Multi-lingual Semantic Interoperability Framework for Road Transport Information Systems in Ethiopia

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Abstract

In Ethiopia, it is a constitutional right for Regional Administrations to use their language as a working language. Hence, all regional transport offices use their respective language as a working language. On the other hand, the road transport sector is not location dependent. Therefore, because of the mobility nature of road transport actors (vehicles, drivers, and transport users), there is a need to exchange road transport data between regional transport offices so as to facilitate road transport services.

So far, different regional offices tried to implement an information system which is localized to their respective working language for their transport related service provision. But they didn't consider interoperability with other regional transport offices' information systems. Data handled and exchanged by these regional offices are facing semantic incompatibility due to language difference. Due to this, these information systems lack seamless data exchanging.

Since the use of harmonized data and interoperable information system results in the provision of efficient service for citizens, it is important to have a mechanism of creating semantic interoperability between these information systems.

In this paper, the problems due to exchanging of semantically incompatible data and use of non interoperable information systems are identified, conclusions and recommendations are drawn and finally a framework which basically uses central translation mechanism to help establish semantic interoperability and easy data exchanging capacity between multilingual information systems is proposed.

Keywords: Interoperability; Semantic Interoperability; Multilingual Semantic Interoperability; Information Models; Transport Information

1. Introduction

Before 1987 E.C., the road transport sector in Ethiopia was under centralized administration. During that time, the sector was governed by similar rules and regulations all over the country. The working principles, languages and control as well as recording format were similar. But in 1987 E.C. after the pronunciation of the Constitution of Ethiopia which determines the State structure into Federal Government and State members [4], the sector was restructured into decentralized administration with 9 Regional Transport Bureaus, 2 City Administration Transport Bureaus and one Federal Authority.

After the decentralization, due to the right given by the Constitution for all members of the federation to determine their respective working language, different Regional Transport Offices (RTOs) started to use different languages as their working language. They also gained the right to draw their own rules and regulations without conflicting the federal rules and regulations [4].

Nevertheless, road transport by its very nature is not location dependent. Actors of the sector (vehicles, drivers and transport users) are free to move, give and get service, everywhere throughout the country. Some of the services given by each RTO are: vehicle registration, driver licensing, public and

fright transport dispatching, road traffic violation fines collection, and some other related activities. Citizens can get all these services in either one of the RTOs without any limitation.

This nature of the sector forced transport offices to have high interaction and intensive data exchange in order to facilitate service provision and enhance good governance.

According to [6], the effective management and sharing of information across agency boundaries will result in information being used more efficiently and effectively. This will provide significant benefits, including:

- reduced costs of information collection and management through streamlined collection, processing, and storage;
- improved decision making for policy and business processes, resulting in more integrated planning and enhanced government service delivery;
- improved timeliness, consistency and quality of government responses – information will be easily accessible and it will be relevant, accurate, and complete;
- improved accountability and transparency for citizens;
- reduced costs and added value for government through reusing existing information, sharing infrastructure and designing integrated, collaborative methods of delivering services;
- improved national and jurisdictional competitiveness; and
- improved national jurisdictional security.

Among the RTOs, six are using their own transport information systems for service provision which are localized to their respective languages. All these systems were developed independently without considering interoperability. Therefore, they couldn't exchange data with each other. This indicates that there is a need to develop an interoperability framework that every actor in this sector should commonly follow.

The rest of the paper is organized as follows. Section 2 presents related works to identify the gap in prior works. Section 3 discusses the proposed solution. Section 4 covers the prototype developed to evaluate the solution, and finally in Section 5 conclusions and future works are presented.

2. Related Work

In general, there are different interoperability perspectives; information, technology and processes. In this line, and in order to facilitate data sharing and integration to assist government business processes, the Australian Government has developed an interoperability framework which contains the following three perspectives:

- the Information Interoperability Framework;
- the Technical Interoperability Framework; and
- the Business Process Interoperability Framework.[1].

The work emphasizes that this framework provides a platform for the development of Information Interoperability capacity. It will also help to establish a shared understanding of information barriers, enablers, principles, and practices. This understanding then will strengthen improved ability to share information across agencies. But, the main focus of the research is on the information interoperability part.

According to [5], semantic interoperability is beyond the scope of technical systems, as there needs to be an understanding among human users, that terms "mean the same" as they are used by semantically interoperable systems. As humans think in informal concepts apart from all technical representations, it is important to express the same concepts but not necessarily the same representations. Thus, we can give a more focused definition: Semantic interoperability is the property of two systems, A,B to be able to map "meaning" represented as terms in system A - after storage, communication, processing from terms in system B

into the original conceptual information ("meaning"), see Figure 1.

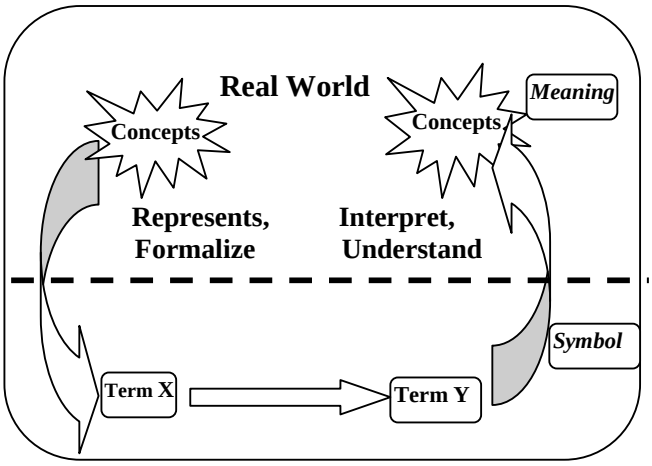

Figure 1: The Goal of Preserving Concepts through Semantic Interoperability (adopted from [5])

The work in [2] aims at facilitating multilingual interaction with a data store by providing a translation component between data stored in one language and users that prefer to interact in one or more different languages. The user can be a system or a human being. It was initiated because of the problem that arises in many companies that utilize databases that have offices in several countries around the world or have a multilingual population.

The researchers proposed a multilingual database interaction system and method. The following are the important contributions of the proposed method.

- The present system and method facilitates interaction with a database in a plurality of different languages. In particular the proposed solution provides for a translation mechanism for storing and interacting with data in a user preferred language.
- The translation component can convert data and/or metadata dynamically to a plurality of different languages by employing translation tables.
- Query information can be accepted in a plurality of different formats and languages.
- Databases can be defined, created, and/or manipulated utilizing the translation system and method.

Having such a translation mechanism allows corporations in different countries or in a single country with a multilingual population to build a single unified view to data.

This solution is developed to allow different users and systems with different languages to access a centralized database on their preferred language. Thus, in decentralized multi-language databases, the solution does not work. Its scope is limited to how to translate data in one database into different languages. But the main concern of our work is creating a mechanism on how different users and systems with different languages can exchange or access multi-lingual transport data found in distributed databases without losing semantic interoperability.

3. The Proposed Solution

Moving simply from presenting information to where computer programs can exchange it and combine it with other information resources and subsequently process it in a meaningful manner, requires agreement on a wide variety of issues that relate to the context within which the information is created and used. This is the subject of semantic interoperability. It entails agreement on, for example, ways to discover, represent and give a context to information. This will allow automated tools to share and process information, even when they have been designed independently. The objective is not only to allow information resources to be linked up but also to allow information to be automatically understandable, and, consequently, reusable by computer applications that were not involved in its creation.[3]. Based on this, a framework was designed by taking the following considerations.

3.1 Interaction Type

In the most general form of interoperability, eight interaction types that cover most of the current trans-regional services can be defined as shown in Figure 2.

Based on the above interaction, to reach its potential nationwide audience, the solution needs to fulfill a wider set of requirements. These include but are not limited to the following.

- To allow the matching of data, a high degree of standardization and agreement is required nationwide in terms of the relevant data structures and the semantic components.
- Agreements must be made between the different Transport Offices regarding the authentication of the sending and the receiving party, the accountability of the data transmitted and received and the appropriate security levels and the procedures and mechanisms to be used in this respect.
- Users need to be identified and their identification then needs to be accepted/ recognized by all offices involved.

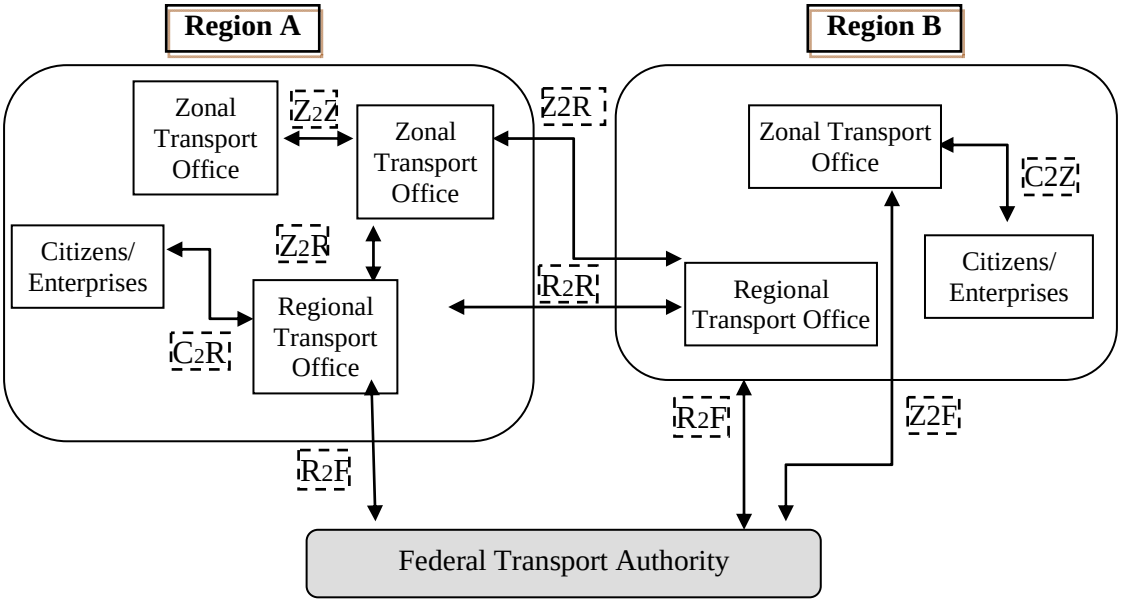

Figure 2: Interaction Types

3.2 Use of Multilateral Solution

In a multi-actor environment, one way to achieve interoperability is to consider different solutions according to the exchange partner one has to communicate with, leading to bi-lateral solutions and agreement. The net effect (and disadvantage) of such an approach is that it requires as many communications as there are external partners, resulting in less efficiency and higher costs. On the other hand, if each of the interoperating partners adopts the same set of agreements for interoperability solutions, each of them can obtain the benefits of a single solution that is developed once and fits the needs of all [3]. Figure 3 presents these two types of agreements. Likewise, since the transport sector is a multi-actor sector and as we have seen above the interaction types are so many, it is better to consider a multilateral solution. One of the recommendations of the respondents was also looking for a central middleware which enables to reduce the number of communications.

3.3 Semantic Interoperability Framework

The interoperability solution proposed in this paper will facilitate interaction between databases in a plurality of different languages. In particular, the framework provides for a translation mechanism for interacting with data in a user preferred language. To facilitate this, there will be a translation component placed between the different transport offices database and a user (which can be a person or a system) to allow translation of data objects (e.g., data and metadata) from a base language in which they

are stored to a user preferred language. Thus, the framework allows users to enter database queries and receive the resulting data from different regional databases in the language in which they are most comfortable. The framework is shown in Figure 4.

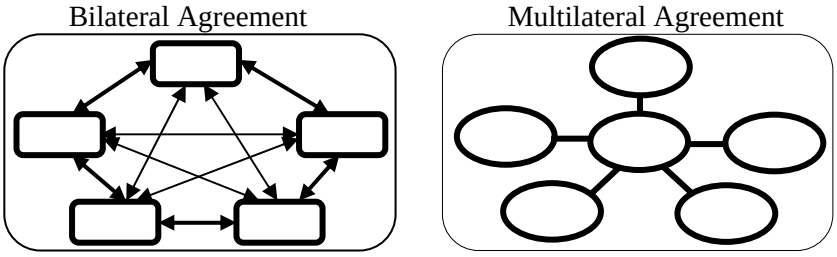

Figure 3: Types of Agreements

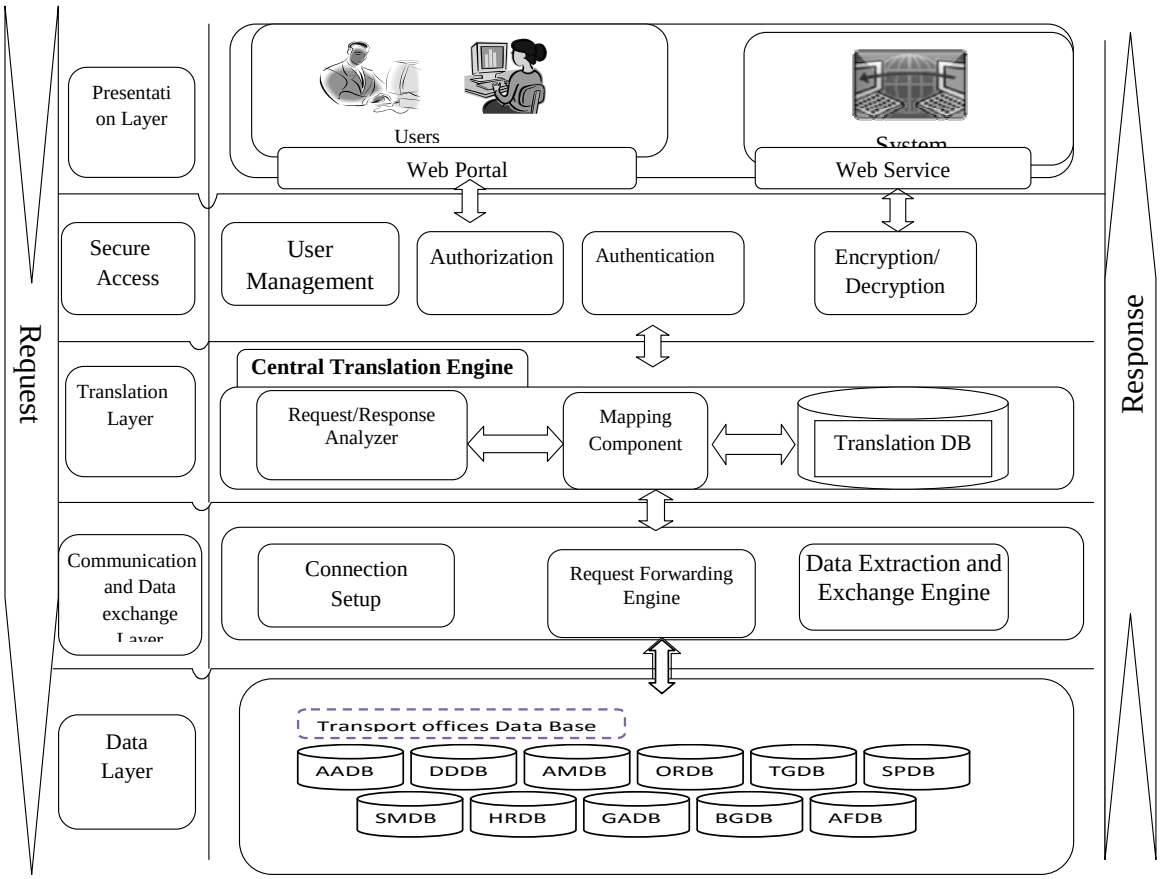

Figure 4: Multi lingual Semantic Interoperability Framework.

4. Prototype

The testing and evaluation of the solution was undertaken using a prototype which considers a case by which two transport offices are involved in data exchanging process during service provision. The selected transport offices were Amhara and Tigrai Transport offices. Their working language is Amharic and Tigrigna, respectively. A web-based prototype application has been developed in order to demonstrate the major points discussed in the paper. The system was developed using SQL Server 2008 for backend database, C# Programming Language and ASP.NET Web technology for the front end.

The application is a multi-tier system that consists of the projects listed in Table 1.

We will demonstrate the system using example cases.

Case 1: A user from Tigray transport office requested a vehicle data having a plate number of 02-

84344 from Amhara region database. The response is retrieved from the Amhara Transport database and translated to Tigrigna which is the working language of the requester. The request interface is shown in Figure 4. If the requested record is available, the translated data is displayed as shown in Figure 5.

Table 1: List of Projects and their Description that were used for the Prototyping

Project	*Description*
Presentation	Represents the UI layer of the system. It provides forms that are used for maintenance as well as information request purposes.
Security	Represents the user management and security of the system.
Business	Contains the business logic of the system.
Mapping and Translation	Contains the translation engine which consists of a translation dictionary as well as the logic used to translate information from one local language into another.
Data Access	Contains the data access logic of the system. The component communicates with the different regional databases used for the demonstration.

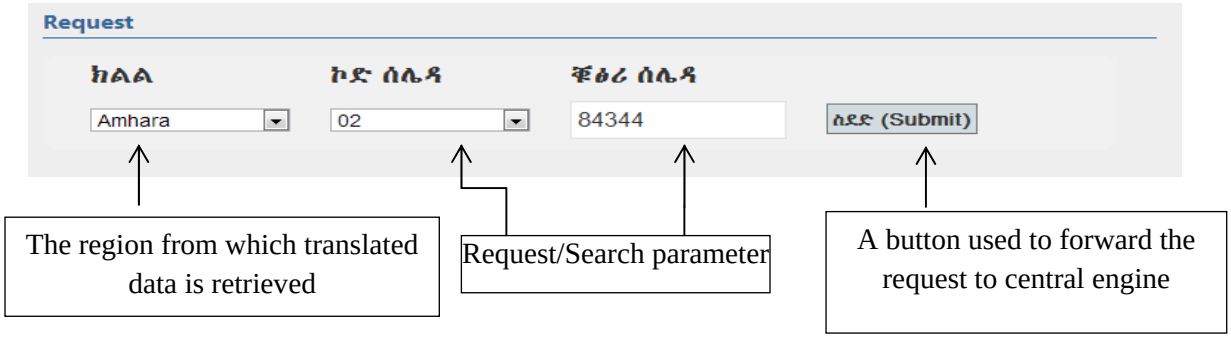

Figure 5: Data Requisition Interface of the Prototype

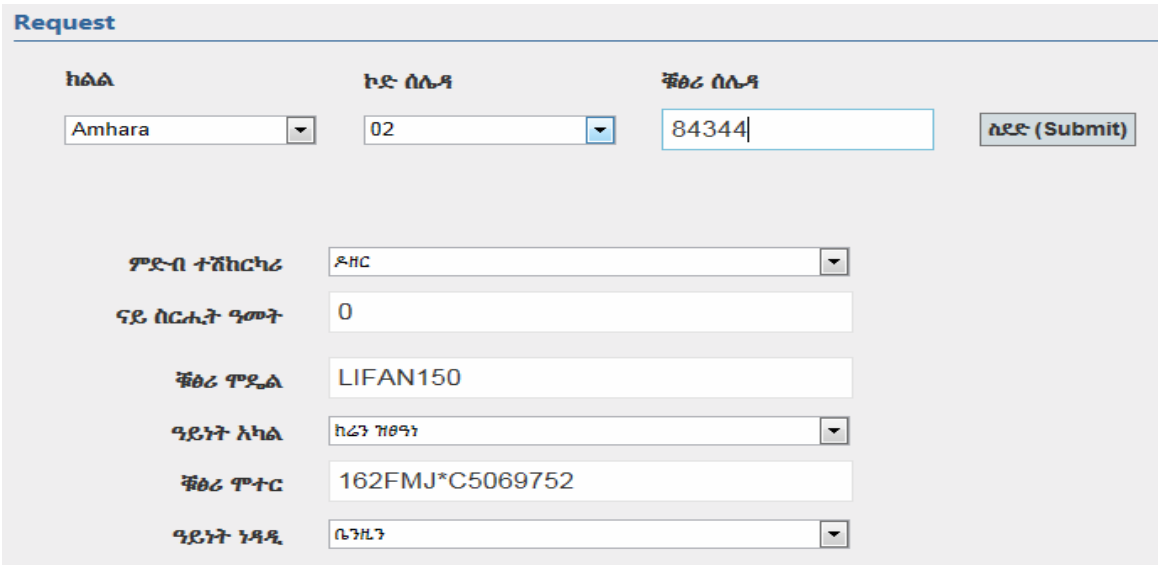

Figure 6: Data Response Interface which Displays Data Retrieved from Amhara Transport Database with Tigrigna Translation

Case 2: A user from Amahra transport office requested a vehicle data having a plate number of 02-A20465 from Tigray region database. The response is retrieved from the Tigray Transport database and translated to Amharic which is the working language

of the requester. If the requested record is available, the translated data is displayed as shown in Figure 6.

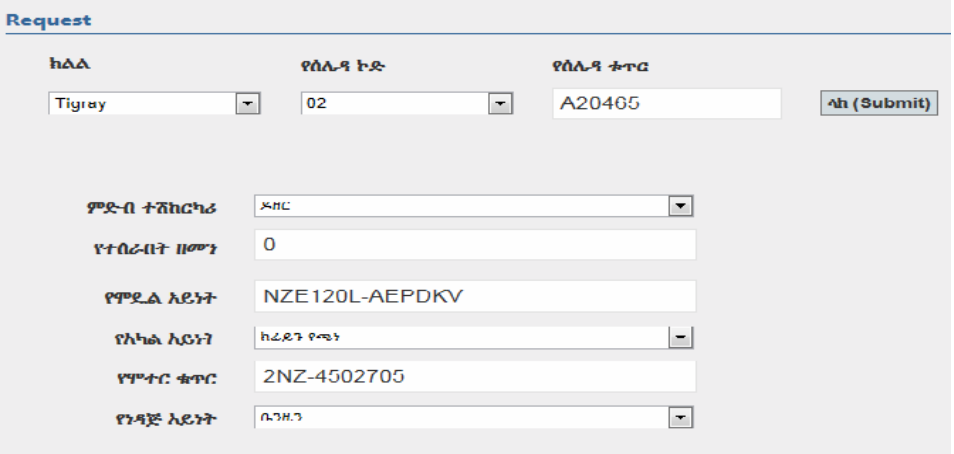

Figure 7: Data Response Interface which Displays Data Retrieved from Tigray Transport Database with Amharic Translation

5. Conclusion

Multilingualism and lack of data standards were found to be problems for road transport offices in Ethiopia since data exchanging activities were facing semantic incompatibility. Due to this the sector is incurring extra cost and time to provide service for citizens. Citizens also face problems to transfer their service file from region to region. Therefore, we have presented a framework for semantic interoperability for multilingual information systems of road transport. It enables users of different languages to exchange transport data with shared meanings. It also enables users to present their data request and get back the data with their preference language. Basically the proposed framework uses central mapping and translation mechanism to facilitate semantic interoperability. In addition it was found that data standard specification is a necessity to be developed by domain experts.

Semantic interoperability is not a binary state that is either present or absent, but rather something that can incrementally improve over time, just as a human's ability to understand English utterance (speech) improves from childhood to adulthood. Therefore, the Interoperability Framework that we proposed will not be expected to be a final one by itself. It will remain a work-in-progress in the future. It will be subject to a continuous consultation process with all transport offices and other stakeholders.

We believe that the solution proposed here will enable different transport information systems to exchange and use basic data understandably without considering language difference. But there are some immediate needs to be incorporated that were not addressed in this work such as exchanging individuals' names with different languages since individuals' names do not need to be translated. They should be used as they are. But the problem is different languages spell names differently.

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