Framework on Open Source Software Adoption in e-Governance Systems

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Ministry of Communications and Information Technology
Department of Electronics and Information Technology
New Delhi - 110 003
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Executive Summary

Open Source Software (OSS) adoption is increasing and leading the innovations worldwide in implementation of ICT solutions across businesses and Governments. The key domains of ICT implementation (like application development, internet connectivity, infrastructure, Data Centre and mobile) have propelled the use and adoption of open source technologies across the world. The OSS solutions has matured to a large extent and committed developers from different technologies are participating in making it conducive to the needs of different areas of ICT implementation. These solutions are available now with 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 multiple Governments and public agencies, across the world to bring out a policy framework/ guidelines so as to accelerate the adoption of OSS. The long term advantage of compliance to Open Standards ensures 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) under MCIT, Government of India and many Indian State Governments have initiated several programs to enhance the adoption of OSS in e-Governance. Some of the major programs initiated by DeitY include setting up the “National Resource Centre for Free and Open Source Software”, “Open Technology Centre”, formulation of “Policy on Open Standards” and notification of Standards for adoption in e-Governance.

This “Framework on Open Source Software Adoption” is brought out by DeitY, for adoption of OSS in e-Governance Systems in India. It suggests a set of recommendations and procedures for promoting, managing and enhancing the adoption of OSS.

This Framework 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.

This 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 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.

This Framework envisages establishment of “Centre of Excellence on OSS” to realise the framework.
PART- I

Main
# 1 Scope & Applicability

<table>
<thead>
<tr>
<th>Scope</th>
<th>This Framework provides a set of procedures and recommendations for promoting, managing and adopting OSS as a potential option in e-Governance Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicability of this Document</td>
<td>All e-Governance systems</td>
</tr>
</tbody>
</table>
| Targeted Stakeholders | (a) Government Departments and Agencies  
(b) Information and Communication Technology (ICT) industry (playing the roles of suppliers, developers, implementers and maintainers, integrators, service-providers) implementing e-Governance projects.  
(c) Citizens as users of e-Governance services  
(d) Academia working in e-Governance domains. |
| When to Comply | (a) Development & Implementation of new e-Governance systems  
(b) Enhancements & Up-gradation of existing/legacy e-Governance systems |
| Nature of Compliance | Advisory |
| Preferred Areas: | 1. Database  
2. Application/Web Server  
3. Cloud Platform (including Virtualisation and Server Operating System)  
4. Desktop Operating System (including Office Productivity Tool)  
5. Cross-Platform Application Development (Unified Software Development for Mobile, Tablet and Desktop) |

**Recommendation:** This Framework should be used to expedite the adoption of OSS in e-Governance in India.

**Recommendation:** Preferred areas should be given priority to start adopting this Framework.
2 Overview of OSS

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

2.1 Closed Source Software / Proprietary Software

The software whose license typically prohibits the access to / modification of the source code without royalty payment and restricts the copy, distributions and reuse of the software without payment; the restrictions may be applicable to the whole or partial software so that the control is with the concerned company.

2.2 Shareware

The software whose license is almost the same as the CSS license except that executables of the software are made available for restrictive-use under free of charge conditions only for the trial-period.

2.3 Freeware

The software whose license is almost the same as the CSS license except that executables of the software are made available for restrictive-use under free of charge conditions

2.4 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/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 Foundation\(^1\) and Open Source Initiative \(^2\) respectively.

2.5 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 a solution is not a simple task. Project teams informally select and use arbitrary OSS solutions quite often, based on their preference and /or convenience; such an informal usage of OSS solutions should be discouraged 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 needs to be identified for each domain through a set of guidelines; the identified OSS solutions are to be integrated, tested and offered as pre-configured OSS Stack; the stack is to be notified for adoption & reuse with support services in a formal way. A typical stack is given in “Annexure-I Typical OSS Stacks for Java, PHP and Open Web Technologies”.

**Recommendation:** Identification of OSS stack for application development and infrastructure shall be carried out.

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\(^1\) Free Software Foundation, [http://www.fsf.org](http://www.fsf.org)

\(^2\) Open Source Initiative (OSI), [http://opensource.org](http://opensource.org)
3 Preamble

3.1 Declining Challenges on Adoption of OSS to 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 eroding. As components of OSS mature, they become easier to use; 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; these have obvious advantages. Alternative business models have emerged which allow OSS contributors to get benefit from their efforts without charging for the software itself.

3.2 Impact of OSS in ICT and non-ICT Domains

OSS 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 ICT fields like Open Standards, Open Hardware and Product Designs, Open Process, Open Course ware, etc. This is collectively known as Open Technology (OT). In addition to ICT fields, the tradition of sharing of knowledge spreads through many other sectors as Open Medicine, Open Knowledge base, Open Law, Open Science, Open Music, Open Agriculture, etc.

3.3 SWOT Analysis of OSS Adoption

OSS adoption also provides many socio, economic & strategic benefits described in terms of Strengths and Opportunities. At the same time, certain precautionary measures are required so as to realise maximum benefits; these measures are explained in terms of Weaknesses and Threats. The Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis of OSS Adoption is outlined below:

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes freedom to use &amp; reuse, cost effective, help innovation, enhanced security, better local capacity building, preservation of foreign exchange, minimised piracy, better interoperability and enhanced competition.</td>
<td>Includes informal use of OSS, adverse impact of legacy systems, limited commercial promotional efforts, dominance of existing marketing forces, high cost of integration and migration, 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 &amp; awareness and lack of awareness on Total Cost of Ownership (TCO).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes low barrier to entry, economic opportunities for local industry, better reuse, better suitability, better support from OSS community, wider choices on OSS and forking for new better solution</td>
<td>Includes resistance from the existing market force, lack of awareness among decision-makers, inadequate support services, reduced activity of the community, incompatible versions, inadequate skilled-staff and risk of forking of stable solution</td>
</tr>
</tbody>
</table>
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".

**Recommendation:** Since many socio, economic and strategic benefits are provided by the adoption of OSS, OSS should be considered along with CSS.

## 4 Types of OSS Support Models

Most of the user-organisations work with one or more Open Source vendors to get commercial Open Source support for the OSS they use. The four most common types of OSS support models are outlined along with their implications on user-organisations:³

### 4.1 Pure Open Source

Selling of “Support and Services” is considered in this model. No lock-in exists. Vendors with this type of business model provide support and services on OSS solutions. As the OSS is freely available under an Open Source license, the user-organisation is not locked in to the vendor. This approach gives the most flexibility for the user Organisation since, they can decide at any time to avail the support services from other vendors or through internal experts..

### 4.2 Certified Distribution Model

Selling of “Subscriptions, Solutions and Support” is considered in this model. Some level of lock-in exists.

Vendors take an Open Source project and do additional testing, certification or bundling; but the build-process is not open. IPR of the community edition is mostly lies with the single vendor. In the process of “certifying” a release, the vendor may select or create patches and fixes. This “certified version” is then branded and the user-organisations are charged for some combination of subscription to this branded, certified release, support and add-on solutions or services. In this case, there is some degree of lock-in. First, if the subscription is not renewed, the user-organisation may be required to remove branding, switch off the certified version or stop using the add-on-solutions or services. While this may be possible, it may require some effort on the user-organisation part to give up some functionality.

### 4.3 Open Core Model

Selling of “Subscriptions” for a Proprietary Version is considered in this model. Same level of lock-in, compared to CSS, exists.

Vendors take an Open Source community version as a core and create a separate layer by adding additional functionalities; this is provided under a proprietary license. These vendors do not provide support on community version. When the user-organisations purchase proprietary version of OSS, they have the same degree of lock-in that they would have with a proprietary vendor. If the user-organisations do not purchase the subscription, they can’t get support.

4.4 Dual License Model

Provisioning of solution under an OSS license and selling the same under Proprietary License is considered in this model. This model can lead to lock-in depending on license requirements.

4.5 Retaining Flexibility

To make the best selection, one should understand the business models adopted for the solution.

The major motivation for adopting OSS is to have multiple choices for the software solutions and more competitions 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.

**Recommendation:** Preference should be given to “Pure Open Source Model” for availing the support services on OSS.

5 OSS Licenses

5.1 Basics of OSS Licenses

This section suggests a simple and effective classification and management of OSS solutions based on their licenses. This will enable the coexistence and use of OSS and CSS solutions without much conflict.

Based on the restrictions to the OSS user, the OSS licenses are classified as Liberal, Less Liberal, Less Restrictive, Restrictive and Highly Restrictive licenses with the restrictions increasing in this order. Legal advice to be sought is based on the restriction level. Sometimes Liberal type license is also known as Permissive, Non-Viral or Academic license; similarly, Restrictive license type is also known as Viral, Reciprocal, Protective, or Copy Left license.

5.2 General Guidelines to choose OSS based on license-type and use

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.

<table>
<thead>
<tr>
<th>Environment for OSS-library Use ——&gt;</th>
<th>OSS-library hosted without modified source</th>
<th>OSS-library hosted with modified source</th>
<th>OSS-library distributed to customer without modified source</th>
<th>OSS-library distributed to customer with modified source</th>
</tr>
</thead>
<tbody>
<tr>
<td>License Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liberal (Public Domain, MIT)</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
<tr>
<td></td>
<td>Less Liberal (Apache-v2, BSD(New), V)</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
</tbody>
</table>

### Environment for OSS-library Use

<table>
<thead>
<tr>
<th>License Type</th>
<th>OSS-library hosted without modified source</th>
<th>OSS-library hosted modified source</th>
<th>OSS-library distributed to customer without modified source</th>
<th>OSS-library distributed to customer with modified source</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPL, EPL</td>
<td>Green</td>
<td>Green</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Less Restrictive (LGPLv2, LGPLv3)</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Restrictive (GPLv2, GPLv3)</td>
<td>Red</td>
<td>Green</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Highly Restrictive (GPL3 Affero)</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

Green denotes the OSS license with less or no restrictions for the particular environment.

Yellow denotes the OSS license with moderate restrictions for the particular environment. (like display of acknowledgements)

Red denotes the OSS license with more restrictions for the particular environment. Its usage requires more legal opinion.

The detailed description of these licenses may be referred at UNDP Report on OSS Licensing[^5]

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**Recommendation**: Preference should be given to select OSS libraries which have liberal, less liberal and less restrictive license model.

### 6 Factors Influencing the Adoption of OSS in Government

Some 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:

These are classified as (i) economic level, (ii) security level, (iii) technological level, (iv) organisational level, (v) environmental level and (vi) individual level

**6.1 Classification of Influencing Factors**

### Economic Level Factors
- Cost Effective (+)
- Preservation of Foreign Exchange (+)
- Enhanced Competition (+)
- Freedom to Use & Reuse (+)
- Help Innovation (+)
- Better Local Capacity Building (+)
- Minimised Piracy (+)
- Low Barrier to entry (+)
- Economic Opportunities for Local Industry (+)
- Better Reuse (+)
- Better Suitability (+)
- Wider choices on OSS (+)

### Security Level Factors
- Enhancing National Security (+)
- Enhancing source code level security without mistrust code (+)

### Technological Level Factors
- Technological Compatibility based on Standards (+)
- Availability of Device Drivers for OSS Operating Systems (+)
- Relative Advantage of OSS (+)
- Trialability of OSS (+)
- Availability of OSS stack (+)
- Technological Complexity in OSS usage (-)
- Presence of Proprietary Lock-in (-)

### Organisational Level Factors
- Management’s Positive Attitudes towards OSS (+)
- Champions of OSS (+)
- Size of Organisation (+)
- Diverse Expertise at Management Level (+)
- Inter-connectedness of Organisation (+)
- Organisational Slack on Resources (+)
- Inclination towards Business Processes Re-engineering (+)
- Availability of Internal Technical Expertise (+)
- Level of Formalisation (-)
- Centralisation on Decision Making (-)
- Availability of Financial Resources (-)
- Outsourcing impact (-)

### Environmental Level Factors
- Rules for the adoption of OSS (+)
- Provision for Capacity Building (+)
- Availability of Support Services on OSS (+)
- Competitive Pressure (+)
- System Openness (+)
- Past Experience on OSS (+)
- Availability of Internal Collaboration Mechanism (+)

### Individual Level Factors
- Level of Organisational Objectives Consensus (+)
- 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”.

6.2 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; thus, the influencing factors also need to be prioritised based on the feedback from managers / users. The complex inter-relationship between these factors is also important.

The application context is also to be accounted for analysing the impact of each factor; it indicates the classification of production systems (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.

Recommendation: The guidelines on influencing factors for the adoption of OSS need to be brought out by customising for Indian Scenario.

7 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 analysis⁶ says that about 35% of OSS adopters are Government agencies.

7.1 Reuse of ICT assets

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

Reuse of ICT assets is being mandated by several Governments / their agencies worldwide; for example, UK Government⁷, and US-DoD⁸. In the recent survey⁹, it was estimated that the annual savings for European Union due to the adoption of OSS is about 450 billion Euro Dollars.

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

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8 Interoperability & Open Standards

Open Standards play 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 India⁴⁰.

8.1 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 (availability of specification, cooperative development-model), but they differ in many ways.

The formulation of technical specification of an OSS need not follow the process followed by the Open Standards. Implementation of Open Standard may lead to OSS or CSS solution. OSS, like any other CSS, may or may not completely implement the Open Standard. In case if only one OSS implementation is available for an Open Standard, there is no lock-in since source code is available and multiple supports can be enabled; but CSS creates a lock-in situation when only one CSS implementation of the standard is available.

8.2 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.

OSS can play a useful role in popularising an Open Standard. The availability of an OSS reference implementation will spur quicker adoption and acceptance of the standard as everyone has easy access to the implementation of the standard and so can try and test it out. Examples include HTML5, JavaScript, etc.

8.3 Mutual impact of Open Standards and OSS

The two strategies, adoption of OSS & adherence to Open Standards, are necessary for Governments as they increase competition and interoperability to drive down ICT cost and improve sustainability of the e-Governance systems developed.

Recommendation: Enforcement guidelines on Open Standard Policy of GoI should be brought out to accelerate the adoption of OSS.

9 Security Aspects in OSS

9.1 Multi-User based OSS System

OSS systems are mostly based on the multi-user, network-ready UNIX model. Because of this, they come with a strong security and permission structure. Consequently, vulnerabilities in most applications result in only a limited security breach in OSS systems. Also, availability of the source code for OSS systems helps the developers to discover and fix vulnerabilities, often before a flaw can be exploited.\footnote{http://en.wikibooks.org/wiki/FOSS_A_General_Introduction/Why_FOSS%3F} Most of the Internet solutions and applications are based on OSS and also on Open Standards; for example, TCP/IP, HTTP, DNS, SMTP & IMAP.

9.2 Vulnerability & Bug-Fixes

Hiding bugs and security vulnerabilities hardly exist in OSS compared to CSS. Any of the service-providers can be engaged to fix bugs and vulnerabilities in OSS compared to the scenario of user at the mercy of CSS vendor. In general, well-known OSS has potential for faster release-cycle of bug-fixes and the security of OSS is better; this is due to fixing of security vulnerabilities frequently by 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.

9.3 National Security and OSS

The security concerns like hidden back-doors or holes in software have encouraged many organisations to switch to OSS. Mistrust of “black-boxed” foreign software that cannot be audited has been cited as one of the reasons for China, Japan and South Korea for their adoption of OSS and as one of the reasons why other Government are considering OSS.

9.4 Establishing Enterprise Security with OSS

OSS Systems tend to be generally more secure and are being used by even banks, finance and insurance companies\footnote{http://www.wallstreetandtech.com/it-infrastructure/wall-street-opens-doors-to-open-source-t/217400216}. Organisations\footnote{Section 4.1, A Guide to Open Source Software for Australian Government Agencies, Version 2.0, June 2011} 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 are to be made available for OSS as in the case of CSS, in order to minimise the risk.

As a first layer, a central core group of ethical hackers should continuously look into the vulnerabilities and loop holes of OSS solutions. This group should stay in touch with communities, provide security patches/updates so that users need not worry about the implementation of OSS. As a second layer, the OSS solutions can be thrown open to Academic community of Computer Science students for testing the security of these OSS solutions and the issues coming up may be used for student projects to get the solutions. Other security implications for OSS are almost the same as for CSS; for example, certain older versions of OSS may go out of date and may not be supported like in the case of CSS. Each must be approached on a case-by-case basis.

Some of the generic security guidelines are:

- Protect network with a strong firewall
- Secured Remote Access
- Securing Data on local desktops & laptops using encryption
- Securing Wi-Fi access points
- Adopting Best Practice for System Administration
- Secured Internet Access from Intranet through Web Proxy.

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

**Recommendation:** The security of OSS solutions under OSS Stacks can be enhanced by creating a two layered internal & external audit mechanism and retrofitting mechanism under the proposed structure.

### 10 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.

#### 10.1 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, Win Phone, Blackberry, etc. This approach utilises the native features of the mobiles effectively.

#### 10.2 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 report\(^\text{14}\), Research firm Strategy Analytics forecasts that one billion HTML5-capable mobile devices will 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 will be wholly or partly based on HTML5 by 2015.

Alternative approaches were explored to simplify the development process. The application development has been drastically changed due to the emergence of HTML5 based Open Web Technology (OWT) and Cloud Technology.

OWT characteristics include adherence to Web Standards, wide-adaptability, facilitation of develop once & run the same on all devices, provision for separation of presentation and logic, facility to create rich client with highly scalable thin server, standards-based in-built methods to send software updates, provision to exploit the generic and native features of mobiles.

Recommendation: 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.

11 Rapid Application Development Environment for OSS Applications

The manually edited software produces highly efficient software for building, maintaining and modernising business-critical Web 2.0 applications. However, it is difficult to follow the same process all the 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.

Recommendation: 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.

12 Localisation and OSS

Localisation involves taking a software product and making it linguistically and culturally appropriate for the target country/region where it will 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, 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 actively pursuing OSS localisation.

Recommendation: OSS application development with Indian languages interface should be encouraged.

13 Device Driver

When implementing e-Governance systems, the Device Drivers are available for Windows Operating Systems (OS) as a default; however, there is a possibility of non-availability of Device Drivers, for GNU / Linux Operating Systems which is another commonly-used / widely-used in Computers and Peripherals deployed in the roll out of e-Governance systems. Users must ensure the availability of device drivers for GNU Linux Operating systems while procuring Computers and associated Peripherals.
14 OSS Current Scenario

14.1 International Scenario

Open competition from OSS support service providers bring a whole new dimension to the business models of OSS. Linux usage in Mission-Critical applications has grown dramatically to 73% in 2013, partially due to growth in Cloud / Virtualisation and Big-Data, as per Research Study in 2013 by Yeoman Technology Group and Linux Foundation\(^{15}\). Netcraft's April 2013 Web Server Survey\(^{16}\) shows the combined world market share of Apache and Nginx web-servers as 65%. As per Gartner Survey\(^ {17}\), August 2012, the market share of Android is 43%. In entertainment sector too, many movie / animation industries\(^ {18}\) like DreamWorks, Pixar, Weta Digital etc. use OSS.

In a recent (Goldman Sachs, IDC) 2013-Survey\(^ {19}\) on common computing platforms (combined market for desktop, laptop, tablet and smart-phone), Linux has more than 40% market; Microsoft-Windows share has gone from 97% in 2000 to 20% expected in 2012.

Gartner\(^ {20}\) report expects that Google’s Android-Linux platform will be installed on more than one billion device by 2014, giving increased dominance to Android; by 2017, shipments of Android devices will “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.

14.2 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”.


\(^{19}\) IDC, Goldman Sachs Research Report, Dec., 2012 http://seattletimes.com/html/microsoftpri0/2019853243_goldman_sachs_microsoft_os_has_gone_from_more_than.html

15 Procurement Guidelines

15.1 Guidelines for Procurement

Some of the important factors, which can be considered for the inclusions in tender terms and conditions while procuring / selecting ICT solutions, are given below:

(a) Equal Consideration OSS should be considered at par with CSS

(b) Essential functionalities – only the required functionalities are to be specified but without over-specifying the requirements; this helps to save resources.

(c) Customisation Cost - if the solutions are 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. are to be accounted.

(d) Security - the security requirements of the solutions are to be considered on a case-to-case basis.

(e) Survival-ability – the continuity of the solutions with further developments till the life-cycle of its usage planned; it mitigates the risks related to change over to another solution in future.

(f) Compliance with Open Standards – the risks depending on one-type of solution should be mitigated; the compliance on Open Standard should be mandated

(g) 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 are to be obtained. Also appropriate structure and guidelines need to be established for shared solutions.

(h) Maturity - its adaptability, activity, longevity, services available on it, documentation, integration, security, skill set availability are to be considered; its developer-community, fork-ability, license-type.

(i) Maintenance and support services - the quality level of support and maintenance services expected to meet the requirements are to be specified; the support & maintenance for the software are to be included in the tender specifications as a mandatory condition to mitigate the risks.

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

Standardised common methodology can 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”; similarly another business metrics based methodology can be developed for comparing OSS solution with CSS solution. These can be carried out by the proposed Centre of Excellence.

Recommendation: OSS Solutions should be considered alongside with Proprietary solutions 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.

Recommendation: Vendors must provide justification for exclusion of OSS in their responses to RFPs (Request for Proposals).

Recommendation: 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.

Recommendation: Government Agencies and Departments will seek to avoid vendor lock-in to proprietary IT products and services. RFP(Request For Proposal) documents will avoid using vendor specific product/brand names.
Recommendation: Applications developed by the Government of India should be cross platform and not be locked in to a specific platform.

Recommendation: Transferability of ICT Assets (which facilitate the reuse) with in all levels of Governments and public agencies without additional expenses should be considered while procuring them.

Recommendation: Hardware and peripherals procured by Government Agencies and Departments should have support for Open Source device drivers for ensuring inter-operability of systems.

15.2 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) can be considered; if required, these models need to be analysed to select / customise a suitable model; these are discussed in "Annexure-VIII Rating of OSS against other CSS using Business Metrics".

15.3 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)\(^\text{21}\); 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 are to 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.

Recommendation: 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.

16 Stages for induction of OSS Solution
Stages for the induction of OSS solution includes the following;

(a) Exploration & Testing: The available set of OSS solutions need to be explored and the required ones may be filtered based on some key parameters such as type of license, functionality, availability, longevity etc., initially the filtered OSS software solution be downloaded and installed to make it work as per the instructions given in the documentation. Then filtered solution needs to be tested for its functionality, performance, security etc. The tested, filtered solutions meeting the benchmarks may be selected for PoC.

(b) Proof of Concept (PoC) for confidence building: The selected OSS solution may have the

facilities and functionalities, which is required to be shown in some of the Projects, until the Level of Confidence about the software/solution will be low. 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 will be easier. User manuals, Technical Documents are to be prepared and handed over to the project team. Backup mechanisms, recovery mechanisms are to be mentioned clearly.

(d) Roll-out in live Systems: The tested solution will be implemented in LIVE systems. Proper and routine monitoring has to be done. Regular backup of application-data has to be taken. The OSS solution shall be maintained in the repository as per the guidelines given in "Annexure-IX General Guidelines to document the details of OSS in OSS Repository"

(e) Creating Multiplication Effect: The OSS solution will be implemented in other project. During this phase, customisation will be done 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 will be provisioned and collaborative mechanism solutions will be established.

17.1 Creation of Institutional Mechanism

(a) Apex Body shall drive the OSS initiatives; the stake-holders include DeitY, NIC, CDAC, and STQC, Industry representatives (NASCOM, MAIT etc.), nominated officials from line Ministries of Centre, State Governments, Public Sectors, Academia, R&D Institutes and OSS Communities.

(b) Centre of Excellence on OSS shall be established to execute the program as per this Framework. 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 are to be provided to offer adequate support services, consultancy services on the adoption of OSS through help desk.

(c) Expert Committees / Specialist Committees shall be formed under program implementing agency and they shall be assigned the tasks related to OSS Stack, etc. The Committees will submit the draft reports for obtaining feedback from stakeholders. They will update the drafts and submit to the Apex Body for ratification.

(d) Key Stakeholders for sustaining the momentum on OSS Adoption will comprise of Senior Management, Project Managers, System-Developer, System-Integrators, Service-Providers, Product-Partners, Technology Experts and End-Users; these are outlined in "Annexure-X Key Stakeholders of Ecosystem"

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

Recommendation: Establish a Centre of Excellence and expand network of OSS Support Centres.

Recommendation: Use of OSS in Government Departments along with skill development programs should be encouraged.
17.2 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. Industry may be involved in development of particular OSS solution to fill the gaps, if required.

**Recommendation:** 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 per module, encourage SMEs participation, reduce the risks in ICT projects and facilitate the adoption of OSS.

17.3 Partnership with OSS Communities in India & Abroad

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

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

**Recommendation:** National repositories/ knowledge banks should be created for OSS solutions, technologies and applications.  
**Recommendation:** Code contribution to OSS community should be encouraged.

17.4 Engaging Academia

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

(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 curriculum development, e-learning and collaborative learning, application of Open Source methodology and business models to real world scenarios.

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 open philosophy of OSS is consistent with academic freedom and the open dissemination of knowledge and information in academia. Therefore, it is recommended that steps may be taken to make education syllabus in academic institutes as vendor neutral. Education system must teach principles and not product/brand names with generic descriptions. This gives teachers and students the freedom to choose the applications that meet their requirements and their budgets. Also, OSS course-ware should be incorporated in schools, colleges and universities.

The working groups will include OSS Technology Experts, Teachers and Course Curriculum Planners.

**Recommendation:** For Government funded software research and development in India, scientists/researchers should be encouraged to publish their innovations under Open Source and Open Document licenses, except for National Security reasons.

**Recommendation:** Course syllabus should be vendor neutral and not based on any brand or product names; it should also incorporate OSS course-ware in Schools, Colleges, Universities and National Institutes curriculum; forming of Working Groups for Course Curriculum Development.

**Collaborative Mechanism**

Enhanced Collaborative mechanism (like help desk mechanism, knowledge portal, issue tracking system, discussion forums, e-mail support, and telephone) will be established for the adoption of OSS.

### 17.5 Provisioning of Support Services on OSS

The multi-level support is proposed and it includes support from:

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

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. This will help in creating countrywide technical support infrastructure for OSS along with requisite trained and skilled manpower.

In-House Experts will work on exploration of technology, internal support and domain-consortia forums; Industry Partners will contribute to configurations settings & running services, source code level enhancements, etc., “Industry Partnership Programme” will be utilised to choose “Right People”; this programme will also be used for exploring “Niche Technologies”, Training and Roll-out of explored Technologies.

**Recommendation:** Establish Multi-Level Support Services on the adoption of OSS.

**Recommendation:** Continue R&D efforts in OSS in identified thrust areas.
17.6 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

17.7 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 will also be provisioned with support services and source-code level enhancements. These will motivate the e-Governance implementers to come forward for the adoption of OSS since it solves issues resulting from the informal use of OSS solutions.

(b) In order to generate adequate trained manpower in OSS, it is required to collaborate with various Educational Institutes for introducing subjects on OSS as part of the curriculum.

(c) Capacity Building for in-house experts and policy makers by way of on-the-job training, class-room training programs and work-shops will be conducted.

Recommendation: Provisioning of application development, staging and deployment environments for the reuse of Open Source Stacks with support services.
17.8 Integration with Existing Efforts

NRC-FOSS Project executed by CDAC focuses on Research and Development of BOSS Linux OS with OSS, Cloud Systems, etc. NRC-FOSS focuses on the support for common use of BOSS OS mainly targeting end-users like students, citizens etc. Also Cloud Services are offered by CDAC. NRC-FOSS project team and their users can also avail the support services on the recommended OSS Stacks and run the bundled OSS Stacks.

Open Technology Group (OTG), NIC, Chennai is spearheading the adoption of OSS and Open Standards in e-Governance Applications through Open Technology Centre (OTC) Project. OTG has formulated the Open Source Stack and has provisioned support mechanism through Industry.

NIC-OTG is collaborating with CDAC-FOSS to test BOSS-Linux, adopt BOSS in other Government agencies and in formulating the Device Drivers Policy, FOSS Adoption Framework, Open Source Course Curriculum for Universities/Colleges, etc. This cooperation will continue and complement each other.

NIC-OTG has been interacting with few State Data Centre (SDC) / National Data Centre (NDC) (like TN-SDC, Pune-NDC) on adopting OSS in e-Governance applications. This effort will be strengthened and extended to other SDC/NDC.

The composite teams at SDC can also avail the proposed OSS services as defined in this Framework document.

**Recommendation:** The existing efforts of the OTC project and NRC-FOSS project can be consolidated and it shall seed the genesis of Centre of Excellence on OSS.

18 Summary of Recommendations for Adoption of OSS Framework

This section summarises the recommendations for the adoption of OSS.

18.1 Recommendations for Implementing Agency for OSS Framework

(a) The existing efforts of the OTC project and NRC-FOSS project can be consolidated and it shall seed the genesis of Centre of Excellence on OSS.

(b) Establish the Centre of Excellence on OSS and expand network of OSS Support Centres.

(c) Preference should be given to select OSS libraries which have liberal and less restrictive license model.

(d) Identification of OSS stack for development of applications and infrastructure shall be carried out.

(e) Establish Multi-Level Support Services on the adoption of OSS.

(f) Provisioning of application development, staging and deployment environments for the reuse of Open Source Stacks with support services.

(g) Offer services for Preferred areas and provide support.

(h) Continue R&D efforts in OSS in identified thrust areas.

(i) National repositories/ knowledge banks should be created for OSS solutions, technologies and applications.

(j) 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.

(k) 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.

(l) 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.

(m) Use of OSS in Government Departments along within skill development programs should be encouraged.

(n) The security of OSS solutions under OSS Stacks can be enhanced by creating a two layered internal & external audit mechanism and retrofitting mechanism under the proposed structure.

(o) OSS application development with Indian languages interface should be encouraged.

(p) Course syllabus should be vendor neutral and not based on any brand or product names; it should also incorporate OSS course-ware in Schools, Colleges, Universities and National Institutes curriculum; forming of Working Groups for Course Curriculum Development.

(q) 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.

(r) The guideline on influencing factors for the adoption of OSS needs to be brought out by customising for Indian Scenario.

(s) Enforcement guidelines on Open Standard Policy of Government of India should be brought out to accelerate the adoption of OSS.

18.2 Recommendation for E-Governance Project Implementation Team

(a) This Framework should be used to expedite the adoption of OSS in e-Governance in India.

(b) Focus on Preferred areas for adoption.

(c) Since many socio, economic and strategic benefits are provided by the adoption of OSS, OSS should be considered along with CSS.

(d) Preference should be given to “Pure Open Source Model” for availing the support service on OSS.

(e) Government Agencies and Departments will seek to avoid vendor lock-in to proprietary IT products and services. RFP (Request For Proposal) documents will avoid using vendor specific product/brand names.

(f) Applications developed by the Government of India should be cross platform and not be locked in to a specific platform.

(g) 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 National Security reasons.

(h) 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 per module, encourage SMEs participation, reduce the risks in ICT projects and facilitate the adoption of OSS.

(i) 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.

(j) Code contribution to OSS community should be encouraged.
18.3 Recommendations related to RFP/Procurement

(a) OSS Solutions should be considered alongside Proprietary solutions 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.

(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.

19 Practical Hints for the use of Recommendations

The RFPs/Tenders for procurement of ICT solution should have a clause indicating need for compliance to the recommendations given in this Framework. The vendor is supposed to deliver the ICT Systems as per the RFP/Tender specifications. The supplied ICT systems should satisfy the features as per the RFP/Tender conditions; in addition any other features supported by the ICT Systems should also be made available as per the recommendations given in this Framework.

A self-declaration (proforma to be prepared) statement shall be obtained from the Vendor with regard to compliance to the recommendations given in this Framework.

The vendor(s) shall be accountable for their claims regarding compliance to the recommendations given in this Framework.

In case of any dispute, a committee may be set up by Government of India / DeitY / Government-Agency for advice and resolution.

20 Road-Map (Way Forward: 2013-17) for OSS Adoption Framework

20.1 Identification of OSS Stack
   a) Formulate OSS Adoption procedures and recommendations ensuring level playing field for OSS.
   b) Identification of suitable rating methodology for rating OSS solution.
   c) Identification of recommended OSS stacks (applications development stack and infrastructure stack related to e-Governance) using the rating methodology.
   d) Create processes (close group review, public review, ratification by Apex Body, etc.) for approving the recommended stacks and version mechanism for maintaining the updates.

20.2 Services
   a) Creation & Maintenance of Repository for identified OSS stacks.
   b) Establish/ Enhance/sustain the ecosystem for support services on the stacks.
   c) Provision of OSS stacks over Virtual Machines/ Cloud Technologies.
d) Skill Development programs (Technical Courses, Awareness Programs, and Workshops).

e) Strengthen internal Support mechanisms on OSS within the Government Agencies.

f) Strengthen domestic industry in OSS and encourage localisation efforts.

g) Create Knowledge Banks for OSS solutions and applications initially in the areas of e-Governance.

h) Develop OSS Components / Libraries / solutions / Enhancements with the help of Industry Partners.

i) Strengthen capacity building on OSS expertise at NIC and C-DAC and state Government agencies.

j) Form Working Groups to develop OSS course-ware and introduction in select Institutions.

k) Identify and implement visible E-Gov projects at State/ Centre levels using OSS.

l) Reuse of OSS stacks in all e-Governance Systems including National Data Centre (NDC) and State Data Centres (SDC) in a phased manner.

20.3 Research & Development

a) Exploration & Adoption of proven emerging open technologies.

b) Continue R&D efforts in OSS in identified thrust areas.

20.4 Interoperability

a) Ensure interoperability among various OSS distributions.

b) Firm-up interoperability Framework for OSS around Open Standards. Encourage vendor-neutral and platform-neutral RFPs for IT procurement in Governments, Open Source device drivers in hardware and peripherals procured.
PART- II
Annexures
### Annexure-I  Typical OSS Stacks for Java, PHP and Open Web Technologies

<table>
<thead>
<tr>
<th>S. No</th>
<th>Functional Areas for Solutions</th>
<th>Java Technology Application Development Solutions</th>
<th>PHP Technology Application Development Solutions</th>
<th>Open Web Technology Application Development Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Programming Language</td>
<td>Core Java (1.7 / 1.6)</td>
<td>PHP (5.4.x / 5.3.x)</td>
<td>Any one mentioned under Java / PHP Technology solutions (or) Server Side JavaScript (1.8.x)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>HTML (5.0 / 4.01)</td>
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<tr>
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<td></td>
<td></td>
<td>CSS (3.0 / 2.1)</td>
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<td>JavaScript (1.8.x)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>jQuery (1.9.x)</td>
</tr>
<tr>
<td>2</td>
<td>Framework</td>
<td>Apache Wicket Framework (6.x/1.5 / 1.4) with extensions</td>
<td>Symfony (2.x ) with extensions</td>
<td>Any one mentioned under Java / PHP Technology solutions (or) Node.js (0.8.x)</td>
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<tr>
<td>3</td>
<td>Application Server</td>
<td>Apache Tomcat (7.0.x/ 6.0.x) with Apache HTTP Server (2.4.x / 2.2.X)</td>
<td>Apache HTTP Server (2.4.x / 2.2.x)</td>
<td>Any one mentioned under Java / PHP Technology solutions (or) Node.js (0.8.x)</td>
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<td>4</td>
<td>Database</td>
<td>PostgreSQL (9.2.x / 8.4) with extensions</td>
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<td>Any one mentioned under Java / PHP Technology solutions (or) Apache Cassandra (1.2.x) / Apache CouchDB (1.2.x)</td>
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<td>5</td>
<td>IDE</td>
<td>Eclipse (4.2) with extensions</td>
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<td>Source Code Control</td>
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<td>Apache Subversion (1.7.x)</td>
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<td>Documentation</td>
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<td>LibreOffice (4.x)</td>
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<td>Testing</td>
<td>Junit (4.x)</td>
<td>PHPUnit (3.7.x)</td>
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<td></td>
<td>Apache Jmeter (2.9)</td>
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<td></td>
<td>W3C markup Validators service</td>
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<td>9</td>
<td>Portal / CMS</td>
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<td>Drupal ( 7.20 / 6.28 )</td>
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<tr>
<td>10</td>
<td>Object Relational Mapping</td>
<td>Hibernate (4.1.9)</td>
<td>Doctrine (2.3.2)</td>
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<td>S. No</td>
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<td>PHP Technology Application Development Solutions</td>
<td>Open Web Technology Application Development Solutions</td>
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<td>11</td>
<td>Database Administration</td>
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<td>Virtualisation</td>
<td>Xen Cloud Platform (XCP) (1.6 / 1.1)</td>
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<td>Cloud Platform</td>
<td>CloudStack (3.0), Meghdoot Cloud</td>
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<td>Server OS</td>
<td>CentOS (6.x / 5.x) / Ubuntu(12.04 / 10.04) / BOSS Advanced Server</td>
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<td>15</td>
<td>Desktop OS</td>
<td>CentOS (6.x / 5.x)/ Ubuntu (12.04 / 10.04) / BOSS (5.0)</td>
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<td>Authentication with Single Sign On</td>
<td>Central Authentication Service (CAS) (3.5.x)</td>
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<td>Digital Archival Repository</td>
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Annexure-III  SWOT Analysis of OSS Adoption

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;

- **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 and in new use cases.
  
  Because OSS is free from per user or per instance costs and there is a guaranteed freedom to use in any way, reuse is enabled.

- **Cost Effective** In general, Public agencies find that they consistently get great value and the desired RoI (Return on Investment) from OSS based software-solutions.

- **Help Innovation** It is easy for public agencies to do pilot study and initial roll-outs using OSS with minimal acquisition cycles and associated entry costs. If required, commercial support services agencies can be easily engaged by public agencies to build value-added capabilities and innovations on top of OSS based software-solutions; this enables an easy path to deploy OSS based Systems in production.

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

  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 can be important. CSS suppliers may also provide the same through a ‘proof of concept’ phase at minimal or no cost; but this approach may include lot of restrictions for use in other phases.

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

- **Better Local Capacity Building** Increased local capacity building for software development based on OSS; this leads to effective participation of local industries.

- **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.

- **Minimised Piracy** Avoidance of piracy and IPR issues which are common with the Proprietary Technology

- **Better Interoperability** No vendor monopoly means no reason to avoid free and Open Standards. With Data transferability with OSS code and a move towards 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 which are based on OSS. Further, many OSS are based on Open Standards.

- **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; which lead to code sharing cultures, better citizen accessibility, and greater control over IT projects. Potential to reduce reliance on particular software developers or suppliers which could in-turn

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encourage competition and reduce commercial barriers to entry and exit for Government. No single-vendor means diversity of support and services choice, sustained competition is a customer benefit

**Weaknesses**

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

- **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
  (viii) Sustainability of implementations
  (ix) Ecosystem
  (x) Related IPR 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.

- **Adverse Impact of legacy systems** Most of the infrastructure and expertise are legacy in nature. 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, Methodologies to overcome the issues faced during the adoption of OSS, etc. Further, Government organisations are locked with long-term (like 5/10 years) conventional contracts / deals on procuring the ICT systems. This gives a little choice for the entry of new systems (which may be based on OSS). The guidelines / policies from the Government will mitigate these risks.

- **Limited commercial promotional efforts** Since the source code of the Open Source solution is available to all, any marketing done by any company to promote that Open Source solution will also benefit all its competitors; this leads to limited commercial efforts to promote the benefits of Open Source. Hence there is lesser business motivation. Hence, the Government needs to initiate the promotional efforts and awareness on the adoption of OSS since they bring a lot of benefits to the Government and the society.

- **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, whereas most of OSS solutions are provided by Small and Medium-sized Enterprises (SMEs) in most of the countries.

  - Also, while most solutions in the Open Source space are provided by small and medium-sized suppliers, the vast majority of Government IT work is still carried out by the major ICT suppliers.
  - The general ICT market conditions are dominated by few vendors or a monopoly. The existing marketing forces create fear, uncertainty and doubt about new entrants from Open Source model in order to avoid further competition and also to continue with the existing domination. Hence, entry of new participants from Open Source model needs support from Government to have a level playing field between Open Source and CSS.

- **High Cost of Integration and Migration** Most of the existing proprietary systems are poorly inter-operate with other software; this is done mainly to retain the customers, as captive, under control;
hence cost of switching from existing CSS to other OSS may become extremely expensive. OSS may require additional developmental efforts to enable integration with an existing proprietary environment. Some OSS may never work well with established proprietary products. Hence Government guidelines are required to avoid lock-ins; solutions which offer standards-based interfaces can be preferred.

- **Security Issues** The availability of source code may make the OSS vulnerable to more threats. However, this may be mitigated by using the recommended stable version of OSS with necessary supports & updates.

- **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 will mitigate the issues due to lack of OSS Policy / Framework.

- **Lack of cost effective Support Services** Sometimes, support and maintenance costs may outweigh 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.

- **Lack of Motivation, Capacity Building and Awareness** 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.

- **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 will mitigate risks.

### Opportunities

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

- **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.

- **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, startup companies).

- **Better Reuse** Hardly any restrictions and licensing are there in reusing the already developed e-Governance Systems which are based on OSS; hence, better re-usability can be achieved with cost-effectiveness while adopting these System in various central, state and local body agencies.

- **Better Suitability** More and more Government are adopting OSS in their e-Governance Systems every year and they are getting very encouraging positive outcome in most of the cases.

- **Better support from OSS community** Ever increasing Internet Connectivity makes the OSS communities do better collaboration and offer better services on OSS.

- **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 server\(^{23}\) (Apache, Nginx), application server (Tomcat, JBoss, Jetty), etc.; in case of migration requirement, moving from one OSS solution to another OSS solution is comparatively easier due to their openness.

- **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;

- **Decision-Makers** Slow change of perceptions of decision makers of e-Governance Systems about OSS solutions. License Model, IPR Infringements and Legal compliance are often misunderstood. Conducting awareness programs and provisioning of appropriate reports will help to take better decisions.

- **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.

- **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.

- **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.

- **Incompatible Versions** Sometimes there may be mismatch among various libraries of the integrated OSS solution. The approved OSS Stacks will ensure the compatibility.

- **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.

- **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.

Annexure-IV    Common Influencing Factors for the Adoption of OSS

**Technological Level Factors**

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

**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.

**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 supports will mitigate the issues due to complexity, if any.

**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.

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

**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 will minimise the proprietary lock-ins.

**Organisational Level Factors**

**Management's Positive Attitudes towards OSS (+)** - The attitudes & supports 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 positively.

**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.

**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 will help the adoption.

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

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

**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.

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

**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.

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

**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 will enhance the expertise of in-house experts.

**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.

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

**Environmental Level Factors**

**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 with CSS will hinder the adoption.

**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.

**Availability of Support Services on OSS (+)** - In case of a bottleneck or failure of a system based on CSS, then it is possible to hold the vendors of CSS; 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 supports.

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.

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

**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.

**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.

**Availability of Internal Collaboration Mechanism (+)** - The availability of collaborative information mechanism with in Government like discussion forum enhances the adoption.
<table>
<thead>
<tr>
<th>Individual Level Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Organisational Objectives Consensus (+)</strong> - The level of clear understanding among the adopters of OSS about the organisational objectives, their agreement &amp; 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 programs on OSS.</td>
</tr>
<tr>
<td><strong>User’s Fear on De-skilling of Legacy Expertise (-)</strong> - 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 will 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.</td>
</tr>
</tbody>
</table>
Annexure-V  Guidelines for Establishing Enterprise security
with OSS

**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.

**Secured Remote Access** - Many times, it is required to work through a secured solution (OSS like OpenVPN) 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.

**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.

**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.

**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, creation of logfiles at the application level are to be enabled at remote servers.

**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 malware.
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 categories

1. Mandating OSS
2. Preferring OSS
3. Mandating Open Standards
4. Best value

Major International Promotions

European Union Initiatives - European Commission (EC) published a report about avoiding vendor lock-ins in Government ICT systems 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 (Joinup program) 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. Joinup 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 Defence (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 available.

France - French Government issued a guideline, to "systematically review" alternatives to CSS when obtaining or developing new versions of applications; it also recommends to build internal expertise on

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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 law\(^{31}\) 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 include\(^{32}\):

- 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 Kingdom\(^{33}\) 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 Toolkit\(^{34}\) is also made available by UK Government.

**UNDP Initiatives** - UNDP has taken many initiatives for promotion of OSS and bringing many important reports / guidelines on OSS. The International Open Source Network\(^{35}\) (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.

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\(^{35}\) IOSN, [http://www.iosn.net/](http://www.iosn.net/)
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 China\textsuperscript{36}", 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 China\textsuperscript{37} 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).


\textsuperscript{37} 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 a 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 center 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.

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**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.


3. **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


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**OSS Servers at NIC Data-Centres**

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.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description</th>
<th>Percentage Deployments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Linux Physical Servers (including RedHat, CentOS, Debian, Ubuntu, BOSS, SUSE etc.)</td>
<td>32 %</td>
</tr>
<tr>
<td>2</td>
<td>Windows Physical Servers</td>
<td>65 %</td>
</tr>
<tr>
<td>3</td>
<td>Other OS Physical Servers (including Solaris, IRIX, etc.)</td>
<td>3 %</td>
</tr>
<tr>
<td></td>
<td>Linux Virtual Machines</td>
<td>69 %</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>------</td>
</tr>
<tr>
<td>5</td>
<td>Windows Virtual Machines</td>
<td>31 %</td>
</tr>
</tbody>
</table>

**Open Technology Centre Project**

OTC ([https://portal.otc.nic.in/](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.

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**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](http://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:

- Development of SaaS stack delivery model in area like Grid Computing / Cloud Computing
- Integration and development of Common desktop development infrastructure
- To setup Centre of Excellence for Mobile Internet Devices based on BOSS Linux
- Creation of NRCFOSS centralised portal for involvement, analysis, R&D and knowledge exchange
- FOSS HRD in the formal & Non-formal sectors
- 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**

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.

If the OSS solution is to be evaluated against CSS, then models like

- Return on Investment (ROI)
- Internal Rate of Return (IRR)
- Total Cost of Ownership (TCO)

can be considered. If required, these models need to be analysed to select / customise a suitable model.

**Approach for Return on Investment**

ROI finds out 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.

**Approach for Internal Rate of Return**

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.

**Approach for TCO**

There are various models used in evaluating the Total Cost of Ownership (TCO). 38

- **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 considered 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 CSS, 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

38 “Total Cost of Ownership of Open Source Software” (PDF), London School of Economics (LSE), http://ctpr.org/?p=701
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 national security and 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 report\(^{39}\), 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) with in 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.

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### Typical Total Cost of Ownership (TCO) Estimation

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td><strong>Search</strong></td>
<td></td>
</tr>
<tr>
<td>Cost of up-front evaluation study</td>
<td></td>
</tr>
<tr>
<td>Cost of up-front proof of concept implementation</td>
<td></td>
</tr>
<tr>
<td>Total Search Cost</td>
<td></td>
</tr>
<tr>
<td><strong>Acquisition</strong></td>
<td></td>
</tr>
<tr>
<td>Cost of Software</td>
<td></td>
</tr>
<tr>
<td>Cost of Customisation for business needs</td>
<td></td>
</tr>
<tr>
<td>Cost of Integration (to current platform)</td>
<td></td>
</tr>
<tr>
<td>Total Acquisition Cost</td>
<td></td>
</tr>
<tr>
<td><strong>Integration</strong></td>
<td></td>
</tr>
<tr>
<td>Cost of Migration (data and users)</td>
<td></td>
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<tr>
<td>Cost of Training</td>
<td></td>
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<tr>
<td>Cost of Process and Best Practice change</td>
<td></td>
</tr>
<tr>
<td>Total Integration Cost</td>
<td></td>
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<tr>
<td><strong>Use</strong></td>
<td></td>
</tr>
<tr>
<td>Cost of Support services - in house</td>
<td></td>
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<tr>
<td>Cost of Support services – contracted</td>
<td></td>
</tr>
<tr>
<td>Cost of Maintenance and Upgrades</td>
<td></td>
</tr>
<tr>
<td>Software scaling (for change in user or transaction volumes)</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost Category</th>
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<tbody>
<tr>
<td>Total Use Cost</td>
<td>Exit costs (in relation to hardware and software)</td>
</tr>
<tr>
<td>Retire</td>
<td>Exit costs (in relation to changeover, re-training)</td>
</tr>
<tr>
<td>Total Retire Cost</td>
<td></td>
</tr>
<tr>
<td>Total Cost</td>
<td></td>
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</tbody>
</table>
Annexure-IX  General Guidelines to document the details of OSS in OSS Repository

A simple spreadsheet is suggested to note the OSS used, its licence, its use and its conditions if any (e.g. license attribution, re-distribution of modified source). The typical fields in the spreadsheet may include:

<table>
<thead>
<tr>
<th>Description of OSS solution</th>
<th>OSS-1</th>
<th>OSS-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Apache HTTP Web Server</td>
<td>Firefox Web Browser</td>
</tr>
<tr>
<td>RIGHTS.type</td>
<td>Apache</td>
<td>Mozilla</td>
</tr>
<tr>
<td>RIGHTS.license</td>
<td><a href="http://www.apache.org/licenses/">http://www.apache.org/licenses/</a></td>
<td><a href="https://www.mozilla.org/MPL/2.0/">https://www.mozilla.org/MPL/2.0/</a></td>
</tr>
<tr>
<td>VERSION.identifier</td>
<td>2.4.4</td>
<td>20.0.1</td>
</tr>
<tr>
<td>Is source code of OSS modified by Government Organisation ?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Is OSS deployed in Government Infrastructure ?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Is OSS deployed in End-user environment ?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Integration type (static / dynamic) between OSS and CSS</td>
<td>static / dynamic</td>
<td>static / dynamic</td>
</tr>
<tr>
<td>Does OSS license require attribution in end-user license agreements?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Does the use of OSS require the re-publishing of modified source of OSS?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Key Stakeholders of Ecosystem

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Roles &amp; responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Management</td>
<td>Policy / Decision Makers from Government who takes decisions on the Projects; they guides Project Management.</td>
</tr>
<tr>
<td>Project Managers</td>
<td>Government / Department users who are responsible for the Projects and adopts the policies &amp; guidelines taken by the Senior Management; they supervise the services from registered partners like Product-Partner, Technology Experts, System-Developer, System- Integrator, Service-Provider.</td>
</tr>
<tr>
<td>System-Developer</td>
<td>Person 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&amp;D Institute.</td>
</tr>
<tr>
<td>System-Integrator</td>
<td>Person 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.</td>
</tr>
<tr>
<td>Service-Provider</td>
<td>Person who offers eServices and Infrastructure-Services; their services are availed by the System-developers and System-integrators; they may be from Government / Industry / Academia / Community / Consortia / R&amp;D Institute.</td>
</tr>
<tr>
<td>Product-Partner</td>
<td>Person who offers product specific solution; they are registered partners from Industry / Academia / Community / Consortia / R&amp;D Institute; they offer source-code level enhancements on the identified OSS solution.</td>
</tr>
<tr>
<td>Technology Experts</td>
<td>Registered Domain experts from Community, Academia, R&amp;D Institutes and Government</td>
</tr>
<tr>
<td>End-User</td>
<td>Person who avails the eServices of the system developed; they may be Citizen, Business-Organisation, Employee of a Government organisation, another Government unit.</td>
</tr>
<tr>
<td>Community</td>
<td>A complete ecosystem of a particular OSS solution which includes Developer, User, Partner Company and Trust.</td>
</tr>
<tr>
<td>Developer</td>
<td>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.</td>
</tr>
<tr>
<td>User</td>
<td>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.</td>
</tr>
<tr>
<td>Partner-Company</td>
<td>Organisation which offers commercial support services (like support, maintenance, training, certification, consulting, installation, enhancements &amp; bug-fixes) on the OSS solution; receives payment (like annual fees, subscription fees, royalties) from the User and paid / unpaid works from the Developer.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Roles &amp; responsibilities</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Trust</td>
<td>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.</td>
</tr>
</tbody>
</table>