Towards an Orchestration Architecture for Service Delivery in International Trade

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Abstract. An international trade supply chain consists of businesses that are involved in procurement, manufacturing and distribution activities of products that cross the borders between countries or economic areas. One of the major challenges in international trade is the development of a network structure and collaboration mechanism that can facilitate adaptive, flexible and synchronized behavior in a dynamic trade environment that is both reliable and secure. Businesses that are involved in the international trade network already invest in three ways to realize this. These investments are the development of trust-certifications, the optimization of logistics and terminal operations and the realization of sustainable supply chains by means of traceability. The availability of reliable trade data throughout the supply chain is a prerequisite to realize a reliable and secure dynamic trade environment. In this paper, a service orchestration architecture is outlined that supports businesses in realizing the three improvements while making use of reliable trade data.

1 Introduction

An international trade supply chain is a global network of autonomous or semi-autonomous business entities involved in procurement, manufacturing and distribution activities of products that cross the borders between countries or economic areas [4]. One of the major challenges in international trade is the development of a network structure and collaboration mechanism that can facilitate adaptive, flexible and synchronized behavior in a dynamic environment that is both reliable and secure [5]. Currently, businesses are investing on three key improvements to realize such a reliable and secure trade environment, see e.g. [6]. These investments are: 1) The development of trust-certifications for businesses which are issued for those businesses that are compliant and trustworthy, and where applicable, safe and secure[3], 2) the optimization of logistics and terminal operations by means of synchro-modality, and 3) the realization of sustainable

[3] See: http://customs.hmrc.gov.uk.

supply chains by means of traceability. Synchro-modality concerns the seamless switching between road transport, railway transport and barge transport. The application of synchro-modality not only optimizes the logistic flows, but barge transport is a much cheaper alternative for road transport and causes a reduction of traffic jams and CO_2 emission. Traceability and visibility enable to identify what is happening and what went wrong in the supply chain in case of problems. A reliable and secure supply network should have a specific fundamental property in order to let the aforementioned three key improvements become a reality. This is the property of reliable trade data, which is owned and exchanged between the businesses and government organizations acting in the network to communicate with each other electronically. The aim of this paper is to describe an outline of a layered service orchestration architecture that supports businesses in realizing the three key improvements while making use of reliable trade data. The architecture should contribute to realizing trustworthy businesses, to realize optimalized logistics and terminal operations, and to realize supply chain traceability once its design has been elaborated. This part is explained in section 2. The paper is concluded in section 3.

2 An architecture for service orchestration in international trade

Figure 1 shows an outline of an architecture for flexible service orchestration in the context of international trade. The architecture should enable the exchange of reliable trade data between actors in the international supply chain and mediates between supply and demand for services in that trade network. The architecture makes use of the existing information systems that are already deployed at public and private organizations which interact with each other in a virtual data pipeline. This is shown in the *what*-layer. The 'virtual data pipeline' forms the basis of reliable source trade data that is exchanged in the network. More specifically, this virtual data pipeline that is part of the architecture design exploits the existing infrastructure of organizational information systems and the existing communication interfaces that are already in place which enable those existing systems to interact with each other.

The layer on top of the *what*-layer is the *who*-layer, which consists of *virtual communities* of actors. In this context, virtual communities are those public and / or private organizations that collaborate in a specific part of the international supply chain. For example, exporters of fruit and vegetables operate in the chain of fruit and vegetable trade and communicate with public organizations such as Customs and the Food and Consumer Product Safety Authority. These communities enable the specification of dedicated contexts, and they take care of the service choreography by describing the rules, requirements and capabilities of the involved parties and their 'local' agreements. Not only are these communities transient in nature, the described rules, requirements and capabilities are transient as well. This poses requirements on the way how workflows are structured, because activities, the sequence of those activities and the agents

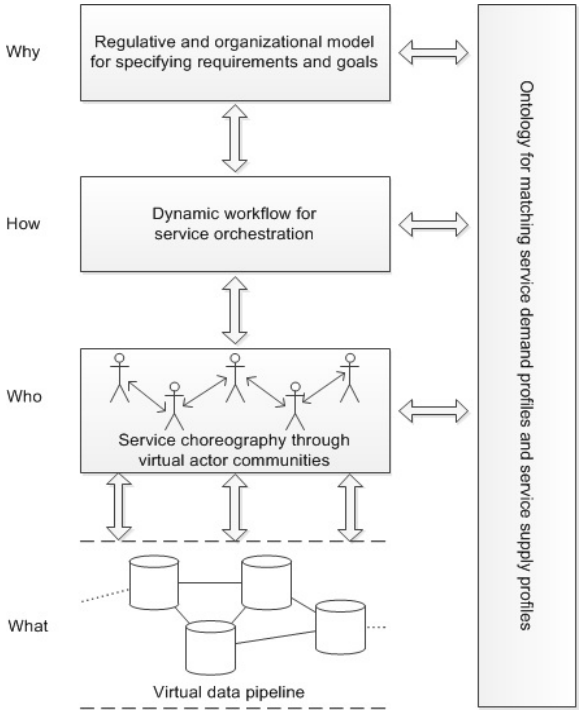

Fig. 1. Outline of an architecture for service orchestration in international trade.

that perform activities are different for each virtual community in the context of international supply chains. Therefore, an adaptive workflow modeling environment is needed for creating these kind of dynamic workflows to realize service orchestration. This is visualized on the *how*-layer of the architecture. Examples of these environments are *Drools*[4] and Yet Another Workflow Language[5], or *YAWL*. The specific requirements and goals that apply for a supply chain in which a virtual community of traders and public organizations operate can be derived from the regulative and organizational model which describes this. This is shown on the *why*-level. On this level, the OperA modeling language [2] is an example of a suitable language for modeling these chain-specific requirements and goals for each possible chain, as it is based on formal foundations and a well-defined structure for specifying roles and dependencies.

The final part of the architecture that needs to be explained is the ontological part. Traders in the international supply chain need services for various reasons, for example, selecting a suitable freight forwarder for physical transportation of goods, the fulfillment of export declarations or the reporting of dangerous goods. Service providers have services on offer that these traders might want

[4] See: `http://www.jboss.org/drools`.
[5] See: `http://www.yawlfoundation.org`.

to use. In the architecture, the *descriptions* of services that organizations have on offer are specified in an ontology language that can also be interpreted by traders participating in the chain. A comprehensive approach to create such an ontology is presented in e.g. [1]. In order to match service supply descriptions with the requests for services, there should also be service demand descriptions that are created by the traders themselves while using the same ontology. These descriptions are dubbed *profiles*. Profiles are used for service matching, as a service demand profile and a service supply profile are semantic descriptions of what traders need in terms of services and which service providers have matching service supply profiles. Dependent of which service supply profiles match a service demand profile, it can be determined which service providers are able to deliver the appropriate services from which traders can choose to make use of.

3 Conclusions

In this paper, an outline of an architecture for service orchestration in international trade has been presented. This architecture should enable the exchange of reliable trade data between actors in the international supply chain and mediates between supply and demand for services in that trade network. The architecture makes use of the existing information systems that are already deployed at public and / or private organizations which interact with each other in a virtual data pipeline. The research methodology that forms the basis for further elaboration of the design and its evaluation will be a design science methodology (see e.g. [3]). Design science is aimed at creating technological artifacts that serve human purposes, which is in contrast with natural science which is aimed at trying to understand reality. Its technology-oriented results are assessed against criteria of value or utility, and it is determined if they actually work or improve the old situation. The artifact in our study is the design of the orchestration architecture applied to international trade.

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