A Web-Based Data Pipeline for Compliance in International Trade

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Abstract. With increasing flows of containerised traffic and growing emphasis on (national) security, businesses and government are struggling to find efficient and effective means to ensure full supply chain control and security. In order to realize reliable and secure global trade, government agencies and businesses have to cooperate. Businesses are already investing in three ways to realize this goal: acquiring the Authorized Economic Operator (AEO) status to prove that a business is compliant and trustworthy, the optimization of logistics and terminal operations by means of synchro-modality, and the realization of sustainable supply chains by means of traceability and visibility. A Web-based IT infrastructure that enables the seamless integration of all data elements from all the different sources in the supply chain is dubbed *integrated data pipeline*. The focus of this paper is to explain a conceptual model of such a pipeline together with an analysis of the stakeholders involved in such a pipeline in international trade.

1 Introduction

An international trade supply chain is a global network consisting of autonomous or semi-autonomous business actors involved in procurement, manufacturing and distribution activities of products that cross the borders between countries or economic areas. One of the major challenges for supply chain management is to

develop a network structure and collaboration mechanism that can facilitate adaptive, flexible and synchronized behaviour in a dynamic environment that is both reliable and secure [1]. However, researchers are still in the early stages of investigating the general principles that govern the birth, growth and evolution of international trade supply chains. Currently, businesses are investing in three key improvements to realize a reliable and secure trade environment, see e.g. [2]. These investments are the achievement of the Authorized Economic Operator (AEO) status, the optimization of logistics and terminal operations by means of synchro-modality, and the realization of sustainable supply chains by means of traceability. An AEO is a status awarded by government to a business involved in the international supply chain which has proved themselves to be compliant and trustworthy, and where applicable, safe and secure[1].

Synchro-modality concerns the switching between road transport and barge transport. The application of synchro-modality optimizes the good flows, which has several benefits. For example, if certain goods can be transported by barge instead of by truck, this is cheaper and reduces traffic jams and CO_2 emission. Finally, goods traceability and supply chain visibility enables businesses to monitor what is happening and identify what went wrong in the supply chain in case of problems. These big investments made by companies in the supply chain are necessary as the current situation in international supply chains is often very complex and unclear. They are aimed to deal with this complexity and to improve supply chain visibility.

However, to realize these goals, the same *reliable* trade data is required. Data reliability can be improved by capturing data at the source and using this original data throughout the chain. In international trade, these sources are either the consignor or the consignee. The term consignor is a more generic term for seller and the term consignee is a more generic term for buyer. The terms consignor and consignee will be used in the remainder of the paper. The actor who knows what is being sent into the supply chain is the actor who ‘packed the box’, i.e. *consigned* the goods. The consignor holds the key to the majority of the information that is needed to improve supply chain visibility, which benefits both buyer and seller.

Apart from the businesses in the supply chain, also government agencies can use this data to realize their goals better, such as improving global security through visibility. In current practice, the consignor is outside the jurisdiction of the importing country’s authorities and therefore those authorities turn to the carrier and the importer for information about the goods instead. Unfortunately, information held by the carrier is not always accurate. It starts with the packing list, if that contains wrong or incomplete information, or is not used or hidden from view, then the transport documents such as way bills and the manifest are likely to be inaccurate [3]. A way bill is a consignment note referring to a receipt issued by a shipper for goods and an

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

evidence of the contract of carriage[2]. The contract of carriage is a contract between a carrier of goods and the consignor and consignee. Contracts of carriage typically define the rights, duties and liabilities of parties to the contract. A manifest is based on the way bill and contains all relevant data related to the transport, such as the type of transport and the status of the goods (communal or non-communal). Non-communal goods are under the supervision of customs, whereas communal goods are not. The actor that packs the container knows what is in it. As a result, the document containing most information about a specific shipment is often the way bill.

A genuine and complete packing list that starts at the consignor plays a key role in minimizing risks such as safety, security, legal compliance and commercial risks. To ensure that the documents contain reliable data on the consignment, it is important to include the *Consignment Completion Point* (CCP) as an additional waypoint to the supply chain [3]. This waypoint is located at the point of container stuffing or *consignment completion* and at that point a full set of accurate data can be provided. The consignor needs to ensure that the order of the buyer matches the packing list, which in turn matches the invoice. The packing list should match the shipping note that matches the contract of carriage that matches the way bill that feeds the manifest. If the packing list is wrong then they are all wrong, which may harm the interests of all the parties involved [3].

Information elements upstream in the supply chain (e.g. the purchase order, an accurate description of the actual consignment, and incoterms) need to come together at the CCP to be verified between the consignor and the consignee [4]. At that point everything relevant to the consignment entering the international trade supply chain for export, transport and import takes on a legal status. If the full amount of data relating to the goods and the consignor and consignee required by Customs and other regulatory agencies for an export declaration is provided electronically at the CCP, this complete and accurate data can be used for advanced risk profiling. This involves Customs in the exporting country and Customs in any transiting or importing countries and the country of the final destination. The seamless integration of all data elements from all the different sources in the supply chain at the CCP can be realized by means of a Web-based IT infrastructure dubbed as an *integrated data pipeline*.

In this paper we explore the concept and issues of a seamless integrated data pipeline and discuss the stakeholders involved in such a pipeline. The paper focuses on the relationships between the pipeline concept and the stakeholder setting. Therefore, the paper is further structured as follows. Section 2 shows the conceptual model of a seamless integrated data pipeline. Section 3 introduces the identified stakeholders of the pipeline. The issues that stakeholders have in their current situations showing the necessity for an integrated data pipeline are mentioned in section 4. Section 5 shows the stakeholders that enable the realization of the pipeline

[2] See: http://en.wikipedia.org/wiki/Waybill.

and relevant standards for electronic data provisioning in the pipeline are mentioned in section 6. Finally, conclusions are presented in section 7.

2 A Conceptual Model of a Seamless Integrated Data Pipeline

A fundamental property that a reliable and secure supply network should have is *reliable trade data*, which is owned and exchanged between the businesses and government organizations acting in the network to communicate with each other electronically. According to Brodie [5], data reliability is a (statistical) measure of the extent to which a database can be expected to exhibit the externally-observable structural properties specified for a database. The process of establishing data reliability, *validation*, involves checking that database values obey the properties defined in the schema [5]. For example, the answer to the query "*what is the Movement Reference Number (MRN) of a shipment?*" can be validated against the format for an MRN. The MRN is a unique number that is automatically allocated by the customs office that accepts a customs declaration. Fig. 1 shows a model of a Web-based data pipeline that enables the seamless integration of all data elements from all the different sources in the supply chain at the CCP.

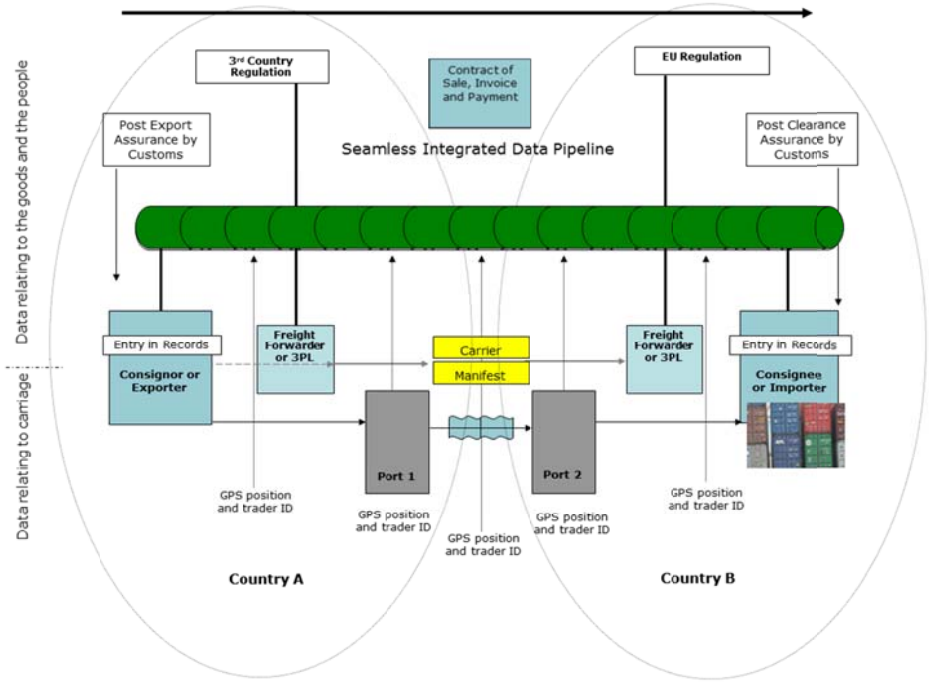

Fig. 1. A seamless integrated data pipeline, adapted from [3].

The figure shows what kind of shipment data is exchanged in the supply chain during transportation. The international contract of sale, agreed between the buyer and the seller before the goods are consigned, should contain all the relevant data about the goods and the parties, the terms and the planned movement of the goods. The consignor makes an entry in its records containing the necessary and accurate data about the shipment fed by the packing list which should match the purchase order and invoice. This precise data is forwarded to the freight forwarder or a third-party logistics provider (3PL). With which parties the data may be exchanged from a legal perspective is determined by legislation at the national level, EU level or federal level dependent of the country in which the goods move. The pipeline concept draws upon Radio Frequency Identification (RFID) technology for localised tracking of goods at unit, pallet, consignment and container levels. It also draws upon Global Positioning Systems (GPS) to track consignment and containers, where appropriate and cost effective, as well as the tracking of vessels carrying containers through the coastal Automated Identification System[3] (ShipAIS) and the Long Range Identification and Tracking system[4] (LRIT). The pipeline model shows that all other destitutes of the shipment data get the original shipment data from the consignor; it is not altered by someone else. This includes the planned port of departure, port of arrival, the carrier with the manifest, Customs and the consignee.

In the data pipeline, a difference is made between data that is related to goods and people, and data that is related to the carriage itself. When sharing data in the pipeline, actors can make this distinction. The benefits that the business world will have with such a pipeline are twofold. For a customs declaration, the right data should be gathered and assembled before a customs declaration can be submitted. With a pipeline, it is easier to gather the complete and accurate data at the CCP. Furthermore, it requires less message exchanges between businesses and government in order to complete a full declaration. Both benefits potentially save time and money and can as such be seen as commercial benefits. These kind of commercial benefits should be clear for the business world for successful adoption of the data pipeline. Without clear commercial benefits it will be difficult if not impossible to motivate the business world to use the data pipeline for data exchange in international trade.

3 Stakeholder Analysis

The implementation of a Web-based, seamless, integrated data pipeline is a complicated endeavour, both from a technical point of view and from many other perspectives, including strategic, organizational, political and cultural viewpoints.

[3] See: http://www.shipais.com.
[4] See: http://www5.imo.org/SharePoint/mainframe.asp?topic_id=905.

Moreover, a large number of stakeholders from different organizations are involved in developing and using the data pipeline. Two scenarios for analysing the stakeholders of the pipeline model can be distinguished, see e.g. [6]. These are the *market-driven* approach by commercial companies and the *market-facilitating* approach by public administrations. In the context of the pipeline model, these public administrations include national government organizations such as Customs and ministries, European bodies like the European Commission's Taxation and Customs Union Directorate-General (DG TAXUD), international bodies like the World Customs Organization (WCO) and the United Nations (UN).

These public administrations can be viewed as *institutions*, i.e. complex social systems. Institutions are the facilitators of innovation in the market [7]. Successful institutions are learning organizations, able to adapt to knowledge and to network. They form alliances and partnerships that result in robust supply chains, whether political, economic, environmental, or social. There is a need for closer real-time collaboration between customs administrations and between Customs and business in facilitating legitimate trade and undertaking customs controls. This global customs network can be created in partnership with the various stakeholders of the public and the private sectors in support of the international trading system[5]. The vision of this network implies the creation of an international e-Customs network that will ensure seamless, real-time and paperless flows of information and connectivity that is realized by the creation of the data pipeline.

Yet the patterns of innovation and the paths to innovation are uneven across sectors and nations, as is described in [7]: "Some Asian countries, such as Japan and Korea, tend to be mission-oriented in their science and technology policies. Some, like members of the European Union, approach innovation from a regulatory and social distribution point of view. Others, like the US - because of their scale and scope and because of their culture of individualism and entrepreneurship - tend to be mixed but focused. Institutions are steered and positioned through governance" [7]. Successful institutional governance requires an understanding of the management of knowledge, but first it must understand the institutional context and value of knowledge.

The market-driven stakeholder approach concerns the stakeholders that benefit from a seamless integrated data pipeline in international trade, which is aimed at minimizing complexity in trade and logically linking the parties involved. Stakeholders that can be identified from a market-driven approach range from the seller/consignor to the buyer/consignee and include the economic operators in-between. These actors include inland carriers, forwarders, shipping agents, sea terminal operators, Customs, inspection authorities and port authorities. These actors

[5] See: http://www.gs1.org/customs.

play a role in both the exporting country and the importing country. Between the countries (at sea) the shipping line is an important actor [8].

In a market-driven approach to the development of an integrated data pipeline, a number of stakeholders can be identified in supply chains for international trade in the Netherlands. This can be illustrative for what could happen in other EU countries and shows which stakeholders are involved in the implementation of a Web-based, seamless, integrated data pipeline for international trade. The following stakeholders play a key role:

- Sea carriers;
- Container terminals;
- Freight forwarders: freight forwarders usually take the responsibility for planning, arranging as well as optimizing shipments [9]. By using the co-loading shipment method, which means filing various goods into a container, different shipments for customers can be handled effectively;
- Providers of Port Community Systems (PCS): a PCS enables all the links within a logistics chain of a seaport or airport to efficiently exchange information with one another [10];
- Providers of the e-Government infrastructure: these are a national message broker, or a single window IT infrastructure to public service providers so that citizens and businesses can conduct electronic business with them;
- Large consignors or consignees: these parties manage most of their supply chains by themselves or have much intra-company transfer. They may use the pipeline to interact with other organizations in the chain;
- International standardization bodies: important standardization bodies in the context of international trade include e.g. WCO, UN/CEFACT and GS1.

Based on their role in the stakeholder network, stakeholders may contribute to enabling an integrated data pipeline, benefit from its realization or may have both properties. Subsequently, the roles of the aforementioned stakeholders in the network are discussed and the issues they currently have. The way the supply chain is managed nowadays is costly for many parties and improving the supply chain visibility is in the interest of the commercial parties.

4 Stakeholder Issues

The stakeholder issues showing the necessity for an integrated data pipeline for international trade are illustrated by means of three examples. The first example is about the relationship between the freight forwarder and the shipping line. Typically,

the freight forwarder is reluctant to share consignor's data with a shipping agent (e.g. an agent of Maersk), because then the shipping agent could directly approach the consignor and offer rates that are lower than the ones of the freight forwarder, and then the shipping line could become a potential competitor of the freight forwarder. Since the data pipeline would provide data visibility to all involved parties, this has to be addressed in order to obtain commitment from freight forwarders for the data pipeline. This is a typical example of a market-driven stakeholder issue.

The second example is that the data pipeline has the potential for synchro-modal logistics. At present, containers with fruit arrive at the Port of Rotterdam and then almost all containers are shipped to the hinterland by road transport, because normally fruit is a perishable good that has to be shipped as quickly as possible. Road transport is expensive and causes substantial CO_2 emission, which is unwanted by companies and citizens. However, some fruit types like bananas do not need to be shipped as quickly as possible. Bananas are plucked unripe and ripen during transport. If it would be known which container at the Port of Rotterdam would contain which fruit type, a choice could be made to ship containers with bananas and fruits with comparable characteristics by means of barge transport. Barge transport is much cheaper than road transport and causes a reduction of traffic jams and CO_2 emission. It is estimated that road transport of vegetables and fruit can be diminished by 50 percent. With the ICT innovation to track individual products, the Port of Rotterdam and Schiphol have this synchro-modal capacity at their disposal and it can be used to reduce traffic jams and CO_2 emissions.

The issue is which party will provide this service. This synchro-modality is only possible if very accurate data about cargo is available real-time in the port of Rotterdam. Traditional trade - based on bill of lading and manifest - are far too inaccurate for this. The data pipeline provides precisely this type of real-time accurate data. Potentially, with the data pipeline, each of the following stakeholders could have access to the data that is required to provide synchro-modality services: container terminals, providers of PCSs, and freight forwarders. The decisive factor is the market share that each of these parties has, which implies the share of data they can see in the data pipeline. If the PCS provider has most of the companies, then they are best positioned to provide synchro-modality. If the container terminal has most of the companies, then they can do it.

The third example shows how this market-driven development interferes with a market-facilitating approach in the case of public-private parties such as PCS providers or national message exchange infrastructures. PCS providers typically have been primarily funded directly or indirectly by port authorities and/or the government. Often this funding is indirect because the government is making it mandatory for companies to use this infrastructure to send them their government related data such as the customs declaration. So, legally, it is an independent commercial company, but its funding is secured by government requirements. However, with the on-going trend

that governments require them to become more financially self-supporting, PCS providers are currently investigating their opportunities for developing new value-adding services that they could offer to the market, and that could generate more revenues.

One profitable option would be if they become data hubs that could provide synchro-modality. But if they offer this, then they become competitors of container terminals or freight forwarders in the area of synchro-modality. Very similar issues are arising for national data exchange infrastructures. Typically, they are funded and operated by the government, but if governments decide that they should become financially more self-supporting, then they also have to look for new value-added services. Since they would also have access to the data pipeline, they also could aim for providing synchro-modality services. However, this might conflict with their public role. For example, in the Netherlands the Supd@x functionality in a message broker called Digipoort is combining data intended for different government agencies. According to privacy regulation, they are allowed to combine these data as long as it is only used by government agencies. They are not allowed to combine these data for commercial purposes. Hence, national data exchange infrastructures have to balance very carefully between their public and private roles. The broader issue here is on the division of roles and responsibilities between government organizations, businesses and intermediaries.

So, a key issue here is whether governments are willing to secure the funding of national data exchange infrastructures, or whether they require them to become financially more self-supporting with new commercial services. In this way these three examples show how market-driven issues are shaped by a market-facilitating approach by public administrations.

5 Stakeholders enabling an Integrated Data Pipeline

Next to stakeholders that may benefit from using an integrated data pipeline, there are stakeholders that enable such a pipeline. Portbase is a stakeholder that offers the PCS for the Port of Rotterdam. Next to Rotterdam, the Port of Amsterdam also relies on the PCS offered by Portbase. Specific functionality to improve information exchange between private organizations in the supply chain and Dutch Customs that Portbase will offer includes for example the automated indication of differences when comparing different export declarations leading to an improved risk profiling by Customs. At this moment, Portbase has commercial relationships with carriers and stevedores that use the PCS for data transactions necessary to channel shipments through the ports of either Rotterdam or Amsterdam. This is different in the case of freight forwarders, from which Portbase does not have a commercial advantage yet, which can change in the near future and provides commercial advantages for

Portbase. On the contrary, the expansion project 'Maasvlakte 2' might prove less of an advantage for Portbase. Maasvlakte 2 is an initiative to expand the Port of Rotterdam by 2.000 hectare, which means a port increase of 20%. After completion, the Port of Rotterdam will measure 12.000 hectare. The Maasvlakte 2 project will attract new container terminals to the port. Currently, 70% of all shipments in the Port of Rotterdam is handled by the Europe Container Terminals (ECT), which is a member of the Hutchison Port Holdings (HPH). Due to the arrival of competing container terminals their share might shrink to about probably 45%. If this happens, it will also affect the operations run by Portbase as their operations are tightly coupled with those of ECT.

Next to Portbase, there are many other companies that provide logistics services on a global level that are also related to customs clearance. For instance, a company like the Kuijken Logistics Group (KLG)[6] offers full customs and documentation facilities for businesses. Clients can rely on the company to undertake all the paperwork related to importing and exporting goods. The KLG customs specialists ensure that goods are correctly and securely cleared. This involves the preparation of documents, calculation of taxes, duties and excises, giving advice on specific requirements, facilitating communication with authorities, etc. Using the KLG customs clearance services businesses can avoid costly delays or seizure of the goods, exposure to error or omission, and save time. A global clearance service offered to businesses has as additional advantage that businesses do not need to use a local PCS for each country through which their goods flow. Another example of a provider of logistics services is the company MIC Customs Solutions[7]. The clearance service provided by this company is a standard customs solution on a single technical platform that supports more than 40 countries. It enables the automated creation of import and export declarations to leverage and seamlessly convert one country's customs export clearance into another country's customs import clearance, streamlining inter-company shipping processes. The system also allows quick electronic transfer of data to third parties like brokers and carriers. This prevents the re-keying of data, eliminates mistakes, reduces costs and increases compliance. Now that it is clear that there are various companies providing PCSs that businesses can use for customs clearance services it should also be mentioned that the government does not have the intention to make the use of a specific PCS for customs clearance mandatory for companies. Global players might even want to use a PCS of their own preference, which can differ from a PCS that is used locally.

Digipoort, the Dutch IT infrastructure for e-Government, is an 'electronic post office' to facilitate message exchange between businesses and government. In fact, Digipoort simply functions as a router for electronic messages that businesses need to

[6] See: http://www.klg-logistics.com.
[7] See: http://www.mic-cust.com.

send to public parties. An extension of Digipoort is called 'Supd@x'. Supd@x offers intelligence to interpret the data from the B2G message interactions and determines which data is relevant for which governmental organization. This also includes additional status information. For example, for a specific way bill additional insight might be provided for all public authorities involved, such as insights in which public authorities have acquired data related to that way bill and if there are public authorities that have already accepted or rejected received messages that are based on data related to a specific way bill. However, the current estimate is that it might take a few more years before Supd@x is fully operational as an extension to Digipoort.

A significant question related to stakeholders enabling a pipeline is which stakeholder(s) is / are actually going to manage an integrated data pipeline once it has been realized. The notions of data *ownership* and data *custody* will then come into play, as for successful data management the owner of the data should be known to the managing party as well as who has data in custody, i.e. which party has which data stored in their company databases. On a global scale, it can even be expected that several data pipelines like the one proposed in this paper exist that may be interconnected with each other and managed by separate parties. One of the reasons that this may happen is because countries involved in the realization of a worldwide data pipeline may not trust each other, resulting in separately managed but interconnected data pipelines. Also, public authorities will have a hard time trusting private parties to manage the data pipeline, because public authorities will not trust private parties to manage data that is owned by those public authorities. For this reasons it could be helpful if international institutions such as the WCO or UN would play a neutral trusted third party role in the management of the data pipeline as a neutral and trusted public institution.

6 Standardized Electronic Data Provisioning

Standardization bodies that offer standard languages tailored to the needs of message exchange in international trade include e.g. WCO, UN/CEFACT and GS1. There are different possible approaches to standardize electronic data provisioning. This can be illustrated by the different approaches as applied by GS1[8] and Descartes[9]. GS1 is an international not-for-profit association dedicated to the development and implementation of global standards and solutions to improve the efficiency and visibility of supply chains globally and across multiple sectors. The standardization approach as applied by GS1 concerns the provisioning of standards of which the intention is that these standards are used globally by everyone involved. For example,

[8] See: http://www.gs1.org.
[9] See: http://www.descartes.com.

the standard barcode is the best example of a GS1 standard which is used worldwide. However, this approach differs from that of Descartes. Descartes runs a Federated Global Logistics Network (GLN) that is a shared services environment based on standardized business processes used by organizations to manage global logistics and trade processes. Descartes offers translation modules, which still enable businesses to use their own message standards but by making use of these modules messages in different standards can still be exchanged if a receiving party makes use of a different standard than the sending party. The way how standardization efforts are approached is also an important matter in the context of the data pipeline as this will have consequences for the way how stakeholders communicate with each other by means of the pipeline. Based on the approach as applied by GS1, every stakeholder will then have to adopt one set of uniform international standards, while an alternative approach as currently applied by Descartes will imply that the data pipeline should offer translation modules between messages that are based on different standards.

The World Customs Organization (WCO) is a notable standardization body in the context of international trade that has adopted the view of UN/CEFACT as laid down in UN Recommendation 33[10] and stresses the importance of a standard data set that will meet governments' requirements for standardized message exchange in international trade. In this respect, WCO has developed the WCO Cross-Border Data Model Version 3. The special feature of Version 3 is that it incorporates all the trade data message standards from the Core Component Library (CCL) that has been developed by the UN/CEFACT group. CCL is an extended version of what is known as Electronic Data Interchange (EDI) message standards. Based on this data model, EDI messages and XML Schemas have been defined, both for communication between cross-border regulatory agencies and for declaration of all types of cargo movements, including incoming, outgoing, import, export and bonded warehouse type of movements.

The WCO data model not only supports all types of declarations to government authorities, but also the Standards to Secure and Facilitate Global Trade (SAFE) framework of standards developed by WCO, the International Maritime Organization (IMO) Facilitation Committee (FAL) and the Safety of Life at Sea (SOLAS) conventions for sharing all maritime vessel movements data with all authorities as required for the Maritime Single Window and other relevant conventions for air and road transport, and transport of dangerous cargo. EU member states with water as a border need to have a maritime Single Window. This requirement has been initiated by the European Commission's Directorate-General of Mobility and Transport (DG MOVE). In the Netherlands, the Ministry of Infrastructure and the Environment is responsible for the Dutch Maritime Single Window. The objective of such a message interface or window is that whenever a vessel enters the European waters, the first

[10] See: http://www.unece.org/cefact/recommendations/rec33/rec33_trd352e.pdf.

port of call of that vessel has to distribute all relevant information according to IMO/FAL recommendations regarding vessels to its authorities and other ports of call of that vessel. These IMO/FAL regulations relate to the vessel, the crew, waste management by the vessel, passengers and cargo.

PROTECT[11], an EDI-based standard for dangerous goods declarations to port authorities is already part of this functionality. WCO states that the IMO/FAL functionality is supported by the WCO Data Model version 3. It is not yet clear if all procedural interfaces derived from this data model will also support this functionality and whether they can be applied differently for other stakeholders than Customs. The data about the vessels come from the European Maritime Safety Agency (EMSA), while the data concerning cargo comes from National Customs offices of country of the port of call. These data are brought together in the Maritime Single Window. For EMSA it is relevant which substances are on board of a ship, especially in case of an accident. Ultimately, data that is required by national governments according to EU legislation should be brought together within an EU-wide Maritime Single Window but that is a goal for the near future.

Besides the standardization bodies national governments themselves have launched programs for standardization of B2G and G2B message exchange. More specifically, the Dutch government has launched such a program called the Standard Business Reporting (SBR) program, which is discussed hereafter. The deployment of a global Service-Oriented Architecture (SOA) provides a solution to enable electronic data provisioning at the Consignment Completion Point (CCP) for international trade. An illustrative example of a related SOA-based approach to organize data integration in the context of agri-food can be found in [11]. SOA is a software architecture where functionality is grouped around business processes and packaged as interoperable Web services. (Web) services are loosely coupled with operating systems, programming languages and other technologies which open up Web services. The services are in fact functions that are distinctly separated and that are made accessible over an IT network to be combined and reused in the production of business applications [12, 13]. SOA enables the definition of components with standardized interfaces, a central repository of published web services and standardized procedures for selection and implementation of components. Thus, SOA-based information systems decouple the process, application services, data sharing and technical infrastructure [11].

The communication between Web services is realized by passing data from one service to another, or by coordinating an activity between two or more services. Service providers publish Web services in a service directory, service requestors search in this directory to find suitable services, bind to that service and then use it [13]. In other words, SOA provides the technology that enables real-time provisioning

[11] See: http://www.smdg.org/jsp/protect.jsp.

of data at the CCP. SOA is widely acknowledged as the de facto standard for data integration. SOA is chosen as the backbone technology of the pipeline's technical architecture. Such a technical architecture based on SOA consists of three layers [13]: Firstly, a *business process management layer* is included, to coordinate the execution of business services. Secondly, a *business services layer* is included, to deliver information services to the business processes. An example of an information service is a service that delivers relevant data from an entry summary declaration for customs to decide about clearance of the container, which is required by customs as they can only decide about container clearance after the reception of this data. Thirdly, a *business application layer* is needed, to execute the application logic and data storage.

A key for realizing a global SOA for electronic data provisioning at the CCP is a standardized, uniform means to describe, offer and discover data that are used for interaction [14]. This means that data sharing standards are a prerequisite. One of the most widely used set of standards that is tailored for data sharing in international supply chains is offered by GS1 and is called EPC Global[12]. The definition of EPC Global standards is still an on-going process. What is available are specifications for Radio-Frequency Identification (RFID) tags and readers, standards for storing and sharing Electronic Products Codes (EPC) event data in EPC information services (EPCIS) repositories and an EPCIS discovery service to search EPC related data across the EPC network [14]. The EPC Global standards are open, vendor-neutral, standards ensuring that the SOA based on EPC Global standards will work anywhere in the world on heterogeneous hardware and software platforms. The openness of standards means that the formation of the standard is not dominated by one single organization, but that there is a standardization community that is open to all organizations that have an interest in using the standards.

Very closely related to the EPC Global standards for electronic data provisioning in international supply chains is the Dutch SBR program that aims to reduce the administrative burden for private organizations and the regulatory burden for public organizations [15]. These burdens are caused by the introduction of stricter laws and regulations that require private organizations to provide more timely and accurately business information to various public authorities. The SBR program is based on the Extensible Business Reporting Language (XBRL). XBRL is an eXtensible Markup Language (XML)-based language for formatting business information in such a way that it can be read across different software applications. The fundamental idea of XBRL is to segregate reporting data from meta data. The differences between data and meta data can be exemplified as follows. An entry summary declaration can be viewed as a report containing data for specification of a container which is used by customs to determine whether or not a container can be cleared. The meta data are data that prescribe exactly what data an entry summary declaration should contain.

[12] See: http://www.epcglobalinc.org.

The meta data are the requirements for the generation of valid entry summary declarations and based on that kind of data the meaning of an entry summary declaration can also be derived. These meta data are used to provide the semantics to reporting data in a standardized way. As an open standard, XBRL is governed by a not-for-profit consortium made up of representatives from more than 170 companies and organizations around the world, including the major accounting firms, software vendors, information brokers, regulators and accounting standards-setters [15].

7 Conclusions

A reliable and secure global supply network can only be achieved by tight cooperation between businesses and government and by making investments that pay off for public as well as private parties involved in international trade. Businesses themselves already invest in three ways to realize the goal of achieving reliable and secure international trade supply chains. These are the achievement of the Authorized Economic Operator (AEO) status to prove that a business is compliant and trustworthy, the optimization of logistics and terminal operations by means of synchro-modality and the realization of sustainable supply chains by means of visibility and traceability. Synchro-modality concerns the switching between different forms of transport. The identification of what is happening and went wrong in the supply chain in case of problems is enabled by real time data visibility and technology driven traceability.

Next to these investments from private parties, public authorities such as Customs want to facilitate the market by stipulating that the seller/consignor and the packing list play a key role in minimizing risks such as safety, security, legal compliance and commercial risks. Therefore, it is of high relevance to include a Consignment Completion Point (CCP) as an additional waypoint to the supply chain. This waypoint is located at the point of container packing or consignment completion and a full set of accurate data should be provided at this waypoint to be verified between the seller/consignor and the buyer/consignee. If the full amount of data relating to the goods and the buyer and seller required by Customs and other regulatory agencies for an export declaration is provided electronically at the CCP, then this complete and accurate data can not only bring the seller and buyer together without being dependent of intermediary logistic service providers but the data can also be used for advanced risk profiling. A Web-based IT infrastructure that enables the seamless integration of all data elements from all the different sources in the supply chain at the CCP has been dubbed as an *integrated data pipeline*.

Analysing the stakeholders that are concerned with this pipeline has revealed three key issues. Firstly, as the data pipeline would provide data visibility to all involved parties, this has to be addressed in order to obtain commitment from freight

forwarders for the data pipeline, which is a typical example of a market-driven stakeholder issue. Secondly, the data pipeline has the potential for synchro-modal logistics but the issue is which party will provide this service. Thirdly, an issue is whether governments are willing to secure the funding of national data exchange infrastructures, or whether they require them to become financially more self-supporting with new commercial services. These issues should be taken into account when an integrated data pipeline is realized for creating data visibility to all involved parties and for achieving reliable and secure international trade supply chains.

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