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THE DATA PIPELINE

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CASSANDRA

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Executive summary

Government agencies and businesses cooperate and invest heavily to achieve a reliable and secure global supply network. Supply chain visibility and transparency along with business-to-business and business-to-government interaction are growing increasingly important as companies struggle to rebound from the economic recession. But complexities of commercial transactions, logistics and border procedures within the international trade supply chain, require a fresh and innovative approach if the demand for efficiencies and savings is to be realized.

Businesses themselves need to invest in the next generation of supply chain-management techniques in order to realize this goal:

- The first improvement is the realization of sustainable, cost-efficient supply chains by establishing shared knowledge between buyer and seller on the trade-transaction process, enabled by better real time data management and traceability.

- The second is the optimization of logistics and terminal operations by means of synchro-modality, which concerns the switching between different forms of transport (truck, barge, airplane, ship, and train) within a strategy of more timely, efficient and environmentally friendly distribution from the major ports – limiting the use of trucks for inland transport.

- The third is to acquire the Authorized Economic Operator (AEO) (trusted trader) status to prove that a business is compliant and trustworthy within the context of risk management and trade facilitation.

- The fourth is by the regulatory authorities through improving the coordination of border management, facilitation and supervision, and working in partnership with businesses trading internationally in order to capitalize on modern information technology and using twenty-first century innovation for risk and data management by "piggybacking" on sound, legitimate business practices used to buy, sell and ship goods globally.

To enable improvements in these four areas, we propose the “data pipeline” innovation. This is 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 Consignment Completion Point (CCP).

Part of the innovation suggested in this paper is to include the CCP as an additional waypoint to the supply chain, as the active participation of the consignor and the information provided in the packing list play a key role in maximizing safety, security, legal compliance and minimization of commercial risks.

This CCP waypoint is located at the point where a container is packed or a consignment is completed. At this waypoint, a full set of accurate data should be exchanged between the seller/consignor and the buyer/consignee. 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, then these complete and accurate data not only can 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 by all cross-border

inspection agencies. The data pipeline thus is viewed as connecting actors in so-called “smart" supply chains.

This paper explains the motivation for the data pipeline vision and provides a conceptual model of such a pipeline, which is a central topic of the EU-funded CASSANDRA project, within an environment of greater coordination and use of real time data from the right source in the supply chain.

Index

1. Introduction

In '*The Wealth of Nations*'[1] Adam Smith, the eighteenth century moral philosopher and pioneer of political economy, suggested that wealth comes from the stream of goods and services a country creates and that regulations on commerce are ill-founded and counterproductive. In his Canons of Taxation, Smith also promoted the concepts of equity, certainty, convenience and economy. In the twenty-first century globalized international trade has certainly proved to generate economic strength. And regulatory and contractual complexity has grown to a level that may be inhibiting rather than simplifying trade.

This paper follows a step-by-step approach, identifying some key problems in the international trade supply chain, and proposing a new concept for the future, using innovative information and communication technology to increase accountability and transparency. The topics we will be discussing include visibility and transparency in global trade chains, better coordination of logistic distribution systems, and streamlining data flows for commercial and regulatory purposes.

The systems used in international trade have developed since the eighteenth century to cater for general cargo and paper-based transactions. They are designed to minimize the liability of the major carriers, protect the financial interests of both buyer and seller but shield the consignor from taking full responsibility for sending goods into the supply chain.

Since the advent of the sea container in the twentieth century, the carrier has entered into a contract of carriage with the shipper concerning goods in a metal box that nobody can see. Outsourcing, consolidating cargo and multi-modal transport chains have allowed the identity of the true seller or consignor to be clouded and contractual terms to be over-complicated. Carriers and importers are being asked to make legal declarations about goods they have never seen and documents containing crucial information can lag three days behind the exported goods. This is all happening while advances in information technology have rapidly outstripped the enthusiasm or willingness of the international trade industry to adapt and keep pace with change. Complexity and mysticism have caused the simple buyer and seller to engage a range of logistics and service providers to handle the processes on their behalf resulting in a lack of visibility of events, costs and assurances.

In this paper we put forward the concept of a virtual, seamless, electronic 'data pipeline' that links the buyer and the seller to assist them in their commercial transactions, their logistics operations and their regulatory responsibilities. Other participants in the supply chain also use the pipeline where appropriate. We propose that if that demands of both business and government are to be realized in the future, a fresh and innovative approach needs to be taken.

To this end, we present the "data pipeline" vision. The data pipeline offers an innovative approach to the exchange of data throughout the international supply chain, as a prerequisite to further establishing secure and reliable supply networks, for business and government.

The remainder of this paper is outlined as follows. Section 2 provides an analysis of the current situation. In section 3 we share the data pipeline vision, as a means to overcome the current issues and to support strategic improvements for both business and government. In

[1] Adam Smith (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*.

section 4 we analyse the potential role of Single Windows and Port Community Systems for implementation of data pipelines. We also address the initial implications for implementation. The paper ends with the conclusions and next steps.

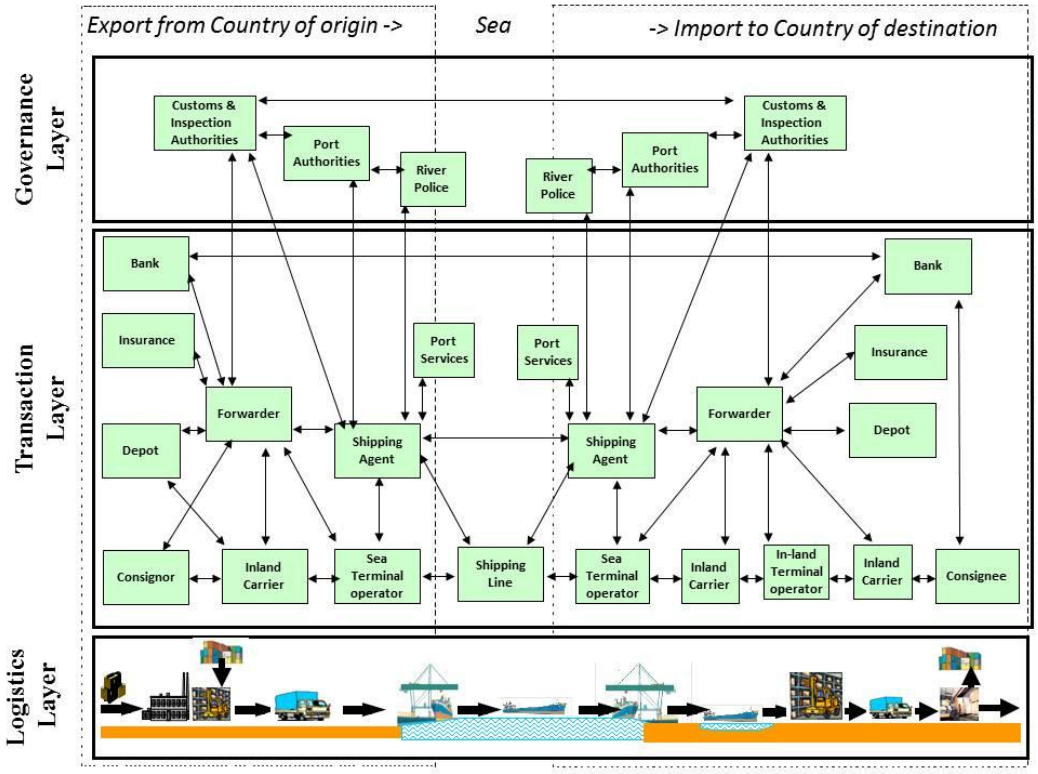
2. How we use information in today's supply chains

2.1 The parties in an international supply chain

An international trade supply chain is a global network of autonomous or semi-autonomous business entities involved in procurement, manufacturing, distribution and payment activities for products that cross the borders between countries or economic areas. One of the major challenges for supply chain managers is to develop a network structure and collaboration mechanism that can facilitate adaptive, flexible and synchronized behaviours in a dynamic environment that is both reliable and secure (Perona and Miragliotta, 2004). While there are many definitions of the international trade supply chain, most give the impression that it takes a linear form. It is often described as "only being as strong as its weakest link". Van Oosterhout et al. (2000) make the distinction between physical, information and financial flows along the supply chain and describe the Logistics Layer, the Transaction Layer, and the Governance Layer (cf. Van Baalen et al., 2008).

Figure 1 presents a visualization of a (relatively straightforward) global supply chain relating these three layers, denoting the physical flow of goods with commercial transactions by business actors as well as the governance layer with governmental actors involved in export and import.

Figure 1. Overview of the global chain (Source: Van Oosterhout et al., 2000)



We want to highlight the following parties:

The consignor is the person sending a shipment to be delivered whether by land, sea, rail or air. This is the actor who knows what is being sent into the supply chain and is generally the actor who 'packed the box', i.e. consigned the goods. Often the consignor is the seller of the goods but that is not always so.[2]

The consignee - the seller puts the consignment together to meet the order placed by the buyer, or consignee. The buyer and seller will have negotiated their International Contract of Sale, which includes details such as the full description of the goods, unit price, Incoterms[3], payment details, insurance, dates and logistics. The consignor holds the key to most of the information that is needed to improve supply chain visibility, which benefits both consignor and consignee.

Carriers are the companies that physically move the goods on ocean ships (or inland: barges), airplanes, trucks, and trains. Some carriers, such as national postal entities, use the term "sender" or "shipper".

Freight forwarders sometimes fulfil the role of **consolidators**, putting together "less than full container loads" (LCLs) or groupage consignments from different consignors. In that case, they also are essential to bring together the information and, if it is on paper, put it into an electronic format.

Customs authorities are typically regarded as a central stakeholder. Generally Customs—at times jointly with other governmental (Border) agencies—are accountable for controlling imports and exports for customs, social, health, safety and security purposes. Customs administer and enforce the law, regulations and procedures regarding duties and taxes, the international trade in goods, trade statistics and import and export prohibitions and restrictions. This includes duty relief schemes, excise duty, customs duty, value added tax (VAT), tariff quotas, Common Agriculture Policy controls, commodity codes, import and export licensing, preferential duty rates, strategic exports, intellectual property rights – and safety and security along the international trade supply chain.

2.2. Supply chains in the twenty-first century: the need for visibility?

Supply-chain visibility relates to access to the underlying transaction data that are necessary for a private-sector operator or government agency to assess what is actually happening in the supply chain. Without accurate and timely data about the goods, the people involved, the payments and the integrity of the logistics, the risk of something going wrong increases, effective planning is inhibited and confidence decreases (Christopher and Lee, 2004).

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[2] A detailed discussion of the differences between seller and consignor/ buyer and consignee is out of scope here, but may for example be derived from the UN Trade Data Elements Directory (UNTDED), see www.unece.org/fileadmin/DAM/trade/untdid/UNTDED2005.pdf.

[3] Incoterms are terms agreed between consignor and consignee about who is responsible for arranging the transport of the goods, insurance during transport, and which party is responsible for the administrative handling of the documents (see International Chamber of Commerce, http://www.iccwbo.org/incoterms/).

Visibility is, in fact, a precondition for the parties to understand the current state of a supply chain and to make intelligent choices in the actions they have to perform. It is now regarded as "one of the largest unmet needs and value opportunities in supply chain management"[4]. Supply-chain visibility is consistently ranked as a top priority for internationally operating businesses and for governments that have to supervise goods flowing across borders[5].

However, in today's global trade, many supply chains have grown in complexity to a point where clear visibility is masked from those who need to know what is going on. This is particularly so in the case of "less than full container" shipments where a consolidator packs consignments from several consignors into one container and often provides only summary data of the contents to the shipper, e.g. "agent to agent"

The Hermes project commissioned by the former UK organization for simplified trade procedures, SITPRO, analysed the use of information in international food supply chains from suppliers in third countries to UK retailers[6]. The project found that documentary systems incur costs for companies moving perishable goods along the international trade supply chain of more than US$1.6 billion annually. In a typical single complete consignment transaction from grower to retailer, 150 documents are used. One billion pieces of paper are produced each year by this supply chain of which over 90% are destroyed. The report estimates up to 1.4 million incidents of missing or delayed documents in a single year for perishable foods imports into the UK alone. These result in additional costs from securing replacements or amendments, as well as costs that delays can exact in terms of additional spoiled food. The report also found that potential savings of over US$1 billion could be made by improving transparency of agriculture supply chains. To achieve this all the parties in the supply chain including importers, exporters and authorities would have to gain access to the information that is relevant for their decision making in electronic format.

Data deficiencies and gaps, together with an outdated paper trail—as updates and changes may not clearly be reflected in them—are creating financial, safety and planning risks. Costs are ambiguous, thereby clouding overheads and profit margins. This lack of visibility is significantly adding to costs in supply-chain networks (Christopher and Gattorna, 2005). Businesses are increasingly interested in getting access to the data that create supply-chain visibility for them, to make better choices in managing the supply chains.

Government actors are also seeking further means to facilitate international trade while safeguarding public values (Tan et al., 2011). Both globalization and the large scale of international trade add to an unprecedented scale of risks related to security, safety, health and fraud (Van Oosterhout et al., 2007; Tan et al., 2011)[7].

Given the increase in international trade, and the substantive risks involved, border management has also increased in complexity, and can cause time delays, cost increases, as well as reductions in the competitiveness of supply chains (Holloway, 2010). For border agencies such as Customs to perform their functions they need transparent supply chains with all relevant information to assess risks and to make intelligent decisions. To do this, their focus lies on information provision by businesses.

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4 World Economic Forum, Logistics Supply Chain Report 2010-2011. http://www3.weforum.org/docs/WEF_GAC_LogisticsSupplyChain_Report_2010-11.pdf, p. 20

5 Aberdeen Group, Supply Chain Visibility Roadmap, http://www.aberdeen.com/aberdeen-library/3609/RA_Visibility_BE_3609.aspx

6 http://webarchive.nationalarchives.gov.uk/20100918113753/http://www.sitpro.org.uk//news/articles/snar200807a.html.

7 See also the World Economic Forum's report "Global Risks 2011", http://riskreport.weforum.org/global-risks-2011.pdf.

Information required by border agencies is being requested further upstream in the supply chain from the parties that are at the source of the information. The best person to provide this information is the one who packed the box or consigned the goods. However, for commercial and reputational reasons, the seller often does not want to let the buyer know where the goods came from originally, i.e. who the producer(s) is / are, in order to prevent the buyer bypassing the seller and purchasing the goods directly from the initial producer.

The information that finds its way into the transport documents—and from there into the customs declaration—is often not from the originator. As a consequence, Customs and other parties in the supply chain have to manage their supply chain with second-hand information that is filtered, altered and likely to be inaccurate (Hesketh, 2010).

The lack of transparency in supply chains becomes particularly visible in supply chains with consolidated consignments were goods form different shippers are consolidated in one container. The contract of carriage is between the consignor and the 'consolidator' or 'agent' who takes the groupage container to the port for loading. The Bill of Lading becomes a contract between the carrier and the agent to deliver the goods to the port of unloading were another agent will deconsolidate the cargo.

Not only do the carriers not know what they are carrying but they also do not know who owns the goods, who is sending them or who is ultimately buying them (cf. Hesketh, 2010). This poses safety, security, legal compliance and commercial risks.

In everyday practice, despite the legal requirement to provide accurate data about the goods being carried, about 60% of vessel manifest information is described as 'agent to agent', making the data unfit for regulatory pre-arrival risk-assessment purposes.

It is generally agreed within the container industry that up to 10% of containers loaded onto a vessel might not be in their planned positions.[8] *Also, discrepancies in weight are widespread within the containerindustry. They can be due to shippers deliberately under-declaring container weight so as to minimize import taxes calculated on cargo weight, allow the overloading of containers and keep the declared weight within limits imposed by road or rail transportation. Well-established commercial practices within the Logistics Layer are masking the accuracy of data and thereby increasing the risks posed by a lack of visibility (Hesketh, 2010).*

Visibility of the supply chains could be ensured if Customs had access to information and data about the consignor, who holds the key to the majority of that information on the shipped goods. However, as the consignor is outside the jurisdiction of the importing country's authorities, Customs has to instead revert to the second-hand information provided by the carrier and the importer.

Many Customs organizations are currently aiming to increase the transparency of their part of the supply chain by requesting Advance Cargo Information prior to shipment to their countries such as the European Import Control System (ICS). However , the advance information comes with a cost: An impact assessment reveals that the estimated costs for businesses in the United Kingdom amount up to € 7.5 million for ICS implementation , and additional average annual costs of up to € 1.1 million (HM Revenues and Customs 2009). In addition ICS is unlikely to solve the transparency issue as the data provided is still coming from the shipper and not from the consignor[9].

[8] Marine Accident Investigation Branch, Report on the investigation of the structural failure of MSC Napoli, English Channel on 18 January 2007, http://www.maib.gov.uk/cms_resources.cfm?file=/MSC%20Napoli.pdf (pp. 28-29).

[9] http://ec.europa.eu/ecip/help/faq/ens1_en.htm#faq_2.

Visibility is also a key issue to meet new demands of supply chains in the twenty-first century in areas such as environment protection and social accountability. Governments have already set ambitious environment objectives such as reduction of CO^2. Channelling goods to their most efficient and least polluting route or mode of transport can be greatly improved if more detailed "original" source data are available, as demonstrated in the case of bananas (see box below).

There is also a trend to establish supply chains with products that conform to social and environmental production standards. These supply chains can bring many additional benefits to the exporting and importing countries, and to the trading partners. They typically achieve higher profit margins and lead to a gradual improvement of quality and services—which is attractive also for developing countries and transition economies.

To create such supply chains all parties require transparency and access to information so as to establish trust and to ensure that the standards are met. This can only be achieved by establishing transparency in the supply chain where parties have access to relevant information at all stages of the supply chain.

The EU "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" found that if Europe sticks to "business as usual", by 2050 CO^2 emissions from transport would be one third higher than their 1990 level and congestion costs would increase by 50%.[10]

At present, more than 95% of the containers with fruit that arrive at the Port of Rotterdam are shipped to the hinterland by road, because normally fruit is a perishable good that has to be shipped as quickly as possible (e.g. strawberries). However, some fruit types like bananas do not need to be shipped as quickly as possible.

If it is known which container at the Port of Rotterdam would contain which fruit type, a choice can 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 only low emissions. It is estimated that road transport of vegetables and fruit could be reduced by 50% (Overbeek et al., 2011) if traders had information to make intelligent logistic choices.

This section has offered a brief analysis of the current situation in global supply chains. We see critical issues regarding visibility and transparency, leading to high risks and high costs. It is a top priority for business and government to make ongoing strategic improvements in order to create and maintain sustainable and secure supply chains. To address the issues identified and to make strategic improvements, both businesses and government require timelier and more accurate data. To make this happen, we propose that an innovative data-sharing concept is required. This so-called "data pipeline" allows original trade data to be made available and used by businesses and government to make their operations more effective, efficient and secure. In that light, one may think of the actors becoming part of "smart" supply chains. We'll discuss the integrated data pipeline in the next section.

[10] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:EN:PDF.

3. Data pipelines for transparency in supply chains

Let's now look at the underpinning principles, the data pipeline and how it works, enabling IT innovations, and the benefits for business and government, as well as initial implications for its development and implementation.

3.1. Underpinning principles of the data pipeline[11]

Two core principles underlie the concept of the integrated data pipeline. The first is that the original trade data (usually supplied by the consignor) are gathered and shared and can be used by (authorized) parties in the trade network to improve their operations. Using what we call the "piggybacking principle", we focus on the re-use of available business data and data flows in the international supply chain for purposes different from those for which they were originally intended, including for control and (regulatory) compliance purposes (Baida et al., 2008; Rukanova et al., 2011; Tan et al., 2011).

Essentially, the parties participating in a supply chain provide data that can be of relevant to other supply-chain parties in a shared information space. The management, access and security of information in such a space can be ensured using different technologies and approaches—for example, cloud computing technology.

The information shared between the parties describes:

- the transactional data (as captured by consignor and consignee, and intermediate parties in the supply chain).
- the physical data (as captured by tracking and tracing, and monitoring devices).
- the relevant commercial risk management data (for example quality and technical compliance checks of the goods against ISO standards).

It is evident that access to this information is regulated and based on dedicated access rights. The piggybacking principle within the data pipeline concept involves a fundamental shift from a document perspective to a data perspective. Instead of sending (pushing) documents with filtered information from one party to another, the parties will rather access (pull) the information required when they need it.

In the traditional document-focused process, the data are "pushed" by business to a variety of government agencies (e.g. Customs, statistics, veterinary), through the obligatory documents and submitting data to the government information systems (Rukanova et al., 2011). Instead of this "data push" model, the radical change proposed here is the transformation towards increased "data pull"—i.e. where the governmental agencies requiring information can "pull" these from the existing information systems of companies (Tan et al., 2011).

[11] The web-based, integrated data pipeline vision has been put forward originally by Her Majesty's Revenue and Customs (HMRC) in the United Kingdom (UK) and the Dutch Tax and Customs Administration (DTCA) (Hesketh, 2010; Overbeek et al., 2011).

The key advantage for government agencies would be that they would obtain "original" quality data from the source. They can obtain the data any time, real-time, rather than only at the moment of border-crossing, thus improving compliance management and risk-based auditing.

The second core principle in the integrated data pipeline concept is the notion of synchronization points that determine when shared information must be available to parties in international transactions.

The supply-chain process includes two critical information points. The first is the sales agreement between the buyer and seller, where an accurate description of the goods and terms under which they are to be bought and shipped, is captured in the purchase order and contract of sale. The second is at the completion of the consignment, where the packing list, shipping note or dispatch note and the transport document show that the goods have started their journey along the supply chain, in accordance with the order and contract. The Consignment Completion Point (CCP) is the stage just before the completed consignment at either 'house' level (in waybill terms for a small individual consignment) or 'master' level (for a single, groupage or consolidated consignment) is dispatched into the international trade supply chain (Hesketh, 2010; Overbeek et al., 2011).

At this point, everything about the goods is known and agreed between the consignor and the consignee and their identity and status is known to each other. The buyer or consignor can confirm electronically with the buyer or consignee that the true packing list matches the purchase order and the contract of sale and that the goods, as ordered and agreed, are about to be sent. It is similar to the prompt or dialogue box on a computer screen saying: "Are you sure?" At this point, the data relating to the goods and to the people involved in the commercial transaction can be made available to the regulatory authorities in the country of export, transit and import—and at the same time by electronic message. Visibility of those two crucial points by buyer and seller ensures conformity with both the contract of sale and the regulatory requirements for safety, security, admissibility and compliance.

3.2. The integrated data pipeline vision

3.2.1. The data pipeline and how it works

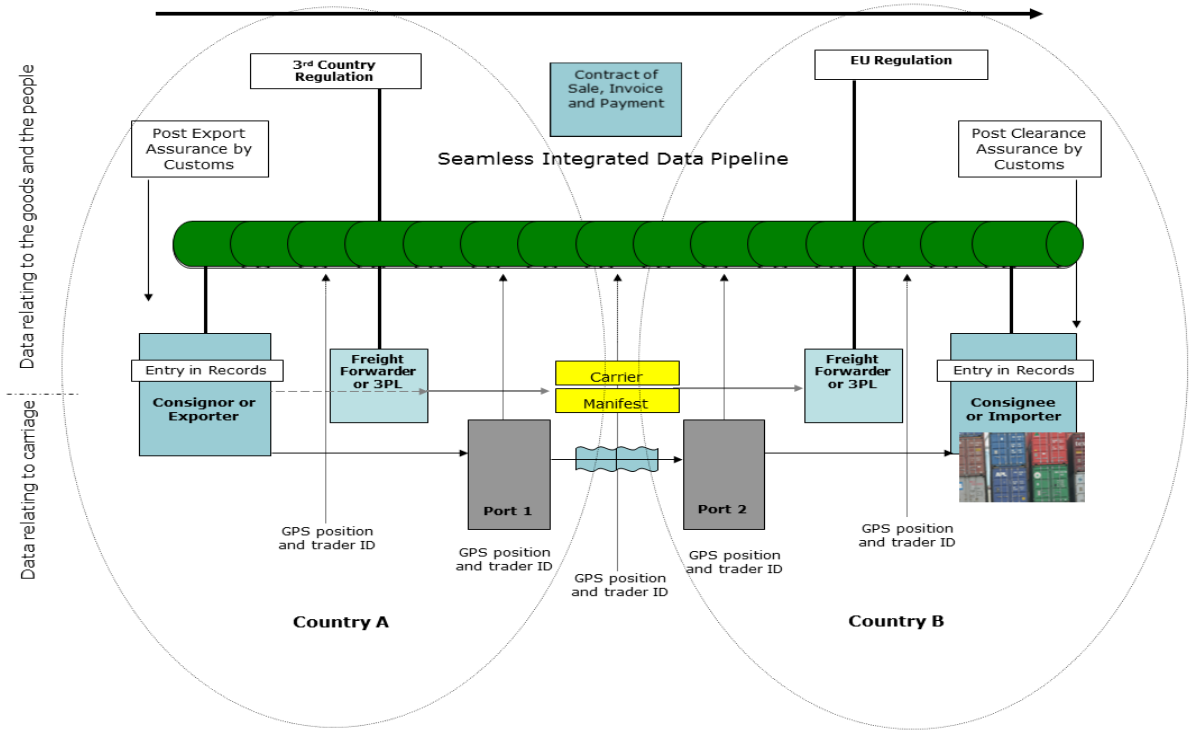
Figure 2 shows a model of an Internet-based data pipeline that enables the seamless integration of data elements from all the different sources in the supply chain at the CCP. It visualizes what kind of shipment data are exchanged during transportation. For example, consider a manufacturer of baby foods in the Netherlands that imports bananas from a South-American exporter. They can agree upon an international Contract of Sale before the goods are consigned, which should contain all the relevant data about the goods and the parties, the terms and the planned movement of the goods. The consignor, in this case the South-American exporter, 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 are forwarded to the freight forwarder or a third-party logistics provider (3PL). The pipeline model shows that all other users of the shipment data get the original shipment data from the consignor: they are 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 distinction is drawn between (a) data related to goods and people and (b) data related to the carriage itself. The different types of data are shared with the relevant parties, for different purposes. Businesses can, for example, use the logistical data to optimize distribution logistics through synchro-modality. The carriage data are captured in the data pipeline by means of container seals with GPS or location data of the ship.

If the journey was short, the bananas will not yet be ripe upon arrival at the Port of Rotterdam. A choice can then be made by the baby food manufacturer to use cheaper and more sustainable barge transport to carry them inland. However, if the shipment is having major delays because of bad weather or re-routing, further transport by truck may be necessary to avoid a spoilt load.

The parties with which the data may be exchanged from a legal perspective are determined by legislation at the national level, EU level or federal level, depending on the country the goods are moving in. Governments can piggyback on the commercial data available in the data pipeline. These data are captured at the source, not changed to fit the regulatory document, and better fit for e.g. risk management purposes. The data pipeline makes real-time data management possible, which would allow for moving the moment and location of inspections and clearance procedures. For example, the physical inspection of the bananas would not necessarily have to take place at the Port of Rotterdam—which would optimize the flow there—but could instead take place at the premises of the South-American exporter (and be sealed afterwards) or at the bonded warehouse of the baby food manufacturer. The data pipeline thus also provides opportunities to improve border-management coordination.

Figure 2: A seamless integrated data pipeline
(Source: Overbeek et al., 2011, adapted from Hesketh, 2010).



3.2.2. Latest ICT technologies to enable the data pipeline concept

The data pipeline concept could be introduced through a cloud computing solution in the context of international trade. Cloud computing is an approach where data are provided through services over the Internet and where the network of services is referred to as 'the cloud' (Andriole and Khorasani).

Cloud computing builds a virtual pipeline of data, functions and applications that ideally can be viewed in or used by any computer system, eliminating the need for duplicative storage of data and services in disparate systems. It combines virtualization, service-oriented software, grid computing, the management of large facilities, and power efficiency to achieve durable and flexible computing services.

Cloud services provide access, confidentiality and sharing of data and can store large amounts of unstructured data (Dikaiakos et al., 2009). Cloud computing provides a new model for information delivery and consumption in which applications and data are accessed from a web browser, while software and data are stored on servers. Some disadvantages are that users must be connected to the Internet to use the cloud, and the availability of data across large geographic distances may in turn create risks for data custody, ownership and use.

A prerequisite for implementing a global data pipeline is to have a standardized, uniform means to describe, offer and discover data that are used for interaction (Baida et al., 2011). This means that data-sharing standards are essential. Such standards should be open standards developed in a standardization community open to all stakeholders.

Two types of data standards can be distinguished here: the trade or customs data standards and the IT standards needed for interoperability and Web service message exchange protocols. The World Customs Organization (WCO) data model version 3 and the Core Component Library of the UNECE Centre for Trade Facilitation and Electronic Business (CEFACT) are the most prominent trade or customs data standards.

The main objective of the WCO data model is to define a set of standardized data usable by both customs and trade operators for electronic data exchange during customs clearance, including completion of the trade manifest and declarations. The WCO data model is essentially a set of harmonized data requirements derived from cross-border regulation. These are updated frequently to meet the procedural and legal needs of cross-border regulatory agencies such as customs, controlling export, import and transit transactions.

The UNECE Core Component Library (CCL) is the cornerstone of the UN/CEFACT standardization activities. Core Components are the syntax-neutral and technology-independent building blocks that can be used for data modelling. CCL is part of the ebXML (ISO 15000) suite of standards for eBusiness interoperability. Major benefits of the CCL include improved re-use of data artifacts, improved enterprise interoperability, and consistency across vertical industry standards.

One of the most widely used set of IT standards that is tailored for data sharing in international supply chains is EPC Global from GS1, which support sharing of data between heterogeneous hardware and software architectures. 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 (Baida et al., 2011).

The pipeline concept draws upon Radio Frequency Identification (RFID) technology for localized tracking of goods at unit, pallet, consignment and container levels. It also draws upon 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[12] (ShipAIS) and the Long Range Identification and Tracking system[13] (LRIT). Other sensors, for example to monitor temperatures, can also be used.

3.2.3. Benefits of the data pipeline

The data pipeline is a means to improve visibility and traceability of transactions and goods in international supply chains. The original commercial data are captured as far upstream as possible, preferably at the Consignment Completion Point (or even earlier), and complemented by data on the movement of the goods.

Such a pipeline offers important benefits for the business world. First of all, improved visibility supports cost-efficiency in the supply chain. For example, it enables cost identification and to bring about lower inventory levels, improved planning of logistics, purchase and sales, better choices of service providers, and it may make information to protect profit and capture more market share available (Hesketh, 2010). The data pipeline will also allow businesses to monitor and trace the goods more precisely during the carriage.

If the goods need to be transported under certain conditions, smart sensors can be mounted on the containers (also providing the GPS locations) or measure at product level, can give alerts if the sensor readings deviate from the set parameters (cf. Tan et al., 2011). For example, in the case of food products, if there have been alerts that the container has been too warm during transport, the consignor might not want to have the consignee pick up the goods before an extra quality test had been done, or it may be decided to ship another consignment, while forewarning the consignee about the delay as well. Again, this would improve logistic planning, which is an important part of managing food safety and quality. The location data can be used to check whether goods are e.g. re-routed or are encountering other delays (for example because of weather conditions). This would allow for better planning, also in terms of determining when exactly which goods will arrive.

Synchro-modality

The data pipeline also allows for the visibility that's needed to make advances in distribution logistics, like "synchro-modality". Synchro-modality describes a flexible and sustainable transport system in which companies can make an intelligent choice from a range of transport modes modalities. In this case, the data pipeline provides the information about which containers contain which food products, for example, so that a better choice can be made between e.g. barge transport versus road transport (Oosterbeek et al., 2011). This enables

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

businesses to save costs and also to make more sustainable, environment-friendly choices. In the long run, this could also lead to less traffic congestion.

Indirect benefits to companies

Besides such direct commercial benefits, the data pipeline will also benefit companies in terms of their compliance with governmental procedures and regulations:

- It requires fewer message exchanges between business and government for completing a full declaration.

- It would reduce errors of e.g. retyping information at different points in the supply chain, which can be time consuming to resolve.

- It minimizes the number of costly interfaces and modifications of enterprise systems that would have to be invested in, both in terms of the linkages with the different governmental agencies involved, but also when the company operates in multiple countries.

- Sharing data through the data pipeline will be a way in which trusted traders (AEO (Authorized Economic Operator)-certified businesses) can demonstrate to government agencies that they have end-to-end transparency and are in-control of the physical flow of the goods (Tan et al., 2011). Already at the CCP, the data that have to be gathered for Customs purposes can be submitted and additional proof (e.g. regarding the final destination of the goods) is provided by the tracking functionality. Thus, the data pipeline supports the certification of trusted traders—who may then get additional benefits such as fewer physical inspections, fast lane clearance, etc.

From a governmental perspective, the data pipeline supports the improvement of risk-management practices. Rather than gathering (electronic) regulatory documents, the data pipeline enables the capture, at the source, of digital commercial data that have not been adapted by business to fit the document. This should improve data quality, making the data more suitable for risk management, as more precise commercial data can be captured about the entities involved in the transactions, the contracts between them, as well as the flow of the goods.

Also, it may be part of the data-sharing between trusted traders and government to include commercial risk assessments in the data pipeline, or to piggyback on other controls put in place by business. For example, for food products, in the case of the temperature alerts we described earlier, government actors and AEOs may cooperate more closely, so that inspections already conducted by the businesses themselves are not necessarily repeated by Customs or the food-inspection agency. This would thus mean less governmental interference for the AEO, and greater efficiency for the governmental officials concerned.

The data pipeline also offers a means of communication for improved coordination of border management. This can include communicating about audits and inspections already conducted at the country of export to the authorities in the country of import. The data pipeline can also provide the data needed for e.g. the “export is import” procedure. If there's no formal mutual recognition between the two countries, the data pipeline can provide an

informal basis for extended cooperation and coordination, and the country of import can take the data into account in their own risk-profiling and border management. The data pipeline thus offers a way for government to improve governance of international trade and to increase trade facilitation, while also providing efficiency benefits.

3.3. Initial considerations for realizing the data pipeline vision

Implementing a web-based, seamless, integrated data pipeline is a challenging endeavour, both from a technical point of view and from many other perspectives, including strategic, organizational, political and cultural viewpoints (Overbeek et al., 2011; Van Stijn et al., 2011a). It involves a large stakeholder group, from many different public and private organizations in different sectors, countries, etc., and affects an even larger network (cf. Overbeek et al., 2011; Van Stijn et al., 2011b).

Global supply chains are networks with complex interdependence between various stakeholders, including freight forwarders, port community systems, Customs and other authorities, terminal operators, consignors and consignees, providers of IT systems, providers of e-Government infrastructure, etc. (Overbeek et al., 2011).

The future situation concerns a shift in data-exchange and control responsibilities between government and businesses. From a governmental perspective, the two basic reasons for change are (a) to achieve further control of international trade to ensure societal values such as security, safety, limiting illegal activities (fraud, smuggling, trafficking) and (b) to further facilitate trade, interfering as little as possible in the logistical operations of trusted parties, while focusing on the potential high-risk trade (Van Stijn et al., 2011c).

To do so, governments need to be able to profile international supply chains, the actors involved and the goods (and money) moving between them. There is also the need to carefully consider how stakeholders will be affected. It is foreseen that the cooperation between stakeholders in the inter-organizational supply chain and the governmental stakeholders will be based on trust and joint responsibility, fundamentally shifting the various interactions between companies and authorities from hierarchical to more horizontal relations (Tan et al., 2011).

Public-private cooperation: shifting boundaries for better collaboration

Public-private cooperation is essential for developing the solutions, with network collaboration and consensus-building being central themes. Developing a pipeline has major implications for the organizations involved, especially where the public and the private sector meet. The boundary between the sectors shifts from the current division of public and private functions to a stronger collaboration.

The "Living Lab" approach has been identified as very useful for bringing stakeholders together to find innovative solutions (Tan et al., 2011; Van Stijn et al., 2009). In a Living Lab, public and private actors from different organizations collaborate with a multidisciplinary research team. The Living Labs provide a real-life, experimental setting in which to develop and pilot IT innovations. We have observed that the Living Lab—through the key

involvement of academics—provides a neutral ground where the real-life actors from companies and institutions are willing to set aside differences, overcome obstacles, and focus on creative cooperation to come to innovation (Rukanova et al., 2011).

It has also been demonstrated that a Living Lab goes beyond mere piloting. The collaboration within the Living Labs lays the foundations for collective action, focusing on network collaboration and consensus building and adoption of the innovation afterwards (Rukanova et al., 2007; Van Stijn et al., 2009). The CASSANDRA project will also apply the Living Lab approach.

Private parties involved in global supply chains are likely to finance the investment in the data pipeline. This requires that every private-sector party that participates in the data pipeline can expect a positive return on investment. However, some parts of the data pipeline may not have a revenue model or the current institutional structure may not yet support the more extensive collaboration needed between the various businesses (cf. Overbeek et al., 2011).

Given this strong organizational component, future research and development of a data pipeline in global supply chains should be accompanied by research or design of a public-private governance model to deal with the challenges of the overlap between the public- and the private-sector roles of the parties involved in global trade.

An important question is if and how a government could facilitate and ensure the public role, while at the same time enable private parties to improve data sharing to realize public goals and be able to make fair revenue. The underpinning principles for the public-private governance model include:

- Identification of the network of stakeholders and stakeholder analysis, which includes:
  - Identification of possible conflicts of interests (often relating to revenue models);
  - Reconstruction of revenue models behind all interests (economic research);
  - Reconstruction of the logic of each of these interests.

- Aligning of conflicts. Those parties that have the greatest economic benefits from an innovation typically should invest most, and in some cases equity stakes should be taken in the others that have fewer benefits. Also, the investments should create enough economic benefits such that businesses are willing to invest.

- Define institutional arrangements in such a way that this alignment can emerge (institutional economics research). The arrangements should be market-driven, but for those parts of the data pipeline that are identified as inherently public goods, a suitable funding scheme has to be devised. In the setting of CASSANDRA, the institution is typically understood to be a government, or even a supranational body (EU), and could also be an international body (e.g. the United Nations or WCO). (Formal legislation should be used as little as possible).

To create the data pipeline and ensure that both the commercial parties and governments derive benefits from it, governments may have to:

- Lead in developing open standards to ensure a level playing field.

- Support the public role of the data pipeline in such a way that the private roles provide sufficient room for businesses to make fair revenue on their investments in the pipeline.

- Provide support for those parts of the data pipeline that cannot be created through a sustainable business model. This support may consist of service provisioning, a funding method (e.g. subsidies), and where needed, laws and regulations, agreements, etc.

4. Integrating the data pipeline concept into the Single Window environment

4.1. Single Windows have become a strategic instrument to support international trade

Single Window is a concept to facilitate business processes and data exchange for national export and import. This is done by enhancing the collaboration and coordination between the involved administrations and between the private sector.

In the course of a Single Window implementation, the business processes and information flows are analysed, simplified and standardized. The Single Window supports the exchange and processing of the electronic documents, providing the participating agencies and companies with efficiency, security and automation.

In 2005 the Single Window concept was summarised in the UNECE Recommendation 33 on Single Window on Establishing a Single Window[14]. Since then this concept has witnessed a stunning success. In particular in developing countries and transition economies, Single Windows have become a strategic instrument of governments for enhancing trade facilitation.

Single Window in developing countries

In developing countries, the main achievements of Single Windows are as follows:

- Efficient introduction of trade-facilitating measures, in particular the analysis and simplification of business processes.

- Automation of data-exchange among government agencies (G2G), and between the private sector and government agencies (B2G).

- Less time and cost for export and import and increased security.

- More efficient use of physical border infrastructure.

[14] See http://www.unece.org/fileadmin/DAM/cefact/recommendations/rec33/rec33_trd352e.pdf.

- Improved collaboration between border agencies, leading to joint inspections and coordination of other interventions

- Support in the implementation of regional and global trade agreements

- Implementation of modern Information and Communication Technologies (ICT) in the participating Government Agencies. This modernization of Government ICT is a side-effect of SW implementation but often has a significant impact on the overall efficiency of national cross border trade.

While the uptake of the Single Window concept in developed countries has been less dramatic (due in part to the often extensive existing installed base of systems, procedures and approaches to data automation), it still remains a key objective and will likely be an important priority for the future. The Single Window concept is included in the current draft agreement negotiated in the WTO under the Doha Development round.

In an effort to capitalize on this success, many Single Window operators are considering the next steps in its development, particularly with regard to the models through which information can be collected and exchanged within and between Single Windows (i.e. across borders).

The data pipeline concept represents a unique opportunity for business and governments to rethink, redefine and redesign the way in which data are exchanged throughout the entire international supply chain—both from an operational and a regulatory perspective. Starting from a "blank sheet", and thinking in an open minded manner, one can conceptualize a totally new framework for the way in which traders and government use and exchange information to facilitate the international trade process.

Countries/companies that get this right will have a huge advantage over their competitors, both in terms of the currency and accuracy of their information, and the cost and time to delivery. Single Window operators and Port Community Systems can be a key catalyst and motivator here, taking advantage of their expertise in automating and simplifying business processes in the international supply chain.

Clearly, such radical transformations of long established practices and procedures do not happen overnight. This change will require the design and implementation of pilot projects to test out new ideas and explore possible models. And such projects will require strong cooperation between governments and business from the outset.

While these projects will be experimental in nature, they should involve real shipments of products under real business- and government-control scenarios. This is where the business gains will be evaluated and realized.

National Single Window facilities improve the services at the border and along the supply chain through simplifying and automating the processes and encouraging greater collaboration between the parties. Using the data pipeline concept, Single Window operators can explore extending these services beyond the national border by integrating other key parties of the international supply chain into the solution—for example, the foreign buyer, sellers, logistic providers and even foreign regulatory bodies.

This new supply chain would be information and knowledge driven, and could become a "smart" supply chain. Establishing smart supply chains can thus be seen as an extension of the national Single Window concept towards a smart Single Window concept that extends its services beyond the national border.

The Single Window operator can support the development of these smart supply chains through a gradual, stepwise approach by identifying the "low hanging fruit". For example, the Single Window operator should identify key export and import products and supply chains of the domestic country that would benefit most from a smart supply chain.

Typically candidates are supply chains with:

- goods with high value
- large trade volumes and/or fast-moving goods
- perishable goods
- parties with strong institutional capabilities.

For these goods, the Single Window operator can analyse the business processes along the complete, international supply chain, assess the potential benefits that an information-sharing concept can bring to the parties, and develop a proposal or "agreement" for that concept.

If the product is of high interest to the exporting or importing country, the operator can also aim to integrate into this agreement government agencies that will grant AEO benefits to the economic operators that meet the obligations of the agreement. The government agencies would be interested in participating in the agreements if the smart supply chain provides them with information and security that helps them to perform their duties more efficiently. The motivation for the private-sector operators to engage in a smart supply chain would then come both from the economic opportunities and the simplified regulatory processes.

4.2. Why Single Window operators are well positioned to lead the establishment of smart supply chains

In developing countries, national Single Window operators and Port Community Systems are in a strong position to champion smart supply chains and provide domestic traders with greater business opportunities. For example:

- Many national Single Windows have already concluded service agreement with border agencies and major exporters, importers and third-party service providers. They can leverage this expertise and negotiate the specific services and agreements for the smart supply chain with other Single Window service providers and their counterparts in the foreign market.
- Single Windows are seen as trusted partners in the national trade chain. They can leverage this trust when establishing information-sharing concepts.

- In many countries, Single Window operators are linked into regional and global networks—and therefore connected to other Single Window operators and port community systems. These international networks are crucial for identifying opportunities for commercially interesting smart supply chains and for bringing the stakeholders together.

- The concept of information-sharing in smart supply chains requires the data to be standardized. The Single Window operators have the experience to be able to provide the data formats based on international standards.

- The operators already have available most of the information and communication technology infrastructure and the expertise to operate smart supply chains. The start-up costs and associated risk to enter into smart supply chains is therefore limited.

- Smart supply chains are implemented for specific supply chains, i.e. specific products and export/import markets. Thus the costs and risks are limited.

Single Window operators can facilitate the development of smart supply chains if they:

- Leverage their existing contacts and know-how of cross-border supply chains and actively seeking opportunities to provide additional services for the international part of the supply chains that are supported by the Single Window.

- Engage in discussions with major national and foreign exporters/importers and forwarders to identify and try to get rid of bottlenecks.

- Engage with other operators to increase the number of operators that participate in electronic data exchange and information sharing.

- Support implementation of national export promotion strategies in developing value propositions for international supply chains for key products.

Developing countries may also negotiate with international donor agencies and governments from importing countries to develop smart supply chains for specific products. In this scenario, in establishing a smart supply chain, specific facilitation agreements with the importing countries agencies and the start-up costs could be considered as an aid for trade support mechanism.

As a first practical step towards the Single Window, operators can conduct business process analyses for smart supply chains to:

- Analyse possible improvements of logistics and regulatory processes for specific products and services using better information. This analysis can be done with key stakeholders by thinking creatively (i.e. using a “blank piece of paper” approach).

- Analyse minimum information requirements and additional information demands from the business/operational perspective and the regulatory perspective to support the ideas captured.

- Apply the data pipeline concept to determine how this information can be shared.

- Assess the regulatory and change management requirements for implementing the information pipeline.

- Perform a cost-benefit analysis to assess feasibility and support of stakeholders.

UNECE will establish a repository of information on pilots and implementations of smart supply chains, including in particular the costs and benefits for developing countries and transition economies. If member countries request this, UNECE will also provide networking between interested parties on the opportunities and lessons learned.

5. Conclusion and next steps

Both business and government are under pressure to produce cost-efficient, sustainable, and secure international supply chains. But, as we've seen, the current complexities of international trade, and the regulatory procedures governing it, are forming a barrier where visibility is obscured from those who need to know what's going on. This affects not only commercial processes but also the way in which government agencies can monitor and facilitate trade.

We have proposed to take an innovative look at data exchange in international supply chains, and at how improved visibility can also help bring about other strategic improvements. To this end, we have presented the data pipeline vision as a novel approach to data-sharing (a) between businesses and (b) between business and government. The actors are seen to become part of "smart supply chains".

Starting at the Consignment Completion Point (or even further upstream), original commercial data on the entities, transactions and the physical flow of goods are captured and shared between those companies that are entitled to view them. The data pipeline is envisaged to bring major improvements for businesses, regarding visibility and traceability and synchro-modality, enabling the establishment of efficient, sustainable supply chains.

Moreover, the data pipeline supports trusted traders (Authorized Economic Operators) to demonstrate that they are in control of the supply chain and have end-to-end transparency, which can provide additional trade-facilitating benefits. The data pipeline also improves the data-sharing between business and government.

For businesses, costs for compliance could be reduced, because the data pipeline is ultimately a virtually integrated, global solution that would not require businesses to modify internal enterprise systems and interfaces for different national and international solutions.

Government actors can piggyback on the commercial data in the data pipeline, and increasingly rely on "data pull" instead of "data push". The pipeline allows the capture and sharing of data rather than electronic documents, data that are considered to be a better fit for the purpose of risk profiling and risk management.

The pipeline allows the moment of data-sharing to be de-coupled from the border crossing (or the current advance notification). This enables shifts in the timing of inspections and clearances. The pipeline also ensures coordinated border management and informal cooperation between agencies within and across countries.

Creating a data pipeline vision is not necessarily an easy task. Standardization and interoperability are prerequisites for an integrated, web-based Service Oriented Architecture, and to put the data in the so-called "cloud". Public-private cooperation, consensus-building and networking are also essential aspects. Likewise, finding suitable ways in which the different interests between the parties can be aligned, and viable business models and institutional arrangements are established, are key.

With the support of governments, Single Window and Port Community Systems have been set up in many countries throughout the world. These systems provide important facilitation and automation of global supply chains at the national borders. They are usually managed in a public-private sector partnership, which is based on agreements, trust and knowledge. The implementation of smart supply chains for selected products and markets can be seen as a further development path for Single Windows and Port Community Systems.

Further research and design of a public-private governance model will be an important part of the CASSANDRA project, as are the Living Labs—both as a real-world research setting, where business and government stakeholders will further design, develop and pilot the data pipeline and the risk-based approach in practice, and as an important means to establish public-private cooperation as a prerequisite for successful adoption.

From a practical perspective, policy managers from both developed and developing countries can jointly pursue the data pipeline vision further. Gradual implementation would include the following first steps:

- Identify a specific trade lane of key interest, with high volume/ high value trade to a major trading partner. During the first stage, an additional selection criterion would be the current maturity and use of IT by the business actors in the trade lane.

- Set-up a Living Lab environment in which a data pipeline for this supply chain is co-developed, piloted and further evaluated. Business and governmental actors from both the exporting and importing country should be included.

- Share knowledge and experiences, e.g. facilitated by UNECE and UNNExT. The CASSANDRA project will also provide further insights into the data pipeline regarding the technological solutions as well as the ways in which they can be put it place.

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