Intermodal Supply Chain Facilitation through Adoption and Implementation of International Communications Standards

By Hanane Becha, Todd Frazier, Rudy Hemeleers, Steen Erik Larsen, Bertrand Minary, Henk Mulder, André Simha, and Jaco Voorspuij.

Introduction

End-to-end supply chains typically involve several modes of transport and a wide range of stakeholders. The original Seller, as well as the final Buyer of the product have little visibility of the location and condition of the product during the transportation phase(s). The original shipment from the Seller is represented as a consignment under contract with each transport operator and may be identified using different identification methods. The shipment also may be consolidated with other non-related Seller to Buyer shipments in different ways, depending on the mode of transportation.

Various standards organisations focused on individual modes of transportation have developed methodologies that have been adopted by their stakeholders in their supply chains. But in the larger picture, the ability to accommodate all modes of transportation by a single set of standards has been elusive. Some of the standards referenced have been developed and available for years but have not been universally adopted. Due to advances in technology and increased cost effectiveness, several international organisations are now developing key new standards for communication and interface technology implementation. Cooperation and adoption of international standards are the building blocks that will facilitate data visibility for intermodal transportation communications and interoperability between the stakeholder platforms.

Background and Current State

We are now in a transition from older standards adopted by individual transport modes to the current effort conducted by multiple international standards organisations to identify a normalised method of identification of required data that will be applicable to any Seller to Buyer shipment, regardless of the transport mode. Any authorised stakeholder to the transaction should be able to access the same data in near-real time.

In order to enable end-to-end tracking and to enhance the collaborations between all stakeholders involved, there is a need for standards for intermodal transport and interoperability in the exchange of data across varying modes of transport platforms. Several standards organisations and initiatives are beginning to focus efforts on identifying and addressing the gaps and challenges for specific domains. The standards organisations for the most part tend to organize themselves by transport mode, e.g. World Road Transport Organisation (IRU), or the International Air Transport Association (IATA) with focus on road and air transports. Other organisations are concerned with the specifics of the transport mode, e.g. Digital Container Shipping Association (DCSA) concentrating on container-based transportation, or a sub-segment of the supply chain. In the latter category, examples for marine shipping are Sea Traffic Management (STM), a concept programme that provides services to the maritime industry for improving connectivity, facilitating information exchange, and driving maritime efficiency, working in conjunction with the International Taskforce on Port Call Optimisation (ITPCO) to further benefit shipping companies. Nearly all of these focused standards groups are now addressing the need to cooperate and normalise their differences to close the gaps between transport modes. Such efforts have the power to facilitate more effective and transparent intermodal supply chains.

Identifying Common Data Requirements

This article identifies some of the gaps and common requirements needed to enable effective end-to-end tracking across all modes of transport. The authors' joint vision is to emphasize the need for international standards development, adoption and cooperation working toward more normalised processes that will readily provide shipment data to all authorised stakeholders for both transport and trade in a near-real time manner.

In the end-to-end transfer from a Seller of Goods to a Buyer of the Goods, the movement of the goods (termed 'shipment' in UN/CEFACT and GS1 terminology) may often be handled by many operators through several modes of transport in the supply chain. These shipments may be transported individually or be consolidated over the various movements of the end-to-end supply chain. The operators execute the individual stages of transportation under various forms of contracts of carriage that cover a consignment[1]. There may be multiple consignments or contracts of carriage concurrently active during the transport phase due to these consolidations that facilitate greater efficiency in the transport processes. This Seller to Buyer shipment approach has been modelled for multi-modal transportation by the United Nations Centre for Trade Facilitation and e-Business (UN/CEFACT) in the Buy-Ship-Pay (BSP) and Multi-Modal Transport (MMT) reference data models.

Due to the usage of different standards for identification and tracking between the various transportation modes, it is often difficult to transmit all the information regarded as pertinent to the varied stakeholders in an intermodal transaction. Visibility of the shipment may be lost to parties other than the current transport operator until arriving at the destination of that transportation mode.

Beneficial Cargo Owners (Seller and Buyer) would prefer to track their shipments, preferably using their own shipment identifiers end-to-end. Operators in different modes of transportation, however, when they are party to the same journey of a specific Seller to Buyer shipment, need to receive information about transport steps taken when changes in mode of transport are planned or occur due to unexpected events.

The European Interoperability Framework (EIF)[2] refers to two types of 'interoperability' that identify the data communication needs and the system requirements in order to effectively communicate between stakeholders:

a) Semantic Interoperability - Ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between parties, in other words ***'what is sent is what is understood'***.
b) Technical Interoperability – the ability for systems to communicate effectively and efficiently between platforms. This covers the applications and infrastructures linking systems and services. Aspects of technical interoperability include interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols.

These two dimensions are used to below identify current efforts now underway in the Transportation industry.

Operational Shipment Identification – Semantic Interoperability

[1] UN/CEFACT and GS1 terminology; consignment is a collection of transport units or cargo transported under a single contract of carriage. IATA definition (which is equivalent to the term 'shipment') is one or more pieces of goods accepted by the carrier from one shipper at one time and at one address, receipted for in one lot and moving on one air waybill or shipment record to one consignee at on destination address.

[2] The European Interoperability Framework (EIF): https://ec.europa.eu/isa2/eif_en

Some concepts and identification schemes are now in development to enable more seamless end-to-end tracking and visibility.

In order to locate the shipments Seller to Buyer end-to-end as they are transported to their final destinations, it is currently necessary to link a unique shipment ID with all the various consignment IDs used for consignments assigned during the transport of the shipment. The cargo carrier or operator has the burden of keeping track of the links between the shipment ID (assigned by the cargo owner - usually the Seller) and possibly multiple consignment IDs currently. In many cases, the cargo owner has no direct relation with the actual carrier, which means the cargo owner has no way to make the link between his own shipment ID and the consignment ID used by the actual carrier. Clearly, in those cases end-to-end tracking through multiple transport modes may not be possible.

In general, the customer does want to be able to find out where the purchase is along the way or trace the movement history, particularly in case of loss or damage. The identity of the type of transport and key locations captured during each operator's movement of the goods may also be preferred or required.

Carriers transport consignments and transport units (such as bulk commodities or liquids) in transport equipment (e.g. intermodal containers or unit load devices [ULDs]) and on transport means (e.g. maritime vessels, road trucks, aircraft, inland waterway barges, short-sea ships). To keep track of the transport units, it is imperative to know by which equipment and/or by which transport means they are carried. Only then, stakeholders will be able use information related to the location of the transport means or transport equipment as reliable information about the location of the consignment, the shipment, the transport unit and ultimately the actual location of the goods.

For example, the position of a maritime vessel (using Automatic Identification Systems) or an airplane (using live plane tracker services) is known. Assuming a shipping line or airline accurately captured (and shared) the consignments that were loaded on board, the geoposition of the vessel is also the current location of the consignment. In container shipping, the shipping line generally knows exactly which containers (transport equipment) have been loaded and even where they are in the vessel. The same is true for an air carrier, which has control of where and when their containers are loaded on an aircraft. Therefore, it can be assumed with a great level of confidence where a specific container (and the cargo/shipments inside) is at any point in that transportation stage. Identification of the goods may be limited to consolidated consignment IDs or shipment IDs. To know for sure what cargo/shipment/s are inside a container, it is necessary that the organisation that "stuffs" or "loads" the container accurately logs what is put into the container. The transport unit IDs may be recorded, if available, for the goods put into the container.

Other modes of transport may record which transport units (e.g. pallets/ULDs) that were loaded onto the transport equipment (e.g. trucks, trailers, rail wagons or aircraft). In all those cases, knowing where the transport equipment is provides reliable information on the location of the transport units carried therein.

Information captured during the transport movement may vary dependent on the transport operation or even by mode of transport. However, this information may be important to making critical and timely decisions by primary stakeholders during or after transport of the shipment. Therefore, multi-modal supply chains currently require to have unique ID's for:

- The shipment (Master transport ID assigned by Seller)
- The packages within a shipment (transport units)
- The transport contracts, consignment notes (like CMR)
- The transport means (like IMO vessel number)
- The transport equipment ID (like shipping container/ULD/rail car)
- The movement of the transport means (like flight for air-cargo)
- The movement of the goods by a transport means (i.e. manifest)

- All events and related data for each unique ID can be captured and cross-referenced for that particular operator and stakeholders of that mode of transport, but can also be related to the Master Transport ID assigned by the Seller
- Other IDs assigned by a stakeholder that relates to the shipment such as Trade Item ID (product code), Sales Order ID, etc.

ISO standard 15459-1 provides a method to assign globally unambiguous Transport Unit IDs to the packages created at source when the seller dispatched the goods independent of any carrier and independent of any shipper. This standard is well over twenty years old and already in use in many parts of the supply chain and in transportation as well, but as yet has not been universally adopted. It enables consistent tracking (and tracing) of the individual transport unit and the shipment associated with it and associated consignments. Similarly, the ISO standard 15459-6 provides a method to identify the shipment (Master Transport ID) in a globally unambiguous way. The European Commission Customs Guidelines for compliance with the new EU VAT Ecommerce regulations[3] also reference this approach[4]. Numerous supply chains have implemented this approach quite successfully. In many cases, it meets the requirements of both cargo owners and authorities. However, the approach does not meet all business or regulatory requirements in all cases.

The maritime industry currently uses the Bill of Lading (BoL) as their primary consignment identifier across a multitude of its operational processes and activities. Once a maritime consignment arrives at port, the containers may be subsequently unloaded and re-loaded onto rail wagons or inland waterway barges to be transported further inland. There are even ship-to-air transfers currently in use for transporting goods in AustralAsia and the South Pacific. Transfers to these alternative forms of transportation may require use of alternative consignment identifiers to be compatible with their current common practices.

In the case of rail transportation, Consignment notes (CIM) and wagon notes trace shipments involving handovers between shippers, forwarders and one or more rail undertakings (RU). These documents do constitute a contract between client and carrier.

IATA Resolutions specify the Air Waybill as the primary key identifier. IATA Resolution standards are in effect regulations with which IATA members (airlines) must comply. This AWB mandatory standard has been universally accepted not only by the air carriers, but also by enactment in law by the world's governments for this mode of transportation and applies also to associated trucking (referred to as 'flying trucks'), facilitating the transport to and from airports, which may be part of that supply chain. Although commonly referred to as an air cargo 'shipment', this is technically a Forwarder's consignment to the air carrier, a consolidation of individual cargo owners' shipments, where each shipment is identified by a Forwarder's housebill number. In the case of air, although not currently an IATA standard, a reference in the Forwarder's housebill to a cargo owner's shipment ID (Master Transport ID) may allow the information to continue to be passed through the supply chain.

In standard 'cargo' consolidated consignments from Forwarders, there could be multiple cargo owner IDs, for shipments grouped into consolidations. Splitting of a large air consignment into different ULDs allows the movement of partial shipments of the consignment in multiple containers on different aircraft or even different routes on different days. It can become complicated to maintain the relationship of a cargo owners' shipment ID, in relation to the Master Air Waybill, and the underlying housebills of the Forwarder, particularly if the Forwarder's housebill number in the consolidated consignment to the air carrier is not the same as the cargo owners' shipment ID. The cargo owners' shipment ID would need to be another data element in the Forwarder's housebill.

[3] https://ec.europa.eu/taxation_customs/business/vat/modernising-vat-cross-border-ecommerce_en
They come into force 1st July 2021

[4] The guidelines will be finalized and published September 2020.

It is not likely, the long and well-established primary identifier standards mentioned above for modes of transportation such as air and related trucking will change rapidly for intermodal transport. Future developments to accommodate new technology and communications standards, however, for interoperability, such as IATA's ONE Record are currently in proof of concept.

During intermodal transport, some type of standard identification or cross-referenced key data elements must be used to capture and pass the information easily to other stakeholders in the transaction, uniquely identifying the specific shipment. Perhaps a subset of information, normalised to accommodate each mode of transportation, might enable the sufficient pertinent details to describe the shipment as unique in the Seller to Buyer transaction, and thus be recognized and acceptable in the future by Regulatory officials. In order to accommodate this development for intermodal transport, the information needs to be provided and accepted into an information-sharing network from which all authorised stakeholders can subscribe to the data for that shipment.

UN/CEFACT has also initiated a new project requested by a number of Member States and governmental organisations for Tracking and Tracing with the aim to track, trace and monitor anything considered a product or service that may be identified by an ID from Seller to Buyer, and vice-versa in case of returns. This project will identify how global (data) standards, such those described in this article, may be used to deliver seamless end-to-end tracking across any mode of transport for a variety of use cases occurring most frequently in supply chains. The solution to this data communications impediment in today's supply chains is an imperative building block to providing more seamless intermodal tracking, which will help facilitate future international trade.

Commonly adopted standard international identification method(s) and incorporation of them in operational processes need to be acceptable to all parties. Regulations recommending, endorsed or even enforcing those methods will be introduced in the future so that shipments and goods may cross international borders more smoothly than is customary today, thus enhancing trade facilitation.

Connecting Information Technology Systems - Technical Interoperability

In addition to the semantic interoperability and considering the huge potential of the IoT data to improve the door-to-door logistic chains, there is a need to address the physical connectivity of the devices and among the different information systems.

DCSA has recently defined the physical connection characteristics related to the radio interfaces to be supported by gateways that ensure smart assets' connectivity on the vessel and on land facilities.

There are new initiatives and approaches now under consideration and development that aim to make the system-to-system communications' exchange of the operational information much easier and much less costly than today. The EIF refers to these communications as "technical interoperability". The overview below to connect IT systems technically is in no way comprehensive. The review, however, will identify some of the ways standards-creating organisations are now moving forward to facilitate an end-to-end transportation supply chain.

While the standards and identification schemes from the International Organization for Standardization (ISO), UN/CEFACT and GS1 all provide a well-established and proven solution approach that could be adopted even more widely, the details required to implement are not as clear-cut when it comes to connecting the multiple and varied IT systems of the stakeholders to provide interoperability.

Currently, several initiatives aim to reduce or even remove most of the complexity involved in the diversity of system-to-system connection. All of these initiatives propose approaches that move away from the traditional one-to-one connections that are the root cause of the lack of system-to-system connectivity of today towards a model of ***"connect once and communicate with many".*** In effect, they

create a "network" based on agreed standards. Organisations wishing to connect their system connect to the network once and after that, they can then communicate relevant information with any other organisation connected to the network. Clearly, this makes it much easier to achieve a positive Return on Investment for building the technical connection with the network, i.e. invest once and see returns from being connected with many business partners.

These networks may adopt different (technical) approaches to enable a much-simplified connectivity. Various approaches can be grouped into two main categories:

1. Networks that do not store data about the business operations within the network. They merely provide the facility to transport the digital data across the network in a trusted, secure and safe way.
2. Networks that store data about the business operations within the network. The data may be a small subset of all data exchanged; it also may be encrypted with access tightly controlled and restricted to only parties who are authorised to see it.

There are many networks that do not store business operations data within the network itself, e.g. PEPPOL, FEDeRATED, FENIX, RISCOMEX/VISURIS, SWING, iCargo, eFreight, ORPHEUS and AEOLIX. Many of these are projects that the European Commission has funded over the years to develop those networks. The European Community now calls those networks "federative networks of platforms". Some have been adopted widely by many organisations (all over the world). The PEPPOL network for instance serves tens of thousands (maybe more than 100,000) private and governmental organisations in Europe and Asia Pacific. The network processes many millions of business transactions every year.

FENIX and FEDeRATED projects are currently in progress and they aim to expand the functionality, performance and power of those federative networks even further. These networks rely on the four-corner model. One organisation connects to one access point for the network. All access points in the network can exchange/transmit data (using agreed technical protocols and patterns) between each other. Another organisation connects to another access point of the network and thus, is able technically to communicate with the first organisation. This then is the four-corner model where there are two organisations plus two access points making up the four corners in the model.

IATA's "ONE Record" project is in development and has a proven proof of concept. Similar to the networks mentioned above, the ONE Record approach does not store business operations data in the network. One Record is a standard for data sharing based on a standard web API, a data security layer with a federated identity system and an airfreight ontology for data specification and exchanges. It has been designed to serve the end-to-end transport and logistics chain with the support from all stakeholder groups along the journey. ONE Record essentially specifies the Internet of Logistics that treats all data sources and suppliers such as transport and logistics companies as nodes on a network of data, using mature web communication standards.

The ONE Record approach may be combined with the federative networks approach as shown in the Figure below from a FEDeRATED pilot project. This was set up with a Benelux-based SME company specialized in the shipping, forwarding, handling, transport and storage of high value goods that are transported by air worldwide, combined with road transports within Europe and the UK.

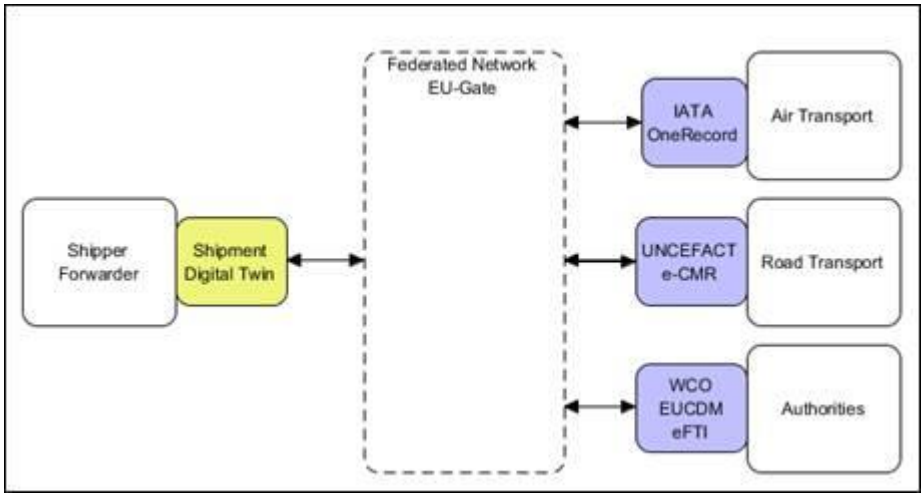

Figure 1. The FEDeRATED EU-Gate living lab project extends the ONE Record "Internet of Logistics" approach to road transport whereby EU Authorities will be able to access transport information when the EU eFTI regulation becomes applicable.

The technical protocols and patterns may differ for the various networks. That said, most commonly supported patterns are RESTful API (using JSON formats), Publish & Subscribe and "transfer of EDI-messages".

The EDI3.org is a global initiative that aims to publish UN/CEFACT Reference Data Models and Code Lists as machine-readable vocabularies (JSON-LD) that will be available to design high quality RESTful API (Application Programming Interfaces) with a goal to safeguard semantic and technical interoperability with the UN/CEFACT standards that are maintained through a bi-annual governance process.

The IATA ONE Record approach is one example of the concept of "Linked Data". GS1 Digital Link is another. Linked data allows companies to reference any data of third-party data sources using web URI (Unique Resource Identifier) and through such linkage access relevant data as needed directly through the web. In this case, mode specific consignment identification as well as tracking data can be linked together. Linked data also implies that a semantic model and an ontology exists, as is the case for the organisations and projects mentioned[5] and therefore, both the context and the meaning of the consignment and tracking data are explicit and understandable[6].

Coming to the second category mentioned above, many networks rely on storing business operations data within the network. Among many others, there are Tradelens, Global Shipping Business Network (GSBN) and traditional VAN (Value Added Networks) like INTTRA and Descartes. The European Commission has funded projects to ensure such networks can more easily share data even when the data is collected and stored using different technologies. The DataPorts project (Data Platform for Cognitive Ports) is one example of those projects.

Some of these networks have been around for many years and use traditional (relational) databases to store the information in a central location managed by a single organisation. Other networks store the shared data in distributed databases that may take different forms. Approaches such as Distributed

[5] FEDeRATED and FENIX are both committed to document the semantic models used within those projects. The clear objective is to ensure those semantic models are the same where they overlap, so the networks can easily exchange data / information between them.

[6] Linked data, semantic models and ontologies extend far beyond tracking and create a web of data that provides full transparency into all aspects of transport and logistics regardless of mode of transport.

Ledger Technologies (DLT), blockchain, EPCIS etc. all store (subsets of) business operations data that may then be accessed by participants in the network. The levels of trust, security and safety may vary from network to network. The scalability of the networks often differs considerably, as well. The data stored in the network ("online") almost invariably connects to databases that run outside the network (but can be accessed via the network). The data in those databases is called "offline" data.

Distributed Ledger and blockchain technologies currently attract a lot of attention as a basis for trusted, secure and safe storage within a networked environment[7]. In many cases, it is easier to connect federative networks that do not store data in the network together than it is connecting networks that rely on data stored within the network. The storage technologies used in the different networks may be difficult (or currently impossible) to combine whilst maintaining support for all functionality that was available in any of the individual networks based on the storage available in the network[8].

Stakeholders' Involvement in Adoption of Standards

The various initiatives and projects mentioned above have literally evolved and involved many hundreds of organisations (both private and governmental). These organisations are active in every area of the supply chain[9].

Clearly, there is a very high demand from supply chain stakeholders to improve the efficiency and effectiveness of the supply chain. All of those initiatives aim to improve tracking first so they have a reliable foundation of information available based on which they can make data-driven decisions with confidence.

Organisations adopting and using standards should remind the standardisation organisations of the paramount need for cooperation in developing these international standards, so they can be more universally accepted and implemented.

Summary

Supply chains today can no longer meet the heightened expectations of Sellers and Buyers when it comes to detailed tracking of the current location and condition of their goods. Even Logistics Service Providers involved in the transportation of the goods from Seller to Buyer are struggling with the lack of reliable tracking information for the cargo, the transport equipment and transport means, particularly when intermodal transfers are involved.

However, current initiatives are delivering the needed building blocks for future interoperability, both semantic (operational data) and technical (IT systems).

We are now in a transition from the standards adopted by individual transport modes to current efforts by multiple international standards organisations to identify a normalised method(s) of identification of the required data that will be applicable to any Seller-to-Buyer shipment, regardless of the transport

[7] UNECE – Conference on "Role of Advanced technologies in overcoming COVID-19 disruptions in international trade", 2 July 2020

[8] The World Economic Forum recognized the issue and issued a white paper highlighting the issue and indicating approaches to deal with the issue. https://www.weforum.org/whitepapers/inclusive-deployment-of-blockchain-for-supply-chains-part-6-a-framework-for-blockchain-interoperability

[9] Besides the projects we mentioned, many more have run and/or are running involving yet again large numbers of different stakeholders

mode. This shipment approach has been modelled in the past by the United Nations Centre for Trade Facilitation and e-Business (UN/CEFACT). However, overall adoption of Tracking and Tracing in a multi-modal approach has not yet been completed. The current initiatives improving upon the standards already developed are delivering the needed building blocks for facilitating future intermodal supply chains. Normalised information using internationally agreed and recognized IT communications standards exchanged between the transport operators and their stakeholders will provide the building blocks toward efficient interoperability. These building blocks, both old and new, should be based on common and open standards regardless of the mode of transport and regardless of any specific stakeholder group to ensure the most efficient end-to-end supply chains can be achieved.

The solution to normalised intermodal data communications between various modes of transport and the interoperability of their systems through the cooperation of the standards organisations and adoption of these new standards initiatives will help facilitate and enhance future international trade.

Note. The opinions expressed herein are the authors' and not necessarily those of their employers or organisations in which they are active.

About the authors

Hanane Becha is actively driving smart assets standardisation for key industries such as maritime and rail freight. She is currently the DCSA IoT program Project lead. She is also the UN/CEFACT Vice Chair for Transport and Logistics leading the UN/CEFACT Smart Container Project as well as the UN/CEFACT Cross Industry Supply Chain Track and Trace Project. Hanane has received a Ph.D. and an M.Sc. in Computer Sciences from the University of Ottawa and a B.Sc. from l'Université du Québec.

Todd Frazier is Strategic Project Lead in the U.S. Regulatory Compliance group and is the FedEx Express Accredited Representative to the International Air Transport Association (IATA). He is also Chairman of the Cargo Services Conference, the cargo standards formulation body of IATA, and participates in several projects in UN/CEFACT.

Rudy Hemeleers is director of 51Biz-PPMB Luxembourg, a management consultancy and policy advisor with private and public customers in multiple modes of transport including air-cargo, road and inland navigation. He represents INE (Inland Navigation Europe) in the EU DTLF (Digital Transport and Logistics Forum). 51Biz Luxembourg is an external advisor of the Luxembourg Government (e-CMR, eFTI, EU RISCOMEX). 51Biz coordinates the FEDeRATED EU-Gate living lab.

Steen Erik Larsen is the head of Technology M&A in A.P. Moller – Maersk, the global integrator of container logistics, connecting and simplifying the supply chains. Larsen has the responsibility of the enterprise risk management aspects pertaining to information technology in integration and partnering. He is also representing Maersk in the Digital Container Shipping Association (DCSA).

Bertrand Minary is Chief Innovation & Digital Officer at SNCF Logistics Rail & Multimodal Division, the 3rd rail freight company in Europe. Due to his important experience in Supply Chain, Rail and Digital, he is in charge of reinventing rail freight business with added value, using Lean startup, UX and Agile approaches.

Henk Mulder is Head of Digital Cargo at the International Air Transport Association (IATA). He initiated and leads the ONE Record data sharing standard. Henk has degrees in IT Engineering and Mathematics.

André Simha is the Chief Digital & Information Officer at MSC Mediterranean Shipping Company, the second largest container carrier in the world, whose team is responsible for implementing and developing the complex data flow between the company's headquarters and its agencies around the globe, as well as steering the business towards the digital future of the shipping and logistics sector. Simha is also the chairman of the Digital Container Shipping Association (DCSA).

Jaco Voorspuij is responsible for Industry Engagement Transport & Logistics at GS1, and has worked developing global data standards with various standardisation organisations (e.g. GS1, CEN, UN/CEFACT) and is co-chair of the International Taskforce Port Call Optimization.