A Methodology of Developing Interoperable Electronic Business in the Transport Sector

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Abstract – **In this paper, we describe a development methodology to achieve interoperability in e-business for different entities in the transport sector. Interoperable e-business is achieved by combining the following methods of B2B (Business-to-Business) integration: information integration, service-based integration and portal integration. The methodology respects diversity of business requirements and constraints in the implementation.**

Keywords – **E-business, B2B integration, Interoperability.**

I. INTRODUCTION

The notion of interoperability, in general, refers to the possibility of two systems to exchange information, as well as to make use of the exchanged information [1]. Traffic and transport systems are heterogeneous systems which share information in their operation. The subject of research in this paper is the definition of the methodology of interoperable electronic business of traffic business systems. The methodology has been based on the combination of the known methods of Business-to-Business (B2B) integration: integration of information, integration on the basis of services and portal integration. The methods of B2B integration have been implemented within the cloud computing environment.

II. THE FRAMEWORK OF ELECTRONIC BUSINESS IN TRAFFIC SECTOR

Electronic business of subjects in the area of traffic should be realized on the following types of relations:

- commercial sector – commercial sector (C-C),
- commercial sector – public sector (C-P),
- commercial sector – Government sector (C-G),
- public sector – public sector (P-P),
- public sector – Government sector (P-G),
- Government sector – Government sector (G-G).

Fig. 1 shows the frame of B2B integrations in the traffic and transportation sector.

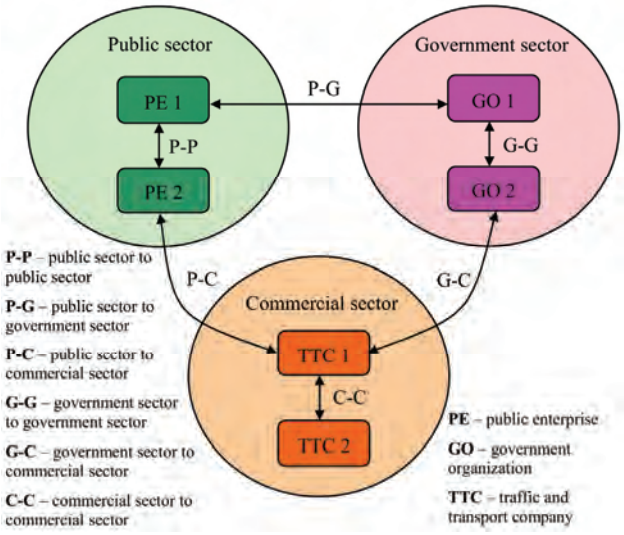

Fig. 1: Frame of B2B integrations i n the transport sector

In defining the legal and institutional frames of integration, two basic types of B2B integrations are distinguished:

- horizontal B2B integrations – integrations of entities which consider the common domain with approximately equal level of abstraction,
- vertical B2B integrations – integrations of entities which consider the common domain with significantly different levels of abstraction.

In practice, during B2B integration of two organizations usually the horizontal and the vertical integration are combined [2]. Depending on whether pure horizontal integration, pure vertical integration, or combined – hybrid integration is meant, also the frames of B2B integration are distinguished.

Horizontal B2B integration is suitable in case of:

- integration of organizations that belong to the same level within the same sector;
- integration of organizations that belong to the same level, within different sectors.

Vertical B2B integration is suitable in case of integration of organizations that belong to different levels within the same sector. Hybrid B2B integration is suitable in case of integration of organizations that belong to different levels within different sectors.

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III. APPROACHES IN THE DEVELOPMENT OF B2B INTEGRATION SOLUTIONS

All the solutions of the B2B integration of traffic-transport business subjects can be classified into three big classes:

- solutions based on the integration of the existing information and applications,
- solutions based on the development of new databases and applications,
- solutions based on the integration of the existing and new applications.

For the solutions based on the integration of the existing information and applications, the "bottom-up" approach is suitable (Fig. 2). The integration of the existing applications requires the development of Web services as required. Therefore, the development of this category of solutions begins with the analysis of the application services. The modelling of application services should result in the definition of the requirements by the applications that can be fulfilled by using Web services.

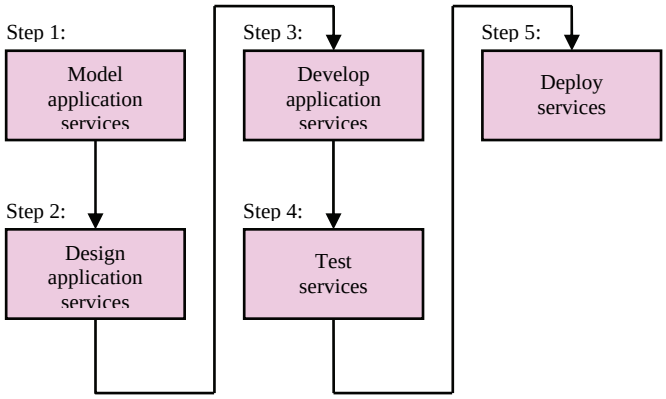

Fig. 2: "Bottom-up" approach

For the solutions based on the development of new databases and applications the "top-down" approach is suitable (Fig. 3).

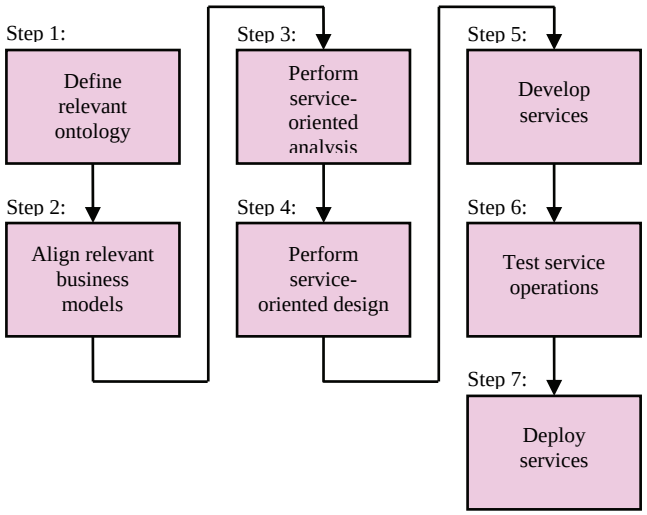

Fig. 3: "Top-down" approach

In this approach, first comes the analysis of the requests and business models of B2B integration subjects. It promotes not only the service-oriented development of the business processes, but also the creation (or harmonization) of the overall business organization model.

This process has been derived from the existing business organization logics, and it results in the creation of a large number of business and application services. The part of the process that has the formation of ontology as consequence, represents the classification of the sets of information processed by one organization. This results in the creation of a common glossary, as well as in defining the relations existing between certain groups of data.

After having established the ontology, the existing business models have to be adapted and harmonized with ontology, and in many cases completely new business models need to be created, for the glossary defined by ontology to be validly represented by the business modelling terminology.

The solutions of B2B integration based on the integration of the existing and new applications are the most complicated ones. For the solutions based on the integration of the existing and new applications the agile strategy is suitable (Fig. 4).

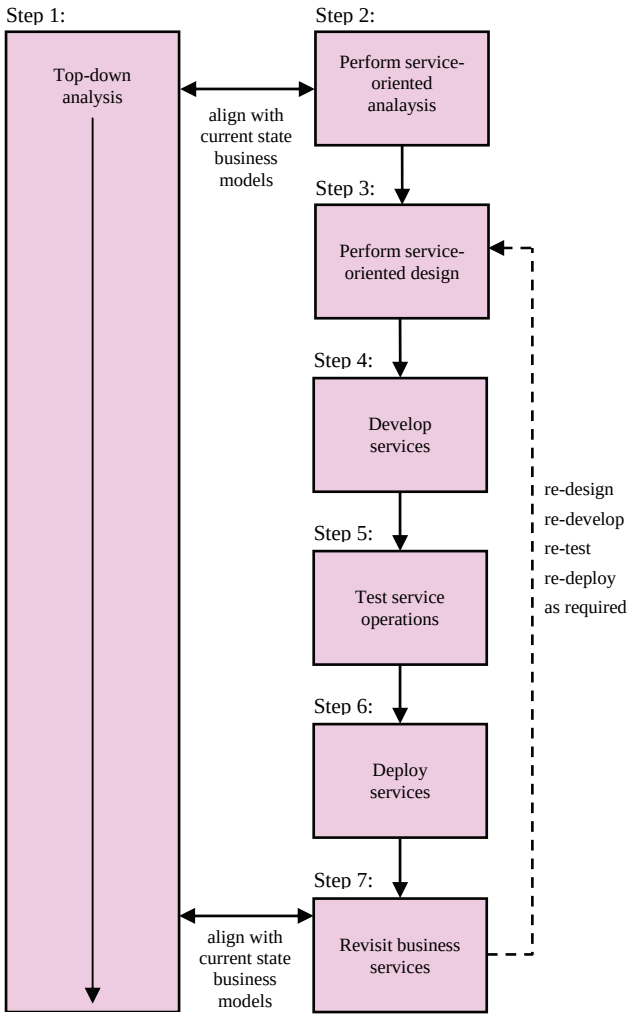

Fig. 4: Agile strategy

In comparison with the previous two approaches, this approach is the most complex one since it has the task to fulfil two sets of opposed requirements. The agile strategy is based on the parallel analysis of the business processes and service development. The biggest challenge is to find the balance in the implementation of the principle of service-oriented design in the business analysis environment. This strategy is also called "meeting-in-the-middle" approach.

The approaches to solving and the development phases are different for the three classes of solutions. Regardless of the class to which the solution belongs, the proposed model of B2B integration means the development of the service-oriented solution in the cloud computing environment.

IV. DEVELOPMENT OF B2B INTEGRATION SOLUTION IN TRANSPORT SECTOR

The essence of the proposed solution lies in the fact that every pair of business systems should select the scenario, or those scenarios of B2B integration which best satisfy their needs, and which are realized on the basis of the following principles:

- the existing databases that are used by the studied business systems, which have a similar structure and purpose, will be integrated into one common base located on the cloud computing platform;
- the Web portal is set on the cloud computing platform and it contains the user interface for updating the common base and for setting the queries over it. The tasks of updating the base will be divided among the studied business systems, in compliance with their jurisdiction and competence;
- the existing applications that are used by the studied business systems, currently operate over local databases set on their servers and generate diverse reports that represent the decision-making support. The proposed solution plans for some of these applications to download in the future the necessary data from the common database from the cloud;
- the existing local applications will download data from the common database which is located in the cloud, using the WCF (Windows Communication Foundation) Data services hosted in the cloud;
- the local databases that have not been integrated in the common base, and whose data the business systems want to share, will be accessed by means of the Web portal hosted on the cloud computing platform;
- the local application of one business system will use the data from the local database of another business system, by calling WCF Data services hosted in the cloud;
- the local applications will be improved by the development of the user interface for accessing the common database in the cloud.

WCF Data services are elegant Microsoft technology for data publishing, either from the database from the local servers or from the databases in the cloud [3]. They may be hosted on local Web servers or on the servers from the cloud. The application which uses the WCF Data service can be Desktop application, Web application hosted on the local Web server, or Web application hosted as a service in the cloud [4].

The phases in the development of the solution of the B2B integration of traffic business systems:

- identification of business subjects that need to be included in the B2B integrations;
- analysis of institutional and business relations between the selected subjects;
- defining of the solution requirement of the B2B integration for every pair of traffic systems that needs to realize the integration;
- development of local ontologies that represent the business domain of every single organization;
- development of the common domain ontology;
- defining of one or several scenarios of B2B integration for every pair of the traffic systems that need to realize the integration;
- defining of mechanisms for the realization of the selected scenarios of B2B integration for every pair of traffic business systems;
- implementation of components that allow the realization of the selected mechanisms of B2B integration;
- analysis of the realization effects of B2B integration for every single traffic business system;
- analysis of the realization effects of B2B integration for the entire safety domain in traffic.

We propose the B2B integration model of traffic business systems which consists of the following components:

- C1 – B2B integration system architecture;
- C2 – development activities of B2B integration systems;
- C3 – software architecture of B2B integration systems;
- C4 – scenarios of B2B integration of traffic systems;
- C5 – methods of B2B integration of traffic systems;
- C6 – time planning of model realization.

Scenarios of B2B integration:

- Scenario 1: local application of one traffic system downloads data from the local base of another traffic business system by calling the service from the cloud;
- Scenario 2: local application of traffic system downloads data from the common database by calling the service;
- Scenario 3: the user accesses data from the common base via user interface of the local application;
- Scenario 4: the user accesses data from the local base via common user interface - Web portal in the cloud;
- Scenario 5: the user accesses data from the common base via Web portal in the cloud;
- Scenario 6: using Web portal in the cloud the user creates queries that are executed over the integrated data which originate from several local databases (Fig. 5).

Two traffic business systems can select even several scenarios of B2B integration [5]. The selection of the integration scenario depends on the nature of the business relations and interdependence of two traffic business subjects, i.e. on the defined requirements of the B2B integration. If there are several B2B integration requirements between two traffic business subjects, the most favourable integration scenario will be selected for each requirement.

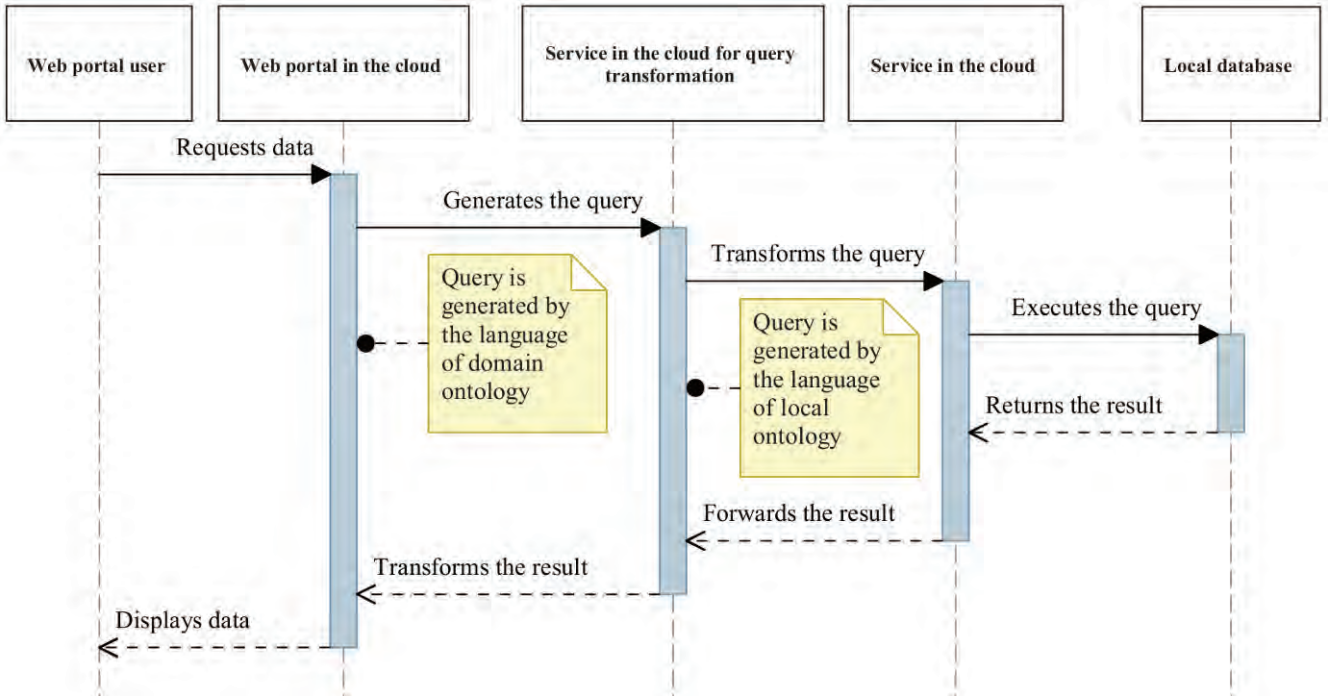

Fig. 5: Diagram of sequences: Scenario 6 of B2B integration of traffic business systems

V. CONCLUSION

The implementation of the proposed solution of B2B integration allows interoperability of the traffic business systems at the level of: data, services, business processes, and operation. The interoperability of data is realized by sharing the information from the heterogeneous sources of data, stored on different machines, under different operating systems, and in different database management systems. The interoperability of the services is enabled by composing different applicative functions to work together, although they had been designed and implemented independently. The interoperability of the business processes has been realized by unifying the service sequences in order to realize a certain business activity. The interoperability of operation has been enabled by the harmonization of cooperation of organizations in the domain of traffic, regardless of the differences in: the decision-making method, working methods, legal acts etc.

The proposed solution exceeds all three categories of barriers to business system interoperability: conceptual, technological, and organizational barriers. The conceptual barriers refer to the syntactic and semantic differences of information that are being exchanged. These problems have been solved by unifying different models of data, used by the studied traffic business systems, into a unique domain data model. The technological barriers refer to the impossibility to connect the information technologies. These problems have been solved by using common standards for presenting, storing, exchange, and processing of data. The organizational barriers refer to the definition of responsibilities and authorities, and they are solved by defining the legal and contractual frame. The common database and the services in the cloud are used in accordance with the pre-determined user authorities. The service-oriented architecture, which is the basis of the methodology, allows the integration of the applications developed on different platforms. It may be concluded that the proposed solution does not require development of new local applications and databases, but rather allows the usage of the existing information systems.

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