



Economic and Social Council

Distr.: General
26 March 2021

Original: English only

Economic Commission for Europe

Executive Committee

Centre for Trade Facilitation and Electronic Business

Twenty-seventh session

Geneva, 19-20 April 2021

Item 6 (d) of the provisional agenda

Recommendations and standards:

Implementation support material

White Paper on Integrated Track and Trace for Multimodal Transportation

Submitted by the Bureau

Summary

This white paper provides a high-level overview as the foundation for developing the business requirements specifications (BRS) document for the project. The BRS will then serve as the guide for the creation of the data models and further standards necessary for supporting digitized track and trace for any single or multimodal transportation scenario. This paper attempts to bridge gaps that exist in the identification schemes used to identify consignment movements and commercial systems.

Document ECE/TRADE/C/CEFACT/2021/INF.4 is submitted to the twenty-seventh session by the Bureau for noting.

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I. Introduction

1. Transportation demand is forecasted to triple by 2050¹. Keeping track of that intensification of transportation is imperative for all supply chain stakeholders. Motivated by factors such as operational efficiency standards, competitive pressures, heightened customer expectations and governmental regulations, both public and private organizations are searching for mechanisms to reduce risks by gaining data-driven visibility into the physical location, condition, and context of their products and assets². Universal track and trace capabilities will enable digital ecosystems to flourish, overcoming current logistics inefficiencies. Companies will have full visibility and sovereignty³ over their supply chains as part of fully interconnected logistics networks so that transport assets and resources are used for optimum efficiency. Unfortunately, today transport and logistics do not offer these universal track and trace capabilities.

2. The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) defined a *Cross-Industry Supply Chain Track and Trace Project* in 2018, which was initiated in early 2020. The project's primary focus is on tracking and tracing during transportation covering the movement of trade deliveries (shipments) from seller to buyer via one or more transport contracts (consignments) and one or more transport modes.

Problem Statement

Currently, there are gaps in the communication of commonly recognized identifiers used in the business-to-business (B2B) trade world to identify the shipments and the equally commonly recognized identifiers used in the B2B transport world to identify the consignments with which these shipments are moved. This also exists in the business-to-consumer (B2C) trade and B2C transport world. These worlds have been tracking and tracing separately for years and the supporting methods and technologies used have been gradually improving. However, there are no proven globally standardized approaches able to link between the trade and transport domains in all situations.

3. Stakeholders involved in the trade transaction (sales order contract) and stakeholders involved in the transportation of consignments of the trade deliveries (shipments) of goods covered in the sales order use common terms and definitions in different ways. For instance, the terms “shipment” and “consignment” are not used with the same meaning across different trading industries and different modes of transport. The various parties may also use different identifiers for the same objects. For example, transport contracts for services provided using different modes of transport are identified by different names (road consignment note, waybill, master airway bill, bill of lading, rail consignment note, etc.).

4. Furthermore, as traded goods progress through the end-to-end transportation journey from seller to buyer, each subsequent stakeholder may issue a new identifier to the objects and entities handled in an individual transport movement stage. Often, during the transportation process, the logical and technical links between the objects and entities involved in the end-to-end journey are not captured or referenced in downstream communications. The result is that few, if any, stakeholders can obtain a complete overview of the actual end-to-end supply chain related to the goods shipments moved as consignments.

5. The gaps between these trade and transport worlds with regard to a consistent set of related trade and transport identifiers can potentially be closed by reusing the UN/CEFACT Buy-Ship-Pay (BSP) integrated framework⁴—which links the UN/CEFACT Supply Chain Reference Data Model (SCRDM)⁵ and the UN/CEFACT Multi-Modal Transport Reference

¹ Organisation for Economic Co-operation and Development, ITF Transport Outlook 2019 (Paris).

² Delen, D., B. Hardgrave, R. Sharda, “RFID for better supply chain management through enhanced information visibility”, *Production and Operations Management*, vol. 16 (5), (September 2007), pp. 612–624.

³ See *JRC LIVE - Regaining supply chain sovereignty*

(https://www.youtube.com/watch?v=kGufoacnsVI&list=PLXdsc7eCmCO4k8RC_PiXW_OZAEBkqu271&index=2)

⁴ https://unece.org/DAM/cefact/brs/BuyShipPay_BRS_v1.0.pdf

⁵ https://unece.org/DAM/unecefact/BRS/BRS_SCRDM_v1.0.0.2.pdf

Data Model (MMTRDM)⁶—in combination with consistently applying standardised identification schemes currently in use within and across supply chains.

6. Figure 1 below defines two of the key terms for which we need to resolve the operational and communications gaps in the end-to-end seller to buyer supply chain. “Shipment” is a trade term for the goods that are purchased and need to be transported to the buyer. “Consignment” is a transport term for the evidence of a transport service contract by which trade shipment(s) are transferred to transport operators to be moved under the terms of the associated transport contract. The cargo moved as a consignment may comprise multiple trade shipments, a single trade shipment, or a portion thereof.

Figure 1

Understanding the difference between the shipment (trade view) and the consignment (transport view)

Global Trade – Semantic Anchors

Shipment (Trade Delivery)

- A shipment is an identifiable collection of one or more Trade Items (available to be) transported together from the Seller (Original Consignor/Shipper) to the Buyer (Final/Ultimate Consignee):
 - A Shipment can only be destined for one Buyer
 - A Shipment can be made up of some or all Trade Items from one or more Sales Orders
 - A Shipment can have only one Customs UCR
 - A shipment may form part or all of a Consignment or may be transported in different Consignments.

Consignment

- A consignment is a separately identifiable collection of Consignment Items (available to be) transported from one Consignor to one Consignee via one or more modes of transport as specified in one single transport service contractual document:
 - A Consignment can only have one Transport Service Buyer
 - A Consignment can only have one Transport Service Provider
 - A Consignment can only have one Consignor
 - A Consignment can only have one Consignee
 - The Transport Service Buyer can be either the Consignor or the Consignee
 - A Consignment is made up of one or more Consignment Items
 - A Consignment can be made up of some or all Trade Items (aggregated into Consignment Items) from one or more Shipments

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7. As trade deliveries (shipments⁷) move from original consignor (seller) to final consignee (buyer), they may be consigned and transported over several transport legs or stages, possibly provided by several logistics service providers (LSPs). Because each operational stage may use different digital environments to identify and communicate information about the goods being moved, the need for interoperability between the operational processes and their systems becomes essential. Tracking and tracing provides significant benefits for the original consignor and final consignee, as well as for subsequent LSPs and other stakeholders involved in the movement of the trade shipments through the complete transportation chain.

8. Such tracking provides knowledge necessary for optimized planning to manage the uncertainties of when the goods will arrive at any agreed location, and especially relating to arrival at their final destination. LSPs use tracking to ensure that the delivery times and locations as delivered by their transport services correspond to the expectations of their contracts with their customers, whether they be the original trade parties (seller/buyer) or intermediate LSPs. To guarantee participation and neutrality in decision-making processes, and to empower collaboration, this interoperability needs to be enabled by standards for information exchange between all the different stakeholders. The ultimate goal is to ensure that the flow of goods is as smooth, predictable, reliable and as resilient as possible based on the exchange of information that guarantees that “what is sent is what is understood⁸”. The

⁶ https://unece.org/DAM/cefact/Standards/MMT/BRS_T_L-MMT.pdf

⁷ This paper uses the term shipment to refer to the Trade Delivery (also indicated in Figure 1).

⁸ European Union, *European Interoperability Framework (EIF)*, (Luxembourg, 2017), p.29. Available at https://ec.europa.eu/isa2/eif_en.

availability of well-understood, reliable information to all stakeholders is a prerequisite to improving the flow of goods.

9. Increased transparency during the multimodal transportation of traded goods from seller to buyer offers new opportunities and huge benefits for supply chain optimization that did not exist prior to the widespread adoption of digital technologies. However, currently there are gaps in the process and flow of this information that must be filled.

10. Information about events related to the movement of cargo between different geographical nodes and operations, such as loading/unloading/transfer, is captured at different levels of granularity in the different systems operated by the transport operators and LSPs involved. One of the primary results of such gaps in the data is that the parties involved do not share information sufficiently with some of the important linking details remaining only within their own systems. Transport operators may not have all the prior assigned reference IDs required to adequately link back to the original trade transaction between the seller and the buyer. In order to establish end-to-end visibility across the supply chain, such data must be accessible to all interim stakeholders. Therefore, it is important to provide the stakeholders with tracking and tracing information to guarantee that the transportation of goods and related events are aligned with the expected procedures, most specifically in providing on-time delivery to the final consignee. Today, there are additional benefits to be derived from using new technologies for tracking and tracing, which can provide information not only relating to the location of the cargo along its journey, but also relating to the environmental conditions or the safety status of the cargo itself.

II. The UN/CEFACT Cross-Industry Supply Chain Track and Trace project

11. In October 2018, seven UN/CEFACT Heads of Delegation supported the *Cross-Industry Supply Chain Track and Trace* project. After investigating the background and considerations necessary for this subject, the development of this white paper marks the first deliverable of the project. This will be followed by the development of a business requirements specification (BRS) document. These deliverables will result in business process models and business class diagrams which will document the business scenarios and business transactions involved. These deliverables will enable the exchange of information during the transportation phase of traded goods from original consignor to final consignee, which are carried in identifiable transport assets (see definitions for “transport equipment” and “transport means” below).

12. This white paper provides an overview of the project scope and objectives, which will provide the basic assumptions to support the development of the (BRS). Tracing methodologies (such as processes and use cases) will be presented which could enable the tracking of each identifiable asset by retrieving the information about the locations and events that affect the asset during transportation. The needed data should be transmitted in electronic format, either directly from a technological solution or keyed into a system by a stakeholder.

A. Target group

13. Anyone who has an interest in the transportation of goods by any mode of transport should consult this white paper. This includes the seller (original consignor) sending traded goods, and the buyer (ultimate consignee). Both parties need to have answers to the basic question “where are our goods?”⁹. In addition, a freight forwarder may want to know “where is my consignment?”, or a customs official may want to know “is it safe to allow this transport unit/consignment into the country?”. This white paper will be beneficial reading to respond to these questions and being able to identify the whereabouts (present and past) and/or the condition of the traded goods.

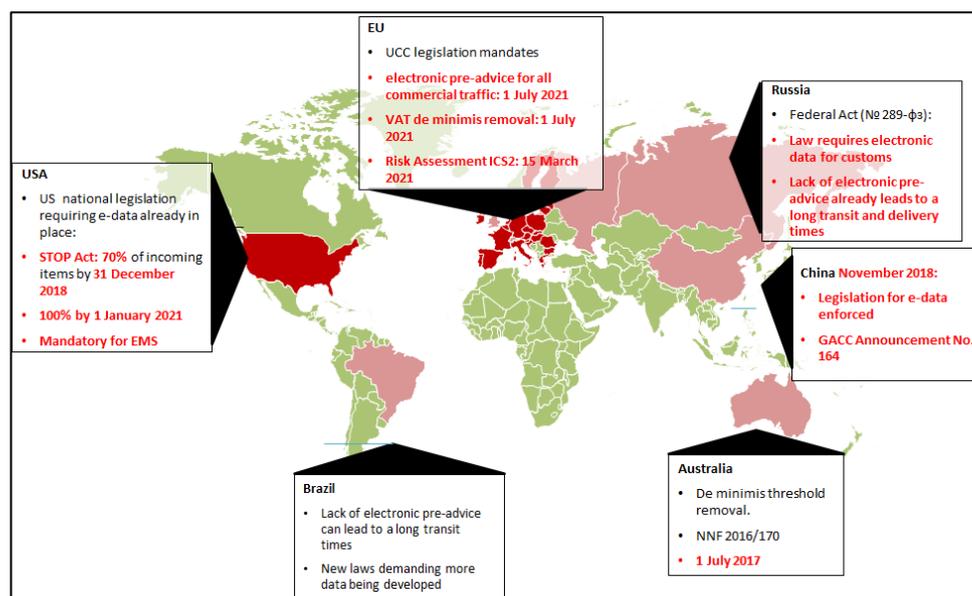
⁹ Stakeholders may also want to know “are my goods still in good condition?” The *UN/CEFACT Smart Container Project* has developed standards to respond to that question. [See project overview.](#)

B. Scope of the UN/CEFACT Track and Trace project

14. The scope of this project covers two distinct areas:
- (a) Tracking - which is monitoring and recording the current location and status of the traded goods once consigned to a transport operator(s); and
 - (b) Tracing - which is monitoring and documenting the history of transport of traded goods from original consignor to final consignee regardless of the type of goods or the mode(s) of transport deployed for their transportation.
15. The following goals are within the scope of this project:
- Standard electronic formats for all information exchanges concerning the transportation of traded goods as consignments. The extent of the information exchanges is to support communications throughout the end-to-end transport supply chain from seller to buyer and vice versa in the case of returned goods. UN/CEFACT will identify the data elements and their business relationships with reference to the UN/CEFACT Multi-Modal Transport Reference Data Model (MMT-RDM). These data exchange specifications will also be applicable to empty, full or consolidated transport assets (container of any size and shape). This will enable the exchange of the location and status of cargo at any time in the transportation chain, regardless of the type of container in which the goods are located or the mode of transport; and
 - Proposals for methodologies to close the gaps between the trade transaction shipment identification and the transport consignment identification in order to reconcile the two and thereby increase transparency and interoperability across the entire supply chain.
16. Beyond the tracking of traditional containerized freight, this project will address transportation involving large quantities of goods covered under a single sales order (as is often the case in bulk transport) as well as transportation of very small quantities of goods (often also quite small in size) such as those typically traded via internet transactions (e-commerce, be it business to consumer or business to business sales)¹⁰.
17. According to the Universal Postal Union, digitalization—or more specifically the much-improved flow of information throughout the supply chain—is required to support supply chain processes such as declarations for value added tax (VAT) and customs, safety, protecting intellectual property rights (IPR) and combatting illicit trade. National and regional legislation, in some cases already initiated, will require end-to-end information sharing among the stakeholders involved. Figure 2 below highlights a few of the relevant regulations:

¹⁰ Most cargo movements in the world today are linked to e-commerce and this can be expected to increase going forward. UN/CEFACT defines e-commerce as an online-initiation, cross-border transaction/shipment, and destined to consumers (commercial and non-commercial); the e-commerce initiation of a transaction will most often lead to a traditional electronic communication for the subsequent services which could be termed e-business.

Figure 2
Regulations requiring e-data from supply chain stakeholders¹¹



18. The objective of the *UN/CEFACT Cross-Industry Track and Trace project* is to publish deliverables which help all stakeholders better meet the requirements of all required regulations with much less effort.

Tracking and tracing overview

19. Today, the granularity of tracking is primarily focused on the means of transport or transport equipment as trackable transport assets in which the traded goods are placed for efficiency and protection from damage. It is often thought that if we know the location of the trackable transport asset, we know the location of the traded goods therein, in other words equating the asset to the goods. However, this is not a one-to-one relationship. Transport assets and their associated identifiers may come and go during the journey from original consignor to final consignee, but primary identifiers do not change. The primary identifier used by different modes of transportation may currently require a different primary identifier during an intermodal transfer. In such a case, the primary identifier from the original transport operator should still be referenced in all the data communications with the new transport operator.

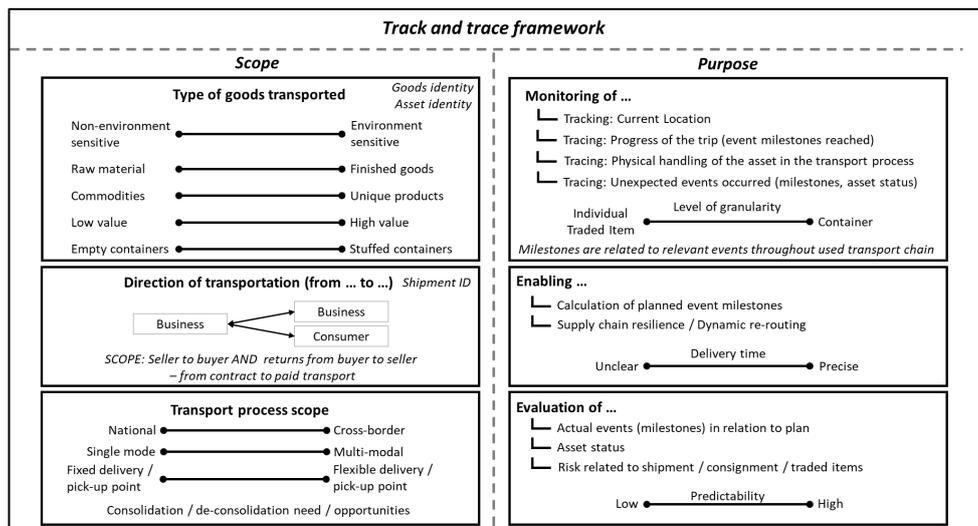
20. However, as stated above, during the transportation chain, the consigned goods themselves may be removed and placed in another means of transport or transport equipment for onward movement. Their identifiers, if they are unique, make a particular piece of transport equipment or a means of transport a trackable transport asset.

21. Tracking and tracing can also include events such as returning goods or returning the transport asset itself to an originating location when empty. Tracking and tracing of an identifiable asset itself is therefore also applicable, even when the asset is empty.

22. In a general sense, the purpose of tracking and tracing is multi-dimensional; different types of goods transported require different monitoring characteristics. It may simply be monitoring the present and historical movements of the goods or it could also include monitoring and capturing the condition or status of the transport equipment. In the framework depicted in Figure 3 below there are some different dimensions to be considered in the *UN/CEFACT Cross-Industry Track and Trace Project*.

¹¹ Figure courtesy Universal Postal Union (UPU), International Bureau.

Figure 3
Scope and purpose of track and trace applications

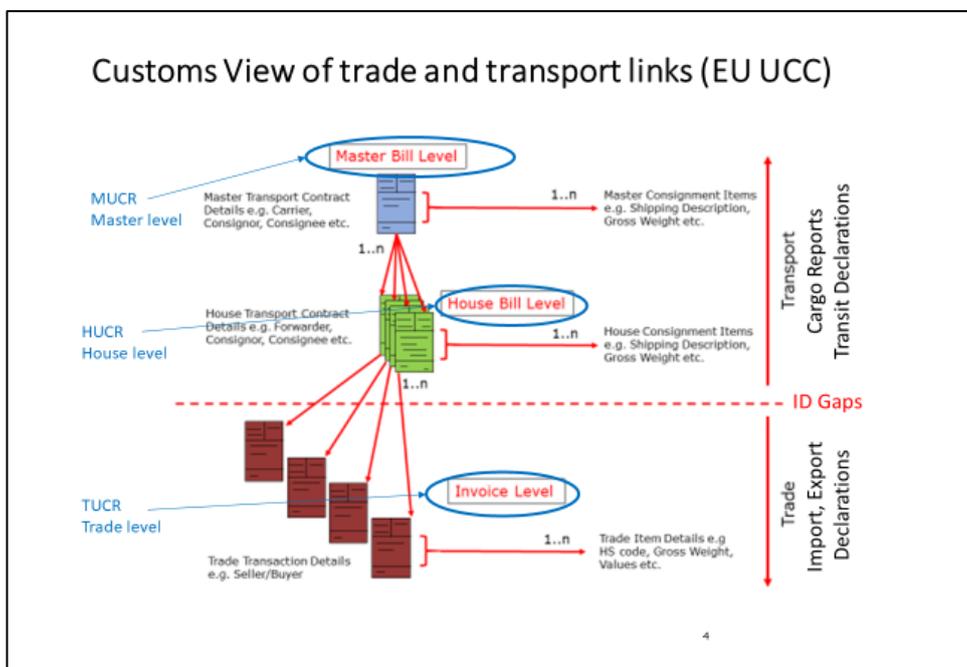


23. The following items are not within the scope of this UN/CEFACT project:
- Trade transaction processes except dispatch and delivery related identifiers;
 - Transport contract processes including charging details;
 - Differentiation by characteristics of individual commodities of transported goods;
 - Customs and other cross-border regulatory reporting; and
 - Transport environmental aspects or related concerns such as cargo footprints (environmental condition is mentioned as a potential additional part of the tracking process, but is explained within the *UN/CEFACT Smart Container Project deliverables*¹²).
24. Track and trace functions need to follow the route of the traded goods through the movements of their associated consignments. This allows the stakeholders to relate actual goods movements with forecasted plans across different modes of transport and across national borders. Today, goods are reported to customs for acceptability into another country by their consignment identification and information provided by the transport operator. Trade information is provided by additional information provided either by the LSP or an agent/broker.
25. In order to provide the missing links between the trade and transport processes, it is necessary to assign identifiers that can be referenced throughout any of the movements or locations of the consigned goods.
26. Figure 4 below describes the types of identifiers used by customs that are differentiated by transport or by trade. These same identifiers can be used to assist in the supply chain track and trace of assets. (See the key identifiers section II, E for more detailed information.)

¹² The *UN/CEFACT Smart Container Project* has developed standards and other documents. See project overview: https://unece.org/fileadmin/DAM/cefact/cf_forums/2020_October_Geneva/PPTs/8Oct_06-T-L-JVoorspuij-SmartContainer.pdf

Figure 4

Identification (ID) gaps exist between the trade declarations and the transport reports and transit declarations. [Master Consignment Unique Cargo Reference (MUCR); House Consignment Unique Cargo Reference (HUCR); Trade Transaction Unique Cargo Reference (TUCR)]



C. Definitions

27. For the purposes of this project, the following terms are used:

- (a) **Cargo** refers to goods carried on a vessel, aircraft, or motor vehicle (such as a truck or train).
- (b) **Consignment** is a separately identifiable collection of consignment items to be transported, or available to be transported, from one consignor to one consignee in a supply chain via one or more modes of transport.
- (c) **Goods** are any collection of traded items involved in a sale contract that are combined to form shipments, also known as trade deliveries.
- (d) **Logistics services buyer (LSB)** is any entity which uses logistics services provided by logistics services providers (LSP) under the terms of a transport contract.
- (e) **Logistics service provider (LSP)** is any entity which provides logistics services to a logistics services buyer (LSB) under the terms of a transport contract.
- (f) **Shipment** is an identifiable collection of one or more traded items (available to be) transported together from the seller (original consignor) to the buyer (final/ultimate consignee). A shipment is related to a sales contract of physical goods.
- (g) **Location of goods** is the physical location of the consigned goods in whichever transport equipment or transport means they are at a given moment in time during transportation, such as in-flight/in-warehouse. This is particularly important when the shipment may have been separated into different transport equipment or on different transport means for efficiency of transport movements.
- (h) **Tracing** is the function of retrieving information concerning traded goods, goods items, consignments, transport means or transport equipment. In the context of this paper, it is the monitoring of the history of the transportation of traded goods from seller (original consignor) to buyer (final consignee).

- (i) **Trackable transport asset** is an identifiable transport means/transport equipment/transport unit in which goods have been placed. Any trackable transport asset has a unique identifier.
- (j) **Tracking** is the monitoring of the present location and status of the goods while in transit.
- (k) **Transport equipment** is a piece of equipment used to hold, protect or secure cargo for logistics purposes, e.g. intermodal containers, unit load devices, rail wagons, trolleys and roll cages.
- (l) **Transport means** is the powered device used to convey people, cargo, animals or other objects from place to place.
- (m) **Transport operator** is a company which provides any transport means to move cargo.
- (n) **Transport unit** is a unit intended for transportation, comprising one or more traded items or shipments, wrapped or unwrapped.
- (o) **Unique identifier** is a unique, non-significant number or code.

Transport assets definition and understanding

28. In the *UN/CEFACT Cross-Industry Track and Trace Project*, transport assets are the transport equipment in which the goods are placed for transport and the means of transport which moves the cargo. A unique identifier associated with a transport asset can be used for tracking the cargo. Buildings and facilities such as terminals and warehouses are not considered assets within the context of this white paper because they do not move with the goods. However, warehouses are locations that may be identified in the history of the transportation (tracing) as intermediate storage locations.¹³

D. Trade processes versus transport processes

29. In the sales order process, physical goods are purchased through agreements and orders between the seller and buyer, which result in the need to contract logistics services (see Figure 5 below):

Figure 5

The relationship between sales order contracts and the transport service contract which initiates the transportation of the traded goods and the track and trace processes



¹³ This is common practice in many transport networks (e.g. in air and maritime environments).

30. The initial logistics services are arranged between the seller or the buyer directly with an LSP depending on the sales order contract (purchase agreement) and transport agreements. Once the goods begin to move from the possession of the seller (original consignor), the transport process begins, setting in motion the track and trace process. Identification of the traded items as part of the sales order contract (purchase agreement) is required as they should be referenced in the transport services contract and throughout the transport chain to the buyer for end-to-end transparency.

E. Key identifiers

31. There are numerous identifiers required during the transport process. Linking those identifiers back to a recognized identifier for the traded items in the original trade agreement between the seller and buyer can close the gap in the end-to-end track and trace transport process.

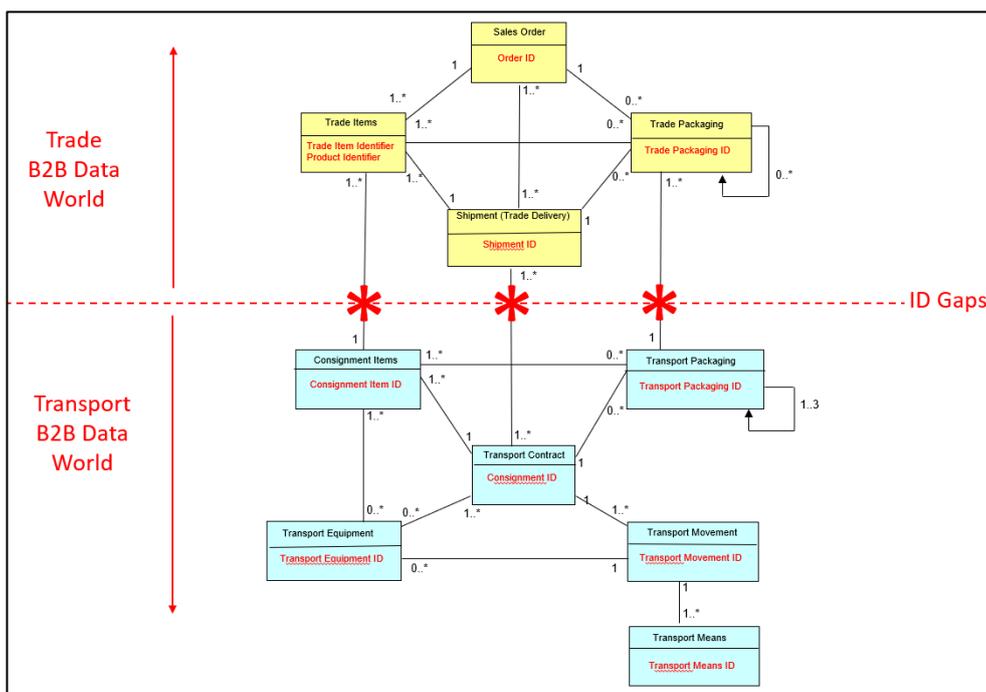
32. Each mode of transport uses various key identifiers for locating and moving consignments. Supporting multimodal transportation operational and systems' interoperability is a goal of this project. The facilitation of key identifiers in the data exchanges and the interoperability of the communications systems will be the foundation of the solutions for future supply chains, which will improve speed, efficiency, reliability and resilience. At the most basic level, each event relevant to tracking and tracing must be able to answer the following two questions unambiguously:

- **Where** did the event take place? A unique identification for the location (if available) would be extremely useful.
- **What** object was involved in the event? This is the trackable asset or the uniquely identifiable cargo that it contains.

33. In an ideal world, all parties involved in the transportation of traded goods will use the same identifiers for locations, trackable assets and for the goods. In business to business transactions the primary identifiers used today are identified in Figure 6 below (these same identifiers should also be applicable in a business to consumer transaction).

Figure 6

The shipment(s) in the trade world become the consignment(s) in the transport world



34. Similarly identified in Figure 5, ID gaps may exist when tracking the movement of the goods when they are consigned by an LSP, particularly if there are multiple modes of

transport involved or if intermodal transfer is required during the transport chain. For example, a consignment of traded goods (shipment(s)) may be delivered by another transport operator to the buyer (final consignee), which may use a different set of identifiers than those assigned by the previous transport operator.

35. Information captured during the transport movement may vary dependent on the transport operator or even by mode of transport. However, this information may be important for making critical and timely decisions by primary stakeholders during or after transport of the goods. Therefore, multimodal supply chains currently assign unique identifiers for the following:

- Traded item identifiers such as bar codes etc.;
- Sales order transaction identifier;
- Shipment identifier assigned by the original consignor;
- Transport unit identifiers;
- Transport contracts identifiers such as waybills or consignment notes;
- Transport means identifiers (e.g. IMO vessel number or truck licence plate);
- Transport equipment identifiers (e.g. shipping container/ULD/rail car IDs);
- Transport movement identifiers (e.g. voyage number or flight); and
- Identifier of all cargo carried by a transport means for a specific transport movement (i.e. manifest).

F. Dedicated versus shared transportation services

36. Depending on the size or volume of an individual consignment to be transported as well as other conditions such as routing, speed or cost of transport, the consignment may require transportation using a specific type of transport asset (transport equipment or transport means).

37. The consignments may be contracted for transportation in two general ways:

- Dedicated transport; and
- Shared transport.

38. **Dedicated transport:** The key characteristic of dedicated transport is that a piece of transport equipment or means of transport carries only a single consignment at a time, and can, therefore, offer door-to-door delivery with efficient speed and frequency of dispatches. Dedicated transport services for these consignments may differ by names depending on the mode of transport, for example Full-Truck-Load (FTL) for road transport; Full-Container-Load (FCL) for container-based transportation; and Full-Wagon-Load (FWL) for rail transportation. Basically, however, transport assets or means of transport pertaining to any dedicated transport service can be described in a similar manner, where the transport equipment or its means of transport is fully loaded, partially loaded or empty.

39. **Shared transport:** The key characteristic of shared transport services is that multiple consignors (sellers and/or their LSPs) are involved in the consignments carried on a specific trip of a transport means. Providing the availability of consolidators and facilities, they are able to transport smaller shipments with higher frequency and increased capacity utilization compared to dedicated transport.

40. Tracking and tracing in shared transport services environments involves additional complexity because the transport operator will often optimize capacity space of the transport equipment or transport means by combining multiple consignments within a single trip. Tracking and tracing are also more critical in shared transport, which requires unique identifiers for each consignment, for each transport asset that is used, as well as the transport means.

41. Shared transport is by far the most common type, especially with the explosive rise of e-commerce. Most e-commerce shipments are quite small in size and will be transported using parcel and postal services. According to Statista, “in less than a decade, global parcel shipping volume almost tripled reaching over 103 billion parcels delivered in 2019. Yet, this is only the beginning of an internationally expanding industry. By 2026, this market is expected to reach over 260 billion parcels delivered”.¹⁴

42. In both dedicated and shared transportation services, the goods may be transported in discrete, uniquely identifiable transport units or they may be moved in “bulk”, not containerized in an identifiable transport unit, but directly within the transport means. When bulk products are transported as shared transport services, tracking and tracing of the shipments (trade deliveries) as agreed in the sales contract become challenging. As long as products are in discrete, uniquely identifiable transport units when sent from the seller (original consignor), it is possible to track those transport units across all of the consignments they may be involved in as long as the transport unit identifiers are referenced throughout the entire history of the transport movement.

43. In the case where bulk products are transported using dedicated services, one can equate knowing where the transport means/transport equipment is (using the unique ID for them) with knowing where the traded item is located. In shared transport services scenarios, such as those frequently used in the cases of dry bulk (soy, grain, etc.) and wet bulk (vegetable oil, petroleum products and other chemicals), stakeholders generally work with lot numbers as identifiers for the traded item covered in the specific sales contract.

44. The specific characteristics of bulk products (unlike manufactured items like chairs or bicycles) tend to vary for each sales contract. For instance, the grade or classification of the product will vary from harvest to harvest as well as from production facility to production facility. Therefore, the sales contract will specify the relevant characteristics for the bulk product within the sales contract and link that to the specific lot number(s) involved in the sales contract.

45. Clearly, lot numbers are a key identifier for bulk products. However, these numbers are not visible or present on the goods being transported (as they would be if they were being transported in transport units). Furthermore, different lot numbers of the same product (with equivalent characteristics) may be in the same “tank” within a wet bulk transport means. This poses specific tracking and tracing challenges for bulk products that will be further explored in the next steps of the *UN/CEFACT Cross-Industry Track and Trace Project*.

46. Even though the number of bulk shipments is quite low compared to the number of e-commerce shipments, bulk shipments are of vital importance for the world’s economy. For example, palm oil is an ingredient in about 60 per cent of all food products and is also used in a wide variety of other products we rely on every day.

III. Benefits for track and trace solutions

47. Integrated tracking and tracing for multimodal transportation can provide a number of benefits for stakeholders. These can include the following:

- More accurate planning of logistics operations (such as load planning, space, tonnage requirements, shore cranes, labour, storage capacity);
- Validation of contractual conditions (such as actual volumes versus declared volumes, actual arrival dates versus estimated arrival dates) based on real-time tracking data;
- More timely reporting of events as they happen (such as packing, discharge, delivery, delays);

¹⁴ Mazareanu, E., “Parcel traffic worldwide by sector 2015-2019”, Statista, 21 December 2020. Available at <https://www.statista.com/statistics/737418/parcel-traffic-worldwide-by-sector/> (Accessed 19 February 2021).

- Risk reduction, by analysing tracing histories to identify pain points to be resolved in future movements;
- Increased optimization of trade routes (for example through performance of trade lanes, identification of blockages in the movement of the goods, analysing the ecosystem and environment around a port);
- Increasing the optimization of supply chain processes (tighter management of just-in-time processes, stock reductions, timely contingency plans if goods are delayed);
- Improving the utilization of existing idle capacity of transport assets in all modes of transport; and
- Reduction of unnecessary intermediate storage.

IV. Forward logistics approaches utilizing technical advances in tracking

A. Introduction

48. In this section, different approaches to tracking and tracing in transport and logistics will be discussed in more detail. These approaches can be used in any combination to meet various business requirements:

- Traditional tracking methods – manual and automated;
- Radio frequency identification (RFID)-based tracking methods; and
- Internet of Things (IoT) telematics device-based tracking methods.

49. Technological advances have enabled the real-time tracking and reporting of events affecting a consignment beyond just its current location. The implementation of each new and emerging technology has its own specific benefits. Such technologies, however, require investment in additional equipment such as handheld devices, GPS accessibility or other mobile devices. The benefits for key players should be apparent in the returns they gain by having a business strategy that reflects their investment in tracking systems. Below is an overview of the benefits for some key stakeholders when applying the approaches mentioned above in frequently used processes. This overview is by no means comprehensive.

50. The approaches described here can be applied to reverse logistics, but in practice they have been mostly applied in forward logistics environments.

1. Traditional tracking methods

51. Manual tracking methods imply a process whereby a physical person (operator) obtains and notes the transport asset ID or transport means ID in which a consignment has been loaded (also referred to as stuffed). This unique ID may be on paperwork provided with the consignment or may be on the transport asset or means itself. That information is then entered by hand or transmitted into a computer system. Such manual processes are time consuming and prone to error compared to other methods described in this document; once this data is digitalized it increases the efficiency of these procedures.

52. Advanced methods include automated tracking, using handheld or fixed devices, to electronically capture information from a single object. Many transport operators use portable data-reading devices such as barcode scanners or mobile phones that can automatically scan, capture, and transmit that information to a computer system to process the information displayed on paper/labels, such as linear and two-dimensional (2D) barcodes. These barcodes are not electronic or responsive themselves and the dataset captured in a single scan is restricted to a relatively small number of data elements and limited data volume.

53. Tracking equipment, such as barcode scanners have been in use for several decades. Barcodes allow physical objects to be linked with information in IT systems much more quickly and reliably than manual entry by operators. The information in the IT system of the

operator often originates from another stakeholder who shares the relevant information in advance. A good example is the electronic data interchange (EDI) transfer of data from LSPs to their transport operators, which is not accessible to other parties beyond the two stakeholders.

2. Radio frequency identification-based tracking methods

54. RFID-based tracking refers to an approach whereby an operator, using a (portable) device, may read information from many different tags placed on objects with a single scan. RFID tags respond to a signal from the scanning device, be it handheld by an operator or a fixed reader that reads the RFID tags as the objects pass by while being transported. The information transmitted is usually just a single (or very few) data elements from each RFID tag.

55. RFID is one of a group of technologies, known as automatic identification and data capture (AIDC), which identify objects, collect data and allow LSPs and transport operators to quickly complete their logistics data-gathering processes. Advanced technologies such as RFID tags enable significant efficiency improvements in operations and make new processes possible over and above traditional approaches. For example, an RFID tag can be read even if it is not directly visible to the operator (radio waves will penetrate inside objects that may obstruct the reading of barcodes). All RFID tags within range may respond simultaneously to the signal from the reader and thus the reader may receive information from multiple objects in a single RFID query.

56. RFID tags and reader hardware have now become mainstream technologies and investment costs related to the implementation of RFID tracking approaches have come down significantly, but the technology is still more costly than other, more traditional approaches.

3. Internet of things tracking methods

57. From a technical standardization perspective, IoT can be viewed as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT).¹⁵ The term “IoT-based tracking” implies an approach where a transport asset has been equipped with an active electronic device, with communications connectivity linked to a receiving internet data platform.

58. IoT devices generally record precise information regarding their geographical location. Even if the transport means (for example, a road vehicle) does not provide real-time tracking, the IoT device, attached to a transport asset (container) within the road vehicle can determine its own geographical position and communicate that independently from the transport means. This capability adds significant value in the context of tracking and tracing.

59. In addition to location information, IoT devices add sensing/measuring capabilities over and above the two technologies above. These enhanced capabilities are further discussed in the *UN/CEFACT Trade Facilitation White Paper on Smart Containers*.¹⁶

60. When IoT devices communicate with nearby devices/sensors, large datasets can be exchanged and communicated with their relevant internet platforms. In most cases, an IoT device is its own gateway and can independently send information related to a particular transport asset, its components and/or transported cargo.

61. In terms of investment, the IoT devices-based tracking method is the costliest of the above-mentioned methods due to higher implementation costs. However, the potential benefits of implementing these advanced technologies are derived from analyses of the extensive data that can be transmitted and received and this may outweigh the setup costs (which can be expected to decrease in the future).

¹⁵ International Telecommunications Union, “Recommendation ITU-T Y.2060: Overview of the Internet of Things”, *Series Y: Global Information Infrastructure, Internet Protocol Aspects and Next-Generation Networks*, (June 2012). Available at <https://www.itu.int/rec/T-REC-Y.2060-201206-I>.

¹⁶ Available at

https://unece.org/fileadmin/DAM/trade/Publications/ECE_TRADE_446E_SmartContainers.pdf.

B. Other technological considerations

62. The ability to gather enhanced tracking information about the transport assets (and their associated consignments and shipments) between an original consignor (seller) and a final consignee (buyer) presents an opportunity to launch more comprehensive digitized tracking and tracing operations by linking the tangible transport assets with the digital dimension. The information received from the real-time tracking of transport assets can be leveraged to create a data-driven environment and to connect asset tracking to asset intelligence. Technologies such as blockchain and distributed ledger, evolving to securely managing data, especially generated by IoT devices, promise to enable and automate decision-making in near-real time based on respective outcomes with the data derived from tracking of the consignments, whether containerized or not. By creating more robust and efficient processes and increasing control over uncertainties, these concepts could positively influence the way supply chains are optimized.

63. As more IoT devices become connected, such as smart containers generating data, tracking data in the form of digital data streams will build upon standardized data sharing. The *UN/CEFACT Cross-Industry Track and Trace Project* aims to deliver the data modelling that will enable technological enhancements such as data analytics and digital twinning¹⁷ to support data-driven decision-making for the different stakeholders.¹⁸

64. The combination of technologies described in this white paper, as well as others yet to be fully recognized or developed, will progress the translation of “physical internet”¹⁹ concepts into practical implementations. These advances will help deliver on the promise of the physical internet, such as much more efficient utilization of all kinds of transport and logistics resources, so that the transport and logistics industry may support the forecasted tripled demand²⁰ for transportation with as little as 50 per cent more resources²¹.

V. Reverse logistics

65. Reverse logistics operations are inevitable and increasing. To have an efficient supply chain, it is necessary to make the reverse logistics operations run as smoothly as the forward logistics operations.

66. Reverse logistics refers to the process of moving traded products, materials and trackable transport assets related to their reuse, recall, repair, repackaging and recycling. Reverse flows include the transport of all, or a portion of, the original seller-to-buyer shipment or its packaging, to be returned to the seller or to a seller’s agent. For example, a car damaged during transit to the buyer might need to be returned to a service point for repair, which may not be the seller’s original location. The reverse flow may include all types of waste, recyclable material, defective parts, defective goods or traded goods returned for any reason. Reverse logistics also cover the return of trackable transport assets such as empty containers back to the transport asset owner.

¹⁷ A digital twin is a dynamic digital representation of an object, or a system describing its characteristics and properties.

¹⁸ UNECE (2020) Trade Facilitation White Paper on Smart Containers: Real-time Smart Container data for supply chain excellence, Geneva Reference: Lind M., Becha H., Watson R. T., Kouwenhoven N., Zuesongdham P., Baldauf U. (2020) Digital twins for the maritime sector, art Maritime Network, 2020-07-15(<https://smartmaritimenetwork.com/wp-content/uploads/2020/07/Digital-twins-for-the-maritimesector.pdf>)

¹⁹ Ballot É., B. Montreuil, R. Meller, *The Physical Internet: The Network of Logistics Networks*, (Paris, France, La Documentation Française, 2014). English language adaptation of Ballot & Montreuil. For more information on the physical internet concept, visit www.etp-alice.eu and watch the video at <https://www.youtube.com/watch?v=DD1z5PBe7Kk&t=141s>.

²⁰ Organisation for Economic Cooperation and Development, *ITF Transport Outlook 2019* (Paris).

²¹ Sergio Barbarino, “Towards Zero Emissions via Physical Internet: Opportunities, Challenges & perspective”. International Physical Internet Conference (2018) paper.

67. In reverse logistics, the IDs used for tracking transport assets may or may not be the same as those used in the forward logistics transport from seller to buyer; but as a return, the communications should reference the original identifiers for tracing purposes.

VI. Tracing

68. Tracing is evaluating the history of the transport movement. It includes the complete record of all the events experienced. Tracing of an individual consignment can be particularly valuable in cases where trackable transport assets, such as containers or wagons, etc., have been lost and/or damaged during the transport process. Moreover, tracing of repeated movements over the same route can provide a historical perspective to allow for the implementation of mitigation efforts, or to adjust the supply chain process in order to increase efficiency.

69. In order to adequately capture the historical data for a consignment, tracking the location over the entire transport movement from origin to destination is key to knowing where it was handled and possibly transloaded. It is also necessary to know which stakeholder groups have collected the history of the trip, in terms of use of devices to capture specific data such as location and status of cargo, ETA and speed of travel. Timing for all events is also needed. If damage occurs, the location and possible stakeholders involved can then be identified from the tracing reports.

VII. Next steps

70. The primary focus of the UN/CEFACT *Cross-Industry Supply Chain Track and Trace Project* is on tracking and tracing of the transport movements of goods resulting from trade transactions between sellers and buyers. This white paper provides a high-level overview as the foundation for developing the BRS document for the project. The BRS will then serve as the guide for the creation of the data models and further standards necessary for supporting digitized track and trace for any single or multimodal transportation scenario.

71. As explained above, gaps exist in the identification of the seller's traded goods once they are consigned to LSPs or transport operators. Additional transfers or movements between different LSPs, transport operators or different modes of transport often complicate full transparency in the movement of cargo throughout a global supply chain. Identifiers assigned by upstream stakeholders are not always communicated to all downstream parties. Lack of reference to these identifiers in the consignment and transport process creates the gaps widely experienced in track and trace records. Data capture and data retention of the identifiers used in transport movements are not efficient or standardized to support many multimodal transport scenarios. Also, different digital environments supporting their operations do not provide the needed interoperability for end-to-end seller to buyer transparency for tracking and tracing their traded goods.

72. In order to fill the gaps between the trade and transport worlds, the following will help:

- Standardized references to trade transactions and trade item identifiers for shipments
- Consistent set of IDs for transport means, transport equipment, transport units and consignments
- Identified and accepted by any transport mode operator,

73. Reuse of the data elements in the UN/CEFACT Buy-Ship-Pay integrated framework, linking the Supply Chain Reference Data Model and the Multi-Modal Transport Reference Data Model, can lead to the relationships necessary to satisfy this need for data integration across multiple modes of transport to the benefit of all global supply chain stakeholders.

Annex of UN/CEFACT standards and initiatives

1. The Track and Trace project will build on and align with other UN/CEFACT initiatives and artefacts:

- Smart Container BRS²², Buy-Ship-Pay Reference Data Model BRS²³, eCMR BRS and related materials²⁴, Supply Chain Management Reference Data Model Guideline²⁵, Fisheries Language for Universal eXchange (UN/FLUX)²⁶, Sustainable Textile and Leather Traceability and Transparency project;²⁷
- BRS Primary Product Traceability Data Exchange v. 1.0, issued September 2017;²⁸
- BRS Animal Traceability Data Exchange v. 1.2, issued April 2017;²⁹
- BRS Cargo Tracing and Tracking Process Standardization about Container Cargo around Export/Import Business v. 2.5, issued July 2012;³⁰
- BRS Mapping Cargo Tracing and Tracking v. 0.2, issued July 2012;
- Harmonized business information entities in the UN/CEFACT Core Component Library (UN/CCL);³¹
- Published SCRDM³² and MMT RDM³³, based on the latest UN/CCL;
- Procedures for Reference Data Model (RDM) & Associated Artefacts Publication, draft v1.0.0.9;³⁴
- UNECE Traceability for Sustainable Trade (ECE/TRADE/429);³⁵ and
- BRS Cross Industry Invoice (CII) Order and Invoice as this is where the initial information for the tracking ID comes from: supplier/order and buyer/invoice number(s).

²² https://unece.org/DAM/cefact/brs/BRS-SmartContainer_v1.0.pdf

²³ https://unece.org/DAM/cefact/brs/BuyShipPay_BRS_v1.0.pdf

²⁴ https://unece.org/DAM/cefact/brs/eCMR-BRS-V_01.zip

²⁵ <https://www.unece.org/fileadmin/DAM/cefact/GuidanceMaterials/ReferenceDataModelGuideline-v1.0.0.2.pdf>

²⁶ https://unece.org/DAM/cefact/brs/FLUX_P1000-v1.1.zip

²⁷ <https://unefact.unece.org/display/unefactpublic/Sustainable+Textile+and+Leather+Traceability+and+Transparency+Project>

²⁸ https://unece.org/DAM/unefact/BRS/BRS__TraceabilityOfPrimaryNaturalProducts_v1.0.pdf

²⁹ https://unece.org/DAM/unefact/BRS/BRS_Animal_Traceability_BRS_v1.2.pdf

³⁰ https://unece.org/DAM/cefact/brs/BRS_CargoTracingAndTracking_v2.5.2.zip

³¹ <https://unece.org/core-components-library-unccl>

³² https://unece.org/DAM/unefact/BRS/BRS_SCRDM_v1.0.0.2.pdf

³³ https://unece.org/DAM/cefact/Standards/MMT/BRS_T_L-MMT.pdf

³⁴ <https://unece.org/procedures-reference-data-model-rdm-associated-artefacts-publication>

³⁵ https://unece.org/fileadmin/DAM/trade/Publications/ECE_TRADE_429E_TraceabilityForSustainableTrade.pdf