A NOVEL TOOLKIT FOR THE DEVELOPMENT OF E-FREIGHT IN EUROPE

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Abstract—This paper shows the results of the first year of activities of a project named E-IMPACT, founded in the framework of the Connecting Europe Facility (CEF) and aiming at fostering the implementation of e-Freight through a series of studies including the development and the adoption of an e-Freight Toolkit. Main concepts of e-freight are introduced in the paper as well as standardization and policy issues related to the use of aCommon Framework for Information and Communication Systems in Transport and Logistics in Europe. The main components of the developed tool are illustrated and first achievements of the project are described.

Index Terms—E-Freight, TEN-T, transport, digital services.

I. INTRODUCTION

A. Standards for freight forwarders and carriers

The global transport and logistics industry comprises more than several million enterprises. Even if divided into smaller communities based on the type of industry served (retail, forestry, electronics, car, etc.) or by geography (corridors), the number of "e-relationships" that need to be established in order for properly facilitate electronic communication between stakeholders would be substantial.The various industries also operate with their own standards (GS1 - retail, PapiNet - forestry, RosettaNet - electronics, Odette - automotive, etc.; see Fig. 1). It is also such that different stakeholders interpret the standards differently.

Hence, the number of standards that freight forwarders and carriers need to relate to is quite substantial if a variety of industries are served.For small and medium sized enterprises (SMEs) the costs of interoperability represent an entry barrier to new markets. Few if any of them can afford connecting to many other companies using conventional technologies. Large companies find themselves in the same situation where the need for connectivity increases, as modern companies tend to work within a network of companies instead of as a single organization.

The consequence of this situation is that there are and will be numerous standards and interpretation of standards used in the foreseeable future in logistics. It is unthinkable that one standard will dominate, even though ISO/IEC have now published 19845, a standard that holds electronic documents supporting multimodal freight transport management [1]. This means that companies using their own standards, will have to communicate with others outside these communities that are using other standards, if they need to collaborate in global supply chains.

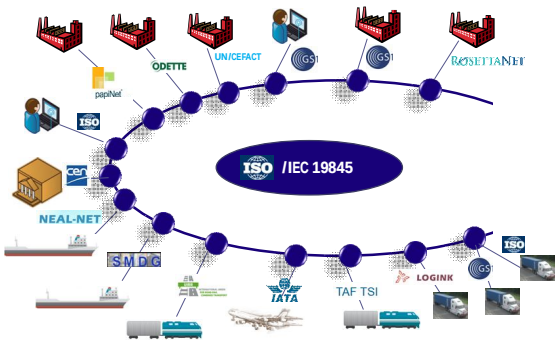


Figure 1: Main standards used by industries for "e-relationships".

This means also that an infrastructure that is to be used for electronic information exchange in logistics also needs to be able to connect people and organizations that are using different standards.This paper shows the results of the first year of activities of the E-IMPACT project [2], a project aiming at fostering the implementation of e-Freight simplifying and reducing the cost of exchanging information between different actors, founded in the framework of the Connecting Europe Facility (CEF). CEF is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level.It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport, energy and digital services.

B. The Trans-European Transport Network (TEN-T)

CEF is based on the development of the Trans-European Transport Network (TEN-T) [3], which is a European Commission policy directed towards the implementation and development of a Europe-wide network of roads, railway lines, inland waterways, maritime shipping routes, ports, airports and rail-road terminals. It consists of two planning layers:

- The Comprehensive Network: Covering all European regions.
- The Core Network: Most important connections

within the Comprehensive Network linking the most important nodes.

The ultimate objective of TEN-T is to close gaps, remove bottlenecks and eliminate technical barriers that exist between the transport networks of EU Member States, strengthening the social, economic and territorial cohesion of the Union and contributing to the creation of a single European transport area. The policy seeks to achieve this aim through the construction of new physical infrastructures; the adoption of innovative digital technologies, alternative fuels and universal standards; and the modernising and upgrading of existing infrastructures and platforms.Following the TEN-T policy, nine Core Network Corridors were identified (see Fig. 2) to streamline and facilitate the coordinated development of the TEN-T Core Network.

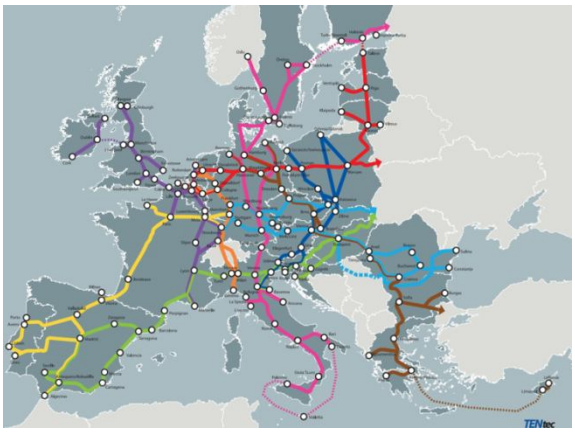


Figure 2: The TEN-T nine Core Network Corridors.

The main TEN-T policy objectives foresee:

- Completion by 2030 of the Core Network, structured around nine multimodal Core Network Corridors.
- Completion by 2050 of the Comprehensive Network in order to facilitate accessibility to all European regions

II. THE E-IMPACT PROJECT

E-IMPACT is a 2 years project carried out by a consortium of 10 partners coming from different EU countries. The project's overall objective is to foster the implementation of e-Freight soas to simplify and reduce the cost of exchanging information betweendifferent actors and transport modes along the chain, leading to a moreefficient, less polluting freight transport, and facilitating the use ofmultimodal freight transport solutions. Achieving paperless and seamlessinformation flows along the whole transport logistics chain (involvingshippers, freight forwarders, transport carriers, network managers as wellas authorities) is a key objective for both the freight transport sector andthe EU. The Action, including studies and real-life pilot deployments, isimplemented in core ports (in Italy, Poland and Portugal along three corenetwork corridors (Atlantic, Mediterranean and Baltic – Adriatic).The primary specific objective of the project is to reinforce the messagedelivered to the stakeholders about e-Freight benefits. This objective will bemet through a series of studies including an e-Freight Adoption Toolkit andan assessment of the e-Freight PPP feasibility, estimating technical, financialand legal requirements on individual stakeholders, at corridor level, andacross different corridors of the core network.

The studies will alsodocument business case implementation, clear migration paths for industrialusers to evolve to e-Freight standards and data interchange infrastructures,based upon e-Freight initiatives carried out on European level. The secondspecific objective is to develop concrete business cases where logisticsstakeholders (shippers, logistic services providers and authorities) willbenefit from the e-Freight policy, in terms of improved efficiency, reducedcosts and enhanced business potential. This objective will be met bydeploying and operating four real-life trials in the core ports of Trieste inItaly, Gdansk, Gdynia, Szczecin and Świnoujście in Poland, and LeixõesandLisbon in Portugal.

The purpose of the e-Impact project is to implement the e-Freight standards and e-Delivery infrastructure developed in other EU funded projects like e-Freight and iCargo in real operations along the 3 corridors.

III. E-FREIGHT

C. The Origin

The term e-Freight was first introduced in the "Freight Transport Logistics Action Plan" [4]. The concept was further developed during the Swedish Presidency in the European Union in the last half of 20091 [5].

The vision for e-Freight is to achieve:

- Paperless, electronic flow of information, eliminating paper handling, transporting and processing costs
- Simple and harmonized procedures supporting the physical flow of goods
- Functions for tracking cargo from door-to-door irrespective of the combination of modes and for tracing its movements if needed
- Automatic electronic exchange of information – business-to-business, business-to-authorities, and authority-to-authority
- Reduction of paper consuming contributing to the environment

Several EU initiatives have been taken in the previous years to deal with information exchange within the various transport modes. Some examples are:

- The Action Plan for the Deployment of Intelligent Transport Systems (ITS) in

Europedealing with road transport and interfaces to other mode [6].

- The TAF TSI (Telematic Applications for Freight – Technical Specification for Interoperability) Regulationfocused on rail [7].
- Harmonised river information services (RIS) on inland waterways [8].
- The EU e-Maritime initiative [9].

As can be seen in the ITS Action Plan title, all these initiatives indicate that there shall be links to other modes. One observation to be made from the initiatives above is that they are essentially focused on the movement of vehicles in the various types of infrastructures. e-Freight, however, is focused on the movement of goods usingthe various modes and combination of modes to the best of their ability. As illustrated in Figure 3, one may say that e-Freight is what "binds together" information about the movement of goods in all modes.

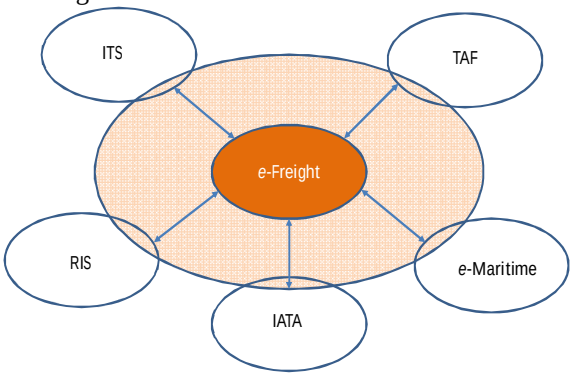


Fig.3: e-Freight is what "binds together" information about the movement of goods in all modes.

D. The e-Freight Framework

The e-Freight Framework as used in the e-Impact project is also known as the Common Framework. Its development started in the FREIGHTWISEproject [10] as a response to the EU Commissions request for a framework for information exchange in transport and logistics aiming to develop a standard framework for information exchange in logistics and make it an international standard. The people involved in these projects understood that collaboration was better than competition, and that led to the joint effort of creating "One Common Framework for Information and Communication Systems in Transport and Logistics".This joint initiative also led to the ambition of making the Common Framework an international standard, ultimately approved by ISO.

E. The Standardisation Process, OASIS and the Universal Business Language

The standardisation process started in 2008 through cooperation with the technical committee in OASIS that was developing version 2.1 of UBL (Universal Business Language).OASIS is a non-profit consortium that drives the development, convergence and adoption of open standards for the global information society promoting industry consensus and produces worldwide standards for security, Internet of Things, cloud computing, energy, content technologies, emergency management, and other areas.OASIS open standards offer the potential to lower cost, stimulate innovation, grow global markets, and protect the right of free choice of technology. OASIS members broadly represent the marketplace of public and private sector technology leaders, users and influencers. Much work was involved in adapting the ideas of the Common Framework to the principles of UBL and to provide the required backwards compatibility. However, eventually key elements of the Common Framework became part of the official version of UBL 2.1. After making UBL 2.1 complete and official, OASIS started a process of having this standard accepted by ISO. This process completed late 2015, and elements of the Common (e-Freight) Framework are now part of ISO/IEC 19845.ISO/IEC 19845 specifies then the OASIS Universal Business Language (UBL), which defines a generic XML interchange format for business documents that can be restricted or extended to meet the requirements of particular industries.

F. The Framework

The development of the Framework started by defining the roles that were involved in transport and logistics. In addition to the EU funded project mentioned above, the Framework was developed in close cooperation with the group within GS1 responsible for what they call the Logistics Interoperability Model. Fig. 4 illustrates the main roles involved in transport and logistics.

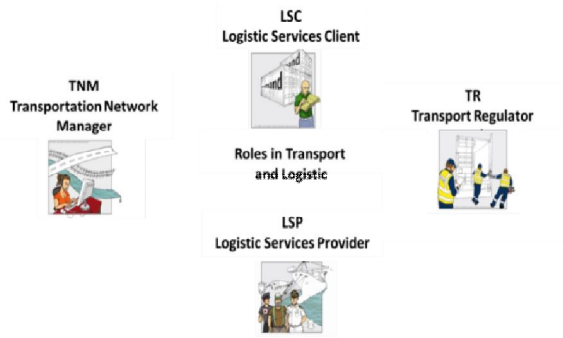


Fig.4: Main roles involved in transport and logistics.

These are:

- Logistics Services Client (LSC) – associated with the Logistics Demand domain, where demand for logistics services originates and where such services are being purchased.
- Logistics Services Provider (LSP) – associated with the Logistics Supply domain, which responds to the demands from LSCs.
- Transport Network Manager (TNM) – associated with the Transport Network Management domain and responsible for providing information about availability and status for the transport and logistics infrastructure

- Transport Regulator (TR) – associated with the Regulation Enforcement domain and responsible for ensuring that transport and logistics operations are being conducted according to rules and regulations.

The first two of these two roles were harmonized with GS1.

However, GS1 concentrated on interaction between commercial stakeholders and did not include authorities.The scope for the Framework was all modes and combination of modes. It was also realized that the role that has been called Freight Services Integrator (FSI) is not a separate role in relation to the ones described above. The FSI characterizes an organization or person that combines the roles of LSC and LSP in order to conduct business. From an information exchange point of view, the FSI does not have any special requirements. By carefully analyzing the information required by these roles to do a proper job, the reference model decomposes the entire transport and logistics domain into manageable sub-domains - each addressing responsibility areas. A minimum set of electronic documents are required for operators in the different domains to do their jobs properly.These electronic documents are:

- Transport Service Description – TSD - is used for a LSP to announce transport and logistics services. Such a service can be the carriage of goods between origins and destinations, but can also be warehousing or terminal handling services, document handling, and other services related to the movement of goods. The TSD interface consists of both a request and response message.
- Transport Execution Plan – TEP - is an agreement established between a LSC and a LSP regarding the movement of goods. Essentially it is the equivalent of a ticket used for passenger transport. The TEP can be used for arranging all kinds of transport services: pure carriage, warehousing storage, and terminal operation services (consolidation, loading and unloading, etc.). The process of establishing a TEP may require many interactions between the two roles, from what is typically called a quotation stage until the TEP is finalized (agreed). The Transport Execution Plan interface consists of a request and response message.
- Goods Item Itinerary – GII - specifies the route and time schedule as well as other service details for a transported item. It may contain one or more transportation segments, or legs. Each such segment represents a part of the total journey. Thus, each segment can be delivered by different LSPs. The exchange of the GII may take place after a TEP is committed between LSC and LSP. In addition to defining the initial route and time schedule, the GII may be used to record the actual progress of transport in the form of new estimated times for departure and/or arrival, actual departure and arrival times. The GII is therefore containing information that may be used for analyzing the performance (in time) of transport services and for tracing the progress of cargo, if such analysis is required.
- Transportation Status – TS - provides the status on a TEP. This includes both status on the overall execution (if the service is according to plan) and the condition of the transported items. The TS is exchanged be-tween the LSP and the LSC. The TS interface consists of both a request and response message.
- Transport Progress Status – TPS - is an interface exchanged between a TNM and a LSP. The LSP requests the TNM to provide tracking information related to a specific transport vehicle (of relevance to some transport modes, e.g. rail). The TNM then provides the relevant information to the LSP. The most typical use of TPS is to ask assistance from the TNM in order to estimate times of arrival. The TPS interface consists of both a request and response message.
- Multimodal eWaybill – MWB – performs the same role as its paper counterparts of confirming that there is a contract of carriage for the cargo and providing relevant information to support the transport execution. It can be used in any transport mode, sector or legal framework. The structure is agile enough to support entire multimodal chains, as well single ‘unimodal’ transport legs. In comparison to the other transactions, the MWB is closer to a “document” as it must have the ability to be signed and must often be displayed in one of a number of standard layout formats required by legislation.
- Common Reporting Schema – CRS - is a single, standardized document containing data fields for all the information required for reporting to authorities across all modes and in all Member States. The CRS is developed using information structures from the TEP supplemented by structures from WCO (GOVCBR). The CRS is developed by the principle that the content should fulfil regulatory requirements but the structure should be driven by the transport planning and booking process, hence making it feasible for a reporting party (e.g. LSP) to translate information automatically from these processes into information required by the regulatory domain.

The TSD, TEP, GII, TS, and TPS are part of the ISO/IEC 19845 standard.

IV. THE E-FREIGHT TOOLKIT

G. The Connectivity Infrastructure

One of the first goal of the e-Impact project has been the development of the e-Freight Toolkit based on a Connectivity Infrastructure.From the adopter point of

view, the Connectivity Infrastructure is constituted by two types of software pieces: an Access Point and the Connectors. The Access Point is a piece of software that allows data exchange between parties in the same business domain. This piece of software can be deployed in each party or shared.The Connector is a piece of software that links the party internal applications or other messages' systems, with the Access Point. As this depends on the specific situation of each party and/or its own requirements, hardly it can be shared.The Access Point solution to be provided in the context of e-IMPACT is based on the results of the European Initiative CEF eDelivery. This initiative aims to ensure that Public Administrations can exchange any type of data and documents across borders. The main advantages are the adoption of a common architecture already tested, a proof of concept already done, the standardization of a common communications solution, the opportunity to propose the creation of a profile for transports and logistics inside the eDelivery initiative, and alignment inside the e-IMPACT project with the other EU CEF initiatives [11].

H. The Tool Kit

The e-FreightToolkit has been designed and assembled in in order to allow a smooth transition from current practices to new e-Freight developments allowing interested partiesto familiarize with the set of principles of e-Freight and its usage, the e-Freight messages definitions, and the Access Points specification and its usage.The e-Freight Toolkit can be considered as an open box containing the adequate artefacts to support an interested party (to be designated simply by adopter hereafter) in the adoption of the e-Freight Common Framework.It is important to underline that the contents of the box can be always and constantly updated and improved coherently with e-Freight developments. This will be ensured through the participation in working groups and standardization initiatives under the e-Freight policy umbrella, through study and interaction with relevant FP7 and H2020 projects, and thanks to the suggestions of the adopters.

I. The content of the e-Freight Toolkit

The e-Freight Toolkit includes guidelines and templates on how to exchange information across modes, through standards and systems in use by the various stakeholders and supporting the deployment of advanced IT infrastructures. These infrastructures are based on access points, allowing each stakeholder's system to connect once and be able to exchange data with potentially every other system similarly connected.

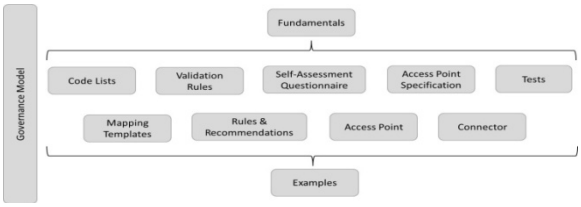


Fig. 5: All the Tools of the e-Freight Toolkit

Fig.5 illustrates a general scheme showing all the tools in the Toolkit: the majority of them are documents to be read and others are piece of software as described in the following:

- Fundamentals: The Fundamentals is itself a tool of the e-freight Toolkit. Fundamentals are constituted by introductory information about e-Freight, set of principles of e-Freight and its usage, the e-Freight messages definitions, and the Access Points specification and usage.
- Mapping Templates: The Mapping Templates tool consists in a set of data elements, making up a data dictionary, to be used by the adopter. Each data element has an id, a name, a description, a type, a size, a reference model (if applicable), and one or more mapping with data elements in different syntaxes (if applicable).For each message or data element, the adopter can register the relation between e-Freight definitions and its own reality or current formats or data models.
- Code Lists: This tool consists in a set of lists. Each list contains the codes, and respective description, to be used in data elements mentioned in the Mapping Templates and that refer to the specific Code List. Code Lists are based on standards, recommendations from reference bodies, generally accepted references, or specific codes. Additionally, for code requirements not covered by standards, the tool offers the possibility to add codes or lists of codes allowing to document these solutions.
- Rule and Recommendations: The Rule and Recommendations tool provides a Set of statements that define the protocol for interactions under e-Freight, and instruct the adopter on what it is required to use the e-Freight for existent or new processes.Moreover a Set of statements is describing the recommended practices and approaches for the adoption of e-Freight, or the change of a current e-Freight usage, including mapping recommendations between partner specifics and e-Freight messages.In particular, when justified, the recommend practices and approaches are described in more detail by mapping of steps and processes to provide guidance to the adopters in achieving the goal of include the e-Freight Toolkit within their own business and/or technical processes.
- Validation Rules: Set of rules, conditions and value contents, in order to assure the interoperability between partners, at process level and technical level.
- Examples: This tool provides possible practical applications. Main examples are represented by Business Cases developed in the e-IMPACT project and by the Toolkit Usage Example where a hypothetical situation of a company that decides to accede to e-Freight is presented through a simple story.

- Self-Assessment Questionnaire: This tool is a list of questions, grouped by category (example: technical, process, business, etc), to help the adopter to clarify its starting point of the path towards the adoption of e-Freight. The questionnaire is complemented with assessment criteria, for each category. The criteria point to classes of situations (examples: ready to adopt e-Freight; minor developments required before adopt e-Freight, etc.).
- Tests: A set of software tests to be performed on the final stages of an e-Freight process adoption. If the expected tests' results are reached, it means that the adopter is ready to interact using the e-Freight framework.
- Governance Model: Set of rules and procedures that guide the group of experts (to be nominated) with the mission to guarantee that the evolution of connectivity infrastructure, and the contents of the e-Freight Toolkit can happen maintaining coherency.
- Access Point Specifications: This tool illustrates the specification adopted by the e-IMPACT project for the Access Point, guidelines for developing the connectors and how they should interact with the Access Point.
- Access Point: This tool is a piece of software to provide the interconnection between stakeholders internal applications and the e-Freight Infrastructure, and allow connections between Access Points. The dialog between Access Points is based on the e-Freight messages. Under these conditions business processes between several partners, based on e-Freight, can be set up. The Access Point is represented by an e-SENS4 open-source reference implementation called Domibus, and the European Commission provides the source for this implementation under the European Union Public License V. 1.1.
- Connector: The Connector is a piece of software that links the adopter internal applications or other messages' systems, with the Access Point. As this depends on the specific situation of each party and/or its own requirements, hardly it can be shared. However, in the context of the Tool Kit, an example connector is provided.

II. Conclusion

A significant share of the companies that deal with transport and supply chain management in Europe recognizeinteroperability and information exchange as a relevant challenge. Interoperability is expensive and complex.Information exchange implementations in this respect have so far mostly taken place at an individual mode level, oftentriggered by traffic management needs and public reporting requirements. To achieve higherefficiency levels, large companies have significant costs in making sure that their transport/supply chains areconnected. Many SMEs lack the capability and resources to interoperate and collaborate with other companies.

In the context of e-IMPACT it was identified the need to build a toolkit containing the adequate artefacts to support an interested party, independently of its dimension, in the adoption of the e-Freight Common Framework.As a first consequence of the adoption of the Toolkit, involved parties will have the following benefits:

- Improved efficiency, by sharing planning and execution data to synchronize inter-modal transport and to optimize loading;
- Reduced costs, by automating data exchange between different stakeholders' systems, including customs and administrations;
- Increased business, by maximizing usageof the infrastructures, vehicles and logistics resources in the target corridors.

The business cases will act as forerunners for market adoption and full-scale deployment of e-Freight capabilities on a European and international scale, producing:

- Applied e-Freight solutions demonstrating concrete benefits in industrial implementations, involving regular cargo flows and operational processes;
- Studies assessing the economic viability of e-Freight solutions on the individual stakeholders, on corridor level, and across different corridors of the Core Network;
- Guidelines and requirements for migrating to e-Freight from current systems and architectures, shared and consistent with e-Freight initiatives carried out on European level.

Collaboration has been established with countries in Asia and the project aims to demonstrate interoperability and connectivity between European and Asian stakeholders. More results from the business cases will be illustrated in a future paper.

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