How to develop real world electronic document equivalents using UN/CEFACT standards and reference data models

Project report

Dmytro Iakymenkov

Galyna Roizina

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Content

List of abbreviations

ABIEs - Aggregate Business Information Entities

IMO – International Maritime Organization

IMO FAL – Committee of the IMO for the Facilitation of the Procedures of the International Maritime Organization

MMT RDM – Multimodal Transport Reference Data Model of UN/CEFACT

SCRDM - Supply Chain Reference Data Model of UN/CEFACT

UN/CEFACT – United Nations Centre for Trade Facilitation and Electronic Business, a subsidiary body of the UNECE

UN/CEFACT CCL - UN/CEFACT Core Component Library

UNECE – United Nations Economic Commission for Europe

Section I. Introduction

The digitalization of the supply chain is the dominant trend in international trade and transport at present and the main tool for facilitating trade procedures. Due to the essence of the supply chain as a process of interaction between many parties within many jurisdictions, ensuring interoperability plays a key role both in the supply chain and in the digitalization processes. In this regard, the development, maintenance and adoption of standards at the international level play an extremely important role. This explains the continued focus on standardization in trade and transport facilitation by UN institutions: notably, the United Nations Economic Commission for Europe (UNECE) and the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT).

UNECE (and UN/CEFACT as a subsidiary intergovernmental body of the UNECE) has developed a range of tools for trade and transport facilitation:

- The UN Layout Key for Trade Documents, which forms the basis of, inter alia, 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 in process optimization, document exchange, international trade and e-business codes, etc.,
- A core component library containing syntax- and technology-independent building blocks used for data modeling,
- XML schemas that provide a set of coherent, consistent and normalized syntactic solutions that are consistent with a family of domain data reference models.

As an introduction to the activities of these institutions, as well as general information on the use of data models developed and maintained by UN/CEFACT for the creation of electronic documents, we would like to provide a link to a guide prepared by David Roff[1], UN/CEFACT expert: https://cmsdroff.gitbook.io/standards-guide/

It should be noted that a number of approaches to the practical application of UN/CEFACT standards for supply chain facilitation that we use in our projects intersect with those described by Mr.Roff in the section https://cmsdroff.gitbook.io/standards-guide/building-electronic-documents-from-mmt/getting-started

At the same time, the experience of operating a real Single Window system interacting with different modes of transport, participants and jurisdictions, on the one hand, as well as the possibility of creating various electronic documents based on UN/CEFACT data models within the framework of the assessments carried out for the UNECE, on the other hand, allowed us to form a practical algorithm for transforming documents and data sets.

In the following sections, we will explore these approaches in more details.

[1] https://www.linkedin.com/in/davidroff/

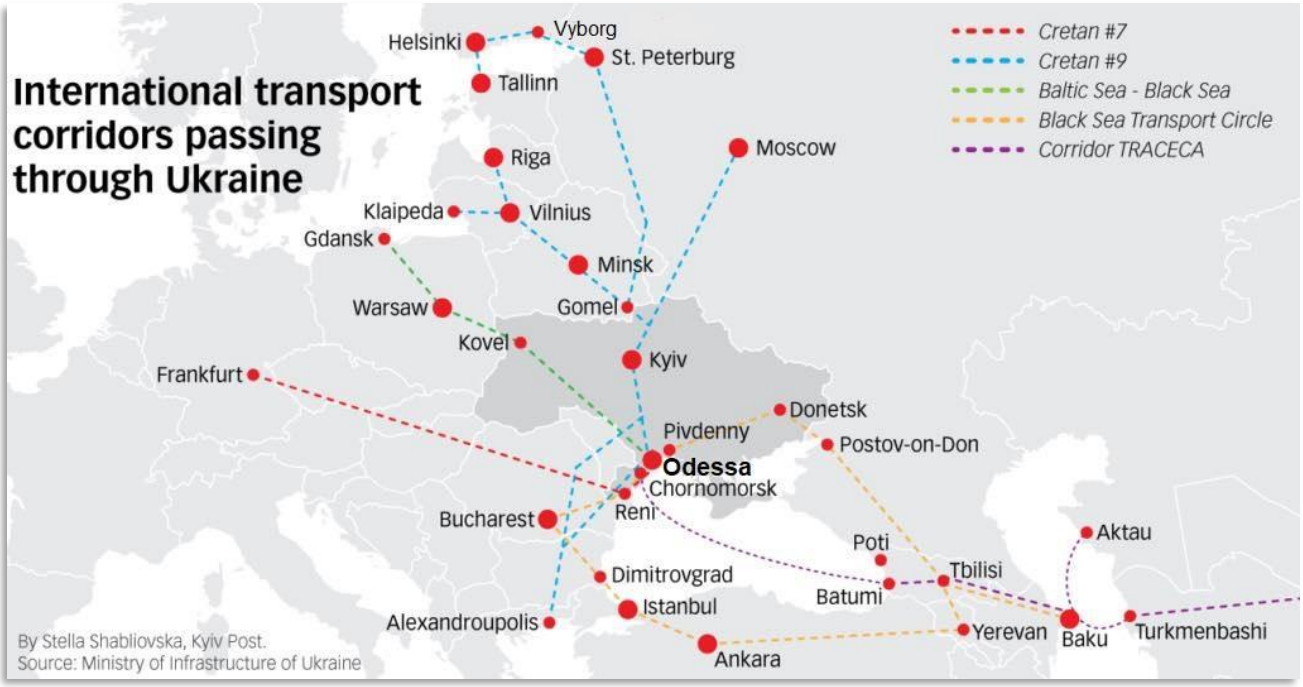
Section II. Practical application in completed projects

1. Report on standards in the digitalization of multimodal transport

The project was carried out in cooperation with the UNECE and UN/CEFACT as part of the response to the COVID-19 crisis. The work itself is a logical continuation of the initiatives reflected in the recommendations of the UNECE Odessa workshops in 2019 and 2020 and was aimed at developing digital multimodal transport corridors in order to harmonize and standardize data exchange in international transport, trade and logistics.

Ukraine, as a platform for conducting such assessments, is interesting in that 5 international transport corridors pass through it, connecting Europe and Asia.

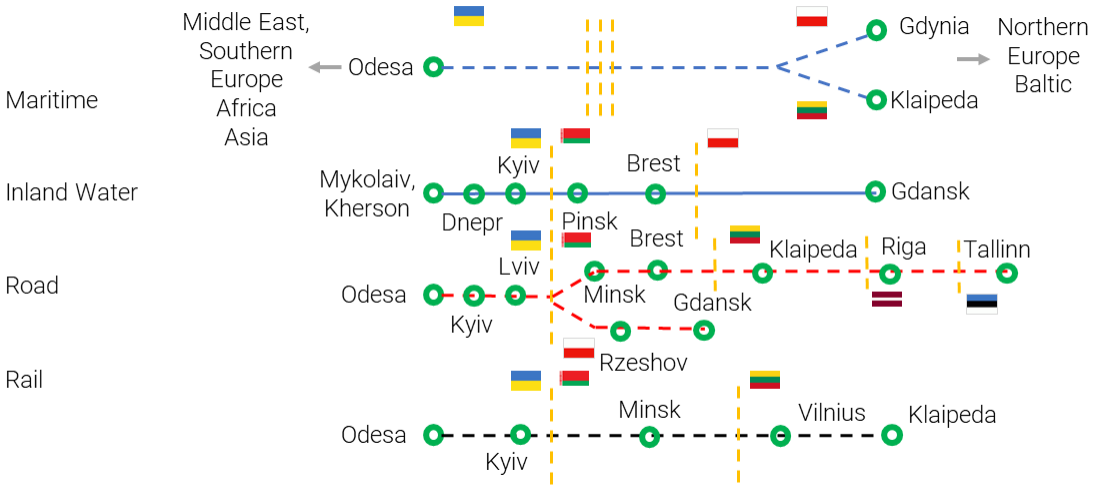
Figure 1 International transport corridors passing through Ukraine



Source: Ministry of infrastructure of Ukraine

The project covers cargo flows in the context of the corridor passing through Ukraine, namely - the Black Sea - the Baltic Sea (passes through Ukraine, Belarus, Lithuania and Poland).

Figure 2 Structure of traffic flow along the transport corridor Baltic Sea - Black Sea



Source: Authors

The project deliverables were a common standardized dataset of documents included in the context of the project and presented in a technical framework along with a common XML schema that conforms to the rules of the UN/CEFACT schema. The common standard document data set supports contextualization by specifying international standards.

The data models were reviewed with examples of actual documents used in the transport corridor. Some issues were identified that need to be addressed in order to support the possibility of real use of the electronic document equivalents and data exchange.

The main stages of the project:

- Analysis of the goods and information flows along the Black Sea - Baltic Sea corridor
- Preparation of the electronic messages (electronic document equivalents) based on the UN/CEFACT standards and reference data models:
  - Mapping documents in the project scope against MMT RDM
  - Creating the equivalents of electronic documents in XML format
  - Investigation of transformation performance between modes of transport and / or jurisdictions based on a data model
  - JSON API Usage Analysis

Documents in the scope of the study:

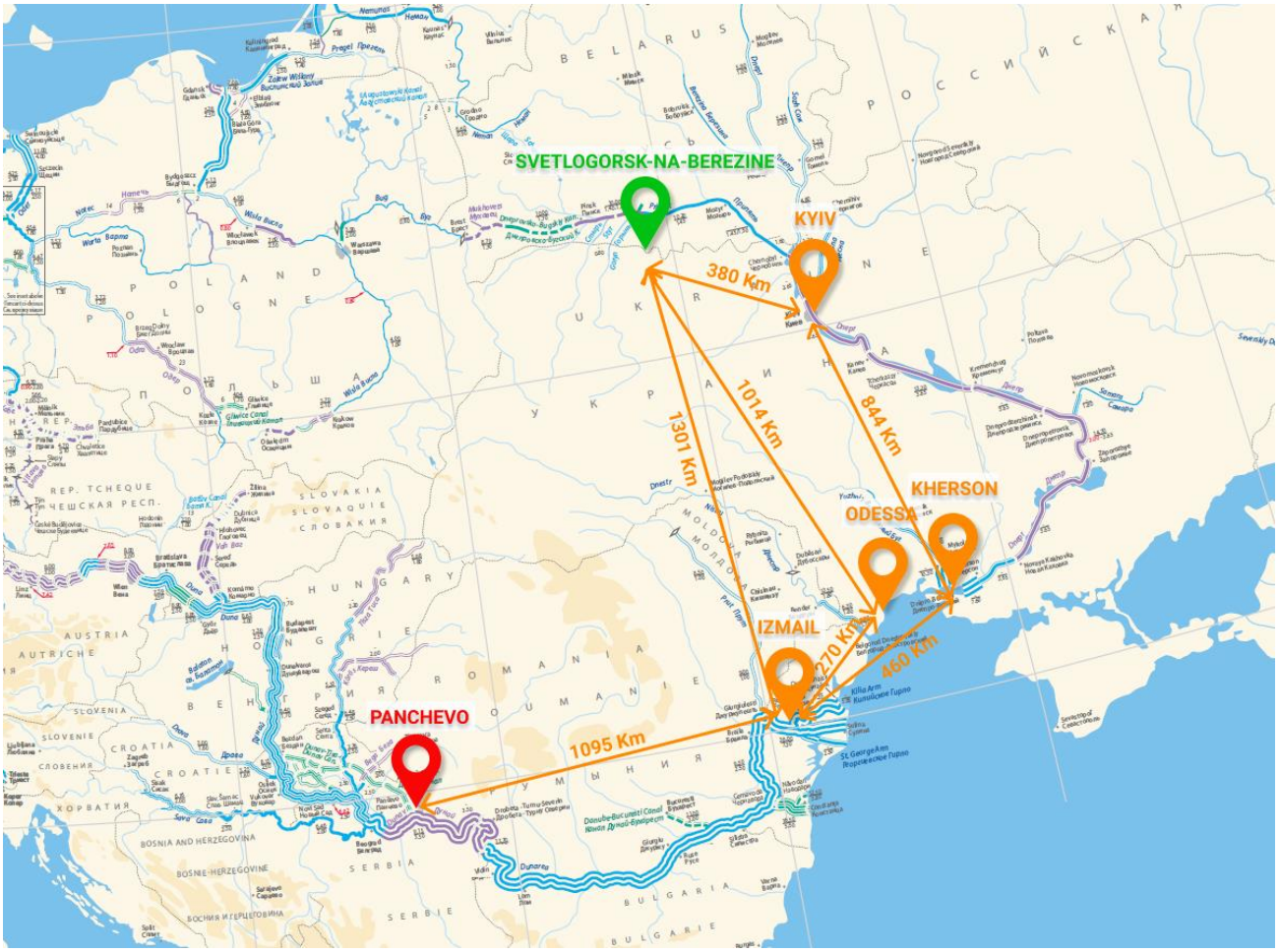
- Maritime bill of lading
- River bill of lading
- Invoice for Customs
- Certificate of origin
- Phytosanitary certificate
- CMR

More detailed information on the assessment is available in the form of a report: https://unttc.org/documents/report-standardized-digitalization-multimodal-transport-ua

2. Dnieper – Danube Corridor Pilot Dataset Alignment to International Standards and Data Models and Documents Implementation Prototypes for Use in Eastern Europe

The project was a continuation of research on the application of electronic documents based on the UN/CEFACT data model for multimodal transport on transport corridors passing through Ukraine. In this study, the possibilities of using inland waterways for multimodal transport in combination with other modes of transport were analyzed.

Figure 3 Transport routes in the scope of the project



Source: Authors

Cargo flows in the scope of project are described in the Table 1.

Table 1 Cargo flows

The routes and the key points	Modes of transport
Route 1	
Belarus-Ukraine (Korosten)-Ukraine (Berezhan)-Ukraine (Kiev river port)	Rail
Ukraine (Kiev river port) - unloading to the warehouse	Warehouse
Ukraine (Kiev river port): loading on a ship	Warehouse
Ukraine (Kiev river port) -Ukraine (port of Kherson)	IWT (Dnieper)
Ukraine (port of Kherson) -Ukraine (port of Izmail)	Maritime
Ukraine (port of Izmail) - Serbia (Pancevo)	IWT (Danube)
Route 2	
Belarus - Ukraine (port of Odessa)	Rail – Viking container train
Ukraine (port of Odessa): unloading to the warehouse	Warehouse
Ukraine (port of Odessa): loading on a ship	Warehouse
Ukraine (port of Odessa) -Ukraine (port of Izmail)	Maritime
Ukraine (port of Izmail) -Serbia (Pancevo)	IWT (Danube)
Route 3	
Belarus - Ukraine (port of Izmail)	Rail
Ukraine (port of Izmail): unloading to the warehouse	Warehouse
Ukraine (port of Izmail): loading on a ship	Warehouse
Ukraine (port of Izmail) -Serbia (Pancevo)	IWT (Danube)

Documents in the scope of the assessment:

- General Declaration
- Cargo Declaration
- Declaration of ship stores
- Personal belongings of the crew
- Crew list
- List of passengers
- Forms DAVID:
  - Arrival (departure) report
  - Crew list
  - List of passengers

A feature of the project was the integration of documents used to facilitate navigation on the Danube River (DAVID forms) with documents used on other modes of transport. To do this, a harmonization of DAVID forms with UN/CEFACT MMT RDM was carried out:

- Creation of a new profile based on a MMT RDM subset for the International Maritime Organization (IMO) FAL Compendium
- Mapping of the documents against MMT RDM
- Identifying differences and creating change requests

- Creation of a prototype of the XML equivalent of the document

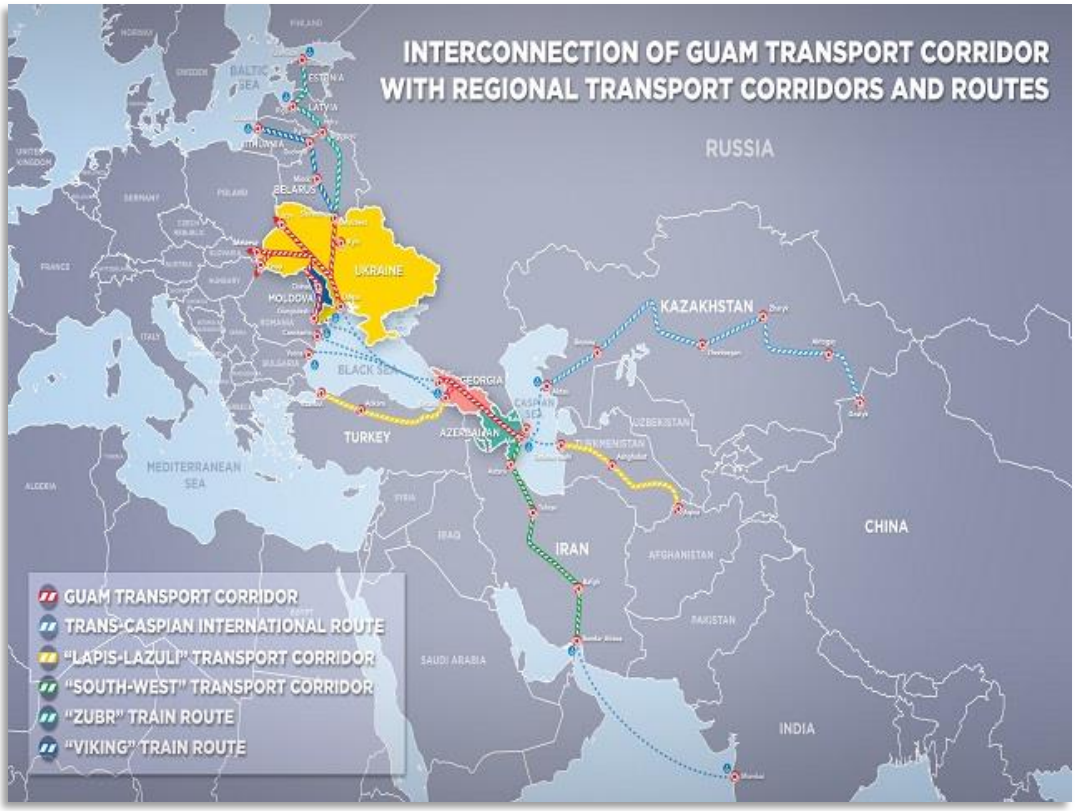
More detailed information on the assessment is available in the form of a report: https://unttc.org/documents/dnieper-danube-corridor-pilot-dataset-alignment-international-standards-and-data-models

3. Alignment of documents used in multimodal transportation along the GUAM transport corridor with the UN/CEFACT reference data model

The objective of this project was further development of the digital transport documents that could provide seamless information flows accompanying cargo flows between countries along the GUAM transport corridor. Due to its position in the middle of the cargo transport routes between Europe and Asia, the use of UN/CEFACT standards and recommendations for sharing information about the cargoes along this route makes much sense.

The focus of the project is on the practical application of the data models and standards to facilitate real-world transport operations that take place along this transport route. This is achieved by creating digital twins of real business documents that are mapped to the UN/CEFACT MMT RDM to ensure interoperability both in terms of changing jurisdictions and modes of transport along the route.

Figure 4 Interconnection of GUAM transport corridor with regional transport corridors and routes



Source: guam-organization.org

Documents in the scope of the project:

- eCMR,
- Maritime waybill,
- SMGS and CIM/SMGS consignment notes and additional documents,
- Invoice for Customs.

A feature of the project was the use of ferry transportation between the ports of Ukraine and Georgia as a maritime part of a multimodal transportation. The ferry shipment made it possible to use the rail waybill as a maritime consignment note, which is an effective example of the procedure's facilitation within the supply chain.

Also interesting is the prospect of using the electronic version of the CMR waybill in accordance with the Additional Protocol[2] to the Convention[3] on International Road Transport, if all countries within this corridor join it.

More detailed information on the assessment is available in the form of a report: https://unttc.org/documents/alignment-documents-used-multimodal-transportation-along-guam-transport-corridor-uncefact

4. Assessment of the use of electronic documents based on the UN/CEFACT Multimodal Transport Reference Data Model (MMT RDM) in the execution of formalities for the registration of the arrival and departure of ships in the seaports of Ukraine

The project aims to help fulfill the formalities in the seaports of Ukraine as part of the global supply chain.

Crossing multimodal transport corridors at the seaports necessitates the use of the UN/CEFACT MMT RDM as a basis, as well as alignment with International Maritime Organization (IMO) requirements and regional and national regulations. The deliverables of the project are aimed at drafting recommendations for the further development of digital solutions in the seaports of Ukraine.

The objectives of the project include assessing the current state of ship-to-shore interaction and identifying established practices, formulating a concept for positioning a national Maritime Single Window in regional and global multimodal transport corridors and supply chains, and then performing practical tests to validate such a concept.

Documents in the scope of the assessment:

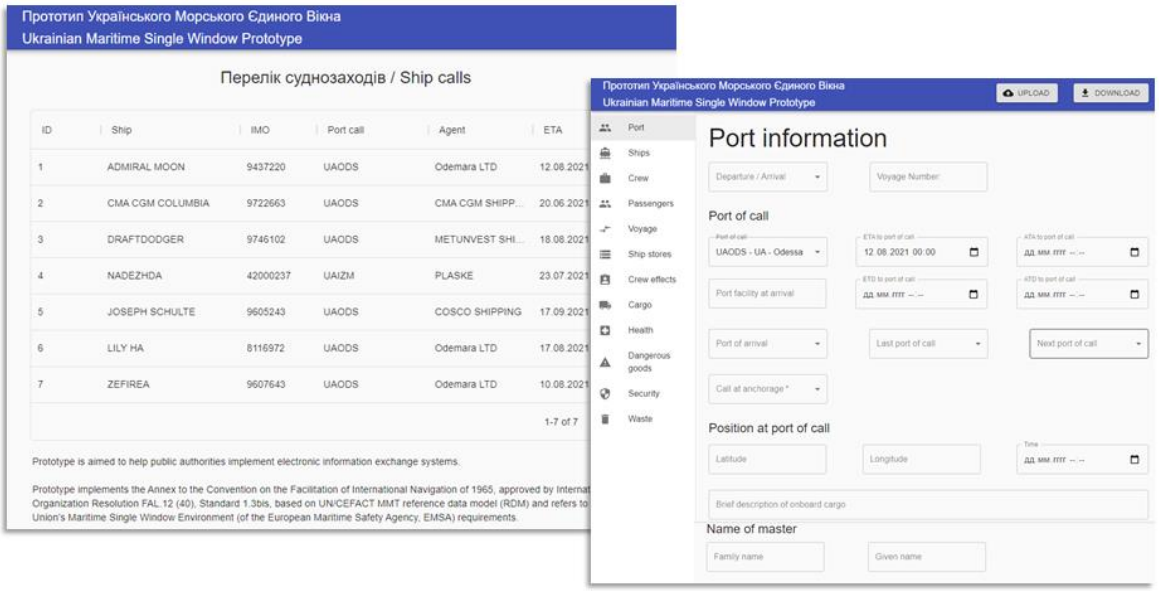
- General declaration (Form 1 FAL)
- Cargo Declaration (Form 2 FAL)
- Ship's Stores Declaration (Form 3 FAL)

[2] https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XI-B-11-b&chapter=11&clang=_en
[3] https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XI-B-11&chapter=11&clangren

- Crew's Effects Declaration (Form 4 FAL)
- Crew List (Form 5 FAL)
- Passengers List (Form 6 FAL)
- Dangerous Goods (Form 7 FAL)
- Waste report
- Security report
- Medical maritime declaration

In this project, electronic documents were not only created based on the data model, but also prototyped in the user interface. It allowed further research on the practical application of such documents in existing business processes and receiving feedback from key stakeholders.

Figure 5 Prototype for POC process



Source: Authors

This project is interesting for the applied approach to harmonize the set of requirements on the international, regional and national levels:

- Using the MMT RDM as a basis for fulfilling the requirements of the IMO Compendium,
- Using the EMSA data set as an interface (implementation guide) to provide information from ships to shore,
- Using the document templates prepared by EMSA in MS Excel format to facilitate ship-to-shore reporting,
- Creation of electronic equivalents of necessary documents based on MMT RDM to ensure interoperability both between modes of transport and between jurisdictions.

More detailed information on the assessment is available in the form of a report: https://unttc.org/documents/assessment-use-electronic-documents-based-uncefact-multimodal-transport-reference-data

Section III. Approach description

As already mentioned in the Introduction, the approaches to the creation of electronic documents based on the UN/CEFACT data model are largely the same among various experts. In the following section, we will use the step names given by David Roff in his Standards Guide as general terminology.

In particular, David Roff suggests the following sequence of actions:

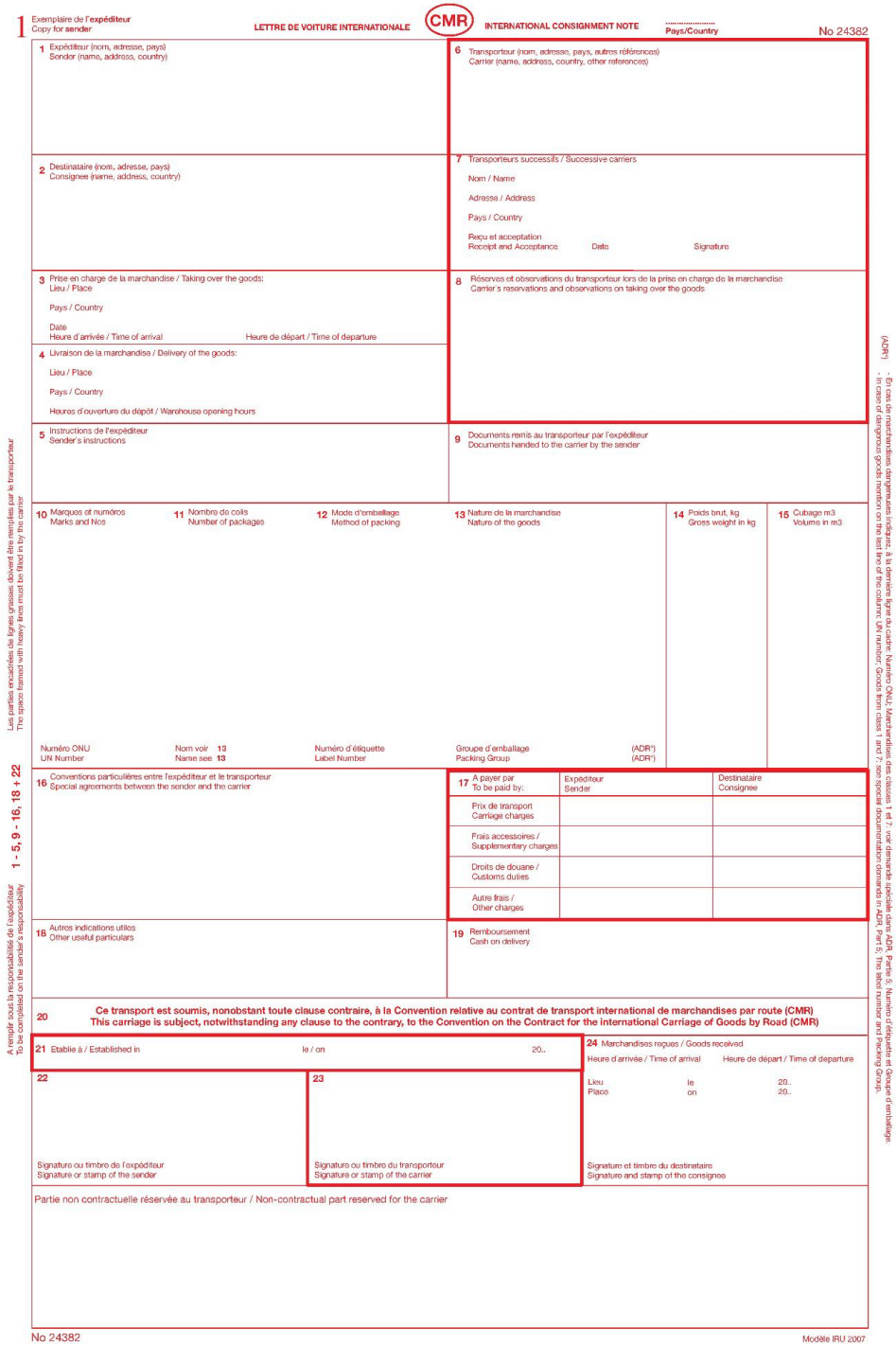
1. Gather Examples
2. Use Cases
3. List of Data Attributes
4. Mapping against MMT
5. Outputs and Questions

As an illustration of the approach taken in our studies and case studies showing some of the differences, we will use the international road transport consignment note CMR.

1. Gather Examples

To digitalize a document, first of all, the paper document itself is needed. For CMR we can use the International Road Transport Union (IRU) description:

Figure 6 CMR



Source: https://www.iru.org/sites/default/files/2017-01/how-to-fill-cmr-model-iru-2007-en.pdf

It should also be noted here that despite the fact that the CMR document is an international transportation document, and, in this regard, it must comply with the requirements of the countries involved in the transport operation, and it is regulated by a Convention, in real business transactions

there are a sufficient number of variations of the above form. This leads to the first interoperability problem already at the paper document level.

We can suppose, for the simplicity of solving the problem of creating an electronic document, that the transport contract parties have agreed to use a certain form of a paper CMR document, as it happens in reality.

2. Use Cases

The next step in the implementation of an electronic document is the analysis of business transactions in which this document is used.

In terms of the CMR, the IRU recommended procedure for filling out the document is given in the guide on How to fill in the CMR consignment note (IRU model 2007)[4]. In particular:

- Box 1 Name and complete address of the consignor of the goods
- Box 2 Name and complete address of the consignee of the goods
- Box 3 Place and date when the goods are taken into charge by the carrier. It is recommended that the carrier indicates the hour of arrival of the vehicle at the place of loading and the hour of departure. These annotations are useful in the event when the vehicle remains standing over a period of time due to the consignor of the goods, so as to enable the carrier to obtain remuneration.
- Box 4 The foreseen place of delivery of the goods. It is recommended to ask the consignor to indicate the opening hours of the warehouse or depot where the delivery will take place. This mention will avoid the carrier having an expensive and unnecessary wait if he arrived outside of opening hours.
- Box 5 Particular instructions of the consignor. If necessary, the consignor is expected to indicate instructions that could affect the transport operation, such as the instructions concerning Customs procedures, the ban on transshipment of the goods, insurance of the goods or any other instruction he deems useful.
- Box 6 Name and complete address of the carrier, other references if applicable.
- Box 7 Successive carrier(s). This box is intended for the eventuality that the transport is carried out by several carriers who carry out the voyage successively.
  This box, if applicable, should be filled in at the moment when the successive carrier takes the goods into charge – these indications will be noted at least on the copy of the consignment note intended for the consignee (second copy) and on the copy intended for administrative procedures).
  If it is foreseen that the transport operation be carried out by several successive carriers, it is important that the copy of the consignment note intended for the consignee has at least a record of the carrier who will deliver the goods.
  The successive carrier must date and sign the box (“goods received and accepted”, “date” sections). Here he can also indicate any reservations concerning the number of packages, their identifying marks and numbers, the apparent state of the goods and their packaging

[4] https://www.iru.org/sites/default/files/2017-01/how-to-fill-cmr-model-iru-2007-en.pdf

at the time of taking the goods into charge. If there is a lack of space, the reservations can be written elsewhere (for example on the back of the consignment note), but a clear indication on the consignment note should state that reservations were made, and these should be validated by the carrier who carried out the part of the transport preceding the taking into charge by the successive carrier.

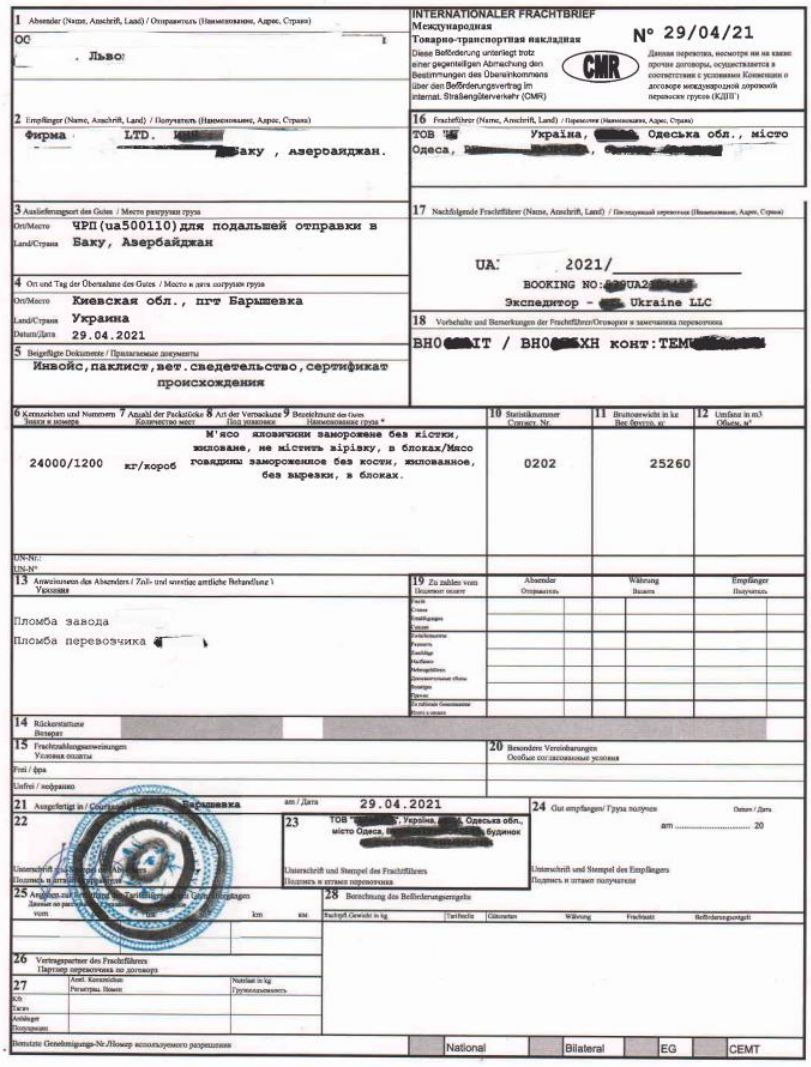
- Box 8 Reservations and observations of the carrier at the time of taking the goods into charge, such as the number of packages, their identifying marks and numbers and their packaging. These reservations must be validated by the consignor, if they are to be valid.
- Box 9 List of the documents handed by the consignor to the carrier (for example: loading list, certificates of origin of the goods etc.).
- Boxes 10-15 correspond to the usual description of the transported goods, including, if applicable, special indications concerning dangerous goods.
- Box 16 Particular agreements between the consignor and the carrier such as the declared value of the goods and the amount representing special interest at time of delivery, the agreed time limit within which the transport must be carried out, the possibility of using open non-sheeted vehicles, the use of palettes, the record of the person responsible for loading, stowing and unloading, the admission of the transport onto a ferry, the applicable jurisdiction or any other indication deemed to be useful by the parties to the transport contract.
- Box 17 Indications concerning the amount of the different payments relating to the transport contract established as well as the indication of the party who is bound to carry out the payment. If the carrier is not capable or if he judges it irrelevant to indicate the exact amount of the payments due, he is strongly advised to at least indicate the party responsible for the payment in order to avoid future discussions in this respect.
- Box 18 Other useful indications: the parties may add any indication of use to other parties or to the competent authorities. This could be the license plate number of the vehicle, load capacity, the net weight of the goods, the number of the TIR Carnet or any other Customs document used during the transport etc.
- Box 19 The indication of the amount of reimbursement transferred by the consignee and to be received by the carrier at the time of the delivery of the goods. Warning: in accordance with the CMR Convention (Article 21), the carrier is bound to remunerate the consignor for the exact amount of the reimbursement if the goods were delivered to the consignee without the said reimbursement being settled at delivery.
- Box 20 (already filled in): obligatory reference reflecting the prevalent value of the provisions of the CMR Convention
- Box 21 Place and date of the establishment of the consignment note
- Box 22 Signature or stamp of the consignor (choice left to the consignor)
- Box 23 Signature or stamp of the carrier (choice left to the carrier)
- Box 24 Signature and stamp of the consignee confirming delivery of the goods, indicating the place, the date and particularly quoting the time of arrival of the vehicle at the place of delivery and subsequent departure following the unloading. These remarks are useful in the case when the vehicle remains idle because of the consignee of the goods, in order to remunerate the carrier, if necessary.

- The consignment note also has at the bottom of the page a "Non-Contractual Part" field, reserved for the use of the carrier (for example: Customs offices used, distances covered, etc., i.e., records that do not entail contractual obligations for the concerned carrier).

At the same time, real business transactions impose certain features on the filling out of such a document. First, this concerns commercial information - the cost and terms of payment. Another sensitive point for business is the practice of using intermediaries in transportation. In this case, the main carrier often does not want to share information about the transport service buyer (TSB) with its subcontractor, so some of the information is not filled in, or is filled in in a modified form.

There is also a practice of requesting a CMR document from the Government administration and regulatory authorities. Despite the fact that, by its nature, the CMR is a private law document and, as part of the control procedures in most jurisdictions, the Government authorities have the right to access only a limited number of details from such a document, in the case of a paper document, it is not possible to implement such restrictions, which, in turn, leads to the unwillingness of the participants in the transportation to enter detailed information into the document.

Figure 7 An example of a completed document

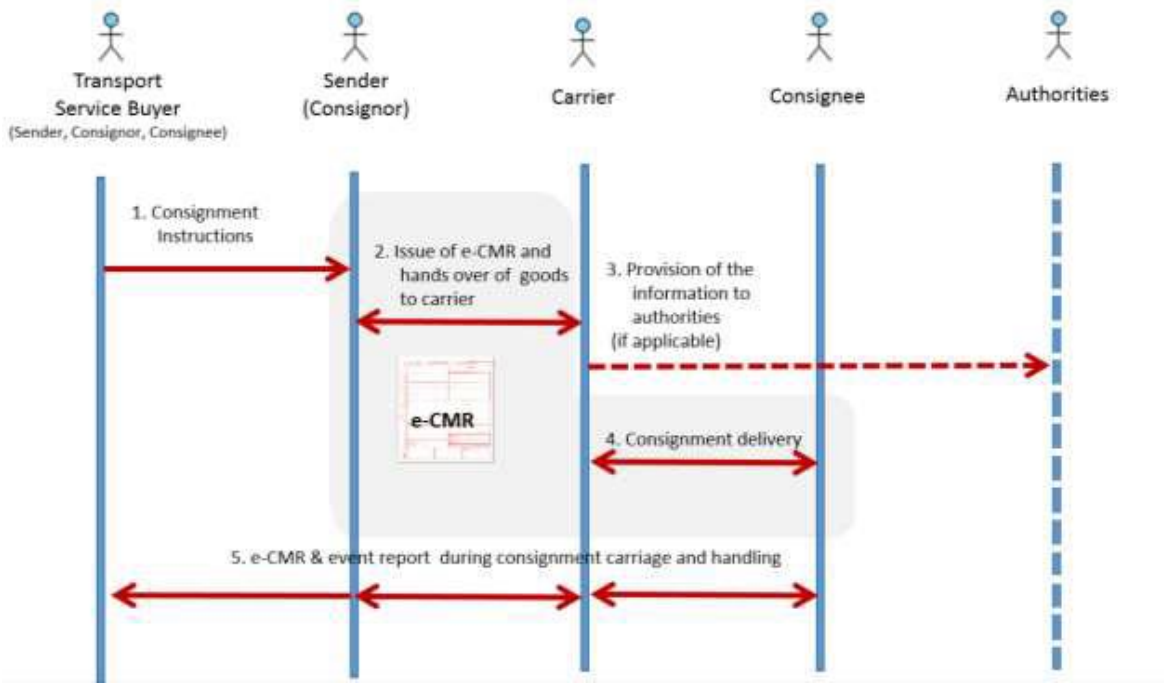


Source: Authors

Figure 8 shows an example of a real document used in international road transportation. As one can see, most of the details (boxes) in the document were left blank. In fact, only the indispensable details are filled in, without which it would be fundamentally impossible to carry out the transport operation or pass through the border formalities.

Another important element of business analysis is how changes are made to and tracked in a document during its life cycle. An example of the lifecycle for a CMR is shown on Figure 10.

Figure 8 – e-CMR Sequence Diagram



Source: http://staging2.unece.org.net4all.ch/fileadmin/DAM/cefact/Standards/eCMR/01_BRS_eCMR_v1.pdf

Although this example is not exhaustive and in real business operations the number of participants may be larger (for example, ports, logistics warehouses, ferry crossings, etc.), it is clear that at least three participants make their changes during the life cycle to document:

- creation of a document by the Sender (or the transportation service buyer)
- amendment of the document by the Carrier (information about the lorry, the driver's name, the fact of acceptance of the cargo and comments on its condition, the driver's signature)
- amendment of the document by the Consignee (delivery information, the fact of acceptance of the cargo and comments on its condition, the signature of the Consignee).

In the case of a paper document, this information is added to the original document at the time of the corresponding logistical event (for example, loading cargo onto a lorry). In case of an electronic document, additional issues can potentially arise:

- The information flow is separated from the cargo flow. This means that the electronic document is not transmitted synchronously with the movement of the goods. Thus, an

electronic document can be available to all participants of the transport operation at the same time, or by any events (rules).

- In the digital world, there are several interpretations of the concept of "original" in relation to a digital asset. They differ from the "all copies are original" approach to the approach taken from the point of view of Blockchain technology - Non-Fungible Token [5](NFT).
- Technological approaches to the very process of making changes to an electronic document - the source document is changed, a new document is created that refers to the source document, or the source document is "embedded" in a new one.
- The issue of legal recognition of the changes made (to be discussed in more detail below).

3. List of Data Attributes

Based on the results of the analysis of business transactions with the assessed document, we can form a list of attributes (information entities) for further formation of an electronic document.

Table 2 List of Data Attributes

Attribute name				Paper form box number
Number of the document				
Date of the document				21
Place of issue				21
	Location name			21
	Country			21
		Country name		21
		Country code		
Consignor				1
	ID (Tax ID)			
	Name of consignor			
	Address			
		Post code		
		Street name		
		City name		

[5] https://en.wikipedia.org/wiki/Non-fungible_token

		Country		
			Country name	
			Country code	
Consignee				2
	Tax id			
	Company name			
	Address			
		Post code		
		Street name		
		City name		
		Country		
			Country name	
			Country code	
Carrier				6
	ID (Tax ID)			
	Carrier name			
	Address			
		Post code		
		Street name		
		City name		
		Country		
			Country name	
			Country Code	
Successive Carriers				7
	Carrier name			
	Address			
		Post code		

		Street name		
		City name		
		Country		
			Country name	
			Country Code	
	Receipt and acceptance			
		Location name		
		Country		
			Country name	
			Country code	
Taking over the goods				3
	Place of acceptance			
		Location name		
		Country		
			Country name	
			Country code	
	Date and time of arrival			
	Date and time of departure			
Delivery of the goods				4
	Place of delivery			
		Location name		
		Country		
			Country name	
			Country code	
	Warehouse opening hours			
Goods received				24

	Place of delivery			
		Location name		
		Country		
			Country name	
			Country code	
	Date and time of arrival			
	Date and time of departure			
Sender instructions				5
Carriers' s remarks				8
Attached documents				9
Information about the cargo				
	Marks and numbers			10
		Text		
		Container Number		
	Number of packages			11
	Type of package			12
		Code		
	Nature of the goods			13
		Name of cargo		
		Code		
	Gross Weight			14
	Gross volume			15
	Dangerous good information			13
		UN number		
		Label Number		
		Packing group		
		ADR		

Notes				18
Signature or stamp of the Sender				22
Signature or stamp of the Carrier				23
Signature or stamp of the Consignee				24

As can be seen from the Table 2, a number of attributes are elementary information entities (for example, the document number), some are aggregated (for example, the party to the transaction, such as the Sender or Carrier).

It should also be noted that some of the attributes from the document form are not included in the table. As mentioned above, the analysis of practical business transactions has shown that there are attributes that are not filled in during actual transportation. On the other hand, attributes such as country, which are simply filled in with the name in a paper document, are accompanied by a code in the case of an electronic document.

4. Mapping against the Multimodal Transport Reference Data Model (MMT RDM)

Mapping the data set created in the previous step against the UN/CEFACT Multimodal Transport Reference Data Model is a key step towards ensuring both harmonization of electronic documents in terms of standards and multimodality. Today, supply chains are quite complex and the need to combine several modes of transport within a single shipment is not something exceptional. Thus, the problem arises of transforming information from transport documents of one type of transport into documents of another type. It is the task that MMT RDM helps to solve.

The MMT RDM is a consolidated list of standardized data formats and processes for use in an application domain that are globally understood and exchangeable between parties using common data exchange structures in a standard format.

The advantage of the reference data model (RDM) approach is that an RDM draws on the overall available Aggregate Business Information Entities (ABIEs) within the UN/CEFACT Core Component Library (CCL), creating a complete and focused subset specific to the needs of a segment. For example, the UN/CEFACT Supply Chain RDM (SCRDM) covers the contract for the supply of goods, and the UN/CEFACT Multi Modal Transport RDM (MMT RDM) covers the contract for the supply of transport and related services. This is a family of reference data models. The BSP RDM is the “umbrella” reference data model, and the other reference data models are subsets under this “umbrella”. Individual messages related to a sector of activity are seen as a subset of the RDM, which itself is a subset of the UN/CCL. So, if certain data elements cannot be found in the subset reference data models (e.g., the MMT RDM), experts may look for them in the overarching RDM or address a request to the UN/CEFACT experts to find these elements in the overarching RDM or in UN/CCL.

Further, in this example, given both RDMs are drawn from (subsets of) the CCL, interoperability between the RDMs is ensured.

The benefits of RDMs are that they provide business process modelers and business process analysts and software designers a base To-Be architecture to be achieved.

Starting from a base To-Be architecture, rather than attempting independently to understand and harmonize numerous disparate As-Is situations will commence to address the long and well-understood problem of lack of information interoperability between applications in the e-business arena, traditionally adversely impacting supply chains.

Such harmonization makes it possible to resolve the issue of interoperability of data sets in the electronic document management when changing both legal jurisdictions and modalities of transport and ensure movement towards the creation of so-called "seamless data pipelines".

5. Mapping process description

The best way to start the mapping process is to select the appropriate subset of the data model for a particular business transaction or document. In the case of CMR, the current version of such a profile is available at the link:

https://service.unece.org/trade/uncefact/publication/Transport%20and%20Logistics/MMT%20eCMR_UNECE/HTML/002.htm

The subset for the CMR invoice consists of 3 main aggregated entities:

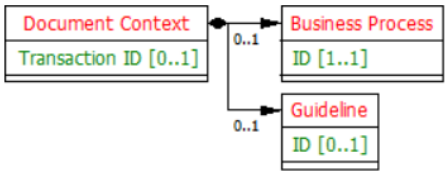
- Document Context - BSP Master. Exchanged Document_Context
- eCMR Header Details - BSP Master. Exchanged_Document
- Road Consignment - BSP Master. specified. Supply Chain_Consignment

The Document Context entity contains information about identifiers of transactions and business processes and is used in the context of certain electronic messaging procedures. For the purposes of the current description, this entity will not be used.

Figure 9 Document Context ASBIE

Document Context

ASBIE BSP Master. Exchanged Document_ Context



Documentation

Common term	Document Context

CCTS

Type	ASBIE
Dict.EntryName	BSP Master. Exchanged Document_ Context
Definition	The set of context parameters specified for a use of this master message assembly.
Obj.ClassTerm	BSP Master
Assoc.Obj.ClassQual.	Exchanged Document
Assoc.Obj.Class	Context
Occurrence	0..1

Publication

UN Identifier	UN01003540

Attributes

Attribute name	Status	Description/Data Type
Exchanged Document_ Context. Specified_ Transaction. Identifier	O	Identifier. Type The identifier of a specified transaction in this exchanged document context.

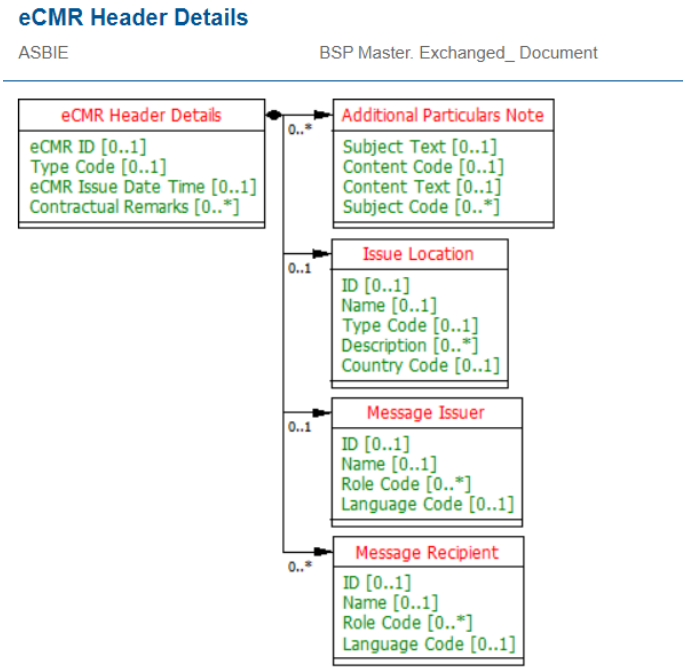
Source: UNECE

The other two entities contain the attributes that we listed in the previous step, so the mapping process will be performed on them.

The mapping is performed by sequential detailing (immersion) into the structure of information entities of the data model.

Let us start with the document header (eCMR Header Details).

Figure 10 eCMR Header Details ASBIE



Source: UNECE

To understand the purpose of each of these entities, the model contains metadata that describes the type of data elements and basic information that such an entity can contain. In particular, ASBIE eCMR Header Details contains 4 base type attributes and 4 aggregated entities:

- Additional Particulars Notes
- Issue Location
- Message Issuer
- Message Recipient

Table 3 Basic type attributes

Attribute name	Description/Data Type	Restricted Code List
Exchanged_ Document. Identification. Identifier	Identifier. Type The unique identifier of this exchanged document.	
Exchanged_ Document. Type. Code	Document_ Code. Type The code specifying the type of exchanged document.	Restricted codes
Exchanged_ Document. Issue. Date Time	Date Time. Type The date, time, date time or other date time value for the issuance of this exchanged document.	
Exchanged_ Document. Remarks. Text	Text. Type A remark, expressed as text, regarding this	

	exchanged document.	

Each of the base type attributes also contains additional descriptions to help identify the purpose of that attribute. In particular, **Exchanged_ Document. Identification. Identifier** is defined[6] as

A character string to identify and distinguish uniquely, one instance of an object in an identification scheme from all other objects in the same scheme together with relevant supplementary information.

Thus, we can make an informed decision to map this attribute to a CMR document number.

As one can see from the description given by reference, in the data model, the data type Identifier.Type consists of two elementary attributes – see Table 4:

Table 4 Attributes

Attribute name	Status	Description/Data Type
Identifier. Content	M	A character string to identify and distinguish uniquely, one instance of an object in an identification scheme from all other objects within the same scheme.
Identification Scheme Agency. Identifier	O	The identification of the agency that maintains the identification scheme.

Moreover, the first of these attributes (Content) is mandatory, the second (Identifier of the agency authorized for the identification scheme) is optional.

This approach came to the data model from the UN/CEFACT Core Components Library (CCL[7]) and applies to almost all identifiers. The approach is unique in its versatility and allows for interoperability between different parties in the supply chain, even in situations where such interoperability has not been previously agreed upon.

In the context of an identifier, in fact, it is possible to specify who is responsible for the order in which such an identifier is assigned, that is, in which coordinate system the document is being reported. Thus, if two organizations indicate a document number, for example, "15", the parties will understand that these are two different documents, and each of such documents will be uniquely identified.

Thus, following the logic described above, we can map the rest of the attributes from the header with the attributes from the paper document

Table 5 Attributes from the header

[6] https://service.unece.org/trade/uncefact/publication/Transport%20and%20Logistics/MMT%20eCMR_UNECE/HTML/041.htm?https://service.unece.org/trade/uncefact/publication/Transport%20and%20Logistics/MMT%20eCMR_UNECE/HTML/0419.htm

[7] https://unece.org/trade/uncefact/unccl

	RDM Path	Paper form attribute name	Paper form box number
┬	BSP Master/Exchanged_ Document	Number of document and date	
├	BSP Master/Exchanged_ Document/Identification. Identifier	Number of document	
├	BSP Master/Exchanged_ Document/Type. Code		
├	BSP Master/Exchanged_ Document/Issue. Date Time	date	21
└	BSP Master/Exchanged_ Document/Remarks. Text		
┬	BSP Master/Exchanged_ Document/Included. Note	Notes	18
├	BSP Master/Exchanged_ Document/Included. Note/Subject. Text	Notes	18
├	BSP Master/Exchanged_ Document/Included. Note/Content. Code		
├	BSP Master/Exchanged_ Document/Included. Note/Content. Text		
└	BSP Master/Exchanged_ Document/Included. Note/Subject. Code		
┬	BSP Master/Exchanged_ Document/Issue. Logistics_ Location	Location and date	21
├	BSP Master/Exchanged_ Document/Issue. Logistics_ Location/Identification. Identifier	Place name	
├	BSP Master/Exchanged_ Document/Issue. Logistics_ Location/Name. Text		
└	BSP Master/Exchanged_ Document/Issue. Logistics_ Location/Country. Identifier	Country name	21
┬	BSP Master/Exchanged_ Document/Issuer. Trade_ Party	Company name and address	1,22
├	BSP Master/Exchanged_ Document/Issuer. Trade_ Party/Identification. Identifier	Company stamp	22
└	BSP Master/Exchanged_ Document/Issuer. Trade_ Party/Name. Text	Company information	1
	BSP Master/Exchanged_ Document/Issuer. Trade_ Party/Defined. Trade_ Contact		
	BSP Master/Exchanged_ Document/Recipient. Trade_ Party		

The rest of the attributes selected in the previous step are mapped in the same way. The result of the mapping is given in Annex 1.

Why are not all the fields mapped?

In our example, there are a certain number of attributes that are not mapped against the data model. For example, BSP Master/Specified. Supply Chain_Consignment/Notified. Trade Party. In the document that we used as a sample, this party of the transportation contract did not participate

(information was not filled in). At the same time, in other examples it may be required, for this purpose this aggregated entity is present in the model (and in the XSD schema).

What to do if there are not enough fields?

There are cases in real business practice when not all attributes of a real document can be mapped to the corresponding profile of the UN/CEFACT data model. There may be several reasons for this:

- Non-standard filling of the document - for example, at the request of one of the parties, data is entered into the document that is not provided for in such a document. If the fields for notes and special marks are not used for this, there are likely to be difficulties with mapping,
- A new or non-standard business transaction - for example, a waybill has been used as a multimodal document when transporting a car on a ferry, in this case, additional attributes may be needed that were not originally present in the profile,
- Local requirements of the authorities/parties to the transaction - for example, in a particular jurisdiction, it is required to additionally indicate information that is not available and/or not required in other jurisdictions.

There may be other reasons as well. In any case, regardless of the reason for the discrepancy, there are two options for further action:

- making changes to business practices and bringing them into line with UN/CEFACT standards and recommendations,
- making changes to the data model profile for a particular document to update it to the current business practice.

The first option should be used in cases where processes deviate from generally accepted ones for reasons that objectively do not contribute to their improvement. The second option is for cases of developing processes and adding new jurisdictions to the data model. It should be noted that in the vast majority of cases, such a profile update is performed by "opening" the relevant attributes from the full MMT RDM.

6. Creating an electronic document equivalent

This stage is not described in the guidance proposed by David Roff, however, it seems appropriate to single it out separately. The list of attributes mapped with the entities of the eCMR profile of the data model created at the previous stage, made using Microsoft Excel, clearly demonstrates the structure of an electronic document, but cannot be used as such. For these purposes, it is proposed to create an equivalent of an electronic document in XML format. It should be noted that the XML format is chosen as widely accepted by the industry, officially published by UN/CEFACT, and easy to process by both a computer and a human.

One can read more about XML standards and technologies for working with them at the following location: https://www.w3.org/standards/xml/core

To create an XML document and then validate it, one needs an XSD document schema.

The eCMR document schema in XSD format is available here:

https://service.unece.org/trade/uncefact/publication/Transport%20and%20Logistics/MMT%20eCMR_UNECE/XSD/Schema.zip

One can work with a document both in one of the specialized software packages and in text editors (both specialized and for general use). In fact, an XML document is a text document without formatting. For convenience, we will provide examples using Microsoft Visual Studio Code.

The document schema consists of 24 files that reference each other. The documentation root starts in the eCMR_1p0.xsd file. Omitting the type definitions in the header, one can see that the schema describes the eCMR document as a type consisting of two nested types:

```
<xsd:sequence>
 <xsd:element name="ExchangedDocument" type="ram:ExchangedDocumentType" minOccurs="0">
  <xsd:annotation>
   <xsd:documentation>eCMR Header Details</xsd:documentation>
  </xsd:annotation>
 </xsd:element>
 <xsd:element name="SpecifiedSupplyChainConsignment" type="ram:SupplyChainConsignmentType">
  <xsd:annotation>
   <xsd:documentation>Road Consignment</xsd:documentation>
  </xsd:annotation>
 </xsd:element>
</xsd:sequence>
```

Each of these complex types is defined in a file eCMR_1p0_urn_un_unece_uncefact_data_standard_ReusableAggregateBusinessInformationEntity_101.xsd

In turn, complex types (aggregated business entities) refer to qualified (eCMR_1p0_urn_un_unece_uncefact_data_Standard_QualifiedDataType_101.xsd) and unqualified data types (eCMR_1p0_urn_un_unece_uncefact_data_standard_UnqualifiedDataType_25.xsd). The qualified data types include top-level information entities that describe certain roles in business transactions, for example, the party to the transaction that makes the payment:

```
<xsd:complexType name="ChargePayingPartyRoleCodeType">
 <xsd:annotation>
  <xsd:documentation>
   UN02000062
   1.0
   (3035)
   D08B
  </xsd:documentation>
  <xsd:documentation>
   UN02000044
   1.0
   [3035]
   D08A
  </xsd:documentation>
```

```
    <xsd:documentation>
      UDT000007
      2.01
      D12B
    </xsd:documentation>
  </xsd:annotation>
  <xsd:simpleContent>
    <xsd:extension base="clm63035ChargePaying:PartyRoleCodeChargePayingContentType">
      <xsd:attribute name="listAgencyID" type="qdt:ChargePayingPartyRoleCodeListAgencyIDContentType" fixed="6"/>
    </xsd:extension>
  </xsd:simpleContent>
</xsd:complexType>
```

The unqualified data types include entities that describe more general types, for example, the Identifier (IDType) type we mentioned earlier:

```
<xsd:complexType name="IDType">
  <xsd:annotation>
    <xsd:documentation>
      D12B
      UDT0000011
      2.01
    </xsd:documentation>
  </xsd:annotation>
  <xsd:simpleContent>
    <xsd:extension base="xsd:token">
      <xsd:attribute name="schemeAgencyID" type="xsd:token"/>
    </xsd:extension>
  </xsd:simpleContent>
</xsd:complexType>
```

In addition, 17 dictionaries (lists of codes) are included in the scheme. It should be noted that it is UN/CEFACT practice to create so-called limited code lists based on the full code lists. The restriction is built according to the semantic principle, for example, for types of vehicles in the road consignment note it is meaningless (and fraught with errors) to see the types of the vessels or wagons in the selection list. At the same time, the constraint is built by profiling, similar to creating subsets for modes of transport from the MMT RDM. This hierarchical approach maintains a link to the original code list and ensures proper change management.

As can be seen from the above description, the structure of an eCMR electronic document is quite complex even for such a relatively simple document. The hierarchical nature of the files describing the structure greatly simplifies their maintenance within the framework of UN/CEFACT, however, complicates their practical application in small projects. In order to create an empty XML document based on the structure we have, one can use one of the options:

- manually describe the XML document based on the structure,

- manually transfer the structure definitions to one file and then generate the empty XML document using one of the available on-line generators[8],
- use the open-source development environment framework Eclipse IDE[9],
- use one of the specialized packages for working with XML, such as Altova XML Spy or Gefeg FX (more on that later).

Having created an empty XML document, you can proceed to populate it:

```
<?xml version="1.0" encoding="UTF-8"?>
<rsm:eCMR xmlns:rsm="urn:un:unece:uncefact:data:eCMR:100"
 xmlns:udt="urn:un:unece:uncefact:data:standard:UnqualifiedDataType:27"
 xmlns:qdt="urn:un:unece:uncefact:data:standard:QualifiedDataType:103"
 xmlns:ram="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:103">
 <rsm:ExchangedDocumentContext>
  <ram:SpecifiedTransactionID>XXXXXXXXXX</ram:SpecifiedTransactionID>
  <ram:BusinessProcessSpecifiedDocumentContextParameter>
   <ram:ID>XXXXXXXXXX</ram:ID>
  </ram:BusinessProcessSpecifiedDocumentContextParameter>
  <ram:GuidelineSpecifiedDocumentContextParameter>
   <ram:ID>XXXXXXXXXX</ram:ID>
  </ram:GuidelineSpecifiedDocumentContextParameter>
 </rsm:ExchangedDocumentContext>
 <rsm:ExchangedDocument>
  <ram:ID>XXXXXXXXXX</ram:ID>
  <ram:TypeCode listAgencyID="6">730</ram:TypeCode>
  <ram:IssueDateTime>
   <udt:DateTimeString format="102">XXXXXXXXXX</udt:DateTimeString>
  </ram:IssueDateTime>
  <ram:Remarks languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Remarks>
  <ram:IncludedNote>
   <ram:Subject languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Subject>
   <ram:ContentCode listAgencyID="XXXXXXXXXX">XXXXXXXXXX</ram:ContentCode>
   <ram:Content languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Content>
   <ram:SubjectCode listAgencyID="XXXXXXXXXX">XXXXXXXXXX</ram:SubjectCode>
  </ram:IncludedNote>
  <ram:IssueLogisticsLocation>
   <ram:ID schemeAgencyID="XXXXXXXXXX">XXXXXXXXXX</ram:ID>
   <ram:Name languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Name>
   <ram:CountryID schemeAgencyID="5">XXXXXXXXXX</ram:CountryID>
  </ram:IssueLogisticsLocation>
  <ram:IssuerTradeParty>
   <ram:ID schemeAgencyID="XXXXXXXXXX">XXXXXXXXXX</ram:ID>
   <ram:Name languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Name>
   <ram:DefinedTradeContact/>
  </ram:IssuerTradeParty>
```

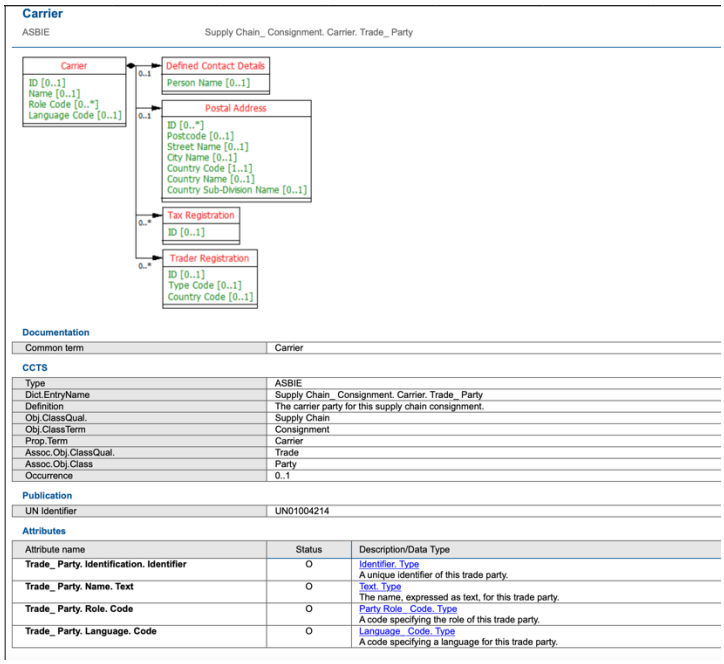
[8] http://xsd2xml.com, https://www.liquid-technologies.com/online-xsd-to-xml-converter
[9] https://www.eclipse.org/ide/

```
  <ram:RecipientTradeParty>
    <ram:ID schemeAgencyID="XXXXXXXXXX">XXXXXXXXXX</ram:ID>
    <ram:Name languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Name>
    <ram:DefinedTradeContact/>
  </ram:RecipientTradeParty>
</rsm:ExchangedDocument>
```

The full content of the empty XML document is given in Anex 2.

It is not necessary to fill in all the attributes available in the schema. In accordance with the specification[10], we can determine the obligatoriness of the corresponding attribute. For example, for a Carrier:

Figure 11 ASBIE Carrier attributes structure



Carrier

ASBIE — Supply Chain_ Consignment. Carrier. Trade_ Party

Documentation

Common term	Carrier

CCTS

Type	ASBIE
Dict.EntryName	Supply Chain_ Consignment. Carrier. Trade_ Party
Definition	The carrier party for this supply chain consignment.
Obj.ClassQual.	Supply Chain
Obj.ClassTerm	Consignment
Prop.Term	Carrier
Assoc.Obj.ClassQual.	Trade
Assoc.Obj.Class	Party
Occurrence	0..1

Publication

UN Identifier	UN01004214

Attributes

Attribute name	Status	Description/Data Type
Trade_ Party. Identification. Identifier	O	Identifier. Type A unique identifier of this trade party.
Trade_ Party. Name. Text	O	Text. Type The name, expressed as text, for this trade party.
Trade_ Party. Role. Code	O	Party Role . Code. Type A code specifying the role of this trade party.
Trade_ Party. Language. Code	O	Language . Code. Type A code specifying a language for this trade party.

Source: Authors

The nested information entities Defined Contact Details, Postal Address, Tax Registration and Trader Registration are optional (links are marked as 0..1 or 0..* in the UML diagram). Thus, if necessary, branches of tags related to these entities can be completely removed from the XML document without the risk of violating its compliance with the schema. Moreover, the attributes of the Carrier entity themselves are also optional, therefore, if necessary, they can also be omitted or removed from the document. Of course, from the point of view of a real business transaction, such a document will be meaningless (the Carrier is one of the parties to the transaction and must be present in the document), however, from the point of view of validating an XML document according to an XSD schema, such a document will be absolutely correct.

[10] https://service.unece.org/trade/uncefact/publication/Transport%20and%20Logistics/MMT%20eCMR_UNECE/HTML/031.htm

As a result, the completed electronic document may look something like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<eCMR xmlns="urn:un:unece:uncefact:data:standard:eCMR:1">
  <ExchangedDocument>
    <ID
xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101">XX1234/15FEB220</ID
>
    <IssueDateTime xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101">
      <DateTime xmlns="urn:un:unece:uncefact:data:standard:UnqualifiedDataType:25">2022-02-
15T12:00:00+02:00</DateTime>
    </IssueDateTime>
  </ExchangedDocument>
  <SpecifiedSupplyChainConsignment>
    <GrossWeightMeasure
xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101"
unitCode="KGM">6055</GrossWeightMeasure>
    <GrossVolumeMeasure
xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101"
unitCode="MTQ">31.0887</GrossVolumeMeasure>
    <ConsignmentItemQuantity
xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101">8</ConsignmentItemQ
uantity>
    <ConsignorTradeParty
xmlns="urn:un:unece:uncefact:data:standard:ReusableAggregateBusinessInformationEntity:101">
      <Name>Some Sender Name just for example</Name>
      <DefinedTradeContact>
        <TelephoneUniversalCommunication>
          <CompleteNumber>123 5 789012345</CompleteNumber>
        </TelephoneUniversalCommunication>
      </DefinedTradeContact>
      <PostalTradeAddress>
        <PostcodeCode>UA-02138</PostcodeCode>
        <StreetName>Name of the street</StreetName>
        <CityName>City</CityName>
        <CountryID>UA</CountryID>
      </PostalTradeAddress>
    </ConsignorTradeParty>
```

The full content of the completed eCMR example in XML format is given in Annex 3.

7. Additional considerations

XML technology is extremely powerful and is not limited to describing the document (data set) itself according to a certain structure with the possibility of its validation. Defining XML as a "language for defining languages" opens up a lot of room for extension. Let us take a look at a few examples.

Checking the requirements for the content of an electronic document.

The Schematron is a simple and powerful Structural Schema Language for making assertions about patterns found in XML documents. It relies almost entirely on XPath query patterns for defining rules and checks. Schematron validation rules allow the author to specify a helpful error message which will be provided to the user if an error is encountered. To get more knowledge about it, please go to Schematron website http://www.schematron.com/index.html

As an example of a real implementation of Schematrons for electronic documents, one can cite the following for eInvoice documents in the PEPPOL[11] ecosystem:

https://ecosio.com/en/peppol-and-xml-document-validator/

Visualization of an electronic document.

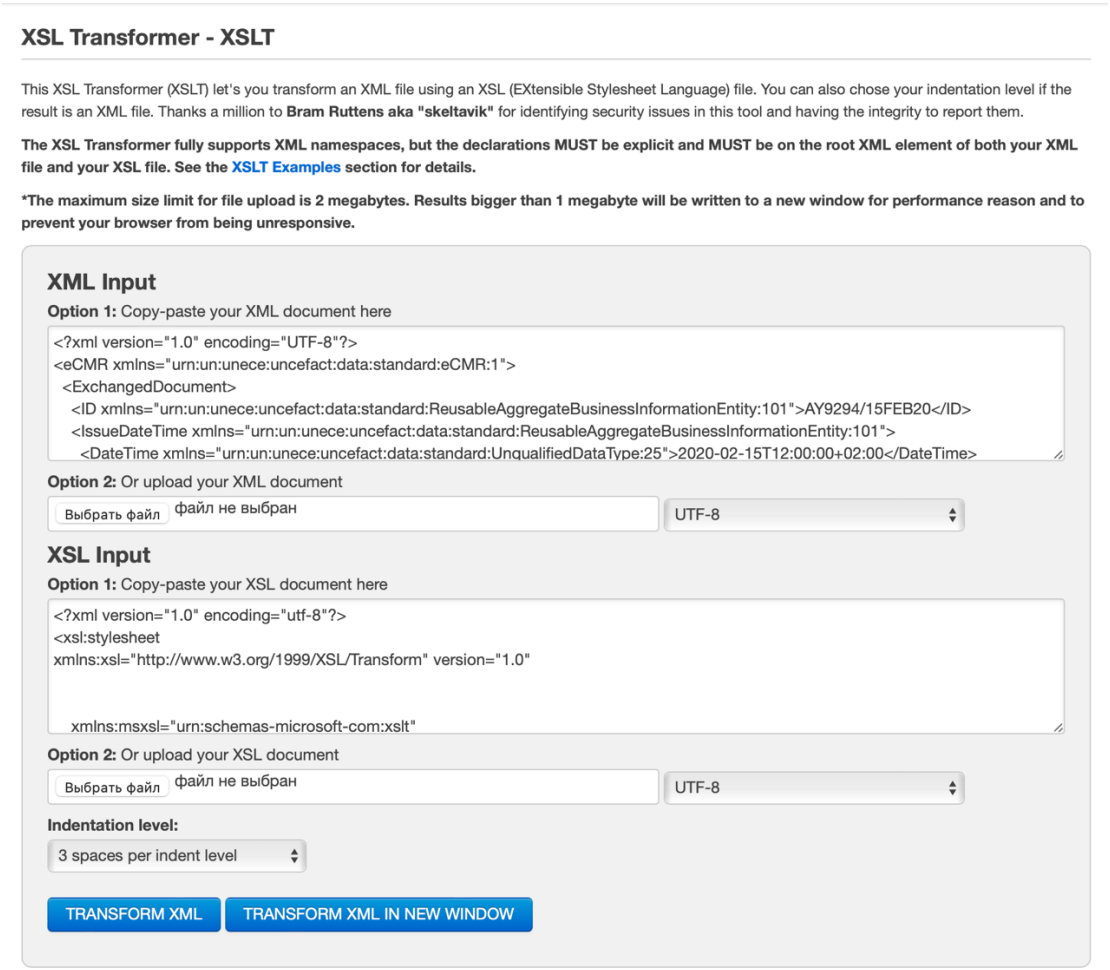
XML transformation technology (XSLT[12]) allows for the description of the transformation of an XML document (in general, any set of data that can be perceived by the processor as an XML document, that is, having a certain structure) into another XML document, into a text document, HTML or PDF.

An illustrative example of the implementation of such visualization by means of XSLT processors can be considered the implementation within the DIGINNO-DINNOCAP projects. The visualization script test is available at the link: https://koodivaramu.eesti.ee/majandus-ja-kommunikatsiooniministeerium/ecmr-index-registry-prototype-2.0/-/blob/main/xslt-xsd-api/src/config/xslt/eCMR_xml_2_html.v-1.1.xslt

It can be executed using any XSLT processor available on the Internet, for example: https://www.freeformatter.com/xsl-transformer.html

[11] https://peppol.eu/about-openpeppol/
[12] https://www.w3.org/standards/xml/transformation

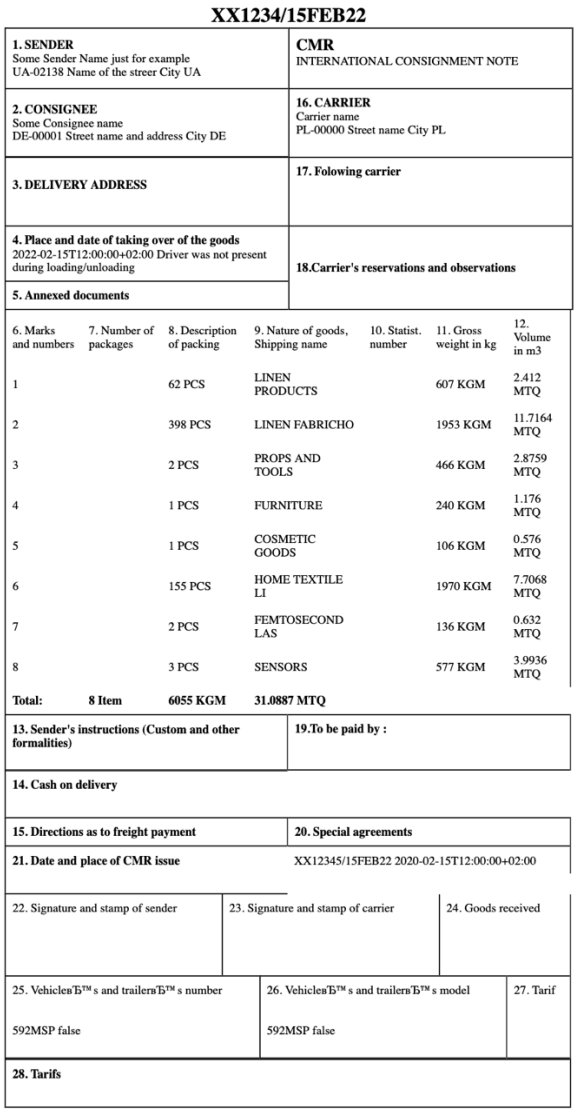
Figure 12 XSLT processor example



Source: https://koodivaramu.eesti.ee/majandus-ja-kommunikatsiooniministeerium/ecmr-index-registry-prototype-2.0

The result of such transformation is displayed as a text document in HTML format. After saving it to disk and opening it in any of the browsers, we will see a visual representation of the original XML document.

Figure 13 Example of the XML document visualization



XX1234/15FEB22

1. SENDER Some Sender Name just for example UA-02138 Name of the streer City UA	**CMR** INTERNATIONAL CONSIGNMENT NOTE
2. CONSIGNEE Some Consignee name DE-00001 Street name and address City DE	**16. CARRIER** Carrier name PL-00000 Street name City PL
3. DELIVERY ADDRESS	**17. Folowing carrier**
4. Place and date of taking over of the goods 2022-02-15T12:00:00+02:00 Driver was not present during loading/unloading	**18.Carrier's reservations and observations**
5. Annexed documents	

6. Marks and numbers	7. Number of packages	8. Description of packing	9. Nature of goods, Shipping name	10. Statist. number	11. Gross weight in kg	12. Volume in m3
1		62 PCS	LINEN PRODUCTS		607 KGM	2.412 MTQ
2		398 PCS	LINEN FABRICHO		1953 KGM	11.7164 MTQ
3		2 PCS	PROPS AND TOOLS		466 KGM	2.8759 MTQ
4		1 PCS	FURNITURE		240 KGM	1.176 MTQ
5		1 PCS	COSMETIC GOODS		106 KGM	0.576 MTQ
6		155 PCS	HOME TEXTILE LI		1970 KGM	7.7068 MTQ
7		2 PCS	FEMTOSECOND LAS		136 KGM	0.632 MTQ
8		3 PCS	SENSORS		577 KGM	3.9936 MTQ
Total:	**8 Item**	**6055 KGM**	**31.0887 MTQ**			

13. Sender's instructions (Custom and other formalities)	**19.To be paid by :**
14. Cash on delivery	
15. Directions as to freight payment	**20. Special agreements**
21. Date and place of CMR issue	XX12345/15FEB22 2020-02-15T12:00:00+02:00

22. Signature and stamp of sender	23. Signature and stamp of carrier	24. Goods received

25. VehiclesЂ™ and trailersЂ™ number	26. VehiclesЂ™ and trailersЂ™ model	27. Tarif
592MSP false	592MSP false	

28. Tarifs

Source: Authors

It should be noted that in a similar way it is possible to transform to any other visual format (for example, the popular PDF), as well as solving the problem of converting the structure of XML data sets to each other, in particular, to ensure multimodality tasks when changing jurisdictions and/or modes of transport. More on this later.

8. Outputs and Questions

As you can see, the approach described above is absolutely working and with its help one can create a really operational and practically applicable electronic document, harmonized with the requirements of UN/CEFACT standards and ready for use in multimodal transportation. This means that the information from such a document can be used to create other documents in accordance with the requirements of UN/CEFACT, for example, when crossing a border or when changing modes of transport.

At the same time, it is worth noting a number of pitfalls in the transition to electronic document management in the supply chain:

- in real business transactions there is a discrepancy in semantics - the same attribute in a paper document can be mapped with several attributes in an electronic one,
- in real business transactions, different requirements for filling in details in paper documents apply,
- in the electronic documents, as well as in the paper documents, there are problems related to the language of filling in text details and to the applied non-harmonized code lists,
- the transition to electronic documents adds the problem of their legal recognition by the parties, including public authorities.

Each of the barriers described above has specific solutions that are recognized by the industry to some extent. The development of new approaches and technological solutions is also ongoing.

Analysis of the Approach Applied

Based on the results of applying the approach described above, the following conclusions can be drawn about its advantages and disadvantages.

Advantages:

- simplicity and speed of implementation,
- possibility of implementation without the need for significant changes to the existing software.

Disadvantages:

- complexity increases exponentially in the number of data elements and documents,
- poor potential for automation,
- difficulty in maintaining and tracking changes.

Thus, this approach is good for conducting proof-of-concept studies before starting the actual design of an information solution, as well as for small projects or academic assessments. At the same time, in the conditions of a real transport operation, a more technological approach is required that can ensure the satisfaction of the requirements for reliability, efficiency and stability of the proposed solution.

The next section is devoted to such an approach.

Section IV. Extension of the approach

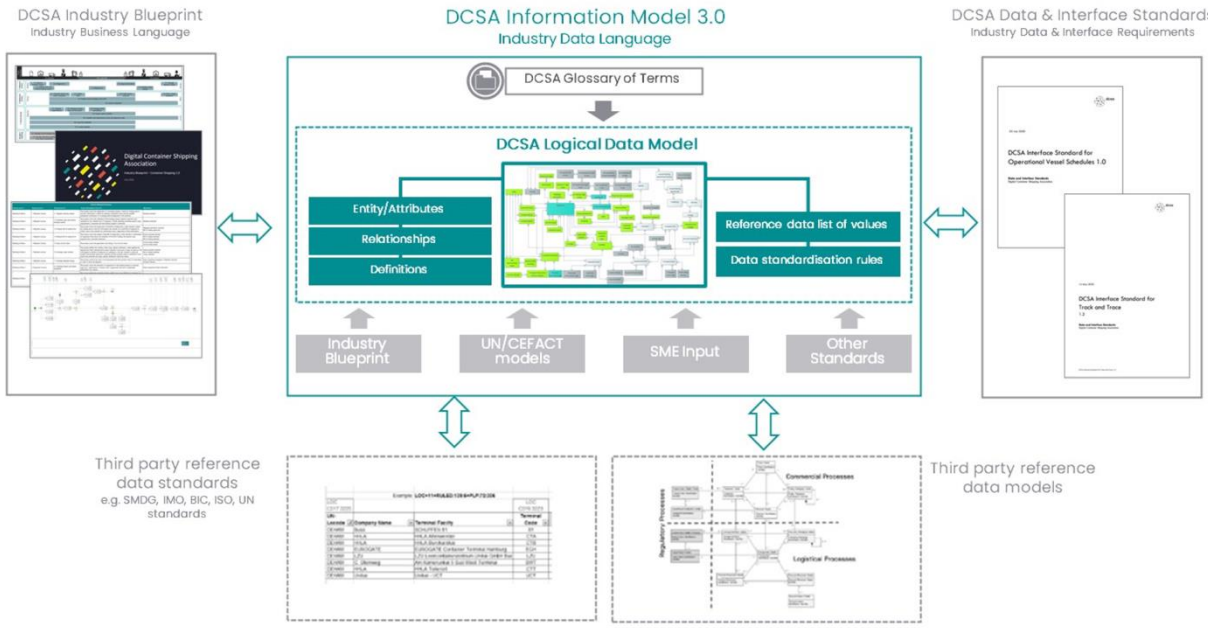
1. Information Models and Data Models

DCSA Information Model

To assess the question of the information models, we offer several industry examples for consideration. In particular, the example of the Digital Container Shipping Association (DCSA[13]).

The DCSA Information Model[14] has been designed to act as a translator between the information requirements identified by the business processes mapped in the DCSA Industry Blueprint and the existing standards for describing reference data relevant to the industry. This helps identify what is already available and where any potential gaps exist that need further investigation.

Figure 14 DCSA Information Model



Source: DCSA

The DCSA Information Model 3.0 consists of the following artefacts and products:

- Logical data model
  A diagrammatic representation of:
  - Data entities and the data attributes that store details about the entities,
  - The relationships that exist between data entities,
  - Standardized names of data entities and data attributes, for example, equipment versus container; definitions of the entities and attributes are stored as part of the metadata for the model.

[13] https://dcsa.org/about/
[14] https://dcsa.org/wp-content/uploads/2020/12/20201208-DCSA-P1-DCSA-Information-Model-v3.0-FINAL.pdf

- Standardized lists of data
  This is particularly relevant for reference data entities, through which a controlled list of values is recommended to help ensure that the same data are being used within and between organizations.
- Data standardization rules
  When a predetermined data value cannot be offered, the data standardization rules can help with the generation of consistent data values that can be used.

The Logical Data Model is defined as a graphical way of representing a data architecture without regard to the physical implementation or the database management system involved in storing the data, providing information about the various entities or the relationships between the entities. The Logical Data Model details the entities and their relationships with one another. An entity is an object that can have information stored about it, for example, Shipment, Equipment, and Transport. A relation describes the industry data-related rules between two entities.

As can be seen, there is a clear relationship between the MMT RDM and the DCSA information model, and between the DCSA logical model and subsets of the MMT RDM. At the same time, the information model is extended with additional artifacts - DCSA Data and Interface Standards, which detail both the requirements of the subject area and the practice of using the data sets described by the model.

Thus, the following pros and cons of information models can be distinguished:

- Pros - focus on the subject area. High detail of both the model itself and the artifacts associated with it. If resources are available, flexibility and efficiency,
- Cons - another set of standards, implying the need to solve the problem of extra integrations.

Another examples

FIATA eFBL

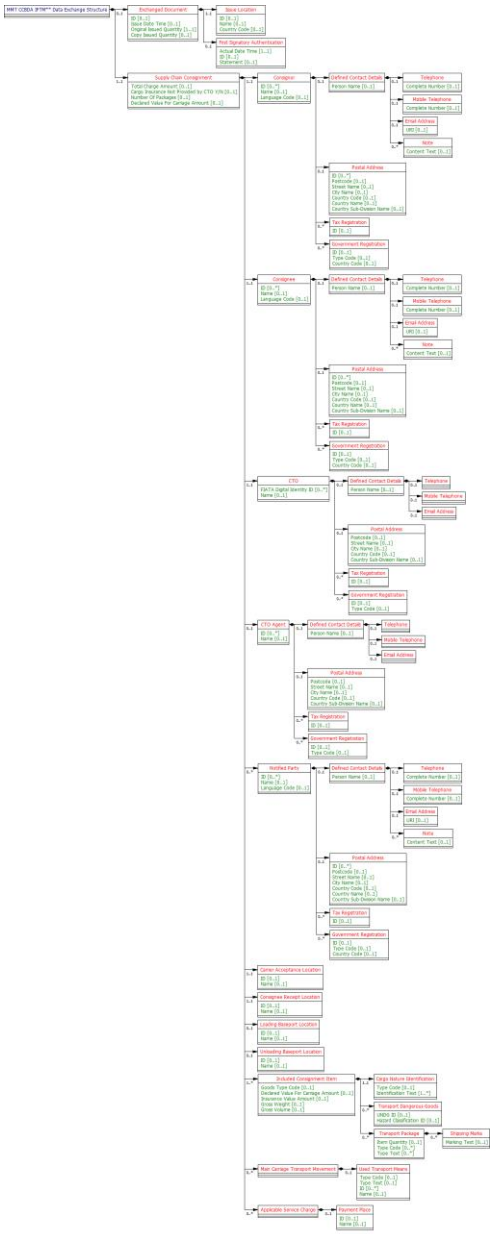
FIATA[15] eFBL[16] (Electronic FIATA Multimodal Transport Bill of Lading) - the Negotiable FIATA Multimodal Transport Bill of Lading is a trustworthy and reputable trade document. It is the only truly multimodal negotiable standard Bill of Lading, set up by FIATA for the use by freight forwarders acting as Multimodal Transport Operators (MTO).

FIATA's eFBL project does not only include the release of the eFBL data model as an open-source standard but will also add a trust and security layer on top of the digital document. The eFBL solution focuses on the development of the document integrity and traceability.

The data model for eFBL is fully based on the MMT RDM.

[15] https://fiata.org
[16] https://fiata.org/what-we-do/digitalization/projects.html

Figure 15 FIATA eFBL data model



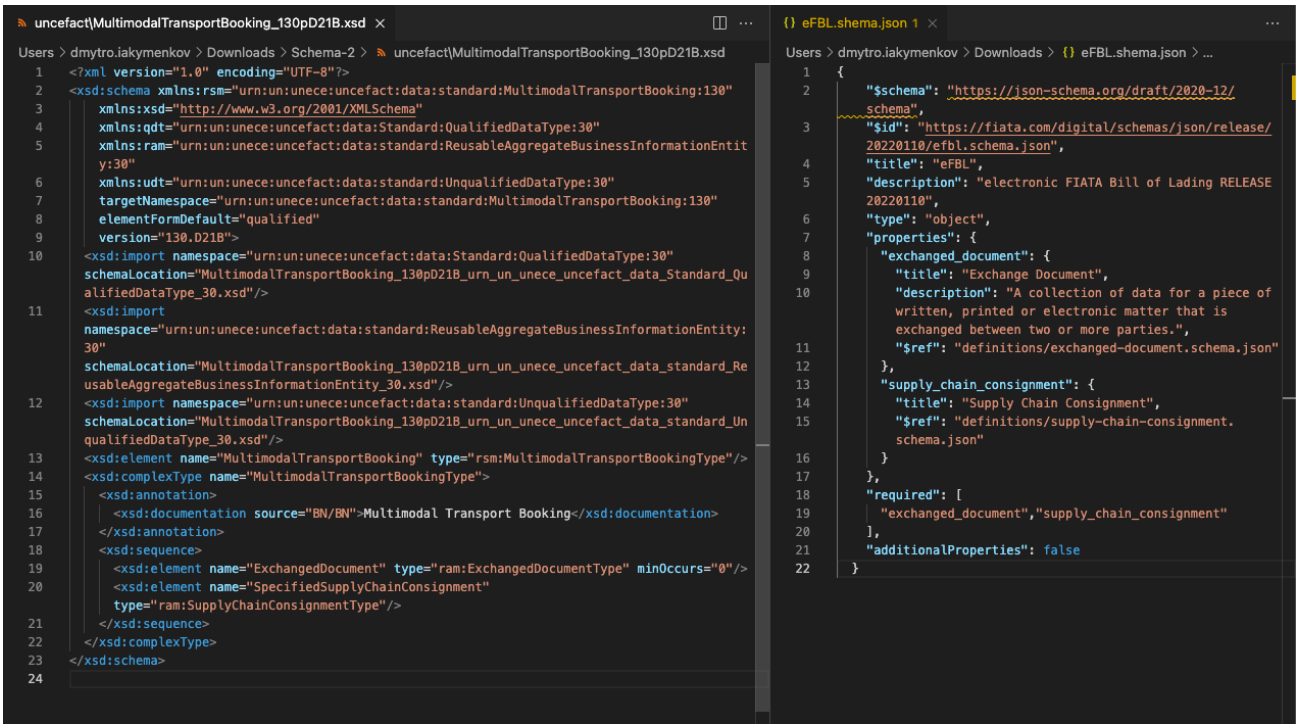
Source: FIATA, https://github.com/FIATA/eFBL/raw/main/docs/model.gif

It also utilizes UN/CEFACT recommended code lists. At the same time, the document schema is built as a JSON schema[17]. Full description of the eFBL schema is available here: https://fiata.github.io/eFBL/schema_doc.html

Whatever the format of description of the document schema, it corresponds to the definition of the UN/CEFACT eFBL document:

[17] https://json-schema.org

Figure 16 Mapping of the UN/CEFACT eFBL and FIATA eFBL schemas

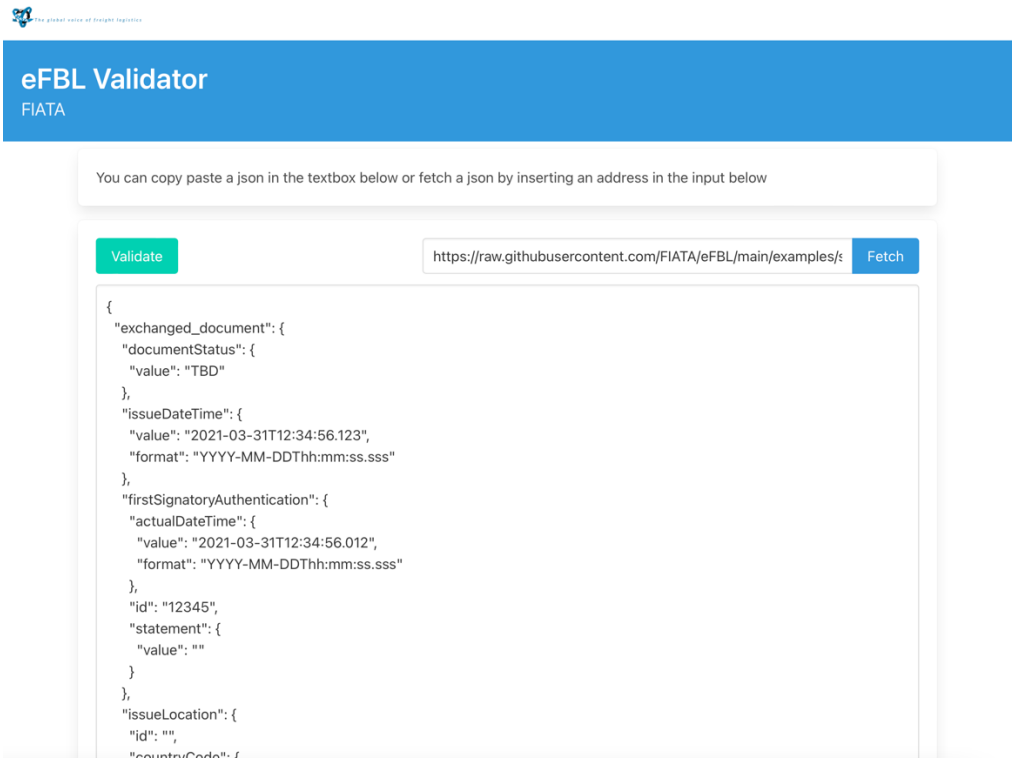


Source: UN/CEFACT, FIATA

The key artifacts of the FIATA information model besides the schema itself and implementation guide consist of the FIATA managed registry and FIATA digital identity. Both of these tools are used to provide trust in the electronic document regardless of the jurisdiction of the issuer and receiver of this document through the trust in FIATA.

The information model for the FIATA eFBL also includes eFBL validator – the solution that can help precheck the conformity of the eFBL electronic document to the FIATA requirements.

Figure 17 eFBL Validator



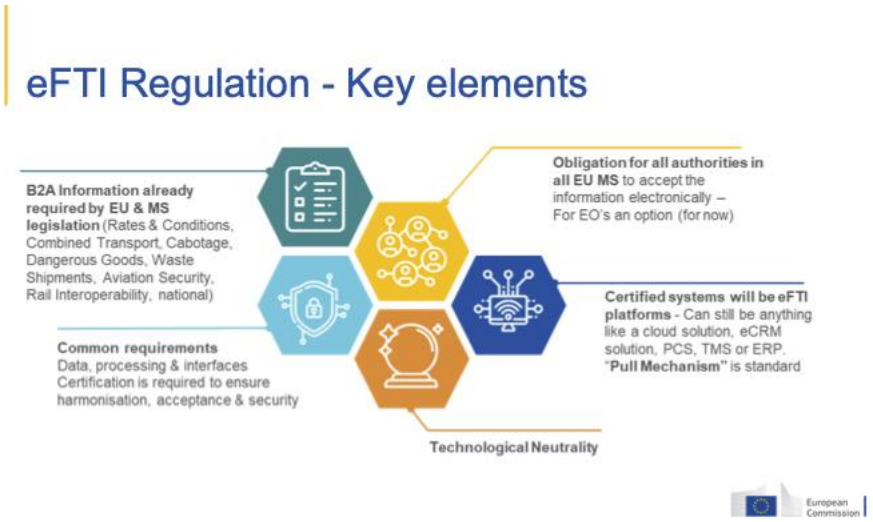
Source: FIATA

EU eFTI Data model

The EU eFTI Regulation[18] is aimed at solving the problem of unharmonized electronic information exchange for freight transport information in EU.

[18] https://eur-lex.europa.eu/eli/reg/2020/1056/oj

Figure 18 EU eFTI key elements

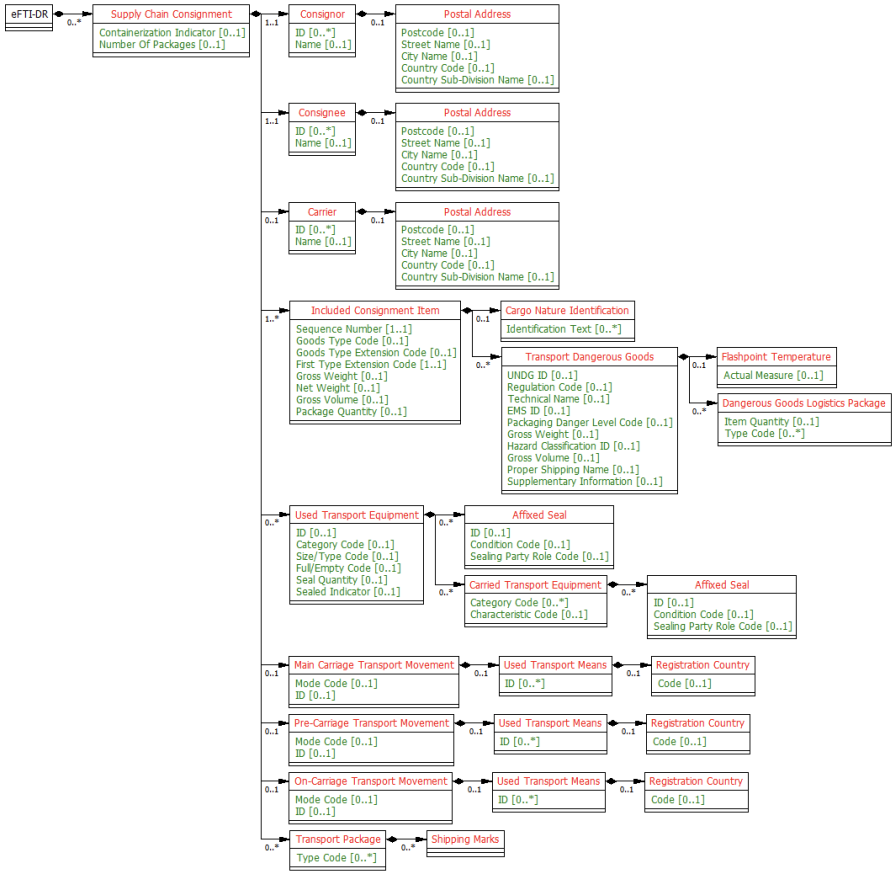


Source: EC

The scope of the Regulation is B2G information flow, but key architectural solutions can also be used to harmonize the B2B information flow at least inside EU. This includes:

- eFTI assumes that data providers will share data at the source of their origin. Authorities pull data from the data providers – like the UN/CEFACT data pipelines concept. This also allows data providers to keep their sovereignty to grant and revoke access to the data at any time,
- eFTI is based on the distributed architecture – as a road to the EU mobility data space,
- eFTI regulates requirements to the datasets and data providers – this creates harmonized and trustable environment for the information exchange as within the eFTI scope so and out of scope data sets.

Figure 19 eFTI data model diagram



Source: GEFEG, https://svn.gefeg.com/svn/efti-publication/!svn/ver/17/HTML/001.htm

EU Customs Data Model (EUCDM)

The EU Customs Data Model (EUCDM[19]) is the model for:

- trans-European Customs systems such as NCTS, AES, ICS
- national Customs clearance systems in the EU.

It is a technical instrument that:

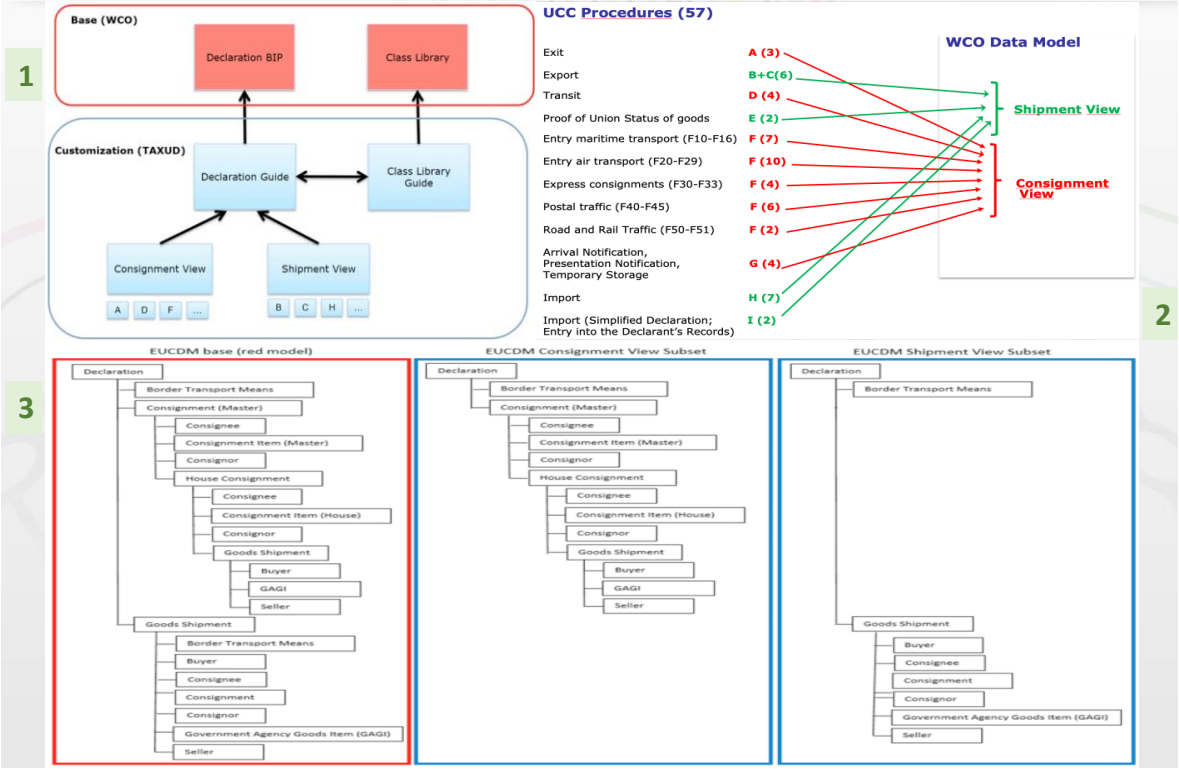
- models the data requirements laid down by EU Customs legislation
- presents a single, authoritative source of information for national Customs authorities wanting to make technical developments to their own IT systems

The data set for the EUCDM is defined in the UCC DA (Commission Delegated Regulation No.2015/2446[20]). Formats and codes are defined in the UCC-IA (Commission Implementing Regulation No.2015/2447[21]).

[19] https://ec.europa.eu/taxation_customs/customs-4/union-customs-code/eu-customs-data-model-eucdm_en
[20] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2446
[21] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015R2447

EUCDM is defined as a fully compatible with the World Customs Organization (WCO) data model[22].

Figure 20 EUCDM processes and repository



Source: UN/CEFACT

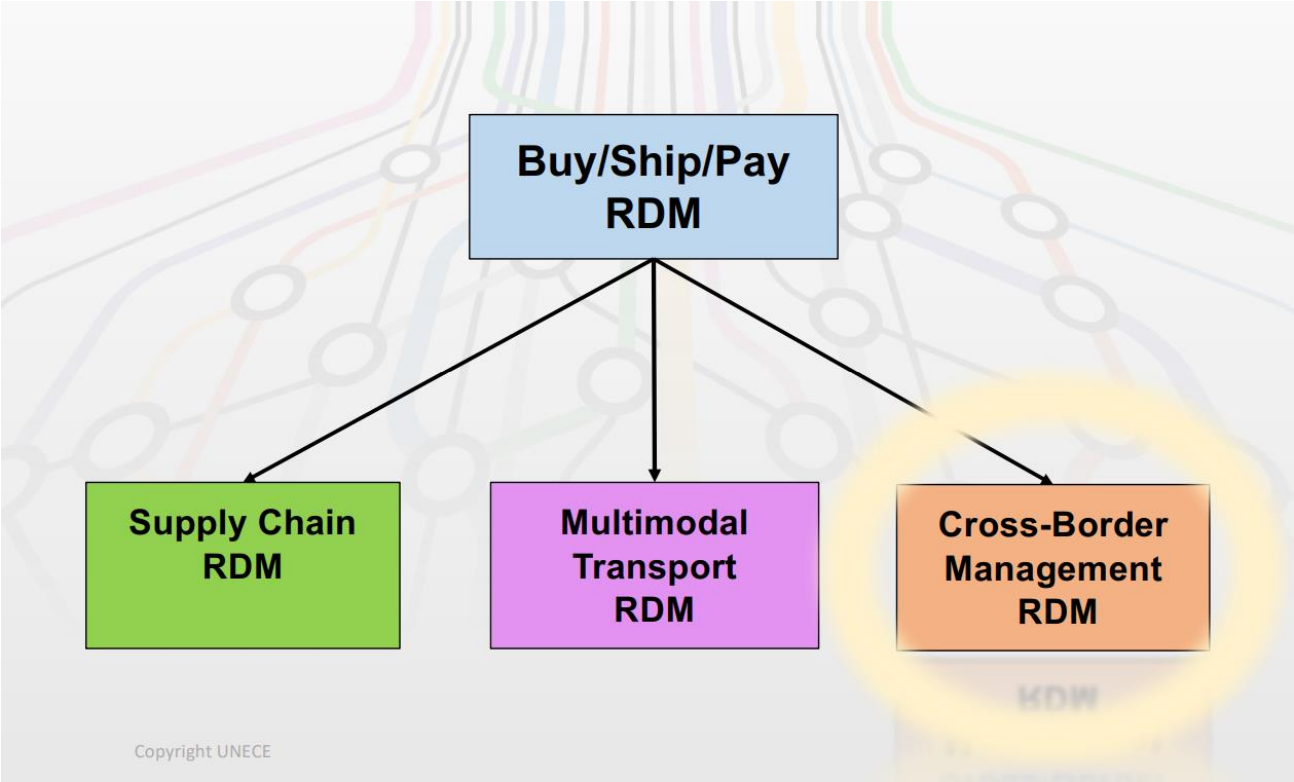
Customs processes in EUCDM are described and published on the WEB at: https://aris9.itsmtaxud.eu/businesspublisher

The EU Customs data model is an excellent illustration of the problem of unharmonized top-level standards. These are the UN/CEFACT data models (MMT, BSP and ISCDM) and the WCO DM Customs data model.

UN/CEFACT has repeatedly initiated activities to map data models for the international supply chain with the Customs data model, the result of which should be the creation of the so-called Cross-Border Management RDM.

[22] http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/data-model.aspx

Figure 21 UN/CEFACT Models hierarchy



Source: UN/CEFACT

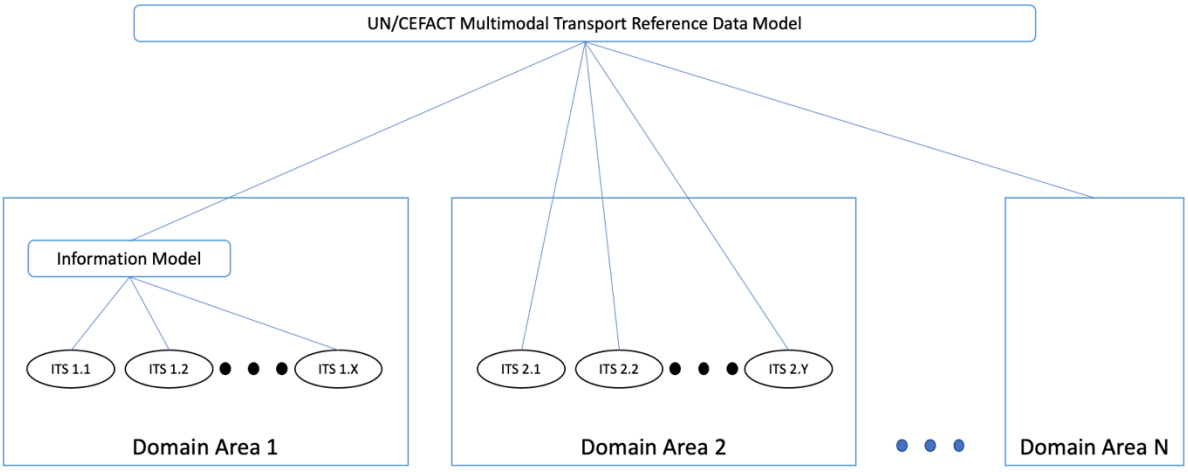
The results of work in this direction, presented at the 36th UN/CEFACT Forum, are available here: https://unece.org/sites/default/files/2021-05/T%2BLa_CBM-RDM-update.pdf

General considerations

In addition to the examples above, there are also many other implementations of information models that are more or less accepted by the industry.

It can be stated that the creation of information models in subject areas is an objectively accomplished fact. From the point of view of multimodal transportation and the global Buy-Ship-Pay supply chain, such models introduce an additional level of complexity to the task of a seamless data pipeline, on the other hand, they provide an effective solution to the problem of digitalization of a specific subject area. If we consider such a subject area within the framework of the Buy-Ship-Pay process as a kind of generalized black box, then the presence of information models is more likely to bring good than evil, providing the possibility of integration with "one another" standard for such a black box today, rather than the prospect of harmonizing dozens, if not hundreds or thousands of the implementations of information systems of participants in this subject area.

Figure 22 Relationship between IDM and MMT RDM



Source: Authors

2. Metadata. What needs to be stored in the model for the possibility of its practical application for document processing.

ICANN[23] defines metadata as a means of classifying, organizing, and characterizing data or content. In other words, metadata is data about data.

National Information Standard Organization (NISO[24]) introduces[25] such metadata classification:

Table 6 Metadata classification

Types of Metadata	**Function**
Descriptive metadata	For finding or understanding a resource
Administrative metadata	
- Technical metadata	- For decoding and rendering files
- Preservation metadata	- Long-term management of files
- Rights metadata	- Intellectual property rights attached to content
Structural metadata	Relationships of parts of resources to one another
Markup languages	Integrates metadata and flags for other structural or semantic features within content

Metadata play a key role in automating the data processing process in general and in application to the process of creating electronic documents based on a data model.

[23] https://www.icann.org
[24] http://www.niso.org
[25] http://www.niso.org/publications/understanding-metadata-2017

As already shown in previous chapters, the MMT RDM stores a large amount of metadata for each information entity.

Figure 23 ASBIE Issuer metadata

Documentation

Common term	Issuer

CCTS

Type	ASBIE
Dict.EntryName	Referenced_ Document. Issuer. Trade_ Party
Definition	The trade related party that issues this referenced document.
Obj.ClassQual.	Referenced
Obj.ClassTerm	Document
Prop.Term	Issuer
Assoc.Obj.ClassQual.	Trade
Assoc.Obj.Class	Party
Occurrence	0..1

Publication

UN Identifier	UN01004016

Attributes

Attribute name	Status	Description/Data Type
Trade_ Party. Identification. Identifier	O	Identifier. Type A unique identifier of this trade party.
Trade_ Party. Name. Text	O	Text. Type The name, expressed as text, for this trade party.
Trade_ Party. Role. Code	O	Party Role_ Code. Type A code specifying the role of this trade party.
Trade_ Party. Quality Assurance. Indicator	O	Indicator. Type The indication of whether or not this trade party is quality assured.
Trade_ Party. Language. Code	O	Language_ Code. Type A code specifying a language for this trade party.
Trade_ Party. Registered_ Identification. Identifier	O	Identifier. Type A registered identifier of this trade party.
Trade_ Party. Role. Text	O	Text. Type A role, expressed as text, for this trade party.

Source: UN/CEFACT

To automate data processing (for example, the data set that we mapped against the data model in the "Mapping against MMT" chapter), at least the following metadata must be present for each information entity (attribute):

- Attribute types:
  - Basic types (numbers, strings, dates)
  - BIE
  - ABIE
- Dimensions
- Mandatory/optional
- Relationships between attributes - ABIE
- Links to the data sources
- Links to the visualization

This information may be stored in various forms, depending on the processing method that is intended to be used. These can be tables in a database, description in the form of markup languages (XML, JSON) and other approaches.

Read on to learn more about some of the specialized tools that you can use to automate data manipulation.

3. Tools for working with models and metadata.

Previously, in the examples of creating electronic documents, we used the Microsoft Visual Studio Code tool, as one of the widespread and free text editors, popular among developers. At the same time, not all data operations were conveniently performed using this tool (for example, generating an XML document form from an XSD schema).

Consider more functional specialized software tools for working with data.

GEFEG FX

The desktop software GEFEG.FX[26] supports data harmonization and streamlines the development and maintenance of eBusiness standards, data models and individual data formats.

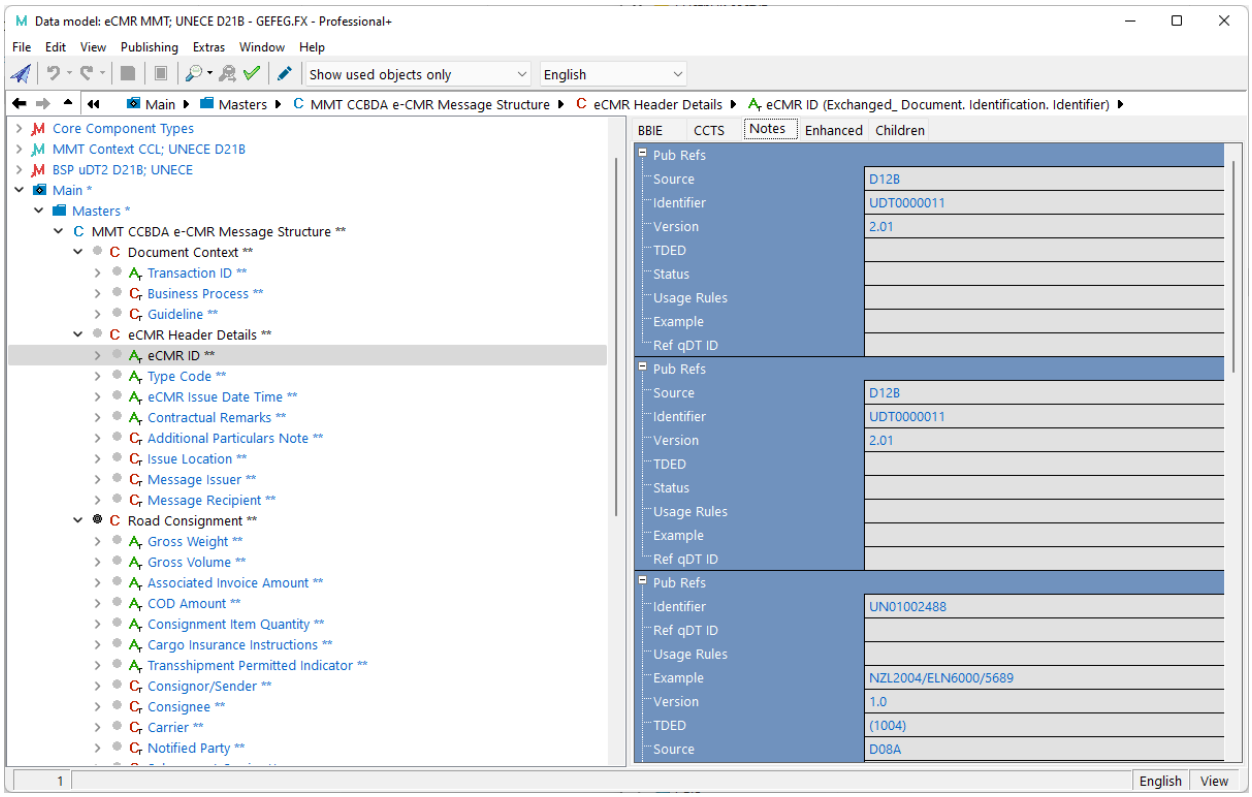
Main functionality:

- Design of electronic interfaces as a model, XML schema or based on classic eBusiness standards,
- Customer-specific description in guidelines,
- Syntactic and semantic check based on eBusiness standards of an industry, a standard organization or a company,
- Visualization of real EDI messages and generation of human-readable documentation in various output formats at the push of a button,
- Management and processing of all company-specific data formats and their use with a single software,
- The single-source principle ensures that specification, documentation and transaction are consistent.

Significant benefit of the GFEG.FX tool is cooperation with UN/CEFACT, WCO, EU/DTLF and other organizations and fora, that are providing international standards in data modeling, so there are ready-made profiles for most of these models for use in GEFEG.FX.

[26] https://www.gefeg.com/en/gefeg-fx.html

Figure 24 GEFEG.FX Data model view



Source: GEFEG

Altova XMLSpy

XMLSpy from Altova[27] JSON and XML Editor gives developers the tools they need to build the most sophisticated applications with its graphical schema designer, code generation, file converters, debuggers, and profilers for working with XSD, XSLT, XQuery, XBRL, SOAP, and more.

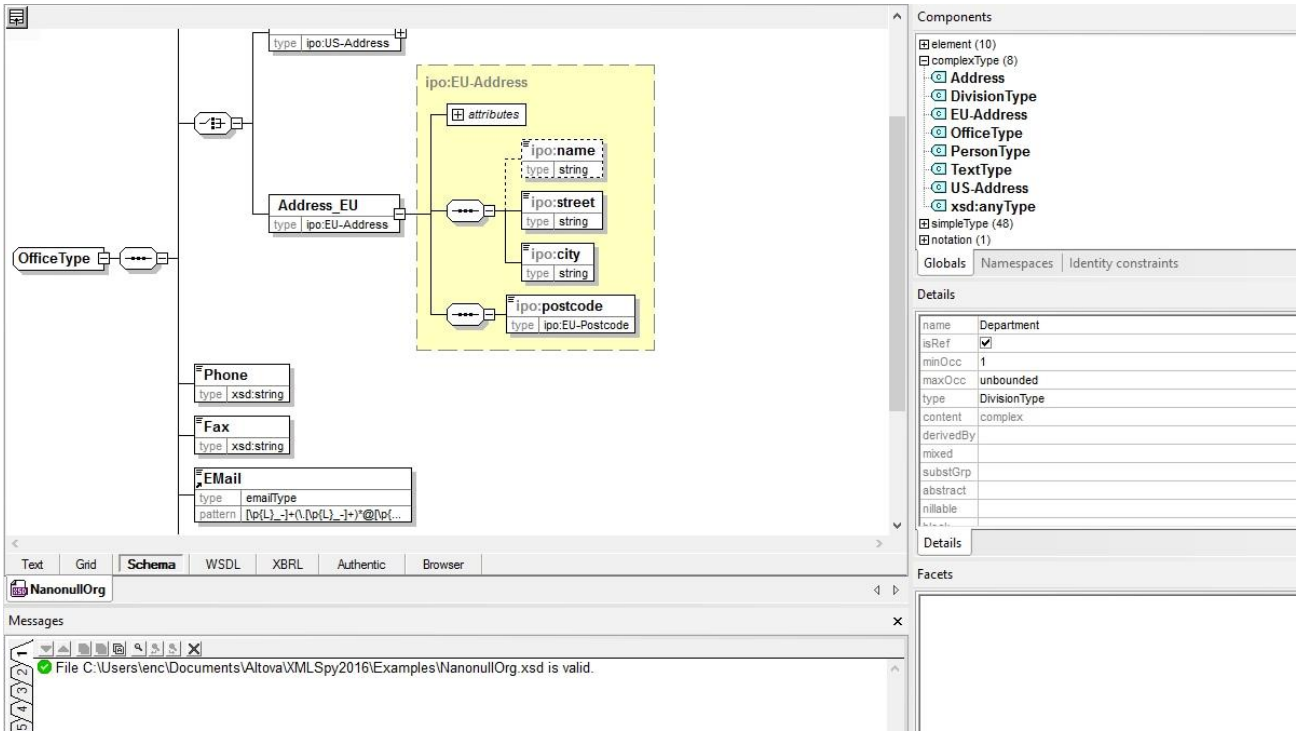
Main functionality:

- JSON editor &JSON Schema editor
- JSON transformation with XPath, XSLT, XQuery
- Edit XML documents
- SmartFix XML validation & error correction
- XML Schema editor
- XSLT editor
- XSLT debugger & profiler
- XSL Speed Optimizer
- XPath / XQuery builder & evaluator
- XQuery editor
- XSLT / XQuery back-mapping

[27] https://www.altova.com/xmlspy-xml-editor

- XPath / XQuery debugger
- XQuery Update Facility editor
- 3-Way diff/merge
- XBRL tools
- WSDL editor
- SOAP client & debugger
- Database integration
- Java, C#, and C++ code generation
- Apache Avro tools
- Visual Studio & Eclipse
- Open XML (OOXML) support
- Chart generation based on XML data
- SharePoint® Server integration
- Integration with installed RaptorXML Servers for super-fast processing.

Figure 25 XML Viewer interface



Source: Altova

XMLSpy includes an intuitive JSON viewer and JSON editor with support for JSON, JSON5, JSON Lines, and JSON Comments, allowing you to view and edit JSON files using the same intuitive Text and Grid Views available for XML editing, with useful editing guides and entry helpers.

In addition to those listed above, there are other tools for working with structured data, both standalone and included in software development and/or database management tools. The choice of

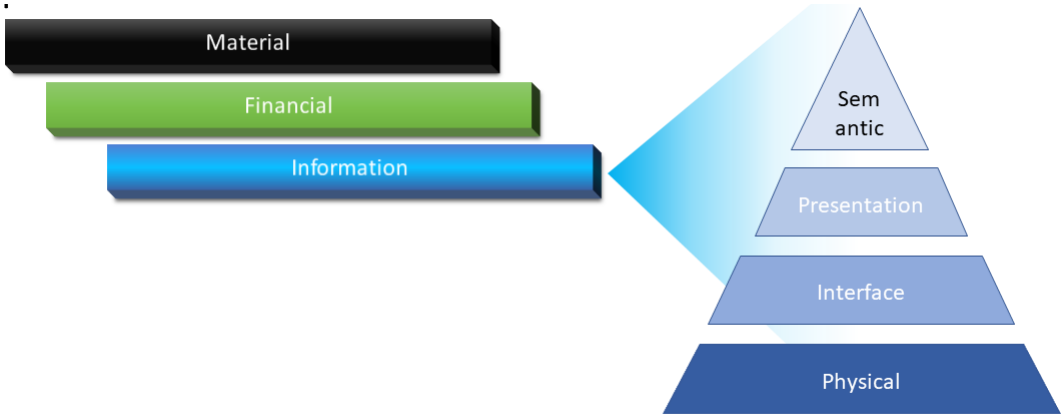
one or another tool depends on the development technologies you use, the size of the project, the prospects for integration and ease of use.

The most effective is the integration of the information model directly into the applied information system. This allows one to realize all the benefits of seamless data processing directly in the course of the main business operation. Read more about data processing below.

4. The concept of data processing

Data processing implies the performance of a certain set of operations on such data during the execution of the steps of the main business process. The main business process should be understood as a sequence of actions for the movement of goods and vehicles in the supply chain, accompanied by certain documents and/or data in the information flow. The relationship of such flows is shown in Figure 29.

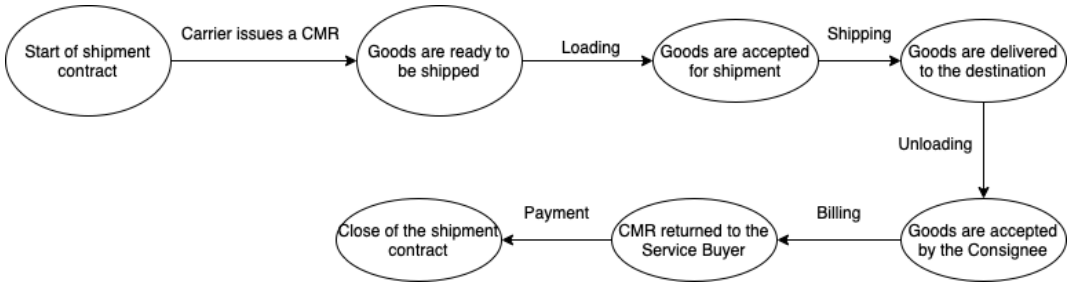
Figure 26 Flows between participants of the BSP process



Source: Authors

Thus, the information flow accompanies the material (goods, people and vehicles) and financial flows, and together they form the execution of the supply chain. The data in the information flow is generated based on and as a result of the states in which the other two flows are located and operations with them, leading to changes in such states (transition to the new states). In turn, the data leads (or initiates) such state changes. This can be shown as a linked graph in which nodes represent states and arcs represent operations.

Figure 27 eCMR state diagram



Source: Authors

In the context of the information flow, the states of material and financial flows can be described as a set of attributes - data, and operations - as functions on this data set, the result of which will be the appearance of a new data set in a new state.

$$F(Set_1) = Set_2,$$

where Set_1 – is a set of attributes that describe the initial state

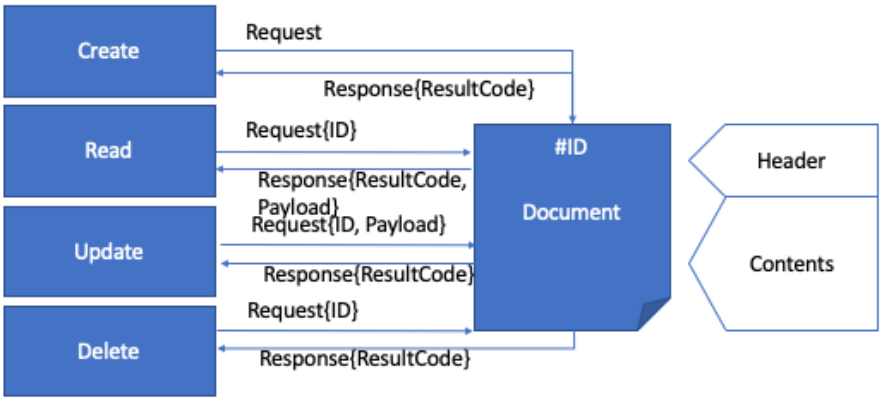
Set_2 – set of attributes describing the final state

F – attribute transformation function that performs the transition from the initial state to the final state.

Thus, data processing is a set of functions that perform the transformation of a Set of data from State 1 to State N, which will be the final state for the considered business process. Considering the fact that even for the simplest process the number of such functions can be large and grow exponentially with an increase in the number of states and connections between them, it is advisable to consider the possibility of enlarging the entire possible set of functions to a limited number. An example of such aggregation would be the CRUD model:

- Create – creation of a new (set of) data
- Read – receiving the (set of) data
- Update - change the (set of) data
- Delete - delete the (set of) data

Figure 28 General approach of the CRUD model



Source: Authors

The complexity and diversity of the original set of data transformation functions can be hidden inside such four metafunctions as the operation of executing a function on a function:

$$F(Set_1, F_a) = Set_2,$$

where Set_1 – is a set of attributes that describe the initial state,

Set_2 – set of attributes that describe the final state,

F_a – attribute transformation function that performs the transition from the initial state to the final state

F – generalized CRUD function for processing data.

The advantage of this approach is the ability to create a standardized application programming interface (API) with a clearly defined set of commands that can provide functionally complete coverage of all required data operations to solve the problem of their processing in an automated form.

Understanding Data Pipelines

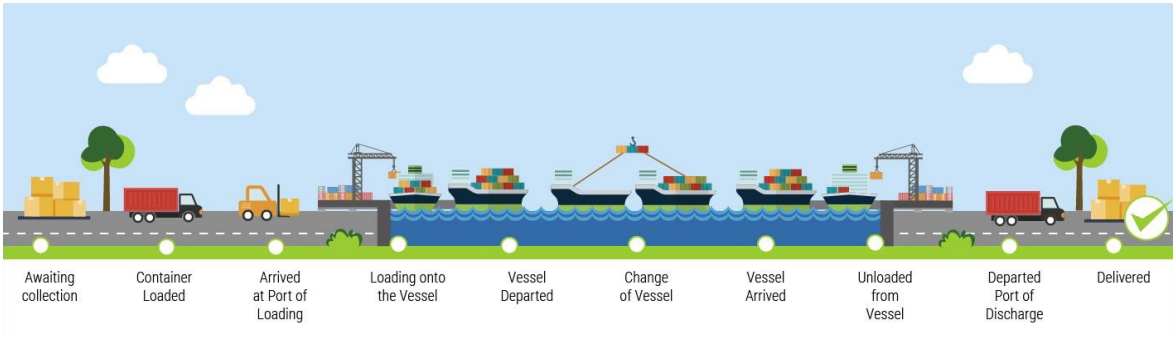
The concept of data pipelines[28], proposed by UN/CEFACT, provides data directly at its source and only once, and reuse it throughout the supply chain, regardless of the mode of transport, party or regulator that needs access to the data.

The key principles of the concept of data pipelines are as follows:

- Capture data from the right person at the right place at the time
- Capture once and use many times in the supply chain,
- Data is passed to the pipeline at its point of origin,
- Data can be retrieved from the pipeline either on demand ("pull" data) or by sending it to a recipient ("push").

The main purpose of data pipelines is to improve the quality of data and ensure its smooth transfer within the information flow of the supply chain, in particular, by shifting the paradigm from the concept of "document" to the concept of "data set". The key difference between these two concepts is that the document model is based on a rigid (paper) structure of the document - even in electronic form, while the data set model involves the presentation of information in the form of flexible structures - data sets (BIE and ABIE), which can be formed from reference data models "on the fly" at the request of the recipient of information and in a form that meets the requirements of a particular business process.

Figure 29 Data Pipeline Concept



Source: UN/CEFACT Data Pipeline Project, David Roff, T&L Domain, https://unece.org/fileadmin/DAM/cefact/cf_forums/2019_Geneva/T_L_DataPipeline2019.pdf

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

The key advantage of the data pipelines concept is the seamless movement of data through the information flow, regardless of its stage, participants, types of cargo or transport and jurisdictions.

The transformation concept

As mentioned above, each subject area, to one degree or another, tends to create its own information model. Such models are created at the level of regional associations, organizations by means of transport, States, specific enterprises, and, sometimes, even within one enterprise (for example, financial, accounting and operating models). Ideally, these models should be harmonized with the corresponding reference data model and the mapping is kept up to date. More often, the reference data model is used as a "starting point", after which the derived model continues to live its own life, or the model is created from scratch without regard to standards.

Therefore, in order to transfer information (document or data set) from one participant or step of a business process to another, provided that they use their own information models, such data must be transformed from one model to another. At the same time, the transformation does not imply any functional data processing, that is, data content should not change as a result of such a transformation.

$$T(Set_1) \Leftrightarrow Set_2,$$

where Set_1 – is the set of initial attributes

Set_2 – set of final attributes

T – attribute transformation function.

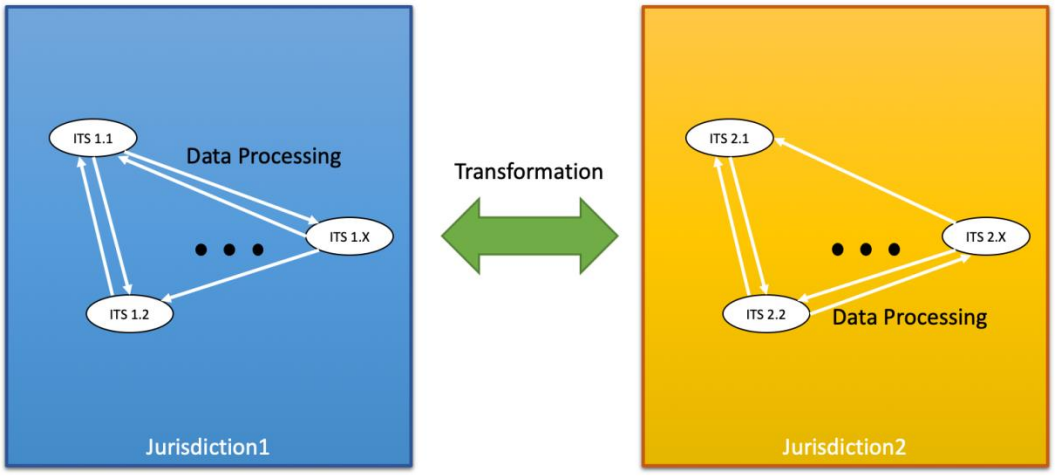
One can think of transformation as a translation of a text from one language into another, in which the content of the text remains unnamed.

Transformation can be considered as a special case of data processing and described as a subfunction of the Update function - data modification. However, it is proposed to separate it into an individual concept and a dedicated implementation due to key features:

- transformation does not (and must not!) change the content of the data and their meaning (semantics),
- the transformation does not (and must not!) change the author of the data (or the person responsible for their completeness, correctness, legal significance, etc.),
- transformation can be performed separately from the main data processing flow - that is, it can be performed in parallel, or at a different time, as well as in other technological ways, different from processing.

Thus, by separating the transformation into an individual operation with data, we ensure the technological neutrality of data processing operations and data transfer processes between jurisdictions.

Figure 30 Data transfer between jurisdictions



Source: Authors

Jurisdictions in this case should be considered not only as a legal jurisdiction - States or legal associations, but any entities with their own set of requirements that affect the data sets processed as part of the information flow of the main business process.

Therefore, transformation can be depicted as a function over a set of data and a set of requirements:

$$T(Set_1, Set_{R1}, Set_{R2}) \Rightarrow Set_1' \quad ,$$

where Set_1 – is the set of dataset attributes in the source jurisdiction

Set_{R1}– is the set of initial jurisdiction requirements

Set_{R2} – is the set of final jurisdiction requirements

Set_1' – set of dataset attributes in the final jurisdiction

T – attribute transformation function.

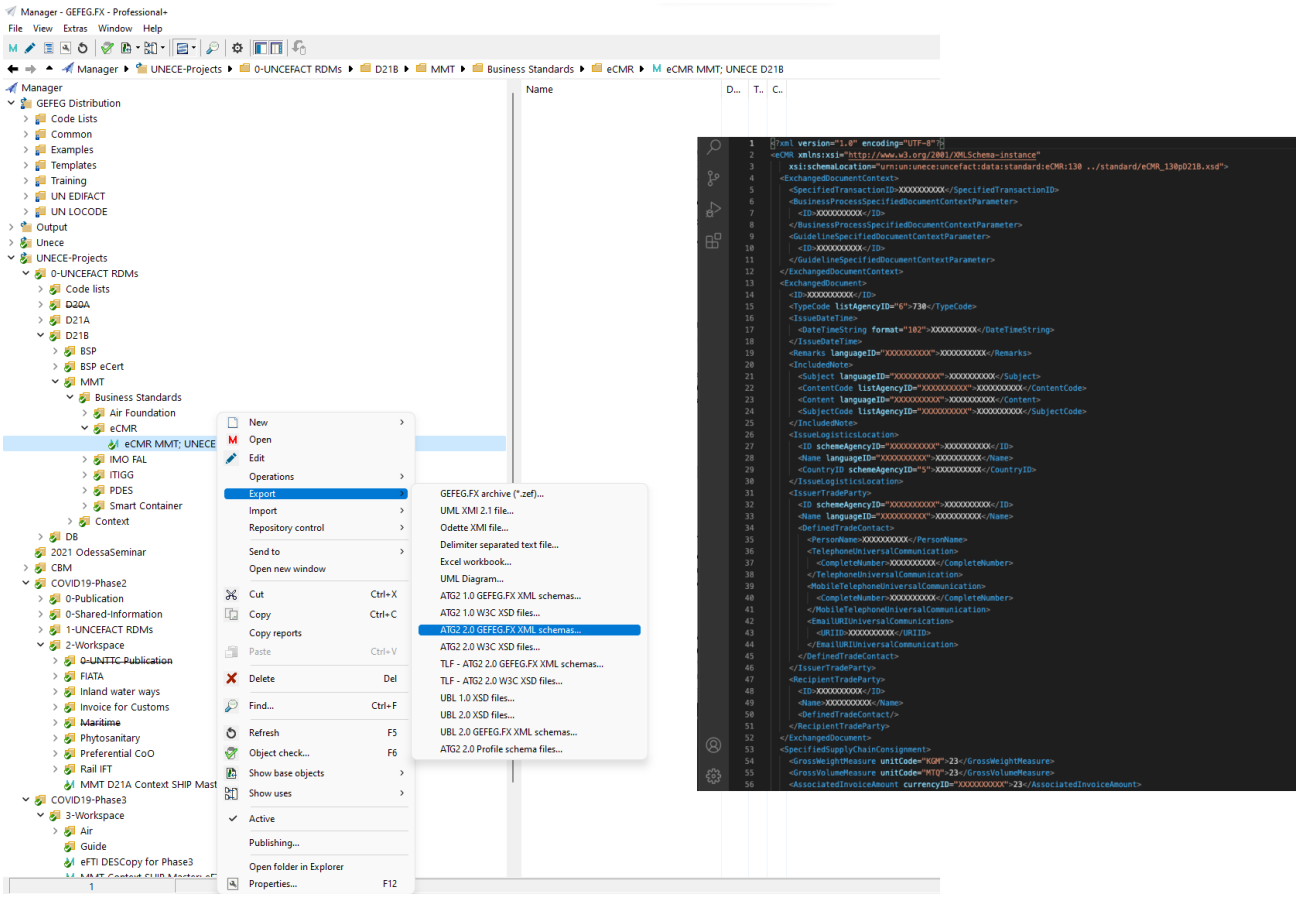
5. Generating documents from a model

When generating a document from a model, we can talk about creating one or more representations of the corresponding document (dataset):

- Document schema (XSD) - as a separate "document" - definition or description of the document,
- Document form - document structure without data,
- Populating a document with data - linking to data sources (see metadata),
- Visual representation of the document (XSLT, PDF) (see metadata).

Each of these views has been discussed in detail in the “Creating an electronic document equivalent” chapter. The key point at this stage is the ability to generate these views in an automated mode from the tool we have chosen or from one’s own information system.

Figure 31 Generation of the schema and blank document from GEFEG.FX



Source: Authors

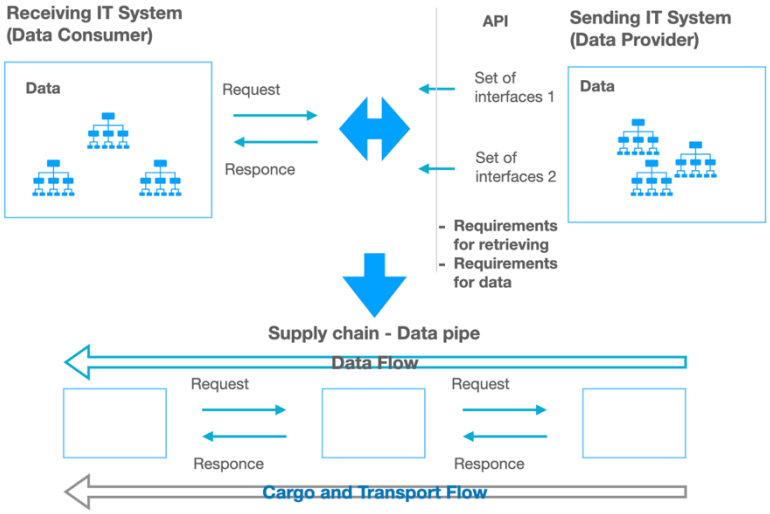
It is also important to note here that it becomes possible not only to automate the creation of the structure (or form) of the document, but also the filling the document with data, as well as the subsequent processing of such documents, that is, a full-fledged exchange of electronic documents. Also, the data model integration into some information system allows for the transformations of electronic documents described above in multimodal transport within a single technical approach.

6. Transition from documents to API

As a next step to expanding the API and moving to data pipelines could be the implementation of automated negotiation of such document requirements using the mechanism of the XML transformation (XSLT). Such a transformation can be implemented as a Schematron by the sending side, which is requested in the same way as any document via CRUD API and executed on the receiving side. Such an approach can guarantee consistency of the content of the converted document and will not conflict with the existing legal recognition schema (or legal regime, if it

exists). This requires publication of extra metadata, particularly – mapping to the RDM entities type (ABIE and BIE) and data type details.

Figure 32 Interoperability models: API model and way to data pipes



Source: Authors

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

- The issue of technical interoperability can be solved in general by using the WEB APIs based on the possibility to describe them in terms of the UN/CEFACT MMT RDM and subsequent programmatic generation from such metadata.
- To resolve the issue of legal recognition, it is proposed to consider the experience of the European Union, in particular Regulation (EU) 2020/1056 on electronic freight transport information (eFTI[29]) and Regulation (EU) 910/2014 on electronic identification and trusted services for electronic transactions in the internal market (eIDAS Regulation[30]), as well as the concept of decentralized identity (Decentralized Identity / Self-Sovereign Identity (SSI[31])).

7. Generating API from a model

UN/CEFACT initiated two API-related projects:

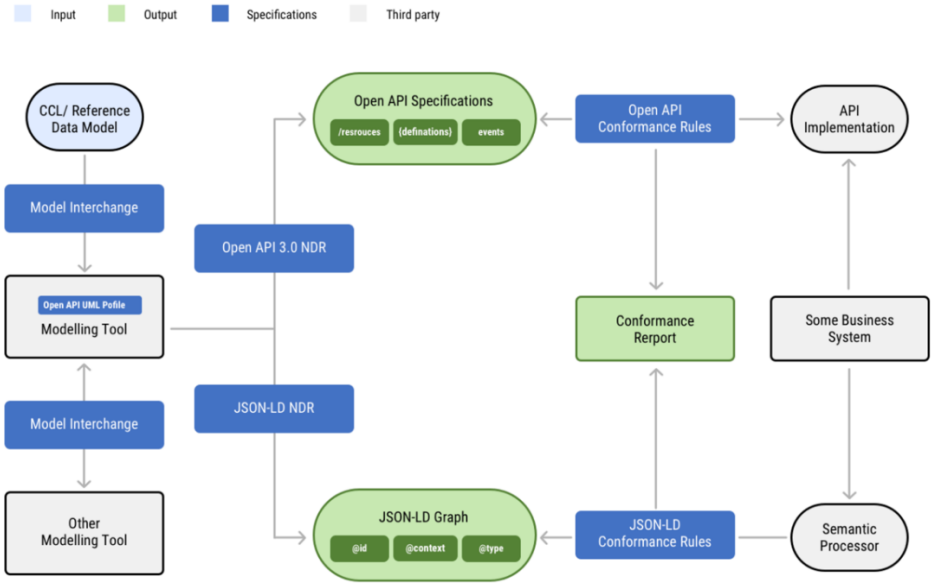
[29] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1056&rid=1

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

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

- RDM2API[32] – A methodology to deliver API specifications and JSON-LD dictionaries with existing UN/CEFACT reference data models (RDMs) as the starting point.
- API Town Plan[33] – An architectural framework and governance model for the delivery of APIs and JSON-LD dictionaries by subject matter experts in business domains.

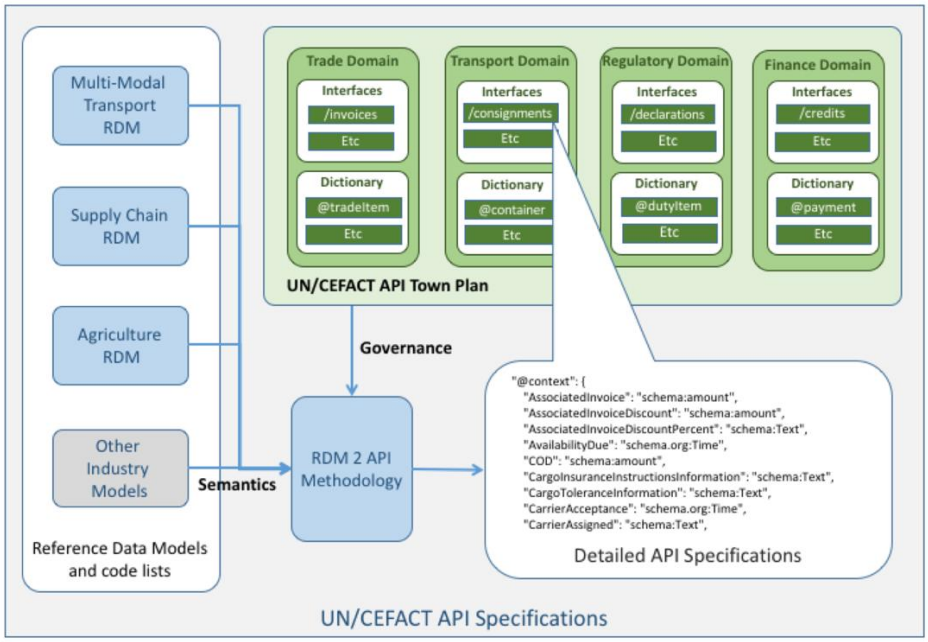
Figure 336 RDM2API Project Scope



Source: UN/CEFACT

[32] https://uncefact.unece.org/display/uncefactpublic/RDM2API
[33] https://uncefact.unece.org/display/uncefactpublic/API+Town+Plan

Figure 37 API Town Plan Project Scope



Source: UN/CEFACT

The focus of these two projects is to bring standardization and UN/CEFACT methodology to the world of WEB APIs. The present situation with API development is very similar to the one in the early attempts to digitalize paper documents – there are hundreds and thousands of implementations and they all are different.

The advantage of the approach advocated by UN/CEFACT is the association of the API with the data model. This provides the ability to reflect the standards implemented in the data model directly in the API. In addition, since the API can be described as a set of structured data (for more details see OpenAPI Specification[34]), it becomes possible to implement a means of generating such a description (that is, the API itself) from the data model. Of course, such an API still needs to be associated with the data access functionality in the target information systems, however, firstly, this process must be performed in any case, and, secondly, it can be implemented much easier due to the presence of a description generated from the data model.

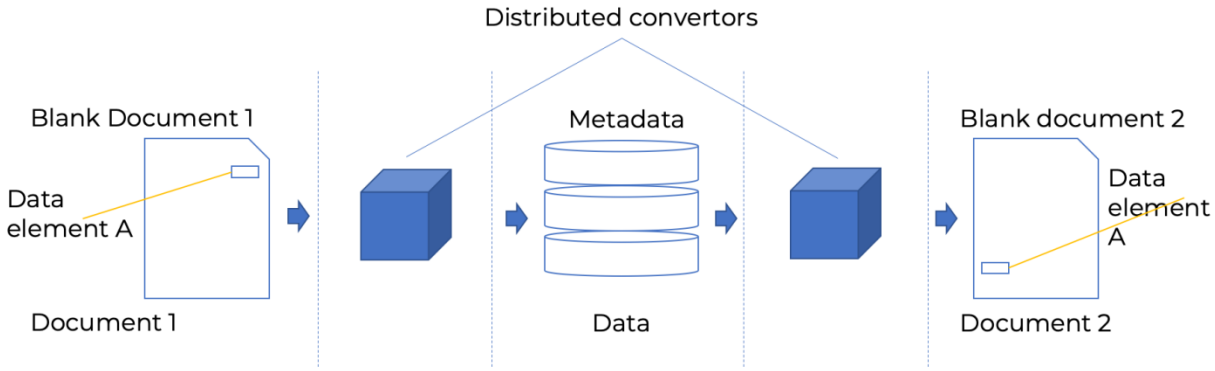
8. Distributed Conversion

Another approach that echoes the UN/CEFACT initiative is the concept of distributed conversion. If in the case of the RDM2API project it is supposed to create a centralized repository of requirements and descriptions of relationships between the data model and the API of subject areas created and maintained by UN/CEFACT experts then, in the case of distributed conversion, a bottom-up approach is proposed. Thus, the implementation of the logic of linking a specific subject implementation (in this case, the domain may not be the entire industry, but one information system of a particular participant) with the data model is directly handled by the owner of this subject area.

[34] https://swagger.io/specification/

The prerequisite for the creation of such an approach was the situation of the presence of many information systems (ITS) of different owners in conditions of general distrust of each other, a conflict of interests in the competition for customers with the impossibility of independently covering the entire market. As a result - the need for a universal "language of communication" - which can be MMT RDM, and the creation of custom "translators" - converters for a specific subject application.

Figure 34 Distributed conversion concept



Source: Authors

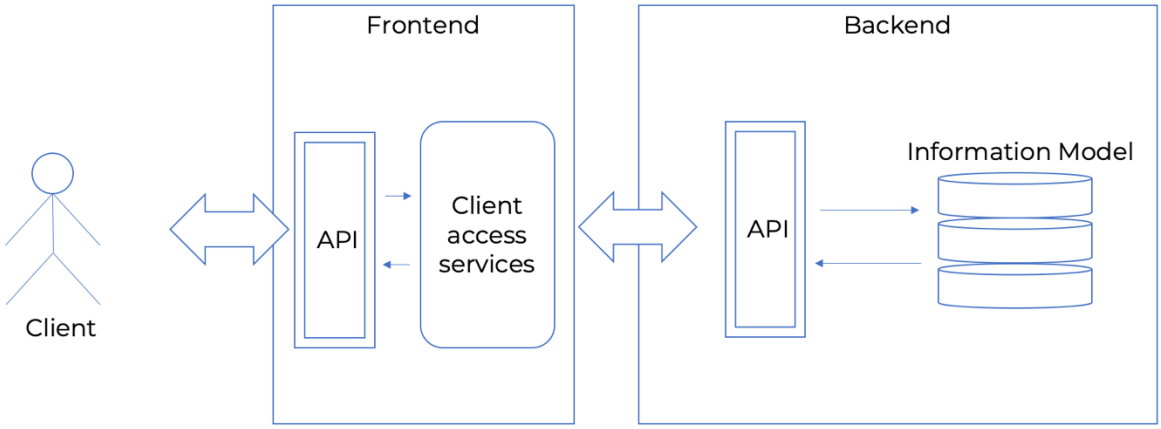
This approach makes it possible to implement solutions that comply with UN/CEFACT data modeling requirements, without waiting for the full implementation of the description of the standards for API by UN/CEFACT. In addition, it solves the problem of trust in the quality of the conversion, since each converter has an explicitly defined owner.

At the same time, the described approaches do not contradict each other. They can complement each other, developing the descriptions of the requirements for API (the API Town Plan) by UN/CEFACT by experts from various subject areas, while simultaneously leading to the realization of the proof of concept of such descriptions through their practical application.

Changing the Application Point of the API While Applying the Distributed Conversion Approach

Another advantage of the proposed approach can be a change in the point of application of the API - from the "client" (or Frontend) model - the API for a document or data set, can be moved to the "server" (or Backend) model - the API for transforming the subject area into a data model.

Figure 39 Changing the point of appearing of the API – from the frontend to the backend



Source: Authors

Also, distributed conversion can be used as a tool for converting information models among themselves if there is a common vocabulary, which can be the UN/CEFACT CCL.

9. Analysis of the Approach Applied

The approach described above, which involves the use of information models and specialized tools to integrate such models into core business processes, has both advantages and disadvantages.

Advantages

- connectivity of the entire set of data and metadata within the information model, providing the ability to effectively manage changes and reduce the impact of errors provoked by the human factor,
- possibility for a full-fledged processing of electronic documents, including transformations when changing modes of transport and jurisdictions,
- possibility to implement highly loaded electronic document management systems.

Disadvantages

- high cost of the tools used (both purchased and home-made IT solutions),
- high requirements for the expertise of specialists operating the information model as the core of the information system.

It can be concluded that the described approach has significant potential, yet it is applicable only in large projects in which the advantages provided by this approach outweigh the disadvantages caused by its high cost.

10. Directions for development: changes to datasets and documents during the execution of the main process

This paper argues that during the execution of the main process of the supply chain, data sets (or documents) undergo changes (transformations). Such transformations can be considered on several levels:

- changing data values in a set - for example, reflecting the fact that a certain amount of cargo has been loaded on the means of transport,
- changes related to the execution of the main process - for example, adding a new data set to the initial data set - as confirmation of the fact that the cargo was accepted for transportation from the Sender by the Carrier,
- change of data format – for example, change of information model when changing jurisdiction (in a broad sense),
- changes of (requirements for) the legal significance - for example, the introduction of a system of digital electronic signatures (DES) or a change in the format of a DES.

To date, there are many approaches to the implementation of such changes, both in each individual case and in combination. Currently, UN/CEFACT experts are discussing the possibility of formulating common recommendations to unify the process of tracking changes in data sets. This is an important point, which is one of the necessary conditions for ensuring the interoperability of electronic documents (data sets) in the process of practical implementation.

This topic can be considered in more detail in future assessments.