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SUPERVISION OF THE DEVELOPMENT OF VAT E-INVOICE SYSTEM FOR GENERAL DEPARTMENT FOR TAXATION

February/March 2015
Ulaanbaatar, Mongolia

Project:	Mongolia Business Plus Initiative Project (BPI)
Report Title:	*Supervision of the Development Of VAT E-Invoice System for General Department for Taxation*
Main Author:	Jerry P. Henzel
Contract No.	438-C-11-00001
Submitted by:	BPI Project/Chemonics International Inc., Express Tower, 12th Floor, Chingeltei District, Ulaanbaatar, Mongolia
Telephone and fax:	(976-11) 32 13 75 Fax: (976-11) 32 78 25
Contact:	Efrain Laureano, Chief of Party
E-mail address:	elaureano@bpi-chemonics.biz

ABBREVIATIONS AND ACRONYMS

GDT	General Department of Taxation
NDC	National Data Center
ORM	Object relational mapping
RAC	Real Application Cluster
SAN	Storage Area Network

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EXECUTIVE SUMMARY

Between February 23 and March 7, 2015, a assignment was undertaken to Ulaanbaatar to provide supervision for the development of a VAT E-Invoice system for the General Department of Taxation (GDT).

A number of specific activities were undertaken. A substantive portion of time was allocated to the review of the second deliverable by the Subcontractor engaged in the project. The result of this review was a significant re-factoring in both the data model and system architecture of the system. A number of weaknesses were discovered; mis-alignment with GDT strategic direction was noted and lack of alignment with National Data Center security and deployment practices were noted. Working collaboratively with the Subcontractor and the GDT, these issues were addressed. The second deliverable can be deemed to be accepted at this point.

Additional issues were discovered. One of the most significant was the lack of licensing of Oracle products at GDT. While the original project did not anticipate hardware or software purchases, the lack of a licensed version of the Oracle database needed to be addressed. Various scenarios were explored. Budget estimates were developed and the local Oracle representative was contacted for guidance. The architecture was also adjusted to conform to the budget realities of the project. This process is on-going currently.

USAID had previously performed an ADS 548 Assessment of this project. The findings and recommendations were reviewed and deficiencies addressed.

In conclusion, the adjustments made have been significant but have brought the project in alignment with good technical practice and strategic directions. The Subcontractor is fully in the development phase of the project. Some preliminary product demos have been done for GDT and feedback is being solicited. There is significant work to do: both the Subcontractor and GDT will need to continue to make efforts to deliver on time for the project to meet its very tight timelines.

SECTION I: BACKGROUND AND OBJECTIVES

Over the last two years the USAID BPI project has provided support to the GDT in the area of facilitating paying taxes in Mongolia. Building on the e-Signature process started by GDT in 2011 with USAID support, the BPI project provided (i) capacity building in the area of taxpayer's services (ii) specialized technical assistance on IT architecture for tax e-Filing and (iii) development of a new tax e-Payment system.

In January 2015, BPI and GDT jointly identified a local firm to develop a VAT E-Invoice system through a competitive procurement process. The electronic system for VAT will continue to build on the earlier successes, making it easier to pay taxes and obtain legitimate tax reimbursement for firms operating in Mongolia who comply with tax responsibilities. At the same time, the system will help GDT focus its effort toward high risk areas in order to address the issues of VAT tax evasion and fraudulent VAT claims. In recent years it has become common to intentionally file VAT incorrectly by establishing fraudulent legal entities. The GDT and the police are working actively to detect and eliminate these fraudulent activities. These types of offenses were previously centered in the capital city, but since 2013, the GDT has seen an increase in this type of activity in the provinces.

The proposed VAT E-Invoice system will automate the current manual process for VAT, which is submitted on paper-based invoices. Taxpayers request VAT invoices from their local tax offices. Tax offices pass these requests to GDT headquarters, which requisitions printed VAT documents from authorized distributors. Tax inspectors must manually check the issuance and allotment of VAT invoices to tax offices and taxpayers. There is no current way to easily match VAT sales and purchases creating another significant avenue to evade taxation. This work is time consuming and laborious and makes fraud detection very difficult. Between 2012 and 2013, GDT detected 4,600 fake invoices amounting to 721.3 billion MNT of loss to the Government of Mongolia. In 2013, the GDT detected 750 billion MNT of sales that were not registered resulting in loss to the Government of Mongolia and its citizens. Therefore, the GDT seeks to reform the current system by transferring paper-based VAT invoices to electronic invoices.

The VAT E-Invoice system is expected to meet the detailed requirements for the following major functions, as well as other functional and non-functional requirements as agreed between BPI, GDT, and subcontractor:

- Issuance of electronic VAT invoices
- Evasion detection improvement
- Third-party information sharing
- Reporting
- Functional requirements
- Non-functional requirement

The purpose of this assignment is to supervise the local subcontractor and provide technical assistance to the subcontractor and GDT to ensure timely and successful implementation of the VAT E-Invoice system.

Broadly speaking, the goal is to perform the following tasks:

- Ensure the system development progresses per the agreed SOW and expectations from the GDT;
- Review and provide recommendations on technical issues of the subcontractor's deliverables:
    - Deliverable 1. Revised Technical Requirements
      Deliverable 2. Technical documentation and approved designs
    - Deliverable 3: Beta version of main software

  - Deliverable 4: Testing and acceptance report
  - Deliverable 5: System Deployment, User documentation and training

- Provide technical solutions for problems or bottlenecks related to the system development and act as a technical resource by providing alternatives for solutions
- Provide guidance on secure and reliable data exchange between the client agencies and stakeholders
- Conduct regular remote calls with the subcontractor and GDT to track the status of the system development and other issues.

SECTION II: SUMMARY OF ASSIGNMENT ACTIVITIES – FEBRUARY/MARCH 2015

The following activities were undertaken during this assignment.

REVIEW OF DELIVERABLE 2 ON PROPOSED ARCHITECTURE

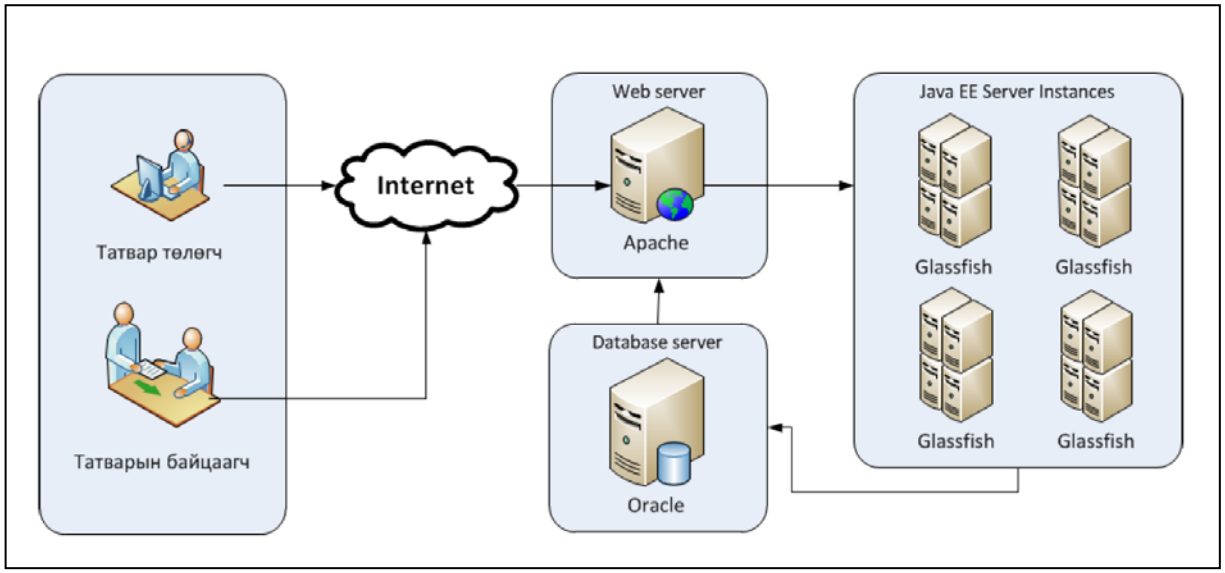
Prior to this visit, the Subcontractor has submitted Deliverable 1. This was reviewed and feedback provided. At the start of the onsite visit, the Subcontractor provided Deliverable 2 as part of their contractual obligations. Deliverable 2 consisted of the following:

- Deliverable No2-Progress Report_v1.0_en.docx
- E-Invoice-GeneralStatusesOfVATInvoice-v2.0_en.docx
- ActionPlan-E-Invoice-v2.0_en.xls
- MobileDesign-v2.0.zip
- WebAppAdministrative&MonitoringPanel-v1.0_en.zip
- WebAppForTaxInspector-v1.0_en.zip
- WebAppForTaxPayersDesign-v3.0_en.zip

A major portion of time during this assignment was devoted to review of items presented in the deliverables for the proposed architecture through discussions with GDT and subcontractor. Most of the work was iterative and refinement went through several cycles before being approved The discussion below presents a review of the proposed architecture and subsequent refinement. The Subcontractor has updated Deliverable 2 – System Architecture to reflect the changes needed. Specific details and comments on Deliverable 2 are presented in Annex A.

A. System Architecture

The system architecture was reviewed and discussed extensively with GDT and the Subcontractor. Additional information was elicited from GDT in regards to the current setup of



the e-Tax system and the infrastructure underpinning it. Further discussion was held on the setup of systems at the National Data Center, where the e-Tax system is deployed and the eInvoice system will live.

The current e-Tax system architecture is shown in the diagram above.

The current e-Tax system has some significant differences from the proposed architecture. Chiefly, it is a three-tier architecture with a database layer, a middleware layer consisting of

enterprise wide web services and a web tier. Further, the National Data Center (NDC) enforces strict security for applications deployed at NDC. For example, traffic between the web tier and the database tier is forbidden. The implication of this is that a server living in the web tier cannot directly connect to a database server in that tier. It must communicate via a middleware layer which is allowed. The proposed architecture does not follow these guidelines and needed to be refactored.

Further discussions were held on performance and the use of the chosen language and framework that Subcontractor has chosen to implement the system. A number of concerns were noted as follows:

1. The use of the PHP language in the middle tier
2. The use of the Symfony framework proposed
3. Strategic implications

The Subcontractor originally proposed using a PHP language based framework called Symfony. That framework was going to talk to the database tier from the web tier. This is not allowed at the NDC. There needs to be a middleware tier developed to meet NDC requirements and also conform to GDT strategic directions. In terms of using Symfony for the creation of web services in the middle tier, concern was raised about how one part of the framework (object relational mapping or ORM layer) talks with Oracle databases. Oracle databases can be finely tuned and run efficiently. However, there are a number of best practices. Oracle itself notes these in a document they publish (http://www.oracle.com/technetwork/database/database-technologies/php/201212-ug-php-oracle-1884760.pdf). Among these is the use of bind_variables. Bind_variables permit the internal query optimizer to cache parts of query statements and make them more performant. They are also strongly recommended for preventing a type of security intrusion called SQL Injections. Further, object relational mapping layers automatically generate database query statements freeing programmers from doing so. Research was done and a strong indication of how efficient the ORM layer was in Symfony as it relates to Oracle was not conclusively found. GDT has hired an Oracle expert to work with them to tune existing systems. He was consulted and also expressed the opinion that using the proposed approach may be problematic. It must be stated that the National Public Registry of the Ministry of Justice in Georgia successfully uses PHP for its web applications with an Oracle database. However, their systems do not use frameworks like Symfony and are custom written and tuned. There systems have been functional and serving Georgian citizens for years.

A number of other concerns were found that potentially relate to potential future performance issues. The GDT Oracle expert was asked how the shared storage (SAN) currently used by the Oracle databases at NDC was designed. Oracle has particular requirements that help eliminate disk input/output saturation and bottlenecks. If these are not followed performance problems can arise. He noted that he believed the design of the storage systems was a default configuration without optimization and that he has noted some issues of this nature with the e-Tax system. This presents a risk to the eInvoice system. Exacerbating this risk is the fact that GDT indicates it has plans to expand use of the e-Tax system from the current 60,000 users to about 1 million users within the next year. That number supposedly conforms to the number of anticipated tax payers. GDT also is discussing optimizing the SAN but due to issues with previous subcontractors does not have full access to the SAN currently. They will have to resolve these issues. This also poses a risk to the eInvoice project.

B. Oracle Licensing

Another concern discovered was legal licensing of Oracle systems currently deployed at GDT. GDT notes that Oracle servers at the NDC and accompanying operating systems are unlicensed. The disaster recovery server located at the GDT is also unlicensed, as well as GoldenGate which

moves data between the NDC and GDT. **Excluding the VAT E-Invoice project**, GDT needs the following licenses:

- 3 x Oracle Enterprise Edition licenses (named user license – 25 user limit)
- 6 x Oracle Enterprise Linux operating system licenses
- 1 x Oracle GoldenGate License

Mainly this corresponds to systems that are in use for e-Tax. An extensive license survey was beyond the scope of this assignment, but GDT is known to run Oracle Business Intelligence (BI) and uses Automated Workload Repository (AWR) to gather performance statistics and monitor Oracle databases. Both require licenses.

In discussions with GDT and the Subcontractor, some of the above hardware and software can be reused for the eInvoice project, thereby making GDT at least partially compliant. Adding licenses to make GDT fully compliant is beyond the scope of this project.

One of the other Oracle products GDT uses is GoldenGate, i.e. to facilitate movement of data between machines. GDT indicates they would like to move away from use of Oracle GoldenGate because they are having some issues with data flows as a result of network outages. Ironically, because GDT is unlicensed, it cannot call Oracle support for resolution of an issue it is facing with GoldenGate.

The e-Invoice project will provision 4 more servers (virtual) for web and application server tiers that will require operating system licenses; in addition to a database license(s).

Various licensing scenarios were prepared and discussed with BPI and the local Oracle representative, Mr. Bayarsaikhan Bayantsagaan and his manager based in Ukraine. Initial discussions indicated that Oracle might be willing to entertain some discounts but not for the Named User Plus licenses. Those would have to be purchased at cost. A follow-up meeting was held with Oracle and submitted to Oracle to provide license quotes. Those quotes are pending.

C. Project Management

It became very apparent early in the process that keeping track of progress and tasks was becoming a challenge. The Subcontractor has provided an Excel spreadsheet with their project plan. However, it was not used for day to day management or noting completion of tasks.

Discussions with the Subcontractor indicated they often used a web-based tool for project management, i.e. Trello. During this assignment the Subcontractor began porting tasks to Trello. GDT and BPI were invited onto the system as observers. Trello offers the opportunity to list all tasks and note tasks that are pending and completed. It has the potential to become a central point of task management if utilized effectively.

E-PAYMENT EXPLORATION

Discussions were held with Mr. Gabit Bazar, IS Executive director, a subcontractor that developed the E-Payment system. The current issue is that very few taxpayers are using the newly deployed system. Most prefer to use the current eBanking system provided by their bank. The eBanking system provides a series of pre-populated templates that users can pull up and simply change the amount of tax owed before submitting. Some use the newly developed tax payment function to look up the amount of tax owed. The newly developed system is linked directly to GDT tax systems and offers the opportunity to pay tax directly; but users often copy the amount owed and revert back to the banks eBanking system.

Currently there is no way to know how many taxpayers are paying electronically via eBanking. Options were explored together to see how that number can be captured. A number of issues were noted:

- To capture this information, current bank systems must differentiate between teller made payments and electronic payments, i.e. via eBanking. If this information is not captured at source then it will be very difficult to capture the number of taxpayers paying via eBanking without modification of current bank systems. This is something where more research is needed. Mr. Gabit Bazar of Infinite Solutions, the original developer of the ePayment system, was going to investigate further.
- If the banks differentiate between teller payments and electronic payments, bank systems could be modified to push, or permit GDT to pull this information. This would require modification of existing bank systems and is likely to be met with resistance from the banks. There is no significant incentive for them to do this.
- If the banks differentiate between teller payments and electronic payments and are unwilling to modify their systems, it may be possible to obtain that information from the Central Bank of Mongolia. The Central Bank is in charge of the funds clearinghouse through which banks process funds. Apparently GDT has distinct accounts setup for each tax type into which funds are deposited. Tax type could be identified by the type of account paid into. If individual transactions coming into the clearinghouse contain sufficient taxpayer identification data and banks differentiate between teller and electronic payments, it may be possible to capture the requested data at this point. Mr. Bazar was going to check into that possibility. Of course, this option is only feasible if the Central Bank is willing to provide access to data in some fashion (real-time to bulk data dumps).
- Another possible option is to closely examine what data is captured and see if there are any proxy measures that might indicate where the payment is coming from (ePayment, teller, eBanking).

USAID ADS 548

USAID has performed an assessment of the e-Invoicing project via their regular ADS 548 process. They noted several concerns in their feedback:

A. Systems Engineering

- "With regard to developing a new VAT E-Invoicing module, the functional requirements (Annex 4) include a large set of yet-to-be-determined requirements including **"requirements for corporate income tax returns"; "requirements for royalty returns"; "requirements for corporate excise tax returns", GDT reporting requirements (Section 7 Reporting) and others not yet listed that will likely add to the scope and amount of development work**. These vague and potentially growing functional requirements can create challenges for the local IT firm that has yet to be selected and cause cost overruns or other problems to be realized, diminishing likelihood of project success."

  The evaluation recommended full identification of all requirements early in the process. The Subcontractor was consulted as to the state of requirements gathering. GDT has provided details for the returns requirements. The Subcontractor is eliciting further details and clarifying. They feel reasonably comfortable with the level of detail provided. In terms of reporting, the Subcontractor is not comfortable with the details provided. GDT was requested at the start of this assignment to clarify and provide needed details. Follow-up is needed.

- "The VAT E-Invoicing functional requirements make frequent reference to the effort to simplify Mongolia's Goods Classification System, which is a related effort largely outside of this project. [See Annex 4: VAT E-Invoicing System Requirements 1.9, 2.1.1.1, and 3.1.1 for

examples.] Non-performance in this area or a delay in reclassification designations can delay the project."

The evaluation recommended simplification and timely delivery of the new classification system. This issue was brought up with GDT and the Subcontractor at the start of the site visit. Consultation with GDT was held on this issue. GDT indicated that it would reduce complexity of the system by using only 2 levels of the 4 available. They also indicated that they would do some refinement first before passing the document to the Subcontractor. The Subcontractor will need this document to complete interfaces. This task is currently behind schedule. At the end of this assignment, GDT has promised to deliver the reclassification by 12 March 2015.

- "The proposal indicates that training and awareness activities are part of the development effort for both systems, but it is not clear if full consideration has been given to assuring user acceptance of the new systems, especially with reference to introducing electronic VAT registration and invoicing."

  The evaluation recommended implementation of stakeholder outreach to support user acceptance. A formal change management program for eInvoice at GDT is not in place currently. To begin the process a demo of very basic functionality developed by the Subcontractor was presented to GDT IT and Risk Management. Risk Management invited their staff and involved them in the demo taking the opportunity to explain the functions and benefits of the project. It is recommended that BPI follow-up with GDT to have them develop a change management plan not only for their employees but for the general public for use of eInvoice. This should begin as soon as possible.

- "Though the project proposal lists several planning, development, and implementation documents required of the local IT firms selected for these projects, a detailed test plan is not required. It has been demonstrated that the early detection of software problems is easier and cheaper than correcting the defect in later stages of the project. Studies have shown that a high percentage of software errors could be eliminated with a greater emphasis on structured testing, and that maintenance and support costs can be cut in half with targeted and thorough testing of web-based applications"

  The evaluation recommended that vendors provide a detailed test plan. Review of the project deliverables to date has noted a weakness in this area and the Subcontractor had been asked to address this issue. The Subcontractor has modified the project plan to include testing of all parts of the application and provided detailed breakdowns of test plans for various system components (taxpayer web application, tax inspector web application, administration panel web application and mobile application). The Subcontractor has been working on a document (E-Invoice-GeneralStatusesOfVATInvoice-v2.0_en.doc) that lists basic tests and outcome for web and mobile applications. They have been working collaboratively with GDT during the assignment. A similar document will need to be produced for the tax inspector web application and the administration panel web application. The Subcontractor has scheduled testing to begin around 6 April. They will need to complete this task before then.

B. Interoperability

- "The procurement is for software development only with no anticipated purchases of hardware or software."

  It has been discovered that GDT is currently running unlicensed versions of Oracle. Oracle will need to be fully licensed. Note additional discussion in the Oracle Licensing section of this document.

C. Integration

- "Though the local IT firm developing the new VAT E-Invoicing module is required to use GDT's existing infrastructure and technology, complexities associated with integration of the newly developed module may still pose a challenge to the project and project schedule "

  The evaluation recommended the project to consider developing an interface control document (ICD), which is typically produced when integrating disparate systems. A meeting on data integration was facilitated with principles. See Annex A – Data Integration for more details. The data integration situation at GDT is more subtle and nuanced than expected. At some level there is already data integration in terms of outside agencies providing data to GDT. In most cases GDT has data repositories into which this data is injected, e.g. TPI or Third Party Database. For eInvoice, practically speaking, integration means pulling that data from those repositories and using it. The Subcontractor has been asked to work with GDT and develop a detailed document that identifies data sources, types of data to be exchanged, frequencies, etc. Additional meetings have been scheduled for clarification. The Subcontractor is expected to produce that document within a week.

D. Capability

- "User acceptance and ongoing cooperation are important to fully realizing the new capabilities with the ultimate goals of enhancing the business climate in Mongolia and making it less burdensome; and to achieve a measurable decrease in tax evasion related to false VAT documents."

  The evaluation recommended special attention be paid to user acceptance. As noted previously, work has begun with GDT to build awareness of the project and its benefits internally. Public user acceptance has not been addressed. It is recommended that BPI follow-up with GDT to have them develop a change management plan not only for their employees but for the general public for use of eInvoice. This should begin as soon as possible.

DATA MINING

A short presentation on data mining was done for GDT Risk Management. It showed some basic examples of using data mining for tax fraud detection and more sophisticated ones using statistical models from Chile. The goal was to facilitate aware of techniques GDT might employ as their information systems mature.

PROJECT RISKS

The following risks have been identified:

1. Currently middleware coding has shown some weaknesses. This layer is responsible for talking to the database and poor coding practices could significantly impact performance. The Subcontractor indicated that they would put a Java expert on the project next week to address deficiencies.
2. Movement to Oracle RAC (database cluster) poses some risk to the project on several fronts:
   - First, implementing RAC means an increase in complexity. GDT needs to meet this new challenge
   - To move to RAC, GDT needs to tear down the existing e-Tax system at database level and rebuild it. This poses risk to both e-Tax and eInvoice.
   - GDT could implement RAC without modifying the shared storage layer of the system. Their internal Oracle expert notes that this layer needs to be rebuilt and properly optimized. This will take some effort and require some downtime.
   - GDT still does not have totally full access to the storage area network (SAN) due to issues with the previous subcontractor. Rebuilding may be problematic.

- To implement RAC, GDT must purchase additional switches and networks cards that are high speed (10GB or Infiniband) for the RAC private network (Interconnect). Latency within this layer will slow the entire system down.
- Middleware coding should take into account RAC coding best practices (http://www.oracleracsig.org/pls/apex/RAC_SIG.download_my_file?p_file=1001921)

To mitigate risks to eInvoice a number of strategies could be employed. First, GDT needs to show commitment to purchasing hardware of sufficient quality to make the system successful. Second, ideally GDT would perform a migration of e-Tax to RAC before eInvoice is ready to deploy. Migrating both applications at the same time is feasible but increases complexity and could introduce all sorts of additional factors that might impact eInvoice deployment but are not directly related to eInvoice itself. During this process they would also properly optimize the storage layer.

Practical reality is that RAC implementation may be constrained by budget limitations.

3. Oracle is currently running in an unlicensed environment at GDT. The practical implication of this is that they are unable to utilize support or get security and bug patches, or utilize Oracle Support. This issue is especially evident at GDT with their implementation of GoldenGate. Oracle GoldenGate transfers data between the National Data Center and GDT. When a network outage occurs, GoldenGate experiences some issue and crashes. Under normal and legal circumstances, GDT would escalate this issue to Oracle support for resolution. Lack of licensing excludes GDT from using that obvious solution.
4. Change management must be implemented at GDT to prepare both staff and the public for the new system. An initial small step was taken by having the Subcontractor perform a demo of basic functionality to GDT IT and Risk Management management and Risk Management staff. This is not sufficient. Staff will be involved in beta testing in April to elicit further involvement. However, the public awareness portion of change management needs to be addressed.

ACTION POINTS

The following items have been identified as action points for follow-up:

1. Completion of porting project tasks to Trello to allow greater visibility and monitoring by GDT and BPI
2. Completion of Goods Classification work by GDT by 12 March 2015
3. GDT to provide details on reporting requirements to Subcontractor. Addresses USAID ADS 548 recommendation
4. BPI to work together with GDT to assist them in developing a change management plan, internal and external (public awareness of application)
5. Subcontractor to develop detailed test plans with outcomes, as per USAID recommendations, for tax inspector web application and administration web application by 6 April
6. Subcontractor to complete detailed data interchange diagrams that document the flow of data between third parties including details of elements, etc.
7. Subcontractor to bring in Java expert for middleware design and development
8. Subcontractor to provide architectural diagram of middleware design by 14 March 2015
9. BPI and GDT to work to complete Oracle licensing
10. BPI to monitor progress on migration of system to Oracle RAC (if RAC is the final selected deployment platform)
11. GDT/BPI to procure a wildcard SSL certificate for production systems
12. GDT to ensure enrollment and payment of fees for Google Play and IOS Developer programs

13. Project plan needs to reflect performance testing requirement
14. Data model has been refactored. Subcontractor to complete adding triggers, sequences, default constraint values, etc.
15. As development proceeds, Subcontractor should check the SQL they are writing using standard Oracle "Explain Plans" (plans that explain how the Oracle database engine runs a query) to identify inefficient queries and identify indexing strategies

ANNEX A: REVIEW OF DELIVERABLE 2

The following is a review of Deliverable 2. Deliverable 2 consisted of the following:

- Deliverable No2-Progress Report_v1.0_en.docx
- E-Invoice-GeneralStatusesOfVATInvoice-v2.0_en.docx
- 3. ActionPlan-E-Invoice-v2.0_en.xls
- MobileDesign-v2.0.zip
- WebAppAdministrative&MonitoringPanel-v1.0_en.zip
- WebAppForTaxInspector-v1.0_en.zip
- WebAppForTaxPayersDesign-v3.0_en.zip

ITEM 1 - DELIVERABLE NO2-PROGRESS REPORT_V1.0_EN.DOCX

This document consisted of the system architecture including the database, web/mobile and security portions. Third party integration and refining goods classification was also presented.

DATABASE ARCHITECTURE

The database architecture was reviewed and discussed with both GDT and the Subcontractor. Discussions were held on how the current e-Tax database system and the new eInvoice system would integrate and where the boundary between then would be. Attention was paid to the strategic direction GDT wants to move towards and key core concepts such as not duplicating data. Deficiencies in the data model were noted.

The Subcontractor re-factored the entire data model to clarify the boundaries between the 2 systems making sure to avoid duplication of dataset and addressed deficiencies, e.g. produced a data dictionary, optimized the design. Several iterations were made of the data model to incrementally improve it throughout the site visit.

The Subcontractor has some limitations in terms of data model development. Chiefly, due to integration with e-Tax they must work with some table definitions that are identical to ones in the e-Tax system. Some of these entities lack features, e.g. lack of foreign keys, lack of indexes to avoid data duplication, etc. Unfortunately, these are unavoidable in dealing with a legacy application. Discussions were held with the Subcontractor and mitigation strategies were developed to offset these deficiencies where possible.

The result is that the Subcontractor has delivered a data model, that while not theoretically sound or perfect in several areas, is within the constraints they have to deal with.

DATA MODEL REVIEW

The submitted data model was presented in Deliverable 2 and reviewed for deficiencies. Details and comments of initial review are noted in Data Model Iteration1 Review.pdf attached to this document.

Several subsequent iterations were made to address deficiencies. Specific issues noted were:

- Need to create sequences for PK
- Where team models many to many relationships with a table, make the 2 foreign keys unique, i.e. add a unique index
- Generate triggers to update PK's
- For bit fields, add some check constraints
- Any other fields that have very few codes that are not likely to change should also have constraints
- Set default values for date and timestamp fields

- Add trigger to automatically update UPDATE_DATE field
- On the table GENERAL_INVOICE_MAP, there is a self-referencing relationship (PARENT_ID back to the ID). However, PARENT_ID is set to be mandatory. What happens when you enter a record that does not have a parent? The PARENT_ID field is mandatory.

At the end of the assignment, after another iteration, the above issues were addressed. It should be noted that the data model is expected to change subtlety as develop occurs and subtleties to processes are discovered. The data model is functional in its current state and a significant improvement over what was presented initially. It has been reviewed by GDT and approved by them as well.

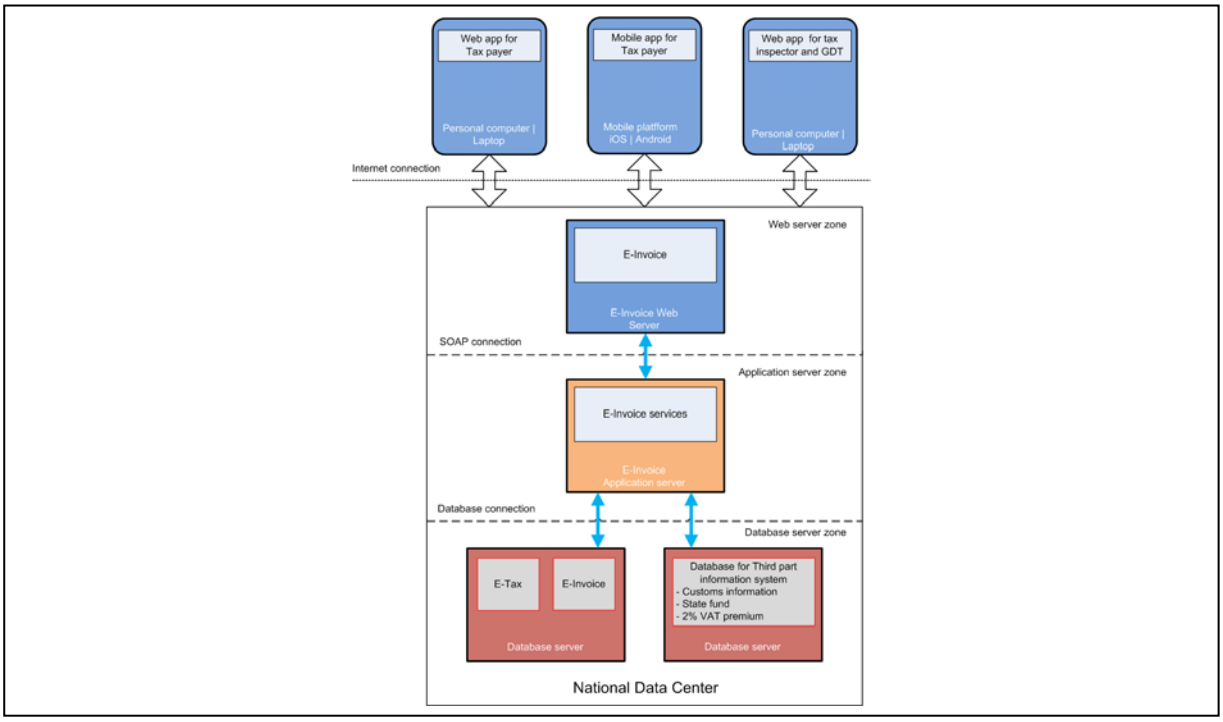
As development proceeds inefficient queries should be identified and proper indexing strategies applied.

SYSTEM ARCHITECTURE REVIEW

A. General

Based on feedback, the Subcontractor has re-factored the system architecture to one that is more in line with the strategic direction of GDT and has less potential performance pitfalls. The originally presented architecture was significantly re-worked during an iterative process.

The newly designed architecture will include an applications server tier and use the same technology as GDT is using currently in its middleware tier. This should reduce concerns about



performance and make long-term maintenance easier for GDT, i.e. it does not introduce a new technology stack. The front end systems will still be written in PHP like the current front end systems of e-Tax. The revised architecture is presented above. **The Subcontractor has revised the initial system architecture documentation in Deliverable 2 to reflect this change**.

Research has also indicated that GDT has a number of pre-built web services in the middleware tier that may have utility for the eInvoice project. The Subcontractor has acquired the documentation of these web services so they may be evaluated for use in the current project to facilitate integration.

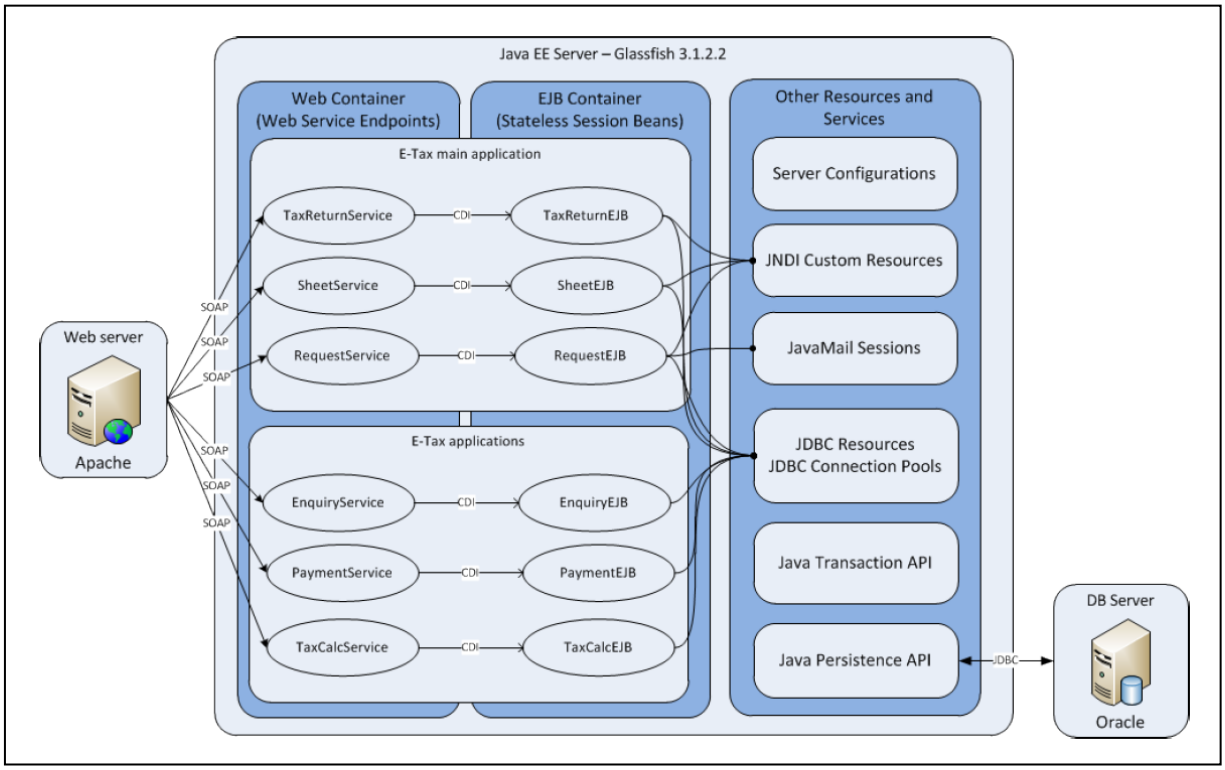
B. Web Service Architecture

This section has been added to Deliverable 2 since the refactoring. This is a new middleware layer that will sit between the web application tier and the database.

During the assignment the Subcontractor presented a NetBeans project with code that indicates how they plan to develop this part of the system. That project was reviewed. Currently it is only in the beginning of coding and only 1 web service has been coded (GetTaxPayerUser).

In general, the e-Tax system was written using the Java EE style of development. Their current e-Tax architecture is noted below. To get a better understanding of their approach, sample code was requested and examined.

The following comments were noted and need to be addressed after examination of the sample



code:

File: GetTaxPayerUser.java

- Line 29 - declaration could be made final
- Line 30 – Variable is declared as private Long PayerUserId = null; Previous line also has a variable declaration (private String tokenStaticString = "d4#FEc_";). Java variables usually start with lower case. Be consistent throughout your code
- Line 48 – connection obtained but not closed on all paths out – leads to leaks and open connections
- Line 48 – check to see if using try-with-resources is more appropriate than try-catch. See http://docs.oracle.com/javase/7/docs/technotes/guides/language/try-with-resources.html for reference
- Line 60 – variable checkuserid – be consistent with coding style
- Line 60 – checkuserid and userid – are 2 boxed values. Comparison done using == instead of .equals. If == is used, the boxed object's identity is compared instead of the boxed value. Is that you want to do here?

- Line 67 – The exception is a generic catch all exception. This also catches runtime exceptions along with generic exceptions. Runtime exceptions are exceptions from programming errors that you might recover from. Might be better to separate them. Look at this discussion (http://stackoverflow.com/questions/2190161/difference-between-java-lang-runtimeexception-and-java-lang-exception). One reason for separating these out is that it makes it easier to find bugs in code.
- Line 68 & 108 – note use of a printStackTrace() without any parameters. Useful for debugging. Not good for production. We should institute a logging class (there are many out there) and properly log exceptions.
- Line 93 – not all paths close your connection – going to lead to performance issues. See previous comments on same issue
- Line 137 – close connection issue again
- Line 150 – Since JDK 7 is being used, you could use the diamond operator, i.e. Map<String, String> user_profile = new HashMap<>(); Look here (http://stackoverflow.com/questions/4166966/what-is-the-point-of-the-diamond-operator-in-java-7?rq=1) and here (http://java.dzone.com/announcements/java-7-do-we-really-need) for references
- Line 183 – Same issue as above – exceptions vs runtime exceptions
- Line 184 – setup a logging class as noted before
- Note that in login.java, class names in Java usually start with upper case. Be consistent. Pick a standard and stick with it.

Discussions were held with the Subcontractor and the Subcontractor will bring on-board an experienced Java resource to fine-tune the middleware architecture. That resource was not available during the visit but will start next week. The Subcontractor will provide an architectural diagram with proper design patterns on the inner workings of that layer next week.

C. Data Integration

The presented document by the Subcontractor indicated the following data exchange avenues:

- "E-Tax system
- TPI /Third party system/
- E-Mark /Offering system/
- TRIPS /Internal administration system for taxation/
- IMS /User management system for taxation/
- Customs information system /duplicated instance of customs main database"

A meeting was facilitated with GDT and the Subcontractor to discuss data exchange. It was decided that there would be no data exchange with the TRIPS system as that system feeds the current e-Tax system and eInvoice pulls from that system.

For Customs, there is currently data exchange between Customs and GDT. There have been connection issues and the current frequency of exchange is monthly. GDT has worked with Customs to rectify that issue and they expect the frequency of exchange to increase. Customs data currently gets imported into a set of tables in the Third-Party Information (TPI) system. That will continue.

GDT identified 6 pieces of information that are needed: sales, purchases, VAT waivers, sales returns, purchase returns and customs declarations. Except for VAT waivers and customs declaration, all other information exists in e-Tax and does not need to be exchanged. For declarations, from the eInvoice interface taxpayers will check which Customs invoices they want/need pulled and eInvoice will pull that data from the TPI tables. The eInvoice system will push summary information to e-Tax. GDT will do more research on exchange of VAT waivers.

There is also another flow of information from eInvoice to Customs. A follow-up meeting between the Subcontractor and GDT Risk Management has been set to explore this flow of information.

Currently, paper invoices are produced by outside parties. This will cease once the system goes paperless. At that point, eInvoice will need to push allotments of generated invoice numbers to the EMark system. The EMark system currently exchanges information with e-Tax via GoldenGate. The frequency of this exchange is to be determined. It has been added to the Subcontractor's task list.

GDT has also agreed to provide documentation on what data exchange there is between EMark and e-Tax. The Subcontractor has added this to their task list.

The Subcontractor was asked to ensure that proper constraints are put into the system to ensure that taxpayers cannot resubmit the same invoice multiple times.

There is another data flow with the State Fund. The Subcontractor has scheduled a meeting with Risk Management to explore details.

Within the scope of this deliverable, the Subcontractor has understood and documented the various in and outflows of data to eInvoice. There are some details and further meetings that need to be held to fully clarify the issue. The Subcontractor will also produce a detailed data flow document.

D. Mobile Applications

The Subcontractor presented wireframe diagrams of both Android and IOS applications. These were examined in detail.

A demonstration of the mobile application was done by the Subcontractor. The demo is the beginning of coding for the mobile wireframe diagrams. GDT has reviewed the wireframes and presented feedback. For functionality to begin to appear in the mobile application, some of the web services will need to be built.

The IOS application has associated wireframes but development has not started. GDT has approved those wireframes as well.

E. Tax Payer Web Application

The Tax Payer web application is being code in PHP using the Symfony framework. It will live on the web tier and talk to web services developed on the middleware layer. Development is following a basic and standard Symfony approach.

A short demonstration of the basic web page functionality was done for GDT. Feedback about the interface was generally positive. At this point in time substantive development has begun. More functionality is expected in the next several weeks.

F. Administrative and Monitoring Panel

Wireframes have been developed for this application. GDT has reviewed and approved the wireframes. Coding has not begun at this point. The deliverable is acceptable in its current form.

G. Tax Inspector Web Application

Wireframes have been developed for this application. GDT has reviewed and approved the wireframes. Coding has not begun at this point. The deliverable is acceptable in its current form.

H. Conclusion

The system architecture segment of the second deliverable presented by the Subcontractor, after revision, meets expectations.

Item 2. E-Invoice-GeneralStatusesOfVATInvoice-v2.0_en.docx

This document consisted of a series of business rules and associated statuses of invoices.

Initial meetings with GDT indicated that some refinement of these rules and statuses were needed. The Subcontractor was involved and together with GDT, they refined the document by the end of this assignment.

Item 3 - 3. ActionPlan-E-Invoice-v2.0_en.xls

This document presents the project plan developed by the Subcontractor and GDT. It is presented in the form of an Excel spreadsheet.

The following comments are noted:

- The team is losing velocity on Goods Classification system refinement. It is awaiting GDT to revise
- Monitoring Administrative panel is behind schedule
- No performance testing has been indicated in the observed project plan
- Testing plans need to be detailed out as per USAID ADS 548 recommendations, i.e.

  "Require the vendor to provide a **detailed test plan listing the range of tests and expected outcomes**, along with the other planning, development and implementation documents. Assess all submitted plans and documents to ensure they are complete and of sufficient quality to contribute to the efficient development, implementation, and operation of the new capabilities."

Neither of the first 2 tasks are highly critical but they will need to be completed. Work on back end services has begun as has work on the Tax Payer web application – a key component. A development environment is in place and in use.

Performance testing is important and needs to be done in order to load and stress test the application before going to production.

Since initial review of this document, the Subcontractor has addressed several deficiencies. Chiefly they have improved quality assurance by including sections on testing of functional requirements for mobile applications, taxpayer, tax inspector and administrative web applications.

The additional functional requirements tests are presented at a high level but seem adequate. The one area where additional testing will need to be done is with the various data flows for data integration. Analysis has shown that there is a wide variety of flows between systems, both in and out flow and these flows will need to be tested accordingly. Some of this testing may be integrated into the functional requirements tests. There may need to be some basic integration tests to ensure that the flows work as expected.

The web-based Trello project management system has been instituted and key stakeholders invited. GDT has requested that the Subcontractor make use of this tool. The Subcontractor has agreed to complete adding tasks to Trello.