Inter-Organization Interoperability in Transport Chains Using Adapters Based on Open Source Freeware

Paul Davidsson[1], Linda Ramstedt[2], and Johanna Törnquist[2]

Blekinge Institute of Technology, Department of Systems and Software Engineering
[1] 372 25 Ronneby, Sweden [2] 374 24 Karlshamn, Sweden
{Paul.Davidsson, Linda.Ramstedt, Johanna.Tornquist}@bth.se

Abstract. The significance of electronic information exchange in transport chains and its influence on the performance of the logistics processes is well-known. While much focus is still on the various techniques for information exchange, many SMEs experience problems that are not primarily caused by an absence of technology. Several advanced solutions exist but investment possibilities within many SMEs are very limited while their needs for electronic data exchange may be very similar as for the large companies. We describe a general "adapter" solution based on open source freeware that make it possible (in principle) for any business system to exchange information with any other business system. It has been successfully applied in a pilot study involving two companies (the transport operator being an SME) using different business systems (Hogia Mobilast and Movex). The solution was evaluated with the result that it met the requirements of the companies and is now planned to be used for future data exchange between the companies.

1 Introduction

A transport chain usually involves a large number of actors, and in order to reach an acceptable level of efficiency it is important to synchronize these actors and their activities. For example, information concerning the status of the cargo needs to be available to the right person, at the right place, and at the right time. Although this is obvious for everyone involved and that advanced technology to collect and distribute information exist, this is seldom achieved. We argue that the main reasons are not due to lack of solutions, but rather based upon difficulties to integrate existing software systems and the high costs associated. Many companies are small or medium-sized enterprises (SMEs) with a limited possibility to invest in the existing solutions, while their needs to perform electronic data interchange to act competitive may not be so much different from those of the large companies. Instead, a large amount of transport-related information, such as bookings and cargo specification, is exchanged manually via fax machines and phone. Problems that arise due to the manual work required are for instance that information may not be accessible at a certain place when needed and also information duplication is complicated. The question that remains to be answered then is; are advanced and expensive systems required to solve these problems, or are there other, simpler and less expensive, solutions?

The project "Transport informatics for increased cooperation between the parts in a logistic chain", also called AIS 42, (`http://www.ec.se/ais/`) focused on this question. The project had a reference group of companies located in, or close to, the city of Karlshamn, Sweden. One of the goals was to show that by using only simple and cheap solutions it is possible to establish adequate electronic information exchange between different actors in transport chains that have different prerequisites and preferences. The overall aim of the project was to develop and demonstrate the use of a common platform where the companies are able to exchange the necessary information between themselves as well as their other customers and suppliers. Moreover, the platform should work independently of the existing information systems and routines used by the different actors.

The project was based on two case studies of which we will focus on one. These were studied in detail and the needs for improvements to support the transport activities were identified. The needs were analyzed and classified into categories such as:

- simplification of transport booking and other administrative activities,
- tracing and positioning of goods and carriers,
- deviation detection,
- support for calculations of environmental load, and
- logging of freight-related data,

all of which require (different levels of) system interoperability. The needs of improvements were ranked based on importance which resulted in a requirement specification for the software platform to be developed. The platform and its functionalities were later demonstrated on one of the transport chain case studies and evaluated. Besides the software platform, the project also generated insights in the problems related to technological aspects as well as organizational issues within the freight transportation industry.

The next section describes related work. Section 3 then describes the solution that was developed to support and facilitate information exchange, while Section 4 presents one of the case studies upon which the project is based. Section 5 provides a discussion of the results and pointers to future work.

2 Related Work

The review includes two parts; related research, in particular projects with similar aims, and existing software solutions available on the market.

2.1 Research Projects

There are a number of projects that have addressed the problem of information exchange and IT solutions for freight transportation. Many of them are projects funded by the EU that focus on how to create solutions and processes for transport mode-independent information exchange that can provide traceability, as well as, a standardized and smooth way to communicate. Some of these projects are:

- INTRARTIP (Intermodal transport real time information platform) [1]
- ITESIC (Integration of technologies for European short intermodal corridors) [1]
- PISCES (Pipeline intermodal system to support control, expedition and scheduling) [1]
- D2D (Demonstration of an integrated management and communication system for door-to-door intermodal freight transport operations) [6].

Other projects focus specifically on traceability and straight-forward combinations of technologies to achieve this for cross-border transportation. Two examples are SITS (Simple intermodal tracking and tracing) [1] and MULTITRACK (Tracking, tracing and monitoring of goods in an intermodal and open environments) [3].

Even though the projects mentioned above and AIS 42 have some issues in common, AIS 42 focus on the particular situation for SMEs. Consequently, usability, simplicity, interoperability, and cost-effectiveness are the primary factors in the choice of technology.

2.2 Existing Technology

Support for electronic information exchange is often found in large business system, e.g., ERP (Enterprise Resource Planning) systems. Such systems often focus on a specific type of company, e.g., a transport buyer or a transport operator. The systems do often have some ability to exchange information with other types of business systems, but this is often limited to a standard set of formats and systems. There exist several off-the-shelf TA (Transport Administrative) systems for storage, synthesis and communication of data, such as Movex (http://www.intentia.com/), Hogia MobiLast (http://www.hogia.se/godstrafik/), and many more. These systems and the other systems that support electronic data interchange have varying characteristics, but all of them require substantial investments both to procure and to use. As a consequence, SMEs are able only to invest in one system, if any at all. This, in turn, makes it impossible to carry out electronic business activities with several companies using different business systems due to system interoperability problems.

One existing solution that meet some of the interoperability requirements is Microsoft BizTalk (http://www.microsoft.com/biztalk/). The main purpose with BizTalk is to facilitate system communication independently of the individual communication formats in the systems by acting as an interpreter between the systems. It is based upon a central server through which all exchanged information pass. It uses XML and supports the main protocols for e-mail and http. However, being a proprietary client-server solution it has several disadvantages, such as, making the actors dependent of third party, being expensive and possible risks for communication bottlenecks.

3 The Adapter Solution

As mentioned in the introduction, some of the most important needs of improvements identified were: simplification of administrative activities, such as, transport booking, tracing of goods and carriers, deviation detection, and calculations of environmental load. Many of these require a complete unbroken process with gathering of data, data processing and information distribution. We decided to focus on the first point that concerns the reduction of usage of fax machines and other manual ways of information exchange (reducing the administrative costs as well as the number of error caused by the human factor) and increase the accessibility of information by making electronic information exchange possible.

Considering the requirement specification, a group of 15 students from Blekinge Institute of Technology developed a software prototype for electronic information exchange. The prototype is built using only on freeware with open source code such as, Java, MySQL, j2ee, jboss etc., and uses state-of-the-art technology like XML and Web services. The prototype provides the possibility for different business systems to communicate and supports information exchange via web portals, e-mail, fax and SMS. The prototype is an information carrying system meaning that the system acts independent on what type of data that is transferred through it.

The basic idea can be seen as a generalization of the well-known *Adapter design pattern* [7] used within object-oriented software engineering. It is also similar to the concept of *wrapper agents* [8] as used within the area of multi-agent systems [9]. To each (legacy) business system an adapter is built that enables the system to interact with other the other business systems in the transport chain. Such an adapter is mainly composed of three parts; a “bridge”, an “interpreter”, and a “message handler”. (See Fig. 1) The Bridge handles the interaction with the business system, and the Interpreter translates the data from the format the sending business is using to the format the receiving business system is using (and vice versa). The Message handler takes care of the communication with the adapters of the other business systems. The bridge typically makes use of the functions for exporting and importing information that most business systems are equipped with. If this is not the case, more sophisticated methods must be used.

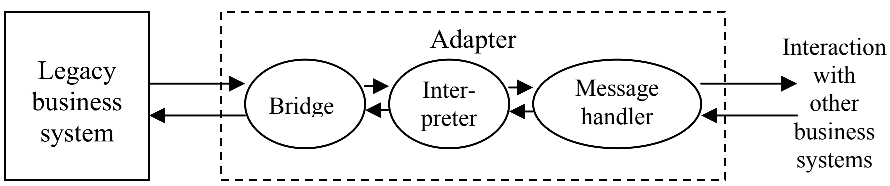

Fig. 1. The structure of the adapter software.

The Adapter prototype software is available as freeware and is relatively easy to install. It is structured as a program that includes general message handling components, and shells for the interpreter and the bridge. Much effort was spent on reusability making it easy to adapt the software to arbitrary business system (at least those that have basic data import and export functionality). Also modifiability was considered and since the software is module-based, extensions of the system are facilitated. The system requires "log in" for usage, and encryption and digital labeling is included to increase the security.

4 Pilot Study

The transport chains that were selected as the case studies of the project are not very complicated consisting of just a few actors and little or no cross-border traffic. The focus is on SMEs based in the region of Blekinge, Sweden, with partly very limited resources for investments in IT but still needs the functionalities to stay competitive. Many of the needs of improvements and opportunities identified in the specific case studies can, however, also be found in many other companies in the transportation business of varying size, nationality and resources.

The transport chain we will focus on here consists of a truck transport carried out by Karlshamns Expressbyrå (KE) containing packaged temperature-sensitive cargo from the production facility of Karlshamns AB (KAB) in Karlshamn to the customers of KAB localized in Northern Europe. KE uses a system developed by SA-data for surveillance and booking. History of cargo temperature stored in the cooling systems in the trucks is made available by TermoKing. During the project, KE decided to start using Hogia Mobilast which is a system that supports the planning of transports since available transport resources can be controlled, transport orders can be administered via the system etc. KAB uses Movex for administration of orders, transport prices etc.

Through interviews the following aspects were identified as important for KE:

- Simplification and speeding up of administration of a transport assignment.
- Control of truck space utility.
- Cargo follow-up during and after transport regarding temperature and time. Deviation detection important.
- Calculation and reporting of environmental impact.

Whereas the following aspects were regarded as important by KAB:

- Delivery time precision (punctuality)
- Status of the cargo regarding deviations, i.e. traceability.
- Simplification and speeding up of the administration associated with transport bookings.

Thus, a common aspect of interest for both companies is to minimize the administration connected to transport bookings, and this is what we decided to focus upon in the demonstration experiment.

The prototype platform was tested by having two different major business systems; Hogia Mobilast and Movex, in two different companies, KE and KAB, interacting via the platform (see Fig. 2). In the demonstration experiments the actual business systems (together with the associated adapters) were executing at the two companies. A number of functionalities were tested. For instance, KAB was able to make transport requests from Movex directly into the Hogia Mobilast system at KE. Similarly, KE was able to confirm the request from inside its system directly to Movex at KAB. Further functionalities include monitoring active requests.

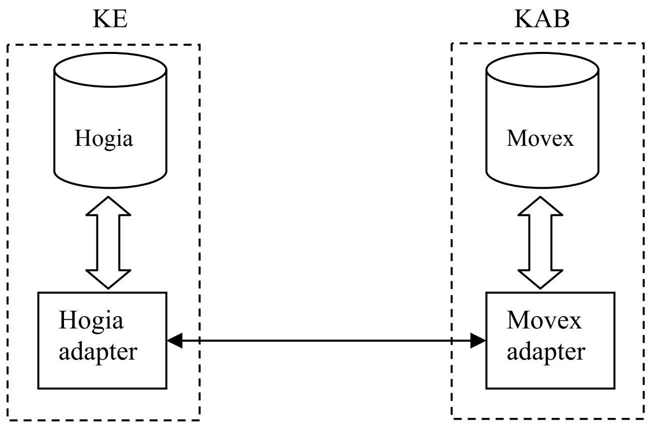

Fig. 2. The setting of the pilot study.

The most complex part of an Adapter is typically the Bridge. As an example, we take a closer look at the Bridge of the Hogia Mobilast adapter which is composed of three threads:

- *Import*, which receives XML messages from the Message handler via a web service client, and saves them as files in the "In" folder.
- *Export*, checks the "Out" folder every fifth minute (this time interval was used in our experiments; it should, of course, be chosen based on the response time requirements for the particular application) and when a new file is detected, it is sent via a web service client to the Interpreter for further processing. When it gets an acknowledgement from the Message handler that the message was successfully sent, the file is moved from the Out folder to a "Sent Orders" folder.
- *Status monitor,* monitors changes regarding the orders that are currently active, by making requests concerning the status of these orders each 20 second (in our experiment) and saves them as XML-requests to the In folder of Hogia Mobilast. It then reads the reply from the Out folder and sends it to Interpreter for further processing.

Bridges for other business systems with import and export facilities work in a similar way.

5 Conclusions and Future Work

An evaluation of the practical relevance and economical gain of the prototype was made and based on interviews of the participating companies. The prototype provides a direct use since it offers cost-effective (due to the use of freeware and easiness of adaptation) and platform-independent communication. Thus, the prototype seems to perform well with respect to attributes such as modifiability and compatibility with several interfaces. These benefits make the prototype useful in several contexts and not only for the project participants. A cost-effective communication solution generates in addition several implicit benefits such a possible reduction of error in documents that are exchanged (due to minimization of manual duplication work) and increased information accessibility.

The economical impacts are more difficult to approximate partly due to that they are long-term effects and partly that they are associated with other factors related to the companies and their adjustments technology-wise. The selection of technology used in the prototype was considered appropriate and in line with their needs and future business plans.

It is hard to create a fully generic communication solution that does not require any adjustments at all. Even our platform requires some adjustments and further development before it can offer a full-scale solution at KE and KAB. We have, however, demonstrated the possibility to achieve basic and sufficient communication functionalities like the large-scale TA systems offer but to a considerable lower cost. This is something that is of significant importance for the survival of smaller actors with same needs as the larger players but with a much more limited investment possibility.

Compared to existing centralized solutions, such as BizTalk, the proposed solution has a number of advantages, e.g., being independent of third parties and avoiding central communication bottlenecks.

We are currently working with applying the prototype to additional companies and business systems. Moreover, we have investigating the possibilities of developing a (or using an existing) ontology so that a common communication language can be used between the adapters. This would significantly reduce the need of developing interpreters, since there for each business system only need to be translation into one language, independent of which business system it will interact with.

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