LAIS 2:
Milestone 1 Report

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It’s easier to be a critic than a playwright.

A report of this nature inevitably focuses on areas for improvement and this can be seen as being overly negative. I should therefore state at the outset that the overall quality of the LAIS 2 software, the existing infrastructure arrangements that support LAIS 1, and the capability of the ICT team all give rise to confidence in the successful roll-out and ongoing support of LAIS 2. The rest of this report should be read in the light of this assertion.

Both the Terms of Reference produced by the RNRA and the Inception Report produced by Dutch Kadaster identify three main categories of project deliverables:

- Software development and implementation
- System security (and availability)
- Capacity building

In this summary I focus on these three categories and identify the key activities that I believe are necessary prior to the start of LAIS 2 roll-out. This is intended for senior management to assist them in their decision-making. The rest of the report provides a technical assessment of the LAIS 2 software and the Land Administration IT Infrastructure.

Software development and implementation

The bulk of the software development work is now complete. Additional areas of functionality such as support for condominiums, the development of GIS reports and the inclusion of auditing in LAIS 2 Admin can be implemented during the roll-out rather than beforehand. There are also a number of issues that have been raised by the ICT team but Solomon Kyewalabye has already committed to dealing with these during his two-week visit from 30th June. Because of a fairly rushed period of development in the middle of June, LAIS 2 GIS is now less stable than its Admin counterpart.

The only functional modification I regard as necessary prior to starting the roll-out is for LAIS 2 GIS to prevent parcels being displayed beyond an agreed, configurable zoom level. This is necessary to prevent unacceptably large amounts of network traffic and an unnecessary burden on the LAIS GIS server. It should take no more than two days to implement.

Some GIS data cleansing scripts also need to be developed to support the roll-out. Again, two days should be sufficient for this.

Beyond that, it’s now appropriate to shift the focus of effort onto comprehensive functional testing, performance analysis and capacity planning rather than developing additional features. It’s imperative that the external developers are on-site during this testing phase and that their time is fully devoted to LAIS 2. Actual execution of the tests should be undertaken by existing LAIS 1 users co-opted for this purpose rather than local ICT developers; the ICT developers should work on bug-fixing alongside the external developers. I would recommend a minimum period of two full weeks for this activity, initially in Kigali but also from a district office in each of the provinces. The test servers will need to be connected to the VPN to enable testing from district offices.
I would also recommend a further week devoted to testing failure scenarios such as a simulated power outage or the loss of Active Directory. This testing should be conducted by the developers (both internal and external) and will not require end user involvement.

**System security and availability**

According to the Inception Report of February 2013, the project was supposed to deliver two reports providing recommendations in the areas of security and availability. The Security Audit Report of November 2013 provides advice across a range of topics and I recommend that Section 5 of that report is reviewed in the light of activity that has taken place since it was written. I’ve been unable to determine whether or not the availability report was ever produced.

On the security side, the significant improvement delivered by LAIS 2 is the fact that access to the GIS system is now controlled through Active Directory rather than being generally available. LAIS 2 GIS therefore presents no significant security concerns that need to be addressed prior to roll-out. LAIS 2 Admin currently transmits security credentials (user name and password) in plain text. This is not a problem providing that the system will only ever be accessed via the RNRA LAN or the RDB VPN. Should this change, an appropriate security certificate may need to be purchased and the GlassFish application server will need to be configured to use encryption. At present, I don’t think this is necessary prior to the initial roll-out.

On the availability and performance side I don’t regard the current arrangement for LAIS 1 Admin as sufficient. LAIS 1 Admin has a single application server and a single database server running on the same machine. This represents a significant single point of failure and a potential performance bottleneck. For LAIS 2 Admin I’d recommend two load-balanced application servers running on separate machines and two PostgreSQL database instances running in “hot standby” mode, also on separate machines. I’d also include a spare machine for the load balancer to give six machines in total. I recommend that this configuration is in place prior to the initial roll-out. If the machines were available, I would expect the ICT team to be able to implement this configuration within a week at most. Procurement of such machines may introduce an unacceptable delay to the commencement of the roll-out. If this is the case, then the roll-out could commence using a single machine configuration as at present but I’d recommend changing to the recommended configuration as soon as possible thereafter.

An additional machine is already available for LAIS 2 GIS; this should be configured to mirror the production server.

The other key area to address concerns the backup procedures. At present the Admin and GIS databases are effectively independent. The introduction of LAIS 2 changes this relationship to one of inter-dependence. In plain terms, if a failure occurs on any one of three separate data repositories¹, then all three repositories will need to be recovered to a prior consistent state even though two of the three have not suffered a failure. The existing backup and restore procedure needs to be modified to take account of this inter-dependence and a procedure for notifying users when they need to re-do work needs to be developed.

It is also necessary to develop a procedure for the remote installation, upgrade and patching of all office machines that will access LAIS 2. A degree of support for this is already built into the Windows operating system and numerous tools are available should the Windows’ capabilities prove insufficient. This should be in place prior to the roll-out commencement.

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¹ I use the term “repository” since it’s actually two databases and a file system.
Capacity building

Regardless of whether or not this was actually delivered by the project, it’s clear that the ICT team has capability in the areas of infrastructure, network and database administration. What is less clear is the extent to which the team will be able to operate, support, maintain and enhance the LAIS 2 software in the future without recourse to external contractors or consultants. To alleviate part of this potential problem, I strongly recommend that ICT developers work alongside the external developers and are actively involved in bug-fixing during the functional testing period. During the course of this work, responsibility for taking the lead on bug-fixing should be gradually shifted from the external developers to the ICT team; by the end of the period the external developers should be providing nothing more than oversight.

Licensing

LAIS 2 Admin makes use of a framework called Sencha GXT.² This framework is only available under an Open Source License if “…you provide the source code of your application to your users so they can be free to modify your application for their own needs.”³ I assume that RNRA will not be making the source code available in this way so it may be necessary to acquire a Commercial License for this framework.

Conclusion

RNRA is dependent on the presence of the external developers to make the recommended changes and to be able to undertake a successful period of functional testing and failure scenario testing. This will take a period of just over three weeks. Dutch Kadaster has already provided a roll-out plan that includes a three-week preparation period so the roll-out of LAIS 2 in Kigali should be able to commence within seven weeks from the start of the functional testing period. A number of ancillary activities to support the roll-out can be accomplished by the ICT team; this work can be started now. I’ve provided details on the project plan that accompanies this document; note that this plan assumes that roll-out will commence on a single machine configuration for the Admin service so it does not include any procurement activities.

Sections 1 and 2 of the report provide a technical assessment of LAIS 2 Admin and the Land Administration IT Infrastructure and they are intended to be of some use to those with technical responsibility for the system. Certain recommendations have cost implications and will therefore require budget holder approval.

Section 3 of the report assesses the extent to which the deliverables identified in the LAEP Inception Report dated 1st February 2013 have actually been delivered.

Section 4 provides some advice on a methodical approach to functional testing.

Section 5 summarises the report recommendations.

Section 6 provides indicative costs for the recommended LAIS 2 Admin server configuration.

LAIS 2 Admin

The client side of the web application is well structured through its separation into listeners, menus and views.

The server side of the web application could be structured differently. The bulk of the business logic resides in a single Java class, `GWTServiceImpl.java`. Although the GWT structure requires this class to act as the server-side entry point the business logic could be farmed out to separate classes so that `GWTServiceImpl.java` would act just as a simple routing mechanism. This would have the advantage of focusing the business logic associated with separate user actions into separate corresponding classes.

This can be implemented at the discretion of the ICT team.

There is also a considerable amount of business logic in 75 stored procedures held within the PostgreSQL database written in the PL/pgSQL language. There are both advantages and disadvantages to the use of stored procedures:

**Stored Procedure Advantages**

- They improve performance by reducing the number of round trips between the application and the database server.
- They further improve performance because they’re pre-compiled and stored in the database server.
- They can be called from any application that can connect to the database so provide reusable code.

**Stored Procedure Disadvantages**

- The PL/pgSQL language is not portable so if there is ever a decision to use a database other than PostgreSQL the functionality provided by these stored procedures will have to be re-created in some other way.
- The development process is often slower because the developer is working in more than one language.
- Stored procedures tend to be quite difficult to debug so can slow down development time.
- The stored procedure code is not under version control.

At present, the most significant disadvantage is the fact that the stored procedure code is not under version control and there is no change management procedure relating to this code.

This should be rectified by the ICT team during the roll-out.

**Access**

LAIS 2 Admin transmits security credentials in the form of user name and password across the network in plain text. Since access to the system is either through the LAN at the RNRA
Kigali office or via the RDB VPN, this doesn’t constitute a major security risk. If access to the system is widened beyond the LAN and the VPN the GlassFish server should be configured to use SSL for the logon page.

**The ICT team should implement this as necessary if access to the system changes.**

**Auditing**

Although the database schema contains a table called “activity_log” that is intended to retain audit information, the current version of the code does not make use of the table. The ability to retain and report on audit information is normally regarded as a key feature of a system of this nature.

This should be implemented by the ICT team during the roll-out.

**Logging**

It’s standard practice to include logging statements, particularly within web applications, as an aid to debugging the application. Although LAIS 2 Admin includes some logging statements these are only used to report severe SQL exceptions. Debug level logging statements should be included at appropriate points.

This should be implemented by the ICT team as changes are made to the system.

**Licensing**

LAIS 2 Admin makes use of a framework called Sencha GXT. This framework is only available under an Open Source License if “…you provide the source code of your application to your users so they can be free to modify your application for their own needs.”

I assume that RNRA will not be making the source code available in this way so it may be necessary to acquire a Commercial License for this framework.

This should be addressed during the roll-out.

**LAIS 2 GIS**

**Protection from User Error**

As far as possible, a software system should protect itself from user error. The user can be instructed on the correct way to use the software but there can be no guarantee that such instructions will always be followed correctly. In this context there are two opportunities for improvement within LAIS 2 GIS. Firstly, it should not be possible to view parcels beyond a particular, configurable zoom level since this provides no benefit to the user and places an unacceptable burden on the database and network.

This should be implemented by the external GIS developer prior to the roll-out.

Secondly, the provisional, actual and historical layers are defined by executing an SQL query against a single table. The precise nature of this query determines the layer definition. It would make sense to pre-define these layers and, if possible, prevent the user from modifying the corresponding query. In its current form it would be possible for different GIS

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users to define layers with the same name but using a different SQL query so that the actual layer content would be different in each case.

This should be implemented by the ICT team during the roll-out.

SQL Injection

Although SQL injection attacks are normally associated with web applications it’s generally considered best practice to protect an application from such attacks regardless of the application type. This is easily achieved by ensuring that user input is not directly included in an SQL query. There are a number of vulnerabilities to SQL injection within LAIS 2 GIS and these should be removed.

This should be implemented by the ICT team during the roll-out.

Hard-coded values

It’s generally accepted best practice that configuration values that could change should not be hard-coded within a program. This hard-coding actually occurs in a number of places within LAIS 2 GIS, most commonly with regard to the database connection string. As it currently stands, changing the password on the database would prevent the application from working as the password is hard-coded. Rectifying this would require a code change, re-compilation and deployment to users. These hard-coded values should be removed from the programs in question and stored separately as configuration items.

This should be implemented by the ICT team during the roll-out.

LAIS 2 Stand-alone Print

I’ve seen this program in operation but have not had access to its source code. I believe that the source code is not under version control so this should be rectified.

This should be implemented by the ICT team during the roll-out.

LAIS 2 Jasper Reports

The Jasper Reports server stores all of the information required to generate its reports in its own database. This database should be subject to a backup regime since its failure would prevent the generation of any reports. The backup regime can be reasonably relaxed once the required standard set of reports has been created.

This should be implemented by the ICT team during the roll-out.

Documentation

Dutch Kadaster has provided extensive documentation for the LAIS 2 system. Areas covered include architecture, use cases, manuals, quick reference guides, sample reports, technical documentation and training materials. The only areas not covered in detail are general purpose frameworks and tools that are not specific to the LAIS 2 system. Documentation for these is freely available on the web:

Jasper Reports: http://community.jaspersoft.com/
Google Web Toolkit: http://www.gwtproject.org/
Sencha GXT: http://www.sencha.com/products/gxt/
There doesn’t appear to be a single network location where this documentation is stored so it’s possible that different people have different versions on their local drives. A network location and folder structure for the documentation should be provided.

This should be implemented by the ICT team during the roll-out.
SECTION 2

Land Administration IT Infrastructure

One of the deliverables of the LAEP Project was a Security Audit Report dated November 2013. The report was prepared by Ton van der Zwet following a site visit during May 2013. Section 5 of that report provides 47 recommendations that are identified as “short-term (urgent)”. The recommendations cover a range of topics including physical security of the server room, electricity supply requirements, change management procedures and software development practices. The server room examined by Mr van der Zwet is no longer used by the RNRA so some of his observations no longer apply; it’s clear that the current server room is a significant improvement on the one he saw. Many of his key recommendations have already been implemented so I won’t go through them here. However, his report is a valuable source of advice and it would be worth reviewing his recommendations.

The ICT team should review the recommendations of the Security Audit Report during the roll-out.

Since LAIS 1 is currently operating as a production service within Kigali many of the central components, structures and procedures that will be needed to support LAIS 2 are already in place. Specific areas of good practice have been noted as follows:

- There are some physical controls on access to the server room.
- There are some fire detection and prevention capabilities within the server room.
- There is battery backup for the production systems.
- Active Directory replication is in place using two domain controllers.
- Active Directory data is backed up and stored off-site on a monthly basis; this is sufficient since the data is not volatile.
- The LAIS 1 production databases are backed up according to a grandfather-father-son regime with backup data stored off-site.
- Access to the LAIS 1 production system is through either the Local Area Network or the RDB VPN for Kigali District offices: this provides a reasonable degree of security from intrusion.

Additionally, the four Zonal offices outside of Kigali and 25 of the 30 District offices are already connected to the RDB VPN.

So although there is more work to be done, there’s a reasonably firm foundation in place on which to build.
Server Room

Physical Access
Some controls on access to the server room are already in place since there are only two key holders. I would recommend that a log of server room access is kept; the log should include name, date and time of entry, date and time of exit, and purpose of visit.

This should be implemented by the ICT team during the roll-out.

Fire Detection and Prevention
Some measures are in place to detect a server room fire and there are fire extinguishers in the server room itself. This is not an area in which I specialise so I would recommend that advice for further improvements should be sought from an appropriate organisation.

This should be implemented by the ICT team during the roll-out.

Business Continuity
As LAIS 2 is adopted throughout the country it will become increasingly central to land transactions and land usage planning. The data held within the system, and the ability to access that data will form a critical national asset and it will need to be protected as such. The standard approach to delivering highly available, resilient systems is to eliminate all single points of failure in terms of hardware, software, infrastructure and people. The server room itself constitutes a single point of failure that can be addressed by replicating it in its entirety at an alternative location. While it would be possible to make use of cloud computing capability for this purpose I assume that RNRA wish to retain the LAIS 2 data within a local data centre so I would not recommend a cloud-based approach.

Business continuity planning should be carried out by senior management during the roll-out.

Procedures

Database backup
The existing backup procedure should be modified to cover all inter-related LAIS data repositories. This should be developed and put into practice as soon as the initial roll-out of LAIS 2 commences. The backup procedure should be based on the information provided in the November 2013 document “Backup and Recovery Procedure LAIS 0.9”. However, it should be noted that this document is currently inaccurate since it refers to the “LAIS Administrative Documents Database”. This database no longer exists since scanned documents are now stored on file.

This should be implemented by the ICT team prior to the roll-out.
Remote software installation

A procedure should be developed to introduce centralised control of desktop machines that will access LAIS 2 both in Kigali itself and the district offices. This should allow the ICT team to install and upgrade software remotely so they can ensure that appropriate software versions and anti-virus protection are consistently applied across the estate.

This should be implemented by the ICT team prior to the roll-out.

Monitoring

An effective IT operation is able to detect that there is an emerging problem within the system before the users become aware of it. This is accomplished by monitoring each of the system components to ensure that they are performing within an acceptable range. Typical monitoring will cover CPU usage, memory usage, disk usage, network usage, database performance and application performance. It’s standard practice to configure automated alerts if an individual component goes out of its acceptable range. I understand that the freeware version of PRTG\(^6\) is used to monitor the network but I don’t know if it’s configured to generate automatic alerts; if it isn’t, it should be. Additional monitoring tools to cover the areas I’ve identified should be acquired.

The ICT team should configure PRTG to generate alerts during the roll-out.

Monitoring tools should be acquired by the ICT team during the roll-out.

Issue reporting and management

A standard approach to reporting issues should be developed and communicated to all LAIS 2 users as part of the roll-out. This should be based on an on-line system such as Droptask or MantisHub to ensure that progress through the issue management phase remains highly visible.

This should be implemented by the ICT team during the roll-out.

Change management

A procedure to implement planned changes that will impact on the LAIS 2 system should be developed and communicated to all LAIS 2 users as part of the roll-out. This procedure should cover any significant change to the central IT infrastructure such as database version updates, application server patches, network infrastructure changes and so on.

This should be implemented by the ICT team during the roll-out.

\(^6\) [http://www.paessler.com/prtg](http://www.paessler.com/prtg)
LAEP Deliverables

In this section I assess the extent to which the deliverables identified in the LAEP Inception Report dated 1st February 2013 have actually been delivered.

Integrated LAIS
With the exception of those items already identified this most significant element of the project has been delivered. Although LAIS 2 GIS is currently unstable I am confident that these problems can be dealt with during the functional testing phase.

LAIS Deployment to Remote Offices
The Inception Report asserts that this deliverable is the responsibility of RNRA staff.

Web Services
All agreed web services and web service clients have been delivered. The ICT team has requested that a summary document detailing these web services should be provided and I agree that this would be useful.

Dutch Kadaster should provide a web services summary document.

Documentation
The Inception Report identified six categories of documentation as follows:

- Architectural overview. Updated architectural documentation has been provided.
- Software source code. Source code has been provided but not all of it is maintained under version control.
- Technical design document. Updated technical documentation has been provided.
- End user manual. Updated user manuals have been provided.
- Training material. Updated training material has been provided.
- Maintenance manual including installation, production, security etc. Although maintenance information is spread across a number of documents there isn’t a single maintenance manual that covers the identified areas.

Dutch Kadaster should provide a maintenance manual as defined in the Inception Report.

Operational Report Server Land Market
The report server has been delivered but there are still some outstanding reports to be developed that depend on GIS data.

Dutch Kadaster should provide these reports during the roll-out.
Trained existing LAIS End Users
Some training has been provided to existing LAIS end users.

Trained Report Server Users
Training in the use of the Jasper Report Server has been provided. However, the reports that have been developed are dependent on quite complex SQL queries. I’m not sure if the ICT team has sufficient understanding of the database structure or the SQL query language to be able to develop additional reports independently.

If necessary, the ICT team should undertake additional SQL training.

Trained Technical Staff
The Inception Report states that this will be delivered through the provision of technical manuals and by the ICT team working alongside the LAIS 2 developers. I think there is more work to be done in this area.

This should be addressed during the testing phase prior to the initial roll-out.

Trained New LAIS End Users
Not yet delivered.

Trained Network Administrators
This appears to have been delivered since the network administrators seem perfectly competent.

Security Principles Explained
This is covered by the Security Audit Report of November 2013.

B2B API Secure Against Bulk Request
The Inception Report states that this deliverable is dependent on the findings of the Security Audit Report mentioned previously. The Security Audit report refers to this requirement but provides no particular guidance as to how it should be achieved.

Dutch Kadaster should provide this during the roll-out.

99% System Availability Assured
This section of the Inception Report identifies a number of key features that are necessary to provide this level of system availability. It then goes on to outline the organisational structure of the ICT team within RNRA before concluding that this deliverable will be achieved by providing the ICT Directorate with advice on short-term quick wins and longer-term aspirational advice. I don’t know if this has been provided.

If this report has not been delivered, Dutch Kadaster should provide it as soon as possible so that its recommendations can be considered.
Effective Backup Strategy

Recommendations for the backup strategy are provided in the November 2013 document “Backup and Recovery Procedure LAIS 0.9” but this document needs updating to reflect the current system.

Dutch Kadaster should update this report during the functional testing phase.
## Functional Testing

Although there has been a significant amount of testing of LAIS 2 I think it could be improved by being made more methodical. A standard approach to functional testing is to provide a set of detailed scripts that the tester follows. The beginnings of a couple of scripts for LAIS 2 Admin might look something like this:

### Title: Logon

<table>
<thead>
<tr>
<th>Step</th>
<th>Instructions</th>
<th>Data Used</th>
<th>Expected outcome</th>
<th>Actual outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open the Firefox browser.</td>
<td>None</td>
<td>Firefox browser opens.</td>
<td>Firefox browser opens.</td>
</tr>
<tr>
<td>2</td>
<td>Enter <a href="http://10.10.10.53:8080/LAIS/">http://10.10.10.53:8080/LAIS/</a> in the Firefox web address.</td>
<td>None</td>
<td>The “Welcome to the LAIS” page opens.</td>
<td>The “Welcome to the LAIS” page opens.</td>
</tr>
<tr>
<td>3</td>
<td>Enter <code>&lt;User id&gt;</code> in the text box labelled “User name:”:</td>
<td>User id = “krowley”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Enter <code>&lt;Password&gt;</code> in the text box labelled “Password:”</td>
<td>Password = private</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Click on the button labelled “Submit”</td>
<td>None</td>
<td>The LAIS 2 Admin page opens.</td>
<td>The LAIS 2 Admin page opens.</td>
</tr>
<tr>
<td>6</td>
<td>End of test.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Title: Find a parcel

<table>
<thead>
<tr>
<th>Step</th>
<th>Instructions</th>
<th>Data used</th>
<th>Expected outcome</th>
<th>Actual outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Execute the Logon test.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Select a <code>&lt;Province&gt;</code> from the uppermost drop-down box labelled “Province:”.</td>
<td>Province = “Kigali City”</td>
<td>The “Welcome to the LAIS” page opens.</td>
<td>The “Welcome to the LAIS” page opens.</td>
</tr>
<tr>
<td>3</td>
<td>Select a <code>&lt;District&gt;</code> from the drop-down box labelled “District:”.</td>
<td>District = “KICUKIRO”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Select a <code>&lt;Sector&gt;</code> from the drop-down box labelled “Sector:”.</td>
<td>Sector = “Kanombe”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Select a <code>&lt;Cell&gt;</code> from the drop-down box labelled “Cell:”.</td>
<td>Cell = “Rubirizi”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Enter a <code>&lt;UPI&gt;</code> in the text-box labelled “UPI:”</td>
<td>UPI = 123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Click on the button labelled “Find”.</td>
<td>None</td>
<td>Parcel details are displayed in the central panel.</td>
<td>Parcel details are displayed in the central panel.</td>
</tr>
<tr>
<td>8</td>
<td>End of test.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Although such scripts are laboriously long-winded, they have the advantage of providing a precise record of user interaction. The tester keeps a record of what they've entered in the “Data used” column. When the “Actual outcome” differs from the “Expected outcome” a defect is recorded and the developer investigating the defect has all the information necessary to reproduce it. Tests can invoke other tests as part of their execution; in the example above the first thing the “Find a parcel” test does is to invoke the “Logon” test. Other tests could invoke the “Find a parcel” test.

It doesn’t take too long to develop a suite of such tests that can be used each time the system is changed to provide confirmation that new functionality has been introduced without compromising existing functionality.

This methodical approach is also the first step towards developing automated tests.

Note that exploratory testing should continue to be used but it should complement this methodical approach rather than standing by itself.

**Performance Testing**

Performance testing can only really be achieved through the use of tools such as LoadRunner. Rather than attempting to make use of such a tool I recommend that monitoring tools should be used to assess the performance of the production infrastructure as the roll-out to the districts progresses.

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SECTION 5

Recommendations

My recommendations for the key activities that need to be completed prior to the commencement of the initial roll-out are contained in the project plan that accompanies this document.

This table summarises the recommendations that appear in bold throughout the document.

<table>
<thead>
<tr>
<th>Category</th>
<th>Recommendation</th>
<th>Responsible Group</th>
<th>Page Ref.</th>
<th>Start by</th>
<th>Estimated Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAIS Admin</td>
<td>Implement separate business classes.</td>
<td>ICT team</td>
<td>1</td>
<td>During maintenance.</td>
<td>N/A</td>
</tr>
<tr>
<td>LAIS Admin</td>
<td>Place stored procedure code under version control.</td>
<td>ICT team</td>
<td>1</td>
<td>I’ve already done this.</td>
<td>N/A</td>
</tr>
<tr>
<td>LAIS Admin</td>
<td>Implement SSL for the logon page.</td>
<td>ICT team</td>
<td>2</td>
<td>If required.</td>
<td>3 days</td>
</tr>
<tr>
<td>LAIS Admin</td>
<td>Implement auditing.</td>
<td>ICT team</td>
<td>2</td>
<td>During roll-out.</td>
<td>5 days</td>
</tr>
<tr>
<td>LAIS Admin</td>
<td>Implement debug level logging.</td>
<td>ICT team</td>
<td>2</td>
<td>During maintenance.</td>
<td>N/A</td>
</tr>
<tr>
<td>LAIS Admin</td>
<td>Acquire appropriate licenses for Sencha GXT.</td>
<td>ICT management</td>
<td>2</td>
<td>Prior to start of roll-out.</td>
<td>1 day</td>
</tr>
<tr>
<td>LAIS GIS</td>
<td>Protect against SQL injection attacks.</td>
<td>ICT team</td>
<td>3</td>
<td>During roll-out.</td>
<td>3 days</td>
</tr>
<tr>
<td>LAIS GIS</td>
<td>Replace hard-coded values with externally configurable resources.</td>
<td>ICT team</td>
<td>3</td>
<td>During roll-out.</td>
<td>3 days</td>
</tr>
<tr>
<td>LAIS Print</td>
<td>Place source code under version control.</td>
<td>ICT team</td>
<td>3</td>
<td>Prior to testing phase.</td>
<td>1 day</td>
</tr>
<tr>
<td>LAIS Jasper Reports</td>
<td>Implement a backup procedure.</td>
<td>ICT team</td>
<td>3</td>
<td>During roll-out.</td>
<td>2 days</td>
</tr>
<tr>
<td>LAIS Documentation</td>
<td>Provide a single network location and folder structure for all documentation.</td>
<td>ICT team</td>
<td>4</td>
<td>Prior to testing phase.</td>
<td>1 day</td>
</tr>
<tr>
<td>IT Infrastructure</td>
<td>Review the recommendations of the Security Audit Report.</td>
<td>ICT team</td>
<td>5</td>
<td>During roll-out.</td>
<td>2 days</td>
</tr>
<tr>
<td>Category</td>
<td>Task</td>
<td>Responsible Party</td>
<td>Duration</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td>IT Infrastructure</td>
<td>Create and maintain a server room access log.</td>
<td>ICT team</td>
<td>6</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>IT Infrastructure</td>
<td>Seek specialist fire detection and prevention advice.</td>
<td>ICT team</td>
<td>6</td>
<td>During roll-out.</td>
<td></td>
</tr>
<tr>
<td>IT Infrastructure</td>
<td>Create a Business Continuity plan.</td>
<td>ICT management</td>
<td>6</td>
<td>During roll-out.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Modify the existing backup procedure</td>
<td>ICT team</td>
<td>6</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Develop a remote software installation procedure.</td>
<td>ICT team</td>
<td>7</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Configure the PRTG monitoring tool to generate alerts.</td>
<td>ICT team</td>
<td>7</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Develop an issue reporting and management procedure</td>
<td>ICT team</td>
<td>7</td>
<td>During roll-out.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Develop a change management procedure.</td>
<td>ICT team</td>
<td>7</td>
<td>During roll-out.</td>
<td></td>
</tr>
<tr>
<td>LAEP Deliverables</td>
<td>Provide a web services summary document.</td>
<td>Dutch Kadaster</td>
<td>8</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>LAEP Deliverables</td>
<td>Provide a maintenance manual as mentioned in the Inception Report.</td>
<td>Dutch Kadaster</td>
<td>8</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>LAEP Deliverables</td>
<td>Provide reports dependent on GIS data.</td>
<td>Dutch Kadaster</td>
<td>8</td>
<td>During roll-out.</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>Undertake additional SQL training</td>
<td>ICT team</td>
<td>9</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>Provide ICT team with hands-on mentoring for bug-fixing during testing phase.</td>
<td>Dutch Kadaster</td>
<td>9</td>
<td>During testing phase.</td>
<td></td>
</tr>
<tr>
<td>Service Availability</td>
<td>Protect the web services from DOS attacks as outlined in the Inception Report.</td>
<td>Dutch Kadaster</td>
<td>9</td>
<td>During testing phase.</td>
<td></td>
</tr>
<tr>
<td>Service Availability</td>
<td>Provide recommendations as outlined in the Inception Report.</td>
<td>Dutch Kadaster</td>
<td>9</td>
<td>During testing phase.</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Update the November 2013 document &quot;Backup and Recovery Procedure LAIS 0.9&quot; to reflect the current system accurately.</td>
<td>Dutch Kadaster</td>
<td>10</td>
<td>Prior to start of roll-out.</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td>Implement a methodical approach to functional testing.</td>
<td>ICT team</td>
<td>11</td>
<td>Prior to testing phase.</td>
<td></td>
</tr>
</tbody>
</table>

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SECTION 6

Recommended Server Configuration

With regard to the hardware configuration requirements for LAIS 2, page 66 of the Security Audit Report of November 2013 states that the “…LAEP project will provide an expert to analyze the situation in detail and to formulate the options available to improve online availability and business continuity to levels that are currently required.”

I’ve not seen such recommendations but if they are available they should take precedence over my recommendations in this area.

**LAIS 2 Admin**

<table>
<thead>
<tr>
<th>Function</th>
<th>Hardware</th>
<th>Software</th>
<th>Hardware Unit Cost</th>
<th>Hardware Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x Load Balancer</td>
<td>Dell PowerEdge R715 Rack Server</td>
<td>Apache web server configured to use sticky session load balancing.</td>
<td>$5,500</td>
<td>$5,500</td>
</tr>
<tr>
<td>2 x Application Servers</td>
<td>Dell PowerEdge R715 Rack Server</td>
<td>LAIS 2 Admin Application.</td>
<td>$5,500</td>
<td>$11,000</td>
</tr>
<tr>
<td>2 x Database Servers</td>
<td>Dell PowerEdge R715 Rack Server</td>
<td>LAIS 2 Admin Database configured to run in hot standby mode.</td>
<td>$5,500</td>
<td>$11,000</td>
</tr>
<tr>
<td>Spare load balancer</td>
<td>Dell PowerEdge R715 Rack Server</td>
<td>Apache web server configured to use sticky session load balancing.</td>
<td>$5,500</td>
<td>$5,500</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$33,000</strong></td>
</tr>
</tbody>
</table>

It may be possible to reduce costs by reusing some of the existing hardware.