS initiatives, like NRCFOSS, BOSS-GNU/Linux, Meghdoot-Cloud through CDAC to adopt and promote OSS.

NRCFOSS (www.nrcfoss.org.in.) was setup in Chennai during April 2005 with the twin roles of bridging the digital divide as well as strengthening the Indian Software industry. NRCFOSS contributes to the growth of FOSS in India through Research & Development, Human Resource Development, Networking & Entrepreneurship development, as well as, serve as the reference point for all FOSS related activities in the country.



Phase – I : NRCFOSS introduced proof of concept based FOSS Technologies in the formal & non formal sectors like engineering undergraduate curriculum of the Anna University with an affiliation of 254 engineering colleges to train teachers of engineering colleges and equip them to offer FOSS electives and student projects in their academics (UG/MCA levels) as part of the curriculum aiming for successive graduated engineers with exposure, training and skills in FOSS technologies.

Phase-II : This is a consortium of C-DAC, Anna University (AU-KBC Research Centre) and IIT-Madras, IIT-Bombay mooted and approved by DeitY with the following objectives:

- (a) Development of SaaS stack delivery model in area like Grid Computing / Cloud Computing
- (b) Integration and development of Common desktop development infrastructure
- (c) To setup Centre of Excellence for Mobile Internet Devices based on BOSS Linux
- (d) Creation of NRCFOSS centralised portal for involvement, analysis, R&D and knowledge exchange
- (e) FOSS HRD in the formal & Non-formal sectors
- (f) Creation and maintenance of knowledge bank repository for education, e-Governance & scientific applications.

In continuation with the work done by AU-KBC Research Centre through the phase-I of the project, I.T curricula has been enhanced FOSS theory and practical sections. Some of the Universities / Colleges who adopted FOSS as elective in their curriculum are Anna University, Loyola College, Chennai, Rajasthan University of Technology. Anna University is offering online course MSc (FOSS) The details can be seen at <http://cde.annauniv.edu/MSCFOSS>.

BOSS GNU/Linux (Bharat Operating System Solutions – <http://www.bosslinux.in>) is a Desktop and Server Linux Operating System with Indian language support derived from Debian Linux developed by C-DAC, Chennai. Also BOSS is customized (EduBOSS) for the ease of use in schools and colleges across the country.

BOSS Support Centre Network: BOSS Linux support Centres project have been setup at various C-DAC Centres. Franchisees have also been used as part of the support centre network. In addition, a National Help Desk facility setup at C-DAC Chennai also provides the additional layer of support. Many State Governments and National institutions have adopted BOSS Linux; some of them are Punjab, Haryana, Tamil Nadu, Chhattisgarh, Tripura, Kerala, and Pondicherry. Indian Navy, Indian Army. Promotional and awareness workshops are conducted across the country. Over 250+ colleges across the country have labs with BOSS Linux installed. Efforts are being taken to bring vendors on board to create an eco-system for BOSS Linux.

Business Model: The Business Model adopted for the BOSS Linux promotion is the Services and Support strategy. License for BOSS is free and the service and support are charged. The revenue comes from branding, training, consulting, custom development, and post-sales support instead of traditional software licensing fees. This could be in a subscription mode charged nominally per desktop per year or is charged lump sum towards provisioning of on-site support. C-DAC has tied up with various vendors to provide technology support on preloaded BOSS Linux on desktop/laptops with minimum price.

In addition to above direct revenue earning, BOSS Linux adoption by the various Government agencies /



Departments has resulted in an indirect savings to the Government.

Meghdoot C-DAC has also developed a cloud product called Meghdoot which offers various features in cloud environment such as Platform and Infrastructure as a service (PaaS and IaaS), On demand dynamic provisioning, Metering & Monitoring, Graphical Installation of Middleware stack, Web based Management of Cloud resources, Provision for deployment of multi instance user appliances, Customized Elasticity, Web service based management of cloud, High Availability, Enhanced Security across layers. Meghdoot Cloud Stack has been deployed at the Tamil Nadu State Data Centre, CHiPS Chhattisgarh, and Indian Navy.



Annexure-VIII Rating of OSS against other CSS using Business Metrics

Basics
<p>The business metrics are needed to identify & demonstrate whether OSS is cost-wise also superior compared to CSS. These metrics along with other technical points influences the decision-makers to take appropriate decision whether to opt for OSS or CSS while developing e-Governance systems.</p> <p>If the OSS solution is to be evaluated against CSS, then models like</p> <ul style="list-style-type: none"> (a) Return on Investment (ROI) (b) Internal Rate of Return (IRR) (c) Total Cost of Ownership (TCO) <p>can be considered. If required, these models need to be analysed to select / customise a suitable model.</p>
<p>Approach for Return on Investment</p> <p>ROI find outs the financial performance of an investment by evaluating the efficiency of the investment; it includes not only the resulting benefits to the organisation due to the investment but also the cost elements.</p>
<p>Approach for Internal Rate of Return</p> <p>IRR, sometimes is called as Rate of Return (ROR) or Discounted Cash Flow Rate of Return (DCFROR). It indicates profitability of an investment. Higher the IRR, then more value to the investment. IRR is somewhat difficult to understand when compared to metrics like TCO, ROI.</p>



Approach for TCO

There are various models used in evaluating the Total Cost of Ownership (TCO).⁴⁶

Simpler Approach The conventional analysis used in Total Cost of Ownership (TCO), in general, simply assumes the total cost involved in the initial procuring (CAPEX) and operating / implementing (OPEX) the particular software. The early TCO studies, in general, did not consider costs like exit/migration costs.

Missing Cost Factors Switching Costs due to lock-ins, may include damages due to contractual commitments, the cost of replacement equipment, loyalty programs, search costs, transaction costs and uncertainty about alternative suppliers, conversion of data & its risks, retraining and compatibility.

Variations of Cost due to environment In developed countries, where labour costs are high, the relative low support cost of OSS need not necessarily reduce total costs of using and maintaining systems; when labour costs are high, labour-intensive components of the total cost represent a high share of the total cost, making the licence fee itself (which is not present in the case of OSS) less crucial.

In contrast, when labour costs are low in a developing country, the share of the licence fee of the software in the total cost of ownership is much more significant, even prohibitively so; even after software price discounts, the price tag for OSS, in general, is enormous in purchasing power terms. The labour-intensive components of the total cost for the Open Source are comparatively very low in developing country; these expenditures, in general, result in local currency to be paid to domestic industry.

Non-Quantifiable Factors However, there are many factors which are non-quantifiable in terms of cost; for example, enhanced security & reduced mistrust, reduced service disruption, reusing the software, etc.

Alternative detailed Cost Model Some attempts are made recently to account additional costing for some of the above factors. In a report⁴⁷, the alternative cost model (“Total Lifetime Cost of Ownership”), including search, exit and transition costs, is recommended. The report says “TCO reflects a measure of all the costs of identifying and acquiring software, away from the software. TCO reflects not just the direct qualities of a software product (price, functionality, reliability) but also the relationship of the software to the organisation’s broader set of technology platforms, installed systems, skills and strategic goals, available market and community based services.”

Local Economy One also has to see whether the money is given to local ICT industry and if the spent-money helps to preserve foreign-exchange and to grow the local knowledge-base (SME / local Community) within the country.

Reuse Cost Not only the immediate cost benefits but also the long term benefits, like reuse of ICT assets in other public agencies, self-reliance in ICT knowledge-base, the improved negotiating power of entire Government as a single entity, are also required to be considered.

Conclusion on TCO All these facts suggest that focusing on conventional TCO model alone is not enough. Alternative TCO models, after customisation to suit developing countries, may be considered to see appropriate impact. However, TCO mainly focuses on cost factors and generally misses benefits/returns.

⁴⁶ “Total Cost of Ownership of Open Source Software” (PDF), London School of Economics (LSE), <http://ctpr.org/?p=701>



Typical Total Cost of Ownership (TCO) Estimation		
Cost Category		Cost
Search	Cost of up-front evaluation study	
	Cost of up-front proof of concept implementation	
	Total Search Cost	
Acquisition	Cost of Software	
	Cost of Customisation for business needs	
	Cost of Integration (to current platform)	
	Total Acquisition Cost	
Integration	Cost of Migration (data and users)	
	Cost of Training	
	Cost of Process and Best Practice change	
	Total Integration Cost	
Use	Cost of Support services - in house	
	Cost of Support services – contracted	
	Cost of Maintenance and Upgrades	
	Software scaling (for change in user or transaction volumes)	
	Total Use Cost	
Retire	Exit costs (in relation to hardware and software)	
	Exit costs (in relation to changeover, re-training)	
	Total Retire Cost	
	Total Cost	

47 Total Cost of Ownership of Open Source software: a report for the UK Cabinet Office submitted by Shaikh, Maha and Cornford, Tony, London School of Economics and Political Science, 2011, <http://eprints.lse.ac.uk/39826/>

Annexure-IX Rating of OSS based on Performance matrix

Basics
<p>The basic step for evaluating OSS or CSS are essentially the same. Typically it can follow the four simple steps</p> <ol style="list-style-type: none"> i) identify, ii) review, iii) compare iv) analyze. <p>The amount of effort spend evaluating OSS software is strongly dependent on how complex and important the OSS software is for the organisation.</p> <p>The quality of OSS solution is affected by many associated variables related to the OSS solution and its stakeholders; the number of variables may be limitless and each variable can be interpreted by others in different ways. Further, the adoption of the OSS solution is affected often by the reputation of the Partner-company / Trust rather than the real quality of the OSS solution. Hence, it is necessary to identify a suitable methodology with a set of structured criteria to access the quality of the OSS solution.</p> <p>Some of the variables associated with the rating of OSS solution:</p> <ul style="list-style-type: none"> (a) Adoptability - the number of downloads, the number of users / well-known users, awards, books, ease of use, modularity, by-products, etc. (b) Activity – showing the progress made by the developers, road map, the number of bugs reported, bugs fixed, new features and discussions, etc. (c) Longevity – how long the OSS solution has been in use (d) License – is one of the general Open Source licenses used which indicates a set of well-defined conditions for the contribution of code to the ongoing development of the software; the flexibility without restrictions to implement alternative formats, integration between the proprietary solution and other systems, etc. (e) Fork-ability – fork probability based on open model, protection against proprietary forks. (f) Services – quality of support, capacity building and consulting from the community, industry and other paid-models. (g) Documentation – user manuals and tutorials, developer documentation (h) Security – reporting / responding to vulnerabilities (i) Functionality – testing against functional requirements which can be further classified as essential and desirable. (j) Integration – standards, modularity and collaboration with other products



(k) Nature of the Trust – the reputation of the Trust which is acting as a driving force behind the project on OSS solution with a very clear development process, level of democracy of management, impact on types of distributions (OpenCore with limited features on open model, Enterprise with enhanced features on proprietary model) released on the OSS by the Trust, etc.

(l) Skill Set – the skill sets available in the user/Partner-Company/Developer/Trust of the OSS solution which indicate the readiness of user to adopt the OSS solution, etc.



Annexure-X Key Stakeholders of Ecosystem

Stakeholder	Roles & responsibilities
Senior Management	Policy / Decision Makers from Government who take decisions on the Projects; they guide Project Management.
Project Managers	Government / Department users who are responsible for the Projects and adopts the policies & guidelines taken by the Senior Management; they supervise the services from registered partners like Product-Partner, Technology Experts, System-Developer, System-Integrator, Service-Provider.
System-Developer	Person / Agency who is assigned with development, deployment and maintenance of systems under the supervision of Project Management; they avail the services from Product-Partner, Technology Experts, System-Integrator, Service-Provider; they may be from Government / Industry / Academia / Community / Consortia / R&D Institute.
System-Integrator	Person / Agency who integrates various e-Governance systems developed by the System-developer and services from Service-Providers; they may avail the services from Product-Partner, Technology Experts; they may be from Government / Industry.
Service-Provider	Person / Agency who offers e-Services and Infrastructure-Services; their services are availed by the System-developers and System-integrators; they may be from Government / Industry / Academia / Community / Consortia / R&D Institute.
Product-Partner	Person / Agency who offers product specific solution; they are registered partners from Industry / Academia / Community / Consortia / R&D Institute; they offer source-code level enhancements on the identified OSS solution.
Technology Experts	Registered Domain experts from Community, Academia, R&D Institutes and Government
End-User	Person / Agency who avails the e-Services of the system developed; they may be Citizen, Business-Organisation, Employee of a Government organisation, another Government unit.
Community	A complete ecosystem of a particular OSS solution which includes Developer, User, Partner Company and Trust.
Developer	Person who builds up the OSS solution; some are paid by the User-Company / Trust / Partner-Company / Other-Institutions; others work on a voluntary basis.



Stakeholder	Roles & responsibilities
User	Person, who adopts the particular OSS solution, provides feedback and suggestions on new features, tests existing features, and offers ideas for the direction of OSS solution; some users engage the commercial support services on the OSS solution from the Partner-Companies / Trust / Developer.
Partner-Company	Organisation which offers commercial support services (like support, maintenance, training, certification, consulting, installation, enhancements & bug-fixes) on the OSS solution; receives payment (like annual fees, subscription fees, royalties) from the User and paid / unpaid works from the Developer.
Trust	A core foundation or a company that maintains and coordinates the entire project of the OSS solution; it receive annual fees from Partner-Companies; it also receives fees from the User for new features in the OSS solution.
Consultant	Person who advises Government on various e-Governance systems. The person may be from Government / Industry.