Data Exchange Using Web Services: The Cases of Ethiopian Revenue and Customs Authority and Transport Authority

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Abstract

At present, the use of the Internet and its volume of information is growing at an alarming rate throughout the world. In particular, the Internet has contributed to the emergence of different applications that are being developed using different tools. Recognizing the significant role of these applications, organizations tend to develop their own domain-specific applications that automate their day-to-day activities. However, the heterogeneity of these different systems represents a major obstacle to data accessibility and data exchange. This paper presents the proposed approach to address such kind of challenges.

Ethiopia is currently well aware of its present position and putting all rounded efforts to improve the services provided through the use of information and communication technology. As a result, the present portal systems or e-Government service initiatives are expected to help it leapfrog ahead towards new development. Some of the organizations are engaged in the process of design and development of web based applications that automate the service delivery. These applications are expected to be interoperable with other autonomous systems. Despite the efforts made by different public bodies to automate their operations, integration of such automated systems remains a major challenge.

This paper intends to deal with such kind of challenges by selecting specific cases with data exchange problem that demonstrates the methodology followed to find a solution. To do so, first the current efforts and technologies towards integration of different systems have been assessed. Then information about existing systems and system requirements for data exchange is gathered. Based on the assessment and system requirement, a system is designed and a prototype is implemented with a selected technology.

Keywords: Data Exchange; Web Service; Heterogeneous Data

1. Introduction

Applications are now being developed by different organizations to facilitate different services. The scope of these applications may not cover all requirements of the organizations. In addition, the output of these applications might be required by other organizations. However, the schema and data structure of these applications are usually different and data exchange among organizations is a major problem. The Transport Authority (TA), now called Road and Transport Bureau was established through Proclamation No 15/2009 in 2003. It provides vehicle registration, driving license renewal, vehicle inspection, vehicle ownership transfer, plate issuance, vehicle value estimation, and other services [2].

The Ethiopian Revenue and Customs Authority (ERCA) was established through the Proclamation No. 587/2008. The Authority came into existence on 14 July 2008 and is responsible for collecting revenue from customs duties and domestic taxes [3].

This paper focuses on assessing and identifying existing problems associated with services provided by TA and ERCA such as vehicle registration, ownership transfer, and tax collection with a view towards improving the service process efficiently. In order to achieve this, existing methods and technologies are assessed and compared based on their opportunities and limitations for creating enabling environment for making efficient and flexible data exchange among applications. Moreover, a web service-based application is designed and implemented to demonstrate the

selected technology applicability for efficient and flexible data exchange in heterogeneous environments.

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TA requires declaration of data as well as proof of tax settlement from ERCA for every vehicle imported as a precondition for providing vehicle registration services. TA requires vehicle's declaration information directly from ERCA not only to use it as an input to register a vehicle, but also to check whether the vehicle imported has gone through all legal procedures. Since both organizations use different applications and data storage systems, this has been creating a bottleneck for exchanging data.

At present, data exchange regarding vehicle data is performed manually. Customers are required to bring hardcopy documents to the TA to register their vehicle. TA also requires an official confirmation document directly from ERCA. To complicate matters, the TA system is distributed over different sites that are disconnected to each other. According to discussions held with ERCA staff, ERCA have been using Automated System for Customs and Data (ASYCUDA++) for over ten years. As it is a very old system, it neither allows integrating with other systems nor extracting information to provide service to other stakeholders like TA is possible. This forced ERCA to extract information manually. But, ERCA has now a plan to upgrade the existing system to a modern system.

The lack of data exchange between these two organization's systems has created the following problems:

- Inconvenience to customers due to delay of service delivery
- Use of forged vehicle's declaration that leads to illegal use of a vehicle
- TA is unable to get up-to-date and genuine vehicle's imported date as a result of disparate systems

2. Related Work

In today's software development world, multiple vendors have been implementing their own data model through practicing the relational theory. Therefore, the data models dealing with the same real world objects are often different. The data exchange between these different software systems is extremely difficult due to the difference of the data model. To resolve the data exchange problem in integration and information sharing among different software systems, XML (Extensible Markup Language) becomes a natural selection as a means to relay the data in the information exchange process [5].

In this context, data is transferred between two sample school administration database systems, which are semantically similar, but have different data models. The transferring is carried out through an intermediate data model as the bridge between these two data sources. The intermediate data model is in XML data format. The mappings are via two XML schemas, one from the source school database to the intermediate data file, another is from the intermediate to the destination school database. The programs are developed using Microsoft .NET and C# programming language. The databases are built on Microsoft SQL server. As shown in Figures 3 and 4, this paper presents two heterogeneous database systems: School A and School B, and data needs to be transferred from one to the other [5].

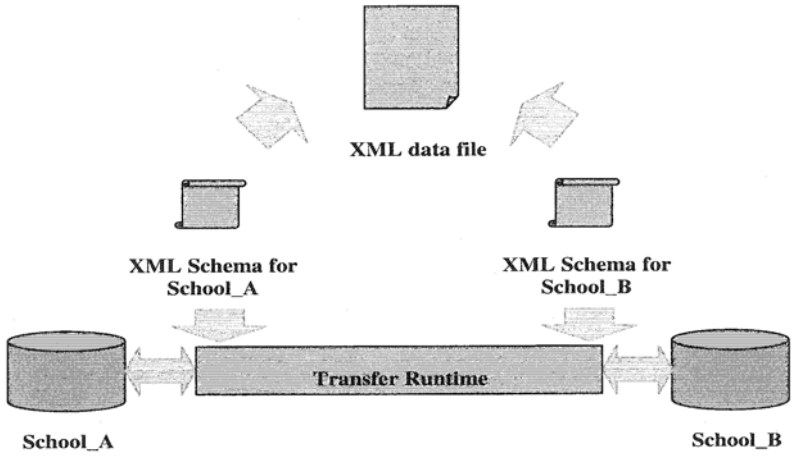

Figure 1: System Architecture

In order to solve the data transferring between the heterogeneous schema problems of these schools, the selected solution is to build a middle-tier data model as a bridge between the transferring and receiving side. The middle-tier data model complies with the semantic meaning of this specific application. It is responsible for the mapping from the source to the destination schema, providing a representation of the relevant data relationship on the transportation pipeline. This middle-tier data model is represented by XML, in particular, an XML data file, and two XML Schemas, each of which is responsible for matching and extracting data from the source data, and mapping and transferring the data to the destined data source [5].

3. Solution Design

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Since both TA and ERCA are currently using a WAN and eventually implement a network using fiber optics as a backup line, availability will not be an issue. In addition, the matching requirement can be addressed through implementing a data mapping for TA and ERCA independently. Therefore, multiple approaches for data exchange have evolved over time. However, the web service is chosen for the following main benefits [1]:

- Hide heterogeneity by developing an application that allows data exchange of heterogeneous systems
- Provides valuable resources, which are data sources that are available for users
- Accesses and retrieves data from multiple data sources at the shortest possible time and lowest cost (such as decreasing transportation, resource cost, etc.)
- Promotes innovation and potential new data uses
- Leads to new collaborations between data providers and data consumers in distributed computing

The architecture chosen for data exchange using Web Services is a combination of architectures since both TA and ERCA have their own heterogeneous systems. Both organizations use three-layered architecture; but the web service architecture that integrates the distributed systems is different. In distributed systems, there are three types of commonly used architectures. These architectures are considered for this web service solution.

The architecture is based on three layered service applications: presentation, business, and data. This pattern presents an overview of the responsibilities of each layer and the components that compose each layer. These are [6]:

- Presentation Layer: provides the application's user interface. Typically, this involves the use of Windows Forms for smart client interaction, and ASP.NET technologies for browser-based interaction.
- Business Layer: implements the business functionality of the application. The domain layer is typically composed of a number of components implemented using one or more .NET-enabled programming languages. These components may be augmented with Microsoft .NET Enterprise Services for scalable distributed component solutions.
- Data Layer: provides access to external systems such as databases. The primary .NET technology involved at this layer is ADO.NET. However, it is not uncommon to use some .NET XML capabilities here as well.

The architecture, as depicted in Figure 2, is well suited because it separates the business logic from the presentation or data access layers. A given layer can be changed without significantly affecting the other tiers and any change to the business requirements and policies can also be easily accommodated.

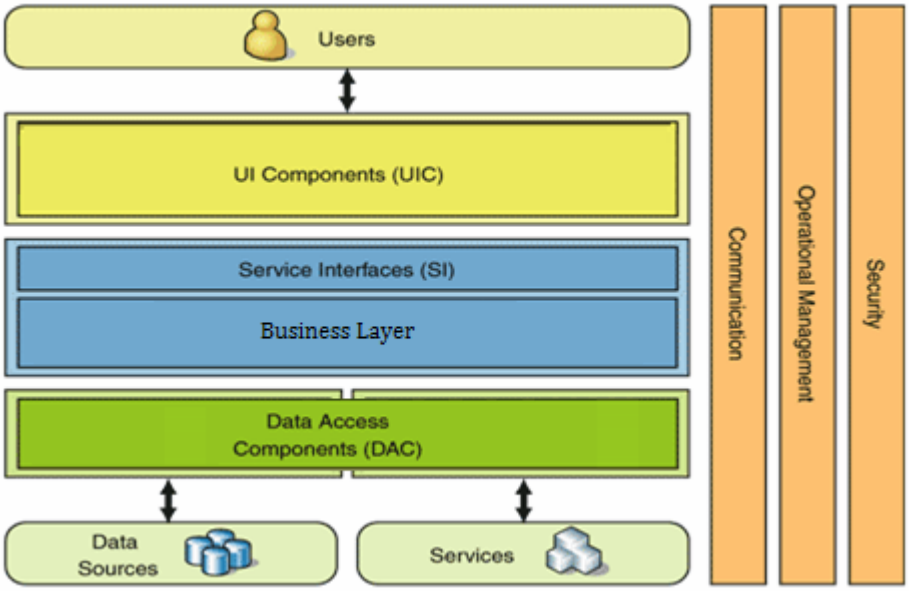

Figure 2: Three-Layered Services Application

The service oriented architecture works on the assumption that the functionality made available by an organization will be exposed as a service. In middleware terms, a service is a procedure, method, or object with a stable, published interface that can be invoked by clients. The interactions between organizations occur in a peer-to-peer fashion where each party exposes its internal operations as (Web) services, which therefore act as entry points to the local information systems [4].

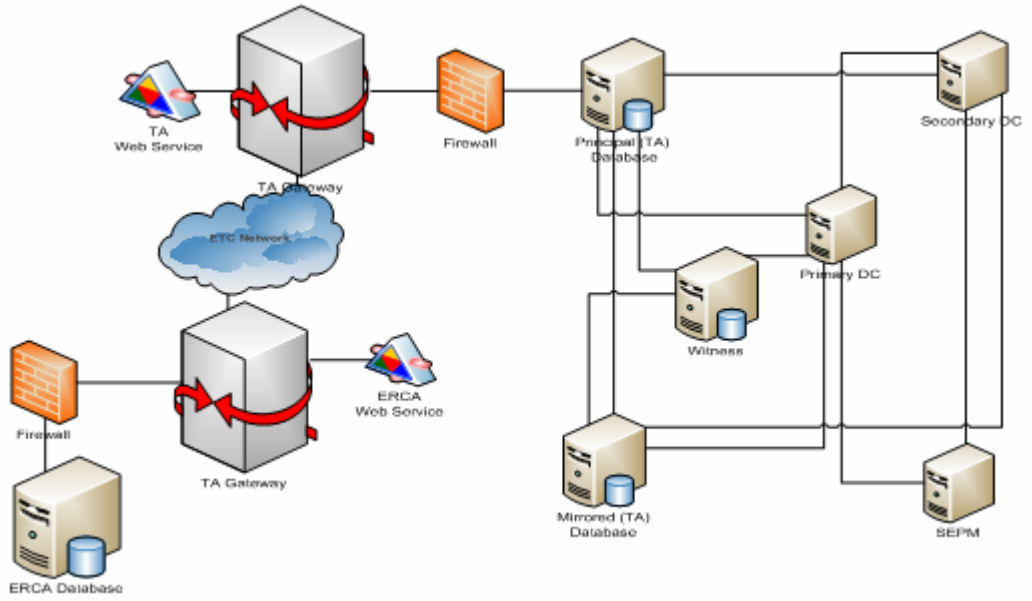

Figure 3: Deployment diagram for DEWS

Likewise, the TA web calls a service at ERCA through the TA business. The TA business is responsible for serializing the request and sends the SOAP request to the ERCA service. The ERCA service transfers the request to the ERCA business to de-serialize the request and queries the ERCA database. Once the ERCA business retrieves a record from the database, it serializes the response to send it back to the consumer as a service response. Finally, the TA business de-serializes the service response to map the data to the corresponding objects. Since the data exchange between the TA and ERCA is bi-directional, the process from ERCA side also works in a similar manner.

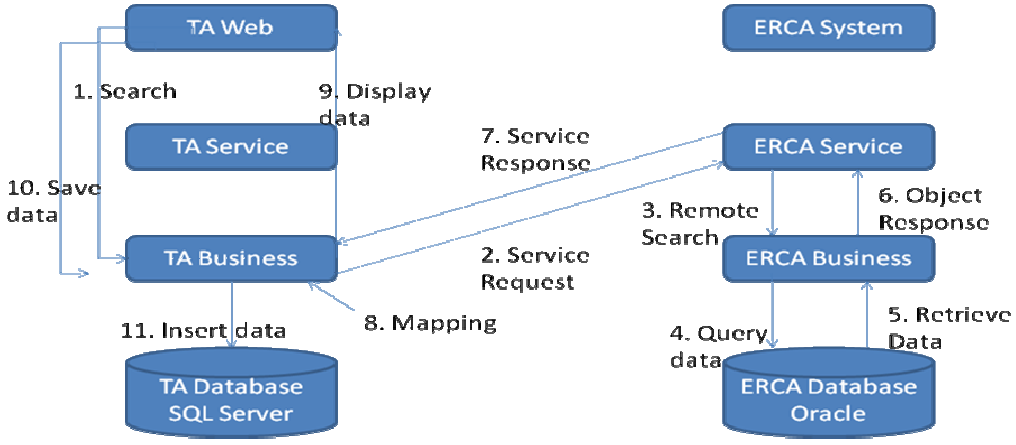

Figure 4: Implementation Architecture of DEWS

4. Conclusion and Recommendations

This paper aims at exploring technologies for data exchange and addressing the problem of data exchange between one of the branches of TA and ERCA. Out of the different approaches and implementation technologies explored, web service-based data exchange mechanism is implemented for the vehicle registration and ownership transfer processes. The prototype developed in this paper demonstrates how a service implementation facilitates exchange of data between TA and ERCA through the use of their systems. Service providers of the TA can search for a vehicle directly from ERCA to carry out the vehicle registration process. It would also allow ERCA to follow-up a vehicle ownership status and tax collection.

In addition, the TA has currently five branches where vehicle registration and other services are given. But, the work in this paper must be somehow modified with further analysis and minor modification of the existing systems on each branch

to provide a comprehensive solution for sharing data sources that hides the heterogeneity between different data sources and between ERCA and other stakeholders as well.

Generally, organizations still tend to automate their process without worrying to interface with other systems. But when there is a requirement to interface with other organization's systems or services, the same project is done over and over again. This has an effect on the organization's time, cost and other resources as well. Therefore, it is recommended that interfacing issues like network infrastructure, security and, particularly they type of data that might be required by other stakeholders, must always be taken into consideration up on project initiation and planning.

The result of this work mainly alleviates processes related to initial vehicle registration and tax collection of ownership transfer of duty free vehicles which are the existing major problems of TA and ERCA, respectively. However, since both organizations might have additional branches which are not considered in this work, adapting the web service to incorporate requirements of these branches and other stakeholders can be further studied.

In addition, due to the time limitation, this work is developed using a standard web service with the implementation of authentication and authorization. Other security requirements like confidentiality, integrity, auditing, and availability must be implemented in order to minimize a risk on both organizations.

Therefore, expansion of the web service to accommodate the requirements of the remaining branches of TA and other stakeholders and consideration of other security aspects are open for future work.

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