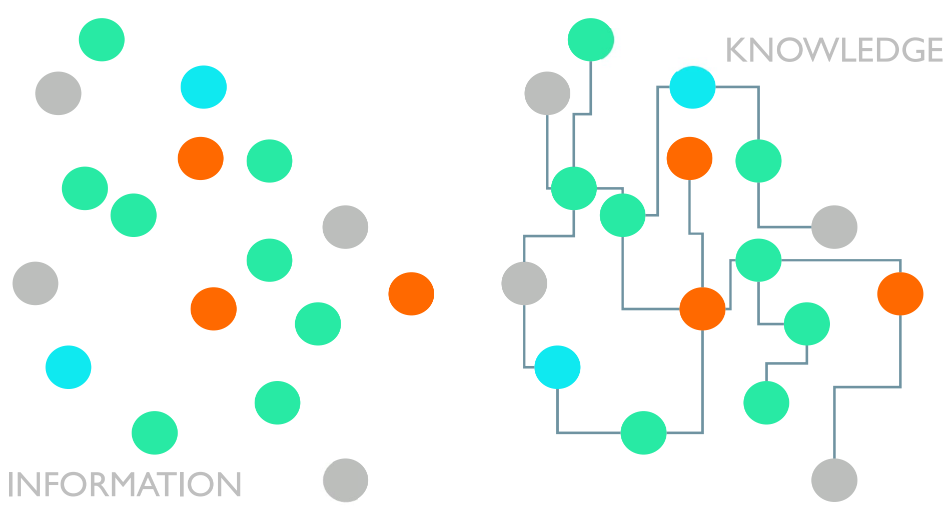
Authors: Kristoffer Skjutare, CLOSER
Anders Dahlén, RISE
Herman van Rens, Ericsson

Report
Multimodal Information Sharing

Date 28 September 2018

MULTIMODAL INFORMATION SHARING

Promoting an efficient, sustainable and connected logistics network



Partners and affiliates of the project

Partners:

Affiliates:

Content

1 Introduction

The need for better communication in supply chains

The opinion of the entire logistics industry, European Union and governmental authorities is that a change is needed in the execution of logistics supply chains. The ways of working are outdated, and the delivery processes consist of too many isolated elements that should better cooperate to achieve efficient end-to-end transport operations.

Logistics companies face challenges in securing and improving the performance of supply chains. Lack of transparency (*where is my cargo and how is it handled?*) and reliability (*will my cargo be on time and is there a risk in loss of cargo?*) in logistics operations causes a need for improved collaboration between organisations to reduce, or even remove, today´s uncertainties.

Communication has always been critical for logistical success. 17th century war campaigns devoted entire armies to secure communication lines, which if broken would mean uncertain food supply and starvation[1]. More recent technological advances in communication (e.g. telegraph, telephone, the Internet) has developed the frequency and richness of the shared information. The ability to share information has also improved. However, contrary to other enabled advancements, distribution of logistics information for supply chain integration is still underutilised. Not because the gains are unclear but because of the inherent complexity in modern supply chains and organisations relationships and cultures[2].

> Distribution of logistics information for supply chain integration is till underutilised. Not because the gains are unclear but because of the inherent complexity in modern supply chains and organisations relationships and cultures

Integrating the supply chain as a part of traditional business processes (e.g. sales and production) was popularised during the early 1990's[3]. Commonly supply chain integration is categorised in four levels: *baseline, functional, internal and external*[4]. The fourth level, where multiple organisations connect to make customer fulfilment more efficient, is the focus of the 'Multimodal Information Sharing project' *(sv. Multimodal Informationsdelning)* and has been explored by aligning information and/or processes quite successfully[5,6,7].

As the topic of supply chain integration has matured, more general lessons have been published. For example, a survey with 110 manufacturing and retail firms[8] concluded that logistical planning was greatly improved by unbundling physical flows from information flows. The authors also found a significant correlation between sustained revenue growth and supply chain integration. It should be noted that the efforts to integrate the supply chain does not have to start from the first level and move towards the fourth (external integration level). Starting at the fourth level in supply chain integration can contribute to internal collaborative efforts as well[9].

1 Leighton, R. M. (2017)
2 Fawcett, S. E., & Magnan, G. M. (2002)
3 Abdur Razzaque, M., & Chen Sheng, C. (1998)
4 Stevens, G. C. (1989)
5 Dell, M. (1998)
6 Hammer, M. (2001)
7 Konsynski, B. R. (1993)
8 Rai, A., Patnayakuni, R., & Seth, N. (2006)
9 Stank, T. P., Keller, S. B., & Daugherty, P. J. (2001)

The promise of external supply chain integration is great, and the examples cited above show that multimodal (and multistakeholder) collaboration can be implemented to spur more efficient freight movements both internally and externally. With such evidence, logistical information should spread like wild fire and be broadcasted like Twitter. However, sharing information over internal and external organisational boundaries are far from common practice. Current information sharing practices need to be better understood as well as the incentives to develop and sustain them.

1.1 Everyone's connected – but not to each other

In supply chains there are numerous stakeholders involved to secure the efficient and timely delivery of a shipment, from the producer (shipper) to the end-customer (consignee*) (Fig. 1).*

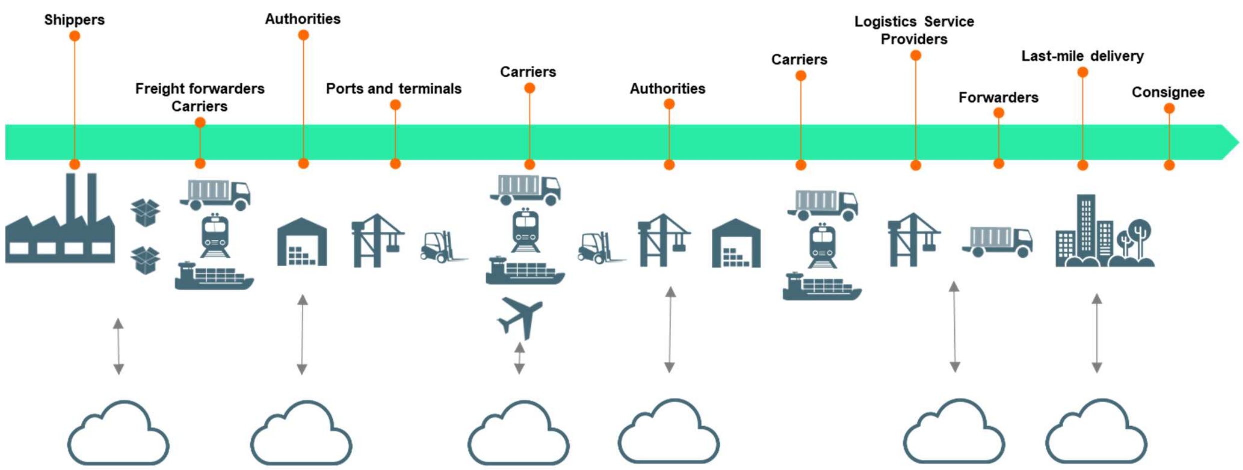


Fig. 1 *Everyone in a supply-chain is connected but not to each other (Source: Ericsson, edited)*

Most stakeholders taking part in supply chain operations are connected in one way or another using digital communications platforms. What is lacking, however, are efficient means and standards to share data and connect parties of a supply chain horisontally to follow, or even surpass, the actual flow of the physical shipment. In addition, a pre-requisite to efficiently share data is to have all the necessary information digitised which is far from reality today.

There are several reasons to why there is a lack of sharing of data in supply chains. Whether it comes down to a lack of common processes, diverse data security requirements, quality and compliance or boils down to the cost of development and implementation, large gains can be achieved if organisations and assets are connected and is willing to share information.

1.2 Challenges of logistics companies

By connecting companies to share data the management of logistics operations will become more efficient. The task of planning, organising and synchronising transport assets, business processes and to meet the requirements to fit to the process of the end-customer are a few of those benefits that can be achieved by sharing the correct data at the correct time with information of high quality.

Below, the challenges that logistics companies face from a multimodal information sharing perspective, are described.

Digitalisation
Digitalisation is the first step in optimising the end to end data flow. Digitising all data already from the start is a pre-requisite allowing other organisations to retrieve, use and share data. An additional benefit of digitalised data is to limit the need for paper documents as all information is available in digital form.

Collaboration
Collaboration is achieved by breaking down the barriers between organisations and domains to simplify the sharing of information. The digitalisation of data is the first step towards developing a common format and understanding of shared information and achieve enhanced collaboration in a supply chain.

Visualisation
Visualisation is possible only when all data is available in digital form and shared between companies. Common meta data will greatly assist using data and visualising the information. Data can be made accessible, and show which party handles the shipment and the cargo can be localised.

This project explores the possibilities to meet these challenges using existing and new ideas and technologies.

2 Multimodal Information Sharing

Promoting and efficient, sustainable and connected logistics network

2.1 Overall objective

The overall objective of the project Multimodal Information Sharing is to, using existing and new technology, describe and test new ways of integrating and connecting different transport modes and stakeholders in a multimodal supply chain by efficient sharing of information.

Demonstrating how increased transparency can facilitate more efficient tracing and steering of freight flows before and during transport is the goal when creating a seamless logistics network.

2.2 Aim of the project

The aim is to *map information gaps* in the communication between stakeholders in an export supply chain, this by exploring two so-called 'use-cases'. Secondly, a draft proposal of a *generic and open system platform architecture* will be presented on how to connect organisations. This to provide better means of sharing the correct data timely and with high quality. Lastly, using *business modelling* the project will evaluate foreseen benefits generated by using the suggested platform for sharing data.

The proposed technical solution and the foreseen benefits that stakeholders gain by sharing data more efficient and to fill identified information gaps will be brought into a business model. The ultimate goal is to find a *business model that distributes value more or less amongst all stakeholders across the entire supply chain*.

2.3 What has been done in the project?

The project has used a *bottom-up-approach* to map and describe the current state in two 'use-cases'. These use-cases represent two actual export supply chains managed by Sandvik and SSAB. Each supply chain has been thoroughly mapped to show-case the current information shared between stakeholders involved in the logistics operations. The mapping also had the purpose of investigating 'blind-spots' were data was insufficient or lacking having an impact on the overall performance of the supply chain. In addition, the performed mapping also had the purpose of investigating the different means of which information is shared today (either by using digital communication, e-mail or simply by using the telephone).

Keeping in mind the current state in the sharing of vital information between stakeholders, the second stage of the pre-study has been to investigate the potentials of implementing existing or new digital platforms to connect stakeholders and to share data efficiently between the different parties. As part of the project, a conceptual design of a system service for sharing multimodal information has been explored and drafted.

It has been, from the start of the project, a *pre-condition is that a future system service is designed to be a neutral and open platform* where all stakeholders can access, use and contribute into. Today companies feel that they are technologically locked into solutions that are restricted and are often very costly and time consuming to develop and maintain. On the contrary, organisations are eager to achieve faster improvements at a lower cost and to achieve more flexibility solutions.

> A pre-condition is that a future system service is designed to be a neutral and open platform where all stakeholders can access, use and contribute into

A potential ‘deal-breaker’ for the future development and implementation of an information sharing service has been examined using suitable business modelling. A business model must prove the potential benefits of an innovation for all stakeholders, this to cover initial development costs, the cost of integrating data services and cover future data transaction costs.

2.4 What has been left out in the project?

For the results from the project to be relevant for all types of supply chains, the focus has been on providing generic results on how a future service for sharing multimodal information could be designed and function and what the main gains and benefits can provide to future users.

For the development of the systems architecture it was decided to keep the conceptual design at a high /generic level. This to describe which benefits and how a more efficient sharing of data between stakeholders can contribute a more efficient transport operation by reducing uncertainty, costs etc. By describing these benefits, it is also worthwhile to pinpoint what types of efforts and decisions an organisation needs to take to make it happen.

Furthermore, the design of the system architecture has not detailed potential services or technology on secure transaction of data such as block-chain technology or different types of authorisation services.

Reporting for this project will be made on an overall level describing the current state for the examined use-cases and what the new approach on implementing a more efficient way of sharing data to can do to ease up restraints in the physical operations of a supply chain. The add-on is on the business modelling and the aim to prove that implementing these types of systems services is feasible from an organisational perspective in terms of cost/gains and so forth.

3 Stakeholders

Several organisations are involved in the execution of a supply-chain operation

As the future service architecture is based on the two use-cases it is also worthwhile to show-case that the two flows are representable, and even similar, to almost any other type of export flow in the field of steel and metal produce. The main stakeholders in a future service for sharing multimodal information are:

Shipper (Consignor) - The shipper is the organisation initiating the shipment from A to B. In the examined use-cases *Sandvik* and *SSAB* represents the role of the shipper.

Receiver (Consignee) - The consignee is the reveiver of the shipment. For the use-cases the Consignee is represented by *Pexco* in the US (Sandvik) and SSAB in Mexico (SSAB)

Road Haulier - The road hauliers are responsible for the actual pre-carriage of cargo from the production site to the port terminal. They can work independent directly with the shipper or together with a freight forwarder. In the examined use-case, *RoadCargo* is responsible for the pre-carriage from Sandvik's production site whilst the pre-carriage for SSAB is made exclusively using rail transport.

Rail Transport Operator - The rail transport operator transports the cargo by rail and can operate independent directly with the shipper or in cooperation with a freight forwarder. In the examined cases, this role is represented by *Green Cargo* performing the carriage of cargo from the SSAB production site in Borlänge.

Freight Forwarders - Freight forwarders are the stakeholders acting as an intermediary and on behalf of the shipper to carry out the shipment and secure that all arrangements between shipping lines, road hauliers, rail transport operators and terminal operator are running smoothly. The Freight Forwarder can also act as clearing agent for customs release of shipments. For the two use-cases Sandvik has appointed *Geodis* to take on the role and SSAB uses *Panalpina* as their contractual partner.

Terminal Operator - The terminal operator has several functions on their plate in the supply chain. They handle the loading and unloading operation of inbound/outbound shipments at the port and also performs stuffing and stripping of container on behalf of their customers. At the port of Gävle, *Yilport Terminal* is the operator of the container terminal.

Shipping Line - The shipping line is the participating carrier over whose sea routes the section of carriage is undertaken or performed. They can work independent directly with the shipper or together with a freight forwarder. In the case a pre-transport by a feeder vessel is carried out the sea carrier can appoint a feeder operator a reserve container slots for their respective shipments.

Authorites - Authorities are involved in several ways in granting and securing access to infrastructure. The roles of the authorities can also include customs, charging and more. In the use-cases *Trafikverket* represents the infrastructure manager of rail and road, *Sjöfartsverket* the safe keeper of fairways and the *Port of Gävle* the infrastructure at the sea port. In addition, customs administration is managed by the *Tullverket*.

4 Current state in the steel industry

Did our initial suspicions turn out correct?

4.1 The Cases of Outbound Steel Logistics

Our case journey begins in Sandviken where its namesake Sandvik Material Technology, part of Sandvik Group was founded and still has one of its main production facilities. At the production site orders are handled, materials are produced and made available for delivery. The case then follows the physical transfer of cargo from the manufacturer’s gate to the port in Gävle, Sweden by road. At the port the incoming goods are made ready for departure on a container feeder ship for further handling and transport towards its destination to the customer Pexco, located in the US. Although it is international outbound deliveries the project, and this report, specifically focused on the first leg of the journey, from the production site to departure out of the port in Gävle.

For the comparable case of SSAB, a similar supply chain was mapped with cargo departing in Borlänge, Sweden with a destination in Altamira, Mexico. Much of the processes and information flows are similar between the two cases although for the SSAB case, rail transport is used for the pre-haulage to the port in Gävle. For the detailed description of the current sharing of information and process the report will use the Sandvik-Pexco as the primary story line to detail the information flow. *Fig. 2* provides a geographical overview of the two examined cases.

Fig. 2 *The two mapped export flows of Sandvik and SSAB*

It should be noted that both Sandvik and SSAB as well as their partners (Geodis, Panalpina, P.J. Haegerstand, Green Cargo and Tullassistans) were instrumental in providing the necessary information used in the detailed mapping and subsequent business analysis.

The physical flow functions as a spine of vertebra to which specific information flows are mapped. The process is divided into three phases: *Slot booking*, *Pre-production* and *Post-production*. Through on-site visits and interviews with individuals the complex interplay between the shipper, carrier, authorities and customer formed into a first draft. This draft was then reviewed independently by the project participants and via joint discussions in a full day workshop. Both cases are pictured in their entirety in *Fig. 3*.

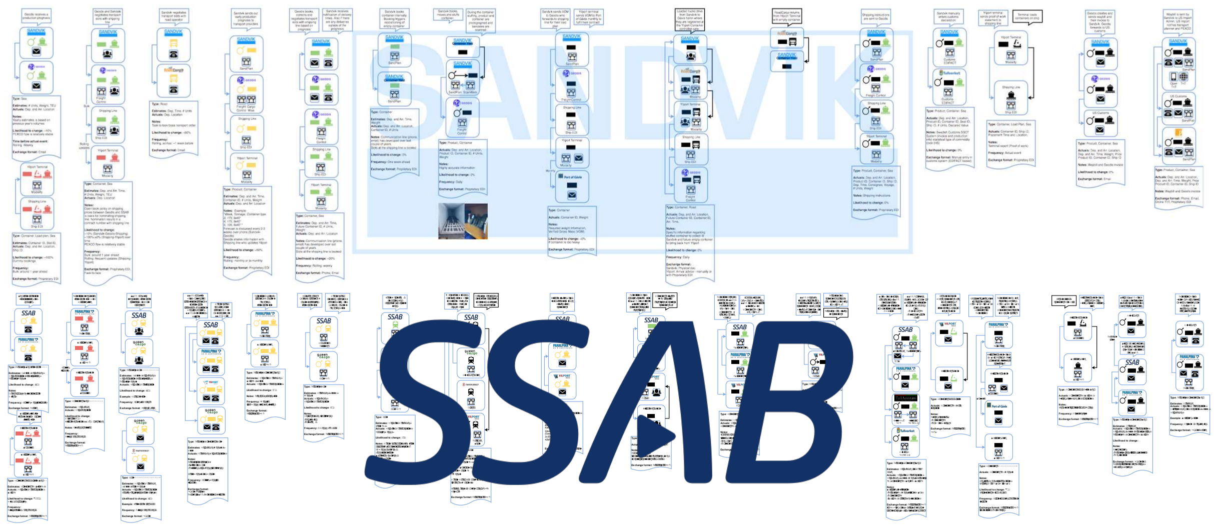


Fig. 3 *Complete overview of the most important informational flows between the manufacturers Sandvik and SSAB and their departure from Port of Gävle*

4.2 Sandvik - PEXCO

The actual transport of cargo is preceded by a long line of prognoses, plans and calibrations. The following mapping begins before any purchase order has arrived and ends with the actual cargo departing form the container terminal at the Port of Gävle.

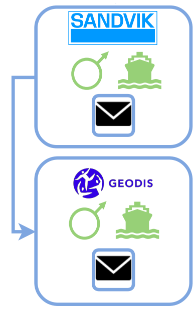


Fig. 4 Geodis receives a production prognosis by email detailing the units of production and probable sea destinations

Slot procurement

Based on previous orders and projections of the Pexco business developments, Sandvik draws up a production prognosis. This early prognosis is shared with their freigh forwarder Geodis, as pictured in *Fig. 4*. The prognosis starts with a yearly plan and is updated via e-mail on monthly or even a weekly basis, where new orders come in and others are altered or confirmed. Stable flows like the Pexco is quite predictable on a yearly basis, however, this can vary considerably from shipment to shipment. The information gives a rough idea of the need for transport, which is based on the number of produced units, their estimated weight and equivalent need in terms of number of containers.

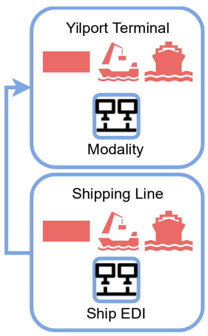


***Fig. 5** Yilport terminal receives the shipping lines' schedules and dummy estimates for container numbers, load operations. The information is sent via a proprietary electronic data interchange (EDI) interface*

In parallel, the prospective shipping line draws up a schedule of their operations. This schedule is shared with each nominated port terminal (in this case the terminal operator Yilport) (*Fig. 5*). The terminal, in turn, plan their operations, staffing and routine maintenance. The information entered into the terminal's system 'Modality' are only placeholders for the subsequent updates with actual container numbers and weights.

The shipper, Sandvik, and the shipping line communicate through the freight forwarder, Geodis, to reach agreements between the need and the available transport slots (*Fig. 6*). The parallel realities of the producer and the shipping line briefly converge – a first piece of the information exchange is created in the form of a contract number as the shipping line is nominated. The updated information is passed on to the terminal operator Yilport to keep them up-to-date.

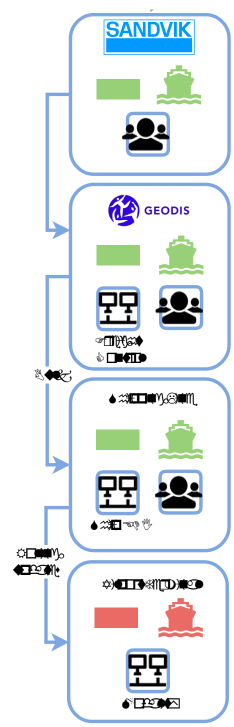


***Fig. 6** Sea and container information to negotiate transport slots and nominate shipping lines. In person meetings are turned into digital communication on the sea carrier side.*

In contrast to the longer time window for negotiating sea transport (6-12 months), road transport is booked more ad-hoc. With around a week's notice, Sandvik sends an email detailing the number of units and departure times to the road haulier Road Cargo as shown in *Fig. 7*. Road Cargo dispatches the request to their drivers and oversees the operation.

***Fig. 7** Sandvik negotiates transport slots with road operator by phone.*

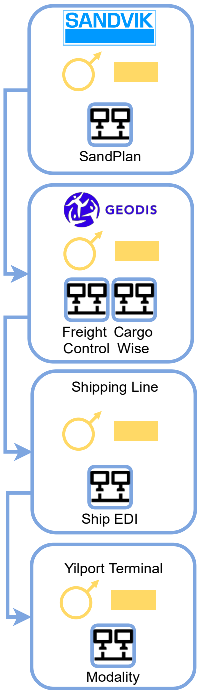


Fig. 8 *Sandvik sends out early production prognosis to transport providers. Prognosis is sent via EDI and is checked against previous slot procurement for anomalies.*

Pre-production

As orders start to trickle in, the previous statistical production averages are replaced by more concrete details (*Fig. 8*). Through proprietary electronic data interchange (EDI) communication channels, Sandvik informs Geodis on the shipment details (e.g. departure times, weights and container types). The information is forwarded to the shipping line, who also updates Yilport Terminal. The terminal's dummy bookings are updated with with these tentative details. For Yilport Terminal, these details are still too uncertain and too far in the future to have any impact on their operational planning.

To give further detail, Sandvik and Geodis also discuss the production forecast over phone bi-weekly to limit unforeseen deviations. Geodis uses this information to secure the optimal slots with the previously contracted shipping line(s). The earlier tentative slot-booking made by Geodis are transformed into specific spots on ships (*Fig. 9*).

Stuffing

After production has finished a specific container is nominated to carry the cargo. Here the second puzzle piece of the information flow surfaces, the 'Container ID'. Sandvik books and uses the containers they have access to in their own container yard as pictured in *Fig. 10*.

Booked containers are moved and stuffed by Sandvik. Before sealing the containers, they are photographed together with the loaded cargo items to simplify potential liability claims of container or cargo issues. Sandvik uses a purpose-built hardware scanning unit called 'ScanWare'.

The third piece of the puzzle, the 'Product ID', is added to the previous Container ID and 'Shipment Contract ID' and sent to Geodis to enable detailed tracking (*Fig. 11*).

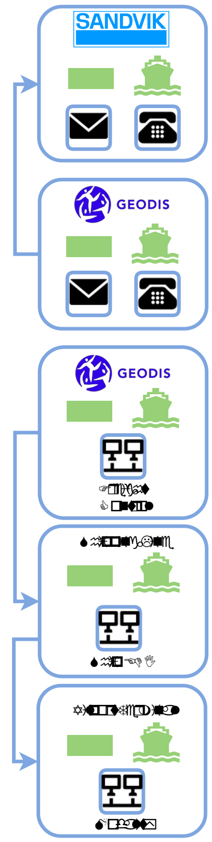


Fig. 9 *After phone conversation Geodis books or renegotiates the slots on the shipping line via EDI. Yilport Terminal is updated on the booking.*

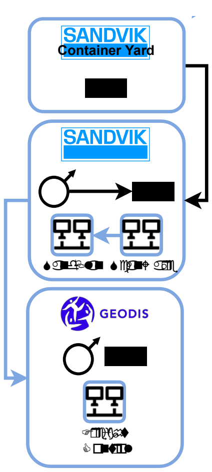


Fig. 11 *Containers are moved from the yard and stuffed. Products and containers are photographed and logged with their ID, sent to Geodis via EDI.*

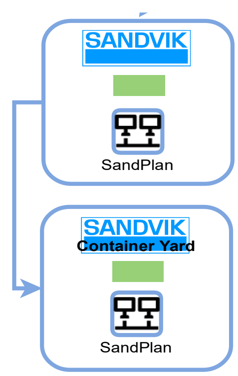


Fig. 10 *Sandvik books the container internally. The booking triggers a repositioning operation for empty containers*

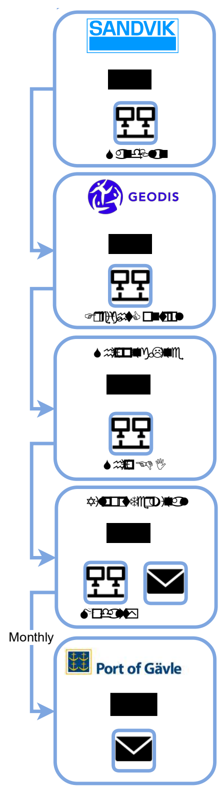


***Fig. 12** Sandvik weighs and sends standardised VGM to Geodis who forwards this to the shipping line and Yilport Terminal in turn via EDI. Yilport Terminal reports to Port of Gävle once a month via email.*

Regulations on a standardised measurements of *Verified Gross Mass* (VGM) requires the shipper to weigh and report container weight. Sandvik measures this onsite and passes this required data to the relevant parties (freight forwarder, shipping line and terminal operator) as shown in *Fig. 12***Fel! Hittar inte referenskälla.** . The VGM is also passed to the port authorities at Port of Gävle via e-mail monthly from the terminal operator to fulfil their contractual obligation.

Land Transport

The sealed container is collected by the driver who gets a paper slip detailing the requested transport assignment. In addition, Road Cargo also receives details for an empty container to bring back and complete the loop. The dispatched truck is registered at the Yilport Terminal operated gate at Port of Gävle. The shipping line, to which the container belongs, is informed automatically on its arrival via EDI. The information is forwarded to the shipping line's primary contact, Geodis, who forwards the arrival notice to Sandvik. The whole chain of the physical and information flow is captured in *Fig. 13***Fel! Hittar inte referenskälla.**

Road Cargo complete their assignment by retrieving and returning an empty container to Sandvik's container yard (*Fig. 14*).

Sea-terminal Movements

The stage is now set to join the flows of information and consolidate and finalise the required documents for the seaward journey. As shown in *Fig. 15*, Sandvik passes on the specific details of the products, containers and vessel to Geodis who informs the shipping line and Yilport Terminal (indirectly). Defining the consignee is an important part of this step. The consignee, being financially responsible for the upcoming logistical events, gets a central function in the upcoming information flows.

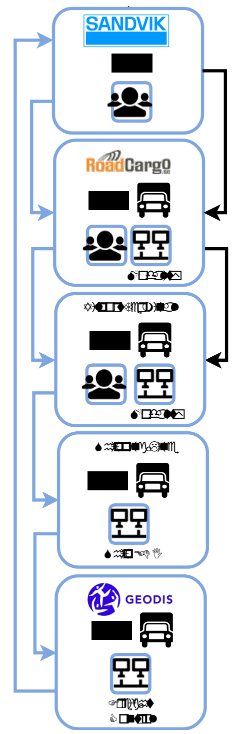


***Fig. 13** Loaded trucks drive from Sandvik to Port of Gävle where they are registered at the Yilport Terminal controlled gate.*

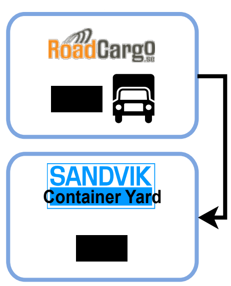


***Fig. 14** Road Cargo returns from Yilport Terminal with empty container.*

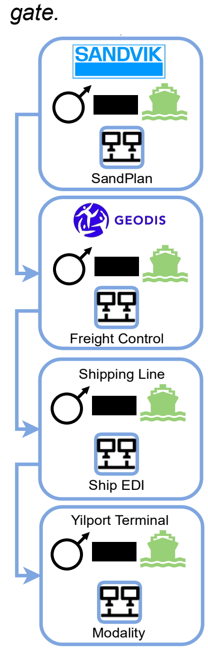


***Fig. 15** Shipping instructions are sent via EDI from Sandvik to Geodis who forwards this to the shipping line.*

CLOSER

Sandvik makes the required customs declaration directly through Tullverkets[10] *EDIFACT*-based system, shown in *Fig. 16*. Depending on destination and type of cargo the requested information might be different and changes according to different national regulations.

With the full outbound information puzzle laid (e.g. Product ID, Container ID, VGM, Ship ID, Consignee, Customs declaration) the shipment is ready to be loaded onboard the vessel (*Fig. 17*). This is the final and crucial physical step that precedes the creation of the final financial documents and transfer of responsibility from the shipper to the receiver. It should be noted that, the degree to which responsibility is transferred and who is liable is regulated in the contract between the buyer and seller and can differ by degrees.

Based on all the proceeding information and actual physical events, a waybill is drawn up by Geodis to detail the nature of the transport (e.g. origin, destination, consignor, consignee and product details), pictured in *Fig. 18*. The waybill is sent to Sandvik for reference. In the case with Pexco being the customer, the waybill is also forwarded by Geodis to the US customs to speed up administrative processes.

Pexco, being the consignee, is notified of the incoming shipment by Sandvik directly and by the US customs (*Fig. 20).* To support customer inquiries, Sandvik has developed a *track and trace* application available to their customers and logistical partners. Certain orders can be monitored by entering the specific order number, which will trigger the mobile application to push notifications as seen in *Fig. 19*.

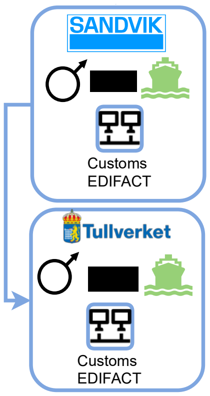


Fig. 16 *Sandvik manually enters the custom's declaration in the EDIFACT based system.*

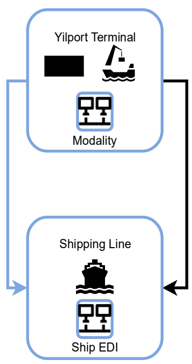


Fig. 17 *Yilport Terminal loads the containers on the vessel. Proof of work is sent to the shipping line.*

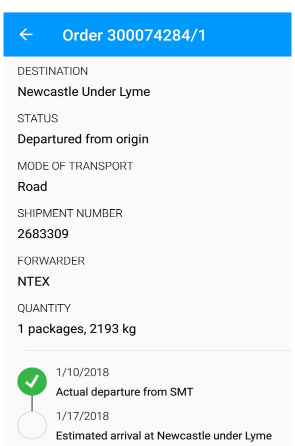


Fig. 19 *Sandvik's track and trace application for their customers and logistical partners.*

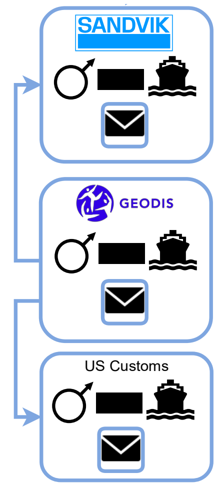


Fig. 18 *Geodis creates and sends waybill and their invoice to Sandvik. Geodis also forwards waybill to the US customs.*

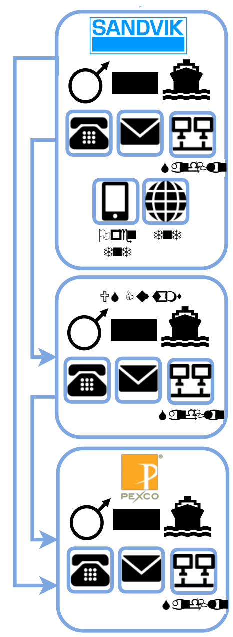


Fig. 20 *Waybill is sent by Sandvik to US Import Admininistration who notify the transport planner and Pexco.*

[10] Swedish Customs Authority

4.3 Discussion and Recommendations

Over the many interviews preparing the multimodal logistical information chain mapping, certain patterns emerged. Unfailingly, current barriers for sharing information were discussed, as well as the great opportunities to make logistics operations more efficient. Based on the stakeholders' input, core logistical experts from CLOSER, Sjöfartsverket and RISE Viktoria sat jointly to categorise the impressions. The following discussion detail the result of this work.

Backwards Information Flow

An interesting insight from interviewing such a wide variety of logistics actors (producers, freight forwarders, goods handlers and carriers) were the counterproductive direction the information flows. Instead of following or even preceding the physical flow of shipments, information most often was sent 'backwards' in the chain towards the producer and shipper. In one way this is sensible, as the producer is the primary initiator and contact for the logistics operations. This is also the source of the value being transported and therefore seen as having ultimate control of how information is distributed.

However, since the manufacturer, first and foremost creates value in production, logistics play a marginal role in their business model. Instead, logistics is more of an unfortunate consequence of customers being far away. An example of the backwards flow is information from land transport (e.g. road and rail) that Sandvik and SSAB has access to. This information often only confirms that the logistical plan is being followed and is of little or no interest to the producer who needs to focus on shipping the next product. Yilport Stuffing and Yilport Terminal on the other hand, being next in the supply chain could prepare their systems for the arrival of a shipment (if the information is reliable).

Another example of information being offered to the 'wrong' party are the sophisticated logistics operations system interfaces that both Geodis (*Iris*) and Panalpina (*myPanalpina*) provides. In these, the freight forwarder visualises their collected intelligence on logistics events. However, despite the wealth of information these systems hold, the interfaces are only sporadically used. One reason is that part of the information is already integrated with the producer's own systems. Another reason is that the producer often fulfils their contract the moment the cargo leaves the production facility gates or the nearest sea port. Having completed their contractual obligations, the cargo's onward journey is only a question of customer service.

'Small Changes, Big Impact'

In the 1990's, when ICT systems were still a novelty, sharing logistical information was a radical departure from traditional operations[11]. Today, having frequent updates to the whereabouts of the shipment is expected. Granted Business-to-Consumer (B2C) logistics has come further than Business-to-Business (B2B) transport information, it became clear in the interviews and analysis that most information is already available. By relatively small means it could be sent forward to make the logistical flow smoother and thus more efficient.

> Most information is already available. By relatively small means it could be payed forward to make the logistical flow smoother and thus more efficient.

The trove of information that the freight forwarders have access to, that could be extended to a wider range of partners, has already been mentioned in the previous section. Another example is Yilport Terminal, who is primarily connected to shipping lines and, therefore, has a complementary perspective on the logistical chain. By simply adding the port terminal or the producers (e.g. Sandvik and SSAB) to the list of recipients a detailed and reliable account of incoming and outgoing transports can be

[11] Utbult, M. (1991)

delivered. Similarly, the rail operator Green Cargo could easily add another e-mail address to their track and trace feed and make Yilport Terminal and Port of Gävle aware of incoming trains.

Access Granted

Naturally extending access to information need to be preceded by explicit admission by the data owner. However, since the data owner in most situations is the shipper this problem seemed to be over-exaggerated in the interviews. Since the shipper has a unique relation to most logistics information – a by-product of producing goods, in contrast to carriers and freight forwarders who use it in their core business – the shipper is less likely to be overly protective of the information. Sharing logistics data to support more reliable transport of goods was unanimously supported by Sandvik and SSAB. In fact, the sentiment the producers were that '*no manufacturer in the outskirts of Europe can afford to be anything but transparent*'.

> Sharing logistics data to support more reliable transport of goods was unanimously supported by Sandvik and SSAB. No manufacturer in the outskirts of Europe can afford to be anything but transparent

Not all information is treated equal. For example, negotiated prices on cargo or transport terms were regarded as sensitive and in need of tighter access control. Also, full transparency between the producer and the end-customer might be sensitive to the local distributor who want to keep their sales network private. However, normal track and trace information for containers are regarded as open. Everyone from the producer, freight forwarder to the terminal operator and carriers offer some form of track and trace interface.

It happens that openness causes issues, as for example, when companies have access to information about available material or containers but are restricted from collecting them since they are kept for an undisclosed customer. However, overall the benefits seemed to greatly outweigh these extreme cases.

'Actually Actuals'

Contractual definitions of when actuals[12] should be reported is often different from the actual event itself. This is fine when everything proceeds according to plan and the actuals are only used to document and file shipment records. However, when the receiver needs to know specific whereabouts of a container, the common contractual terms of feedback within 24-96 hours of the actual event is too late. In this case the information delay mean that the shipment has physically arrived but cannot be reached since the information is lagging.

Similarly, more accurate insight into the real need of customers would assist producers to a large extent. For example, some customers place an order for a certain date – weeks before it is needed. The manufacturers then produce the goods only to find that the payment for the order is not released. Instead the customer let the manufacturer store the cargo until they are needed at which point the funds are transferred.

In this scenario, more accurate logistics can help. It should be noted, however, that reliable logistics information is only part of the problem. The other part is the difficulty to reliably predict the complex production process of Sandvik and SSAB, which also make this buffer creating behaviour necessary.

High Quality Estimates

Actuals is only a small slice of the needed logistical intelligence and is mostly used for following up on agreements and historic analysis. Estimates and the reasons for current events are necessary for ongoing decisions. When more alternatives can be evaluated, through trustworthy and reliable estimates,

[12] 'Actuals' refers to notifications about an event occurring during the transit of a shipment

costly distribution centres can be limited. More direct flows from the production facility is instead promoted. Furthermore, with such high-quality estimates' plans could be developed more proactively, in contrast to the prevalent follow-up analysis.

There are three main stakeholders that influence the quality of estimates. First (*1*) it is the producer and their production line, with its inherent complexities. Second (*2*), it is the carriers who often have the ultimate detailed insight into the next steps, concerns and influences. The third (*3*) stakeholder to influence estimation quality is the freight forwarder. The freight forwarder has a unique ability to raise the quality of estimates because of their overview of the whole supply chain. Coupled with years of experience this means that they can spot irregularities and offer their, more realistic, version.

Inflexible Infrastructure and Information

Both the physical and informational sides of logistics follow well-worn paths. One example is that containers can only be used for a certain amount of time and with a specific shipping line. The restrictions mean that the containers and products are combined at the latest possible moment, which obviously impacts the ability to form reliable information at an early stage.

Another example of the current inflexibility is slot procurement. Slot procurement is done over time horizons that are disconnected from the actual needs. The long-term contracts impact both shippers and carriers who must live up to impossible forecasts. To manage these time horizons a balance need to be struck between batch size (resource utilisation) and flow efficiency.

Inflexible IT-systems limit the logic that can be used to log and communicate events. Precision is lost by using inappropriate number formats. Allocation of containers is not allowed to be communicated and only stored in the shipping lines internal systems. E-mail with all its advantages is not appropriate to automate administrative tasks. Restricting communication to email, phone or face-to-face meetings, which is still normal in the Sandvik and SSAB case, cements the current situation. Without significant change the current manual ways of doing business are unlikely to change, which is a strategy that only works until it becomes a value proposition.

> Inflexible IT-systems limit the logic that can be used to log and communicate events. Precision is lost by using inappropriate number formats.

Finally, when digital interfaces are used they are proprietary without exception. Creating one of a kind information formats and integrations severely limits the utility of the obscured interfaces. Different customers are, in effect, locked into systems that all have the same information but are separated by incompatible languages (data formats and standards).

Same Same but Different

Full insight and control are currently only possible in a situation where outbound and inbound logistics is within the same company. In other situations, the amount of integration for similar control quickly spirals away. Every stakeholder has their own perspective and language to communicate their needs. Road transport, being the most diverse actor category is also the most difficult to integrate and communicate with.

The diversity also means that it is virtually impossible to identify all partners in the logistics chain. Identities from one domain or system are unique from another. This is an important issue since if partners cannot be identified in a trustworthy way the communication cannot be controlled in a meaningful way. This limits the type of information that can be shared beyond the immediate known vicinity. A truly efficient logistics chain needs to be able to allow partners access to information in the same ad-hoc fashion that they get physical access to handle it.

5 Sharing data tomorrow

A future system architecture

This chapter provides insights in how existing, or new technology, can assist in connecting stakeholders of a supply chain. This for the purpose to enable more efficient sharing of information. To form and draft the systems platform architecture, the so-called 'TO-BE' proposal, the two investigated use-cases of Sandvik and SSAB will act as reference when describing the principles and contents of the proposed achitecture.

5.1 Investigated use-cases of Sandvik and SSAB

The two use-cases of Sandvik Material Technology and SSAB each represent two, quite typical export supply chains. Despite the two companies' different product portfolios they have a lot of common processes in their supply chains:

- Both companies' carry out pre-haulage of shipments from the production site to the sea container terminal using road or rail transport
- They both have a contract with a freight forwarder responsible for the booking and planning of the sea transport
- There are still mostly manual actions performed, the level of automation is low
- During the supply chain operations neither Sandvik nor SSAB are updated on where their shipments are located or how the cargo is treated

Sandvik Material Technology

From the performed mapping of Sandviks export flow the results show a lot of manual actions being carried out to share information to stakeholders downstream the supply chain. Information are shared using several different lines of communication including e-mail, phone calls and in some cases EDI-messages. The mapping also reveals several shipping documents being digitised in Sandviks internal system are sent via e-mail to external recipients. The recipient must retype information and digitise information all over to use in their own IT-environments.

Besided the handling of shipping documents, Sandvik representatives stress the need for better feedback from the logistics providers on the localisation of their shipments during transit. Today, Sandvik has little direct information on the whereabouts of their container shipment once they have left the port in Gävle until the shipment arrives at the destination port. For the mapped export flow, the lack of information becomes an issue once the container feeder vessel arrives at the ocean container terminal (e.g. port of Hamburg) were the cargo is shifted to transoceanic container vessels.

SSAB

The analysis of the process of SSAB also reveals a lot of manual actions being carried out for sharing information to external receipients. The shipping documents are digitised by SSAB but sent as an attached document via email to the recipient(s) in the downstream supply-chain. Once more, the receiver needs to retype information and digitise to fit into their IT environment.

Besides the handling of shipping documents, there is no or little feedback from the logistics providers to SSAB where the shipment is or when it will arrive according to the ETA (Estimated Time of Arrival). Information from Green Cargo (rail operator) can be sent to SSAB but their IT-systems have not been designed to handle the data formats. The high number of road transport providers used by SSAB to perform haulage makes these IT-challenges even bigger.

5.2 Generic market observations

Observartions and results presented under chapter 4 on the two examined use-cases reflect general issues and concerns applicable on the overall transport and logistics industry.

To summarise, the main challenges for the two examined supply chains boils down to two main topics:

Lack of end-to-end capabtilities limits responsiveness and the potential of reducing lead times. This includes the lack of visibility of the shipment location in the value chain and the lack of integration and coordination for managing the entire operational spectrum. It also leads to the inability to reflect changes in data made by one actor throughout the entire supply chain. Furthermore, using expensive EDI-connections a vast jungle of different messages with a too flexible workflow are created which leads to unpredictable and even unreliable responses.

Manual processing of information limits timely identification of problems and bottlenecks. The freight forwarders rely on telephone communication and emails with attached documents to a large extent. In general, interations between stakeholders are based on telephone calls, emails and manual interventions. In excess, as a positive consequence of digitised information, a significant reduction of paper-based processing is in line with environmental targets of the UN, EU, IATA amongst other international and national institutions. This by limiting the large amount of paper used in today´s supply chains.

To address these challenges and to limit their constraints, *Data Integrity and Analytics* need to be brought into consideration. By creating and providing data access through one connecting interface helps eliminating data re-entry and errors when updating and maintaining data used by all parties in the supply chain. Reporting tools and real-time information dashboards are fundamental when analysing data. Whether it is for finding patterns or deviations, the possibility to drill-down in data is a pre-requsite for constant improvements in supply chain efficiency. Similar, master data and regular updates to ensure quality and relevance are important aspects as well as the use of unique IDs for single assignments, items etc.

> By creating and providing data access through one connecting interface helps eliminating data re-entry and erros when updating and maintaining data used by all parties in the supply chain.

5.3 Design principles

As an introduction to the system architecture in the 'TO-BE proposal' a few design principles will be explained as background to better understand the chosen approach. The design principles that form the basis for the generic system architecture are fundamentals of *the Internet* and *Internet of Things (IoT)*. Both principles and the unique items of which they are built upon are described below.

Utilise the power of the Internet

By utilising the power and architecture of the Internet provides a solid foundation for accessing and sharing logistics data. Currently, sharing digitised data between organisation is mainly performed using EDI links, which are both expensive and has caused a monopoly by a few actors in the market. The main objective for using the Internet for sharing logistics data is the possibility for organisation to interact directly with each other. This by using a simple, flexible and accessible mean to support their business and entire supply chain. As of today, it is foreseen that the transport and logistics sector will drive the development and evolution of sharing logistics data over the Internet.

By using the Internet to share and retrieve data, organisations can interact in a more efficient way providing a boost on digitisation, collaboration and visualisation. The way organisations communicate today, as mentioned previously, is by using physical or digitised documents. By instead utilising the Internet, a new approach will emerge where the main objective is about communicating data. To group the data needed for the different roles in the end-to-end shipment, the term 'Pouch' is introduced in the proposed architecture (a shipper's pouch, a freight forwarder's pouch, a carrier's pouch, etc.). Using a Pouch, data will only be described once and limits the need for retyping data and easens the authorisation process for the recipient to access data.

A core component of the proposed architecture is the 'Logistics Data Interchange' (*LDI*) (*Fig. 21*) enabling on-demand digital collaboration between relevant stakeholders in the supply chain and logistics network. It is based on an open, distributed and standardised architecture and is the core component when communicating logistics data through the Internet. The LDI is part of a generic concept that can be used throughout the logistics market. It is up to the involved companies to create their own LDI or to use an existing one.

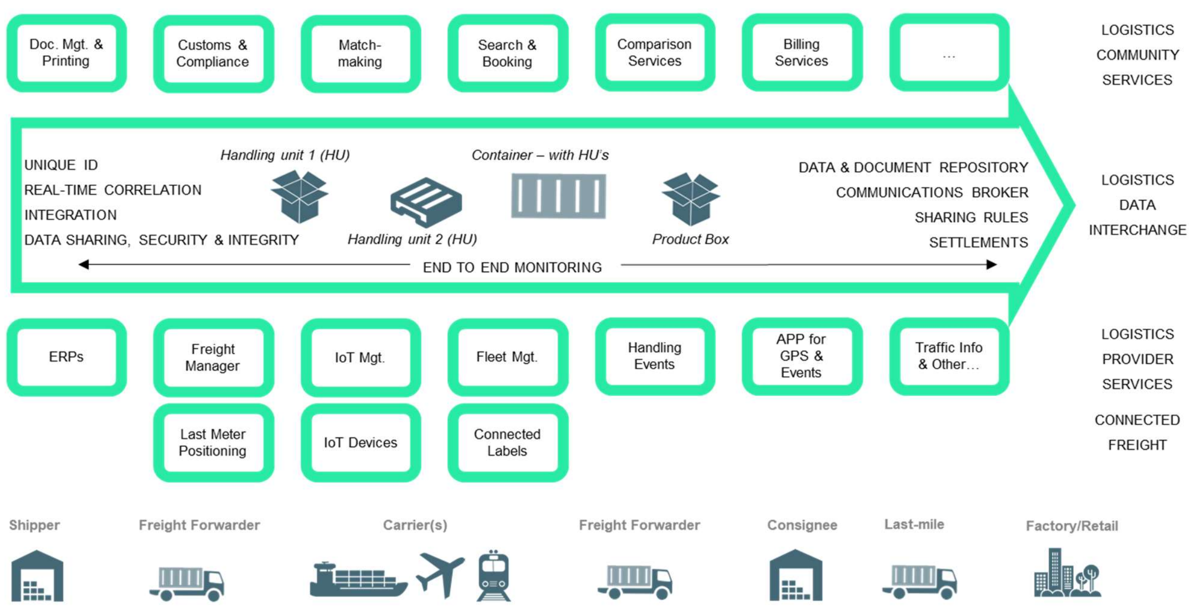


***Fig. 21** Overview – Logistics Data Interchange and examples of functions to be linked (Source: Ericsson, edited)*

It is foreseen that many many LDI's will be developed in the coming years, all these LDI's together will contribute to the future sharing och logistics data using the Internet.

Global Unique Identifier

One important item in the proposed architecture is that for each logistics object (package, pallet, container, truck, etc.) it should be possible to uniquely identify them throughout the Globe, no matter where their physical location might be. For this reason, the term *Global Unique Identifier* is introduced. To make it more concrete an example will be given.

"Imagine having a box in your warehouse and not knowing anything about it as in the future all boxes will be paperless. The box has a label (QR code) consisting of a Global Unique Identifier. When

scanning this label, you will be routed to a Uniform Resource Identifier (URI) - http[13] link - that will show you (when authorised) all data of that specific package: Consignee, Consignor, Delivery Address, Contact Person, Shipping Document Data, etc."

The first hurdle to pass when striving towards a *Global Collaboration and Information Sharing Platform* is how to create a Global Unique Identifier for the object for which information should be shared. Especially since most companies have invested in systems which have existing unique numbering within their realm and are reluctant to change or modify these systems. A solution to overcome the different unique identifications used by single organisations, the architecture proposes the use the Global Unique Identifier and to design it in such a way that each organisation can easily adapt their existing applications.

A Global Unique Identifier consists of the following information, as summarised in *Fig. 22*:

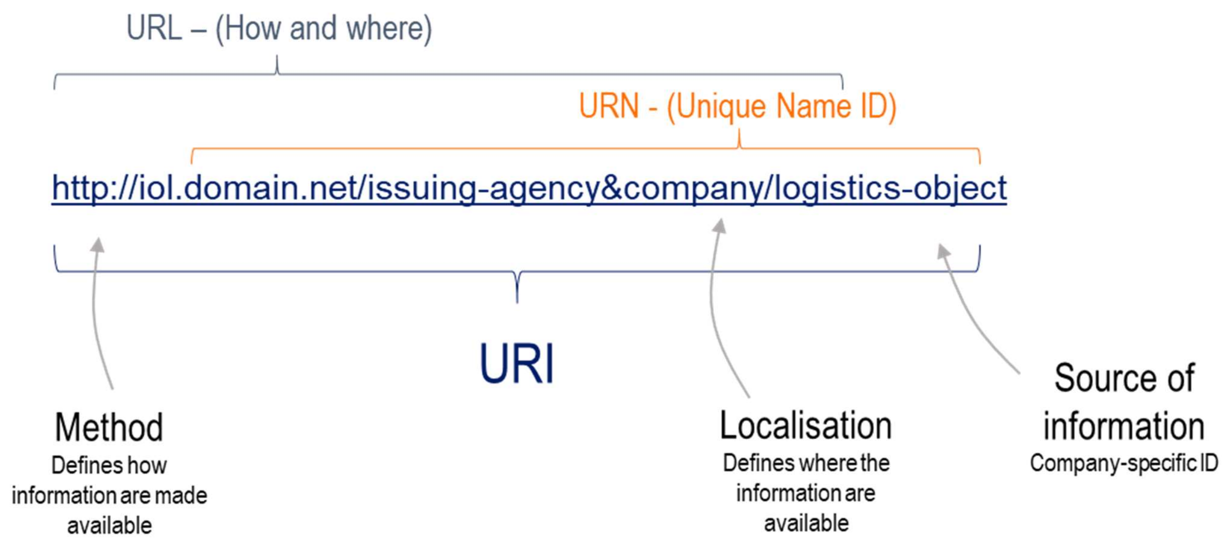


Fig. 22 *Fundamenatals of the Global Unique Identifier (Source: Ericsson, edited*

Logistic Object

Most logistics companies already have a unique identifier e.g. a Package ID in their own logistics domain. This unique number, or *Logistic Object* will, in the future, still be used but more information will be added to make it globally unique. (Standards: ISO 15459, GS1 SSCC, EDIFICE)

Issuing Agency & Company

The *Issuing Agency & Company* corresponds to which organisation having issued the *company license plate* and which company have issued the Logistics Object. Today there are multiple organisations registering companies according to the ISO 15459 standard / EDIFICE standard, e.g. NEN or GS1.

"To give an example: The company Ericsson is registered by the issuing Agency called NEN, their abbreviation is LE. They registered Ericsson as LME. This leads to the combination LELME as an identifier."

[13] HTTP - *HyperText Transfer Protocol* is the underlying protocol used by the World Wide Web and defines how messages are formatted and transmitted.

Logistics Backbone

The *Logistics Backbone* is a string to identify a Logistics Data Interchange - LDI. There will be multiple LDI's and every LDI should be able to support multiple organisation. In above example described as: http://iol.domain.net. (Standard: RFC 3986)

On demand collaboration

The earlier described the Unique Resource Identifier is the key to create on demand collaboration in several ways. By introducing a Global Unique Identifier for Logistics Objects, it enables multiple IT-systems to connect and agree on naming of objects without integration or standardisation efforts and agreements.

The URI serves as an information address for anyone or any system that would like to retrieve or add information related to the object. By putting an URI in a browser (or scanning a bar code, that leads to the URI) will end up in the '*Home Information Center'* of the object. The user and the informations dashboard of the object can now interact. The URI is used to publish data related to the Logistic Object. Other systems can subscribe to information updates.

The URI enables multiple LDI's to work seamless together. It also enables a distributed architecture where digital collaboration can be achieved across all digital platforms. It also allows on-demand collaboration between all stakeholders in supply chains and logistics networks without the need for peer-to-peer integrations or previous knowledge about each others existence.

Real-time correlation and layering

As a next step, the LDI's link relevant Logistics Objects and correlates information in-between. The physical layering, also called 'Hierarchy of Objects' (*Fig. 23*, next page), is a starting point. However, in real life the layering is a lot more complex.

The proposed application helps keep track of layered logistics objects and the correlation between different Global Unique Identifiers. So, when a package is put on a pallet and then into a container the application needs to associate the container with the specific package and even to which shipping document (e.g. bill of lading) or GPS location data it relates to.

Information about such relations between different objects is captured in different IT systems owned and operated by many different players in a typical logistics chain. For example, a shipper scans packages and links these to a pallet. A forwarder links the pallets to a Bill of Lading and a truck driver registers which pallets are delivered where and when. Currently these systems are typically not linked to each other or do not exchange enough depth of information. An LDI is picking up this information from all these different systems and can correlate this data by using '*Semantic Database'* technology.

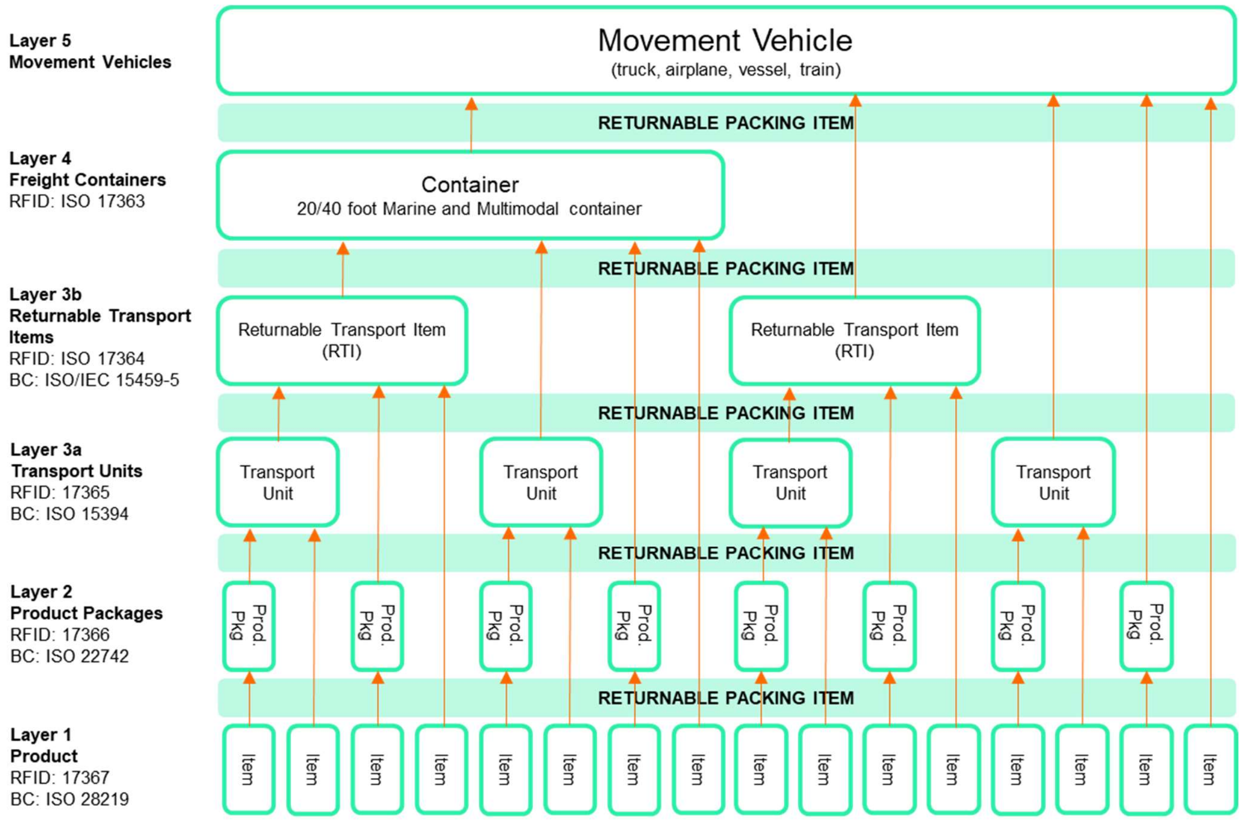


Fig. 23 *Physical layers or 'Hierachy of Object' (source: EDIFICE, edited)*

Integration with Semantics

Since the realm of logistics is so widespread it has shown to be almost impossible to agree on a globally applicable information model and standard for communication. To create on demand digital collaboration in the logistics environment, the technology needs data allowing information to be exchanged without synchronisation of data models or message formats. The technology should also be open and evolvable through partnership and collaboration. The (standardised) collaboration solution is based on the foundation of a *Semantic Database*. This technology allows integrations of data across different data models and formats.

> To create on demand digital collaboration in the logistics environment, the technology needs data allowing information to be exchanged without synchronisation of data models or message formats.

The LDI solution is based on the principle of separating data content from the format it is stored in or received. A lot of information in different transport documents and message is the same and splitting format from data elements improves consistency, reduces mistakes and creates flexibility in workflows. It also allows data access rights to be at data level and not at document or message level. Finally, it allows data updates to be shared across multiple stakeholders in almost real-time. There will no longer be a need to wait for a document to be fully completed.

The Semantic technology is based on Resource Description Framework (RDF), Uniform Resource Identifier (URI), W3C Ontology Language (OWL) and SPARQL.

Internet of Things (IoT)

Today when a shipment is in transit there are already status messages defined by different organisations for tracking the shipment. It is a manual process which leads to high costs as individuals must manually add status updates occurring during the execution of the logistics operations. Furthermore, every company uses its own set of status messages and at the moment a new status is set it might be too late to reflect the actual time of the event (i.e. "*arrived at warehouse*" when the shipment actually already "*left the warehouse*"). Another issue that often occurs when surveilling supply chain events is the order in which status messages are submitted. It is not rare that a newer event is communicated prior an earlier event (i.e. "*left warehouse*" can be issued before "*arrived at warehouse*").

To overcome uncertanities on actual events, when they occurred and making sure that all data is recorded the use of *Internet of Things-* (*IoT*) *devices* can provide a solution. In the future messages will, most likely, become automated using IoT-devices. These devices will not only provide location information on the whereabouts of an individual shipment but also provide details on status of the cargo. As an example, these devices could be a *light sensor* to advise when a container door is opened, a *shock sensor* in the event of the unit being dropped, *temperature monitoring*, *humidity* and so forth.

Beside the type of devices used for a specific shipment the system architecture can differ depending on already existing IT-infrastructure of a single organisation. Either the IoT devices are linked and integrated with existing applications or can work as a stand-alone system used only for monitoring shipments.

5.4 Overlooking Future System Architecture

In export flows, like the described supply chains orchestrated by Sandvik and SSAB, early stages in planning ('*Slot-booking*' and '*Post-production activities*') is based on rough estimates on shipment volumes. Closing in on actual departure of the shipment, production and shipment data becomes more accurate.

Most of the planning in the earlier stages of a transport is carried out mainly using email and telephone calls between the involved stakeholders. The conclusion is that, even though to the relative low frequency in communicating at these early stages, efficiency gains can be achieved by introducing new communications technology. However, there are hurdles to overcome in terms of aligning internal production processes with logistics operations and thus focus will be laid on 'Post-production activities' at this stage.

The closer to the date of the actual physical transport communication becomes more intense. In the stage of '*Post-production activities*' information is shared between the different stakeholders and the content of the information is similar or even standardised. The TO-BE architecture focuses on the *Post-production activities* using the examined use-case of Sandvik as an example. The activities of this phase of the transport is initiatied by the actual handling of the individual container at the yard at Sandvik (*Fig. 25,* next page*)*. Like Sandvik, the post-production activities of SSAB set of by the physical handling the pre-haulage by train from the production site (*Fig. 24,* next page).

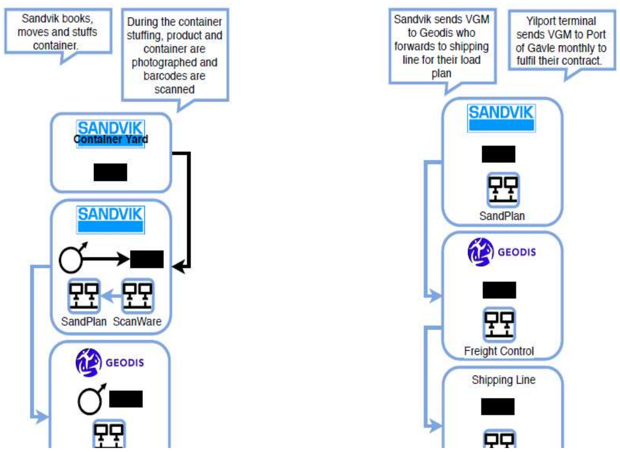


__Fig. 25__ Start of post-production activities Sandvik

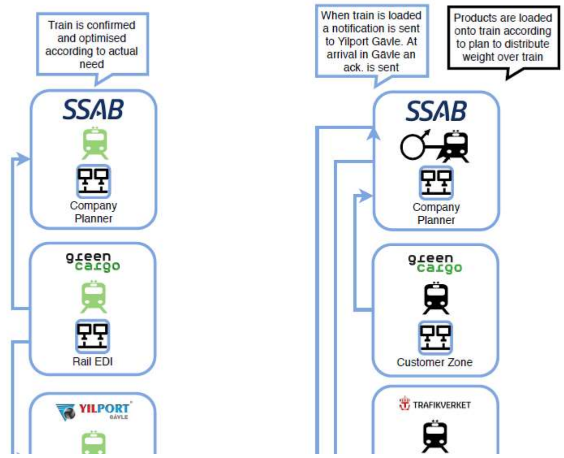


__Fig. 24__ Start of post-production activities SSAB

Each use-case are reliant on sharing data using proprietary EDI's and EDI-links to share data. Instead the aim of the proposed system architecture is to replace these existing EDI-couplings by connecting all stakeholders using the Semantic Web. The removal of the EDI links can be done in multiple phases, e.g.one by one or several at the same time. This eliminates the 'lock-in' effect and enables each stakeholder to connect and share to all relevant recepients.

5.5 How does the architecture work in practice?

The way the communication and sharing of data using the LDI is described as an example (*Fig. 26*) on how communication between the shipper and stakeholders of the supply chain works.

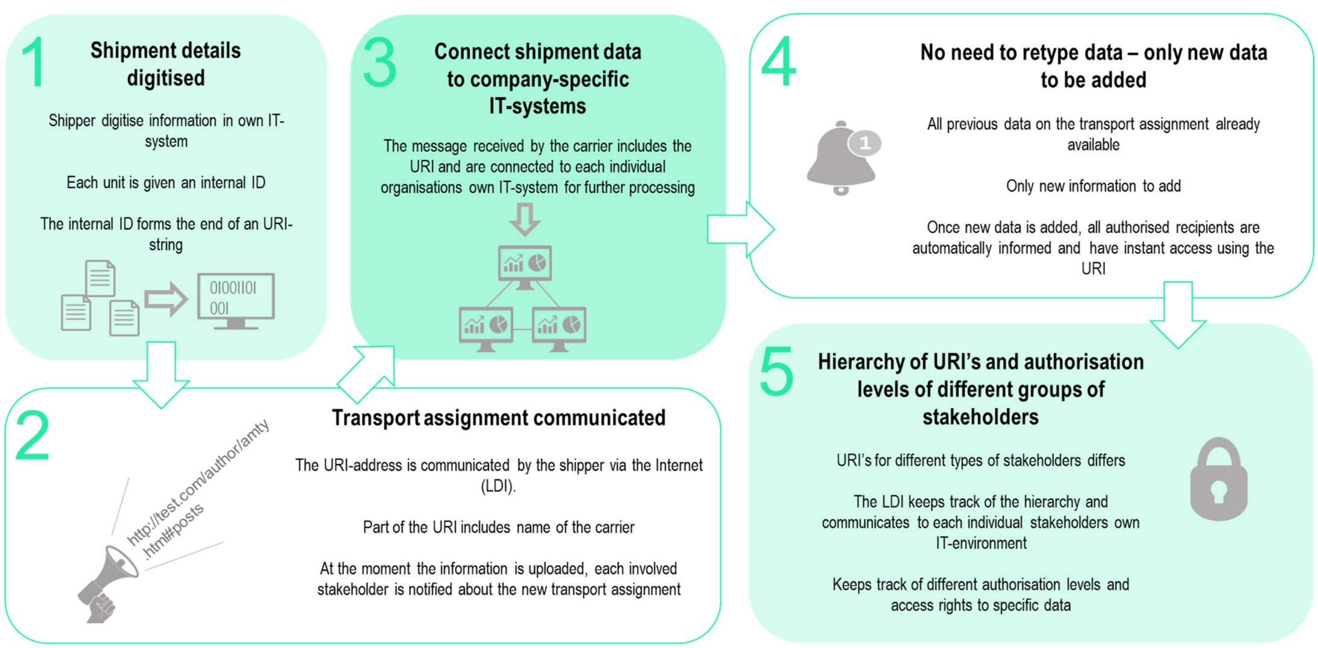


__Fig. 26__ A brief explanation on how the future system architecture works in practice

The described process continues throughout the entire supply chain. All involved stakeholder involved in the end-to-end shipment can rather simple, use the LDI to connect and share data in the supply chain.

In *Fig. 27* an overlooking systems architecture on the proposed future system is presented including how posting and retreiving data from the LDI works. It also describes how using the messaging functions to inform other stakeholders on new or updated information is available. Besides using existing systems, it is also described the possibility to use a (simple) 'URI-viewer' to look at data from the URI.

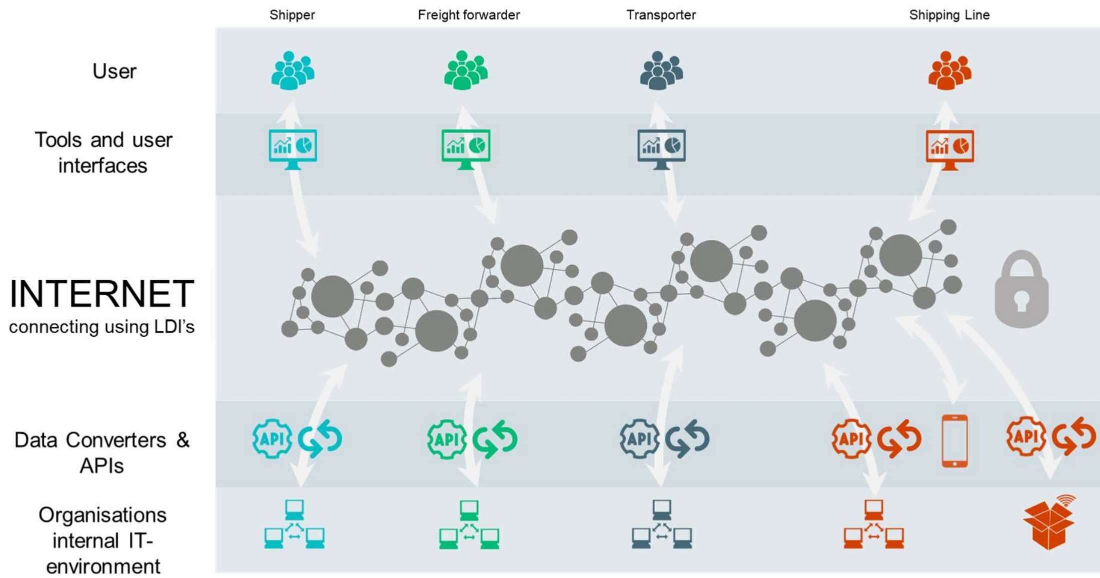


***Fig. 27** Overlooking systems architecture using the Logistics Data Interchange (LDI) to share and collect data between stakeholder (Source: Ericsson, edited)*

Using the proposed system architecture, the shipper can overlook the handling of their individual shipment from origin to destination. For example, they can trace who did what and where the location (roughly[14]) are located at a given time. Introducing the LDI as the interchange node for sharing data, the system architecture opens the possibilities to share data with all types of stakeholders including customs, authorities, terminals and so forth.

IoT devices

Depending on the type of cargo there are different type of IoT-devices that can be implemented to track and monitor the shipment. These devices can provide location information (GPS/mobile cell data) and can have sensors for temperature, humidity, tilt, shock etc. The data coming from these devices will be correlated to an URI so that at every moment in time the shipment can be monitored with real-time information.

Questions that can be answered are for instance: *Where are my goods?* (e.g. at the Port of Hamburg); *Is the shipment handled properly?* (e.g. not turned upside down); *Do I need to act on information coming from these devices?* (e.g. change reefer settings for lowering the temperature.) This will lead to less shipments 'lost', less damages on cargo or initiate a new shipment when it is needed before it arrives at the customer.

[14] Note: only detailed near real-time information can be provided using IoT devices.

Implementation costs

From the overall systems architecture previously, described shows where the adoptions of the companies' individual IT-systems occurs to integrate to the LDI. By the proposed system architecture, the shipper can overlook the handling of their individual shipment from origin to destination. For example, they can trace who did what and where the location (roughly) are located at a given time. A rough cost estimate shows that integrating the proposed IT-architecture of a single organisation to an LDI is approximately 200,000 SEK. This is excluding new features that can now be introduced due to this huge improvement and availability of real-time information from the IoT devices.

Security

There are three areas that needs to be highlighted on security when designing a system service for sharing multimodala informaiton. First (*1*) Authorisation, people are only allowed to see data when they are authorised to. Secondly (*2*) the integrity of the documents and data should be secured. At the time something is changed it should be highlighted so that people can act on it. Third (*3*) All actions that persons are performing should be logged. These are just the major ones, but security covers of course a lot more.

5.6 In summary

The proposed systems architecture enables the possibility for all stakeholders to, by using their existing IT-environment to connect and share data using the Internet. This is enabled using a Global Unique Identifier and to share URIs. Secondly, to overcome different data formats and standards, the use of Semantic Technology and Ontology (i.e. the Semantic Web) enables different IT-systems to share and retrieve information without the need of re-typing data. Finally, and as an add-on the use of 'Public-verifiable ledgers' to secure identities and trust in the chain of information thoughout the supply chain. However, the aspect of security has not been analysed in-depth in the current phase of the project. A summarised overview on the main characteristics of the proposed information sharing service is presented in *Fig. 28.*

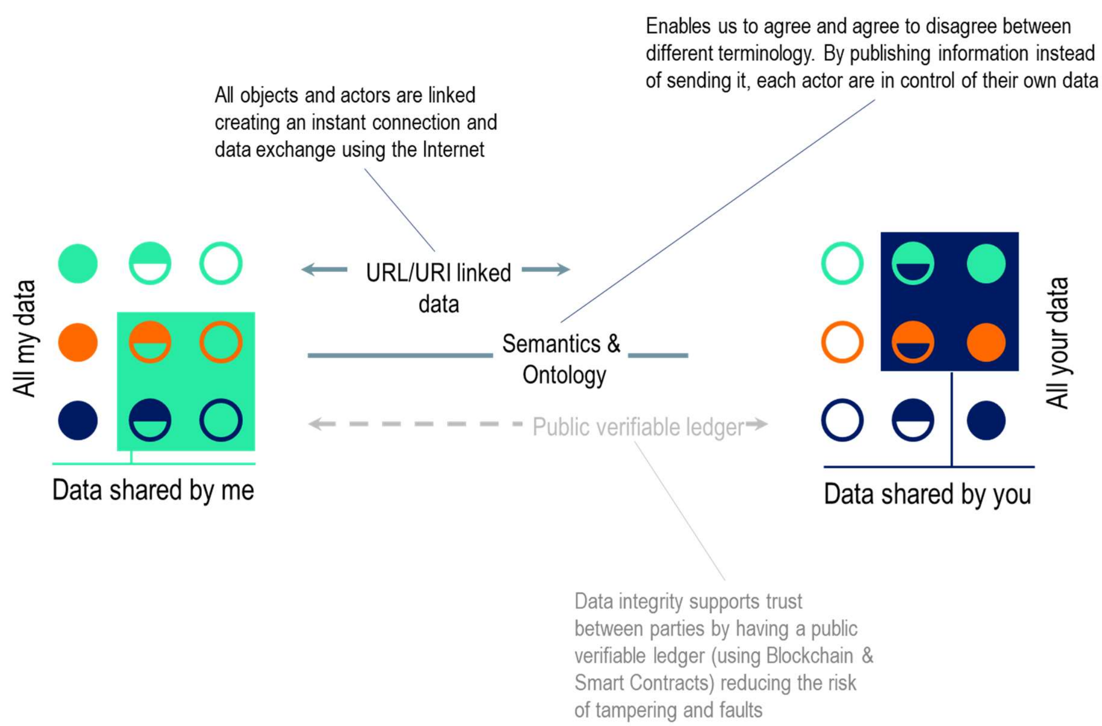


Fig. 28 *A summarised description on the main characteristics of the proposed system service for sharing information in a supply chain.*

6 Value added by sharing multimodal data

What can be expected from more efficient sharing of information?

The mapping of the physical and information flow created the necessary holistic overview to understand potential business opportunities. Taken one by one, the input from the stakeholders only amount to separate needs and wishes. Taken together, the input can describe fruitful exchanges of value based on the unique qualities and roles of each stakeholder.

6.1 Major Needs and Values

With a better grasp of the overarching issues and needs the iterative process to develop and test fundamental assumptions could begin. Led by RISE Viktoria, the core team of logistics and IT experts from CLOSER and Sjöfartsverket met in a series of rapid development workshops to explore concrete topics and their fundamental assumptions. The group settled on three topics to test the with project's domain experts:

- Physical scanning – Tracing aggregations of products
- Logistical artificial intelligence – Ad-hoc alternative routes
- Extended infrastructure - Platform ownership models

Physical scanning

Connecting information between organisations and transport modes to capture value is the final goal of the Multimodal Information Sharing project. However, information is both siloed in between organisational boundaries and over information types. The second issue means that even when information can be shared the data points remain separated. To remedy the second issue there is a need to traverse steps of aggregation and connect products being put onto pallets, into containers and onto trucks, trains or ships. Linking identities make sure the information is traceable from product and container to transport vehicle or vice versa.

> Linking identities make sure the information is traceable from product and container to transport vehicle or vice versa.

These kinds of linked identities are beneficial to develop a forward flow of information, where the receiver often lack part of the logistical detail that the shipper takes for granted. With little effort, Sandvik and SSAB could make both Product ID and its Vessel ID (container or railway wagon) part of the outgoing information to establish this connection.

Manufacturers may see limited direct value from linking identities for the rest of the logistical chain. However, tying a Product ID to the Container ID enables a receiving operator to plan more accurately. The current disconnect means that even if a Container ID is sent, more inquiries are necessary to figure out the content. A customer can directly see if a certain product has been delayed based on the available order or container number.

Logistical Artificial Intelligence

The idea of a 'Logistical AI' captures the immense number of standards and information sources that must be matched and combined. Based on the semantic architecture described in chapter 5, the Logistical AI interprets the logistical meta-data from carriers, terminals and other sources and offers a range of multimodal transport alternatives. Being automated, the Logistical AI can provide the service ad-hoc as needed and interpret new information based on previous training and experience.

One example of the end-user service provided from a Logistical AI can be compared to a GPS navigation system that provides route alternatives based on certain preferences and events. Behind the scenes the Logistical AI integrates diverse streams of information from different sources and standards. In this way, the AI require logistical information that can be connected. Part of this information can be created by identity links and part is connected by relating meta-data terms used for communication.

Furthermore, experiences from the STM project has shown that multiple perspectives and definitions of the same event co-exists. Access to multiple closely related data sources linked through semantic similarities will challenge the AI to find the most relevant and accurate estimate for a certain event.

Extended infrastructure

Extending the current digital infrastructure is necessary to support a more flexible information flow and access management. This will ultimately allow actuals and estimates to be shared securely over traditional boundaries. The question of who should own and operate this enabling platform remain. Some candidates, as for example, Port of Gävle were identified as potential neutral actors. By broadening their definition of infrastructure to include IT capabilities, the port authority could administer these under their current mandate. Offering IT facilities as a port authority could be as natural as making sure the appropriate number of access roads, railway tracks and quays are available to the goods flow.

> Offering IT facilities as port authority could be as natural as making sure the appropriate numer of access roads, railway tracks and quays are available to the goods flow

Discussion

The workshop discussion of the three topics brought new insights that were used to draft a first viable market to commercially carry the necessary components to enable sharing of multimodal information across the supply chain.

In the discussions on linked identities, it proved difficult to directly relate the additional work effort of capturing the full range of identities to a need for the participating experts. The uncertainty implies that a stronger case needs to be developed. For example, a flexible architecture that can show the strength of integrating information types is needed. One objection is that the current separation provides a natural barrier of concerns for different information types. However, to control access with obscure separation in different systems cannot scale and necessitates more integration work.

Utilising logistical information from the existing diverse sources was a potential competitive advantage to the manufacturing representatives. Where production has developed and optimised its flow, logistics have remained sub-optimised because of a lack of integration between partners. The Logistical AI was well received by the workshop experts.

Access to information outside the current project scope (Sandvik and SSAB to Port of Gävle) was raised as a question mark. Especially the availability of terminal operation information seemed uncertain to the participants.

Finally, in the discussion of the potential platform ownership it was generally agreed that a port authority could take on the role of owner in a piloting phase. However, to scale the solution to its global ambition it became obvious that a more distributed solution, without certain pre-defined ownership, would be preferred.

Based on the comments and concerns from the workshop participants, a first draft of a potential business case for sharing multimodal information was developed. The following sections will describe the fundamental assumptions of a 'Multimodal Information Sharing Market' and the experiments that have been carried out to test them. The specifics used to describe the setup is not meant to convince the reader of their absolute correctness, instead they should be looked upon as the latest hypotheses that should be challenged and developed. Multimodal information sharing is still in the early phases.

6.2 The Will to Share

Before anything else, the willingness to share information must be established. Yes, both manufacturers and their carriers gave clear signals that they both have access to the information requested and would be willing to share it. The carriers and freight forwarders even stated that it would be rather simple to extend their existing IT systems. However, an explicit consent from the transport customer (i.e. the shipper and manufacturer in the cases covered in this report) would be required. Therefore, to test the manufacturer’s willingness to share information beyond the current exchanges a mock contract was drawn (*Fig. 29).*

The Will to Share

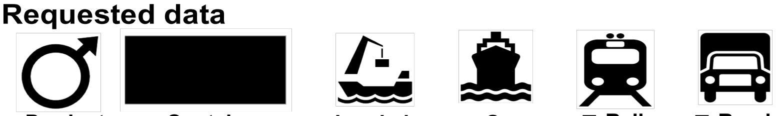
Purpose

This document is NOT legally binding. The purpose of this document is to explicitly state the data owner’s will to share relevant information with its logistics partners for a more transparent and reliable logistics chain.

Definition

A data owner is the primary source of a data point (i.e. the organisation who created the data point)

Requested data



☐ **Product** ☐ **Container** ☐ **Load plan** ☐ **Sea** ☐ **Rail** ☐ **Road**

Frequency	☐ Yearly	☐ Monthly	☐ Weekly	☐ Daily
ID		☐ Actual ☐ Estimated	☐ Current time ☐ Current location	
Departure time		☐ Actual ☐ Estimated	Arrival time	☐ Actual ☐ Estimated
Departure location		☐ Actual ☐ Estimated	Arrival location	☐ Actual ☐ Estimated
Number of units		☐ Actual ☐ Estimated	Weight	☐ Actual ☐ Estimated
______________		☐ Actual ☐ Estimated	____________	☐ Actual ☐ Estimated

Statement

The data owner cannot see any obstacle in sharing the requested data and herewith wishes to leave the unnecessary secretive past behind in favor for more reliable and sustainable movements of goods in the future.

Data owner		**Data requester**	
Company:	____________________	Company:	____________________
Signature:	____________________	Signature	____________________
Place, date:	_Gävle, 5th of April -18__	Place, date:	_Gävle, 5th of April -18__

Fig. 29 *The mock contract used in the Gävle workshop to explore the willingness to share information beyond the current praxis.*

The contract was used during the review of the performed mapping. At the end of each individual step the participants who were currently passive in the interaction were asked if they would want to take part of the exchanged information. In the limited logistics chain covered from Sandvik and SSAB to Port of Gävle only had a few scenarios were passive partners had interest in the information. For example, information about incoming road and rail carriers might be interesting for Port of Gävle. This information is currently only shared with the shipper who has limited use of it.

When presented with the mock contract in the context exemplified here, SSAB curiously asked why the port was interested in the information. After explaining that real-time information of the traffic through Port of Gävle could help the port prioritise improvements in the infrastructural access, SSAB signed the contract. Naturally, the contract is not binding in any way, however, the interaction and final consent is indicative of the possibility for a future with sharing multimodal information.

6.3 Information Access

The second fundamental concern regarded access to international terminals, ports and shipping information. Multimodal information sharing without insights about the perceived 'black holes' at points of transfer is limited in its usefulness.

6.3.1 Intelligent Video Gateway

Luckily, there are multiple initiatives developing the quality and access to this kind of information. One prominent example is the *Intelligent Video Capture project* (IVG)[15], which is currently developing sophisticated scanners to automate the registration of arriving and departing containers in a terminal area. The IVG project directly complements this project by developing a reliable information source that have been highlighted as problematic by logistics managers. A more continuous information exchange has been discussed between the projects. Similarly, new potential applications of IVG's automation of terminal information have been found at the manufacturer's sites. By extending the learnings in the IVG project advancements the manufacturers' internal logistics could improve.

6.3.2 The Efficient Flow-project

Another major initiative to develop information exchange is the Sea Traffic Management based projects (e.g. STM Validation[16] and Efficient Flow[17]). This portfolio of projects all centres around maritime operations. The concept has grown to include port operations and is also in dialogue with this project among others to ensure the development is compatible with greater (hinterland) logistics chain. Based on the STM concept the necessary 'service discovery' and 'identity management' mechanisms would be in place to efficiently connect to new data sources and application services as they become available.

Opening a reliable interface to logistical data is a great complement to STM's navigational and operational shipping focus. The STM service registry, which holds all the vetted STM services, could be then be extended with logistical information. This is perfectly aligned with the goal of STM to make shipping more efficient, secure and environmentally friendly. The STM project has been aware of the importance of current "out of scope" services that are more goods centric and have prepared to allow third party service developers. In fact, allowing to more closely monitor and define how the value flows (the goods flow) is one of the highest priorities for STM to become a commercial success and might be a decisive factor for the continued development of the STM goals. To support this assertion, STM has already discussed how the shipping industry could bridge the gap towards logistical information with representatives of the Trade and Cargo Facilitation Association (TCF) who are spearheading the semantic development of the logistical sector.

[15] Shift2Rail – FR8HUB project (2018)
[16] STM Validation project (2018)
[17] Port of Gävle – Efficient Flow Project (2018)

The readiness of sharing multimodal information at larger European Terminals

One area that has 'fallen through the crack' is access to terminal information. Being of major importance to the partners of this project, this issue was explored in a separate experiment.

The experiment analysed the information available in the major German, Belgian and Netherland ports. It was found that, similarly to the IVG and STM initiatives, ports are developing their information services rapidly. For example, Bremerhaven[18] has already digitised all shipments and provide encrypted access restricted interfaces for partners to consume information. Wilhelmshaven[19] stores and organises the information centrally, which benefits traffic throughput.

The major ports in Hamburg, Antwerpen and Rotterdam take ICT development even further, with specific information channels and contracts for traffic, cargo and infrastructure information. Furthermore, Antwerpen's recent stake in *NxtPort*[20] means that they will be provide transparent means to the terminal's information flow for all supply chain stakeholders. Similarly, Rotterdam's *Pronto project*[21] have been developing the transparency and quality of port operations information. By cleaning and analysing multiple sources the large port can offer very detailed and reliable physical flow prognoses.

The reviewed ongoing activities along with tests of public APIs for operational information from the ports, terminals and vessels, fulfil the needed capabilities for sharing multimodal information comprehensively. Many ports will certainly lag the once exemplified here in terms of technology, however, by showing the practical gains from sharing more information the practices are likely to spread.

6.4 The Market for Multimodal Information Sharing

Based on the early indications of the willingness to share and availability of information from the major stakeholders in the supply chain, the market for multimodal information sharing is designed. Multimodal information sharing has many potential customers. Outbound logistics managers could gain more insight and flexibility in their booking of transportation. Improving the ability for inbound logistics managers and customers to continuously evaluate the certainty of arrival could have more significant effects on the need for capital binding and storage facilities. Furthermore, sharing fairly simple track and trace information early and liberally is a requirement for more long term and efficient planning for all partners (e.g. carriers, authorities, freight forwarders) in the logistics chain *Fig. 30* gives a schematic overview of the overall market that will be explained in more detail.

---

[18] dbh – Bremer Hafentelematik (2018)
[19] dbh - Wilhelmshafen Telematik (2018)
[20] Port of Antwerp - Nxtport (2018)
[21] Port of Rotterdam – Pronto (2018)

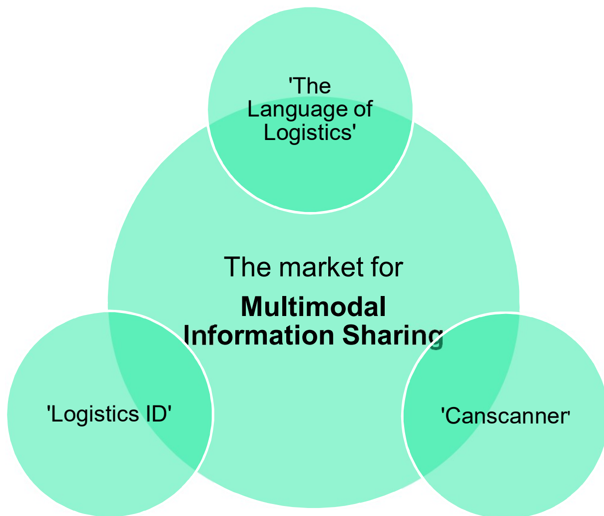


***Fig. 30** Overview of the Multimodal Information Sharing market and its initial two fundamental business models, 'The Language of Logistics' and 'LogisticsID', that enable the operational improvement service the 'Canscanner'.*

The 'Language of Logistics'

There are far too many examples of project developed standards and architectures that only survive while the project is ongoing. Clearly a different approach is needed, and semantic-web model described in the architecture section in this report offers new possibilities. First, it is based on common Internet protocols and hyperlinks (URI's), which have proven their immense scalability and robustness. Second, tools to match separate meta-data schemas are built in expectation the everchanging landscape of standards that are so elusive to pin down.

Acknowledging that standards organic character is more realistic than the many projects who have tried to define the ultimate standard. This is directly related to the "Semantic Database" mentioned in the chapter on the technical architecture (Chapter 5). However, a more realistic model also means that there is a need for an ongoing maintenance and update of the schematic meta-data consensus, as for example, when issues are solved, or new standards need to be assimilated. To this end, it is important to find a steward who can pursue a common view without vested interest in a certain terminology.

As can be seen in *Fig. 31*, the steward in the first draft are the manufacturers. Since they have minimal interest in the proliferation of a certain logistical standards and a maximum gain from common agreement the producers and sellers can be both pragmatic and have the market position to enforce such rules.

<table>
<tr>
<td rowspan="2">Problem
No united standard for logistics data

Today each format of data is developed and maintained by each logistics firm or platform developer</td>
<td>Solution
Transport buyer sets the premise for the standard</td>
<td rowspan="2">Unique Value
No stake in what standard ‘wins’

Great long-term benefit from having a united standard

Great mandate to impose a particular standard</td>
<td>Unfair Advantage
Semantic web Implementation provides tools for ‘organic’ growth and low infrastructure costs (Utilises the Internet)</td>
<td rowspan="2">Customer
Carriers and forwarders who wants to provide services to consortium of shippers</td>
</tr>
<tr>
<td>Key Metric</td>
<td>Channels</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Initial development cost
Cost for maintenance</td>
<td colspan="3">Revenue Stream
Initial fee for standard
Subscription of updates for ongoing work

Membership fees for participating organisations</td>
</tr>
</table>

Fig. 31 *The ‘Language of Logistics’ (ver.0.1) - Manufacturers foundation to promote global logistics semantics.*

It is uncommon for manufacturers to take such an active role in the logistics domain. However, unlike the entrenched carriers and freight forwarders, who have invested in their own standards to lock customers in, the manufacturers have a unique position to set common market terms. The manufacturer, who focus mostly on production and sales, can also apply great pressure on the logistics companies to adopt processes and standards since they ‘pick up the bill’ in the end.

By creating a membership organisation that licenses out the meta-data scheme, which translates and combines disparate standards, can even make this support function worthwhile economically. The service providers, for example the freight forwarders, would pay the nominal fee to get access to a much broader range of information. Much of the business model canvas is still unexplored. However, representatives from the manufacturers were interested in the model and positive to come together with other producers and discuss the subject further.

LogisticsID

To manage access to information and build a foundation of trust, identities from different domains and organisations must be managed. In this case the freight forwarders have a unique position as ‘*identity managers’*, which means that they can reliably authenticate and maintain trustworthy identities. The freight forwarders already have strong cross-boundary networks in the logistics sector. In these networks most of the worlds logistical partners are present and are often based on relationships that stretch over many years.

By forming a foundation, the freight forwarders can offer a ‘*Global Authentication Service*’, which can charge based on transactions (*Fig. 32*). Alternatively, local or regional authentication services could join forces in a federation.

***Fig. 32** ‘LogisticsID’ business providing secure and reliable identities through two factor authentications across domains and organisational boundaries.*

This means that each time a company needs to authenticate a partner’s identity and log a transaction or manage access to data the LogisticsID foundation would be consulted as shown in *Fig. 33*. A similar model is used successfully in Sweden by the larger banks to authenticate and authorise anything from quick payments to electronic information (i.e. *BankID*).

<table>
<tr>
<td rowspan="2">Problem
A shipper is not aware of all partners in logistics and their identities are part of different systems

Need to know identities to share and control data

Today information are kept in silos where identities are known</td>
<td>Solution
Major freight forwarder creates identity solution that mediates and ensures known and authentic identities</td>
<td rowspan="2">Unique Value
Trusted bridge identities is necessary to break information stove-pipes</td>
<td>Unfair Advantage
Already know most carriers and customers

Trust already built up</td>
<td rowspan="2">Customer
Minor freight forwarders who need to reach and disseminate information</td>
</tr>
<tr>
<td>Key Metric
#identity requests

#new customers</td>
<td>Channels
Sjöfartsverket
Sea Traffic Management</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Amazon EC2: $0.1-$5/h = $876-$43,800/year</td>
<td colspan="3">Revenue Stream
Pay-pre-use of identity requests

Swedish BankID: 0.30 SEK/login, 1.5 SEK/signature</td>
</tr>
</table>

***Fig. 33** ‘LogisticsID’ (ver.0.1) - Foundation of major freight forwarders that cover most logistical identities and charge based on lookups.*

‘Canscanner’

Based on a scalable architecture that supports semantic coupling between current logistics standards, one foundation to maintain and promote a shared understanding and another foundation to provide known and reliable identities, the first building block of the Logistics AI can be laid.

Naturally, not all standards and identities have to be integrated before developing the Logistics AI, however, it will become increasingly powerful the more access to logistics information it has. In this first phase the focus is on gathering and presenting logistical alternatives with the ‘*Canscanner*’ example. This is a slimmed version of the potential services that a Logistics AI could offer, however, the underlying data sharing platform is essentially the same.

The necessary data is being produced throughout the logistical chain (e.g. from shippers, carriers, terminals). Most of this data is pretty 'raw' and can be irregular and outdated. This means that the data sharing platform provider must interpret and cleanse the data to raise its quality and make it useful for logistical services. Fortunately, most of the tedious work of integrating all these sources have already been done by freight forwarders. Also, the freight forwarders are experts in spotting data with poor quality (e.g connections that obviously will be missed) that will improve the value of the raw incoming data.

By opening data sharing platforms based on this information the freight forwarders can start offering commercial data and service solutions to a wide range of partners in the logistics chain. The business model canvas in *Fig. 34* shows how this might look in a commercial setting.

<table>
<tr>
<td rowspan="2">Problem
Integration to data producers is a large undertaking and almost full coverage is needed to compete with today's solutions

Quality of information is unclear and uneven

Each company makes individual integrations to data producers</td>
<td>Solution
Shorter planning windows for transportation

Simple visualisations</td>
<td rowspan="2">Unique Value
Joint logistics platform to enhance competition, service and flexibility</td>
<td>Unfair Advantage
Freight forwarder owned – integration already done

Customer supported standards (Log. United)

Global LogisticsID</td>
<td rowspan="2">Customer
Steel producers
(Main project partner)
- Big potential savings in logistics chain
- Uncertain production

Early adopters will be steel producers in remote locations</td>
</tr>
<tr>
<td>Key Metric
#transports booked/week

Cost of booking

#days before transport</td>
<td>Channels
This projects

Industry Partnerships</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Hosting costs = $100K setup +$50K in yearly maintenance

One transport group membership = $10K/year

Customer of the product = $1,000/month</td>
<td colspan="3">Revenue Stream
Commission of each booking goes to platform development and potential consortium

(Google Play, Apple App Store – 30 % profit and operations)</td>
</tr>
</table>

Fig. 34 *'Canscanner - for Freight forwarders or 3PLs (ver. 0.2) - Tentative model of a multimodal information service based on gathered data from a comprehensive selection of the logistics industry.*

The *Canscanner* service is only one example of a service that can be developed based on shared logistical information. In this early stage, little artificial intelligence is used to interpret the information apart from some semantic reasoning. The service is a tool to understand logistical choices in a transparent way. The target is to provide better predictions and give a higher granularity of the logistical steps.

Initially the Canscanner was modelled according to *Google Maps*, which only shows alternatives without offering customers the ability to pay. In discussions with representatives from SSAB it became clear that the service would fill a gap in their information flow. However, since manufacturers cannot prioritise outbound logistics information their role as the customer was questioned and need to be further explored.

The second version, shown in *Fig. 35*, was instead based on the '*Skyscanner*'[22] service and included links to were transport contracts could be purchased.

The more ad-hoc nature of transport bookings that this could promote is much welcome to the manufacturers who are constrained in flexibility by their production precision. More flexible logistics arrangements can make up for eventual irregularities in production.

The second model with the manufacturers as customers met some hesitation from the freight forwarders when presented. The service design seemed difficult to implement due to the logistics industries need for advanced slot procurements to achieve competitive prices. However, by focusing on inbound logistics as the customer the opportunity became more realistic to both manufacturers and freight forwarders.

6.5 Conclusion

From the initial experiments of the fundamental requirements for a future of a multimodal information sharing service there is wide agreement on the potential value of enhancing the flow of logistical information. However, it is a windy road to create, deliver and capture this value. The market described in this report is still based on many assumptions about the ability to turn information into more efficient physical goods flows.

As the description of the architecture shows, the technology to make this a reality exists and has a proven track record. What is needed is to continue the experiments of the remaining assumptions of the market for a future service. To straighten the question marks and incrementally turn multimodal information sharing from something possible to something inevitable.

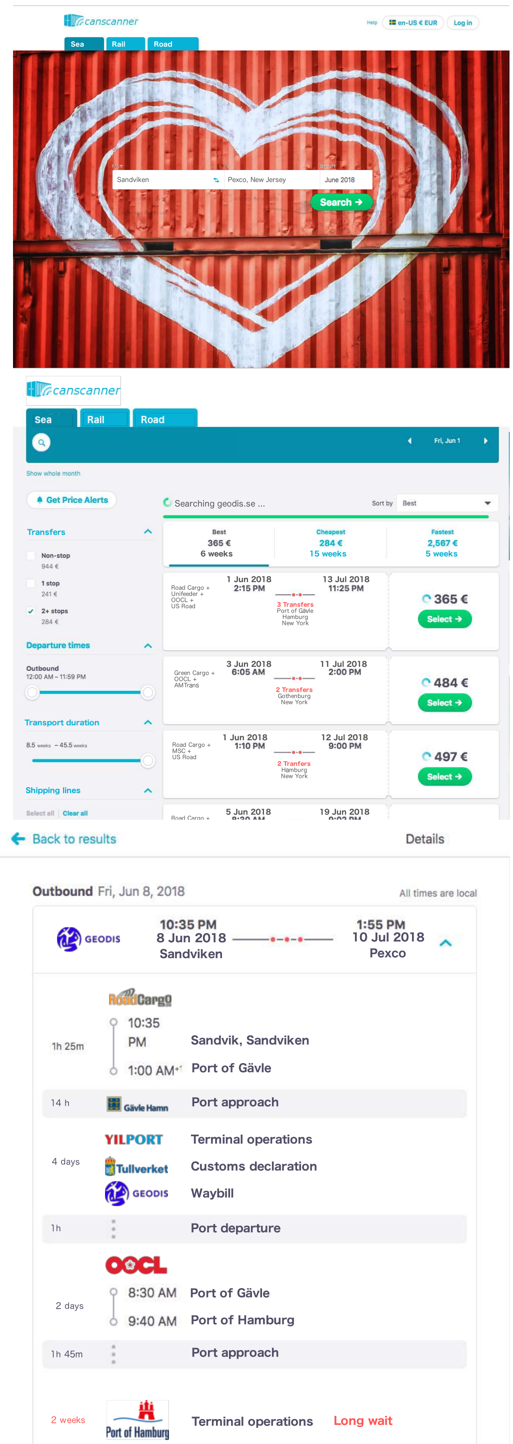


Fig. 35 *Canscanner interface modelled on the personal and business travel search engine Skyscanner*

[22] Skyscanner is an independent search engine to find and book passenger flights worldwide based on certain preferences of the user. www.skyscanner.com

7 Lessons Learnt

What benefits can be drawn from this project?

Sharing digitised data between stakeholders in logistics operations is key to pursue increased efficiency in supply-chains. Still in 2018, a lot of processes in capturing and sharing data are done using manual processes and the risk of vital data for planning, execution and reporting of a transport operation not being shared to all relevant stakeholders is imminent.

It is obvious that vital and relevant information and data exists in amongst the stakeholders involved in supply chain operations. On the contrary, it might even be too much data to process within each single organisation. Thus, to sort and share relevant data fit for each organisation is key to achieve increased transparency and abilities for stakeholders to take proactive decisions.

By the proposed systems architecture, new opportunities to share data arise using the well-established foundation of the Internet. By adding semantics and ontology as the main technology data formats and standards of different IT-environments can be interpreted and communicated increasing the efficiency in sharing – or even broadcasting – information amongst all relevant stakeholders.

Granting access to correct and timely data of high quality amongst involved stakeholder open new possibilities and to add new information services could support the physical execution of transport operations. Having access to actual real time data or even having a possibility to take a glance into future developments, can have an impact on the supply chain efficiency. It can increase proactiveness in the planning and execution of transport and logistics operations. Adding new services based on better intelligence and knowledge might have an impact on traditional roles and responsibilities in the supply chain. Thus, by enriching the roles of each stakeholder and to strengthen each individual actors' unique expertise is fundamental to form a strong and solid future business model for the information sharing platform.

This project has had the aim to describe a future service for sharing data across a systems platform for information sharing, and the benefits foreseen for each stakeholder. Thus, the next natural step is to show-case how the system could work in reality by bringing the proposed architecture into a demonstration phase. By demonstrating and to trial the system, the foreseen improvements by sharing data can be followed and measured. Another important element is to describe and analyse the future organisation and governance aspects for the information sharing service, especially as too many IT-development projects face the harsh reality of not overcoming the hurdle on how should run, own and manage the service once implemented.

The Multimodal Information Sharing project has 'scraped the surface' to the potentials of increasing the transparency in logistics operations. However, there are still a vast djungle of opportunities and hurdles to overcome in future development. Still, it is expected that the results described in this report give an idea of the potential that more efficient sharing of information can lead to a more efficient transport system.

8 References

Leighton, R. M. (2017). Logistics. Retrieved June 15, 2018, from https://www.britannica.com/topic/logistics military/Historical-development

Fawcett, S. E., & Magnan, G. M. (2002). The rhetoric and reality of supply chain integration. International Journal of Phys-ical Distribution & Logistics Management, 32(5), 339–361. https://doi.org/10.1108/09600030210436222

Abdur Razzaque, M., & Chen Sheng, C. (1998). Outsourcing of logistics functions: a literature survey. International Jour-nal of Physical Distribution & Logistics Management, 28(2), 89–107. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.599.6239&rep=rep1&type=pdf

Stevens, G. C. (1989). Integrating the Supply Chain. International Journal of Physical Distribution & Materials Manage-ment, 19(1), 235–246. Retrieved from https://doi.org/10.1108/EUM0000000000329

Dell, M. (1998). The power of virtual integration: an interview with Dell Computer's Michael Dell. Interview by Joan Ma-gretta. Harvard Business Review, 76(2), 73–84. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10177868

Hammer, M. (2001). The superefficient company. Harvard Business Review, 79(8), 82–91, 160. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11550633

Konsynski, B. R. (1993). Strategic control in the extended enterprise. IBM Systems Journal, 32(1), 111–142. https://doi.org/10.1147/sj.321.0111

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities. MIS Quarterly, 30(2), 225. https://doi.org/10.2307/25148729

Utbult, M. (1991). Gods-och informationsströmmar -idag och framtidsdrömmar. Teldok-Info, (9). Retrieved from http://handelsradet.se/wp-content/uploads/2014/11/TELDOK_Info_9_1991_Utbult_Gods-_och_informationsstrommar.pdf

FR8HUB-project, Shift2Rail website, visited June 2018, Retreived from http://projects.shift2rail.org/s2r_ip5_n.aspx?p=FR8HUB

STM Validation project, website visited June 2018, Retreived from http://stmvalidation.eu/

Efficient Flow project, Port of Gävle website, visited June 2018, Retreived from https://gavlehamn.se/EN/efficient-flow-stm

Bremer Hafentelematik, dbh website, visited June 2018. Retreived from https://www.dbh.de/en/solutions/port-management/bremer-hafentelematik/

Wilhelmshafen Telematik, dbh website, visited June 2018. Retreived from https://www.dbh.de/en/industry-solutions/port-management/port-community-system/solutionsport-managementport-community-system/

Nxtport. Port of Antwerp website, visited June 2018, retreived from http://www.portofantwerp.com/en/news/port-authority-and-fpim-acquire-stake-nxtport

Pronto, Port of Rotterdam website, visited June 2018, retreived from https://www.portofrotterdam.com/en/tools-services/pronto

ABOUT CLOSER

CLOSER is a neutral platform that gathers players from the business community, industry, universities and institutes, cities, regions and government agencies to establish collaboration and projects that lead to enhanced transport efficiency.

Together with our partners, we identify needs and ideas among companies and agencies that could lead to demonstration projects and, in the long term, implementation in reality. This enables new, innovative products and solutions that help the transport industry and contribute to new solutions for the goods transport system, which is to supply a sustainable society. We also contribute to research benefiting companies and society.

By transport efficiency, we mean: as efficient transports and logistics as possible based on the perspective of resources, energy, environment and economy, to achieve increased sustainability, growth and competitiveness.

CLOSER is hosted by Lindholmen Science Park

www.closer.lindholmen.se

The project has been funded by:

VINNOVA

The Swedish Governments Innovation Partnership Programmes under the portfolio 'The Next Generation's Travel and Transport'