Progress towards Federated Logistics through the Integration of TEN-T into A Global Trade Network

D3.5 LL3 Specifications and baseline measurements

Document Summary Information

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Glossary of terms and abbreviations used

Abbreviation / Term	Description
B2B	Business to Business
B2C	Business to Customer
BPMN	Business Process Model and Notation
EGTN	EU-Global Transport &Logistics Networks
EPCIS	Electronic Product Code Information Services
GLN	Global Location Number
GTIN	Global Trade Item Number
ILIM	Institute of Logistics and Warehousing
IoT	Internet of Things
M-Box	Modular logistics unit
PP	Polish Post
RS	Rohlig Suus
SSCC	Serial Shipping Container Code
UPU	Universal Postal Union

1 Executive Summary

The New Silk Road's vision, aimed at developing a transport infrastructure that could connect China, Central Asian countries, the Middle East, Europe and Africa into a single network, existed for a long time, but it was only since 2013 that actual measures were taken to put the concept into practice. The transport market between China and the EU had already been developed since 2008 through private initiatives, while in 2013 a decision was made to accelerate the development of transport infrastructure, and more extensive promotional activities were undertaken to develop the Belt and Road initiative.

Based on current state of the art, a huge potential for the development and optimization of logistics processes within the Asian-European corridor is recognized. Accordingly, Living Lab 3 set out to test solutions for technological and process innovation in collaboration with business partners - operator Rohlig Suus and postal carrier Polish Post.

LL3 will focus on streamlining logistic processes in flows from China to Europe along the Silk Road Route by implementation of IoT technologies and EPCIS platform along with other GS1 standards that would facilitate transmission of data between the partners involved in the logistics operations within an e-commerce channel.

Living Lab was established around two main goals:

1. **Increased visibility of goods thanks to IoT along the Silk Road**

Development of IoT solutions based on DASH7, RFID, LPWSN and sensors systems that help control resource parameters in real time and identify them while moving in the transport process, examining potential positive results in terms of broad implementation

2. **Implementation of the SSCC number and EPCIS test (standardization of information flow)**

Creation of a digital connection between actors in the transport network, enabling standardized data flow and access to information about cargoes coming from China to Poland in the whole supply chain in real time (implementation of the SSCC number and EPCIS test)

The above solutions will become the basis for the development of not only the logistics network in China-Poland corridor, but also become a significant contribution to the development of EGTN network, as demonstrated in Section 6.

So far, the following key achievements and their value to the involved actors as well as the industry have been recognized:

Wide usability of Process Analysis & Simulation based on BPMN for mapping of processes in both Use Cases

- An open repository of these processes together with simulations of changes will be a reference for the logistics market and can be widely used by industry professionals as best prectices

Increased cooperation between business partners towards sharing of data

- Polish Post has strengthened cooperation with GS1 China and Chinese Post in order to improve data sharing via EPCIS
- Rohlig Suus has started working with Blocklab to identify opportunities for blockchain implementation in customs processes

Increased awareness of business partners in the area of the Physical Internet and the possibility of implementing its components into operational processes

- LL3 is currently testing IoT solutions for the use of EPCIS and sharing of data and information with EGTN in real time in order to improve the quality of processes and improve cooperation within supply chains.

2 Introduction

Within the framework of the Deliverable 3.5 – "LL3 Specifications and baseline measurements" an analysis of the current situation on the examined Asian-European transport corridor was made together with a detailed analysis of the logistic processes performed by the business partners Rohlig Suus and Polish Post. Based on the complete state-of-the-art picture the objectives for the Polish Living Lab were proposed, which through the implementation of modern technologies and process innovations will positively influence the described operational, economic and environmental KPI's, as well as EGTN network.

Additionally, document provides a full description of the LL organization, its implementation plan and evaluation.

2.1 Mapping PLANET Outputs

Purpose of this section is to map PLANET's Grant Agreement commitments, both within the formal Deliverable and Task description, against the project's respective outputs and work performed.

Table 1: Adherence to PLANET's GA Deliverable & Tasks Descriptions

PLANET GA Component Title	PLANET GA Component Outline	Respective Document Chapter(s)	Justification
DELIVERABLE			
D3.5 LL3 Specification and Baseline measurements	*This deliverable will provide in-depth analysis of the current situation, including identification of key needs and problems affecting global transport, definition of use cases, KPIs and the respective tests and produce the complete definition of the organization and planning for the LL.*	*3 Living Lab AS-IS situation* *4 Living Lab Goals* *7 Test Planning* *8 Living Lab Organisation & Planning*	*Within the framework of the mentioned sections 3&4 an analysis of the current situation in the examined Asian-European transport corridor was made together with a detailed analysis of the logistic processes performed by the business partners Rohlig Suus and Polish Post. Based on the complete state-of-the-art picture the objectives for the Polish Living Lab were proposed, which through the implementation of modern technologies and process innovations will positively influence the described operational, economic and environmental KPI's.* *Section 7 & 8 included a full description of the LL organization, its implementation plan and evaluation.*
D3.5 LL3 Specification and Baseline measurements	*The report will also address simulation-based designs for the LL's EGTN.*	*5 Simulation-based Designs for the LL's EGTN*	*Sections 5&6 respond to the simulation-based designs for LL's EGTN by providing:* *-Map of a PLANET architecture with LL3 components and descriptions*

		6 Technical Requirements	*-General objectives and expectations for EGTN* *-Stakeholder's contribution to EGTN and expected outputs* *-Data sources for the corridor route optimization analytics* *-Objectives for the route optimization applications* *-Description of a consortium findings in regards to AI based applications* *-General requirements for IOT infrastructure for LL3* *-Requirements for building an accurate AI based model forecasting* *-Main challenges in gathering BIG data for the Planet project* *-Predictive modelling objectives and potential* *-References to WP2* *-Data sources for AI based algorithm* *-Potential of the AI machine-learning in regards with PLANET data sources and infrastructure*
TASKS			
ST3.3.1 LL AS-IS analysis and detailed specification and plan	*ST3.3.1 LL AS-IS analysis and detailed specification and plan will provide an in-depth analysis of the current situation, including infrastructure analysis for the corridor as the basis for:* ***(1)** the identification of main needs and problems affecting global transport corridors, warehousing and last mile distribution, and the final selection of the specific problems that*	***(1)** 3 Living Lab AS-IS situation*	***(1)** 3.1 Infrastructure Corridor Analysis* *In this section we have described the characteristics of the New Silk Road and the main rail connections including those used by Living Lab business partners* *- Rohlig Suus and Polish Post on the China-Poland route.* *3.2 Information Flows -* *This section consists of:* *-Analysis of the data and information transmission process and identification of communication standards in the New Silk Road rail transport*

	will be addressed in the LL; ***(2)** the definition of tests based on new technologies and concepts proposed and supported by PLANET's EGTN approach in order to overcome the selected problems;* ***(3)** the final selection of specific supply chains or transport flows to perform the tests, affecting specific shippers, corridors, logistics nodes and transport and logistic operators.* *After this, this subtask will provide a complete definition of organization and planning of the LL1, LL2 and LL3. More specifically,* ***(4)** the purpose of the test;* ***(5)** the actors and systems involved;* ***(6)** the link with the EGTN technological framework and infrastructure designed in WP2;* ***(7)** the plan and calendar for the preparation and execution of the test, as well as for the analysis of results;*	***(2,3)** 4 Living Lab Goals* *8.3 Innovation Plan* *7.1 Test Cases Selection Criteria* ***(4)** 7.1 Test Cases Selection Criteria* ***(5)** 7.2 Actors & Involved Systems* ***(6)** 6 Technical Requirements* ***(7)** 7.3 Tests Execution Plan 8.2 Implementation Plan* ***(8)** 4.3 Envisioned Business Model & Incentive system*	*-Analysis of the flow of transport documents in the New Silk Road rail transport (Europe-Asia)* *-Analysis of information and communication conditions of customs procedures in the New Silk Road* *-Analysis of information related to monitoring of e-commerce parcel shipments from China to Poland* ***(2,3)** 4 Living Lab Goals* *4.1 Envisioned physical flows - In this section, we described LL's objectives related to the physical movement of goods, related to:* ▪ *increased visibility of goods thanks to IoT deployment along the Silk Road* ▪ *implementation of the SSCC number and EPCIS test* *In this subchapter we also included bird's eye view process maps, which indicated target changes in the area of flow of goods and information for both B2B Rohlig Suus and B2C Polish Post processes* *4.2 Envisioned information flows, addressing interoperability and standardization requirements. (also elaborate need for semantically enriched rich data models) - This section consists of:* ▪ *The vision of application of GS1 standards in the logistic processes of the New Silk Road* ▪ *Characteristics of UPU standard in postal services* ▪ *Characteristics of TARIC Integrated Customs Tariff* ▪ *Vision of parallel application of the GS1 and UPU standards* ▪ *The usage of EPCIS in logistic processes of the New Silk Road* *8.3 Innovation Plan - this section contains the implementation objectives for the different actors involved in the test and*

	(8) *the business model, data sharing, rules for intelligent decision making and incentive system for the implementation of the solution or concept being tested;* ***(9)*** *the related KPIs for evaluation;* ***(10)*** *the expected results and specification of surveys from LL actors to ascertain impact KPIs as specified in section 3.1. Simulation based designs of each LL EGTN of a PI-inspired network including entry nodes (ports or inland terminals, warehouses, intermediate TEN-T Nodes and city-hubs) will be produced.*	*for the implementation of the solution/concepts* ***(9,10)*** *7.4 Expected Test Results & Evaluation Plan* *8.4 Assessment plans*	*describes the expected results affecting the supply chains of the business partners* ***(4)*** *7.1 Test Cases Selection Criteria - This section consists of description of two business case scenarios:* *-Container transport monitoring on the New Silk Road (Rohlig Suus),* *-Monitoring of shipments on the New Silk Road, in terms of e-commerce parcel distribution (Polish Post).* ***(5)*** *7.2 Actors & Involved Systems - In this section, we described LL's partners and their business IT systems* ***(6)*** *6 Technical Requirements - 6.1 Mapping LL3 technical components into PLANET architecture - In this section, we presented:* *Map of a PLANET architecture with LL3 components and descriptions* *6.2 Cloud-based Open EGTN Infrastructure Technical Requirements (incl. performance capabilities) - In this section, we described:* *-General objectives and expectations for EGTN* *-Stackeholder's contribution to EGTN and expected outputs* *6.3 Visibility and product status (Big) data for 'Corridor route optimisation analytics' - In this section, we described:* *-Data sources for the corridor route optimistation analytics* *-Objectives for the route optimisation applications* *-Description of a consortium findings in regards to AI based applications* *6.4 IoT Requirements - In this section, we described:* *-General requirements for IOT infrastructure for LL3* *6.5 Big-data requirements - In this section, we described:*

			-Requirements for builinding an accurate AI based model forecasting *-Main challenges in gathering BIG data for the Planet project* *-Predictive modelling objectives and potential* *6.6 Decision making intelligent algorithms (based on AI machine-learning) - In this section, we described:* *-References to WP2* *-Data sources for AI based algorithm* *-Potential of the AI machine-learning in regards with PLANET data sources and infrastructure* ***(7)** 7.3 Tests Execution Plan - The Test Execution Plan was broken down into 4 main phases, which were then presented within a Gant chart and positioned in time.* *8.2 Implementation Plan - As part of the ongoing work, the research team defined 4 phases of the TEST implementation plan:* *Phase 1 - LL organisational preparation* *Phase 2 - test preparation - data collection, visualisation, analysis (as is & to be mapping)* *Phase 3 - design & implementation* *Phase 4 – validation* ***(8)** 4.3 Envisioned Business Model & Incentive system for the implementation of the solution/concepts - In this section, we described:* *- Strategic analysis for a product event database based on the EPCIS standard* *- SWOT analysis* *- Business Model Canva* *- Potential Sales model & Marketing strategy*

			(9,10) *7.4 Expected Test Results & Evaluation Plan - As part of the ongoing work, the research team:* *- defined 7 KPIs that will allow to assess the impact of implemented solutions on key areas related directly to operations and the business environment. In order to achieve a common understanding of particular KPIs, the project extended their description with a detailed definition. This approach allowed the indicators to be properly matched with the relevant business processes.* *- described the logic of action that will be used as part of the KPIs' assessment process* *8.4 Assessment plans - - Aim of the assessment plan is a Living Lab's process evaluation with overall learning and insights, which come from the whole experiment, in order to improve and transfer to others.* *Five Key Principles which have been agreed by the Living Lab team as criteria for LL process evaluation are: Value, Influence, Sustainability, Openness, Realism.* *That assessment model requires from the team the implementation of five main activities:* *1. Monitoring sessions 2. Evaluative qualitative questionnaires with experiment teams 3. On-site visits* *4. Documentary analysis 5. Reporting*

2.2 Deliverable Overview and Report Structure

This report describes the preliminary findings employing in-depth analysis of the current situation, including identification of key needs and problems affecting global transport, definition of use cases, KPIs and the respective tests and produce the complete definition of the organization and planning for the LL. The report also addresses simulation-based designs for the LL's EGTN. In this scenario, this document details the requirements and the architecture of the solution designed for the PLANET project, thus providing the technical overview regarding the final implementation.

This document is organized with the following structure:

3 Living Lab AS-IS situation

3.1 Infrastructure Corridor Analysis

- In this section we have described the characteristics of the New Silk Road and the main rail connections including those used by Living Lab business partners - Rohlig Suus and Polish Post on the China-Poland route.

3.2 Information Flows - This section consists of:

- Analysis of the data and information transmission process and identification of communication standards in the New Silk Road rail transport
- Analysis of the flow of transport documents in the New Silk Road rail transport (Europe-Asia)
- Analysis of information and communication conditions of customs procedures in the New Silk Road
- Analysis of information related to monitoring of e-commerce parcel shipments from China to Poland

4 Living Lab Goals

4.1 Envisioned physical flows - In this section, we described LL's objectives related to the physical movement of goods, related to:

- increased visibility of goods thanks to IoT deployment along the Silk Road
- implementation of the SSCC number and EPCIS test

In this subchapter we also included bird's eye view process maps, which indicated target changes in the area of flow of goods and information for both B2B Rohlig Suus and B2C Polish Post processes

4.2 Envisioned information flows, addressing interoperability and standardization requirements. (also elaborate need for semantically enriched rich data models) - This section consists of:

- The vision of application of GS1 standards in the logistic processes of the New Silk Road
- Characteristics of UPU standard in postal services
- Characteristics of TARIC Integrated Customs Tariff
- Vision of parallel application of the GS1 and UPU standards
- The usage of EPCIS in logistic processes of the New Silk Road

4.3 Envisioned Business Model & Incentive system for the implementation of the solution/concepts -In this section, we described:

- Strategic analysis for a product event database based on the EPCIS standard
- SWOT analysis
- Business Model Canvas
- Potential Sales model & Marketing strategy

4.4 Logic/rules and available data for intelligent decision making

4.5 Modularity for shared transport - This section consists of:

- Principles of the open logistic network
- Modular format in the distribution process

- Potential benefits of implementation
- Potential of using modularity in shared transport in postal services on the example of Polish Post

4.6 Visibility and product status (Big) data for 'Corridor route optimisation analytics'

4.7 Expected Impact of adopted innovations including metrics - In this section, we described LL's partners, Rohlig Suus and Polish Post, needs, and expected impacts on:

- financial and business level
- economic & social level
- vision of the Małaszewicze terminal as a main logistics node

5 Simulation-based Designs for the LL's EGTN

5.1 LL Modelling - This section consists of:

- Basic assumptions for modelling and simulation of logistics processes
- Characteristics of the research methodology in the field of process analysis divided into:
    - Stage I: Study of the current processes (AS IS analysis)
    - Stage II. Development of target logistics process models (TO BE analysis)

6 Technical Requirements

6.1 Mapping LL3 technical components into PLANET architecture - In this section, we presented:

Map of a PLANET architecture with LL3 components and descriptions

6.2 Cloud-based Open EGTN Infrastructure Technical Requirements (incl. performance capabilities) - In this section, we described:

- General objectives and expectations for EGTN
- Stackeholder's contribution to EGTN and expected outputs

6.3 Visibility and product status (Big) data for 'Corridor route optimisation analytics' - In this section, we described:

- Data sources for the corridor route optimistation analytics
- Objectives for the route optimisation applications
- Description of a consortium findings in regards to AI based applications

6.4 IoT Requirements - In this section, we described:

- General requirements for IoT infrastructure for LL3

6.5 Big-data requirements - In this section, we described:

- Requirements for builinding an accurate AI based model forecasting
- Main challenges in gathering BIG data for the Planet project
- Predictive modelling objectives and potential

6.6 Decision making intelligent algorithms (based on AI machine-learning) - In this section, we described:

- References to WP2
- Data sources for AI based algorithm

- Potential of the AI machine-learning in regards with PLANET data sources and infrastructure

6.7 M-bags modularity - This section provides a technical description of the requirements for modular logistic units, which was developed as part of the Horizon 2020 MODULUSHCA project and could potentially be used in shared transport of the Polish Post.

7 Test Planning

7.1 Test Cases Selection Criteria - This section consists of description of two business case scenarios:

- Container transport monitoring on the New Silk Road (Rohlig Suus),
- Monitoring of shipments on the New Silk Road, in terms of e-commerce parcel distribution (Polish Post).

7.2 Actors & Involved Systems - In this section, we described LL's partners and their business IT systems

7.3 Tests Execution Plan - The Test Execution Plan was broken down into 4 main phases, which were then presented within a Gant chart and positioned in time.

7.4 Expected Test Results & Evaluation Plan - As part of the ongoing work, the research team:

- defined 7 KPIs that will allow to assess the impact of implemented solutions on key areas related directly to operations and the business environment. In order to achieve a common understanding of particular KPIs, the project extended their description with a detailed definition. This approach allowed the indicators to be properly matched with the relevant business processes,
- described the logic of action that will be used as part of the KPIs' assessment process.

8 Living Lab Organisation & Planning

8.1 Living Lab Organisational Structure (roles & responsibilities) - In this section, we described Living Lab 6P' components:

- Place and location of the Lab
- People and stakeholders involved
- Priorities: or issues and challenges to be worked on
- Platform: a system for exchange of information and knowledge
- Process setup of the Lab as an experiment within the resources and time available
- Process evaluation: overall learning and insights which come from the whole experiment

8.2 Implementation Plan - As part of the ongoing work, the research team defined 4 phases of the TEST implementation plan:

- Phase 1 - LL organisational preparation
- Phase 2 - test preparation - data collection, visualisation, analysis (as is & to be mapping)
- Phase 3 - design & implementation
- Phase 4 – validation

8.3 Innovation Plan - this section contains the implementation objectives for the different actors involved in the test and describes the expected results affecting the supply chains of the business partners.

8.4 Assessment plans - Aim of the assessment plan is a Living Lab's process evaluation with overall learning and insights, which come from the whole experiment, in order to improve and transfer to others.

Five Key Principles which have been agreed by the Living Lab team as criteria for LL process evaluation are: Value, Influence, Sustainability, Openness, Realism.

That assessment model requires from the team the implementation of five main activities:

1. Monitoring sessions 2. Evaluative qualitative questionnaires with experiment teams 3. On-site visits 4. Documentary analysis 5. Reporting

9 Conclusions

3 Living Lab AS-IS situation

3.1 Infrastructure Corridor Analysis

The development of global logistics infrastructure, like other sectors of the economy, depends on the progress of globalization and international integration. Eurasian transport corridors, as part of the Belt and Road initiative and one of the key elements of China's development strategy, are of particular importance in the economic development of the entire Eurasian continent. Thanks to the cooperation of individual communities - China, the Eurasian Economic Union and the European Union, the development of the conglomerate of China-EU-China connections is so dynamic.

The vision of the New Silk Road, which aimed to develop a transport infrastructure that could connect China, Central Asian countries, the Middle East, Europe and Africa into a single network, existed for a long time, but it was only in 2013 that steps were taken to put the concept into practice. The transport market between China and the EU had already been developed since 2008 through private initiatives, while in 2013 a decision was made to accelerate the development of transport infrastructure, and more extensive promotional activities were undertaken to develop the Belt and Road initiative.

The development of the initiative greatly accelerated with the acceptance of the project by the provincial government of China, which provided organizational and administrative support and mobilized huge financial resources in assistance. Thanks to the subsidies, rail freight prices have come close to those of sea freight. It should be noted, however, that subsidies for regular container transportation amount to about 40-50% of the total cost. Without these subsidies, the transport could not function - the total cost of rail freight is much higher than sea freight. Chinese policy makers have announced a gradual reduction or even termination of subsidies from 2022. However, there is optimism that the utilisation of rolling stock capacity on trains from Europe to China is improving, making regular container rail services increasingly profitable. [1]

The development of infrastructure on the New Silk Road route should be considered in relation to individual transport corridors. This is because development prospects depend not only on the current state of infrastructure, but also on the degree of utilization of a given route and the transportation barriers that exist along it. In terms of the entire Belt and Road Initiative, it is worth looking at the potential for utilization and development of the railroad network, as well as the road and maritime network.

The key role in **rail connections** between China and Europe is played by the **Trans-Siberian corridors (Northern Route)**, in particular the most extensive and exploited New Eurasian Land Bridge corridor. Less important, although with great potential, is the **China-Central Asia-West Asia** corridor, which together with additional variants (e.g. the Southern Route) form the Trans-Caspian corridors (Central Route).

An important role is also played by the **Land and Sea Express Route**, which connects to the Balkan corridor and is part of the Maritime Silk Road. Goods on this route are transported by sea from Chinese ports to Piraeus in Greece, from where they reach Central and Western Europe via the Balkan corridor, connecting to the TEN-T network.

[1] " Intermodal Transport on the New Silk Road" Polish Road Transport Institute,2020

The Trans-Siberian Corridor

The New Eurasian Land Bridge, also called the Eurasian Land Bridge or the Northern Route, is a link between the 2nd Pan-European Transport Corridor (Berlin-Minsk-Moscow-Nizhny Novgorod) and the 2nd Railway Cooperation Organization Corridor (Moscow-Astana-Lianyungang). It runs through China, Kazakhstan, Russia, Belarus, Poland and reaches Western Europe.

- The Trans-Siberian corridor group consists of four connections:
- via the China-Kazakh Alashankou-Dostyk crossing,
- through the Sino-Kazakh Horgos crossing,
- via the Sino-Mongolian Erenhot Passage,
- via the Sino-Russian Manzhouli-Zabaykalsk crossing.

Three of them join in Yekaterinburg, the fourth - via Horgos - runs through Almaty, Aktobe, Orenburg, Samara and joins the others in Moscow. From there, they all head to Poland via the Terespol-Brest crossing, where one of Europe's largest dry ports, Małaszewicze, is located. There the containers are transshipped on 1435 mm wide platforms, from where they go to Western Europe.

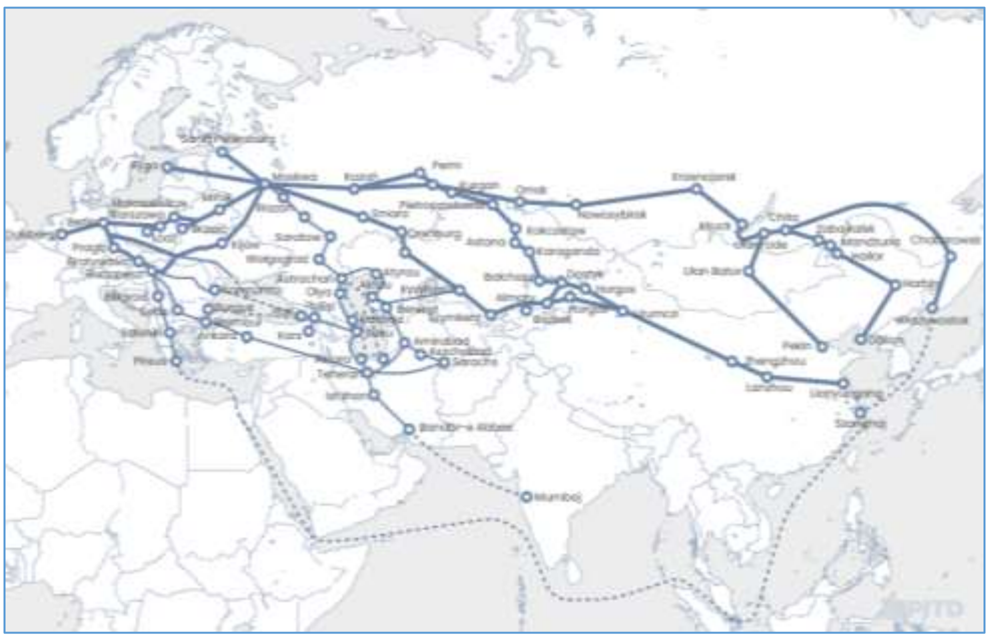


Figure 1 Trans-Siberian transport corridors

Trans-Siberian corridors are the cheapest, fastest and safest freight routes on the China-EU-China route. They are characterized by **favorable relations and the best hard (linear) and soft infrastructure**, i.e. developed international regulations, customs clearance and procedures. Their use is facilitated by the fact that Russia, Kazakhstan and Belarus belong to the **common economic area** (EAUG). Thanks to the favourable cost-effectiveness ratio, the Trans-Siberian Corridors have received the greatest support from the Chinese government.

Infrastructure

The hard infrastructure of the Trans-Siberian Corridors is a **fully electrified, double-tracked railroad** line with a length of about 10,000 kilometers (13,000 kilometers in the variant to Madrid). Up to 100 million tons of cargo are transported on it annually. In 2020, the average speed of trains on the line was 1099 km/day. Delivery of cargo on the route **from the Chinese border to the Polish border** through the territory of Kazakhstan, Russia and Belarus **averaged 4.96 days** in 2020, while in 2019 this time was 5.14 days.

The speed of trains in the first half of 2020 was 1099 km per day. For comparison, in the same period of 2019 it was 1029 km, 2018, - 980 km., in 2017. - less than 950 km per day. The use of Trans-Siberian connections is hampered by **the depleting capacity of the corridor**. It is caused, among others, by the **lack of transshipment terminals** and **train stoppages at the terminal in Małaszewicze**. Rebuilding of the transshipment terminal in Małaszewicze is crucial for the development of the entire corridor.

In addition, the development of intercontinental transit via the Trans-Siberian corridor is hampered by the required **train length**. Depending on the country, train sets of wagons can reach:

- 994 m on the territory of Russia
- 910 m in Belarus
- 600 m in Poland

Limitation of train length, resulting from technical requirements of railroad lines, leads to **accumulation of containers on loading fronts of terminals**, which in turn results in longer delivery times and higher costs.

Despite the mentioned bottlenecks, the transport structure of the Trans-Siberian Corridor is its advantage, because in addition to the developed hard infrastructure, its advantages over other connections are evidenced by:

- only **two customs borders** (China-EAUG and EAUG-EU)
- low modality (only **2 changes of track gauge and no congestion in maritime transport**)
- a **single through fare**
- well **established transport patterns**

The main New Silk Road train corridors

The south route via (transit time 12-14 days)

Urumqi CN => Alashankou CN(CN-KZ border) => Dostyk KZ => Nur-Sultan KZ=> Orenburg RUS => Moscow RUS = > Baranovichi BY => Brest BY=> Malaszewicze PL

<u>Departure from:</u>

Chengdu, Xi'an, Chongqing, Wuhan, Zhengzhou, Changsha

The north route version via Mongolia (transit time 16-18 days)

Erenhot CN (CN-MNG border) => Zamyn-Uud MGL => Ulan Bator MGL=> Irkutsk RUS => Novosibirsk RUS => Yekaterinburg RUS => Kazan RUS=> Moscow RUS = > Baranovichi BY => Brest BY=> Malaszewicze PL

<u>Departure from:</u>

Suzhou, Zhengzhou

The north route version via Russia (transit time about 18 days)

Manzhouli CN (CN-RU border) => Zabaykalsk RUS => Irkutsk RUS => Novosibirsk RUS=>Yekaterinburg RUS => Kazan RUS=> Moscow RUS = > Baranovichi BY => Brest BY=> Malaszewicze PL

<u>Departure from:</u>

Shenyang, Dalian, Harbin

The following graph shows the connection between China and Poland used by LL3 business partners -Polish Post and Rohlig Suus.

Figure 2 Trans-Siberian transport corridors

3.2 Information Flows

The flow of information is an essential factor for the functioning of logistics. This fact follows from the definition of logistics, indicating the integrity and inseparability of the flow of cargo and information about this cargo and the delivery process. The flow of information between different actors in the supply chain can occur in a formalized or informal form. The transfer of information in a formalized form entail, in many cases, the standardization of "input" and "output" information. The flow of information in this form requires the creation of procedures. The scope of these procedures depends on both the commercial and operational values of the information transmitted and the size and rank of the entity participating in a given supply chain.

Information in supply chains

Information flow is an integral part of supply chain operations. The circulation and exchange of information takes place between all active and passive entities participating in a given supply chain. The increasing complexity and scope of logistics operations make it necessary to handle more and more data. The ability to effectively use information translates into a more efficient planning process and better control of the current operation of the company. However, errors in the functioning of the information flow cause severe consequences in relation to the effectiveness of the delivery process, but also in relation to the functioning and market image of entities involved in this process. Hence, logistics companies attach great importance to the design and implementation of information circulation systems. Telematics plays a key role here, but before creating a specific IT tool to support information processes, the company must analyze its logistical goals and determine the nature and challenges facing the communication system.

The following tasks typically play a primary role in the preparation of a communication system:

- identification of message groups,
- information standardization and analysis,
- ensuring availability of information,
- ensuring free and effective flow of messages between entities,
- circulation security,
- archiving.

Identification of message groups means defining what type of data appear in the system and their classification according to the content criterion. Such message types appear in logistic processes as e.g. information on cargo characteristics, information on transport and storage conditions or information on freight and payment. The number of message types varies depending on the complexity of the supply chain.

Our work identified the following participants and information flow within the Living Lab 3 supply chains in Eurasian transport corridors.

The organization of rail transport is one of the main tasks of the Intermodal Operator, which is a broker in the organization of transport between other transport participants, such as the Forwarder, Terminal, and rail carrier. The actions taken by the Intermodal Operator as part of the organization of rail transport are a service aimed at the implementation of the customer's order, which is the Freight Forwarder, but the activities initiated as part of this service, and messages transmitted in connection with the organization of transport, come from the Intermodal Operator mainly to the entity providing the transport service , which is a railway carrier. As part of the provision of the rail transport organization service, the main messages and documents created by the Intermodal Operator for the Railway Operator are:

- *Timetable order* - the action of ordering the timetable occurs in the relation Intermodal Operator - Railway Carrier. The intermodal operator gives the Railway Undertaking an order for the transport of a specific suit of wagons, specifying the required date and time of commencement of transport, and the date when it delivery of the wagons to the destination station is requires. In order to establish a timetable, the intermodal operator should also provide the assumed gross weight of the entire train set with loaded goods. The order of the timetable is transferred by the intermodal operator to the railway carrier by e-mail.

- *Order of wagons* - the activity of ordering wagons for loading a specific pool of containers and goods to be exported by rail from the loading terminal, occurs in the relation Intermodal operator - Railway carrier. The intermodal operator submits to the Railway Undertaking an order for a specific suit of wagons, specifying the exact number of wagons of the requested series, planned weight of goods on wagons of a given series, transport route, and the date of bringing the wagons to the place of loading (Terminal). Placing a wagon order is done by filling in a form specified by a given Railway Operator, in paper form, or in the Railway Operator's system, depending on the degree of maturity of the Carrier. The completed order form may be delivered by e-mail or in paper form to the railway carrier's wagon office. If the Railway Undertaking has its own IT system which enables customers to place wagon orders in electronic form, no other way of delivering the wagon order is necessary. On the basis of the placed wagon order, the Railway Undertaking determines the availability of the ordered wagons on a given day for the customer placing the order, then confirms the availability or reports the unavailability. If the ordered wagons are not available, the Railway Undertaking may specify the availability of replacement series of wagons, the Intermodal Operator then submits an updated wagon order.
- *Railway consignment note* - the intermodal operator, on the basis of the loading list provided to him by the Terminal commissioned to load the goods onto the train, generates a railway consignment note based on the template and in accordance with the conditions specified by the Railway Operator. The railway consignment note, containing information such as the sender's data, data of the recipient of the consignment (train), sending station, destination station, a list of transported goods with the indication of weights and names, container numbers, and a list of wagons on which individual containers are transported, is created depending on on the capabilities and requirements of the Railway Undertaking in the carrier's system or in its system | of the intermodal operator. The handover of the completed consignment note to the Railway Undertaking either by e-mail as an attachment to the e-mail, or this document is delivered in a hard copy to the Loading Terminal, which is then forwarded. In the event that the railway letter is filled in in electronic form in the system of the Railway Undertaking, there is no need to print it and deliver it in paper form to the Carrier.

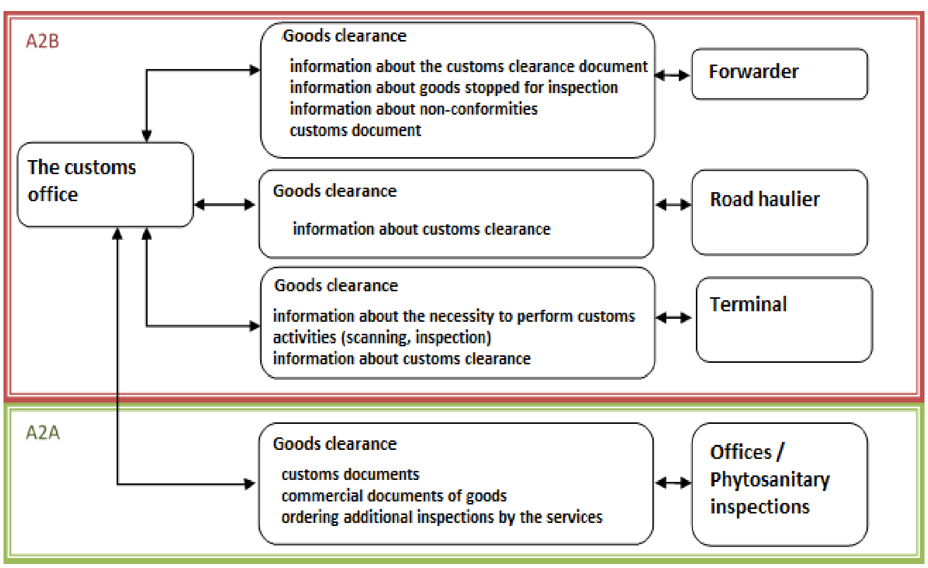


Figure 3 Information flow in the cargo handling process

In the process of cargo handling, the Customs Office undertakes a number of activities aimed at the implementation of the customer's order, cooperating in the implementation of transport both with state administration entities, taking actions included in A2A services, and with business partners for whom the Customs Office provides B2B services.

The business entities with which the Customs Office may cooperate when carrying out a cargo handling order are:

- Freight forwarder
- Road haulier
- Terminal

In the area of A2A administrative services, the Customs Office cooperates mainly with the units of phytosanitary inspections, through which it performs customs and sanitary clearance activities in control units.

The basic service that the Customs Office provides to business partners is the customs clearance service including activities such as:

- *Information on customs clearance* - an activity occurring in the relationship between the Customs Office and the Freight Forwarder and the road carrier. The service consists in informing the Freight Forwarder about the completion of customs activities related to the container or goods in the possession of the Freight Forwarder, and reported for customs clearance. The forwarder receives information from the Customs Office about the completion of the procedures, which enables him to carry out further reloading or transport activities. Information about the check-in may be made available by e-mail or by phone..
- If there is an *intermediary on the way of transport* - if the goods are located at the transshipment terminal and they are cleared at this point, the information about the customs clearance is sent to the Terminal, which acts as an intermediary in notifying further customers about the completion of the customs clearance procedure. The road carrier receives information from the Customs Office regarding the completion of the customs clearance procedure, directly from the official, along with receipt of documents confirming the customs clearance..
- *Information on goods detained for inspection* - the Customs Office provides the Shipper with information, which is also an order to issue a container for inspection, inspection or scanning. In the scope of handling customs activities, the Terminal issues the container and provides the Customs Office with information about the time and place of availability of the given goods at the yard. Such information is provided by e-mail or by phone. Information about the necessity to perform customs activities is sent by the Customs Office to the Terminal electronically in the terminal system.
- *Customs documents* - handing over the customs documents completed and approved by the Customs Office is part of the customs clearance service. The Customs Office may provide customs documents to the Freight Forwarder, Road Carrier or Terminal service, depending on the representative of which entity provides customs documents for clearance. The documents for the cleared goods may be handed over by e-mail in the relationship between the Customs Office - Freight Forwarder and the Customs Office - Terminal, while in the relationship between the Customs Office and the road carrier, the documents of the driver of a given carrier are handed over in paper form. Despite the use of electronic document flow of the cleared goods, it is required to provide the Shipper with the original documents confirmed by the Customs Office in paper form.

- *Information on the need to perform customs operations (scanning, inspection)* - the Customs Office transmits information to the Terminal, which is also an order to issue a container for inspection, inspection or scanning. In the scope of handling customs activities, the Terminal issues the container and provides the Customs Office with information about the time and place of availability of the given goods at the yard. Such information is provided by e-mail or by phone.

Analysis of the data and information transmission process and identification of communication standards in the New Silk Road rail transport.

Process participants: Freight Forwarder, Road carrier

The process is preceded by activities carried out in the general road transport process, in which there is a need for transport with the use of railway infrastructure. The forwarding order is prepared by the freight forwarder and transferred to the intermodal operator (phone, e-mail, PDF, Xls, EDI). Road transport activities take place. After loading the container and customs clearance, the exporter provides the forwarder and the customs agency with information regarding the description of the goods (by phone, e-mail, EDI). For the exporter, this is the end of the process. The forwarder accepts the data of the goods after loading, then sends the list of containers to the intermodal operator (mail-xls file, EDI). The further flow of the document is the goods clearance at the customs agency. After the cargo data and carrier data have been verified, the freight forwarder sends a notification to the land terminal (Mail-xls file). The road carrier confirms the implementation status of the road stage - delivery to the inland terminal by sending the POD transport status (telephone, e-mail, in the EDI forwarder's IT system), preceded by the implementation of the road stage and the container. The POD document is received by the forwarder and the land terminal, for the road carrier it is the end of the process (further document circulation for the participant - land terminal described in the Land Terminal process). The Freight Forwarder accepts the report on the end of road transport. The initial loading list sent by the intermodal operator (mail-xls file, EDI) is subject to verification, in the event of non-compliance with the order, the forwarder sends the operator comments on the loading list (tel, mail), in response he receives a corrected loading list, if its verification was completed successfully, the information about the compliance of the list is sent to the intermodal operator (tel, e-mail, EDI), which, after generating the loading report, sends it to the forwarder. The freight forwarder prepares a container notification to the railway terminal, it is sent manually. The intermodal operator sends a monitoring report to the freight forwarder, which is verified by the freight forwarder, and the result of deficiency verification, on the basis of which the freight forwarder sends a notification update to the terminal (manually).

Process participants: Railway terminal

The process starts from receipt of the forwarding notification (Mail-xls), then the railway terminal receives notification details (Mail-XLS). After the receipt of the notification, the information from the loading report and the unloading list (xls) are entered into the system, then the compliance of the notification is verified, and in the event of deficiencies, the intermodal operator receives a deficiency report from the Railway Terminal - the verification result is sent to the forwarder. The forwarder updates the notification and sends it to the railway terminal (e-mail - xls). The railway terminal accepts the advice from the forwarder with explanations, if the advice is compliant, the trains are accepted and the railway undertaking sends the ETA (Expected Time of Arrival) of Trains (mail, xls) to the railway terminal, where the report of planned train arrivals is verified. Then, arrangements for the substitution of wagons and coordination take place, the ETA of trains is discussed with the railway carrier (tel., Fax, mail). When the railway carrier confirms the ETA of the trains (tel., Fax, e-mail), the place of depositing the containers on the square by the Railway Terminal is planned, then the wagons are rolled in, and the technical condition of the containers is assessed. In the case of damage or lack of a seal, the intermodal operator is informed about the situation, explanatory activities also take place, if no damage or lack of a seal is found, a verification of the consistency of the wagons sequence is carried out, as a result of which the correctness of data is checked. If a discrepancy is identified, a data correction is sent to the logistic operator and the revision is performed again. After receiving a positive result of the audit, unloading is planned, the container is unloaded and the unloading report is generated, which is sent to the forwarder (txt, xls) and the intermodal operator. Then, verification of customs activities takes place, and if the goods require clearance, the railway terminal sends a customs declaration to the customs agency, which, after performing activities related to customs clearance, sends information about the customs release. When the goods are cleared or did not require clearance, the container is loaded onto the train, which ends the process for the railway terminal.

Process participants: Railway operator, PKP PLK (manager)

The process initiates the wagon order received from the intermodal operator. After accepting the wagon order, the availability of the ordered wagons is verified, in the absence of wagons, the specification of the available wagon suit is sent to the intermodal operator (tel, e-mail-xls). The intermodal operator verifies the availability of wagons and sends the wagon order back to the railway carrier, where the availability of the ordered wagons is once again checked. If the ordered wagons are available, the railway undertaking issues a wagon order confirmation and sends it to the intermodal operator from whom it receives the final wagon order. The final order of wagons is accepted, and the route is ordered by placing an order for a journey (IT system, online route ordering system) at PKP PLK. When PKP PLK receives an order for a rail journey, it analyzes it, then a prepared offer for a journey and timetable, which is sent to the railway carrier. After the railway undertaking accepts the timetable, information on the timetable is sent to the intermodal operator and to the railway terminal. The railway undertaking accepts the railway consignment note from the intermodal operator and the inland terminal, which additionally sends information about the readiness of the train set for transport. Then the containers are transported by rail, monitored by PKP PLK, the journey monitoring report is sent to the railway carrier, which completes the process for PKP PLK. After receiving the monitoring report, the railway undertaking verifies it and then sends the journey report to the intermodal operator. Reports of planned train arrivals are generated (authorization), train ETA (mail-xls) is sent to the railway terminal, then the railway operator receives from the railway terminal the train ETA confirmed by phone. The substitution of wagons completes the process for the railway carrier.

Process participants: Intermodal operator

Acceptance of the forwarding order (phone, mail, pdf, xls, EDI) and the list of containers (mail-xls, EDI) from the forwarder starts the process, the intermodal operator verifies the forwarding notification. After receiving the information about the acceptance of the container at the yard sent by the inland terminal (tel., Mail-xls, EDI EDIFACT CODECO), an initial loading list is prepared and sent (mail-xls, EDI) to the forwarder and to the land terminal. Information from the forwarder about the compliance of the list (phone, e-mail, EDI) initiates the submission of a wagon order to the railway carrier (phone, e-mail). The railway undertaking sends the availability of a wagon suit (tel., E-mail-xls) to the intermodal operator, who verifies the availability of wagons, then re-places the wagon order (tel., E-mail). After receiving the wagon order confirmation (phone number, e-mail), the intermodal operator sends the final wagon order (phone number, e-mail) to the railway carrier. If the loading list does not comply with the order, the intermodal operator receives comments on the loading list from the railway terminal (phone, e-mail). The final loading list is prepared, which is received by the land terminal and the forwarder (mail-xls, forwarding system). After receiving the railway timetable from the carrier, the timetable is accepted, then the intermodal operator receives the loading report sent by the land terminal. The accepted loading report is sent by the intermodal operator to the forwarder. The intermodal operator generates and sends rail waybills to the land terminal and to the rail carrier, then receives a journey monitoring report from the rail carrier, after its verification, it is sent to the forwarder.

Analysis of the flow of transport documents in the New Silk Road rail transport (Europe-Asia)

The CIM international consignment note is to be used for international rail transport. It is a document stating the conclusion of a transport contract with the railway undertaking. The contract is deemed concluded at the moment of acceptance by the railway of the shipment and placing the date stamp of the sending station on the consignment note.

Pursuant to Art. 36 sec. 1 CIM, the Carrier is liable for damage resulting from total or partial loss or damage to the goods during the time from accepting the goods for transport until their release, as well as for damage resulting from exceeding the delivery date, regardless of the railway infrastructure used. International rail transport is regulated by many laws and directives.

One of the most important rights developed by OSŻD - Organization of Railways Cooperation is SMGS, i.e. the International Rail Waybill. SMGS regulates the conditions of freight transport. The latest version entered into force on July 15, 2015. The International Rail Waybill is used in rail transport with the former USSR and the Far East.

Components of SMGS

The SMGS International Rail Waybill consists of:

- Original - for the recipient of the shipment,
- Shipping rate - for the destination station,
- Duplicate - for the sender,
- Certificate of receipt,
- Information about arrival of the shipment,
- Additional quotation - for statistical purposes.

SMGS is a personal, non-transferable and non-transferable document. This means that the goods are sent by name to the designated recipient who ordered such goods and must collect them personally or give an authorization to a person. Ownership of such goods may be transferred to another person only by assignment, which, however, involves many formalities.

The SMGS consignment note is used in rail communication with the former USSR and the Far East. Applies to countries such as:

- the Republic of Azerbaijan,
- the Republic of Albania,
- the Republic of Belarus,
- the Republic of Bulgaria,
- the Republic of Hungary,

- Socialist Republic of Vietnam,
- Georgia,
- the Islamic Republic of Iran,
- the Republic of Kazakhstan,
- Mongolia,
- Polish Republic,
- the Russian Federation,
- Ukraine,
- the People's Republic of China,
- the Democratic People's Republic of Korea,
- the Kyrgyz Republic,
- the Republic of Latvia,
- the Republic of Lithuania,
- the Republic of Moldova,
- the Republic of Tajikistan,
- Turkmenistan,
- the Republic of Uzbekistan,
- the Republic of Estonia.

The following goods cannot be transported on SMGS:

- small parcels with a unit weight of less than 10 kg - these restrictions do not apply to goods whose volume exceeds 0.1 m3 per item. This means that a single e-commerce shipment is not supported by SMGS, only in the case of consolidation of shipments into collective packages,
- goods with a unit weight exceeding 1.5 tons in reloading communication in covered wagons with a retractable roof,
- items which are forbidden to be transported even in one of the countries whose railways are to participate in the transport,
- some dangerous goods regulated in the agreement on International Rail Freight Communication.

SMGS is a bill of lading constituting a document confirming the conclusion of a transport contract with a railway company. The implementation of the contract (its conclusion) begins when the railway accepts the shipment and stamps it at the forwarding station (the date is put on the consignment note).

The SMGS consignment note is completed in Russian or Chinese, depending on the country to which the goods are transported.

The contract of carriage may be concluded in the form of an electronic letter.

CIM document

In addition to the SMGS, there is also a CIM document. The CIM International Rail Waybill is valid in Western Europe, and SMGS in Eastern Europe. In the case of transport by rail of dangerous goods, when filling in the SMGS, there are also some additional markings and boxes. However, these are very slight differences compared to the CIM document.

The CIM International Bill of Lading confirms the conclusion of a contract for transport by rail. The obligations and rights of the parties result from **the International Convention on the Carriage of Goods by Rail.**

The CIM document consists of 5 copies:

- the original is intended for the recipient of the shipment, the shipping note accompanies the shipment and is intended for the destination station,
- the confirmation of receipt accompanies the shipment to the destination station and constitutes a settlement document between the railway authorities involved in the transport, the duplicate is intended for the sender of the shipment, the confirmation of posting is intended for the sending station,
- the CIM letter is issued by the sender in the language of the country of origin with a translation into one of the three languages: Italian, French or German.

From the perspective of the integration of information flow using the Data Bus, the differences between the CIM and SMGS documents should be identified in such a way that all the data is reflected in the functional scope of the integration platform. The table below lists the differences and similarities in the informative content of both documents.

Analysis of information and communication conditions of customs procedures in the New Silk Road

Customs clearance procedure in the import process

After being unloaded from the train, the containers are transported to the storage areas of the railway terminal. Then the data related to a given container are entered into the railway terminal system. For goods originating from outside the EU (in this case it concerns goods from China), the terminal's IT system imposes the so-called "Customs stop" - it means that it blocks the possibility of collecting the container and making the cargo available for further goods circulation.

The initiator of the customs clearance process is the Freight Forwarder who, acting on behalf of the Importer, collects the container from the area of the Railway Terminal. The Freight Forwarder orders the selected Customs Agency to perform customs clearance. For this purpose, he sends the clearance order and necessary customs documents to the Agency by e-mail. The Customs Agency completes and prepares the necessary commercial documents and submits them in paper and electronic form to:

- control services,
- the Customs Office.

The inspection services, on the basis of the received commercial documents, carry out proper control of the cargo. They submit the confirmation of the inspection via the UC system to the Customs Office and by e-mail or telephone to the Customs Agency.

Confirmation of inspection by the Control Services and commercial documents received from the Customs Agency constitute the basis for the Customs Office to perform customs clearance of the declared cargo. After the clearance, the Customs Office has entered the information about the completion of the customs clearance into the system. This information is sent to the Customs Agency, which, on the basis of both information (about proper control and customs clearance), takes the photo of the "customs alloy" from the container. From that moment the Freight Forwarder may pick up the container and, with the help of the Road Carrier, deliver it to the place indicated by the Importer. The set of shipping and customs documents is prepared by the Customs Agency and handed over to the carrier.

Customs clearance procedure in the export process

The initiator of the process is the Exporter who intends to export the container (goods, cargo) outside the country. The exporter determines the destination country for the exported cargo and thus defines how the export customs clearance will be performed. If the collection point is located outside the EU, the Exporter arranges for clearance to be made by the Customs Agency. For this purpose, he sends the clearance order and the necessary customs documents by e-mail. The Customs Agency prepares the necessary commercial documents and submits them in paper and electronic form to:

- control services,
- the Customs Office.

During this time, the road carrier places the container at the place of customs clearance.

The inspection services, on the basis of the received commercial documents, perform a proper inspection of the container. The confirmation of the inspection is sent to the Customs Office via the UC system. The inspection services also inform the Customs Agency about the inspection by e-mail or telephone.

Confirmation of the inspection performed by the inspection services and commercial documents received from the Customs Agency constitute the basis for the Customs Office to clear the declared cargo. After the customs clearance, an employee of the Customs Office puts the customs seals on the container and enters the information about the customs clearance into the UC system.

The Customs Agency, on the basis of both information (about proper control and customs clearance), prepares a set of customs documents. Then it transmits:

- Road haulier - a paper version of the clearance confirmation and a complete set of customs documents,
- Forwarder (by e-mail) confirmation of the clearance.

The carrier, after receiving the complete customs documentation, transports the container to the terminal for loading and export to the final recipient.

The Freight Forwarder, received via e-mail confirmation of the customs clearance, enters the terminal's IT system and informs the Terminal in this way.

The entities involved in the customs clearance process are: Railway Terminal, Freight Forwarder, Exporter, Road Carrier, Customs Office, Customs Agency, Inspection Services.

Information related to monitoring e-commerce parcel shipments from China to Poland

Below you can see the flow of information and documents on ecommerce shipments between different participants of the distribution process of parcels from China to the final customer in Poland realized by the Polish Post.

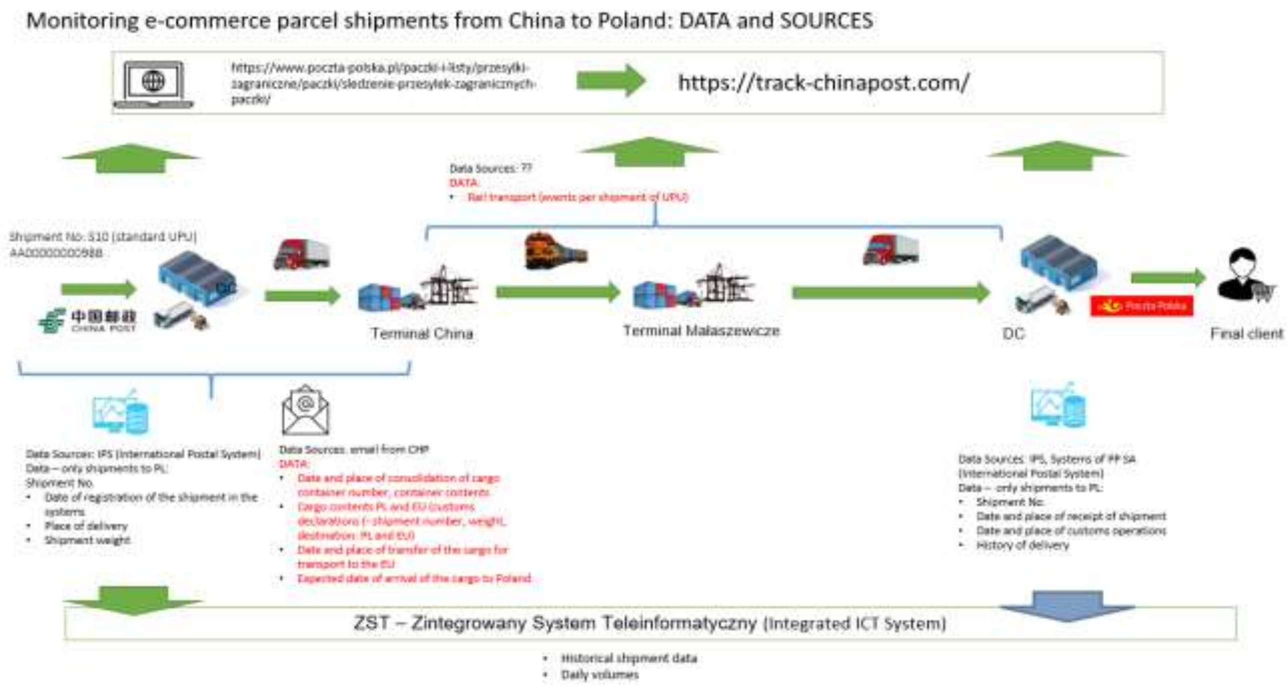


Figure 4 Parcel shipments monitoring – Polish Post

From the point of view of information flow in the mail distribution process, three basic aspects should be noted:

- information integration in the relationship between the Polish Post and the customer,
- analysis of application of dedicated IT systems for Polish Post in logistic processes within the New Silk Road,
- integration of IT systems within the structures of the Polish Post.

The flow of data and information between the customer and Polish Post is possible by using the main application for business customers, EN (Electronic Shipper), which is integrated with the rest of Polish Post's IT systems, including domain systems used in logistics operations. Within EN, customers have several options, the most frequently used of which are:

- web application (https://e-nadawca.poczta-polska.pl/) - functions of generating labels/adding shipments/ generating reports - application also available in English,
- integration of an external system (usually ERP/WMS/e-commerce platform), e.g. using WebAPI (technical documentation available online - https://e-nadawca.poczta-polska.pl/ - both in terms of label generation and tracking system).

A separate issue is the analysis of the IT systems of the Polish Post Office, which are involved in the implementation of logistics processes within the New Silk Road. Figure below shows how the IT systems of the polish Post Office are used during the realization of the New Silk Road processes.

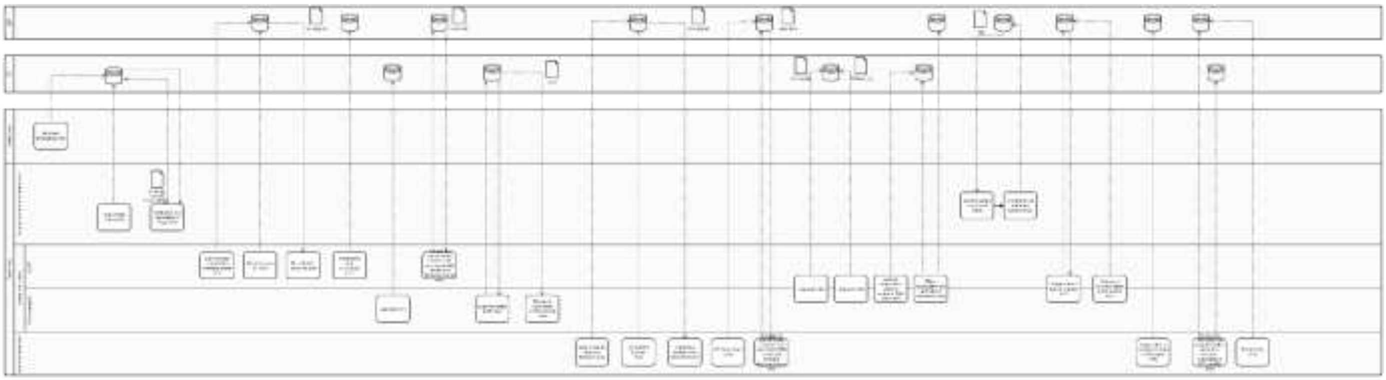


Figure 5 Use of Polish Post IT system

Activities performed in Postal Service information systems:

International Postal System:

- China Post enters data at intake,
- China Post scans and verifies,
- PP uploads CN37 shipping document in it,
- PP includes letter flags (standard/express) in it,
- Final verification

Polish Integrated ICT System (ZST):

- PP enters shipment data into the system,
- OT cargo list is generated,
- KRP (Postal and forwarding course) list is generated,
- Sampling and data completion,
- Registration of receipts,
- Scanned shipments.

The last issue, which is important in terms of integration of IT systems with the Data Bus within the New Silk Road, is the issue of system integration within the structures of the Polish Post. The implementation of a new ERP solution in the form of Microsoft Dynamics AX 2012 is supposed to integrate all systems and domain applications of the Polish Post. Microsoft Dynamics AX is supposed to support the Polish Post in handling processes of its own economy:

- finance and accounting
- fixed assets
- warehouse management
- real estate settlement

The Microsoft Dynamics AX system can be accessed in many ways, e.g. through an Internet browser, as a Windows user, from another application using COM technology or by means of mobile devices. The Microsoft Dynamics AX solution works with Microsoft SQL Server and Oracle databases. Microsoft Dynamics AX enables the exchange of EDI messages both in EDIFACT and XML, which significantly influences the readiness of Poczta Polska for system integration with the designed Data Exchange. Dynamics AX makes it possible to use the "enHanced Integration Framework" (EIF), which is designed to eliminate any integration issues between Dynamics AX and business partner systems.

The solution for integrating Microsoft Dynamics with both the Postal Service's internal systems and external systems demonstrates the Postal Service's high functional and technical readiness for information integration with the Data Exchange.

4 Living Lab Goals

4.1 Envisioned physical flows

Basic use case assumptions

LL3 will focus on streamlining logistic processes in flows from China to Europe along the Silk Road Route by implementation of IoT technologies and EPCIS platform as well as other GS1 standards that facilitate transmission of data between the partners involved in the logistics operations within the e-commerce channel.

Increased visibility of goods thanks to IoT along the Silk Road

Development of IoT solutions based on DASH7, RFID, LPWSN and sensors systems that help control resource parameters in real time and identify them while moving in the transport process, examining potential positive results in terms of broad implementation

Implementation of the SSCC number and EPCIS test (standardization of information flow)

Creation of a digital connection between actors in the transport network, enabling standardized data flow and access to information about cargoes coming from China to Poland in the whole supply chain in real time (implementation of the SSCC number and EPCIS test)

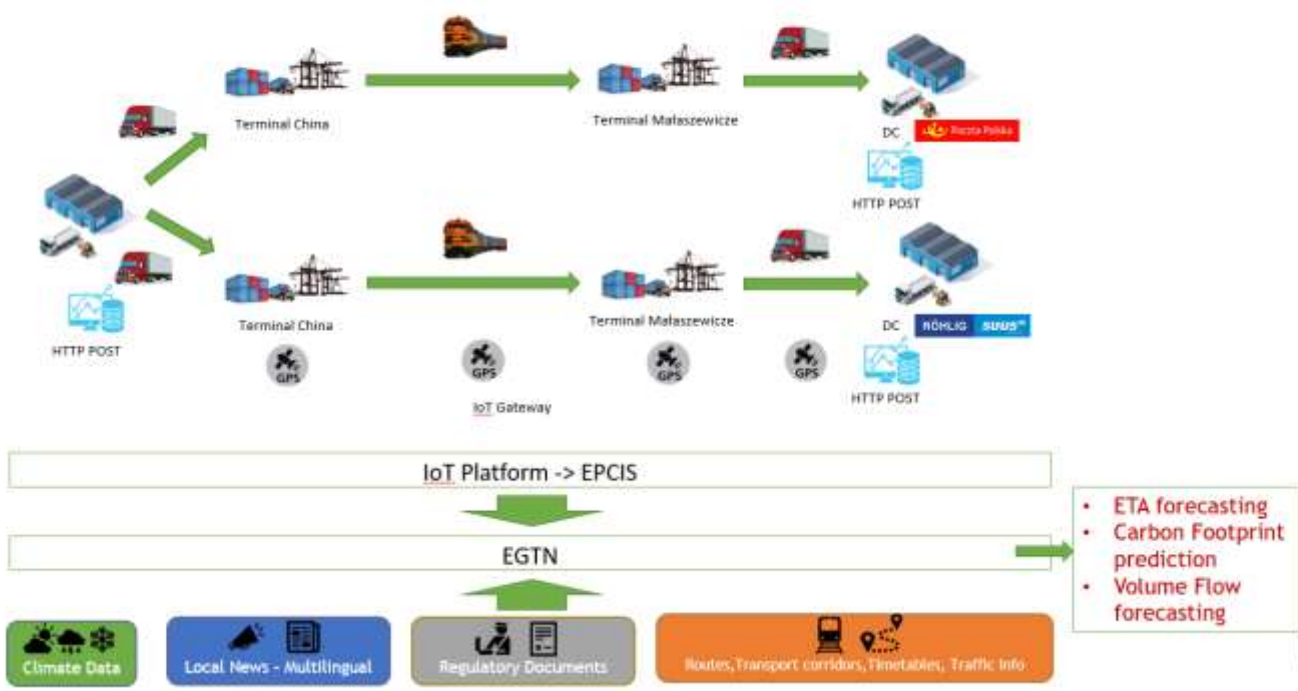


Figure 6 Use case scenario

Envisioned physical flows from a bird's eye view are shown below. The areas where the change will occur are highlighted in yellow.

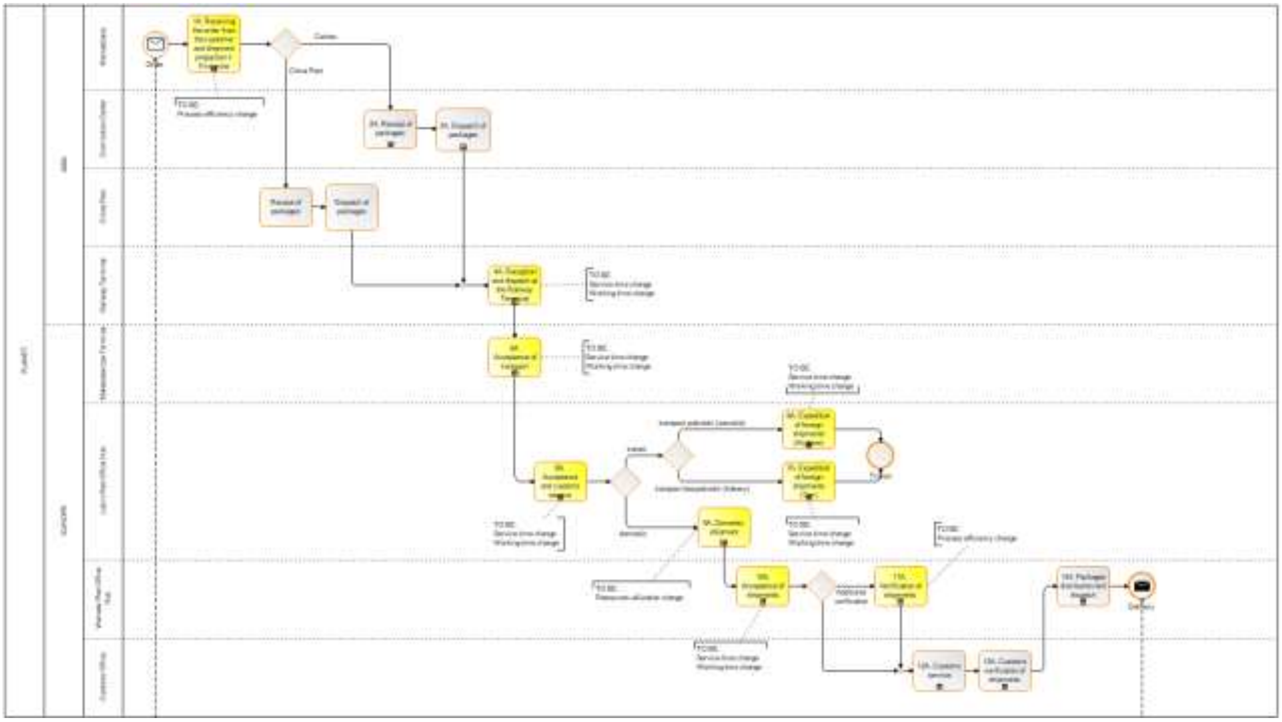


Figure 7 Polish Post Use Case

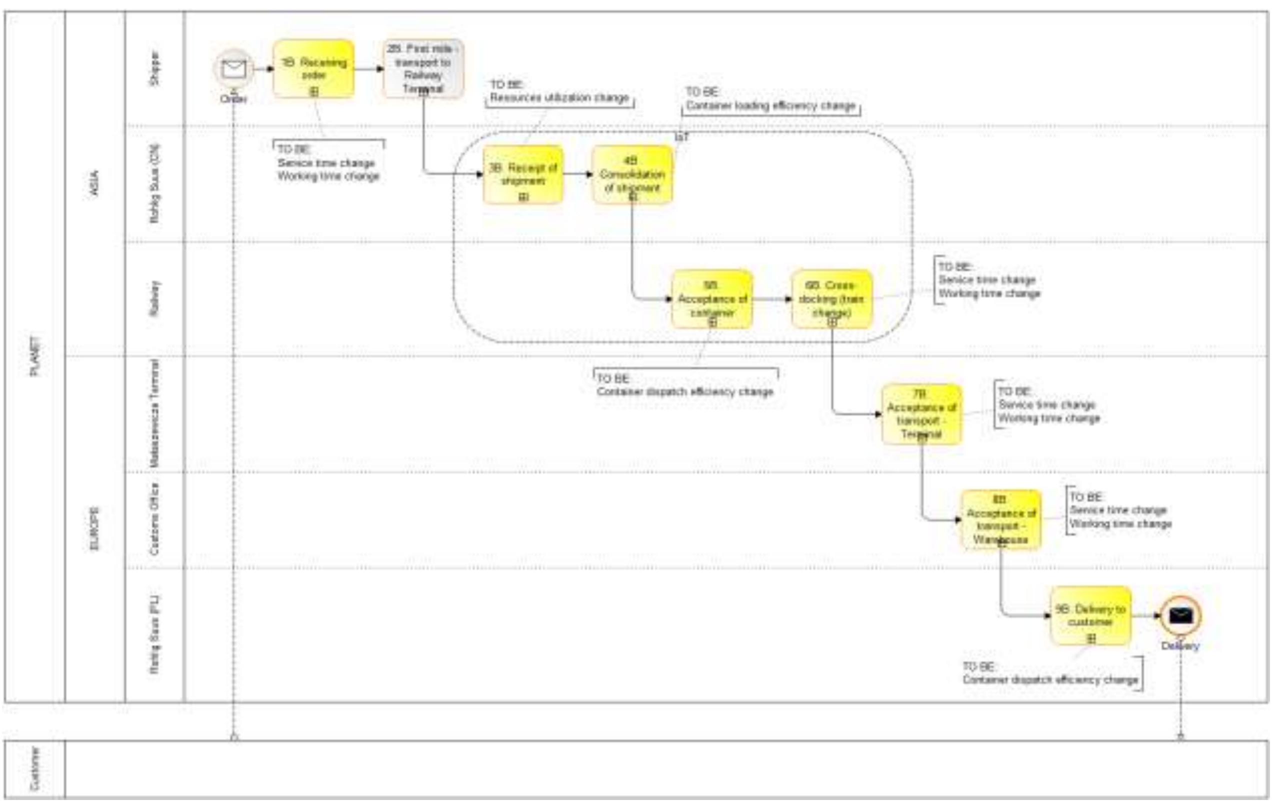


Figure 8 Rohlig Suus Use Case

4.2 Envisioned information flows, addressing interoperability and standardization requirements

To improve information flow and visibility of shipments through the supply chain and due to the nature of LL3 and the composition of the team of business partners carrying out project tasks in LL3, the substantive scope of implementation has been divided into two aspects:

- usage GS1 standards,
- usage of EPCIS and sensory networks [2].

The application of GS1 standards in the logistic processes of the New Silk Road

The analysis of the identified requirements indicates the necessity of a uniform and standardized identification of the shipments handled within a common IT system and the exchange of information and electronic documents throughout the supply chain.

The problem of standardization of the e-commerce parcel (goods) identification system in cross-border trade concerns four basic systems:

- marking and recording of goods and loads according to the global GS1 standard for the needs of broadly understood logistics,
- classification and grouping of GPC products for the purposes of commercial transactions between suppliers and recipients,
- identification and customs classification of goods according to the Combined Nomenclature CN using the Taric tariff for the purposes of customs and treasury service of commercial transactions,
- identification of shipments and loads according to the UPU industry standards for the purposes of their recording, tracking and planning.

Below, we would like to present an assessment and a short description of the four basic systems for the identification and classification of products (postal items) between China and Poland, taking into account the analysis of shipments on the Europe-Asia route.

A particular attention was paid to the possibility of unifying and standardizing the used identifiers and cooperation of the used IT systems.

GS1 Standards

GS1 is a global standard for the identification of goods, services and entities, which uses two basic marking standards -barcode and RFID technology.

For the purposes of the GS1 system, there have been developed the 11 global identifiers, which are used in the logistic process of handling goods flows, services provided and inventory of resources.

- GLN – Global Location Number
- GTIN – Global Trade Item Number
- SSCC – Serial Shipping Container Code
- GSRN – Global Service Relation Number

[2] The use of sensor network is described in another document "Detailed IoT requirements".

- GRAI – Global Returnable Asset Identifier
- GIAI – Global Individual Asset Identifier
- GDTI – Global Document Type Identifier
- GSIN – Global Shipment Identification Number
- GINC – Global Identification Number for Consignment
- GCN – Global Coupon Number
- CPID – Component/Part Identifier

For the purposes of handling the import of goods from China, it is highly recommended to use primarily two basic identifiers, which include:

- **GTIN** - Global Trade Item Number, that is recommended for the identification of goods,
- **SSCC** - Serial Shipping Container Code, that is designed to identify loads,
- **GLN** – Global Location Number, is used for standard location (warehouse, distribution center, terminal..etc) identification, together with its specific infrastructural features.

The usage of the developed GS1 standards is aimed at streamlining logistics operations in the entire supply chain by using a unique and uniform data recorded by all participants of the GS1 system.

GPC standard

The Global Product Classification (GPC) - is an international GS1 standard that allows for a unified grouping and classification of products. This standard is primarily used to support the process of product data exchange. The GPC standard is used in the catalogs of the Global Product Data Synchronization Network (GDSN).

The data structure in the GPC classification corresponds to the logistic needs of commercial transactions between suppliers and recipients. Basic data contained in the catalog include at least: product name, brand name, product specification / characteristics, product identifier (GTIN - bar code), dimension and weight information, types of packaging, local and international classifications, etc. The range of goods in the TARIC database so far is much larger than in the GPC catalog.

Using the GPC classification as a source of logistic data for goods imported from China in customs and tax or trade processes requires an unambiguous correlation between the GPC product structure and the Taric Tariff according to the CN Combined Nomenclature.

UPU standards

The determinants of the process of handling e-commerce postal items from China may vary on the internal regulations and principles of handling Polish Post and they are in line with the standards of the International Postal Union (UPU).

The industry standards of identification S24-1 and S26-1 are used to handle postal items, according to the UPU recommendations

An e-commerce postal item from China in import to Poland or in transit to other EU countries can be defined at three levels of identification:

- shipment from China - with an identifier, that compliant with the UPU S8 standard (20 characters),
- bag /container in the shipment, containing postal items - identified in accordance with the UPU S9 standard (29 characters),

- postal items in each bag / container - parcels, letters - identified in accordance with the UPU S10 standard (13 characters).

For the operational handling of shipments from China, Polish POst uses the Integrated IT System - ZST WiEmPOST.

It is intended for registration and monitoring of all postal items, including courier items, parcels and payroll. This system, used in all forwarding and distribution nodes (WERs) in Polish Post, enables planning and registration of cargo handling operations. Based on the data registered by ZST, it is possible to track the status of a postal shipment (truck & trace) in the operating system of Polish Post in Poland.

Data exchange between ZST and the International Postal System (IPS) enables the shipper and the recipient to track the shipment status.

The UPU guidelines recommend that companies using proprietary solutions should also use global and industry standards, if such are applied by its partners (in Poland, customers of Polish Post apply global standards GS1).

The IT systems of Polish Post are not connected with the systems of the Customs Service, as well as with the systems of partners within the supply chain (including railway carriers, logistics operators). Currently, data exchange between systems takes place bilaterally by means of e-mails and the transfer of files with data about shipments.

The lack of widespread use of standard identifiers of load unit makes it impossible to track the physical flow of logistic units with postal items throughout the entire supply chain. The use of the identifier according to the UPU standard enables limited tracking of the shipment status only for registered events.

CN standards

The basis for the identification of e-commerce goods in cross-border trade, customs and tax procedures is the Harmonized System for Marking and Coding HS Goods and the product identification system based on it according to the Combined Nomenclature CN. This nomenclature is the basis for identifying goods for the EU TARIC Integrated Customs Tariff. The TARIC code, which consists of a total of 14 digits, contains a wide range of data, including:

- duty rates expressed as a percentage or amount,
- period of validity of the duty rate,
- quantitative limits (quotas) and tariff quotas,
- import and export restrictions,
- anti-dumping duties,
- countervailing duties,
- import and export bans.

The digital version of the tariff is creating the TARIC IT system. The TARIC database does not contain the national internal tax information of individual EU countries, such as VAT or excise duty rates. They are included in the national counterpart of the TARIC system - the ISZTAR4 system.

The CN codification is obligatorily used in commercial, customs, tax and settlement transactions in the world, and the CN nomenclature is the basic reference for the law regulations in the EU.

In order to improve the efficiency of handling postal parcels, it is necessary to consider linking the HS / CN / TARIC codes with the GPC and GTIN code dictionaries in the GS1 standard. Such a correlation would enable, first of all:

In order to improve the efficiency of handling postal parcels, it is necessary to consider linking the HS / CN / TARIC codes with the GPC and GTIN code dictionaries in the GS1 standard. Such a correlation would enable to:

- filling in obligatory descriptive fields for goods in all active documents (waybills, logistics and transport labels),
- scanning of postal items in the control process with the possibility of their verification.

The mechanism of mutual correlation of HS / CN / TARIC → GPC codes can be an important support tool for handling the mass flow of small consignments imported from China in the e-commerce channel.

Parallel application of the GS1 and UPU standards

The research carried out as part of this project irrefutably demonstrates the need for simultaneous use of GS1 and UPU standards. The following table shows the processes in which dual use/scanning of GS1 and UPU standards should occur. This involves some process inconvenience, but the benefits of full shipment monitoring are incomparable.

Table 2: Possibility of parallel application of GS1 and UPU standards

Process	Business role	Application of GS1 standards	Application of UPU standards
Identification of goods/product	Manufacturer/Seller/Internet Shop in China	GTIN product labelling	Classification of shipped goods for customs and tax charges according to the data of ISZTAR4 system
Creation of bulk packaging	Consolidator/Chinese Post	Assigning master SSCC to a master package	Bag identification with CN34 label
Transport	Railroad carrier	-	-
Acceptance of cargo in WER Lublin	Polish Post	Receiving an EDI message with a list of all packages*	Receipt of CN37 document
Unloading the bags from the container	Polish Post	SSCC scanning of each bag	CN34 Label Scanning
Transport to Warsaw	Polish Post	-	-
Acceptance of consignments for inspection	Customs	SSCC scaning	CN34 Label Scanning
		GTIN analysis	Analysis of data from ISZTAR4
Registration of unregistered shipments	Customs	Application of GS1* label	Internal labeling of the Polish Post

Organisation of returns	Customs	SSCC scanning of the returns	CN34 Label Scanning

The project work also identified the following potential problems of parallel application of both standards:

- the size of some parcels, making it difficult if not impossible to affix the two cargo identification codes (UPU and GS1),
- the need to perform duplicate scanning operations on both codes,
- the high probability of scanning operations twice generates the need to use an appropriate system filter (e.g. in the ZST or IPS system) to eliminate mistakes, preventing the scanning of the wrong code at an undesired stage of the process.

The usage of EPCIS in logistic processes of the New Silk Road

There is a possibility to use EPCIS to monitor rolling stock. However, when considering the application of the EPCIS to the monitoring of rolling stock, there are a number of specific issue.

At first, it is important to understand the division between the EPCIS interface specification and the RFID specification. The EPCIS standard assumes that the RFID system will send location and other information in specific situations, but should not dictate how to create and capture this information. The EPCIS standard has an impact on RFID implementations as it defines what information should be collected. Second, the use of EPCIS to ensure the monitoring of rolling stock requires the use of EPCIS and CBV standards. EPCIS also enables the exchange of information. The consistent EPCIS event structures ensure that the data can be shared and used by other rail operators.

The rolling stock is needed to be monitored as it moves within and between countries ("asset tracking").

It is assumed that with the growing popularity of the use of radio frequency identification in rolling stock, there will be more and more applications of information related to the monitoring of railway wagons and locomotives. It is a solid basis for the usage of EPCIS in rail transport.

The need of monitoring rail vehicles refers to the operational functions in the company's operations where one needs to know the current location of the rolling stock. Asset tracking allows for better planning of operations and can also improve the utilization of the rolling stock.

When monitoring assets, it is usually based on level 1 of the mode of transport (wagon, locomotive), tracking the location and status of individual rolling stock during transport. The potential use of EPCIS can be indicated below:

- real-time tracking of loads,
- estimating the distance travelled by the vehicle in order to plan preventive maintenance,
- vehicle availability planning.

It is also possible to use EPCIS to obtain data on rolling stock (wagons, locomotives), as well as rolling stock components to facilitate preventive maintenance.

Wayside Train Monitoring Systems (WTMS), because we are talking about it, is an integrated system of measuring devices that monitors the condition of the rolling stock moving on railway tracks. These systems have been in use for many years and are becoming more and more common as a way to reduce the number of accidents by enabling preventive maintenance and improving the reliability of the railway system. Using EPCIS it is possible to monitor:

- hot axle detection - measure the temperature of wheels and axle bearings to identify components that require maintenance or repair.
- wheel shock load detection - measurement of static and dynamic forces between rail and wheels in order to identify wheel defects and abnormal rolling stock loads.
- Acoustic axle bearing monitoring - measuring axle bearing degradation with acoustic sensors.
- pantograph - the use of high-speed cameras and image processors to identify broken pantograph carbon strips.

There is a potential for using EPCIS in rail transport in the New Silk Road. It was indicated that the greatest potential for the use of EPCIS exists in the real-time monitoring of rolling stock. Thanks to this solution, it will be possible to: track loads in real time, estimate the distance traveled by the vehicle in order to plan preventive maintenance, as well as the control of vehicle availability. EPCIS can also be used to collect information related to the operation of rolling stock, e.g. hot axle detection, wheel shock load detection, acoustic axle bearing monitoring, and pantograph damage monitoring.

4.3 Envisioned Business Model & Incentive system for the implementation of the solution/concepts

Strategic analysis for a product event database based on the EPCIS standard

From an ideological point of view, a product is a set of tangible and intangible attributes which are offered by the seller and acquired by the buyer, who accepts the properties of a given good or service as those which satisfy his own needs. A product is therefore everything that can be offered on the market, i.e. every good and service that can be purchased, used or consumed, thus satisfying a human need.

Taking into account the above definition, one may be tempted to define an event database based on the EPCIS standard as a product. In this sense, the core of a product is its technical and functional dimension, or in other words, it is a developed information solution. This solution has been built on the basis of specific functional requirements according to a specific project defining its architecture in accordance with the requirements of the EPCIS standard.

Accordingly, it should be assumed that the starting point for this product are the requirements of functional nature, which largely result from the analysis of the needs of potential customers interested in the created solution.

Thus, from the users' point of view, the system must meet the following requirements:

- process large amounts of data in a rigorous timeframe - have high performance communication interfaces that allow for fast registration and retrieval of large amounts of data,
- be characterized by high availability - the system must ensure high accessibility via the global Internet network,
- No Single Point of Failure - the system must be resistant to the breakdown of individual components, therefore each component must be at least duplicated.

- easy scalability - the system must be scalable, which means that the architecture can be easily adjusted in terms of performance.
- allow for quick and easy integration - the system must allow for easy and effortless integration with other IT and hardware solutions,
- ensure a high level of data security,
- be standard - i.e. compliant with a specific global standard, such as EPCIS.

Realization of all the above requirements supported by activities resulting strictly from the adopted marketing strategy and business model makes it possible, in principle, to define the real product, i.e. including the core/nucleus along with other elements of the product that determine how it is perceived by the customers. In typical physical products, the non-core elements are features such as price, quality, packaging, style, model, appearance, brand, trademark, and materials and raw materials used. In our case, the catalog of additional features is not so extensive and is limited to: price, quality (understood as the quality of the database itself but also as the quality of website production, information and advertising materials, etc.), brand (perceived as a promoted trademark) and appearance, but only in relation to the website being the front side of the created solution and dedicated both to persons representing the management levels of companies/start-ups and to developers (as separate websites).

The last variant is the so-called extended or augmented product. It includes in its scope the core/nucleus which is a component of the actual product and the so-called added value which creates additional benefits for the customer. This includes elements such as: the method of product delivery, the length of the guarantee, the complaint system, included spare parts, ease of installation and maintenance, contact with the potential customer, availability of service and maintenance points, payment terms, as well as adequate information about the product and its promotion.

Of course, in the case of EPCIS, it is necessary to define the features that can be treated as added values for customers. These may be: the length of the guarantee, the way of solving and maintaining the so-called technical support, payment conditions, which result partly from the adopted business model and the product information and promotion system resulting from marketing activities.

SWOT analysis

A SWOT analysis was conducted to provide a more complete picture of the product situation. Such analysis began by identifying a list of Strengths and Weaknesses of the solution.

STRENGTHS

- Scalability (ease of expansion) understood as the ability to easily increase the capabilities of the database by adding additional system components and computing power.
- Reliability, perceived as a feature of the system allowing to receive data efficiently with minimum risk of failure. In other words, the system is resistant both to continuous transmission of large volumes of data and to sudden increases in the number of events.
- Openness of the solution, i.e. access to the system in the freemium model, allowing to launch products without additional start-up costs.

- No limitations as to the data model, understood as the universality of the database, i.e. possibility to accept events of any information content and structure.
- Ease of entry and integration (connecting) resulting from the simplicity of the adopted API
- Hosting, seen through the prism of Beyond.pl's brand, in fact its new hosting centrum, and the Rated-4/Tier-4 security certificate in accordance with AN-SI/TIA-942:2014 (as the only company in Poland and one of few in Europe)

WEAKNESSES

- Lack of brand and marketing support, understood as a weakness of ILiM, resulting from lack of human and financial resources to conduct effective marketing campaigns.
- Difficulty of the standard, especially its non-intuitive nature, which can be a barrier to entry, especially when trying to use the database in a manner fully compliant with the current EPCIS standard.
- Limited human resources on the part of the Identification Laboratory department resulting from the lack of sufficient financial resources and above all from the existing model of financing ILIiM, which causes dispersion of resources (forces to engage in many projects at the same time).
- Lack of experience with databases with such an extensive structure, which is due to the relatively early stage of development of this technology.

Next, a list of Opportunities and Threats in the product's market environment was defined.

OPPORTUNITIES

- Exploding market for IoT, cloud and BIGData, in other words a huge increase in interest in solutions of this type and an increase in the number of solutions operating in these areas.
- Niche market for systems combining IoT and event logging capabilities, i.e. little competition for systems combining these two functions in one.
- Base for ILIM projects, i.e. basis for implementation of projects like WIR, PCS, etc. and building new products like EtLog.2D
- Growing market of solutions resulting from increased ecological awareness, i.e. possibility to use the system in implementations related to environment monitoring (example: air quality monitoring)
- Market opportunity resulting from implementation of a global standard understood as a bonus on the market resulting from the fact of using a standard promoted also on a global scale by GS1 organization.
- Use of market opportunity resulting from the need for globalization, that is the need to transfer information between partners in supply chains.

THREATS

- Changeability of the standard due to its continuous development and dependence on many other GS1 standards, which are also in the process of continuous improvement.
- Lots of strong competition, not necessarily perceived directly but in specific applications e.g. lots of solutions for traceability, lots of IoT platforms.

- Lack of trust in distributed systems in relation to data security issues, which is the case mainly in Poland
- Uncertainty of development understood as uncertainty of relationship between GS1 Poland and ILIM and ultimately uncertainty of long term financing.
- Competition in the labor market, i.e., difficult access to staff at reasonable cost levels and problems with maintaining existing resources.

Business Model Canvas

The Business Model Canvas is a strategic management template used for developing new business models and documenting existing ones. It offers a visual chart with elements describing a firm's or product's value proposition, infrastructure, customers, and finances, assisting businesses to align their activities by illustrating potential trade-offs.

The nine "building blocks" of the business model design template that came to be called the Business Model Canvas were initially proposed in 2005 by Alexander Osterwalder, based on his earlier work on business model ontology.

1. Target segment – it includes different groups of people, organizations that will be targeted by the activities of the project:

- ICT solution providers
- Logistics operators
- Manufacturing companies

2. Value proposition - it is what we offer to customers that sets us apart from what the competition is offering. These are the benefits that the customer will receive:

- Collection and sharing of event data generated by a larger system developed by the licensee.
- No Single Point of Failure - the system is resistant to the breakdown.
- Scalability (ease of expansion) understood as the ability to easily increase the capabilities of the database just by adding additional system components and computing power.

3. Key partners - business partners without whom the business could not function:

- ICT solution providers.

5*. Distribution channels - channels are how we reach the customer and sell the product:*

- Direct sales during sales meetings with potential customers.

5. Revenue streams - indication of how the product or service will generate revenue:

- License fees for using ECPIS as part of a larger solution.
- or “Freemium". This model assumes that a given product or service is available for free, but using its advanced functions requires buying the premium version.

6. Cost structure - all expenses incurred in connection with the operation of the business model:

- Costs for maintenance (hosting) and ongoing operation of EPCIS
- Sales
- Marketing

7. Key resources - company resources that are essential to the operation of a particular business:

- EPCIS database
- People working to develop the EPCIS
- Individuals responsible for the ongoing maintenance of EPCIS
- Servers provided by the hosting entity or owned by ILIM

8. Key activities - the most important steps a company must take to deliver value, establish a relationship with a customer, and generate revenue:

- Prepare a dedicated contract for this audience.
- Formulation of a license agreement.
- Planning and execution of acquisition meetings combined with presentation of the solution.

Sales model

In general, the models for selling specific services based on the operation of the EPCIS system and the model for selling access to the event database itself should be separated.

The model for selling EPCIS as a solution to be used in other larger systems will be related to the sale of a licence and requires a valuation of that solution.

The model of selling access to the event database in EPCIS may be based on a freemium scheme. This model assumes that the product or service is available for free, but the use of its advanced features requires the purchase of a premium version. In the case of EPCIS, based on a comparison of competitive offers, it is assumed that paid solutions will be based on specific service parameters. In this case, it is proposed that the basis for calculating fees should be

- number of connected devices/business locations that are the source of data
- number of sent/generated events on a daily or monthly basis
- number of queries sent on a daily or monthly basis
- amount of used space in the repository
- resolution of data access

As the solution was created in cooperation with GS1 Poland, it is proposed that for registered members of the system it is possible to obtain an additional discount (verification by the company prefix in cooperation with the GS1 Poland database).

The platform as such, similarly to theThings.iO will also natively support implementation of solutions in a selected technology. These are proposed to be LoRa and DASH7. Access to DASH7 know-how will be covered by a free license. Additionally, it is worth considering that ILiM in cooperation with selected partners should offer ready hardware solutions in the form of "Starter Development Kit", modelled on WizziLab products (http://wizzilab.com/wizzikit) as well as development support (including prototyping services) and production support (in cooperation with an external partner e.g. EBS company - http://www.ebs.pl/o-firmie/produkcja-oem-odm).

The cost-effectiveness of the alternatives, understood mainly not as switching costs but as a comparison of business models, is rather favorable.

Marketing strategy

A marketing strategy refers to a business's overall game plan for reaching prospective consumers and turning them into customers of their products or services. The following are tools for implementing the strategy:

- *Promotional instruments:* mainly direct marketing (personal selling) supported by promotion of access to the pilot solution (concrete application of the system e.g. for traceability) and public relations activities (cooperation with industry organizations) and advertising.
- *Media:* organization of workshops presenting the solution through its specific use (stationary and mobile) and webinars, participation in conferences and fairs, sponsored articles in trade press and promotion via the Internet (via ILiM newsletter, information on industry portals, social networking sites (FB, linked-in, goldenline), own blog).
- *Forms of promotion:* presentation of the product through its benefits and specific applications, mainly in terms of traceability and 2D label (ppt, prezi), video, website (multilingual) with more dedicated content (more in terms of application than the technology itself).

4.4 Logic/rules and available data for intelligent decision making

In LL3 we focus on streamlining logistic processes in flows from China to Europe along the Silk Road Route by implementation of IoT technologies and EPCIS platform as well as other GS1 standards that facilitate transmission of data between the partners involved in the logistics operations within the e-commerce channel.

Development of IoT solutions based on DASH7, RFID, LPWSN and sensors systems will be used to control resource parameters in real time and identify them while moving in the transport process, examining potential positive results in terms of broad implementation. At the same time creation of a digital connection between actors in the transport network, will enable standardized data flow and access to information about cargoes coming from China to Poland in the whole supply chain in real time by the implementation of the EPCIS event based database and exchange of the gathered data with EGTN infrastructure.

Data gathered from sensors and IT systems of the silk route actors, brought to the EGTN planet platform through the IoT pipeline applications, will be made available within the platform to be further processed by being aggregated with other supporting information. This includes but is not limited to:

- a model of train routes with corresponding timetables, history of travel times, and freight train composition (number of cars, engine specifications),
- historical weather data and historical weather forecasts from the vicinity of route train stops,
- integrating IoT sensor readings with train movements along the route and loading/unloading of containers.

These additional data aggregation tasks will become relevant for additional considerations for services and applications such as for the reduction of CO_2 emissions, and developing models for transport volumes, transit time, transport costs, delays, and incidence of trade.

The currently developed predictive models are to be further validated using IoT data available to forecast information to enable different services such as a corridor route optimization analytics and transport models' services to build decision support systems, perhaps at least on simulation settings.

4.5 Modularity for shared transport

The promotion of cooperation in the field of logistics services is dictated by the inefficiency and instability of the current organization of the logistics system. Transport, due to incomplete use of cargo space and limited information on the availability of resources in real time, generates significant economic, social and environmental costs. Another important aspect affecting low operability, especially in distribution, is the lack of modularity of loads. This has a negative impact not only on the transport process, but also on handling and storage activities.

Modular format in the distribution process

An important step towards the realization of the Physical Internet concept is the aforementioned introduction of modular loading units in which goods will be securely sealed. To justify the need for such a solution, the Physical Internet can be treated as an analogy to the traditional digital Internet. Information is transmitted on the digital Internet and tangible goods on the Physical Internet. Information on the Internet is sent in the form of packets, appropriately marked. Thanks to the marking it is possible to identify the packet - names, senders and recipients, while the content itself, the information is "closed" in the packet and is available only to devices or persons with appropriate privileges. Markings are stored in a standardized form. Similarly, the Physical Internet will not "handle" goods directly, but only manipulate specially designed modular containers that allow for full protection of those goods, which responds to the fears of broadcasters that the placement in one warehouse or vehicle of products of competing companies may allow access to trade secrets.

Modular loading units on the Physical Internet will be constructed in such a way that the elements can be joined together, folded out and folded several times, and ultimately easily recycled. A very interesting property envisaged by the creators of the Physical Internet concept is the possibility of using modular units as shop displays - through easy disconnection of selected walls. Modular loading units will be equipped with sensors that allow full control during the transport process - e.g. temperature, humidity, pressure, shocks. The units will be able to communicate with the Physical Internet system using transmitters sending information in a standardized e-Fright format available to authorized recipients (Landschutzer, Ehrentraut, Jodin, 2015)

Ultimately, the modular unit is to play the role of both collective packaging for products (equivalent to e.g. cardboard) and an alternative transport unit (equivalent to e.g. a pallet).

Shared transport concept in postal services

Physical Internet concept that was first introduced to FMCG distribution shows that efficiency growth can be achieved by sharing resources, information exchange and new reusable and recyclable packaging under the condition of willingness to collaborate among involved parties. Physical Internet shows the new approach towards logistics operations and its positive impact on efficiency and cost reduction need to be further examined.

Full implementation of the concept of Physical Internet, i.e. the flow of products and commercial information in the safest and most cost-effective way, according to initial estimates, this is the work planned for the next 20 years. Despite the fact that it seems to be a rather distant horizon, the logistics industry environment is already intensively developing tools supporting cooperation in supply networks. Most activities are currently focused on IT solutions, although companies more and more often point to the need for increased activity in the area of collective packaging.

Standardization of flows and reloading operations, and thus reduction of logistics costs in the low-margin transportation industry is a key factor in building a competitive position. Speaking of PI-box, apart from standardization of this unit, the possibility of its modelling and use as a shop display, its significant feature is the ability to fully monitor the condition of goods and the course of the distribution process in real time. It is also a key factor giving a sense of security and appropriate protection of shipments on the Physical Internet (Ballot, Montreuil, Meller, 2014). Taking into account the above benefits, the concept of the Physical Internet with the use of standard modular units (M-box) seems to be an interesting alternative to the pallet transport system, which, although so well-known and well-established from the logistic point of view, still leaves a lot to be desired.

The realization of the above concept can be partially realized within the Living Lab in the Polish Post use case. While the idea of the Physical Internet still requires many years of research and operational work, the partial realization of this idea through shared transportation resources may be the first step in spreading this vision.

Polish Post's current process for processing shipments from China assumes that:

- e-commerce parcels, with domestic destination in PL are transported from terminal Małaszewicze (PL) to PP distribution center WER Lublin/WER Warsaw (PL) and from there after sorting they are forwarded to appropriate regional center or directly to the final recipient,
- e-commerce parcels with a foreign destination (BE/NE/LUX) are transported from the terminal Małaszewicze (PL) to the distribution center WER Lublin (PL) and then **without sorting** they are transported to the destination country as **full bags.**

Currently, Polish Post operates the EU foreign postal channel with its own fleet or by cooperating with external carriers who perform the transport of postal items only.

The current analysis of the efficiency of these transports shows that there is an area for improvement in terms of:

- increasing vehicle fill rates,
- reducing costs.

One of the solutions that could positively influence the improvement of the above-mentioned results is the introduction of transport sharing model.

Requirements from both the fields have been considered in the definition of the approach to data and processes, in order to define a solution viable for both scenarios.

Due to significant differences in the characteristics of products (mainly weight) and the way they are packed in the FMCG industry (cartons) and in the postal industry (bags), there is a need to implement a modular solution that would allow sharing transport resources while increasing the rate of filling by stacking.

Potential benefits of modularity implementation

- Increased willingness to share means of transport and warehouse resources in distribution processes - reduction of operating costs.
- Possibility of easy consolidation of loads due to modularity of units - more efficient use of loading space - reduction of transport costs.
- Full monitoring of storage, transport conditions and geolocation during the entire distribution process (especially in the case of fresh products or products sensitive to temperature/humidity changes).

- Simplified identification of product liability for damage due to real-time data access (e.g. compensation from carriers).
- Preventing the spread of commercial information, such as transported volumes or new packaging for promotional campaigns.
- Use of data transmission from packaging sensors according to the global standard GS1 – eFreight allowing companies to easily exchange goods and information at inter-national level.
- Possibility of creating new packaging sizes according to needs thanks to modularity of folding panels.

4.6 Visibility and product status (Big) data for ‘Corridor route optimization analytics’

The visibility of data from relevant events within the transportation network should be further developed by creating more trusted innovative technologies that have a wider view of the different aspects that have an impact in the development of a more optimized transport network. Part of these technologies is the corridor route optimization service considered for the Planet project and for which initial approaches considered are described in the deliverable D2.9.

For the corridor route optimization analytics service, Big data augmented by the detailed corridor transport models and real time IoT sensor information should be used to develop effective routing optimization that is based on accurate real-time information rather than static data. The development of the corridor route optimization-based analytics requires not only the Big data augmented by detailed corridor transport models and IoT sensor information, but also domain expert knowledge to be used as criterion to take the final decision on changing routes.

The corridor route optimization should allow to reduce its dependencies on predefined routes. By avoiding dependencies in the cargo flow, a more flexible and efficient transport network towards the Physical Internet (PI) concept of digital internet inspired protocols on adaptive routing, at each node, for information networks, would be enabled.

4.7 Expected Impact of adopted innovations including metrics

As part of the preparatory activities for the Living Lab, workshops were held with key business partners Polish Post and Rohlig Suus to identify their needs and expected results from the implementation of innovative solutions on their operations and EGTN development.

At the beginning of the workshop, Living Lab 3 participants constructed an answer to the question of how the solutions implemented in the pilot affect the development of EGTN in particular aspects:

- **Geo-economics aware**: The implemented solutions improve monitoring of cargo in supply chain increasing the attractiveness of the New Silk Road and development of the TEN-T network on a global scale.
- **Innovation:** Application of sensory network (IoT) for transport monitoring.
- **Impact:** Improvement of logistics processes both economically (ETA forecasting) and environmentally (carbon footprint).
- **Integrated:** An information-integrated supply chain enables the optimization of operational activities regarding unloading activities and potential consolidation of transported cargo.

- **Inclusive:** Enabling small businesses to develop PI networks through the use of GS1 standards.

Then, the business partners defined their roles and activities to be performed in the project that impacted test execution and operational KPI's.

Living Lab role of Polish Post

- Participation in global supply chain from China to Europe
- Development and evolution of solutions based on supply chain digitization
- Exploitation of information flow standardization
- Logistics’ processes optimization through IoT practical utilization
- Better planning of logistics processes thanks to additional analytics options
- Business communication improvement between supply chain partners

Expected impact of adopted innovations on Polish Post’s business operations

- Cost optimization
- Operational times optimization
- Transparency and supply chain correctness
- Distribution time reduction
- Improvement of delivery status monitoring in transit to client
- Possibility of monitoring of additional data, which cause in higher delivery service quality
- Safety increase of loadings / shipments
- Improvement of competitiveness of business partners on the market – higher quality of services, faster performance in terms of delivery times
- Reduction of operational errors caused by lack of detailed information about delivery
- Lower risk of shipment loss in international supply chain
- Increase of reloading operations’ effectiveness

Living Lab role of Rohlig Suus

- Increase transparency and control of organized rail transports on New Silk Road by tracking location, temperature, humidity, shocks and interference.
- Optimize logistics processes in rail transport by using IoT solutions.
- Carefully examine the conditions in which the cargo is transported by rail from China to Poland.
- Increase the accuracy of the estimated transport time and the prediction of its change.
- Improve the adjustment of the method of transport to the customer's requirements and prevent possible damage to the cargo thanks to the collected information on temperature, humidity and shock.
- Assess the potential to speed up transportation handling processes with instant access to cargo status and location information.
- Assess the potential of rail transport costs reduction.
- Assess the potential to improve the complaint process and search for the causes of damage.
- Increase the level of services provided by Rohlig SUUS Logistics (RSL) to customers thanks to IoT technologies and increasing the transparency of transports.
- Increase the awareness of RSL among potential domestic and foreign customers.
- Gain experience in the use of IoT technology in logistics and work under PPP and projects with EU funding.

- Promote industry cooperation and increase transport transparency on New Silk Road

Expected impact of adopted innovations on Rohlig Suus' business operations

- Shortening the time of transport thanks to faster reaction at individual stages
- Providing information on the status and location of goods on an ongoing basis
- Clear records of events affecting the cargo condition (exceeding temperature, humidity, shocks, tampering) and a clear division of responsibilities for damages
- Possibility of planning further activities after transport (e.g. production) with an accurate ETA
- Reduction of operational errors due to the lack of detailed information about the delivery
- Confirmed and documented conditions and risks of rail transport

Identified impacts have been matched to indicators that make it easy to measure whether the actual test results match the expectations of the business partners and meet their needs.

The identification of metrics has been divided into two levels:

- *financial & business impacts*, i.e. quality improvements and cost efficiencies achieved in day-to-day operations,
- *economic & social impacts*, i.e. congestion, accidents, air & noise pollution and climate change.

Indicators for financial & business impacts level

The following table provides a summary of indicators at the financial and business impact level. This table contains metrics for both business cases. Some of them are dedicated exclusively to Polish Post, some to Rohlig Suus and some are common.

Table 3: Indicators for financial & business impacts level

Data scope	CHARACTERISTICS/PARAMETERS
Transportation costs	• % Filling the container (LCL service) • % Timely collected containers from the TM in Małaszewicze • $ Costs of storage and detention
Accuracy of estimated transport time	• % Transports with accurate ETA • % Transports with documents prepared on time for customs clearance
Transparency of rail transport	• % Transports with exceeding the permissible temperature / humidity / shock levels • % Transports with interference with the goods during transport
Filling of the containers	• % occupancy of the loading container
Structure of loading	• qty of single (scannable) loading units in containers • qty of partners involved • % shipments with delivery time guarantee required
Transport information accuracy	• % of transports notified for pickup accordingly • % of containers complying with the detailed notification
Logistics service effectiveness	• % of containers hold for information completing • Allowance time for container (customs service preparation) • Average daily loading units handled in distribution center (project perspective)

Customs service effectiveness	• % of containers hold for additional customs data completing • Time from presenting the shipments for customs purposes until procedure finish • % of shipments hold for control / inspection
Safety of shipments	• % of containers consistent with detailed notification • qty of damage protocols (transport unit)

Indicators for economic & social impacts level

The following table provides a summary of indicators at the economic and social impact level. This table contains metrics for both business cases. Some of them are dedicated exclusively to Polish Post, some to Rohlig Suus and some are common.

Table 4: Indicators for economic & social impacts level

Data scope	CHARACTERISTICS/PARAMETERS
Shipment security	• Number of transport incidents • % of information compliant with the transport content
Network capacity	• Quantity of cargo entering the distribution center in a given time unit in relation to a specific contract • Quantity of cargo leaving the distribution center in a given time unit with reference to a specific contract • Average daily number of cargo units processed at the distribution center for a specific contract
End-to-end visibility	• Possibility of monitoring the delivery at every stage of transport from China to Poland
Disruptions of the Supply Chain	• Number of disruptions in transport from China to Poland caused by incorrect information flow
CO_2 emissions	• Monitoring of carbon footprint

Business context of the Małaszewicze terminal as the main logistics node

Malaszewicze-Brest

State: Currently, this crossing serves 9 trains in both directions per day (China trains). Although this is the main border crossing, the service level is still not considered optimal (delays, but heavy investments in infrastructure extension are ongoing – additional border bridge, customs facilities, tracks).

Advantage: This is the biggest border crossing point with all facilities on the main corridor. The main corridor (TEN-T standard) is double track, electrified and currently upgraded to 100km freight services in Poland. Also, this serves the shortest route to the main markets and with most intermodal services connected, and targets the logistics hubs in Middle Poland and North West Europe (Hamburg, Duisburg, Netherlands).

Disadvantage: Facing delays, operators are looking for alternatives. The rail infrastructure on the Polish territory is facing detours, as the main line is renewed, but this will be finished in 2022.

Future: This will continue to be the most convenient border crossing, even with all its issues. No additional handlings other than the gauge change (like shipping), shortest to the main EU markets (Germany, Benelux) and UK. It is next to border crossing investments, also the corridor is upgraded.

For Eurasian rail freight transport, rail services coming from China and arriving at the European border in 2019 overwhelmingly used Malaszewicze as principle entry point (PEP). The 200.000 TEU per year coming from China translated into some 55 trains per week. About 12% of this flow branched off towards Lodz. Some 23% went to Hamburg and some 44% went on to Duisburg. Smaller flows went to Liege, Ghent, Tilburg and Madrid. Export flows also travel in the opposite direction, but to a lesser extent.

Break of gauge takes place on the Polish-Belarusian border (Malaszewicze/Brest or alternative EU-EAEU border crossings) and on the Kazakh-Chinese border (Dostyk/Alashankou; Khorgos) or, for the Trans-Siberian route, the Russo-Chinese (Zabaykalsk/Manzhouli) or Mongolian-Chinese border (Erenhot). Customs procedures also take place on these border crossings, with Russia, Belarus and Kazakhstan being members of the Eurasian Economic Union (EAEU) customs area and Mongolia being aligned to it.

The essential milestones (both westbound and eastbound) are thus:

- Assembly/arrival of the goods at European rail terminals, such as Duisburg, Hamburg or Tilburg,
- Brake of gauge, transhipment, and customs procedures at Malaszewicze/Brest,
- Brake of gauge, transhipment, and customs procedures at Dostyk/Alashankou or Khorgos,
- Arrival/assembly of the transports at Chinese rail terminals, such as Chongqing, Chengdu, Wuhan, Xi’an or Yiwu.

The trains reach the Polish-Belarus border at Malaszewicze/Brest, where break-of-gauge transhipment and customs procedures take place. Traditionally, westbound trains were transshipped in Malaszewicze, whereas eastbound trains were transshipped at Brest. However, nowadays operators can decide on which side of the border the transshipment takes place.

The Malaszewicze/Brest border crossing is identified by all stakeholders as the first and foremost bottleneck, notably for westbound transport. Ideally, transshipment and customs procedures would take some 18 hours for an entire train (this is the official aim of the Belarus Railways), but in practice this may last for 2 to 3 days or even longer. This, combined with the notorious difficulties of the busy European railway network, causes many trains to arrive with serious delay at their Western European destinations and leads to rescheduling issues and congestion at the most important arrival terminals.

5 Simulation-based Designs for the LL's EGTN

5.1 LL Modelling

Modeling and simulation of logistics processes - basic assumptions

As part of the Living Lab preparation activities, a workshop was held with key business partners to identify all business processes related to logistics for New Silk Road operations. With a complete state-of-the-art understanding, an AS-IS map of the situation was created. In the next step, operations with potential for improvement by implementing innovative solutions were identified. In this way, TO-BE maps were created. The full methodology of the business process mapping and modeling approach is presented below.

One of the ways to verify correctness and completeness at the information flow management model is to make tests in an IT modelling environment and simulation. Modelling of processes and variety of information flow, algorithmization of decision-making functions in processes enable multi-dimensional studies of scenarios for managing the flow of information in the supply chain along the New Silk Road.

The created model should be treated by others as a tool that allows to learn and understand a certain fragment of reality and to conduct experiments and simulations.

In specialist literature as in business practise there are a lot of different ways to show processes in supply chain for analytical purpose. Simulation methods take into account the passage of time and the variability of control parameters; therefore, they seem appropriate for the presentation of the dynamics of processes. Analyzing the problems of simulation in logistic processes, should be created a list of several factors which are influence on conduct of simulation. Figure 2 shows the classic design of the multiple simulation process.

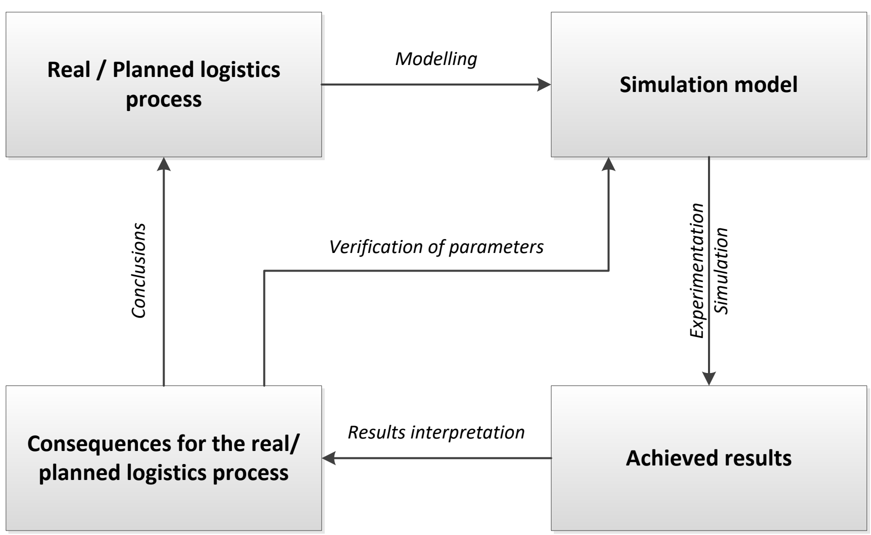


Figure 9 The classic design of the multiple simulation process

Conducting a simulation enables the analysis of the process in terms of various variants, which are verified in a virtual way, i.e. in a way that does not affect the operation of the process in real time. However, based on well-developed control parameters, consistent with the actual state, it high probability that the analyzed process variant has a chance to be implemented in the economic reality. Each simulation requires some basic rules. (Dullinger, 2009, s. 3):

- in the case of complex processes of simulation, it is necessary to select a simulation tool and more accurately model the analyzed process, define the input data and define the strategy,
- in the case of flexible processes of simulation, it is necessary to frequently change the values of the control parameters,
- when analysis are based on average values of parameters, it carries the risk of incorrect interpretations,
- the simulation must be provided at the appropriate time, to get the most benefits.

Research methodology in the field of process analysis

The process analysis is conducted using a standardized methodology based on the following steps:

Stage I: Study of the current processes (AS IS analysis):

1. Conducting a local vision in a chosen company in order to obtain comprehensive data that are necessary for analyse the designated processes.
2. Analysis of the current situation of the processes that are going to be identified and verified during the local vision, including the following elements:
    - assigning business roles to individual participants of the processes covered by the analysis,
    - mapping processes using activities and events as well as decision points using an innovative methodology compliant with the BPMN 2.0 standard, regulated by ISO / IEC / 19510: 2013 Information technology - Object Management Group Business Process Model and Notation,
    - agreeing on the management and operational level maps of currently functioning processes, compliant with the BPMN 2.0 standard,
3. Construction of AS IS simulation models, their parameterization and calibration - agreeing with the ordered KPIs (Key Performance Indicators), with particular emphasis on the service time of logistic processes within the New Silk Road and the percentage use of personnel resources. As a result will be created AS IS simulation models, which will be a reference point for the target process.
4. Simulation of the models created in action 3 and then, based on the results, identification of process areas representing optimization potential, such as:
    - process bottlenecks,
    - activities that do not bring added value, that increasing the probability of errors and mistakes,
    - gaps in the information flow,
    - manual work that can be replaced or reduced by applying identification solutions.

Stage II. Development of target logistics process models (TO BE analysis):

1. Construction and simulation of target models for the functioning of processes, taking into account the recommendations developed during the implementation of the first stage and assuming the use of the proposed technological solutions - modeling of TO BE processes (in accordance with the BPMN 2.0 standard).
2. Conducting simulations of the developed process models, allowing to forecast the level of reduction of task completion time as a result of the implementation of new identification solutions (GS1 standards, IoT solutions), compared to the initial values.
3. Determining the values of the Key Performance Indicators (KPI) agreed with the Client for the current and target status, which will allow for a parameterized assessment of the effectiveness of the target concept.

4. Agreeing with the client about the target concept, at the management and operational level.
5. Sharing the visualization of the base and target concept. Process maps and models in the AS IS and TO BE versions, reports on process simulations as well as comments and comments collected during the process study will be available in the process repository.
6. Preparation of a proposal of the scope of information necessary to be placed on information dashboards, based on the identified needs for information flow, both from the point of view of operational employees and management staff.
7. Preparation the report taking into account in synthetic way the results and conclusions resulting from the project implementation.

A detailed description of the BPMN notation is included in Annex I.

Envisioned physical flows in the Living Lab 3 from a bird's eye view are shown below. The areas where the change will occur are highlighted in yellow:

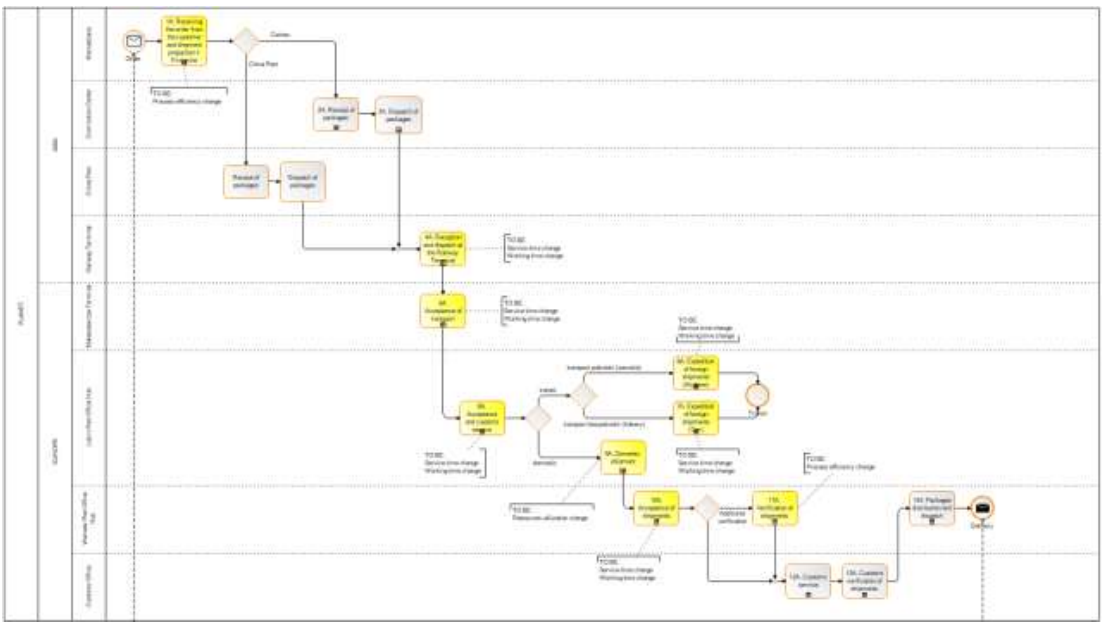


Figure 10 Polish Post Use Case

Source: Own elaboration

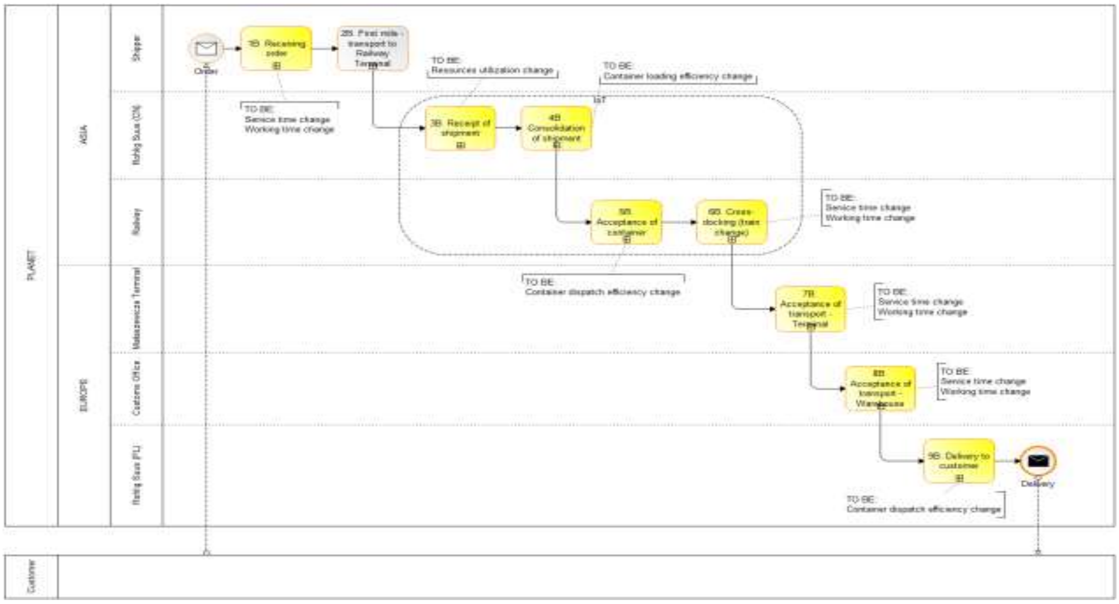


Figure 11 Rohlig Suus Use Case

Source: Own elaboration

6 Technical Requirements

6.1 Mapping LL3 technical components into PLANET architecture

Living lab 3 (LL3) is focused on streamlining logistic processes in flows from China to Europe by implementation of IoT technologies and GS1 EPCIS platform to facilitate transmission of data between the partners involved in the logistics operations along the Silk Road Route using trains. Its main objectives are:

1. **Increased visibility of goods thanks to IoT along the Silk Road**, though the development of IoT solutions and sensors systems that help control resource parameters in real time and identify them while moving in the transport process, examining potential positive results in terms of broad implementation.
2. **Standardization of information flow,** by creating a digital connection between actors in the transport network, enabling standardized data flow and access to information about cargoes coming from China to Poland in the whole supply chain in real time (implementation of the SSCC number and EPCIS test).

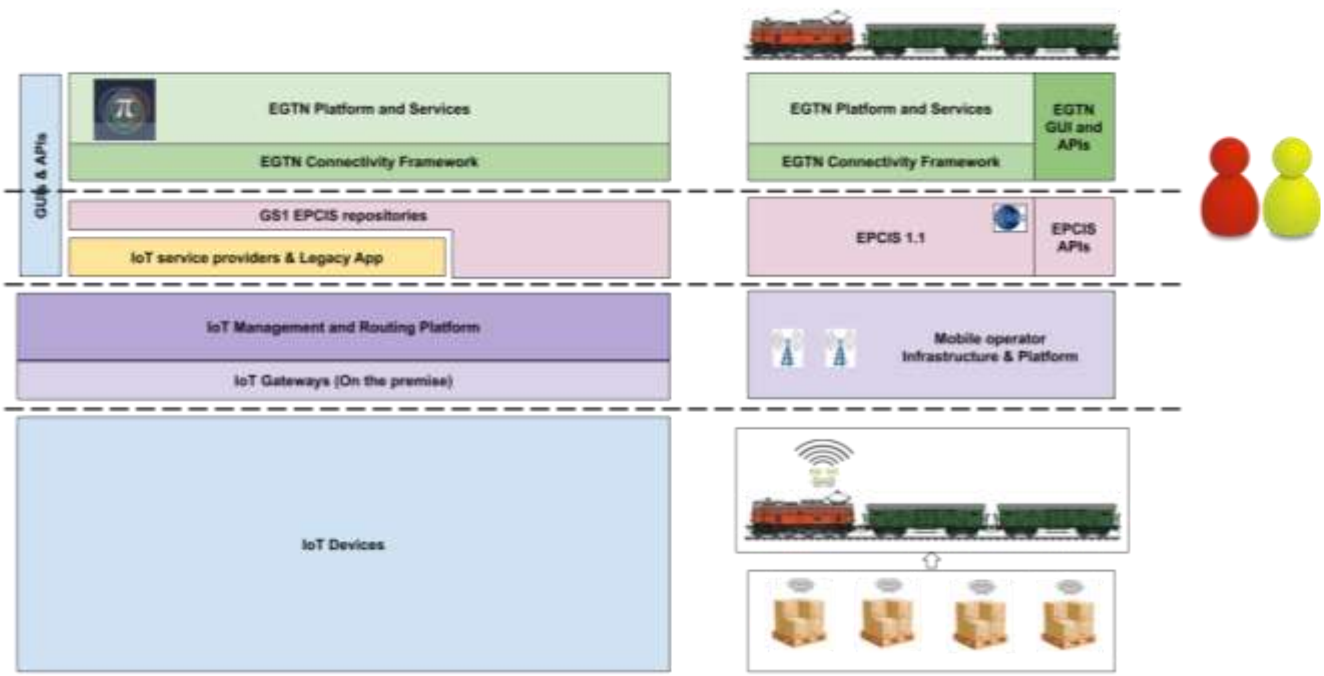


Figure 12 LL3 Use Case IT architecture

The figure above shows the system architecture of the proposed approach:

- The **mobile operator IoT platform** collects the data/parameters during the execution of logistics processes feeding the EPCIS repository, considering the standardized data-model.
- The **EPCIS repository** ingests the data from IoT platform and feeds the EGTN system. The EPCIS repository enables a secure and ad-hoc data sharing with the stakeholders involved in the logistic transactions.
- The **EGTN Platform** receives data from EPCIS and exploits it to implement added value services toward greener and more optimized logistics networks.

Based on the presented logic, the basic analytical data that are necessary for the stakeholders involved in the logistic transactions to monitor the shipments all along the New Silk Road.

The considered IoT system is created specifically for goods monitoring purposes providing high flexibility of asset tracking. It includes position monitoring devices (mobile base stations) and beacons to monitor the cargo contents. All components are connected via an ultra-low energy IoT network connected to the external infrastructure through GSM gateway. In the following the list of considered elements:

1. **Beacons** are devices designed for monitoring the current condition of parcels present in the shipment. Their main purpose is transmission of environment parameters (e.g., temperature, humidity) and state of cargo (e.g. orientation, shock reporting).
2. **Mobile base station** mounted inside the wagon connects the mobile sensor network of devices communicating the world by GSM network. Due to embedded GPS provides end users with data on current location of the shipment.

The EPCIS repository

GS1 EPCIS 1.1 is a standard used to track the progress of objects, in real time, during their flow in the supply chain, as depicted below. GS1 EPCIS 1.1 operates on event definitions. Each data in the system is stored as one of 5 types of events: ObjectEvent, AggregationEvent, TransactionEvent, TransformationEvent, SensorEvent.

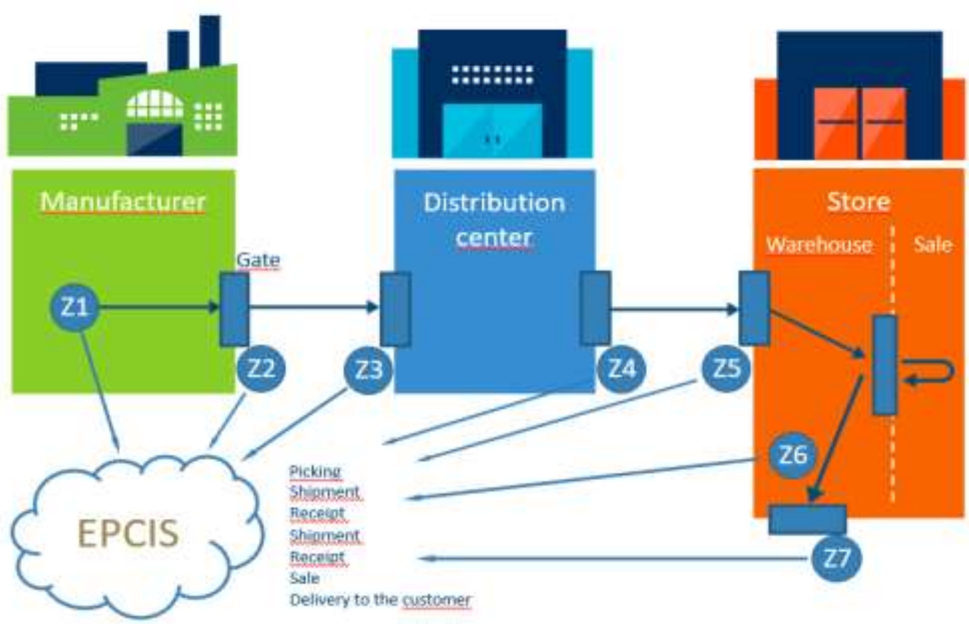


Figure 13 GS1 EPCIS 1.1 functionalities

In GS1 EPCIS 1.1, each event is defined as a file in XML format with a specific structure. EPCIS is a key component providing both long term storage for event-oriented data and interface for exchanging information with external systems. Its internal architecture makes it extremely flexible and scalable and provides high throughput at the same time. This basic setup may be easily scaled up to meet growing requirements of the system.

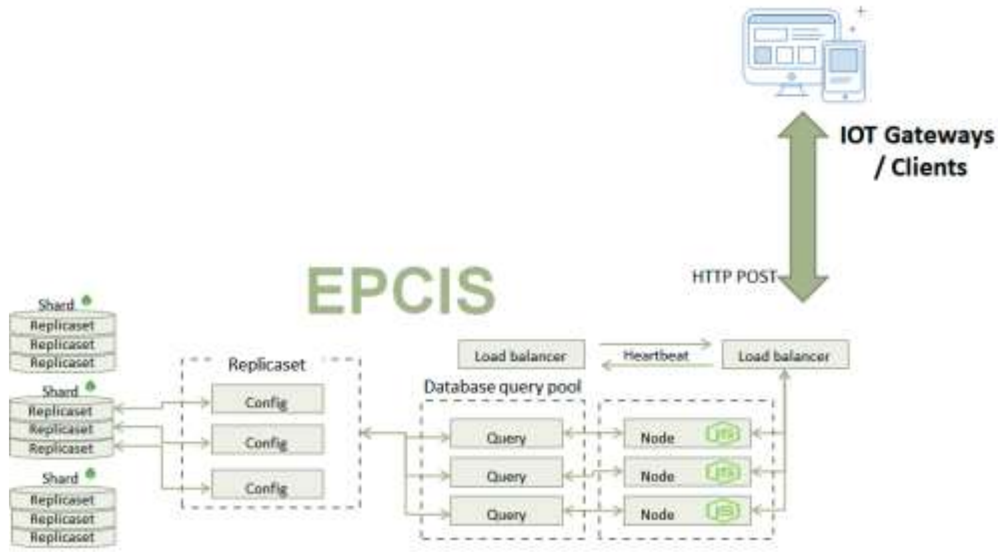


Figure 14 GS1 EPCIS 1.1 repository architecture

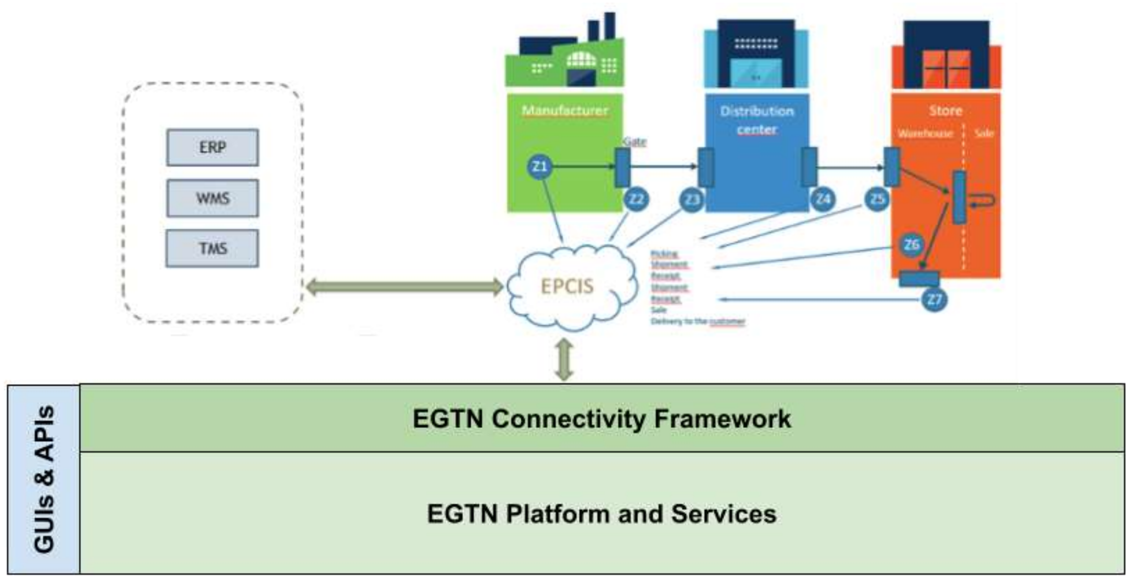


Figure 15 Interoperability of the EPCIS with EGTN architecture

As shown in the figure above, all the sensor data coming from supply chain and required business documents provided by internal IT systems are stored and shared using EPCIS. This approach makes it possible to give proper business context to IoT sensor data which in some cases might be just a stream of bare measurements hard to interpret without such additional information.

6.2 Cloud-based Open EGTN Infrastructure Technical Requirements (incl. performance capabilities)

EGTN Planet cloud infrastructure is an open infrastructure to enable digital communication amongst actors within the transport network, to access the various data available in the supply chain and outputted by the analytical model-based services.

Project partners has contributed to initial architectures to connect the analytic models to other services in the platform, helping to establish the overall requirements for the technical architecture in which the predictive analytics components are effectively integrated with other components in the platform as services. This includes, the AI based smart contracts service for the further automation of payments across multiple blockchain ledgers.

The EGTN Connectivity Infrastructure is accessible through a GraphQL endpoint that provides access to the objects in the Knowledge Graph (KG). The endpoint support query auto-completion based on the semantic model and has implemented schema-stitching that supports retrieving data from multiple databases in a single query. This means that GraphQL queries can seamlessly retrieve enrichment information form the KG combine with time-series data in other storage. The GraphQL endpoint is highly scalable, and the read-side operations can easily be parallelized with multiple services supporting hundreds of reads per second should it be required.

The consortium collaboration includes the utilization of the data collected in the EGTN platform to enable the utilization of the corridor route optimization service to create more efficient route planning for complex and dynamic change in routes through town/city hubs utilising the new criteria for corridor connectivity indexes. Also, to enable warehousing as a service that allows warehouses along transport route/corridor to be utilized on demand by T&L operators. And supplier collaboration analytics that leverage Big Data generated along the cargo routes.

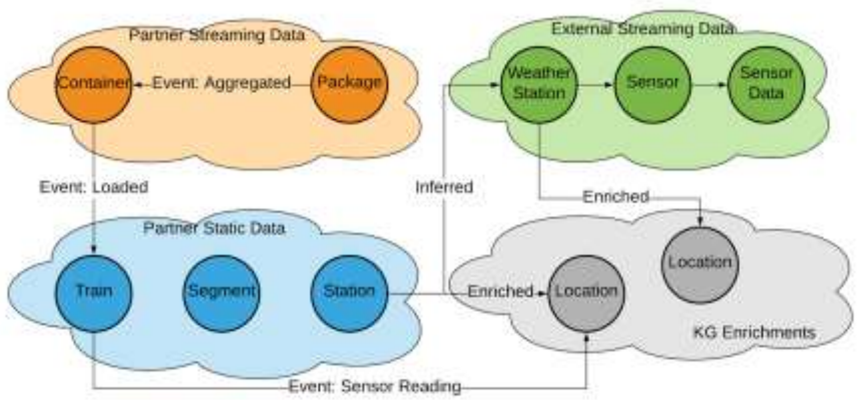


Figure 16 Unified data sources model

The analytics and optimization services take input from a variety of sources that are integrated into the Connectivity Infrastructure and incorporated in its unified model. As the figure above visualizes the stitching of a few sources into the unified model. Each "cloud" represents one type of data with its unique formatting (green is weather data, blue is the train route model, orange is partner-provided data, grey are various enrichments produced by AI systems). The links between clouds are the semantic connections created by Connectivity

Infrastructure services. Some are based on EGTN IoT infrastructure sensor readings, others are inferred based on custom rules, created by machine learning algorithms or collected as partner expertise.

A simple query to the GraphQL endpoint might be retrieving the forecast for a particular weather station for a particular day or the latest known location of a train. A complex query could be retrieving the weather along the upcoming route for a given package when calculating its ETD but a single query is capable of making the connection from package to the container it is in to the train it is loaded on to the station(s) the train is traveling towards to the closest weather stations to the forecasts at each of those stations.

The route model used as an example of partner static data is built in collaboration and with significant input from RSUUS and ILIM. Specifically, RSUUS provided the raw data for the existing train routes and initial rough timetables. The simulated freight train compositions were developed in an iterative process with ILIM.

6.3 Visibility and product status (Big) data for 'Corridor route optimisation analytics'

For the corridor route optimisation analytics service, Big Data augmented by the detailed corridor transport models and real time IoT sensor information will be used to develop effective routing optimisation that is based on accurate real-time information rather than static data. The development of the corridor route optimization-based analytics requires not only the Big Data augmented by detailed corridor transport models and IoT sensor information, but also domain expert knowledge to be used as criterion to take the final decision on changing routes.

The corridor route optimisation application focuses on real-time dynamic routing of cargo traveling throughout the network to reduce its dependencies on predefined routes. By avoiding such dependencies in the cargo flow, a more flexible and efficient transport network towards the Physical Internet (PI) concept of digital internet inspired protocols on adaptive routing, at each node, for information networks, can be enabled.

Part of the enablement of an enhanced visibility and traceability, using services such as the route optimisation is the use of the EPCIS and GS1 standard protocols to store and transmit data respectively. These standards have the capability of further enabling trading partners to share information about the physical movement and status of products as they travel throughout the supply chain, from business to business and ultimately to consumers. It helps in answering key questions such as the "what, where, when and why" to meet consumer and regulatory demands for accurate and detailed product information. The goal of EPCIS is to enable disparate applications to create and share visibility event data, both within and across enterprises.

IBM and the Planet consortium partners identified the importance of exploring ways in which more automated means can be implemented using AI based applications to provide more reliable, alternative, cost-effective and timely route optimization decision tools that make the process of transportation more efficient. This includes data flow monitoring and connectivity for T&L planning and forecasting to enable improved means of route optimization.

Another aspect regarding visualisation considered within the Planet project is with regards to the use of knowledge graphs as components that can facilitate the access to time series data of events that are relevant for the predictive model to ingest and carry out useful forecasts. And how the forecasted information could be feedbacked to the knowledge graphs to aggregate knowledge and to issue alerts, estimations, visualization and recommendations to carry out logistics within the transportation network, which includes the mentioned route optimization service.

6.4 IoT Requirements

The proposed use case includes in the scope a metering equipment of a means of transport such as a train going from China to Poland. It is required to track the current position of train itself, but also its wagons and shipments being transported. The selected technology must ensure on-line communication with supply chain actors and monitor the location and environmental conditions of the transport on an ongoing basis.

According to DCSA Standards dry container on land should be monitored by LoRaWAN solutions, but on the Silk Road such connectivity is not unavailable and must be replaced by GSM communication. On the other hand, DCSA suggests using RFID on gateways at event locations which can be fully supported by LL3 proposed solution.

Furthermore, there is no DCSA proposition for the monitoring of the container contents, and in that case LL3 will propose a coherent solution based on DASH7 – positioned in the group of active RFID solutions.

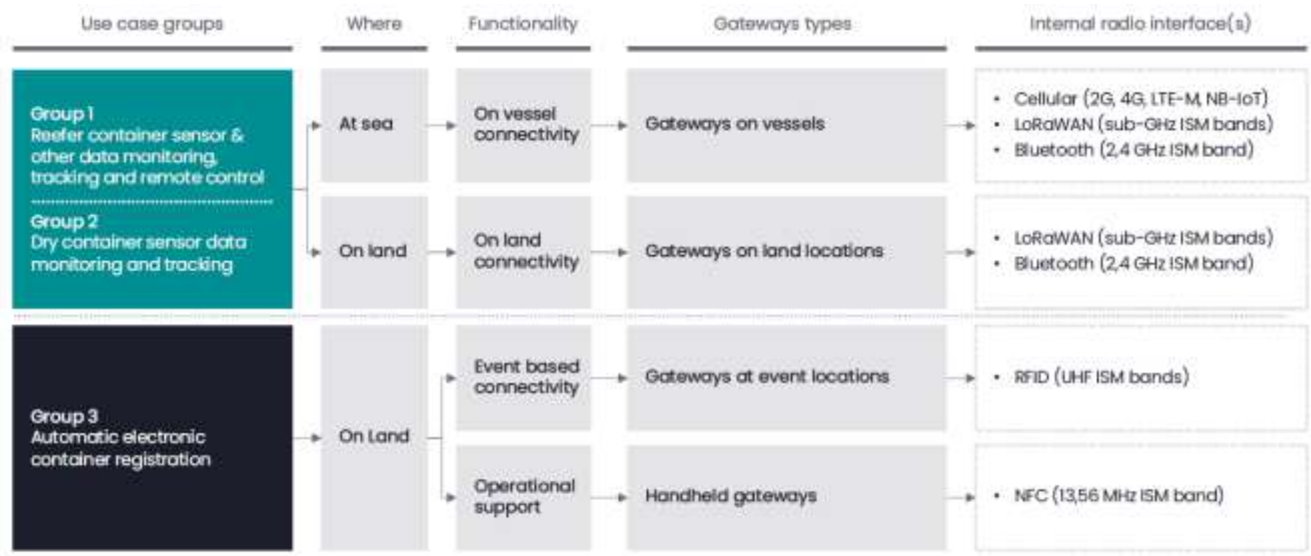


Figure 17 DCSA IoT Standards

Source: https://dcsa.org/initiatives/iot-gateway-connectivity-interface-standards/)

It is proposed to use DASH7 wireless sensor networks, an active RFID solution for a communication between monitoring system components, and a GSM connectivity between mobile base station and software platform. A comparison of possible techniques is presented in Table 7.

Figure 18 Wireless sensor networks classification

IT core architecture

EPCIS or Electronic Product Code Information Services is a part of the EPCglobal network, which provides a secure environment for storing specific data about products and their exchange between partners. In other words, it is a standard used to track the progress of objects, in real time, during their flow in the supply chain. EPCIS stores information about when a particular facility was registered, where it was located and with what business step; for each registered facility.

EPCIS operates on event definitions. Each data in the system is stored as one of 5 types of events:

- ObjectEvent,
- AggregationEvent,
- TransactionEvent,
- TransformationEvent,
- SensorEvent.

Each event is defined as a file in XML format with a specific structure, compliant with GS1 EPCIS 1.1 standard [1].

GS1 EPCIS 1.1 functionalities are presented in Figure 18.

EPCIS is a key component providing both long term storage for event oriented data and interface for exchanging information with external systems. Its internal architecture makes it extremely flexible and scalable and provides high throughput at the same time. Basic setup shown on the picture below may be easily scaled up to meet growing requirements of the system.

GS1 EPCIS 1.1 repository architecture is presented in Figure 19.

As shown on the picture below all the sensor data coming from supply chain and required business documents provided by internal IT systems are stored and shared using EPCIS. This approach makes it possible to give proper business context to IoT sensor data which in some cases might be just a stream of bare measurements hard to interpret without such additional information.

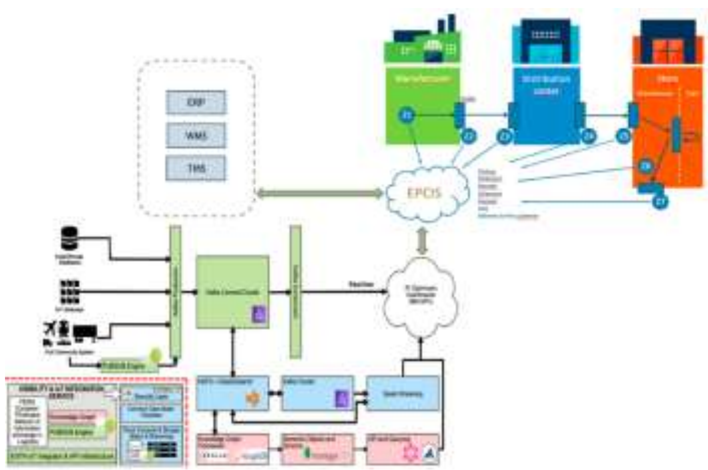


Figure 19 Interoperability of the EPCIS with EGTN architecture

EPCIS has two interfaces:

- query - to obtain data from the database,

- capture - to save data to the database.

Both queries and saved data are XML documents. To guarantee easy integration with external systems, the proposed implementation of the EPCIS standard realizes access interfaces via HTTP POST interface [2]. Moreover, EPCIS is equipped with a subscription interface. In this mode, after sending an appropriate request and saving the subscription in the system, the system will deliver the events of interest to the indicated address when they appear in the repository. The PUB/SUB interface allows to limit the number of queries by external systems and simplifies integration.

EPCIS system is an event repository. Therefore, it needs the source of these events. These events are often generated by analytical systems, which have access to raw sensory data sent by devices. A popular standard in the world of IoT is the light MQTT [3] data exchange protocol. Alternatively, HTTP or CoAP [4] interfaces can be used, which are more popular when it comes to the availability of libraries in embedded systems. The software must receive data from sensory devices that use multiple protocols and generate corresponding reports based on raw data.

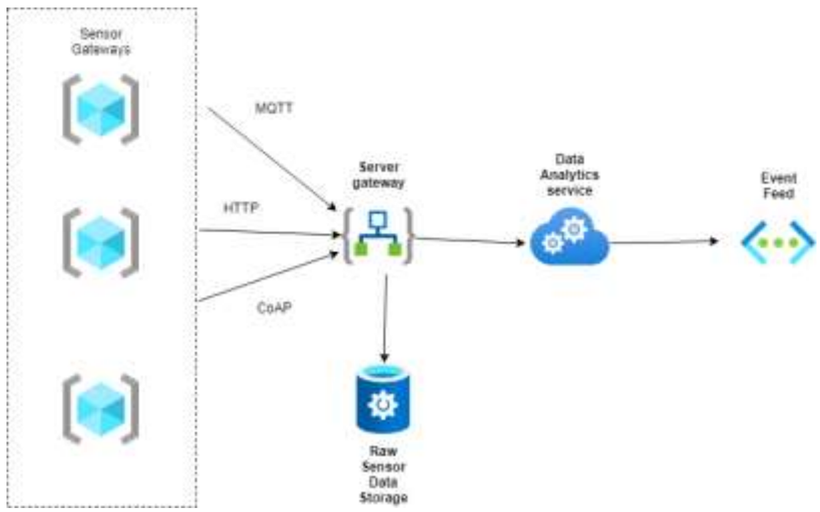


Figure 20 Example of IoT measurement storage and analytics

IoT components overview

DASH7 VAYASENS wireless sensor networks, an active RFID solution was chosen as a solution for train and shipment monitoring.

VAYASENS is a spin-off of the Łukasiewicz – ILiM and a product developer and producer of a comprehensive range of equipment providing access to the most important transport parameters. System created specifically for goods monitoring purposes provides high flexibility of asset tracking. It includes seals to monitor the closure of the semi-trailer, position monitoring devices, beacons to monitor the cargo and devices to interface with the truck's on-board systems. All of these components are connected via an ultra-low energy wireless network connected to the external infrastructure through GSM gateway. Each system component is enclosed in a robust sealed housing.

Beacons are devices designed for monitoring the current condition of pallet units present in the shipment. Their main purpose is transmission of environment parameters (e.g. temperature, humidity) and state of cargo (e.g. orientation, shock reporting).

Mobile base station mounted inside the trailer connects the mobile sensor network of devices communicating in DASH7 with the world by GSM network. Due to embedded GPS provides end users with data on current location of the shipment.

Testing LL3 solutions involves the use of:

- Mobile base station with computer, GSM module, GPS module and DASH7 module - 5 pcs,
- Beacon DASH7 - 75 pieces,
- Access to a web-based platform with location data for the duration of the project for a minimum of 50 users for a minimum of 12 months.

Specific requirements:

Mobile base station:

- GPRS communication within Europe and Asia (Silk Road),
- position determination with accuracy up to 2,5m using GPS module,
- communication in the 868MHz band compliant with the DASH7 protocol with the LoS range of min. 400m in open space and min. 200m in closed space,
- parallel communication with the remaining elements of the sensor network on at least 4 channels,
- acceleration measurement (+/- 980ug),
- functionality of detecting the opening of a sea container door (also in the case of total absence of light),
- functionality of monitoring the presence of DASH7 beacons, recording the measurements of temperature, humidity and acceleration of DASH7 beacons within the range of correct operation and transmission of these measurements to the web platform in the Internet cloud,

Beacon DASH7:

- communication in the 868MHz band compliant with the DASH7 protocol, with a LoS range of min. 400m in open and min. 200m in a closed space,
- temperature (+/- 0.2 degrees), humidity (+/- 2%) and acceleration (+/- 980ug) measurement,

- monitoring of temperature, humidity and a monitored goods orientation with a possibility of generating alarms by events,

Cloud-based web platform:

- map view of a location of tracked objects with historical data covering at least 90 days,
- preview of monitored environmental parameters with historical data covering at least 90 days,
- ability to define criteria underlying the generation of events, reports, and alarms,
- possibility of editing beacon configuration parameters from the level of the web platform (modifying the frequency of measurements, defining alarm thresholds for environmental parameters),
- generation of events in accordance with the GS1 EPCIS standard and the GS1 Business Vocabulary in version 1.1 or higher,
- communication interface with the ability to upload events to a GS1 EPCIS version 1.1 or higher compliant database.

6.5 Big-data requirements

Building accurate AI based forecasting models requires large amounts of continuous time series data, which for the case of Planet are to be gathered by the IoT applications and to be made available through the connectivity infrastructure to be developed within the task 2.2 of WP2. Other data made available to carry out preliminary AI based modelling tests includes data regarding the inflow of containers and pallets to the ports and warehouses, which have been provided by the project partner of the Planet project.

A main challenge in gathering Big data for the Planet project is that the potential sources of data are scattered across different heterogenous formats and structures making the effective aggregation of distributed sources of data at different levels more challenging. For instance, in the carbon footprint application where different data variables are relevant: package-weight, transport related data (engine type, size etc), origin, destination, quantity of packages/pallets, road density and intensity of traffic is a type of data that could be challenging to gather.

An effective routing service is one of the best ways to provide value to the transport and logistics networks by adopting big data and analytics. This is to be able to make an informed timely decision to adjust a pre-determined route, which might require different sources of data to form a more solid criterion. The data is not only used by the predictive models, but also required to better understand the dynamic evolution of the network flow. An optimal re-routing dynamic depends directly on the behaviour and evolution patterns of transportation towards an equilibrium. But since this state of network equilibrium is inherently unseeable and with bottle necks constantly arising, a dynamic constant switch is in the routes that is required to narrow the gap between the estimated preferred arrival time and actual delayed times provided by congestions in the network.

Predictive models have become hugely important in today's world where there is a plethora of historical data available. This historical data can be used to train models that can identify and forecast values which follow trends and patterns not easily noticeable using manual non-automatic means. Predictive modelling can enable smarter decision making as they give us a near accurate forecast of the future thus making planning in advance more efficient. By having future information about potential scenarios, a delivery strategy could be adjusted to reach the desired scenario in a timelier manner and perhaps be faster than other delivery companies acting as competitors. The predictive models built using Big time series data would provide accurate forecasted information that could contribute to improving the planning and agility of processes and, improving business relationships within the supply chain, that otherwise would require full manual, constant, and more time-consuming management. Since big data is produced from these processes, it appears that data driven solutions are a natural fit to further automate and integrate key processes and reduce costs, which have been estimated could oscillate from 20 to 50 percent. By forecasting useful information regarding individual tasks or events such as the number of pallets or containers arriving at a particular time, operators could impact related activities in terms of allocating resources to handle better product-arrival related port and warehouse events, such as reducing waste, efficiency, or inventory costs.

Such AI based application services enabled by Big data (including IoT) can contribute to increasing the monitoring of relevant events across the TEN-T and the connectivity index of its nodes by enhancing their digital connectivity with other nodes by sharing relevant flow of historical, present and forecasted information. This information across time is core for a more informed decision making of the network operators. While at the same time pushing the nodes' digital innovation, solutions, and the further development of their infrastructure

6.6 Decision making intelligent algorithms (based on AI machine-learning)

The task 2.3 in the work package 2 will develop AI based services for different applications relevant for the optimisation of the transportation network. The services are boosted on AI based algorithms that enable the forecasting of information to allow the user to make more informed decisions. The algorithms include the use of Recursive Neural Networks models to forecast time series data, which currently have been enabled to predict the inflow of pallets and containers to warehouse and ports respectively.

The intelligent AI based algorithms are to be fully developed using data gathered from sensors brought to the EGTN planet platform through the IoT pipeline applications. The data made available within the platform is to be further processed by being aggregated with other supporting information for training AI algorithms. This includes but is not limited to:

- a model of train routes with corresponding timetables, history of travel times, and freight train composition (number of cars, engine specifications),
- historical weather data and historical weather forecasts from the vicinity of route train stops,
- integrating IoT sensor readings with train movements along the route and loading/unloading of containers.

We have also evaluated opportunities for supporting data related to flight tracking, customs regulations updates and others.

These additional data aggregation tasks can become rather relevant for additional considerations for services and applications such as for the reduction of CO_2 emissions, and developing models for transport volumes, transit time, transport costs, delays, and incidence of trade.

The currently developed predictive models are to be further validated using IoT data available to forecast information to enable different services such as a corridor route optimization analytics and transport models' services to build decision support systems, perhaps at least on simulation settings. Also, it includes a supplier collaboration application for warehouse to enable the implementation of smart contracts.

The value to the industry that the decision-making algorithms can bring to the transportation logistic network industry includes higher levels of decentralisation in terms of being able to gather relevant data across the network to visualise and share relevant historic, present and future data in a more standardised way.

Train corridor flows from China to Europe, navigate through north and south routes that have different operational limitations, travel time and capacity capabilities. By utilizing the IoT train tracking capability integrated in the EGTN platform it becomes possible to develop customized DSS tools for optimizing both corridor and supply chain operations as well as using modelling and optimizing tactical decision making. On the operational side, the intercontinental rail corridor is modelled as a series of links and nodes, operating with different characteristics, of throughput and travel speed, transshipment capacity and rate. For each network section, models trained using Big Data analytics, can provide accurate estimates of operational efficiency and assist in making more accurate and reliable predictions on transshipment times and estimated times of arrival, enabling the better organization of adjacent supply chain operation. Furthermore, collaborative tools can be developed to enhance functionality both within the rail corridor as well as the subsequent supply chain functionality.

On the tactical side, the integration of infrastructure, policy, technology and operational data available through the EGTN platform, can be used to assess infrastructure and rolling stock availability, and inform investment decisions for the improvement of the operational efficiency of the network.

6.7 Modularity technical requirements

Technical requirements for modular container solutions have been developed within the Horizon 2020 project called MODULUSCHCA. The following are the results of Graz University of Technology's work on the technical aspects of M-Boxes.

Today one has to distinguish between two categories of containers: The first category refers to as “handling containers”. Examples of handling containers today are cartons, cases, boxes and pallets used to cover product or provide a means to handle products together as a unit load. (Note that for most products today, the product itself provides the structural integrity of the handling containers; as opposed to the handling containers) The second category refers to as “transportation containers”. Examples of transportation containers today are the international shipping container, train wagons, and truck trailers, used to transport handling containers. Unlike with handling containers, transportation containers must provide the structural integrity of the load and must be able to resist the elements. With the advent of the PI, its inventors assume that transportation containers will remain relatively unchanged. Perhaps, over time, their dimensions will be modified so as to synchronize them over a variety of modes (e.g., ship, rail, truck). However, it is an assumption that in a future vision with the PI, handling containers will be reduced to modular containers and unit loads that are built out of multiple modular containers. That is, the need for a pallet will be removed and modular containers will replace the cartons, cases and boxes used today. Going forward, in this section will refer to modular containers simply as M-boxes to make clear that M-boxes represent thoughts on the characteristics of modular containers used in the PI.

In today´s SC for FMCGs the diversity of brands and types of products with various sizes and weights leads to a nearly infinite range of different sizes of carton boxes. Building unit loads with such a high variance of cases is rather complicated and leads to inefficient space utilization at the pallet level and as a consequence also on a truck level. Therefore the first problem to solve can be stated accordingly: For the FMCG market, determine the set of modular container dimensions that would balance the desire to decrease the number of options while at the same time not overly restrict options, because to do so will result in handling containers that are less full than today. In doing so, one has to consider that FMCG products that are shipped today have specific item dimensions and are shipped in specific quantities of items per handling container.

One of the first decisions to be made in specifying a set of modular containers is the “platform” for the set. That is, if one defines the platform’s width, W, depth, D, and height, H, then the possible dimensions of containers that are modular to the platform can be chosen. At the outset one considers the European trailer dimensions and the current Euro pallet dimension. As the dimensions of the Euro pallet are 0.8m by 1.2m and the inside dimensions of the Euro trailer are 2.44m wide by 13.40m deep by 2.5m tall, the modular M-box platform can be 0.8m (W) by 1.2m (D) by 2.4m (H). Note that it is also considered a platform of 1.2m x 1.2m x 2.4m and other platforms based on the international shipping container. However, such a footprint would not utilize the current European trailer as well as the rectangular 0.8m x 1.2m footprint. To further refine this all three dimensions (0.8m, 1.2m, and 2.4m) are divided by 1, 2, 3, …, as long as the result was greater than or equal to 0.1m. These dimensions would be considered exterior dimension standards. Then, based on many discussions, all combinations of x, y, z that were not integer at the mm level (that is, eliminating an x-value of 266.7mm formed by dividing W by 3 because 266.7 is not an integer) were eliminated; including a few other values (e.g., y = 150mm, and z = 160mm, 150mm). The reduced set of modular container dimensions is presented below.

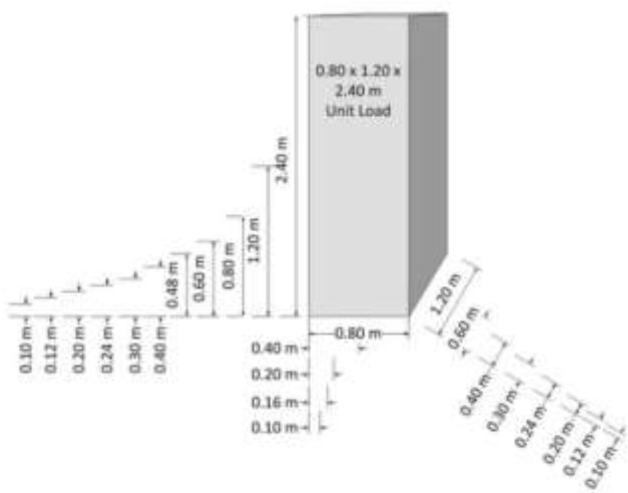


Figure 21 Modular container dimensions

Modular Platform with 440 different M-box dimensions. With this platform presented above the total possible number of M-boxes would be 440. These 440 different sizes of boxes can be considered to be a platform for further development and as a starting point for the recommended set of pooled containers. They are recommended by the MODULUSHCA consortium to maintain container fullness as much as possible and to improve overall utilization at the unit-load level However, decisions around final platform selection will be iterative, subject to cost, industry and retailer support and also subject to the future development of the products in the FMCG Industry. Moreover, in addition to the benefits of a modular platform, there are benefits that can result if a small number of dimension combinations are in use in an asset pooling arrangement.

Defining functions and specifications for M-boxes and unit loads

After defining the sizes for the M-box units the next step is to develop a clear functional specification of logistic containers in FMCG. The functions and specifications are analyzed using two different approaches: The Box and unit load functions from technical restrictions and box functions from logistics SC demands

A key enabler of this work is to develop a functional specification for the modular units. To do this requires a better understanding of cross industry and sector views, of the type of functionality that is desirable. Insight into what traits are considered most important via appropriate stakeholder input, enables identification and prioritization of potential design features. In order to capture as full an array of stakeholder views as possible from which to define the suite of functionality requirements, an e-survey is used to solicit input. The survey is based on a map of "typical" SC interactions between manufacturing sites, Distribution Centers, Co-packing sites and Retail outlets. These SC interactions are based on scenarios provided by a storybook approach (a particular example is outlined in Figure 4) focusing on particular aspects of the SC and on five focus areas: ♣ Reuse ♣ Repair ♣ Recycle ♣ Reach (also beyond EU) ♣ Ergonomics.

The development of a feasible PI-scenario requires that technical restrictions have to be identified and implemented in the engineering process right from the beginning. These technical restrictions which determine essential functions of the M-boxes and unit loads are specified by restrictions of law and guidelines as well as requirements resulting from the packing, shipping and loading processes. To fulfil all these restrictions the whole process from packing the goods in the box, building unit loads and interlocking the boxes as well as the truck specifications have to be taken into account.

7 Test Planning

7.1 Test Cases Selection Criteria

The identified business needs of our partners were the starting point for developing LL3 business scenarios. Looking at both the business needs of the partners as well as the scope for testing solutions in LL3, two primary scopes were identified to be tested in LL3:

- Container transport monitoring on the New Silk Road (Rohlig Suus),
- Monitoring of shipments on the New Silk Road, in terms of e-commerce parcel distribution (Polish Post).

Since two scopes were created, which also naturally corresponds to the characteristics of the test area, provided for in LL3, it was decided that each of the scopes should identify two extreme cases of implementation of these processes (business scenarios). According to the adopted testing methodology, positive verification of extreme cases (business scenarios) proves the effectiveness of the applied solution.

Rohlig Suus Business Scenarios

In terms of container transportation, the following business scenarios were identified:

- B2B_W1 – departure from China of all scheduled containers on a single train (Container/s departure according to booking slot)
- B2B_W2 – departure from China of all scheduled containers by several trains (Container/s detention and departure at later slot).

Distinguishing features of the variants:

- Container transport status monitoring,
- Transport costs,
- Transport time.

These features correspond to the KPIs presented in Section 8 of this document.

Business scenarios for the Polish Post

In terms of e-commerce parcel distribution, the following business scenarios were identified:

- B2C_W1 – container transport to Belgium and EU shipments' distribution
- B2C_W2 – container transport to Poland and EU shipments' distribution.

The choice of the above options indicates the need to analyze the current situation and answer the question why the option B2C_W1 is used? What should be changed to make the option B2C_W2 more beneficial?

Distinguishing features of the variants:

- Scope of logistic services provided by the transshipment terminal,
- Analysis of customs processing,
- Transport/delivery cost,
- Transport/delivery time.

7.2 Actors & Involved Systems

Actors:

- Łukasiewicz - Institute of Logistics and Warehousing coordinates LL, analyses business process, implements IoT technology to control resources and their parameters in real time and implements the EPCIS platform and analyses implementation efficiency.
- GS1 Poland and GS1 China coordinate the implementation GS1 standards (including EPCIS) in the chain from China to Europe, to simplify customs clearance and streamline logistics operations in the operator's system.
- Polish Post provides access to operational data and infrastructure for LL: 1 / testing the use of GS1 standards, 2 / modularizing cargo to enable sharing container space with other loads, and 3 / assessing alternative transport shipments throughout Europe..
- ROHLIG SUUS provides access to operational data and rolling stocks by testing the use of IoT technology and the EPCIS platform used along the Silk Road, including the Container Terminal in Małaszewicze (cargo handling point originating from China to the EU).
- Partners on the Chinese side responsible for: Installing the tags on the wagons /Transmission of data to EPCIS

In both use cases the EGTN infrastructure will integrate with EPCIS, additionally in use case 1 also with IoT sensors. The integration logic of the solutions used in LL3 is shown in the figure below.

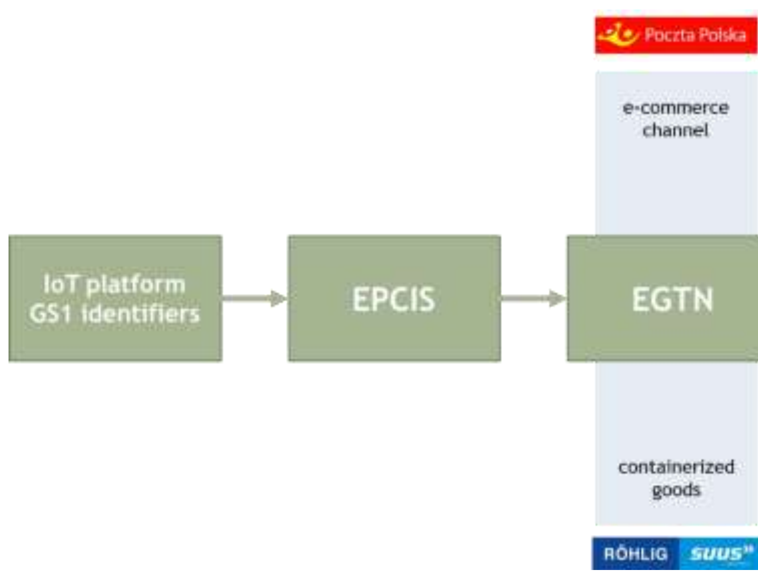


Figure 22 Integration of solutions used in LL3

This scheme contains the following logic:

- IoT platform collects some of the data/parameters identified by business partners during the execution of logistics processes - the collected data feeds the EPCIS system,

- EPCIS receives some data from IoT platform, but also independently collects some of the data/parameters identified by business partners during the execution of logistics processes - the collected data (from both IoT platform and EPCIS) feeds the EGTN system,
- EGTN receives data from EPCIS (and IoT platform via EPCIS), but also independently collects some of the data/parameters identified by the business partners - the set of necessary data (separately for Polish Post and Rohlig Suus) is transferred to business partners' IT systems (system integration is necessary).

Based on the presented logic, the basic analytical data that are necessary for LL3 partners to monitor transport along the New Silk Road have been identified. The following tables summarise the data that should be integrated between the business partners and EGTN.

Table 5: Data integration for PP with EGTN

Analytics solutions	Description	Required Data	Data Sources
Volume Flow forecasting	Predicting the inflow and outflow quantities of cargo from a distribution center	Packaging lists	Chinese logistic consolidator
		DC inflow and outflow cargo quantities	PP
Carbon Footprint Prediction	Forecasting the carbon footprint for transport routes/modes taken to deliver the goods or per package	Weight of packages	Chinese logistic consolidator
		Transport mode with information about train	Chinese logistic consolidator Champ
		Origin and Destination	Chinese logistic consolidator and PP
		Quantity of packages	Chinese logistic consolidator
ETA forecasting	Forecasting estimated time of arrival with comparison of different calculation models to determine the best accuracy. For example: • Decision Tree Based Models • Artificial Neural Network (ANN) • Recurrent Neural Network (RNN) • Support Vector Machine (SVM)	Origin & Destination	Chinese logistic consolidator and PP
		GPS data	Champ
		Traffic density & intensity	Champ
		Weather conditions along route	TBD
		Train parameters i.e. (type, weight, speed, schedule etc.)	Chinese logistic consolidator Champ
		Route information (distance, intermediate stops)	Champ
		Holidays? (for ex. Chinese New Year causing delays ?)	TBD

BlockLab solution	Blockchain solution for speeding up some of customs processes	TBD	TBD

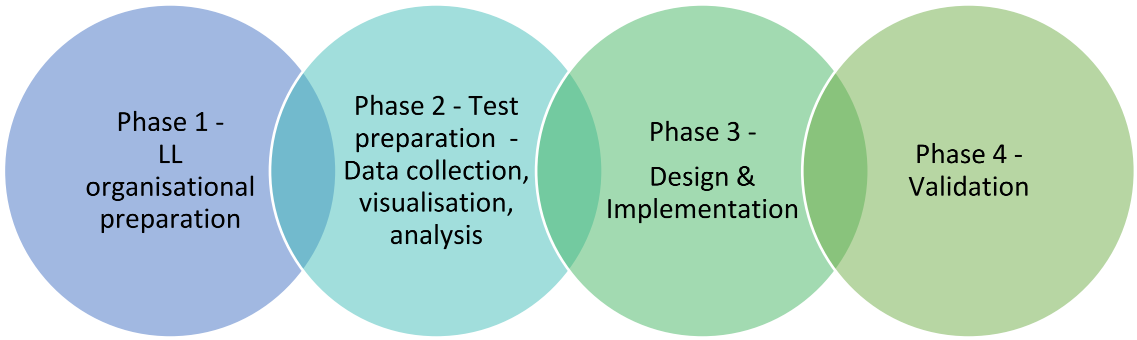
Table 6: Data integration for RS with EGTN

Analytics solutions	Description	Required Data	Data Sources
Volume Flow forecasting	Predicting the inflow and outflow quantities of cargo from a distribution center	Packaging lists	Chinese logistic consolidator
		DC inflow and outflow cargo quantities	RS
Carbon Footprint Prediction	Forecasting the carbon footprint for transport routes/modes taken to deliver the goods or per package	Weight of packages	Chinese logistic consolidator
		Transport mode with information about train	Chinese logistic consolidator
		Origin and Destination	Vayasens IoT and RS
		Quantity of packages/pallets	Chinese logistic consolidator and Vayasens IoT
ETA forecasting	Forecasting estimated time of arrival with comparison of different calculation models to determine the best accuracy. For example: • Decision Tree Based Models • Artificial Neural Network (ANN) • Recurrent Neural Network (RNN) • Support Vector Machine (SVM)	Origin & Destination	Vayasens IoT and RS
		GPS data	Vayasens IoT
		Traffic density & intensity	TBD
		Weather conditions along route	TBD
		Train parameters i.e. (type, weight, speed, schedule etc.)	Chinese logistic consolidator
		Route information (distance, intermediate stops)	Vayasens IoT
		Holidays? (for ex. Chinese New Year causing delays ?)	TBD
BlockLab solution	Blockchain solution for speeding up some of customs processes	TBD	TBD

7.3 Tests Execution Plan

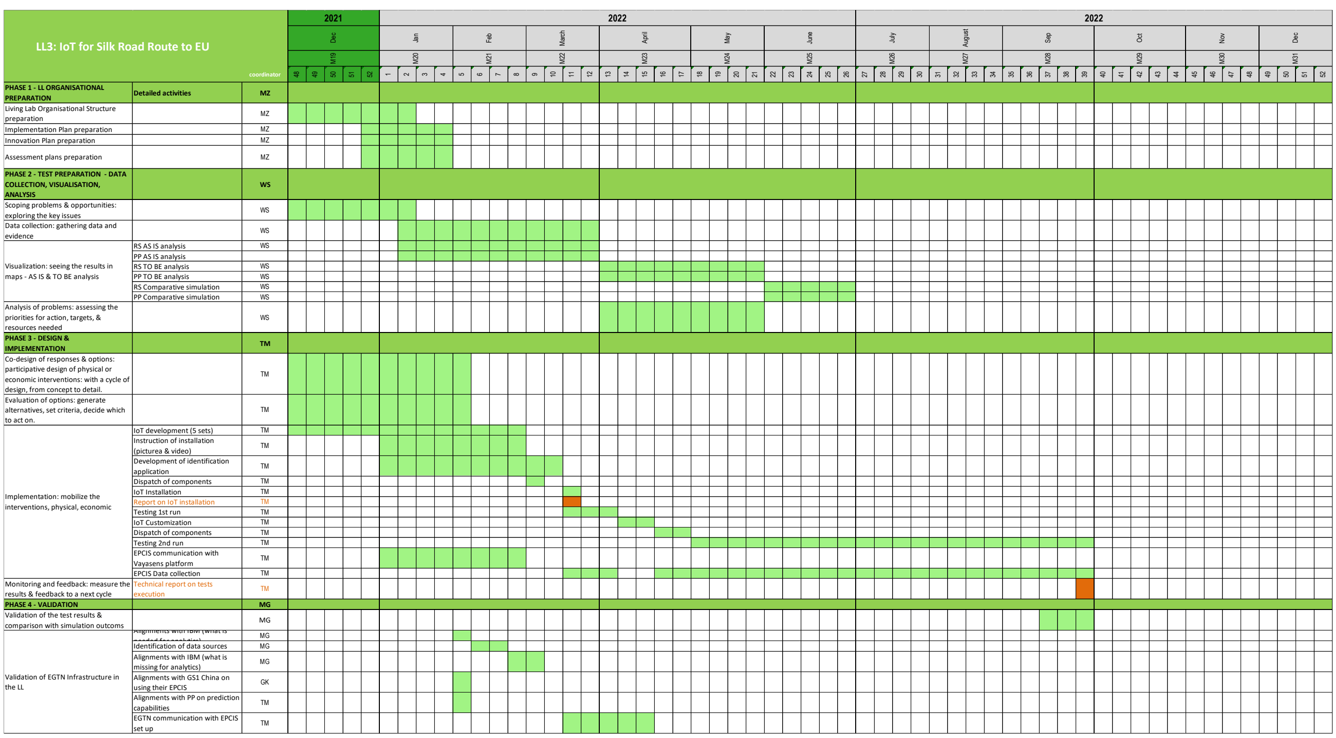
A Test Execution Plan is a list of tasks that need to be completed in a timely manner and order so that progress can be made on the test. Individual tasks will be completed by the project team and controlled by the Project

Manager. The Plan was broken down into 4 main phases, which were then presented within a Gant chart and positioned in time.



A Gantt chart is a bar chart that provides a visual view of project tasks scheduled over time. A Gantt chart is used for project planning: it's a useful way of showing what work is scheduled to be done on specific days. It helps project manager and team members view the start dates, end dates and milestones of a project schedule in one simple stacked bar chart.

Table 7: Test Execution Plan - Gantt chart



7.4 Expected Test Results & Evaluation Plan

As part of the ongoing work, the research team defined 7 KPIs that will allow to assess the impact of implemented solutions on key areas related directly to operations and the business environment. In order to achieve a common understanding of particular KPIs, the project extended their description with a detailed definition. This approach will allow the indicators to be properly matched with the relevant processes.

1. ***Reduced compliance costs (>10%) -*** Compliance costs are all expenses that a company uses up to adhere to government regulations. Compliance costs incorporate salaries of employees in compliance, time and funds spend on announcing, new system necessitated to meet retention, and so on. Compliance costs happen to be as results of local, national or even international regulation (for instance MiFID II or GDPR applying to countries in European Union). Global firms operating all over the world with varying new regulations in each country tend to face significantly larger compliance costs than those functionating solely in one region. Given the nature of the pilot and the regulatory challenges associated with logistics operations in the New Silk Road area, the main cost to be considered will be the compliance cost of customs processes.
2. ***Improved end-to-end visibility (>50%)*** - end to end supply chain visibility is transparency at all stages of supply chain management from procurement through delivery of finished goods to customers. This transparency is made possible by carefully monitoring each step of the process, capturing all related data, and organizing it in a centralized data management space, where it can be reviewed, analyzed, and, in time, mined for actionable insights that improve business processes, long-term financial planning, and strategic decision making.
3. ***Improved customer experience (>15%) -*** customer experience, also known as CX, is customers' holistic perception of their experience with the business or brand. Detailed areas of interest, important from the end customer's point of view, will be defined through a survey conducted among Polish Post and Rohlig Suus clients.
4. ***Increased volumes (>8%)*** - in this case, volumes are defined as the quantities of products, expressed in pieces/packages/pallets, that can potentially be processed through logistics operations in the supply chain
5. ***Reduced operational costs (>10%)*** - operational costs, are the expenses which are related to the operation of a business, or to the operation of a device, component, piece of equipment or facility. They are the cost of resources used by an organization to maintain its existence. In this case, we are talking about the cost of logistics operations related to the direct handling of products. Logistics costs include the following:
    - cost of transport activities, for each mode;
    - cost of storage or warehousing activities;
    - cost of time value or investment in goods in a logistics system, including the
    - added value of transportation;
    - cost of physical form changes required for effective and/or safe transport, storage, and handling;
    - cost of marking, identifying, recording, analysis, as well as data transfer and
    - handling;
    - cost of stacking/unstacking activities;
    - cost of added packaging required;
    - cost of material transfer activities;
    - cost of consolidation/deconsolidation activities;

- cost of information and telecommunications integration;
- cost of logistics system management;
- cost of unavailability of goods (when required).

6. ***Reduced disruptions of the Supply Chain (>15%)*** - A supply chain disruption is any sudden change or crisis - be it local or global - that negatively impacts that process. It is defined as major breakdowns in the production or distribution of a supply chain, including events such as a fire, a machine breakdown, natural disasters, quality issues, and an unexpected surge in capacity. It can lead to decreased productivity, increased costs, rising customer dissatisfaction, and more. Therefore, since the solutions implemented in the pilot are not able to affect external supply chain disruptions, this KPI is defined as the reduction of the impact caused by Supply Chain disruptions.
7. ***Reduction in CO2 emissions (>20%)*** – in this case CO2 emission refers to the logistics operating phase that corresponds to the use made of the means of transport, and therefore to the combustion of the energy source (fuels). From the perspective of the pilot, such an indicator can be expressed indirectly for example as a reduced number of trips due to a reduction in complaints (no need for reshipment).

Due to the need to gain insight into the business processes of individual LL actors as well as physical and documentation flows, 17 B2B and 13 B2C processes were mapped as part of the pilot preparation phase. This holistic approach will allow us to identify processes where there is potential for improvement through implementation of new technological solutions as well as changes in the organizational area. Additionally, process mapping allows us to see the connections between activities and actors and their potential impact on each other.

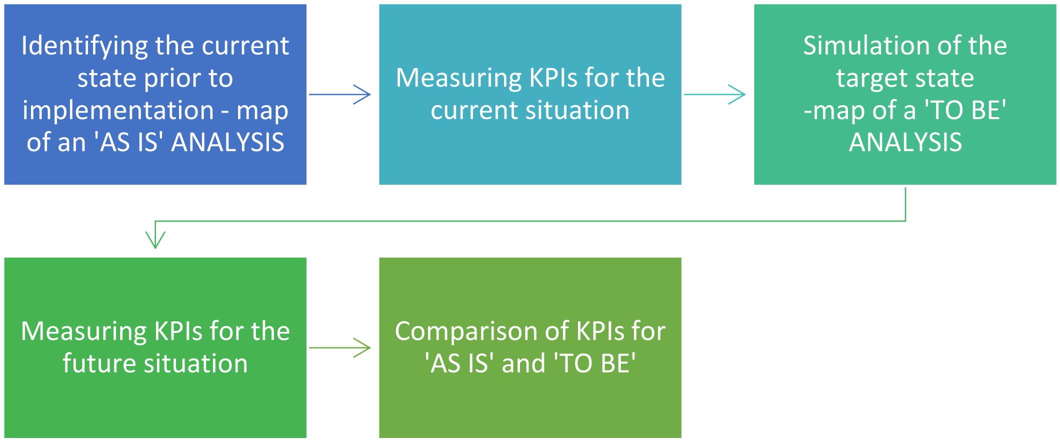
The KPIs presented above have been assigned to individual processes in accordance with the theme.

The processes mentioned were divided into 3 groups:

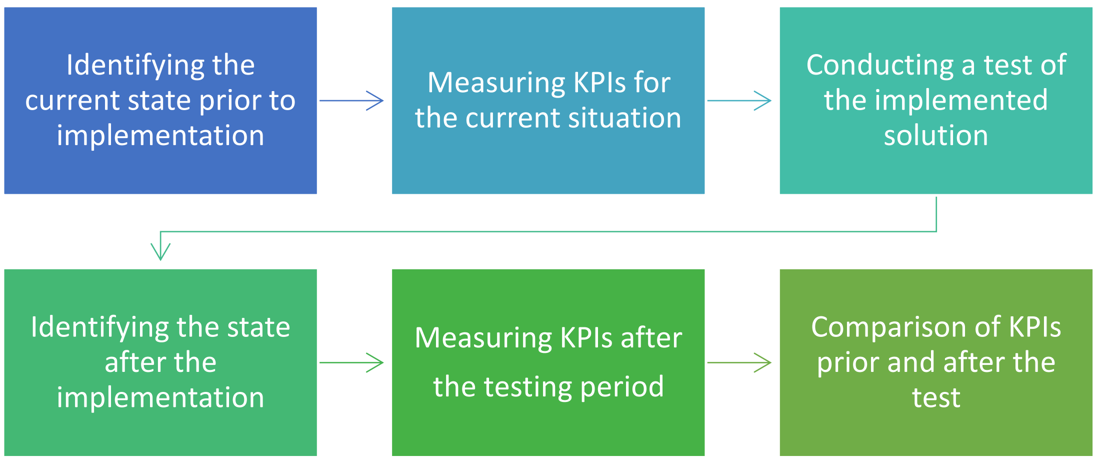
- processes in which there will be a **real implementation** of technical and organizational solutions **tested within the Living Lab,**
- processes in which there will be a **potential implementation** of technical and organizational solutions **simulated within the iGrafx platform,**
- processes that will **remain unchanged** and only reflect side operations.

The following logic of action will be used as part of the KPIs' assessment process:

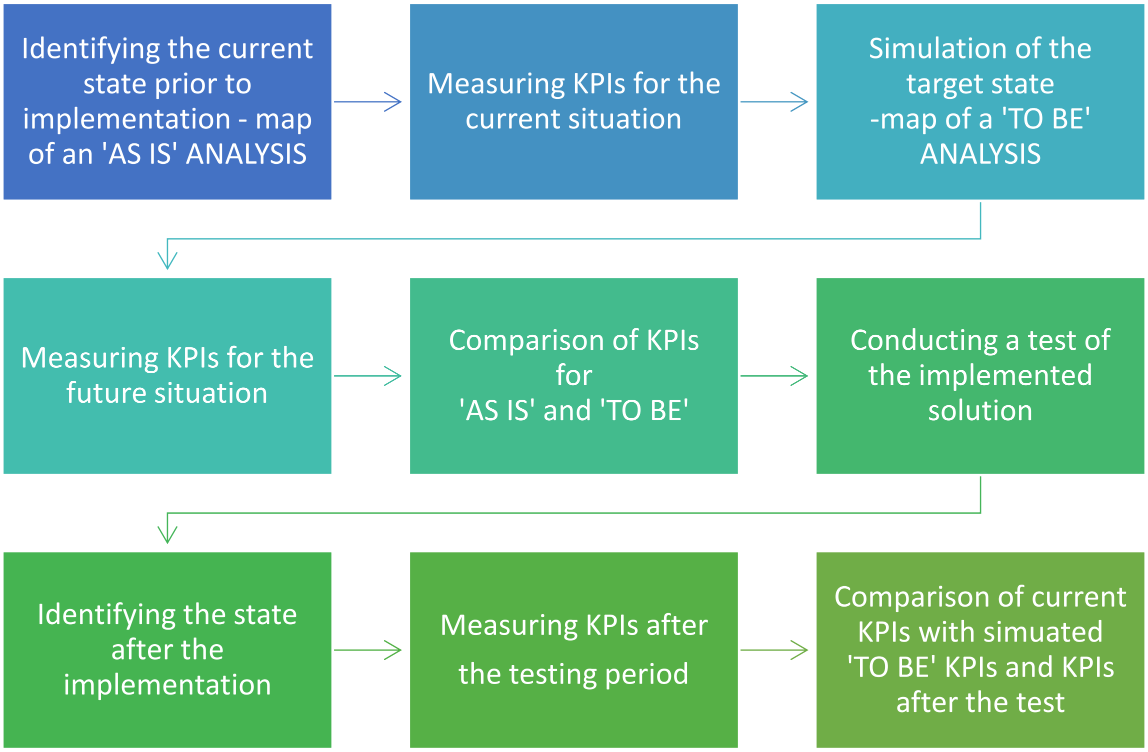
1. for the KPIs that can only be measured by ***simulating changes in the process by iGrafx platform***



2. for the KPIs that can only be measured by ***testing changes within the pilot*** *(it also includes qualitative KPIs that will be assessed through a survey of LL's actors.)*



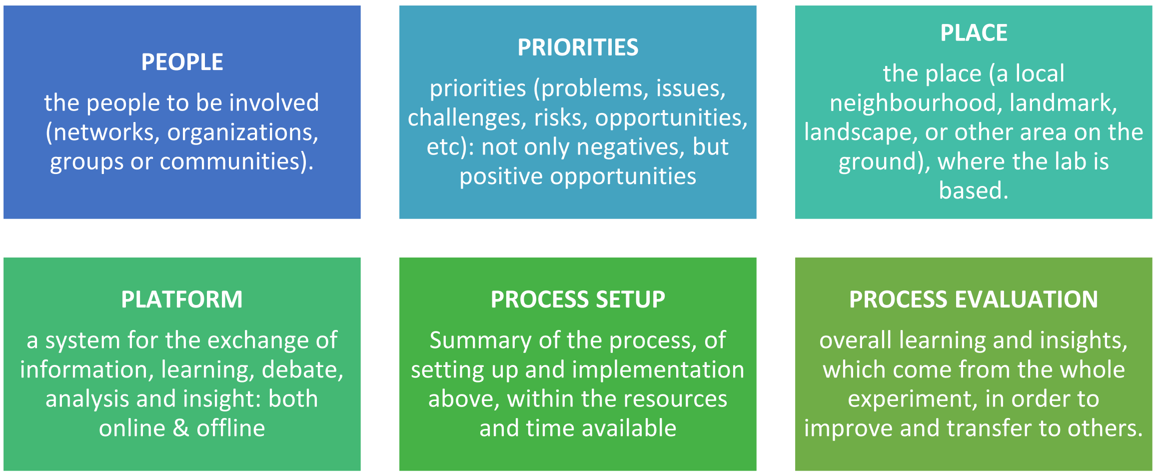
3. for the KPIs that can be measured by ***both iGrafx simulation and pilot testing***


Identifying the current state prior to implementation - map of an 'AS IS' ANALYSIS
Measuring KPIs for the current situation
Simulation of the target state -map of a 'TO BE' ANALYSIS
Measuring KPIs for the future situation
Comparison of KPIs for 'AS IS' and 'TO BE'
Conducting a test of the implemented solution
Identifying the state after the implementation
Measuring KPIs after the testing period
Comparison of current KPIs with simuated 'TO BE' KPIs and KPIs after the test

8 Living Lab Organization & Planning

8.1 Living Lab Organizational Structure

The Living Lab's organizational structure is described under 6 major components.:



PEOPLE AND STAKEHOLDERS INVOLVED

- Łukasiewicz - Institute of Logistics and Warehousing coordinates LL, analyses business process, implements IoT technology to control resources and their parameters in real time and implements the EPCIS platform and analyses implementation efficiency
- GS1 Poland and GS1 China coordinate the implementation GS1 standards (including EPCIS) in the chain from China to Europe, to simplify customs clearance and streamline logistics operations in the operator's system
- Polish Post provides access to operational data and infrastructure for LL: 1 / testing the use of GS1 standards, 2 / modularizing cargo to enable sharing container space with other loads, and 3 / assessing alternative transport shipments throughout Europe
- ROHLIG SUUS provides access to operational data and rolling stocks by testing the use of IoT technology and the EPCIS platform used along the Silk Road, including the Container Terminal in Małaszewicze (cargo handling point originating from China to the EU).
- Partners on the Chinese side responsible for: Installing the tags on the wagons /Transmission of data to EPCIS

PLACE AND LOCATION OF THE LAB

Testing the physical flow carried out by Polish Post:

- Chongqing terminal, China
- Małaszewicze terminal, Poland
- Polish Post Distribution Centre WER Lublin, Poland
- Polish Post Distribution Centre WER Warszawa, Poland

Testing of IT system operations carried out by Polish Post

- PP Headquarters in Warsaw, Poland

Testing the physical flow carried out by Rohlig Suus:

- Shenzen/Shanghaj China - Rohlig Suus Agent Centre
- Chongqing/ Chengdu terminal, China
- Małaszewicze terminal, Poland
- Main Distribution Center in Sokołów

Testing of IT system operations carried out by Rohlig Suus:

- RS Headquarters in Warsaw, Poland

Testing of IT system operations carried out by ILIM:

- ILIM Headquarters in Poznan, Poland

PRIORITIES: OR ISSUES AND CHALLENGES TO BE WORKED ON

1. Application of GS1 standards in parcel flow processes from China to Poland
2. Application of IoT solutions through the use of sensor network and EPCIS

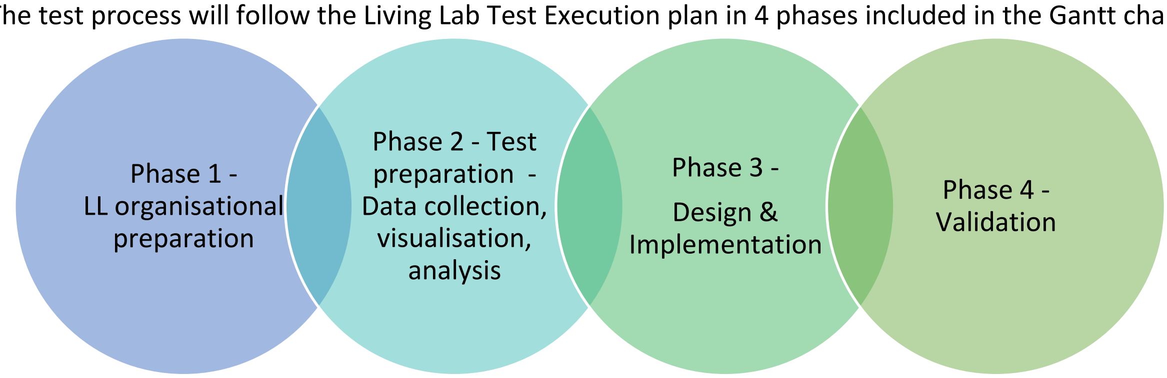
PLATFORM: A SYSTEM FOR EXCHANGE OF INFORMATION AND KNOWLEDGE

Data collection as well as exchange of information about the test progress will be carried out among the participants via a Sharepoint platform. Microsoft SharePoint - a web application platform developed by Microsoft. It is designed for complex web applications and supports various combinations of managing, publishing and manipulating information between users in a corporate network.

SharePoint is a multi-tasking platform, which allows managing and securing various types of files and documents imported between the server and the client. Additionally, it enables collaboration and integration of network servers and data repositories contained in them.

PROCESS SETUP OF THE LAB AS AN EXPERIMENT WITHIN THE RESOURCES AND TIME AVAILABLE

The test process will follow the Living Lab Test Execution plan in 4 phases included in the Gantt chart.



PROCESS EVALUATION: OVERALL LEARNING AND INSIGHTS WHICH COME FROM THE WHOLE EXPERIMENT

Aim of the assessment plan is a Living Lab's process evaluation with overall learning and insights, which come from the whole experiment, in order to improve and transfer to others.

Five Key Principles which have been agreed by the Living Lab team as criteria for LL process evaluation are: Value, Influence, Sustainability, Openness, Realism.

That assessment model requires from the team the implementation of five main activities:

1. Monitoring sessions 2. Evaluative qualitative questionnaires with experiment teams 3. On-site visits 4. Documentary analysis 5. Reporting

The details of this process are described in Section 8.4.

8.2 Implementation Plan

Within the PLANET project's overall timescale of 36 months, the pilot Lab has a work program with timescales of 9 months. The implementation plan was divided into 4 consecutive phases:

PHASE 1 LL ORGANISATIONAL PREPARATION (1st month)

The first phase is the time in which the LL team works on the organization of the test course and how this plan will be implemented. In the next step, an assessment plan for the LL organization is developed. Such preparation is essential so that the entire team working on the test knows the purpose and scope of each task.

1a. Living Lab Organizational Structure preparation

1b. Implementation Plan preparation

1c. Innovation Plan preparation

1d. Assessment plans preparation

PHASE 2 TEST PREPARATION - DATA COLLECTION, VISUALISATION, ANALYSIS (1st -6th month)

The general aim is to identify in practical detail, the problems of a business partners, through a five-step process. 'Problems' here also includes "opportunities" and pathways to go forward.

2a. Scoping problems & opportunities: Following the broad Priorities for the whole Lab setup, here we focus or zoom in to particular interventions with problems/opportunities, for particular business case, with particular causes and effects. The problems will be framed in a way so that the tangible aspects can be identified

2b. Data collection: Data to identify the scope, location and type of challenges will be collected, as far possible, with the participation of business partners. This includes direct monitoring or participatory sensing and qualitative data through face-to-face discussion.

2c. Visualization: Visualizations of the collected data will be produced with iGrafx platform in the form of AS IS and TO BE maps. This task consists of additional detailed subtasks:

- Rohlig Suus AS IS analysis
- Polish Post AS IS analysis

- Rohlig Suus TO BE analysis
- Polish Post TO BE analysis
- Rohlig Suus Comparative simulation
- Polish Post Comparative simulation

2d. Problem analysis & assessment: The results of the visualization will be discussed with business partners and technical team and analyzed in terms of targets, priorities, opportunities.

Phase 3 DESIGN & IMPLEMENTATION (1st-9th month)

This next phase is about responses to the problems and opportunities. This involves collaborative (co)- design and evaluation of the options. The main issue with co-design is an iterative loop, i.e. from concept, to sketch, to outline, to detail etc. Each of these needs some form of participation between technical experts & business partners.

3a. Co-design of responses & options: Participants will engage in qualitative and interactive online and face-to-face deliberation activities to propose a range of solutions. Co-design is an iterative process, which can include many cycles, from concept to detail. It also involves a relationship of power between community and experts/policy-makers, which can be problematic, or if possible, can also be empowering. Activities include: - 'Ideate': generate creative divergent visions, ideas, synergies, & possibilities - 'Design': iterative process moving from vision, to concept, to outline, towards detail. Here the relationship is very important, between experts/providers, and community/non-experts. - 'Resources': funding sources, other resources e.g. land

3b. Evaluation of options: Where possible this process generates more than one option, so that the positives/negatives (costs/benefits) of each can be compared. In most practical cases the first criteria will be cost/ funding or feasibility. Where possible, a multi-criteria analysis will be used to appraise the alternatives. Activities include: - 'testing' the design prototypes/sketches at each stage - 'options': generate clear alternatives where possible - 'evaluation' of options/sketches & implications

3c. Implementation: This will be different for each use-case. Where there is physical action on the ground, it would be possible to involve the stakeholders through their contribution. Activities include: - Detailed/technical design & specification - Contracts, service agreements, procurement paths - Physical construction / service implementation. This task consists of additional detailed subtasks:

- IoT development (5 sets)
- Instruction of installation (pictures & video)
- Development of identification application
- Dispatch of components
- IoT Installation
- Report on IoT installation
- Testing 1st run
- IoT Customization
- Dispatch of components
- Testing 2nd run
- EPCIS communication with Vayasens platform

- EPCIS Data collection

This last phase includes the implementation of the best option, and monitoring feedback of the results.

3d. Monitoring and feedback: The question is then, what are the results, impacts, outputs and outcomes? Where possible we will monitor the impact of the co-designed solutions, with the same set of tools as in Phase 2, with the input of stakeholders through participatory sensing and open data. This information would then go towards feedback for the next round of problem scoping and co-design. Activities include: - Monitoring of the 'before & after' results, quantitative or qualitative - Evaluation of the implications, e.g. did the co-design work, could it be improved etc.

- Technical report on tests execution

PHASE 4 – VALIDATION (2nd-4th & 9th month)

This task is key to answering whether the final test result is consistent with the Living Lab goal. In this step, the result obtained from both the system simulation and the real test is validated.

- 4a. Validation of the test results & comparison with simulation outcomes
- 4b. Validation of EGTN Infrastructure in the LL
    - Alignments with IBM (what is needed for analytics)
    - Identification of data sources
    - Alignments with IBM (what is missing for analytics)
    - Alignments with GS1 China on using their EPCIS
    - Alignments with PP on prediction capabilities
    - EGTN communication with EPCIS set up

8.3 Innovation Plan

IoT in the PLANET project is considered as enabling technology capable to "translate" the physical world events into digital ones, thus realizing the supply chain complete visibility. All the goods and the assets involved in the supply chain can be Track & Trace & Monitored, allowing the implementation of proactive activities toward the optimization of the logistics transactions. The main purpose of Planet EGTN IoT environment is to provide the possibility of T&T&M the goods. In this scenario, the goods are monitored all along the supply chain, exploiting the open EGTN IoT environment. The pervasive set of IoT devices will provide pervasive and dedicated information about the position, the time, and the status of the goods. On the other hand, the objective of the EGTN IoT infrastructure is to envision an interoperable environment capable to accommodate different service and device providers, maintaining a security and privacy constraints. Utilization of the data collected in the EGTN platform would be realized by enabling the utilization of the corridor route optimization service to create more efficient route planning for complex and dynamic change in routes and the new criteria for corridor connectivity indexes. Big data augmented by the detailed corridor transport models and real time IoT sensor information will be used to develop effective routing optimization.

Tests conducted within the Polish Living Lab are aimed at implementing the Process Innovation in the area of operations of individual business partners. It is worth emphasizing that the implemented technological and process solutions are not innovations on a global scale, but they have a great innovative potential on the scale of the tested companies, as well as supply chains within the Asian-European transport corridor - New Silk Road.

Process innovation is the implementation of a new or significantly improved production or delivery method. This category includes significant changes in technology, equipment and/or software. In the case of Rohlig Suus and Polish Post process innovations can be aimed at lowering the unit cost of delivery and increasing quality of service. Delivery methods relate to the logistics of the firm and include equipment, software, and techniques used to acquire inputs, allocate resources within the firm, or deliver final products.

Process innovations include new or significantly improved methods of creating and delivering services. These may involve significant changes to the hardware and software used in service firms or changes to the procedures or techniques used to provide services. Examples include the introduction of GPS-based location devices in transportation services. Project innovations also include new or significantly improved techniques, equipment, and software in support activities such as procurement, accounting, IT, and maintenance. The implementation of new or significantly improved information and communication technologies constitutes a process innovation if it is aimed at improving the efficiency and/or quality of ancillary activities.

Process innovation can generate value to either internal customers, including employees or the actual organization itself, or it can create value to external customers, including business partners, end users or actual consumers. In terms of the Polish Living Lab values stemming from process innovation include reducing the time it takes to deliver a product or perform a service; increasing the number of products delivered or services provided within a time frame; and reducing the costs per product delivered or service provided. Additionally, process innovation can generate significant gains in product quality and service levels. Overall, an individual organization needs to see a significant increase in some of its key performance indicators (KPIs) to be a true process innovation.

The positive impact of the implementation of the process innovation on the business operations of Rohlig Suus and Polish Post will be assessed by evaluating the test results through the various KPIs described in section 7.

ILiM is focused on the development and implementation/testing of innovative solutions enabling digitization of supply chains and standardization of information flow to provide optimization of logistics processes in enterprises and supply chains, such as the use of sensory systems, the use of RFID, the use of automation in logistics, implementation of EDI communication, GS1 standards in logistics processes and optimization of logistics resources in order to reduce the risk of supply chain failure to resist disruptions.

The task of ILiM is to combine scientific concepts and innovative technologies for the optimization of logistics processes and development of technology with the business needs of enterprises. This project is a response to both the competences of ILiM in the field of intermodal transport along the Silk Road Route, as well as the identification of location and other parameters in real time, information integration of business partners in supply chains and monitoring of logistics processes along the whole supply chain. Research and implementation works along the New Silk Road allow for the synergy of goals for ILiM in the field of practical verification / testing of technological solutions produced by ILiM, as well as the concept of applying the optimization proposed by ILiM.

The two main innovation goals that have been set within the Living Lab:

- Application of GS1 standards in parcel flow processes from China to Poland

- Application of IoT solutions through the use of sensor network and EPCIS

A separate goal of ILiM is to extend the research on the effectiveness of the application of standards to international business ties with the use of rail transport, as so far, the focus has been on domestic transport, mainly on a national scale.

ILiM recognizes business needs not only in terms of the use of modern technologies that enable monitoring of logistics processes, but also information integration of business partners in supply chains, which is currently a problem.

At the same time, this scope should be treated as a risk of implementing activities in LL3 of the Planet project. Technical problems in the system integration of partners may be a problem with testing the offered solutions.

The solution based on sensor networks with the use of the EPCIS system in the PLANET project will be used as Proof-of-Concept implementations as part of the acquisition of new business partners in the field of monitoring cargo flows and logistics processes in real time.

As regards the use of GS1 standards, integration of standard solutions with the IT systems of business partners is planned. Moreover, in addition to the practical experience gained during the implementation of tests of sensor networks and GS1 standards in the intermodal supply chain, ILiM plans its further substantive and technical development in the application of the concept of Industry 4.0 and the Internet of Things, through participation in specialist and scientific training and conferences for its project team.

An additional role of ILiM of the PLANET project is to coordinate the work of partners in LL3. For this reason, a parallel task to the substantive tasks in the project is to monitor the achievement of goals and implementation of tasks by each of the LL3 partners.

Polish Post

Polish Post, as a member of LL3 in the PLANET project, intends to participate in testing GS1 solutions (mainly SSCC) in servicing the supply chain from China to Europe implemented through the New Silk Road.

As part of the Living Lab, Polish Post cooperate with a number of world-leading entities dealing with the issues of broadly understood logistics, supply chain optimization, and the use of IoT in the cross-border flow of goods.

Polish Post, as the designated postal operator that delivers parcels delivered from Asia by rail, as part of the PLANET project intends to use GS1 standards and establish cooperation with business entities from China.

In this regard, PP counts on closer cooperation with GS1 China, whose local activities among partners that can use the SSCC in logistic operations, as well as the promotion of rail transport in international trade will contribute to the operational use and practical verification of benefits. Considering the growing importance of Poland on the European e-commerce map as a destination country for shipments from Asia and the growing popularity of Chinese platforms among Polish e-shoppers, we trust that choosing a partner by GS1 China will not be a problem. We are waiting for feedback from GS1 China on the above-mentioned issue.

As part of cooperation with SUUS, Polish Post expresses its hope to develop a uniform rail supply chain process using the partner's transport services for cross-border e-commerce shipments.

We identify the needs for further good communication and cooperation with all Living Lab partners, in particular at the current stage with GS1 China and GS1 Polska (choosing a business partner in China to test the designed solution), Rohlig SUUS (using rail transport services for consolidated e-commerce shipments) and ILiM (design works, process documentation, process mapping, preparation of test environments).

Currently, Polish Post does not express any concerns regarding the implementation of the plans under the PLANET project, however, it is important that all partners involved in the work of Living Lab fully use their organizational potential for the purposes indicated in the project.

PP expected impact

The results of the PLANET project will allow Polish Post to assess the practical use of GS1 standards in servicing the global e-commerce supply chain, its benefits and possibilities of operationalization and potential commercialization of the solution.

PP hopes to establish contacts with new business partners who have not yet cooperated with Polish Post in the implementation of e-commerce shipments from China to Europe.

PP would also like to promote modern and innovative supply chain solutions for the benefit of e-commerce entities and to improve the flow of parcels to recipients in Europe.

Rohlig Suus

The main needs of RS dealt with by the LL3 are:

- optimization of operations, processes and efficiency of the entire supply chain of containerized cargo between China and Poland,
- improving the visibility of cargo flow throughout the supply chain by monitoring data in real time.

As part of the main objectives, activities are planned to analyze the benefits of using new IoT technologies (sensor networks).

The activities implemented under LL3 will allow the integration of partners along the New Silk Road. At present, the flow of information along the supply chain using rail transport is not continuous and has gaps in access to information lasting several days, which prevents effective planning of train arrivals and monitoring of transport statuses.

The introduction of a solution based on the use of sensor networks and the EPCIS system can eliminate the problem. There is potential for using EPCIS in rail transport in the New Silk Road.

It was indicated that the greatest potential for the use of EPCIS exists in the real-time monitoring of rolling stock.

Thanks to this solution, it will be possible to: track loads in real time, estimate the distance traveled by the vehicle to plan preventive maintenance, as well as the control of vehicle availability. EPCIS can also be used to collect information related to the operation of rolling stock, e.g. hot axle detection, wheel shock load detection, acoustic axle bearing monitoring, and pantograph damage monitoring.

RS expected impact

The results of the PLANET project will allow Rohlig Suus to assess the use of sensory networks and the EPCIS system in servicing the intermodal supply chain, its benefits and the possibility of widespread use in business conditions.

RS also hopes to establish contacts with new business partners who have so far not cooperated with RS in the implementation of rail transport from China to Poland.

As part of the LL3 PLANET project, RS plans not only to gain experience and knowledge in the use of modern technologies in the field of real-time cargo monitoring, but also to promote modern and innovative solutions in the field of digitization of the supply chain for the benefit of business partners in the field of safety and improvement of rail transport processes.

GS1 Poland/GS1 China

There are few main needs of GS1 in the work of LL3 addresses:

- improving the visibility of cargo flow throughout the supply chain by monitoring data in real time,
- developing integrated supply chains on a global scale, using GS1 standards.

The activities carried out under LL3 will allow for the identification of GS1 standards that could be used in the logistics processes of the New Silk Road, the development of guidelines for the implementation of GS1 standards in the logistics processes of the New Silk Road, and for an analysis of the benefits of applying GS1 standards in the global supply chain.

The use of developed GS1 standards is aimed at streamlining logistics operations throughout the entire supply chain through the usage of a unique and uniform data recorded by all participants of the GS1 system.

The goal of GS1 is to support business practice in implementing solutions that integrate companies in global supply chains and this is the motivation to implement activities in LL3.

These activities are primarily aimed at increasing the business benefits for the New Silk Road stakeholders (business partners in the supply chain), in terms of:

- Reduced freight cost,
- Realtime visibility of freight.

Currently, the main threat to the effective implementation of works at LL3 there are business limitations caused by the COVID-19 pandemic, which increases the risk of minimizing China-Europe transport along the New Silk Road.

GS1 expected impact

The results of the PLANET project will allow GS1 to generate the following benefits for GS1 participants (business partners who are stakeholders of the New Silk Road):

- SSCC mandatory on the Transport Label and in the 2D barcode
- Improved first and last mile processes through the capture of essential information relating to the transport task from the barcode on the transport label
- Visibility of transport task requirements even if the remote IT systems are unavailable for look-up
- Improved efficiency and interoperability across industry through a standard label across the entire supply chain
- All this leads to smoother processes and greater customer satisfaction.

GS1 Poland also hopes to clarify cooperation with GS1 China, both in terms of the use of the SSCC on the New Silk Road, as well as the use of EPCIS in the field of container transport from China to Poland.

As part of the LL3 of the PLANET project, it is also planned to achieve synergy from the application of GS1 standards along with the use of modern technologies in the field of digitization and monitoring of loads in real time.

8.4 Assessment plans

Aim of the assessment plan is a Living Lab process evaluation with overall learning and insights, which come from the whole experiment, to improve and transfer to others.

Five Key Principles which have been agreed by the Living Lab team as criteria for LL process evaluation are:

- ***Value*** – refers to the user or business value, where user value is created by understanding the users' needs and motivation and involving them in the innovation process, and business value is added through the insights gathered and innovations delivered.
- ***Influence*** - based on the idea of acknowledging users as active, competent partners and domain experts as they could generate innovative concepts driven by a desire to solve their problems and fulfil their needs. However, their involvement in the process will only be worthwhile if their needs and ideas are visible in the concepts, prototypes, and final product.
- ***Sustainability*** - aimed at ensuring that living lab is solving present and future needs by taking responsibility for their actions, addressing sustainability issues while implementing environmentally friendly processes.
- ***Openness*** – is about the creation of an open innovation process that utilizes collective creativity by involving various stakeholders.
- ***Realism*** - the real-life context is a key factor for living lab, so creating like the world environments for testing and evaluating products is essential. Moreover, the users and other stakeholders are part of the processes and play a crucial role

That assessment model requires from the team the implementation of five main activities:

1. Monitoring sessions - during the bi-monthly sessions, the team will reflect on the progress of the planned actions and the main obstacles, opportunities, deviations, and results.

2. Evaluative qualitative questionnaires with experiment teams - at the mid-term and after the end of the experiment, the team leader will fill in questionnaires.

3. On-site visits - the evaluation team will visit the location where the experiments are conducted and conduct interviews or focus groups with beneficiaries, stakeholders, and actors involved in the experiments.

4. Documentary analysis - the document collected by the evaluation team will be analysed by a dedicated grid, which considers the above-presented indicators. Thus, the evaluation team will be able to assess the experiment and the project.

5. Reporting - a mid-term and final report will summarize the evaluation activities. The reports represent the final evaluation and the results obtained through the experiments and the project.

9 Conclusions

This report described the preliminary findings through in-depth analysis of the current situation, also covering identification of key needs and problems affecting global transport.

Preliminary analysis of the Living Lab environment revealed strong need to employ solutions both at the process as well as technology innovation level so as to increase the visibility of supply chain flows in the China-EU corridor, and access to shipment information for the final e-commerce customer.

This conclusion led to the establishment of the objectives to be implemented within the framework of the Use Cases. LL3 will focus on streamlining logistic processes in flows from China to Europe along the Silk Road by implementing IoT technologies (based on the EPCIS platform) and GS1 standards that facilitate transmission of data between the partners involved in the e-commerce operations. LL3 aims at:

1. Standardizing information flows and digitalizing interactions between actors within the network (China Post, Polish National Post); Providing access to real time information on cargo coming from China to Poland along the entire supply chain through application of IoT and EPCIS to monitor supply chain events and support operational optimization;

2. Facilitating effective co-modal end-to end transport within EU's internal rail network. LL3 will therefore support the PLANET's vision, in particular:

- Assess implications of new trade routes, the Silk Road, and how best to maximize the EU's economic prospects through the sustainable development of the transport nodes and development of new logistics routes enabling links with national/regional markets, particularly Easter Europe corridors and optimization of e-commerce distribution networks in Europe particularly through increased collaboration of Postal operators,
- Promote standardization both by GS1 and the development of European and worldwide standards easing adoption of EGTN innovations; contribute to emerging standards and relevant future releases,
- Simplification of customs clearance and improvement of logistics operations due to identification of parcels flows from China to EU,
- Support increased automation in T&L operational management through EPCIS (GS1 standard that enables trading partners to share information about the physical movement and status of products as they go throughout the supply chain – from business to business and ultimately to consumers),
- Apply PI principles in the development of a Polish EGTN for the e-commerce sector.

As part of the ongoing work, the research team defined 7 KPIs that will allow to assess the impact of implemented solutions on key areas related directly to operations and the business environment:

- Reduced compliance costs (>10%)
- Improved end-to-end visibility (>50%)
- Improved customer experience (>15%)
- Increased volumes (>8%)
- Reduced operational costs (>10%)
- Reduced disruptions of the Supply Chain (>15%)
- Reduction in CO_2 emissions (>20%)

To achieve a common understanding of KPIs, the project extended their description with a detailed definition. This approach allowed the indicators to be properly matched with the relevant business processes.

In the next release of this deliverable, D3.6 *LL3 EGTN Solution description and test results*, the final outcomes of the pilot will be presented. This will include post-implementation analysis, which will allow to assess the impact of implemented solutions, both on business partners and their supply chains (China-EU corridor) as well as the value generated by EGTN's platform's deployment and predictions.

10 References

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Annex I: Business Process Modelling and Notation

BPMN

One of the most frequently used methodologies of mapping business process is the methodology based on the SCOR reference model (Supply Chain Operations Reference Model). It should be noted that the necessity to exchange operational data of the process, taking into account the division into operations and transactions as well as initiating events, documents and output reports, constitute the basis for the dimensioning and operational preparation of processes in accordance with the BPMN concept.

BPMN (Business Process Model and Notation) is a standard designed to present in a graphical manner the processes taking place in virtually every type of business. The main goal of BPMN is to provide a methodology that is comprehensible for users, ranging from business analysts who create initial sketches and prototypes of designed processes, through technical programmers responsible for their actual implementation, to employees of companies verifying practically the models - implementing and monitories process. BMPN notation was inspired by UML (Unified Modeling Language) diagrams in order to graphically represent processes, and also filled with the possibilities of mathematical analysis, which allows for direct translation into the execution languages of business processes.

BPMN notation uses unique terminology to avoid confusion with other modeling notations. Table 2 shows the basic terminology used in BPMN notation.

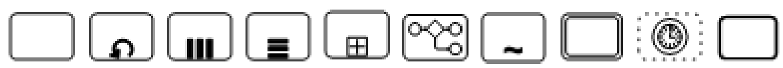
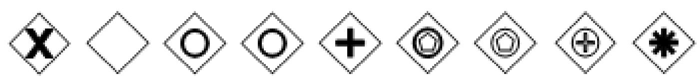
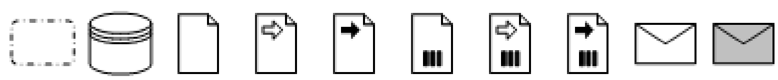
Table 8: Basic terminology used in BPMN notation

Category	Term	Description
Process flow objects	Event	Events symbolize the cause or result of a process. The BPMN specification defines three types of events: start events, intermediate events, and end events.
	Activity	Activity is a general term that describes an item of work that is performed within an organization of processes. An activity can refer to processes, sub-processes, or individual tasks and operations.
	Gateway	The gateway controls sequence flow discrepancies and convergences. Specifies the branching, conditional forks, and joining of process paths.
Connection objects	Sequence flow of process	The process flow represents an ordered sequence of actions. It is visually represented by arrows between flow objects.
	Message flow	Message links are used to map the information flow in the form of messages throughout the whole process.
	Association	Association links represent the relationship between artifacts and flow objects and swimlines.
Swimlines	Business unit, participant (pool)	A business unit is used to separate the activities in the process among the participants in the process.
	Roles (lanes)	Roles allow to allocate individual activities of which is composed the appropriate organizational units.
Artifacts	Data objects	Data objects are elements showing the input and output data of individual activities that make up the process.

	Groups	Groups allow to mark objects for information purposes, which does not effect of the simulation process.
	Annotation	Annotations are additional information that is included in the process model for informational purposes.

For a detailed description of the analyzed process and its individual elements, are used an appropriate graphic symbols, which have been presented in Table 6.

Table 9: Symbols used to describe the process according to BPMN notation

Events	
Activities	
Gateways	
Artifacts	

In business practice there are a lot of information tools for modeling and simulating in accordance with the BPMN notation. One of the most frequently used simulation tools in enterprises is iGrafx Process. The iGrafx Process IT environment allows to edit complex process diagrams in order to present them clearly and to easily carry out simulations at a later time. iGrafx Process also enables reading diagrams prepared in MS Visio and their verification in terms of the correctness of the process logic.

In an integrated IT environment that uses BPMN notation, is used the BPEL (Business Execution Language for Web Services) programming language, which based on XML (Extensible Markup Language) and used to create the program code that implements the process described with BPMN, and a unified writing method business process models in XML - XPDL (XML Process Description Language) format.

Annex II: Comparison of possible technologies

Table 10: Comparison of possible technologies

Functionalities	VAYASENS (DASH7)	BLE / NB beacons	GPS/GSM trackers	Passive RFID	Indoor sensory networks	Electronic seals	Online/Offline loggers
Built-in temperature sensors	YES	YES	NO	YES	YES	NO	YES
Built-in humidity sensors	YES	YES	NO	NO	YES	NO	YES
Built-in accelerometric sensors	YES	NO	NO	NO	NO	YES	NO
Battery power supply	YES	YES	YES	NO	NO	YES	YES
Operating time at temperatures from -25ºC	up to 5 years	no data	days or weeks	unlimited	unlimited	days	days or weeks
Wireless communication	YES	YES	YES	YES	YES depending on the solution variant	YES	YES depending on the solution variant
Range of correct operation	up to 3 km	in GSM network coverage or up to 100m	in GSM network coverage	few /a few dozen meters	n/a	in GSM network coverage	few /a few dozen meters
Control over all layers of the communication protocol	YES	NO	NO	NO	NO	NO	NO
FOTA mechanism (remote wireless software update)	YES	NO	NO	NO	NO	NO	NO
Advanced anti-collision functions (large number of devices in a small space)	YES (upgraded CSMA/CA)	FHSS/TDMA/CDMA/ FDMA/Slotted Aloha	YES	FHSS/Slotted Aloha	Aloha	NO	NO
Built-in passive RFID option	YES	NO	NO	YES	NO	NO	NO
Precise in-door location	YES	NO	NO	NO	NO	NO	NO

Out-door location	YES	NO	YES	NO	NO	YES	NO
Electronic seal function	YES	NO	NO	NO	NO	YES	NO
Parameter monitoring function	YES	NO	YES	NO	NO	NO	NO
online means of transport							
Use of theNO AI in data analysis	YES	NO	NO	NO	NO	NO	NO
Tracking of cargo units in transport	YES	NO	YES	NO	NO	NO	NO
Function of monitoring the condition of loading units in transport	YES	YES	NO	NO	NO	NO	YES
Cloud platform for data collection	YES	YES	YES	NO	YES	YES	NO