Terms of Reference
For

System development for Land Use Policy Planning Department (Phase I)
(ICTA/GOSL/CON/QCBS/2016/140)

1. Introduction

Spatial planning in Sri Lanka is shared by several government institutions such as Land Use Policy Planning Department (LUPPD), National Physical Planning Department (NPPD) and Urban Development Authority (UDA). However, the roles and objectives of these institutions are varying thus their planning activities are different mainly in terms of the level of planning and the scale of planning. LUPPD that comes under the purview of the Ministry of Lands was established by Gazette number 1654/21 and 20th May 2010 with the following objectives

1. Create the legal background for implementing the National Land Use Policy adopted for Sri Lanka

2. Prepare a National Land Use Plan for Sri Lanka

3. Provide technical guidelines so as to utilize the limited land resource for the betterment of the human beings while maintaining environmental equilibrium

4. Issue recommendations and directives to establish the conservation and future existence of land resource in development plans based on the land resource

5. Launch programmes so as to expand the knowledge, training and education on scientific land use planning

The main role of the LUPPD is to prepare land use plans at various levels to allocate the land resource in the country in rational manner. In addition, the Department is having a responsibility to provide updated land use information for all stakeholders to facilitate the decision making process in land use and land administration. Updating of land use information is crucial and it should be done efficiently and accurately parallel to the other development activities in the country. Therefore, LUPPD has commenced a re-engineering of processes to increase the efficiency and accuracy of land use data capturing and to expedite the land use planning.

2. Background

LUPPD is a central government organization with the staff network up to the DSD level now. The LUPPD Head Office located at Colombo implements the land use planning activities through the District Land Use Planning Offices located at each districts. Generally land use planning covers all the lands irrespective of the ownership. However, presently more attention is given for the planning of use in state lands mainly due to inadequate legislative provisions to regulate the land use in private lands. But it does not mean that acquisition of land use information is only limited to state owned lands. Data gathering is pre-requisite for land use planning and therefore re-engineering of processes id very important to increase the efficiency of data collection and to increase the accuracy of data and expedite the planning activities. LUPPD has conducted the Re-engineering study a set of re-engineered processes have been established at this moment. Further a software requirement study has been conducted based on the re-engineered processes and a detailed requirement specification has been finalized with the participation of all the institutions.

3. Concise statement of the objectives

This project intends to develop a system for the re-engineered land use planning and management processes. Hence this project intends,

a) To prepare a requirement specification for the new processes based on the Re-engineered process report.
b) To develop a solution that is capable to work as per the re-engineered processes (Refer 4.17).
c) To deploy the solution in the Lanka Government Cloud.
d) To train the users of all offices of related organizations as trainers.

4. Scope of Work

4.1 Conduct a system requirement verification study of the processes
4.2 On completing the above, submit a requirement verification report.
4.3 Design and develop the system, upon obtaining ICTA approval for the above.
4.4 Implement the in collaboration with the SPA consultants appointed by ICTA, or review committee and facilitate the ‘Software Process Audit (SPA)’ specified by ICTA. Refer Annex C
4.5 Maintain project source code in the ICTA Source Code Management system (SCM).
4.6 Maintain all issues in the Issue tracking system maintained by ICTA.
4.7 Adopt a proper application release procedure to release the Land Use Planning system of LB to ICTA during the deployment in the staging / production environments.

4.8 Participate for Project Review Committee meeting and Project Implementation Committee (PIC) Meetings as a member

4.9 Obtain User Acceptance (UAT) for the implemented processes.

4.10 Deploy into production environment at Lanka Government Cloud (LGC).

4.11 Provide support and maintenance services, from the date of launch to an agreed time period.

4.12 Adhere to the Service Level Agreement, during the support and maintenance phase (SLA) indicated in Annex B.

4.13 Adherence to e-Government Policy of Sri Lanka [1].

4.14 Adherence to Web 2.0 concepts, open standards and Service Oriented Architecture (SOA) principles.

4.15 Adherence to LIFe standards [2].

4.16 Work collaboratively with ICTA and other stakeholder organizations

4.17 Followings are the functional requirements at high level

4.18 ICTA or its designated entity (end user) shall have the ownership rights to client specific components arising from the requirements specified in the DSRS. The ICTA may consider shared ownership rights to such components provided there is a cost benefit to ICTA or its designated entity (end user) at the discretion of the ICTA.

4.19 ICTA or its designated entity (end user) should have the right to access, modify, further develop and enhance the system at no cost to ICTA or its designated entity (end user).

4.20 The evaluation and the selection of the successful Bidder will be based on Total Cost of Ownership to ICTA or its designated entity (end user).

Major Processes	**Sub Processes**
1. Collection of Land Resource Information (Step 1 and 2) *From the point of deciding to carry out the land resource information collection at the GN level,* - *Define type of data needed and data collection channels,* - *To capture digital coverage prepared by Survey Department and satellite information to develop base maps and gather information from other relevant institutions as secondary data sources,* - *Data collection and verification* - *To upload collected data to land information system so as to update the existing database.*	**1.1 Planning of collecting land resource information (Field data collection and secondary data collection)** **1.2 Compilation of existing land use related information as per the secondary data collection plan** **1.3 Collection, verification and updating of new/additional information related to use of land at the field**

Note: Steps mentioned above are the steps given in the FAO guidelines given for land use planning.

4.21 Detailed requirements relating to above processes are documented in Business Process Re-engineering study report into detail levels such as main processes, sub processes, process components, steps and related forms.

4.22 The developer should follow BPR report to prepare the DSRS document by translating such requirements into a software requirement specification.

4.23 Integrate the new processes with the existing LB processes which contain functions of deed registration and The existing system has been developed based on the architecture stated in the Annex D.

4.24 Citizen services should be connected to country portal (www.srilanka.lk) as eServices.

4.25 Refer following Annexes which form a part and partial of the "Terms of Reference".

Annex A - Non-Functional Requirements

Annex B - Service Level Agreement (SLA) for Support and Maintenance Services

Annex C - Software Project Audit Process

Annex D – Proposed System Architecture of LB

Annex E – Re-engineering process of Land Use Planning functions

5. Final outputs, Reporting Requirements, Time Schedule for Deliverables;

Project duration is 2 months including requirement Verification, designing, developing and deploying the system.

Consultancy firm is required to submit the following list of deliverables for the Land Use Planning System of the Land Bank project.

No	**Deliverables**	**Phase**
5.1	Implementation Proposal 5.1.1 Inception report 5.1.2 Requirement verification report 5.1.3 Implementing schedule 5.1.5 Acceptance criteria for the UAT 5.1.7 Proper maintenance of issues in the Issue tracking System	Inception
5.2	5.2.1 Design and Architecture Document 5.2.2 Data migration and integration plan (if applicable) 5.2.3 Release Management plan (including staging, production and support and maintenance) 5.2.4 Proper maintenance of issues in the Issue tracking System	Elaboration
5.3	5.3.1 Iteration one release note 5.3.2 Iteration two release note 5.3.3 Iteration three release note 5.3.4 Proper maintenance of source code in SCM for all three iterations	Construction

	5.3.5 Proper maintenance of issues in the issue tracking System	
5.4	5.4.1 Solutions deployment and installation guide 5.4.2 Online help and the User manual for back office application 5.4.3 Administrator Manual 5.4.4 Proper maintenance of issues in the Issue tracking System 5.4.5 Successful UAT acceptance of the system 5.4.6 Production deployment confirmation report	Transition

Refer http://en.wikipedia.org/wiki/IBM_Rational_Unified_Process for more information about RUP (Rational Unified Process) phases.

6. Qualifications of the key consultants

Preferable Minimum Qualifications;

- **System implementing team**

Key Professional Staff	**Academic Qualification**	**Experience in the PROPOSED ROLE**	**Experience in working in SOA / web services / integration projects**	**Exposure SQA Process**
Project Manager	B. Sc or equivalent	5 years	2 years	2 years
Software Architect	B. Sc or equivalent	3 years	2 years	2 years
Technical Lead	B. Sc or equivalent	2 years	1 years	2 years
Business Analyst	B. Sc or equivalent	3 years	1 years	2 years
Quality Assurance Lead	B. Sc or equivalent	2 years	1 years	2 years
Software Engineer	B. Sc or equivalent	2 years	1 years	1 years
UI Lead	B. Sc or equivalent	3 years	2 years	1 years
UI Engineer	B. Sc or equivalent	2 years	1 years	1 years
QA Engineer	B. Sc or equivalent	2 years	1 years	1 years
DB Specialist	B. Sc or equivalent	3 years	2 years	1 years
IS Security Specialist	B. Sc or equivalent	3 years	1 years	1 years

- **Support and Maintenance team**

Key Professional Staff	**Academic qualification**	**Experience in the PROPOSED ROLE**	**Experience in working in SOA / web services / integration projects**	**Exposure SQA Process**
Technical Lead	B. Sc or equivalent	2 years	1 years	2 years

Software Engineer	B. Sc or equivalent	2 years	1 year	1 year

7. Services and Facilities Provided by ICTA

7.1 Web-based access to the ICTA SCM system
7.2 Designs of the existing system
7.3 Access to staging/ production servers
7.4 Issue Tracking System
7.5 SQA dashboard

References

[1] e-Government Policy Approved by Cabinet of Sri Lanka http://www.icta.lk/index.php/en/e-governement-policy

[2] Lanka Interoperability Framework - http://www.life.gov.lk/

9.Review Committees and Review Procedures

The Software Development Service Provider is required to work closely with the ICTA Technology Team and the Software Process Audit (SPA) consultants or the review committees such as SAGE – Software Architecture Group of Experts.

All versions of deliverables will be reviewed by/either the SPA consultants, SAGE, or ICTA Technology Team.

All the deliverables must be verified and confirmed to be accurate and complete by the Project Implementation Committee (PIC) or the Project Management Committee (PMC). Deliverables must be formally endorsed by the PIC or PMC or CTO or Head of Technology Team.

Annex (A)
Non-Functional Requirements

1. Workflow based operations

A workflow is activated when an initiating event occurs. The workflow would guide a user in actioning an event. It would define the requirements to initiate a workflow. Once initiated, the processing should be controlled as to the sequence of activities, and the officers who execute it.

Some key terms and concepts of workflow based operations are:

- Task: Work performed to effect a single change. A workflow would consist of several tasks. In workflow construction, the task definition is a template for action. The task must be associated with an actual event in order to carry out the action.
- Activated Task: When an action is required, and a task is associated with a specific item which must be actioned, the task is instantiated and a single instance of the task is created. It is the instance of a task (ie- Activated Task) which can be executed. (Note: This is not a standard workflow term, and has been adopted for clarity).
- Work Item: A workflow-item moving through a work process. A work item would be associated with a single instance of a workflow, and Activated Tasks within the workflow.

Refer Annexure A1.1 for more supporting services

2. Security

1. User authentication and authorization

An administrative application need to be developed wherever applicable.

2. Availability

The system should be developed to ensure "High Availability" to remain the system available all the time. (e.g. Portlets clustering capability should be taken into consideration in the development)

3. Non-repudiation

The system should ensure non-repudiation by having standard audit-trails and provisions to have WS-Security using digital signatures.

3. Audit Facilities

Wherever applicable, an audit trail of all activities must be maintained. On a service or operation being initiated, the system should log the event, creating a basic 'audit log entry'. It should not be possible for the operation to be executed without the log entry being made.

The information recorded in the audit trail depends on the type of activity which takes place. Each service would be responsible for logging detailed information. The different types of operations are -

1. Data Capture & Maintenance
2. Creation of an entry / item
3. Modification an item
4. Deletion
5. Control (or status change)
6. Process execution
7. Data synchronization

8. Print (only selected item)
9. Retrieval
10. Monitor

Detail logging may be enabled or disabled for each type of operation, and/or for each business object. It should be possible to configure which attributes of a data item should be traced at the detail level. Tracing of some attributes may be considered mandatory, and they should not be turned off.

4. Backup and Contingency Planning

The main contingencies that should be considered and the training with regards to these shall be given to the relevant staff -

11. Equipment failure
12. Physical / natural Disaster
13. Messaging or communication facilities.
14. Changes in operations and policy
15. Sudden absence of key personnel
16. Breach in Security

Automatic Backups daily, weekly and monthly should be taken. All the backup procedures and backups needs to be tested regularly for restoration.

5. Performance

Following performance criteria is provided as a guideline only. If the actual performance is falling below the stipulated figures, the consultant is to justify the reasons. However, the performance level must be accepted by the technical evaluation committee appointed by the client.

The bandwidth is assumed at 512kbps (shared) (point to point between LIX and the Department web service) with 1,000 concurrent users (50% load factor) in total.

Item	**Performance**
Screen Navigation: field-to-field	< 10 milliseconds
Screen Navigation: screen-to-screen	< 5 seconds
Screen Refresh	< 3 seconds
Screen list box, combo box	< 3 seconds
Screen grid – 25 rows, 10 columns	< 5 seconds
Report preview – (all reports) – initial page view (if asynchronous)	< 60 seconds in most instances. It is understood that complicated / large volume reports may require a longer period
Simple enquiry – single table, 5 fields, 3 conditions – without screen rendering	< 5 seconds for 100,000 rows
Complex enquiry – multiple joined table (5), 10 fields, 3 conditions – without screen rendering	< 8 seconds for 100,000 rows
Server side validations / computations	< 10 milliseconds
Client side validations / computations	< 1 millisecond
Batch processing (if any) per 100 records	< 120 seconds
Login, authentication, and verification	< 3 seconds
Daily backups (@ Dept.) – max duration	1 hour (on-line preferred)

Total Restore (@Dept) – max duration	4 hours

Annex (B)

SERVICE LEVEL AGREEMENT *for*
SUPPORT AND MAINTENANCE SERVICES

1. Introduction

The aim of this agreement is to provide a basis for close co-operation between the Client and the Consultant for support and maintenance services to be provided by the Consultant, thereby ensuring a timely and efficient support service is available. The objectives of this agreement are detailed in Section 1.1.

This agreement is contingent upon each party knowing and fulfilling their responsibilities and generating an environment conducive to the achievement and maintenance of targeted service levels.

1.1 Objectives of Service Level Agreements

1. To create an environment conducive to a co-operative relationship between Client, Consultant and Client's representatives (government organizations) to ensure the effective support of all end users.
2. To document the responsibilities of all parties taking part in the Agreement.
3. To define the commencement of the agreement, its initial term and the provision for reviews.
4. To define in detail the service to be delivered by each party and the level of service expected, thereby reducing the risk of misunderstandings.
5. To institute a formal system of objective service level monitoring ensuring that reviews of the agreement is based on factual data.
6. To provide a common understanding of service requirements/capabilities and of the principles involved in the measurement of service levels.
7. To provide for all parties to the Service Level Agreement a single, easily referenced document which caters for all objectives as listed above.

1.2 Service Level Monitoring

The success of Service Level Agreements (SLA) depends fundamentally on the ability to measure performance comprehensively and accurately so that credible and reliable information can be provided to customers and support areas on the service provided.

Service factors must be meaningful, measurable and monitored constantly. Actual levels of service are to be compared with agreed target levels on a regular basis by both Client and Consultant. In the event of a discrepancy between actual and targeted service levels both Client and Consultant are expected to identify and resolve the reason(s) for any discrepancies in close co-operation.

Service level monitoring will be performed by Client. Reports will be produced as and when required and forwarded to the Consultant.

1.3 Support Levels

The consultant must provide support and maintenance services during Support Levels mentioned below;

Support Level: **High**

Component/ Service	Core Components of Lanka Gate
Support Hours	24 hours a day, all days in the week (including public and mercantile holidays)

Support Level: **Medium**

Component/ Service 1	Government Interface and related backend services (deployed at Government organization site)
Support Hours	From 08:00 AM to 05:00 PM Monday to Friday (excluding public holidays)
Component/ Service 2	For front-end portlets and supporting back-end applications (web services, etc.. deployed at Lanka Government Cloud (LGC))
Support Hours	From 08:00 AM to 09:00 PM, all days in the week (including public and mercantile holidays)

1.4 On-Call Services Requirements

Consultant MUST make at least ONE qualified personnel available to the Client by telephone and email for the reporting and resolution of non-conformities or other issues, defects or problems. Dedicated telephone numbers and emails should be available for reporting issues. Client will nominate the personnel who are authorized to report non-conformities or other problems with the system from the departments. Reporting of non-conformities includes requests by the Client to apply critical software updates or patches.

Table-1 shows the response priority assigned to faults according to the perceived importance of the reported situation and the required initial telephone response times for the individual priority ratings. All times indicated represent telephone response time during specified Support Levels. The indicated telephone response time represents the maximum delay between a fault/request being reported and a Consultant's representative contacting the Client by telephone. The purpose of this telephone contact is to notify the Client of the receipt of the fault/request and provide the Client with details of the proposed action to be taken in respect of the particular fault/request.

Support Level	**Business Critical**	**Business Critical**	**Non-Business Critical**	**Non-Business Critical**
	Fatal	**Impaired**	**Fatal**	**Impaired**
High	60 minutes within Support Hours	90 minutes within Support Hours	90 minutes within Support Hours	120 minutes within Support Hours
Medium	120 minutes within Support Hours	150 minutes within Support Hours	150 minutes within Support Hours	180 minutes within Support Hours

Table-1: Response Priority

Note:
Fatal - Total system inoperability
Impaired - Partial system inoperability
Business Critical - Unable to perform core business functions
Non-Business Critical - Able to perform limited core business functions

Consultant notification can occur outside Support Level time, and thus the response may occur after the next Support Level begins. Furthermore, "Time to Arrive On-Site (Table-3)" starts from Support Level starting time and "Time to Resolve the Problem" is Support Level time starting from the actual time of arrival on site.

1.5 Problem Resolution and Penalties

If problems have not been corrected within two (2) hours of the initial contact, the Consultant shall send qualified maintenance personnel to the respective Client's site to take necessary actions to correct the issue reported (defect, problem or non-conformity).

If faults are not corrected within the time limits specified in the Table-2, the Client shall be entitled to a penalty payment for each hour that the Consultant fails to resolve the fault.

Maximum ceiling of penalty for a given month is 10% of the monthly support and maintenance price.

The time to arrive on-site is specified in the Table-3.

Support Level	**Business Critical**	**Business Critical**	**Non-Business Critical**	**Non-Business Critical**
	Fatal	**Impaired**	**Fatal**	**Impaired**
High	6 Hours LKR 5,000.00 per hour	10 Hours LKR 3,000.00 per hour	10 Hours LKR 3,000.00 per hour	15 Hours LKR 2,000.00 per hour
Medium	8 Hours LKR 5,000.00 per hour	12 Hours LKR 3,000.00 per hour	12 Hours LKR 3,000.00 per hour	20 Hours LKR 2,000.00 per hour

Table-2: Resolution Time and Penalties

Support Level	**Business Critical**	**Business Critical**	**Non-Business Critical**	**Non-Business Critical**
	Fatal	**Impaired**	**Fatal**	**Impaired**
High	Not applicable	Not applicable	Not applicable	Not applicable
Medium	2 Hours	3 Hours	3 Hours	5 Hours

Table-3: Time to arrive on-site

Annex C

Software Project Audit Process

Version 1.2

Information and Communication Technology Agency of Sri Lanka

1. Introduction

1.1 Purpose

Purpose of this document is to describe the Software Project Audit Process which is capable of auditing and ensuring the quality of different activities carried out throughout a software project life-cycle. The main purpose of this process is to provide much higher level of confidence in the quality of the deliverables received by the client from the developer. The quality level of the audited activity is presented using a measurement technique called metrics.

The process should be followed by both the development team and the Software Project Audit team to derive their own metrics to measure the quality status of a software product in its life cycle. Eventually, the trend analysis of such metrics can be used to identify any potential project issues or failures and to come up with solutions.

This document explains several guidelines which can be used within the audit process for project progress calculation and mapping payment milestones with project deliverables or and project artifact reviews to effectively manage the project.

Further, the document contrasts the Software Project Audit process from typical software development life cycle and illustrates how it has been automated by integrating several testing tools and testing methodologies as well as embedding best industry standards.

1.2 Scope

Scope of this document is to provide an insight about the Software Project Audit Process, importance of metrics, analysis of metrics, automated process of metric generation, skills required to generate certain metrics, guideline for project progress calculation, guideline for mapping payment milestones with deliverables and guideline for Review of Project artifacts.

1.3 Definitions, Acronyms and Abbreviations

Acronym	Definition
AQI	Architecture Quality Index
AD	Architectural Design
CQI	Code Quality Index
DD	Defect Density
DQI	Design Quality Index
DSI	Defect Severity Index
ISI	Issue Severity Index
PERI	Project Execution Readiness Index
RCI	Requirement Clarity Index
SPA	Software Project Audit
SR	Software Requirement
TTEI	Tasks Tracking Efficiency Index
TR	Transfer
UAT	User Acceptance Test
OAT	Operational Acceptance Test

2. Process Overview

It is often said that if something cannot be measured, it cannot be managed or improved. There is immense value in measurement, but you should always make sure that you get some value out of any measurement that you are doing.

What is a Metric?

It is a standard of measurement which can be used to measure the software quality. It gives a confidence in the software product. They are typically the providers of the visibility of the software product you need.

Why Measure?

When used appropriately, metrics can aid in software development process improvement by providing pragmatic, objective evidence of process change initiatives. Although metrics are gathered during the test effort, they can provide measurements of many different activities performed throughout a project. In conjunction with root cause analysis, test metrics can be used to quantitatively track issues from points of occurrence throughout the development process. In addition, when metrics information is accumulated, updated and reported on a consistent and regular basis, it ensures that trends can be promptly captured and evaluated.

What to Measure?

When considering the metric driven process, it can be divided into two parts. The first part is to collect data, and the second is to prepare metrics/charts and analyze them to get the valuable insight which might help in decision making. Information collected during the software development process can help in:

- Finding the relation between data points
- Correlating cause and effect
- Input for future planning

Normally, the metric driven process involves certain steps which are repeated over a period of time. It starts with identifying what to measure. After the purpose is known, data can be collected and converted into the metrics. Based on the analysis of these metrics appropriate action can be taken, and if necessary metrics can be refined and measurement goals can be adjusted for the better. Data presented by Development/testing team, together with their opinion, normally decides whether a product will go into client or not. So it becomes very important for Development team/test teams to present data and opinion in such a way that data looks meaningful

to everyone, and decision can be taken based on the data presented. Every software project should be measured for its schedule and the quality requirement for its release. There are lots of charts and metrics that we can use to track progress and measure the quality requirements of the release. In Figure 1.0 shows some of main metrics which can be derived at specific level of the software development life-cycle.

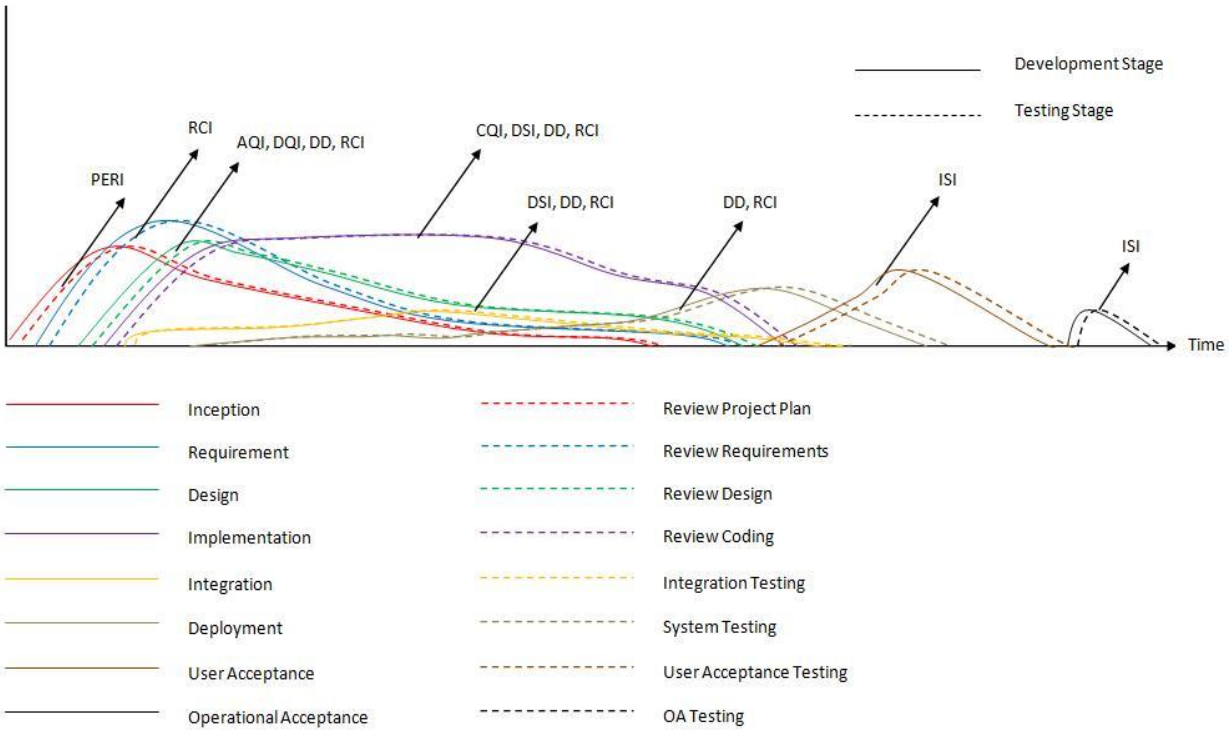


Figure 1.0 - Various Metrics derived at different levels of SD process

2.1 Metrics in Brief

Metric	Purpose
Project Execution Readiness Index (PERI)	This Proposed index at requirements stage is derived based on quality of the documents involve with this phase. The main Documents involve in this phase are; * User Requirements Document * Acceptance test plans * Project management plan for the SR phase * Configuration management plan for the SR phase * Verification and validation plan for the SR phase * Quality assurance plan for the SR phase When reviewing , reviewers can verify the document by checking its content with a checklist. Each of thesecontent in a checklist is categorized under their Severity to the System. All defects in those contents should be logged in a defect tracking system. Finally, index can be derived as; Weighted average of the total number of Open Issues in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight } (162+54+18+6+2+1)}$ Note: Can be calculated based on the review cycles
Requirements Clarity/Change Index(RCI)	This index measures following two criteria relevant to requirements 1. Requirements Clarity This is the proposed index is at Specification Stage which should indicate how well each member of the Software development team comprehend the requirements and also indicates How well the requirements are cleared for Software Development Team. 2. Requirement Changes Requirement changes may be arisen at any stage of a project. Therefore, this index should be continued till UAT phase of a project and all the requirement changes arisen during that period should be captured under this index.

	The index indicates, weighted average of the total number of Open Issues in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight } (162+54+18+6+2+1)}$ Note: Can be calculated based on the review cycles.
Architectural Quality Index (AQI)	Testing indicator for Architectural design level. The main documents of the AD phase are; *Architectural Design Document (ADD); *Software Project Management Plan for the DD phase (SPMP/DD) *Software Configuration Management Plan for the DD phase (SCMP/DD) *Software Verification and Validation Plan for the DD Phase (SVVP/DD) *Software Quality Assurance Plan for the DD phase (SQAP/DD) *Integration Test Plan (SVVP/IT) When reviewing , reviewers can verify the document by checking its content with a checklist. Each of these content in a checklist is categorized under their Severity to the System. All defects in those contents should be logged in a defect tracking system. Finally, index can be derived as; Weighted average of the total number of Open Issues in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight } (162+54+18+6+2+1)}$ Note: Can be calculated based on the review cycles
Design Quality Index (DQI)	This is the Index proposed at Detailed Design Level. Should define a quality index (DQI) to measure and evaluate the quality of the Detailed Design based on the quality of the documents involve with the Detailed Design phase. The main documents of the AD phase are the; *Detailed Design Document (DDD) *Software User Manual (SUM) *Software Project Management Plan for the TR phase (SPMP/TR) *Software Configuration Management Plan for the TR phase (SCMP/TR)

	*Software Quality Assurance Plan for the TR phase (SQAP/TR) *Acceptance Test specification (SVVP/AT) When reviewing , reviewers can verify the document by checking its content with a checklist. Each of these content in a checklist is categorized under their Severity to the System. All defects in those contents should be logged in a defect tracking system. Finally, index can be derived as; Weighted average of the total number of Open Issues in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight } (162+54+18+6+2+1)}$ Note: Can be calculated based on the review cycles
Code Quality index (CQI)	- Indicates how well the software codes are written and maintained. - To be derived using considering multiple aspects. This will be decided in project execution. - Index can be derived as; Weighted average of the total number of Open Issues in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight } (162+54+18+6+2+1)}$
Defect Density (DD)	- Number of defects per unit size of the application (KLOC) - Calculated end of each drop cycle. - The Number of Known Defects is the count of total defects identified against a particular software entity, during a particular time period - Size is a normalizer that allows comparisons between different software entities (i.e modules, releases, products). Size is typically counted either in Lines of Code or Function Points.
Defect Severity Index (DSI)	- Indicates application stability - Weighted average of the total number of Open Defects in the product detected till date against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{}$

	Total weight (162+54+18+6+2+1) Note: Calculated weekly and delivered by drop
Issue Severity Index (ISI)	During the User Acceptance Test(UAT) time issues can be arisen. All those issues should be logged in UAT documentation as well as in the bug tracking System. - Weighted average of the total number of Open issues in the product arisen during the UAT period against all categories (Blocker (B), Critical (C), Major (Ma), Normal (N), Minor (Mi), Trivial(T)). Metric: $\frac{(B*162 + C*54 + Ma*18 + N*6 + Mi*2+ T)*10}{\text{Total weight (162+54+18+6+2+1)}}$
Defect Category	ttribute of the defect in relation to the quality attributes of the product. Quality attributes of a product include functionality, usability, documentation, performance, installation, stability ,compatibility , internationalization etc. This metric can provide insight into the different quality attributes of the product. This metric can be computed by dividing the defects that belong to a particular category by the total number of defects.
Defect Cause Distribution Chart	This chart gives information on the cause of defects.
Defect Distribution Across Components	This chart gives information on how defects are distributed across various components of the system.
Defect Finding Rate	This chart gives information on how many defects are found across a given period. This can be tracked on a daily or weekly basis.
Defect Removal Efficiency	The number of defects that are removed per time unit (hours/days/weeks). Indicates the efficiency of defect removal methods, as well as indirect measurement of the quality of the product. Computed by dividing the effort required for defect detection, defect resolution time and retesting time by the number of defects. This is calculated per test type, during and across test phases.
Effort Adherence	As % of what is committed in contract. Provides a measure of what was estimated at the beginning of the project vs. the actual effort taken. Useful to understand the variance (if any) and for estimating future similar projects.
Number of Defects	The total number of defects found in a given time period/phase/test type

	that resulted in software or documentation modifications. Only accepted defects that resulted in modifying the software or the documentation are counted.
Review Efficiency	# of defects detected /LOC or pages reviewed per day
Test Case Effectiveness	The extent to which test cases are able to find defects. This metric provides an indication of the effectiveness of the test cases and the stability of the software. Ratio of the number of test cases that resulted in logging defects vs. the total number of test cases.
Test Case Execution Statistics	This metric provides an overall summary of test execution activities. This can be categorized by build or release, module, by platform (OS, browser, locale etc.).
Test Coverage	Defined as the extent to which testing covers the product's complete functionality. This metric is an indication of the completeness of the testing. It does not indicate any thing about the effectiveness of the testing. This can be used as a criterion to stop testing. Coverage could be with respect to requirements, functional topic list, business flows, use cases, etc. It can be calculated based on the number of items that were covered vs. the total number of items.
Test Effort Percentage	The effort spent in testing, in relation to the effort spent in the development activities, will give us an indication of the level of investment in testing. This information can also be used to estimate similar projects in the future. This metric can be computed by dividing the overall test effort by the total project effort.
Traceability Metric	Traceability is the ability to determine that each feature has a source in requirements and each requirement has a corresponding implemented feature. This is useful in assessing the test coverage details.
Scope Changes	The number of changes that were made to the test scope (scope creep). indicates requirements stability or volatility, as well as process stability. Ratio of the number of changed items in the test scope to the total number of items
Task Tracking Efficiency Index (TTEI)	This index indicates the average time taken to attend to general project tasks. TTEI = $\frac{\Sigma \text{ Time taken to attend task}}{\Sigma \text{ open task}}$

Table 1.0 – Metrics

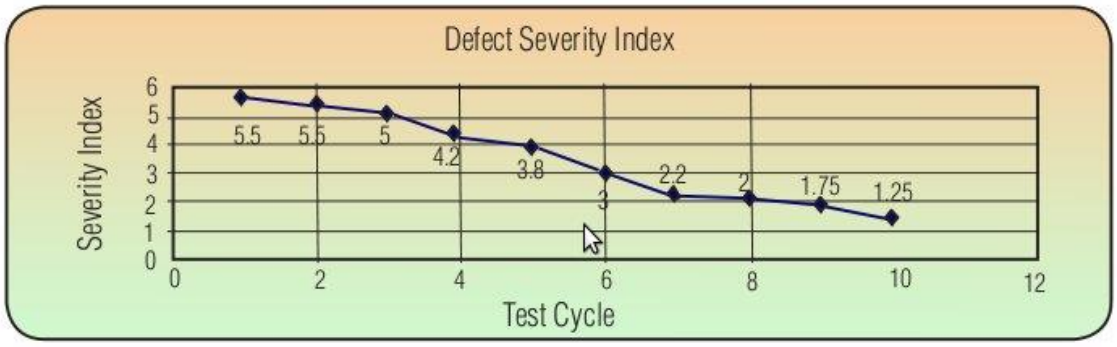
2.2 Metrics Analysis

Much as the time is spent gathering or maintaining metrics, enough time should be spent to review and interpret on a regular basis throughout the test effort, particularly after the application is released into production. During review meetings, the project team should closely examine all available data and use that information to determine the root cause of identified problems. It is important to look at several metrics, as this will allow the project team to have a more complete picture of what took place during a test.

Let's assume that as part of the SPA Process, the following metrics are collected by the SPA team.

Metric	Purpose
Defect Severity Index	Weighted average index of the Severity of defects. A higher severity defect gets a higher weight. S1 is a show stopper, S2 is high severity, S3 is medium & S4 is low. Ideally, this should slope down as test cycles progress.

For instance, if the test team has generated the following metrics:



a

t the graphs one can safely deduce the followings;

Defect Severity Index Trend:

What does the graph indicate? The defect severity index is sloping down consistently. This indicates an increasingly favorable trend. As the test cycle progresses (from cycle 1 to cycle 10), the severity index is sloping which suggests increasing quality of the application (as lesser number of critical and high severity defects are being reported).

This is what it could mean: While a fall in the defect severity index is definitely a good trend, looking at this index in isolation could be misleading. Following factors need to be considered in order to have a meaningful analysis.

Number of defects logged - let us consider an example where the test team executed two cycles of testing (assuming other things as constant). The number of defects logged against each of these cycles along with the calculated severity index is shown below.

Number of Defects

Defect Severity	Cycle 1(# of defects)	Cycle 2(# of defects)
s1	5	5
s2	10	15
s3	50	30
s4	100	100
Severity Index	1.52	1.50

At first thoughts, when we compare cycle 1's Severity Index with cycle 2's Severity Index, cycle 2 looks to be favorable (as the severity index is lower). If you go into the details of the number of defects logged and their severity, the picture turns out to be the opposite. While the total number of Severity 1 and Severity 2 defects for cycle 1 is 15, the number of Severity 1 and Severity 2 defects for cycle 2 is 20. In terms of quality, cycle 1 is better than cycle 2 as cycle 1 has lesser number of high severity defects (though the total number of defects logged in cycle 1 is more than cycle 2 defects and the severity index is greater than cycle 2 severity index). Test coverage has a similar impact. A lower test coverage coupled with reducing severity index would not be a healthy trend.

Severity of Defects

Defect Severity	Cycle 1(# of defects)	Cycle 2(# of defects)
s1	4	0
s2	4	0
s3	42	75
s4	27	2
Severity Index	1.81	2.03

- Defect Severity - let's consider another example where the test team executed two cycles of testing (assuming other things as constant). The severity of defects logged against each

of these cycles along with the calculated severity index is shown below.

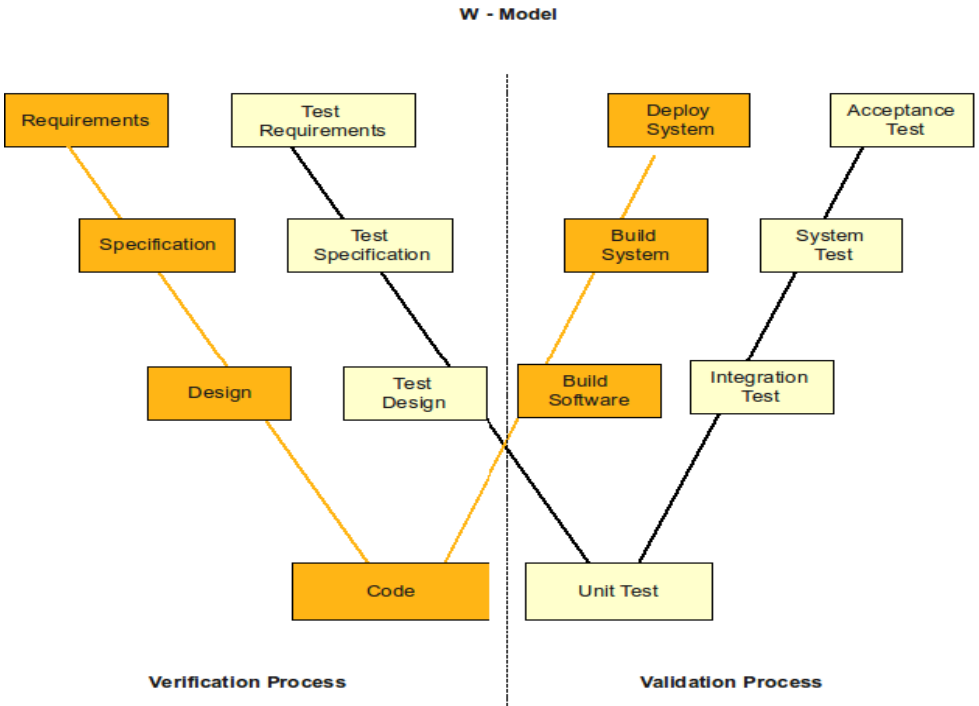
Looking at the severity index, it looks like cycle 1 is better than cycle 2 (as the severity index is low for cycle 1 compared to cycle 2). However, cycle 2 is better than cycle 1 as total number of Severity 1 and Severity 2 defects is zero compared to a total of 8 severity 1 and severity 2 defects of cycle 1. Just because the severity index is low, do not believe the quality of the application is better than the earlier cycle.

3. Process Automation

In following section describes about the testing methodologies, process and tools to be used while automating the typical software development life-cycle in order to deriving the metrics.

3.1 Testing Methodology

According to the Automated testing process, every development activity is mirrored by a test activity. The testing process follows a well-proven testing methodology called W-model. Following Figure-2.0 explains, the way of testing activities of W-model involve with the standard software development life-cycle.



While the execution of the project, either developers or SPA team can generate the related metrics.

3.2 Skills required to generate Metrics

During the different stages of a software project, several roles and parties will be involve with development, reviewing and testing activities. In Figure 3.0 shows the different stages of a software project, the main activities which should perform during those stages, the roles/parties should involve and the metrics which derive and maintain in those stages.

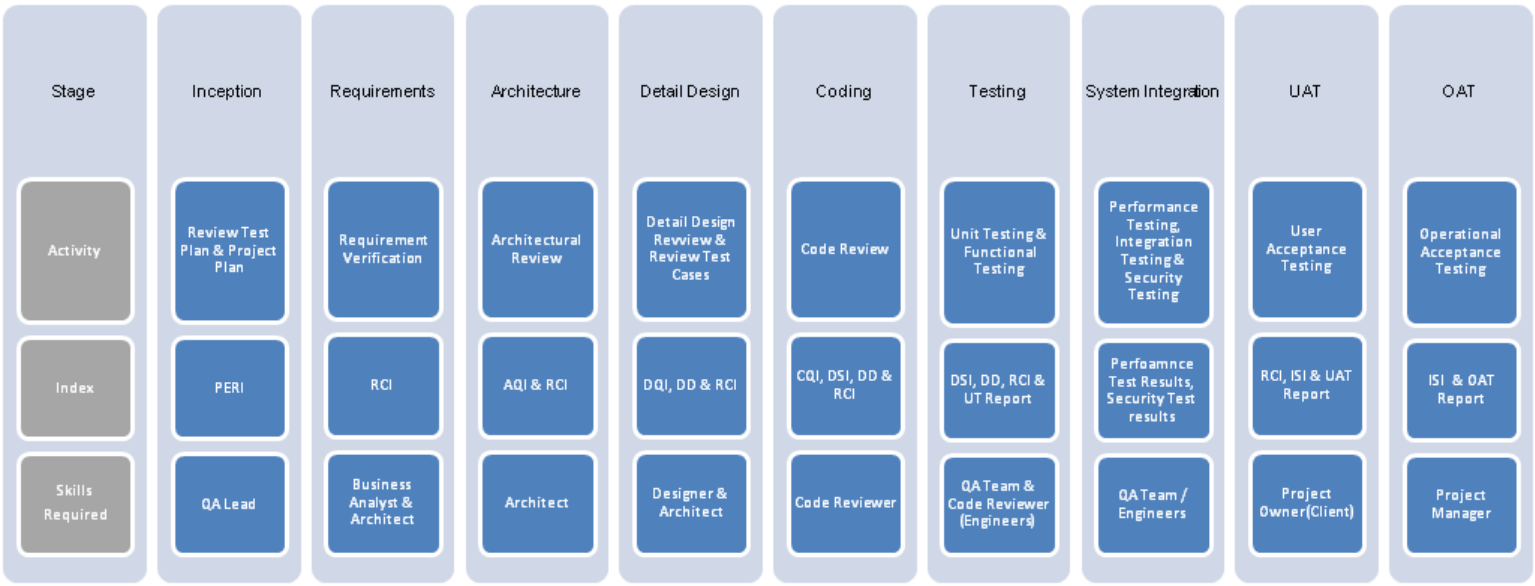


Figure 3.0 - Skills required to generate Metrics

3.3 Process of Setting-up a Metric

The Figure-4.0 explains the life-cycle of a Metric or the process involved in setting up the metrics:

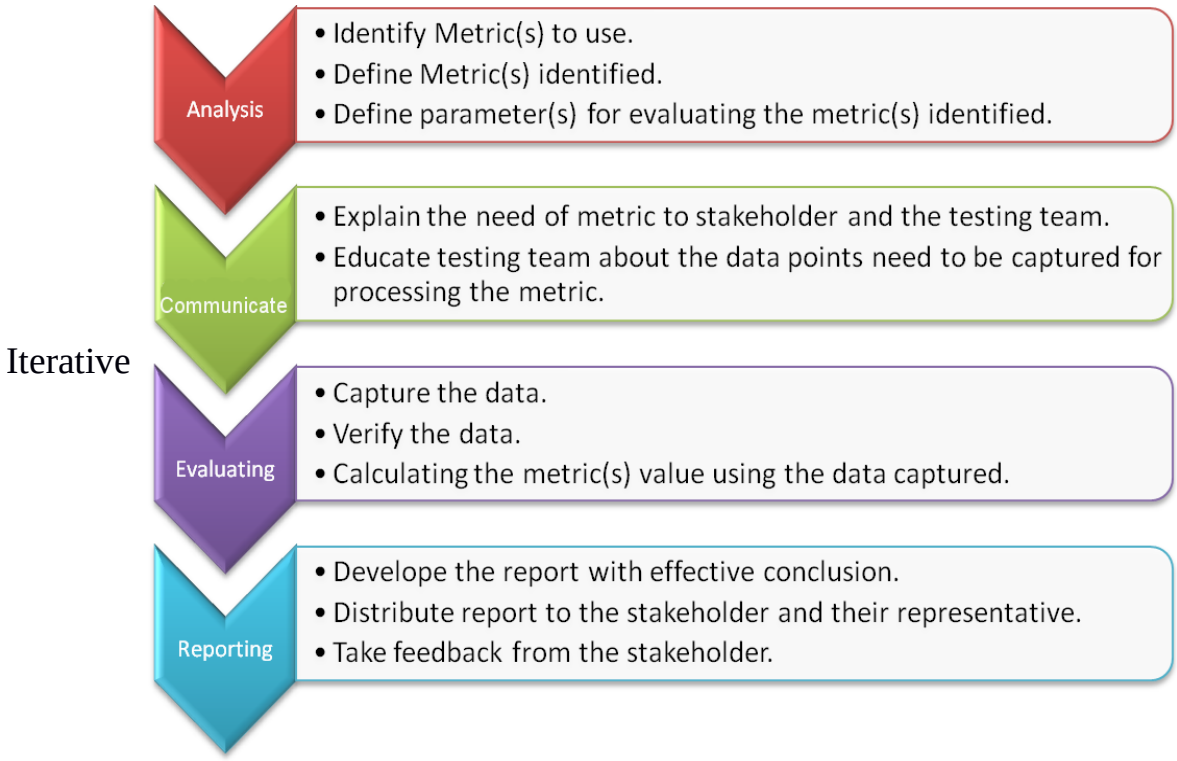


Figure 4.0 - Metrics Life-Cycle

When implementing this process, several testing tools and techniques will be used along with the automated testing process in order to generating, maintaining and evaluating the metrics derived at specific level of the Software development life-cycle.

3.4 Integration of testing tools/process

Below you find a list of tools /process which will be used when automating the typical SD life-cycle suits to the Software Project Audit Process.

- **Fagan inspection -** Fagan Inspection defines a process as a certain activity with a pre-specified entry and exit criteria. Activities for which Fagan Inspection can be used are:

1. Requirement specification

2. Software/Information System architecture (for example DYA)
3. Programming (for example for iterations in XP or DSDM)
4. Software testing (for example when creating test scripts)

- **Cruise Control –** It is both a continuous integration tool and an extensible framework for creating a custom continuous build process. It includes dozens of plug-ins for a variety of source controls, build technologies, and notifications schemes including email and instant messaging. A web interface provides details of the current and previous builds.

- **Bug-zilla -** It is a Web-based general-purpose defect tracking and testing tool.

- **SVN -** It is a revision control system which use Subversion to maintain current and historical versions of files such as source code, web pages, and documentation.

- **Git -** Git is a **free & open source, distributed version control system** designed to handle everything from small to very large projects with speed and efficiency.

- **SCM -** For Configuration identification and Identifying configurations, configuration items and baselines. Also for Configuration control ,Configuration status accounting and Configuration auditing

3.5 Displaying Metrics –The Dashboard

The Dashboard is the interface to help project teams to visualize their project statuses by several indexes. And also it could be used to displaying the test results of specific tests carried by the SPA team who responsible for the given project. As an example; in Figure 5.0 displays the current status of the project with its estimated effort against the predicted effort.

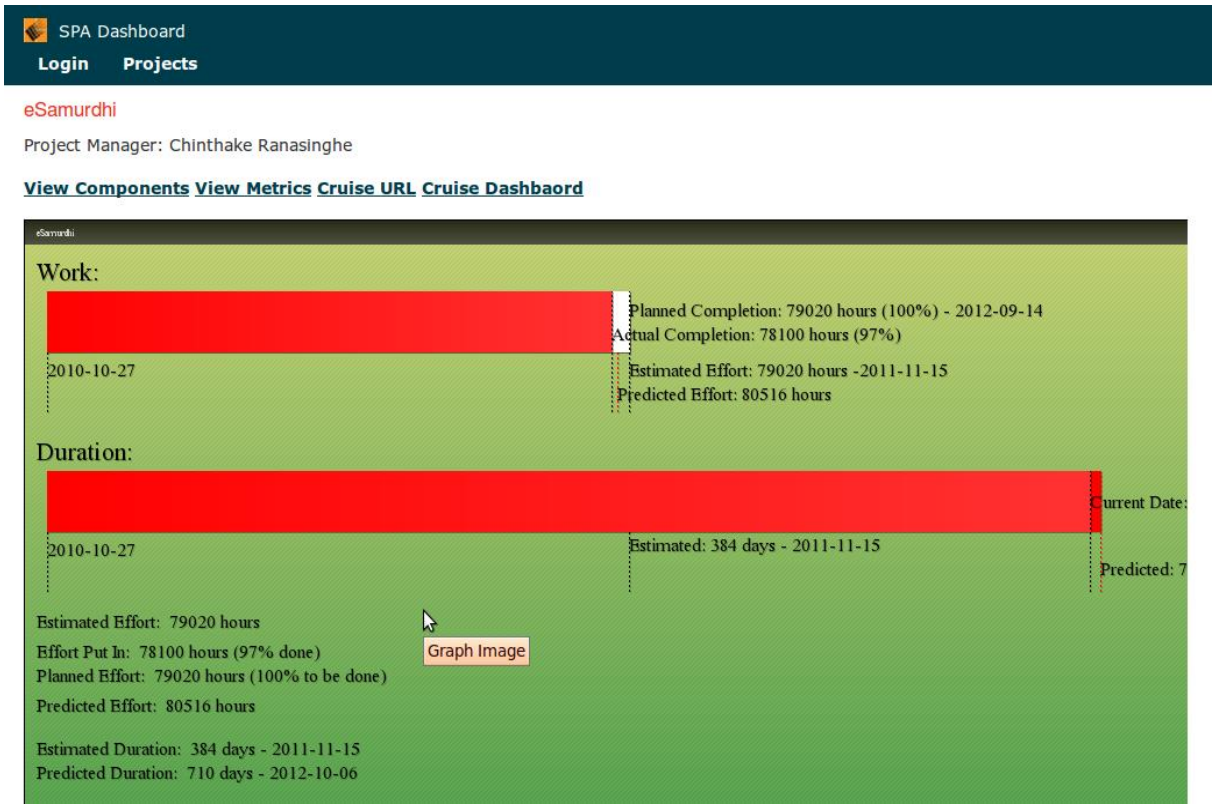
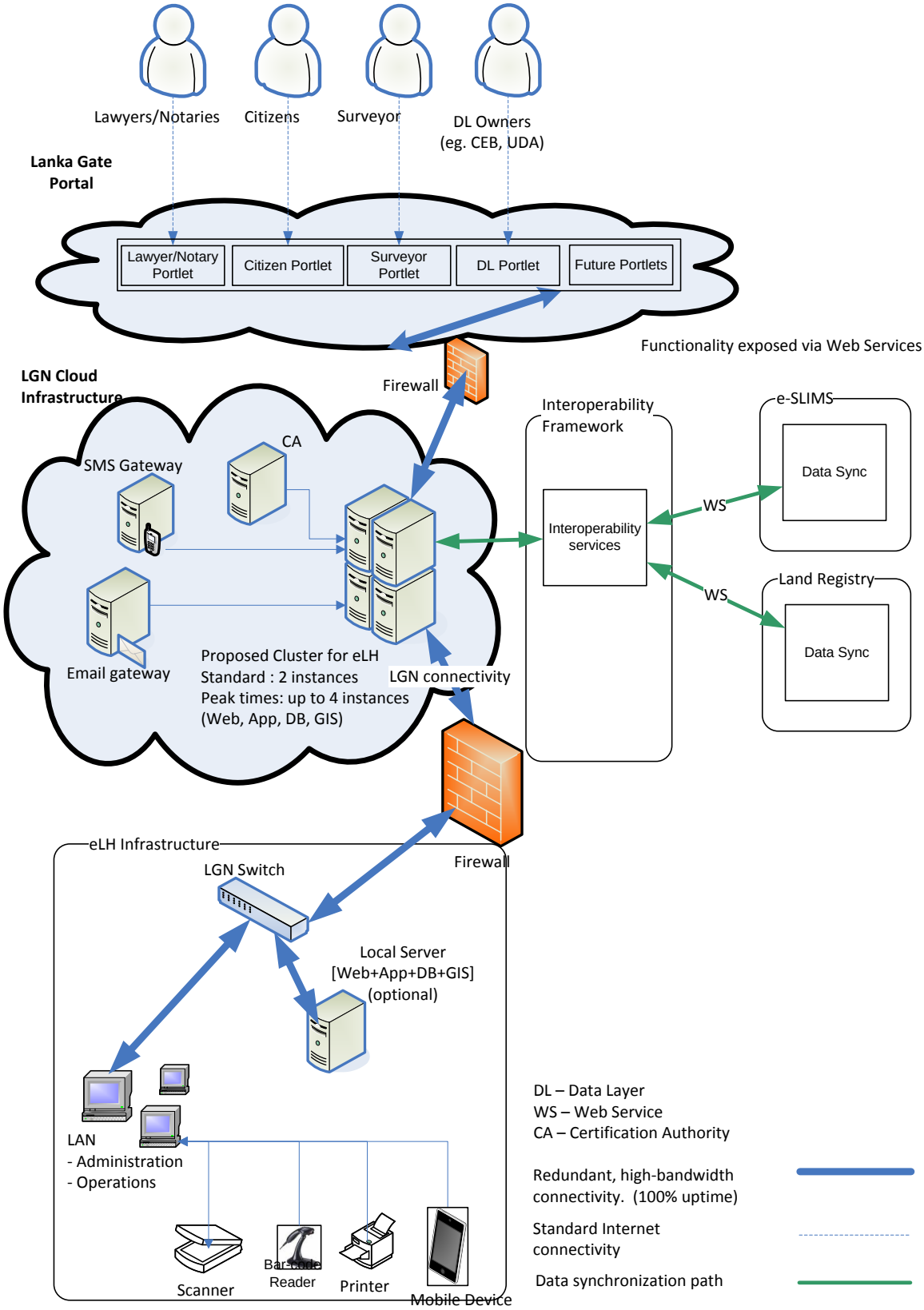


Figure 5.0 – SPA Dashboard view

Annex D – Proposed System Architecture



Configurations of server instances

Web Server instance

OS: an Enterprise level OS (Linux)

- RAM 4GB (720 RAM Hours per month)
- Storage 10GB per month (OS + Application Server + caching etc)
- Required Qty: Standard Months □ 1, Peak Months □ 2

Application Server instance

- OS: an Enterprise level OS
- RAM 8GB (720 RAM Hours per month)
- Storage 10GB per month (OS + Application Server + caching etc)
- Required Qty: Standard Months □ 1, Peak Months □ 2

Database Server instance

- OS: an Enterprise level OS
- RAM 16GB (720 RAM Hours per month)
- Storage 1000GB per month (OS + Database Server etc)
- Required Qty: Standard Months □ 1, Peak Months □ 2

GIS Server instance

- OS: an Enterprise level OS
- RAM 16GB (720 RAM Hours per month)
- Storage 1000GB per month (OS + Database Server etc)
- Required Qty: Standard Months □ 1, Peak Months □ 2

Solution overview

The complete solution will be hosted within the LGN and exposed to the citizens and other third-parties via Land Bank single window as services. Business functionality is provided via web-services. The solution will be hosted on a cluster of 2 application server instances and 2 database server instances to provide redundancy. However, during peak months, up to 2 additional instances of application and database servers may be deployed.

The solution needs to send SMS and digitally signed email messages to citizens and other third-parties. LGN must provide facility for this. Necessary digital signature must be provided.
The domain/site must be provided with a digital certificate.

It is proposed to maintain a local server which will be used as a cache for local work-flows. In case of this server being down, the system can function through the LGN-hosted solution. The performance of GIS and image manipulation will be slightly slower but, this option ensures business continuity. To minimize the down-time, the Local Server must be synchronized with the LGN-hosted application periodically (eg daily, hourly etc).

This architecture option is proposed based on the assumption that LGN is capable of providing the features and capabilities discussed above.