Applying the UN/CEFACT Multimodal Transport Reference Data Model (MMT RDM) Along the GUAM Corridor

Dmytro Iakymenkov
Consultant
UN Economic Commission for Europe
Odesa, Ukraine
d.iakymenkov@pl33-35.com

Galyna Roizina
Consultant
UN Economic Commission for Europe
Odesa, Ukraine
g.roizina@ppl33-35.com

Mario Apostolov
Regional Adviser, *Economic Cooperation and Trade Division*
UN Economic Commission for Europe
Geneva, Switzerland
mario.apostolov@un.org

This article stems from the experience of projects of the United Nations Economic Commission for Europe (UNECE) to support digitalization of transport corridors and facilitate trade and transport in the region.

The UNECE is one of the five United Nations regional commissions, the main purpose of which is to promote economic integration in the broader European region. The UNECE brings together 56 member States and more than 70 international professional and non-governmental organizations. One of the tasks of the Commission is to set regulations, standards and conventions to promote international cooperation in UNECE region and beyond.

The UNECE has consistently made efforts during decades to support the development of digital transport corridors. This position was re-emphasized at the eleventh UNECE International Seminar on Trade and Transport Facilitation "Digital Transformation of Multimodal Transport Using the UN/CEFACT Reference Data Model", which took place in Odessa, Ukraine, from 26 to 28 May 2021.

The UNECE actively cooperates with regional organizations on these issues. In particular, an agreement was reached on cooperation with the Organization for Democracy and Economic Development GUAM (GUAMNet) on support a digital multimodal corridor.

Within the United Nations Economic and Social Council, the United Nations Economic Commission for Europe acts as the focal point for trade facilitation recommendations and e-business standards covering both commercial and government business processes that can foster the growth of international trade and related services. In this context, the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) was established as a subsidiary intergovernmental body of the UNECE, with the task of developing a work programme of global relevance to improve coordination and cooperation worldwide on the development of semantic standards and other trade facilitation tools.

UN/CEFACT supports activities aimed at enhancing the ability of business, trade and administrative organizations from developed, developing countries and countries with economies in transition to effectively exchange products and related services. Its main focus is on facilitating national and international transactions through the simplification and harmonization of processes, procedures and information flows, which contributes to the growth of global trade.

UN/CEFACT's work in the areas of trade facilitation and e-business encompasses both commercial and government business transactions that can contribute to the growth of international trade and related services. The Centre encourages close collaboration between governments and private businesses to ensure interoperability for the exchange of information between the public and private sectors, as well as among regulatory agencies and within the business community. To achieve this goal, UN/CEFACT offers such tools as:

- The UN Layout Key for Trade Documents, which forms the basis, for example, of the EU Single Administrative Document (SAD) in the European Union;
- UN/EDIFACT, the only global standard for electronic data interchange (EDI);
- Over 40 Trade Facilitation Recommendations, covering best practices for streamlining processes, documentary exchange, codes for international trade and electronic business, etc.;
- The Core Component Library, containing syntax-neutral and technology-independent building blocks used for data modelling;
- XML Schemas that provide a set of coherent, consistent, and normalized syntactic solutions, which are aligned with a family of domain reference data models.

The UN/CEFACT data model structure is a hierarchy of Reference Data Models, notably the more general Buy-Ship-Pay Reference Data Model (BSP-RDM), which acts as a chapeau for the more specialized Multi-modal Transport Reference Data Model (MMT-RDM) and the Supply Chain Reference Data Model (SCRDM)

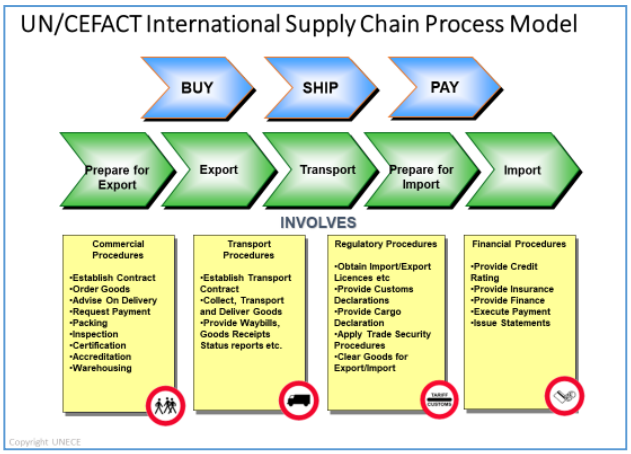

Fig. 1. The UN/CEFACT International Supply Chain Model (Buy-Ship-Pay, BSP) - Source: UN/CEFACT Recommendation No. eighteen

A broad spectrum of information is exchanged within the international procurement and supply chain. SCRDM and MMT-RDM provide a cross-domain framework for creating common data exchange structures for the exchange of information between customers, suppliers, resellers and authorities, regardless of which countries or modes of transport may be involved.

Both SCRDM and MMT-RDM are based on the UN Trade Data Elements Dictionary(UNTDED version 2005 [1]), maintained by UN/CEFACT, which is also the basis for the World Customs Organization (WCO) data model. Thus, the models use the same set of common terms and definitions for the parties involved and for the business information objects they contain. These models also use the UN/CEFACT Core Component Library.

The diagram in Fig.2 shows the top-level business information objects and relationships (BIEs) in BSP-RDM, which combines SCRDM and MMT-RDM.

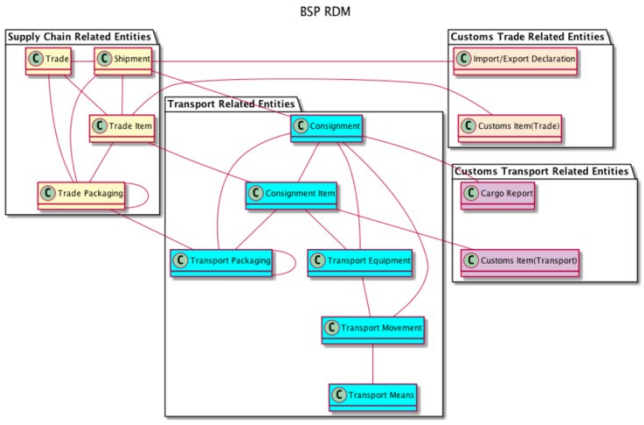

Fig. 2. Hierarchy of data models. Source - BUY - SHIP - PAY Reference Data Model BRS, UNECE-UN/CEFACT

A typical supply chain process can be represented by the diagram in Fig.3:

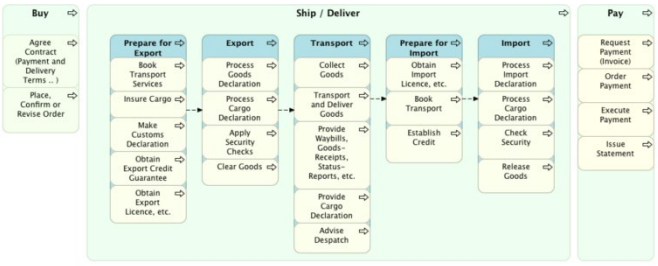

Fig. 3. Processes and operations in the BSP model. Source – The BUY - SHIP - PAY Reference Data Model BRS, UNECE-UN/CEFACT

The multidimensionality of the model is due to the multiplicity of roles of the actors, participating in the process. From the point of view of the purchase transaction, the actors can be the Client, the Buyer, the Seller, the Supplier, the Exporter, the Importer, etc. From the point of view of the delivery, the roles are the Transport Service Provider, Carrier, Sender, Recipient, Buyer of Transport Services, Forwarder, etc. Also, government agencies (Customs, border control agencies, sanitary inspections, port authorities, etc.) and auxiliary participants - warehouses, terminals, banks, brokers, insurance companies, etc., are involved in the process at its various stages.

The execution of such a process involves the movement of material, financial and information flows between the participants. Due to the methodological complexity of the model and the fact that each of the participants has a large number of documents and business requirements, as well as the direct interdependence of the regulatory process on the information flow, the process as a whole is often slowed down precisely because of delays in the information flow.

Thus, the focus the UN/CEFACT data modelling is to harmonize datasets and requirements within the information flow in the supply chain.

The information flow itself is also a complex concept that includes several levels (views):

- physical level - the level of organization of the information exchange between the sender (of information) and the recipient (of information);
- interface level - the level of negotiation of the interaction between the sender and the receiver;
- presentation level - the level of description of the information transmitted between the sender and the receiver;
- semantic level - the level of semantic content of the information transmitted between the sender and the recipient.

The UN/CEFACT Data Models and the tools on which they are based focus on enforcing the Semantic Layer, namely:

- defining the business information entities (BIEs) and the relationships between them;
- defining the aggregated information entities and the relationships between them (ABIE);

[1] untded-iso7372:2005 – UNECE – Trade Data Elements Directory (TDED) - https://unece.org/DAM/trade/untdid/UNTDED2005.pdf

- defining the specifications of the business requirements for datasets of the information entities.

A further development of these efforts is the concept of Data Pipelines proposed by UN/CEFACT [2]. The concept involves providing data directly at the source and only once, and reusing it throughout the supply chain, regardless of the mode of transport, party or regulatory body that needs access to the data.

Connectivity infrastructures for information exchange, such as Pipeline Data Exchange Structures, enable higher data quality, supply chain transparency, and information exchange. They open new possibilities for system-based audit and the development of smart software applications to offer value-added services to business, such as automated planning and scheduling, and for regulatory agencies, such as automated monitoring and targeting.

Basic principles of the concept of data pipelines:

- Capture the Data from the Right Person at the Right Place at the Right Time;
- Capture Once and Use Many Times in the Supply Chain;
- Data is transferred to the pipeline at the point of their origin;
- Data can be retrieved from the pipeline both on demand and sent to the recipient.

The main purpose of data pipelines is to improve the quality of data and ensure their seamless transfer within the information flow of the supply chain, in particular, by shifting the paradigm from "document-based" exchange of information to support international trade to the concept of "data and dataset"-exchanges. The key difference between these two concepts is that the document-exchange model is based on a rigid (paper) structure of the document - even in electronic form, whereas the dataset model assumes the presentation of information in the form of flexible structures - data sets (BIE and ABIE), which can be formed from generic data models on the fly by a simple request of information by the recipient in the form, which corresponds to specific business process requirements.

Another key shift of paradigm is the move to a possibility to "pull" (PULL) data from the pipeline instead of the usual practice of sending or submitting documents to recipient's information systems (PUSH). "Pulling" data, or receiving data on demand, opens up the possibility of optimizing information processes for receiving, processing and storing data and increases its efficiency.

Of course, such paradigm shift is not possible without appropriate support at other levels of the information sharing process. In particular, the usual mechanism for electronic document authentication by signing them with a digital electronic signature (DES) is not applicable to data sets generated on the fly. At the same time, the use of the DES as the only legally trusted means of authentication of information in electronic form has become in recent years a significant obstacle to international trade. This is because of the difference in cryptographic algorithms used in different countries, as well as the need for a single supranational (root) key certification authority to automate the recognition of such signatures. This approach is unacceptable for many States for a number of reasons, which, in turn, has led to the development of alternative approaches, for example, a Trusted Third-Party mechanism [3] (TTP). This mechanism has been implemented in practice in cross-border trade transaction in a number of countries. However, it has not been widely recognized, because of methodological limitations associated with the use of the documentary model, among others.

As an alternative, concepts focusing on the use of blockchain technology have been proposed[4] to simplify trade procedures, as well as Application Program Interface technologies - WEB APIs[5]. These approaches demonstrate the existence of technical solutions for implementing the principles of the data pipeline concept, provide mechanisms for working with datasets, access to them both on demand (PULL) and on supply (PUSH), strong identification and authentication of data with the ability to create flexibly modifiable and limited by time access tokens (JWT[6] and JWS[7] mechanisms).

Thus, providing a harmonized dataset that is a subset of a functionally complete model built on standardized and generally accepted definitions of information entities for business operations is key to optimizing the information flow of the supply chain.

In this regard, in response to the crisis caused by the COVID-19 pandemic, which had an exceptional impact on the global economy and supply chains, the United Stations (UN) initiated the UNTTC project [8] Transport and Trade Connectivity in the Age of Pandemics, implement all five UN regional economic commissions and UNCTAD. The UNECE leads several segments in it, including the one on developing a package of standards for the digitalization of multimodal transport data and document exchange and pilot projects on their implementation.

As part of this initiative, several assessments aimed at increasing the harmonization and standardization of data exchanged in international transport, trade and logistics took place. The objective is to stimulate the transition to paperless information exchange technologies in trade and transport, and reduce physical contacts between people and between people and objects, such as paper documents, during the COVID-19 pandemic, thus supporting economic recovery after the crisis using UN/CEFACT instruments.

---

[2] White Paper Data Pipelines – UN/CEFACT - https://unece.org/fileadmin/DAM/cefact/GuidanceMaterials/WhitePaperDataPipeline_Eng.pdf

[3] White Paper on Trusted Transboundary Environment – UN/CEFACT - https://unece.org/fileadmin/DAM/cefact/cf_plenary/2018_plenary/ECE_TRADE_C_CEFACT_2018_7E.pdf

[4] https://unece.org/trade/uncefact/blockchaintf-april2018

[5] https://unece.org/uncefact/34thcfforum-conf-webapis

[6] JWT – JSON WEB Token, RFC 7523, https://datatracker.ietf.org/doc/html/rfc7523

[7] JWS – JSON WEB Signature, RFC 7515, https://datatracker.ietf.org/doc/html/rfc7515

[8] https://unttc.org

In particular, studies were carried out on the application of the UN/CEFACT Reference Data Model for Multimodal Transport (MMT RDM) along the Black Sea-Baltic Sea transport corridor, as well as on the Danube-Dnieper inland waterways. Transport and trade documents used in real business operations in the transportation of goods along transport corridors in the scope of the project were analysed and mapped with the data model. Prototypes of electronic documents were prepared based on the MMT RDM data model. Also, practical tests of data transformation took place between documents used in different modes of transport and jurisdictions.

The key objective of the projects is to test and advance the use of the MMT RDM data model as the semantic core of the information system to automate the task of transforming data between different trade and transport documents.

As a result, a number of recommendations were prepared, the implementation of which should facilitate and support the information exchange along these transport corridors and the expansion of the application of international standards in the electronic interaction of participants in the supply chain.

The reports are published on unttc.org:

- https://unttc.org/sites/unttc/files/2021-07/Belarus%20report%20on%20CIM_SMGS.pdf
- https://unttc.org/documents/report-standardized-digitalization-multimodal-transport-ua

This resource also provides information on standardized packages for documents by modes of transport, in particular:

- eCMR
- RASFF (Rapid Alert for Security of Food and Feed)
- Export Packing List
- Waybill
- Shipping instructions
- Booking
- CIM/SMGS and SMGS consignment notes, CIM/SMGS Wagon List
- Maritime bill of lading
- River bill of lading
- Preferential Certificate of Origin
- FIATA eFBL

The implementation of the GUAM digital corridor project is a further development of the East-West transport corridor projects. The scope of the current study includes shipment of cargo between Ukraine and Azerbaijan, both import and export, via Georgia using rail, road and maritime transport. For the purpose of the assessment, freight and transport documents, used in real business operations for the transportation of goods between countries, were analysed.

The need to transform information between different documents emerge both when changing jurisdiction (that is, crossing the border between territories with different jurisdictions), and when changing the mode of transport (modality). As an example of multimodal transportation, we can note the practice of using a railway consignment document as a maritime consignment note on the Poti (Georgia) – Chornomorsk (Ukraine) route. At the same time, certain sections of the transport operation are often carried out using their own documents. Thus, a port becomes a key point in the transformation of documents and data as a place of change of both national jurisdiction and mode of transport.

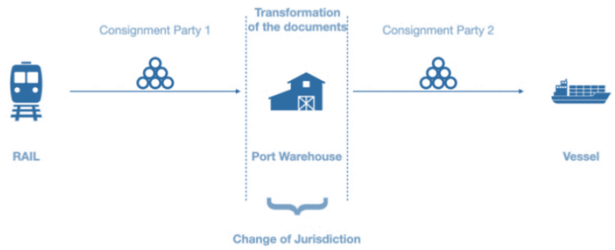

Fig. 4. Port as a transformation point. Source: Authors

As most participants in the transportation process already have their own information systems, which fully meet the requirements imposed on them by the business community, the main point for optimization is at the borderline of interaction of these systems with each other. In most cases, this problem is solved by building a system-to-system interface based on an appropriate bilateral agreement (between the railways of different countries, between railways and maritime carriers, etc.).

As a result, to solve the problem of information exchange between all participants in the supply chain, we need to reach in general terms a solution represented in the following equation:

$$Q_S = \frac{n!}{(2 \cdot (n-2)!)} \quad (1)$$

where Q s is the total quantity of interfaces between IT systems, and

n is the quantity of IT systems to be linked.

For each IT system, the quantity of interfaces to be implemented is:

$$Q_S^1 = n - 1 \quad (2)$$

where Q_s^1 is the number of interfaces for one IT system, and

n is the number of IT systems.

Considering the number of parties interested in this information exchange, such a task looks poorly implemented in practice.

The use of international standards and formats for electronic documents and messages looks like an attractive solution to the problem. However, the complexity is caused by the presence of a large number of complex and expensive information systems run by the different participants in the supply chain. For this purpose, it is proposed to use the UN / CEFACT electronic document formats based on the MMT-RDM data model as interface for solving the interaction problem. In this case, the complexity of the task of building information interaction decreases:

$$Q_S = n \quad (3)$$

where Q_s – is the total quantity of interfaces between IT systems, and

n is the quantity of systems.

The quantity of interfaces for each IT system in the case is minimal:

$$Q_S^1 = 1 \quad (4)$$

where Q_{s^1} is the quantity of interfaces for one IT system.

The application of the UN/CEFACT data model and the formats of electronic documents (data sets) generated from it looks obvious in view of the above discussed properties of its functional completeness and semantic commonality for business information entities.

Consequently, the use of the MMT RDM data model offers as a direction for implementing the transformation of data sets in the interaction of IT systems solves the problem of not only reducing the fundamental complexity of implementing interaction interfaces between information systems of one mode of transport, but also between systems of different modes of transport operating with different types of data sets, using common information entities.

For the practical application of the data pipeline, in addition to the semantic issue, it is necessary to resolve the issues of technical interaction and legal recognition. These issues are supposed to be considered in the framework of further research in the following areas:

- The issue of technical interaction can be solved in a general way by using WEB APIs, using the possibility to describe then in terms of the UN/CEFACT MMT RDM and subsequent programmatical generation from such metadata.

- To resolve the issue of legal recognition, it is possible to consider the experience of the European Union, in particular the Regulation (EU) 2020/1056 on electronic freight transport information (eFTI[9]) and Regulation (EU) 910/2014 on electronic identification and trusted services for electronic transactions in the internal market (eIDAS Regulation[10]), as well as the concept of decentralized identity (Decentralized Identity/Self-Sovereign Identity (SSI[11])).

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1056&rid=1

[10] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.257.01.0073.01.ENG

[11] https://w3c.github.io/did-core/