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

# D3.8 EGTN Generic Use Case final version

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1 According to PLANET's Quality Assurance Process

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# Glossary of terms and abbreviations used

| Abbreviation / Term | Description |
|---|---|
| AI | Artificial Intelligence |
| DASH7 | Developers' Alliance for Standards Harmonization of ISO 18000-7 |
| DoA | Document of the Action |
| DSS | Decision Support System |
| EGTN | EU-Global Transport &Logistics Networks |
| EPCIS | Electronic Product Code Information Services |
| ETA | Estimated time of arrival |

| Abbreviation / Term | Description |
|---|---|
| EU | European Union |
| GS1 | Global Standard 1 |
| KPI | Key Performance Indicator |
| HMI | Human Machine Interface |
| ICT | Information and communications technologies |
| IM | Infrastructure Manager |
| IoT | Internet of Things |
| IT | Information technology |
| LL | Living Lab |
| LMD | Last Mile Delivery |
| LPWSN | Low Power Wireless Sensor Networks |
| LSP | Logistics Service Provider |
| LSW | Logistics Single Window (JUL in Portuguese) |
| MAMCA | Multi-Actor Multi-Criteria Analysis |
| MLP | Multi-level perspective approach |
| M2M | Machine to Machine |
| PEN | Principal Entry Node |
| PEP | Principal Entry Point |
| PI | Physical Internet |
| PP | Position Paper |
| RFID | Radio Frequency Identification |
| RO | Rail Operator |
| RU | Railway undertaking |
| SSCC | GS1 coding: Serial Shipping Container Code |
| T&L | Transport and Logistics |
| T&T&M | Track and Trace and Monitoring |
| UC | Use Case |
| VNA | Value Network Analysis |
| WP | Work package |

# 1 Executive Summary

This deliverable sets up and specifies the parameters of an EGTN Generic Use Case. It brings together elements from the three PLANET Living Labs under a common EGTN framework and employs the analysis of the effects of the new trade routes in the TEN-T flows carried out in T1.2 and the simulation capability described in D1.3.

The EGTN Generic Use Case is used in PLANET to produce a Digital Clone aiming at investigating through simulation the impacts of introducing the EGTN infrastructure and the new logistics concepts and technologies along complete TEN-T corridors. The approach is presented in this document and has been applied in the port of Sines Use Case (D3.9).

This report, as other deliverables produced in WP3, aims to facilitate the EGTN adoption by EU T&L actors and communities. It incorporates contributions from all relevant project partners. Main aim is to demonstrate how EGTN generic models and services based on the outputs of the three LLs can be widely applied by T&L communities and sustain project outputs after its finalization.

# 2 Introduction

## 2.1 Mapping PLANET Outputs

The 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** | | | |
| D3.8 EGTN Generic use case final version | EGTN Generic use case that brings together and expand the results of the three Living Labs and the simulation of selected TEN-T corridors covering financial, business, economic and social impacts. | Chapter 4<br>Chapter 5,<br>Chapter 6,<br>Chapter 7 | Living Labs impacts are presented in Chapter 4. EGTN Generic Use Case framework is presented in Chapter 5. The simulation design is introduced in Chapter 6, and the Generic Use Case impact assessment in Chapter 7. |
| **TASKS** | | | |
| ST3.4.1: EGTN Generic use case. | The EGTN Generic use case will be built in order to bring together and expand the results of the three Living Labs. The generic use case will use the results of the simulation of selected TEN-T corridors (the ones to be mainly impacted by the emerging trade routes to/from Europe) undertaken in T1.2, but this time taking into consideration the actual impacts of the LLs. | Chapters 4 and 5 | Chapter 4 presents the Living Labs activities and their impacts. Chapter 5 addresses the framework for the Generic Use Case, specifically its components and principles (section 5.1.2) and the Criteria and Selection of TEN-T corridors (section 5.1.4) |
| | A Digital Clone will be produced based on the generic use case enabling answers to the question: what would be the impact of introducing the EGTN infrastructure and the new | Chapter 6 | Chapter 6 describes the simulation design of the Generic Use Case and the approach towards the Digital Clone. |

| | | | |
|---|---|---|---|
| | logistics concepts & technologies that were tested in the LLs, along complete TEN-T corridors? | | |
| | The assessment will include: (i) financial & business impacts, i.e. quality improvements and cost efficiencies achieved in day-to-day operations; (ii) economic & social impacts, i.e. congestion, accidents, air & noise pollution and climate change. | Chapter 7 | The Impact Assessment Methodology of the Generic Use Case is described in Chapter 7. The generic KPIs for determining the impacts at financial & business levels, and economic & social are also listed.<br>The simulation of selected TEN-T corridors covering financial, business, economic and social impacts was addressed in the application of this Generic Use Case in the Port of Sines (D3.9). |
| ST3.4.4 Identification and engagement of interested agents, complementary networks and use cases. | Additional external networking opportunities and networks for the project to link up with during the project, will be identified. A Value Network Analysis, in which the collaboration between each of the partners will be visualised, and the way of fulfilling this collaboration, will be used to show the relations between partners, for both tangible and non-tangible transactions. | Chapter 8 | The identification of additional use cases and their VNA is addressed in Chapter 8. |

## 2.2 Deliverable Overview and Report Structure

In this section, a description of the Deliverable's structure is provided, outlining the respective Chapters and their content.

- **Chapter 3** introduces the EGTN concept and vision for 2030. It is based on the work carried out in T1.5 EGTN Reference Specification and more specifically, reported in D1.10: EGTN Reference Specification v1. It also presents (in a nutshell) the Cloud-based Open ICT Platform developed in WP2.
- **Chapter 4** provides a background regarding the three individual PLANET Living Labs and use cases in which the generic one is based upon.
- **Chapter 5** describes the EGTN Generic Use Case purpose, components and principles.
- **Chapter 6** deeps into the Generic Use Case simulation design and scenarios definition. It also provides the basics regarding the Digital Clone applied to the port of Sines use case (D3.9).

- **Chapter 7** provides a set of generic Key Performance Indicators which allow the Generic Use Case impact assessment on a standard and common basis among different use cases and scenarios.
- **Chapter 8** deals with the identification and engagement of interested agents, complementary networks and use cases.
- **Chapter 9** summarizes the outputs of the present deliverable and how it has contributed to the overall project goals.
- **Chapter 10** contains the bibliographic references used in the document.

# 3 EGTN Framework

PLANET focuses on in two key R&D pillars:

- A Geo-economics approach, modelling and specifying the dynamics of new trade routes and their impacts on logistics infrastructure & operations, with specific reference to TEN-T;
- Speeding up the process and transition towards the Physical Internet paradigm, demonstrating how different technologies, business cases and standards come together in real-world applications, and are able to deliver added value to the users and have positive impacts in the environment.

PI lays the foundations to realize the EGTN strategy towards Smart, Green and Integrated T&L Network. PLANET contributes to the PI concept together with other previous completed European projects, ICONET[2] being the most directly related, and also noteworthy to mention SENSE[3], CLUSTERS 2.0[4] or SELIS[5]. A comprehensive list of European projects for the PI development can be found at the ALICE-ETP Knowledge Platform[6].

## 3.1 The EGTN concept and vision

This section aims at introducing the PLANET environment by describing the main purposes and attributes of the EGTN, exploiting the preliminary results coming from WP1. It is based on the work carried out in T1.5 and more specifically on D1.10 EGTN Reference Specifications v1 that defines the EGTN vision for 2030.

The **Integrated Green EU-Global T&L Network** (EGTN) can be understood as an advanced European strategy that implies the development of a Smart, Green and Integrated Transport and Logistics Network of the future to efficiently interconnecting infrastructure (TEN-T, Rail-Freight Corridors) with geopolitical developments, as well as to optimize the use of current & emerging transport modes and technological solutions, while ensuring equitable inclusivity of all T&L participants, increasing the prosperity of nations, preserving the environment, and enhancing citizens quality of life. The strategy definition, the support to strategy implementation, the strategy possible outcomes (digital & physical infrastructures, new operational methods etc.) and the monitoring and maximization of strategy impact are functional components of the EGTN concept.

EGTN can be defined as a green, globally connected and smart network that will be aware of the global and EU geo-economic developments and take advantage of technological advancements, timely responding to changes by adapting its development and operation. It will be an optimisation ready network in terms of logistics operations, able to better respond to the industry needs through the implementation of innovative technologies under the PI concept. At the same time, it will be an open network in terms of information sharing by its stakeholders, supporting their decision making at every level (operational, strategic etc.) and including them to its governance scheme through a multi-level governance approach. Finally, its structure will ensure that the disadvantaged regions of EU will have the required level of connectivity.

In this context PLANET defines the **Attributes** of the future EGTN as following:

- **Geo-economics aware:** A European T&L network that is aware of the geo-economics aspects driving the development of new trade routes and flows to/from Europe and their impact on the TEN-T;
- **Innovation:** A European T&L network that takes advantage of the potential of innovative logistics concepts (e.g. PI) and enabling technological innovations (Industry 4.0, blockchain, IoT, 3D printing, etc.) in its operation;
- **Impact:** A T&L network that is more economically, environmentally and socially sustainable than the existing TEN-T;

[2] https://www.iconetproject.eu/
[3] https://cordis.europa.eu/project/id/769967/
[4] http://www.clusters20.eu/
[5] https://cordis.europa.eu/project/id/690588/
[6] https://knowledgeplatform.etp-logistics.eu/

- **Integrated:** An EU T&L network integrated with the global network both in terms of hard & soft infrastructure;
- **Inclusive:** Accessible to disadvantaged regions, supporting the development of workforce skills & knowledge.

The TEN-T network was intended to address the implementation and development of a pan-European network of railways, roads, inland waterways, maritime shipping routes, ports, airports and railroad terminals. TEN-T policy evolved into supporting the application of new technologies and digital solutions to all modes of transport with the aim to reduce environmental impact and enhance energy efficiency and safety. The EGTN vision goes a step further in its ambitions and has the following **additional characteristics:**

- Responsiveness to changes
- Readiness for optimisation
- Resilience
- Orientation towards facilitating EU exports
- Supporting social cohesion & inclusiveness
- Bridge business/industry needs for planning to EU policy and infrastructure planning

The EGTN is foreseen to be composed by three interactive layers:

- The physical/**infrastructural layer**. It refers to how the EGTN will be structured in terms of physical corridors and nodes. The objective is to have a network that is better adapted to the new EU & Global geo-economic conditions, serve more efficiently future freight flows and facilitate better the development of disadvantaged regions in comparison to the current TEN-T structure. In this context, the infrastructural layer of EGTN is defined as the TEN-T of the future in terms of T&L infrastructure consisting of revised and enriched existing rail/road/maritime TEN-T infrastructure (nodes & corridors). The forecasting of future freight flows for years 2030 and 2050 which will lead to defining the final form of the physical network needed to efficiently serve these flows, was mainly done in PLANET WP1.
- The **technological layer**, that represents the digital EGTN infrastructure and aims at leveraging emerging enabling technologies capable to support the PI paradigm. The main objective of the EGTN technological layer is to ensure that the EGTN fulfils its ‘innovation embedding’ attribute in the sense that it takes full advantage of the potential of innovative logistics concepts and enabling technological innovations in its operation, ultimately aiming to become a network operating under a PI paradigm. Towards achieving this goal, a Cloud-based Open Platform is being developed in the context of WP2 to support accordingly the main aspects of the EGTN concept: the planning and the decision support (on governance level) for the development of EGTN infrastructure and the operationalisation of the EGTN.
- The **governance layer**, that consists of the ecosystem of stakeholders interacting and collaborating for developing and sharing T&L infrastructure and participating in the decision making of the EGTN. The EGTN governance goal is to ensure that the EGTN members in the PI network engage in collective and mutually supportive action, that conflict is addressed and that network resources are used efficiently and effectively.

## 3.2 The Open EGTN platform overview

The EGTN platform is a platform for sustainable, integrated, and multimodal freight transport that engages diverse stakeholders of the T&L supply chain and enables them to interoperate and exchange data through a secure ICT infrastructure. It supports decision making, ensures transparency and equity to all stakeholders, improves operational procedures, and goes one step further towards the materialization of the PI concept. The EGTN platform is cloud-based and integrates services for interoperable logistics by exposing secure interfaces for data ingestion, data management, data governance and data visualization. PLANET **Cloud-based Open EGTN**

**platform** developed in the framework of WP2 features a modular, multitier architecture (Figure 1) and brings together cutting-edge technologies such as IoT, 5G, AI and Blockchain (further information regarding the EGTN Platform Infrastructure can be found in D2.2).

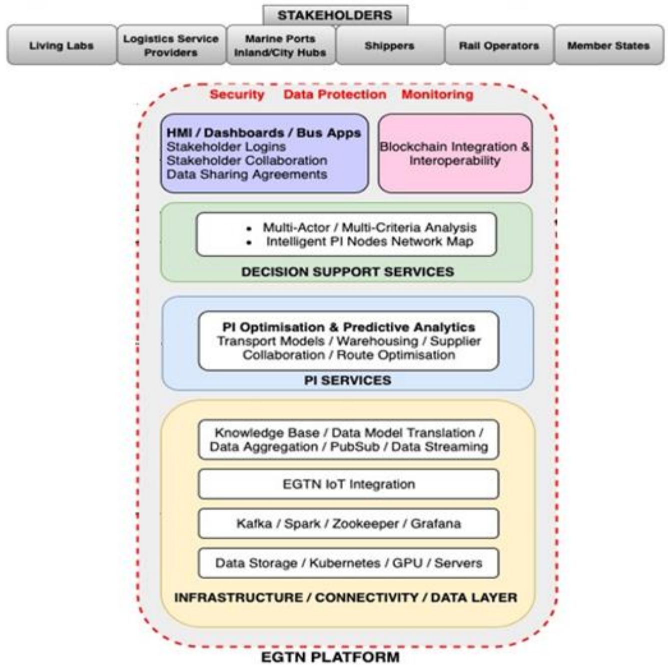


Figure 1: PLANET high-level architecture

The Open EGTN platform provides tools and services that support stakeholder for operational decision making and improve procedures towards achieving operational excellence for customers and external stakeholders, enabled by disruptive transport and logistics concepts and technologies.

The Open EGTN platform develops and integrates:

- Visibility services, exploiting the available technologies (low cost satellite, IoT sensors, drones etc.) for monitoring assets (tracking and tracing of the location and status) and processes of companies which will be accessible through an appropriate visualization dashboard.
- A data lake and tools for data analytics & aggregation of data resulting from PI services, leading to 'Big data' utilization for the creation of advanced transport and logistics services such as route optimisation, warehousing as a service and supplier collaboration and also for feeding indices calculation for supporting public & industry decision making.
- Connectivity tools to digital infrastructure available at corridors and nodes (inside & outside EU) and to federated public and private platforms at EU for providing open access to data & services & for creating neutral Data availability to enable visibility, collaborative planning among stakeholders & optimization of supply chains "using" the network and "consuming" its capacities.
- Tools and services for planning regional logistics in order to enhance operations at a regional level through achieving collaborative logistics & shared capacity models' implementation by the ecosystems in a geographical area or along a corridor.
- Tools to support cross organizational, cross country and cross system workflows with the use of interoperable distributed ledger ('blockchain') and 'smart contract' technologies.
- Synchromodality modelling & PI simulation capability for supporting industry decision making.
- Models to support optimum network setup and routing optimisation.

Figure 2 shows the integrated technology architecture of the EGTN Platform that includes connectivity components for ingestion of various datasets, spanning real-time data, batch data and blockchain events, a

Data Lake for data storage, analytics tools and the EGTN PI Services developed by the WP2 tasks. Further details regarding the platform can be found in PLANET D2.2.

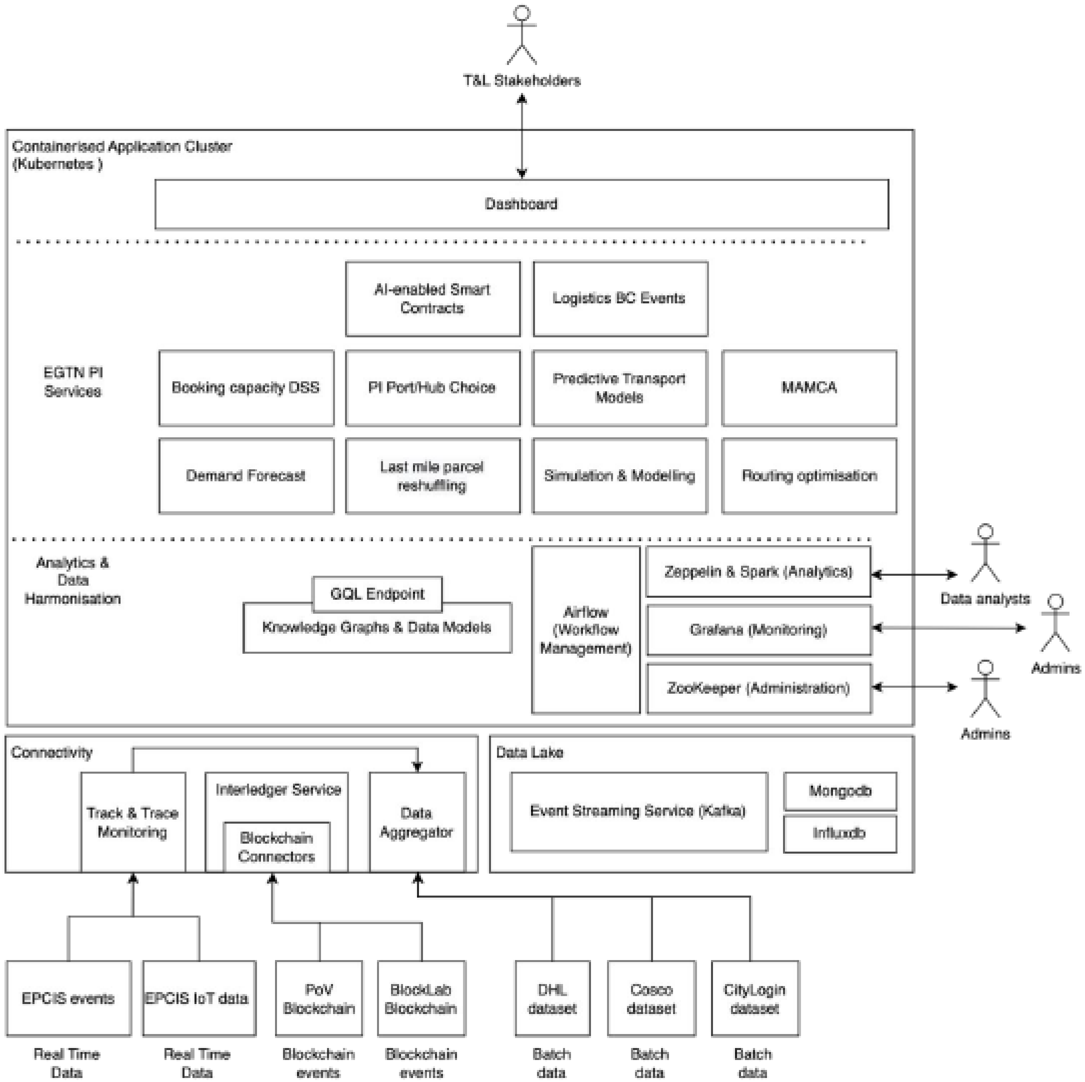


Figure 2 EGTN Platform - infrastructure and PI Services (from PLANET D2.2)

# 4 PLANET Living Labs and use cases

Compared to the TEN-T, the EGTN will be a network with an increased focus on regional logistics through the development of infrastructure and services that will enhance operations at regional level as an approach that will increase inclusiveness of the disadvantaged regions and support their development.

The PLANET Living Labs and use cases are examples of those EGTN regional ecosystems. In the LLs, local and global actors are collaborating for implementing technological solutions which meet ecosystem needs for optimised logistics operations under the PI paradigm. These ecosystems will be enriched and PLANET tools will contribute to regional PI hubs infrastructure planning and further logistics operation enhancement in the view of the 2030-time horizon. They encompass multi-modal and intercontinental routes with the overarching objective of optimizing end to end supply chains.

This section contains a summary of the three PLANET Living Labs, use cases, technologies tested and derived impacts.

## 4.1 Living Lab 1

The LL1 aimed at testing new technology solutions and concepts to improve process, operations, and efficiency along door-to-door transport chains linking China with Spain, as depicted in Figure 3.

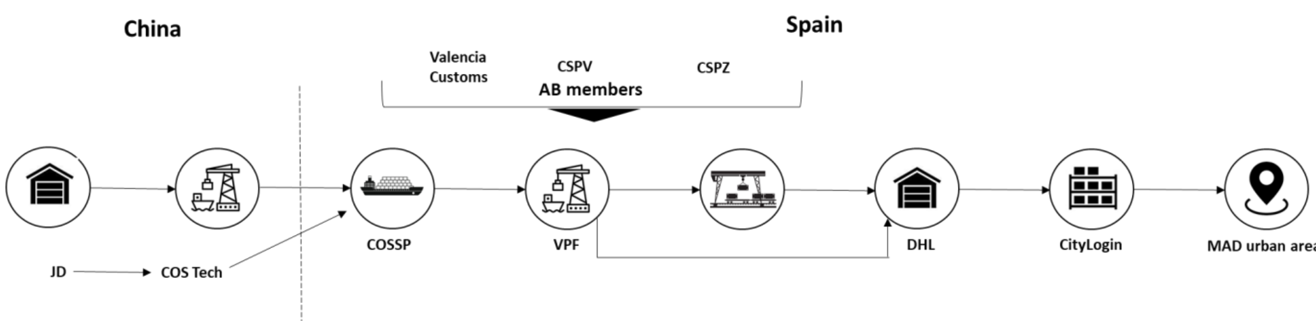


Figure 3: LL1 D2D transport chain and actors involved

To achieve the living lab objectives, LL1 work is structured to cover two different use cases:

- **Use Case 1** focused on import/export door-to-door transport chain of containerized cargo between China and Spain in order to evaluate how the combination of IoT (for real-time monitoring of logistics assets), AI (for better forecasts and intelligent decisions based on machine learning algorithms) and blockchain (for paperless transactions and the register of transport events), can contribute to a better management of the transport chain. The development of the PI paradigm is also investigated in UC1 where intelligent logistic nodes or hubs play a key role in transport decisions and are optimized based on real time events/information and historical data.
- **Use Case 2** focused on warehouse operations and explores how new IoT, AI and blockchain (smart contracts) technologies can contribute to the development of intelligent automated logistics nodes of the EGTN/PI network. This use case complements Use Case 1, particularly on how to integrate smart Warehouse Nodes for EGTN routing decisions, ultimately creating PI Warehousing Nodes.

To carry out and demonstrate the work envisaged in both use cases, LL1 defined a set of five activities where different technological solutions will be developed:

- **Activity 1:** This first task addressed the simulation-based specification and testing of a PI network including entry nodes (ports), warehouses (DHL) and city-hubs (CityLogin) (use cases 1 and 2) using the EGTN Architecture designed in WP2. It provides a specification of a PI network in Spain, by providing intelligence to the entry nodes to take decisions and linking them to the automated warehouse nodes that will then be connected with the city nodes.

- **Activity 2:** The second task addressed the intelligent decision making at transport and logistics hubs (operations and routing) by performing: (i) Simulation and assessment of a real-time synchromodal planning approach aligned with PI principles where the port-terminal logistics hubs provide optimized dynamic routing of containers through the network considering capacity, level of service and cost of the multiple modes of transport available (use case 1); (ii) Application of intelligent algorithms (based on AI machine-learning) for the detailed assessment of the impact of route changes of large oceanic container ships on terminal operations, considering the necessary inland transport re-routing of shipments (use case 1); (iii) Application of AI/Analytics for improved predictions and warehouse operations planning (use case 2); (iv) digital clone of a warehouse for resources optimization (use case 2).

- **Activity 3:** The third task covered the design and implementation of interoperable blockchain platforms: connecting the blockchain platform in the Port of Valencia with DHL blockchain network which will be developed by FV and KNT respectively. In addition to the investigation of smart contracts, this task also addresses the management of multiple interactions and transactions with a large number of different stakeholders, public and private in different counties, including port and maritime authorities, customs and other inspection bodies, transport companies, port and rail terminals, freight forwarders, importers and exporters, etc.

- **Activity 4:** This fourth addressed the IoT deployment for worldwide tracking of containers and other load units and logistics assets: (i) Testing with specific Asia-Europe shipments of the innovative solutions proposed and developed within PLANET (T2.2) (use case 1); (ii) Testing low-cost sensors for tracking and tracing materials in warehouses (use case 2).
- **Activity 5**: This fifth task focused on the development of digital clones in order to carry out design-planning, operation and optimization of logistics infrastructure in warehouses. These clones combine a 3D model of the facility with IoT data collected in connected warehouse platforms, as well as inventory and operational data including the size, quantity, location, and demand characteristics of transport cargo.

The different EGTN technologies implemented in both UCs and their business impacts are summarized in Table 2 and Table 3. A detailed impact assessment of LL1 has been carried out in PLANET D3.2 (LL1 EGTN Solution Description and Test Results). Within this document, a quantitative analysis of implementing the different technologies considered in the project in the two use cases is presented. Those impacts feed the PI Network simulator presented in section 6.1.1.

Table 2: LL1 UC1 EGTN technologies and business impacts (from PLANET D1.2)

**LL1 UC1 Improving container cargo operations between China and Spanish hinterland**

| Technology | Expected benefits |
|---|---|
| **Blockchain** | • Time reduction in administrative processes<br>• Secure business-to-business data exchange |
| **IoT** | • Control of the location of the cargo<br>• Reduction of waiting times in the loading/unloading process (lorry, ship, train).<br>•Improved synchronization of processes. |
| **AI** | • Selection of the best means of transport according to timetable, capacity, etc. |

| | |
|---|---|
| | • Vessel planner decision. Selection of alternative if there is congestion in a port: wait for the port to clear or go to another port. |
| **PI** | • Autonomous decision per container at each node.<br>• Open logistics environment to share capacity data to improve the use of assets. |

Table 3: LL1 UC2 EGTN technologies and expected benefits (from PLANET D1.2)

**LL1 UC2 Optimizing warehouse operations and automation and last mile deliver efficiency and sustainability.**

| Technology | Expected benefits |
|---|---|
| **Blockchain** | • Facilitate collaboration with other companies<br>• Greater use of green vehicles<br>• Support conflict resolution |
| **IoT** | • Anticipated arrival of container at short range<br>• Location of a package during delivery |
| **AI** | • Cargo demand forecast<br>• Route optimization<br>• Standardization of information (addresses, opening hours...) |
| **PI** | • Collaboration with other companies<br>• Standardization of containers for last-mile delivery |

## 4.2 Living Lab 2

This living lab addresses improvements in the handling of rail freight between China-USA with the port of Rotterdam serving as transshipment and modality shift point.

Three use cases are developed:

1. **Use case 1** focused on synchromodality in a Blockchain enabled Platform utilising advanced IoT, supporting BlockLab customers & communities to create the best multi-modal alternatives for logistics solutions within the LL2 corridors. Within Use Case 1, Blocklab developed a blockchain demonstrator to deal with post-Brexit customs processes between the Netherlands (PoR) and the UK (Figure 4). UC1 developed the fundamental digital infrastructure to share logistic events and shipment documents between regional systems (UK customs, PoV platform and PoR platform) and the overarching EGTN platform, in support of TEN-T and intercontinental flows and in preparation of dynamic synchromodal management. For the PoR-UK connection, fully digitised customs declarations were established, the application having been materialized in Quayconnect. For the PoR-PoV connection, the sharing of road logistics events was enabled. For the PoR-ASIA connection, shipment document management and distribution was created. The functional specifications of this demonstrator were used as an initial step for the document management platform of Use Case 2

2. With the definition of high-level functional requirements, **Use Case 2** stakeholders, including HUPAC and VTG, have developed a proof-of-concept for sharing documents for railway transportation on the selected Eurasian corridor. In addition, the Intercontinental Collaborative Platform, under the coordination of UIRR, has been successfully launched with the publication of a manifesto compiling the main hurdles and barriers for railway transportation on the new Silk Road. Finally, the potential of transporting green hydrogen on rail has been evaluated on various Eurasian corridors.

3. Use Case 3 analysed LL2 corridor flows and assessed the implications for the ports of Rotterdam, Hamburg, Duisburg, Tilburg and (other) TEN-T infrastructure, extending T1.2 results with data from the EGTC "Interregional Alliance for the Rhine-Alpine Corridor." The use of the PLANET tools by the EGTC is directed at strategic corridor planning. For these purposes, a dynamic simulation for the 2030- and 2050-time horizons of the impact of the Belt and Road Initiative (BRI) on the Rhine-Alpine (R-ALP) corridor was carried out.

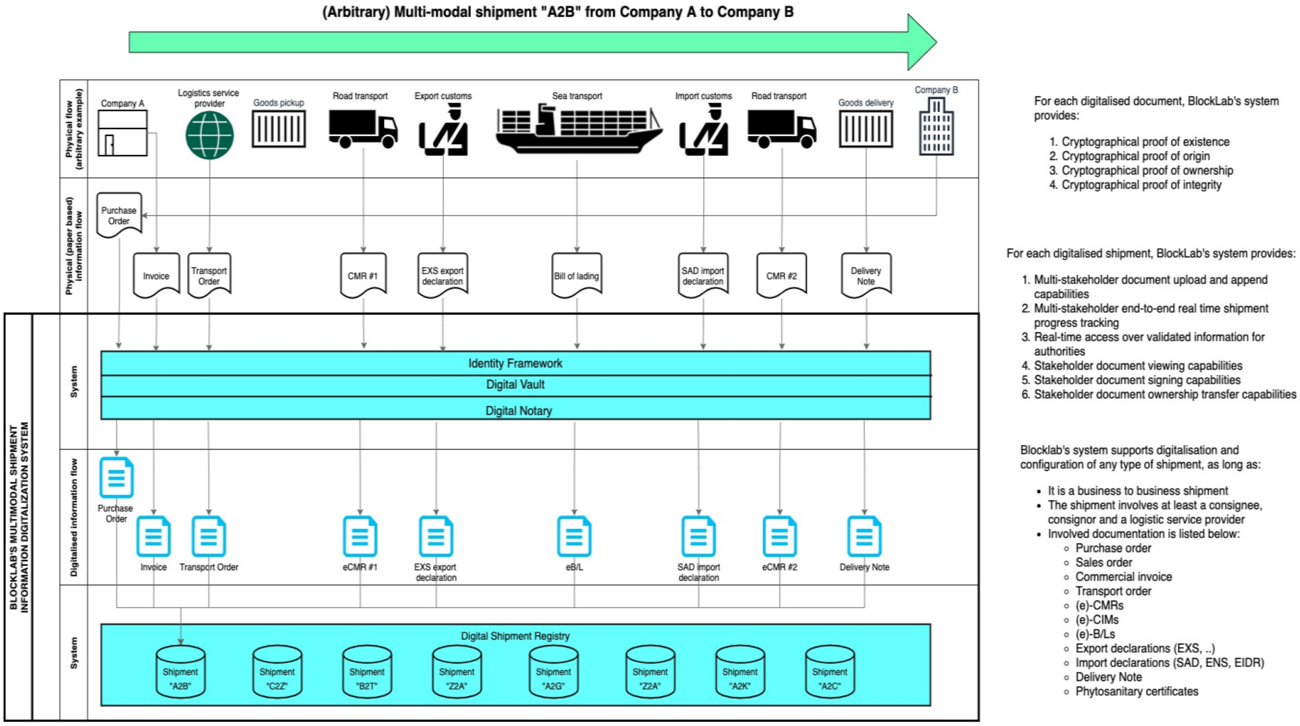


Figure 4: Living Lab 2, Use Case 2-Blockchain enabled platform

Table 4: LL2UC1 EGTN technologies and business benefits

**LL2 UC1 Synchromodality in a Blockchain-enabled Platform**

| Technology | Expected benefits |
|---|---|
| **Blockchain** | • Significant (up to 40%) cost reductions per shipment for customs clearance through automation of existing paper-to machine-to paper processes. |

| | |
|---|---|
| | • Provide digital proof-of-integrity, proof-of-origin and proof-of-ownership of digital (document) assets providing unprecedented levels of compliance.<br>• Secure digitization of multi-modal information flows at shipment level. |
| **Machine Learning** | • Reduce manual entry time per shipment up to 50% through Optical Character Reading of documents. |

Table 5: LL2UC2EGTN technologies and business benefits

**LL2 UC2 Investigating the potential of Eurasian rail freight expansion**

| Technology | Expected benefits |
|---|---|
| **Blockchain** | • Improvement the electronic management of documents (commercial and customs) will be defined. The relevant processes on specific intercontinental rail routes are mapped, based on which the optimal digital solutions are defined. The digital solution(s) will build upon the results from UC1, using Blockchain as preferred technology for platform implementation. |

## 4.3 Living Lab 3

LL3 worked on streamlining logistic processes in flows from China to Europe along the Silk Road by implementing Internet of Things (IoT) technologies (based on the Electronic Product Code Information Services, EPCIS, platform) and GS1 standards that facilitate the transmission of data between the partners involved in the e-commerce operations.

This Living Lab consisted of two Use Cases:

- Use Case 1 focused on providing access to real time information on cargo coming from China to Poland along the entire supply chain of the Rohlig SUUS through the application of IoT and EPCIS to monitor process events and support operational optimization.
- Use Case 2 addressed the standardization of information flows and digitalization of interactions between actors within the Polish Post network and the monitoring shipments on the New Silk Road, including rail transport, in terms of e-commerce parcel distribution from China to EU.

The following diagram (Figure 5) illustrates the spatial scope of the Living Lab 3.

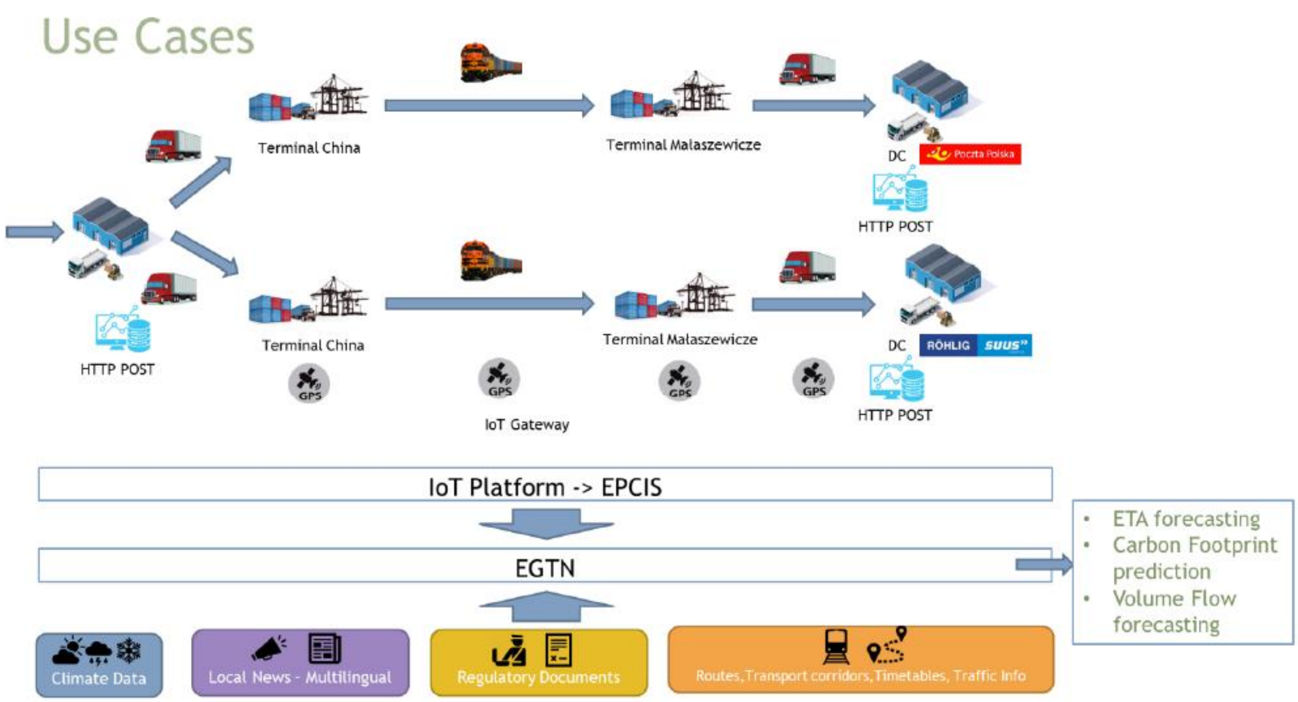


Figure 5 LL3 use cases scenarios (PLANET D3.6)

The identified business needs of the Living Lab partners were the starting point for developing LL3 use cases (Figure 5). 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:

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

This subdivision of use cases results from the specific business characteristics of the partners in LL3 and the used solutions. Therefore, each use case includes the following activities:

- Use Case 1 Monitoring and optimization of container flow along the New Silk Road:
    - Activity 1: Implementation of sensor network mobile base stations and beacons on containers and selected logistic units - Implementation of sensor network technology to collect data on container transport conditions and selected logistic units during transport,
    - Activity 2: Integration of operational data in the supply chain - Use of EPCIS for event data collection and integration with IT systems of business partners and IoT sources,
    - Activity 3: Use of EGTN for estimation and prediction of selected logistic KPI's - Use of EGTN for Volume Flow forecasting, Carbon Footprint Prediction and ETA forecasting. Comparison of different ETA calculation models on the bases of ETA forecasting accuracy,
- Use Case 2 Optimization of e-commerce flows in global supply chains:
    - Activity 1: Integration of operational data in the supply chain - Use of EPCIS for event data collection and integration with IT systems of business partners,
    - Activity 2: Information flow standardization in supply chains - Application of GS1 standards (mainly SSCC) for monitoring e-commerce parcel shipments from China to Poland,

- Activity 3: Use of EGTN for estimation and prediction of selected logistic KPI's - Use of EGTN for Volume Flow forecasting, Carbon Footprint Prediction and ETA forecasting. Comparison of different ETA calculation models on the bases of ETA forecasting accuracy.

Table 6: LL3UC1 EGTN technologies and benefits

**LL3 UC1 Monitoring and optimization of container flow along the New Silk Road**

| Technology | Benefits |
|---|---|
| **Sensor Network** | • Shortening the time of transport thanks to faster reaction at individual stages<br>• Providing information on the status and location of goods on an ongoing basis<br>• Clear records of events affecting the cargo condition (exceeding temperature, humidity, shocks, tampering) and a clear division of responsibilities for damages |
| **EPCIS platform** | • Reduction of operational errors due to the lack of detailed information about the delivery<br>• Possibility of confirmed and documented conditions and risks of rail transport |

Table 7: LL3UC2EGTN technologies and benefits

**LL3 UC2 Optimization of e-commerce flows in global supply chains**

| Technology | Benefits |
|---|---|
| **GS1 Standards** | • Cost optimization<br>• Operational times optimization<br>• Transparency and supply chain correctness<br>• Distribution time reduction |
| **EPCIS platform** | • Reduction of operational errors caused by lack of detailed information about delivery<br>• Lower risk of shipment loss in international supply chain<br>• Improvement of delivery status monitoring in transit to Client<br>• Possibility of monitoring of additional data, which cause in higher delivery service quality |

Detailed impact assessment of LL3 has been carried out in D3.6 LL3EGTN Solution Description and Test Results. Within this document, the quantitative analysis of implementing the different technologies considered in the project in the two use cases is presented. Those impacts feed the PI Network simulator presented in section 6.1.1.

# 5 EGTN Generic Use Case Framework

### 5.1.1 General Overview

The EGTN Generic Use Case demonstrates how EGTN generic models and services based on the outputs of the three LLs can be applied by T&L communities. Thus, PLANET simulation capability was used to further investigate specific use cases proposed in the context of the project (i.e. Port of Sines). PLANET has built upon the Generic Use Case developed in the European Project ICONET which linked the Living Labs under a common PI framework following a top-down approach. In PLANET, disruptive technologies, emerging transportation modes and the impact of the new trade routes in the TEN-T are also incorporated following a bottom-up approach. It is defined with the time horizon of 2030.

The Generic Use Case represents an abstraction of the TEN-T network operating under the PI paradigm, based on the selected elements which correspond different LLs within PLANET and following the EGTN principles and requirements stemming from T1.5. It makes a representation of a real-world system by creating a conceptual model for a generic geographic area, a series of descriptive elements, the logical relationships relative to the components of the system, the input and output data and a set of capabilities for different scenarios configuration.

PLANET EGTN Generic Use Case is conceived as a modelling use case in a strategic planning context (Figure 6).

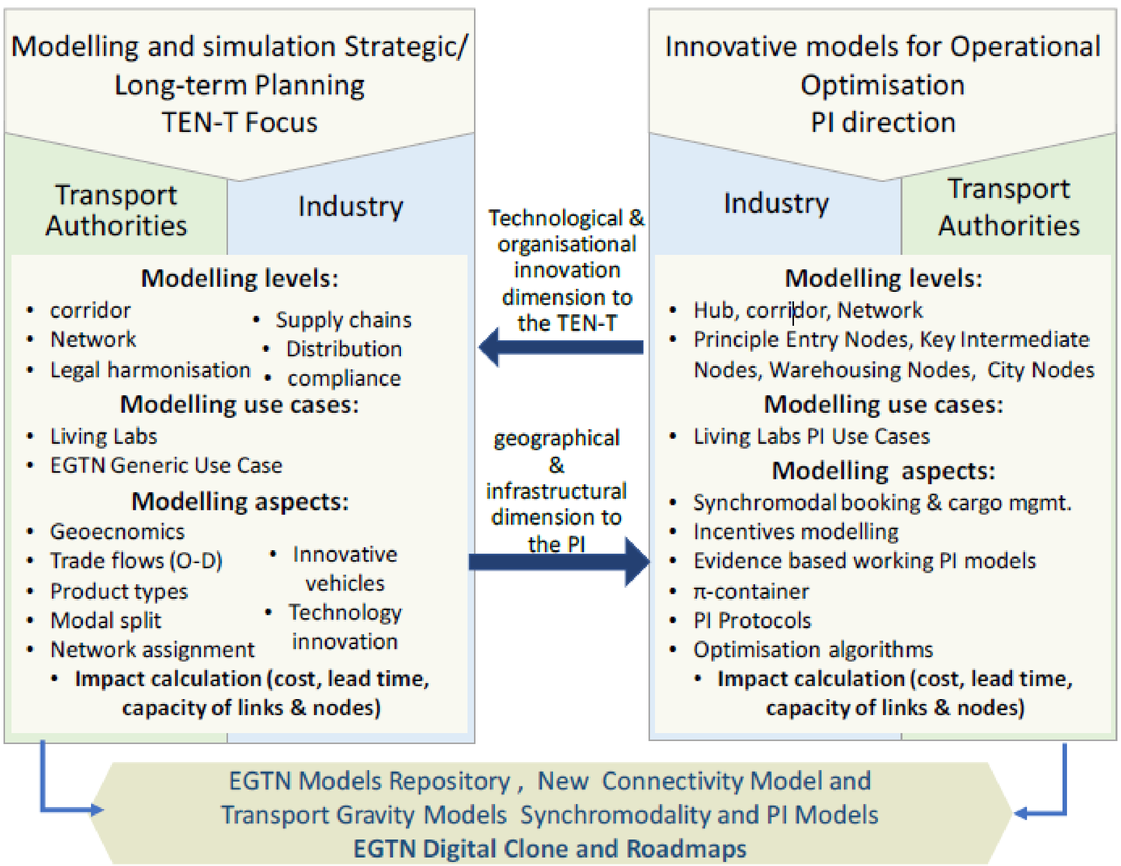


Figure 6: PLANET's modelling and simulation scope and approach (from PLANET DoA)

By **modelling use case**, PLANET refers to a specific situation in which a model could potentially be used. To define the modelling use case, the first step is: 1) to provide main user (stakeholder interested in the analysis), 2) the context of application (logistic setting of interest) and 3) the evaluation scenarios of interest.

PLANET's "modelling syntaxis" defines model and simulation as (see D1.2):

- a **model** is a representation of the structure and operation of a system of interest. It is similar to, but simpler than the system it represents, and its purpose is to enable the analyst to predict the effect of changes to the system. A model should be a close approximation to the real system and incorporate most of its key features while at the same time it should be simple enough to understand and experiment with it.
- a **simulation** is the operation of a model of an existing or proposed system to evaluate its performance under different configurations and over extended periods of real time. It is used before an existing system is altered or a new system is built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance.

The decision-making support offered by PLANET is based on consortium background models and simulators which were enhanced and integrated and new that have been developed during the project life cycle as part to the PLANET decision making capability & tools. The PLANET modelling and simulation capability allow for companies to perform informed decisions for their technology investments and operations improvement based on strategic knowledge about tendencies along the TEN -T and the global trade corridors and modal points. Similarly, decision making related to TEN-T corridors and nodal points development and investment choices can consider the impact of the technologies, optimization solutions & collaborative models considered under PI paradigm.

The table below is indicating the PLANET suite of models and their use in the context of the EGTN platform and the strategic modelling activity of the project.

Table 8 Models relationship with the EGTN platform

| Objective | Long /medium term Planning | Medium/Short term Planning & operationalization | Governance |
|---|---|---|---|
| **Geopolitical uncertainties & tendencies** | • Impacts of uncertainties to operations<br>• Impact of policy to operations & flows<br>• Demand & flows forecasting | | |
| **Risks identification & mitigation** | Impact of technology to capacities and operations of corridors | Data Analytics & detection of expected flows (AI) or anomalies<br>*Flows optimum serving considering special conditions* | |
| **Impacts calculation** | • Costs<br>• New corridor flows<br>• new connectivity and attractiveness of nodes | Short term impact (including ETA, CO2 & efficiency) | *Impact information from company to the ecosystem* |

| | | | |
|---|---|---|---|
| | | | *Information on Capacities & alternative services availability from ecosystem to company* |
| **Technology enabled & Services optimization driven adaptation** | PI priority corridors<br><br>Impact of technology to operations and of best technologies combinations to PI nodal point | Alternative routes service<br><br>Optimized use of resources service<br><br>Collaborative last mile service | *Support Business agreements for collaborative logistics*<br><br>*Information provision through Corridor or regional observatory to plan for response* |
| **Infrastructure driven response** | Prioritization of alternative investments | Decision support for Response & business adaptation<br><br>Port selection service | |

The user of the Generic Use Case is foreseen to be an operational user, supporting companies to create strategies business and technology. However, it can be also used by Policy Makers to explore the impacts of EGTN-related concepts and create policies in advance. The context of application and evaluation scenarios are described in subsequent sections in this document.

The Generic Use Case produces a digital clone answering what would be the impact of introducing the EGTN infrastructure and the new logistics concepts and technologies considered in PLANET along complete TEN-T corridors.

### 5.1.2 Components & Principles for composing the Generic Use Case

Drawing from the conceptual foundations of PLANET, the future EGTN has five attributes that are transforming it to a : geo-economics aware, innovative, impact, integrated and inclusive network. The Generic Use Case is aligned to this vision, addressing those attributes in the following way:

Table 9: Generic Use Case Attributes

| EGTN Attributes | Generic Use Case |
|---|---|
| Geo-economics aware | Incorporates the Impact of the new trade routes on the TEN-T corridors (results from T1.2) |
| Innovation | Considers logistics innovations (PI, Cargoloop) and disruptive technologies (tools and services offered through the cloud-based Open EGTN platform developed in WP2) |
| Impact | Provides a set of generic KPIs which will allow the Generic Use Case impact assessment on a standard and common basis among different scenarios. |

| | |
|---|---|
| Integrated | Considers the integration of the European T&L network with the global network (in both, entry and exit points) |
| Inclusive | It has been applied to European less developed regions (Port of Sines Use Case) |

The approach of PLANET EGTN Generic Use Case is defined in Figure 7, combining generic elements from the three Living Labs.

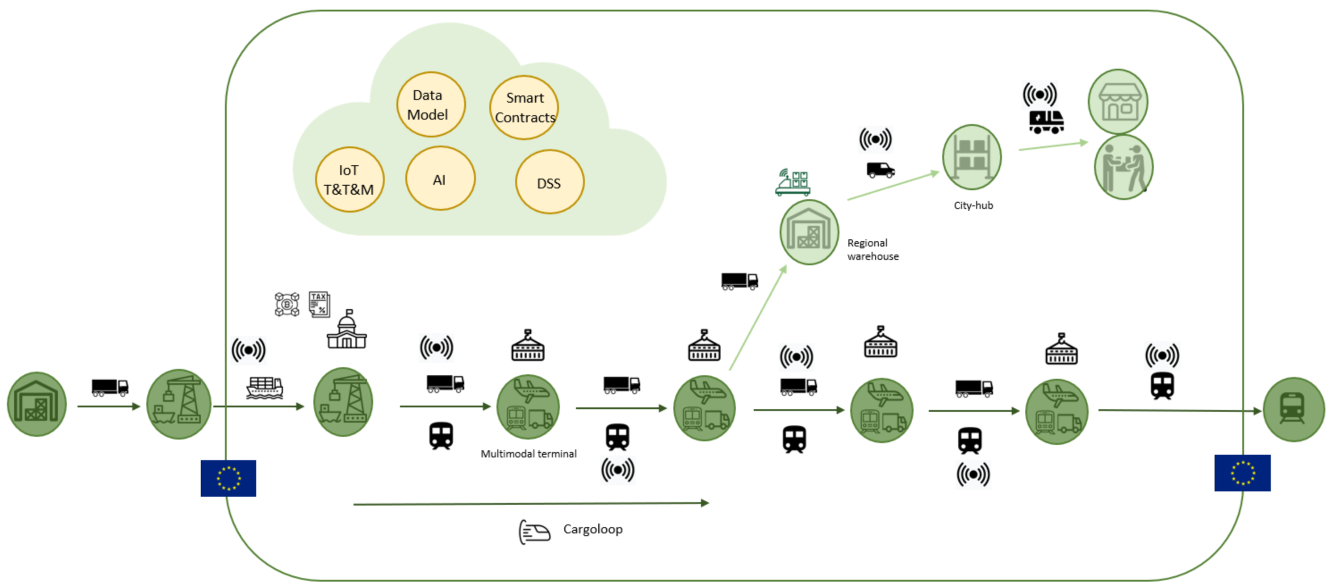


Figure 7: EGTN Generic Use Case overview

The Generic Use Case is composed of the following elements:

- Time-horizon: 2030
- Geographic Coverage: Europe, including EU disadvantaged regions and the interface with Intercontinental trade routes.
- Nodes/hubs: ports, multimodal terminals, (smart) warehouses.
- Corridors: current and future TEN-T network
- Long-distance transport/Last mile delivery with sustainable vehicles
- Disruptive logistics technologies: AI, IoT, Blockchain, Cargoloop, smart warehouses etc.
- Cloud-based Open EGTN platform offering services to the actors under predefined rules
- Cross organizational, cross country and cross system workflows.

### 5.1.3 Tools and services in the EGTN platform

The proposed PLANET Cloud-based Open EGTN Infrastructure platform developed under WP2, accommodates 'live' technologies and services that allow stakeholders to better understand the impact of emerging technologies, and also to exploit such technologies to optimize their infrastructures and operations within the new economic reality of global trading systems so as to gain economic, environmental, and societal benefits. It is a collaboration platform for sustainable integrated multimodal freight transport.

In order to properly model the Generic Use Case and simulate the impacts of PLANET innovations, it is essential to understand the tools and services that the Open EGTN platform will offer to the different T&L actors and how collaboration will be articulated. This workstream of this platform has been developed in WP2 through the interaction with PLANET LLs (WP3).

The following table shows the list of specific services hosted by the platform and the interoperability with other services.

Table 10: Services to be hosted by PLANET EGTN Platform (updated from D3.7)

| Service | Description | Stakeholders | Interoperability with other services |
|---|---|---|---|
| **Interface to all offered services (HMIs, M2M)** | Unified interface(s) to provide the user(s) with an overall real-time support visualization of EGTN infrastructure components (services & data). It will aid decision making. | LL users (internal and external) Transport services, customer services, terminals, authorities, warehouses, HR depts., buyers, LSPs, FFs, IT depts., associates. Some access rules and permits have been already defined in the project | Interaction with all other services |
| **Volume flow forecasting service (AI)** | Predicts the quantity of pallets flowing in and out of a warehouse for the next day. | Warehouse operator, LSP, human resources agencies | Can integrate with smart contract service to advance book delivery vehicles and other resources. |
| **Container flow forecasting service** | Predicts the flow of containers coming into a port. | Shipping line, port operator | Integrated with Port choice model to make maritime routing decisions |
| **EGTN blockchain Interoperability Service** | Develop a universal front-end to BCs existing in the LLs (within and between) | All stakeholders involved in T&L process (from Port Authorities to Customs and Shipping Companies) and need access to transported documents | Blockchain events will be displayed on the EGTN HMIs.<br>Smart contracts will consume IoT Data from the Connectivity Layer of the EGTN Platform. |
| **AI-enabled smart contracts** | Trigger smart contracts based on the output of the AI models. | Warehouse operators, LSP | PLANET AI models |
| **Track and Trace and Monitoring (T&T&M) of pallets along the entire supply chain.** | Pallet-wise T&T&M covering both last-mile and cargo logistics. Cloud Platform based on Kafka. Real-time data processing for features extraction. API based on EPCIS 2.0. | Supply chain actors, AI services, Data layer of the platform | With EGTN platform using EPCIS2.0. AI, Blockchain will consume the data |
| **Port choice model** | The model determines which ports a vessel should call depending on hinterland transport availability and port congestion | Shipping line, port, LSP | Interacts with the congestion prediction model. If the PI has a networking service that registers available capacity and cost per hinterland transport services, it needs that too. |
| **Urban delivery rounds redistribution** | The model determines how to mitigate delays in late running urban delivery rounds. It identifies nearby rounds that can help and then redesigns the route for the round helping through a meeting point. | LMD operators | Prediction of the time of completion for each round. |
| **Kafka data pipeline** | An Apache Kafka service running on the EGTN platform enables data providers to push their heterogeneous data to the platform | Data providers, Developers/Engineers to perform post-processing of the data | EGTN Dashboard to visualize data, EGTN Connectivity layer to create a common data model, other services possibly |

PLANET has developed a unified interface to EGTN Data and support Services. The HMI (Human Machine Interface) delivers a unified interface to communicate with all of the project's cloud-based open EGTN Infrastructure components via suitable interfaces, including mobile devices and HMI touch panels. It also supports non-human (Machine to Machine-M2M) interfaces such as those used by Industry 4.0 and Industrial IoT systems, ensuring a more informed calculation of the analytics.

Figure 8 shows a summary of the EGTN platform services offered to a generic user through the HMI which is adaptable to the users' needs with different access roles with customizable dashboards.

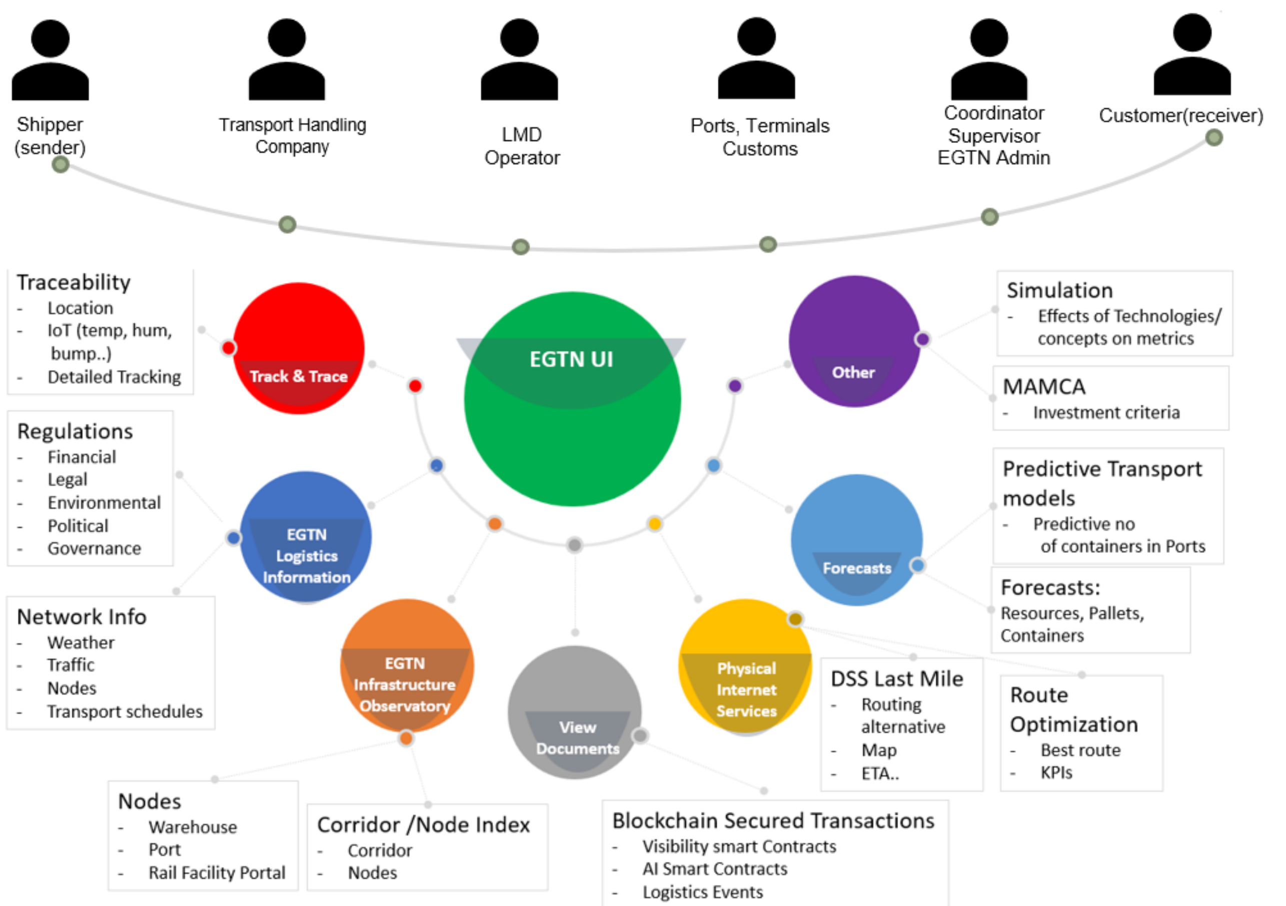


Figure 8: Representation of the services in the EGTN Platform (updated from D3.7 and D2.20).

### 5.1.4 Criteria and Selection of TEN-T corridors

One of the objectives of PLANET project is to better understand the impact on the TEN-T network of global transport and geo-economic trends. In order to do so, the project performed a strategic analysis of the most relevant emerging trade routes which are expected to gradually change global transport patterns, and a simulation of their potential impacts on the TEN-T.

The modelling and simulation of the expected impact of new trade routes on the TEN-T was carried out in T1.2. It consists of a strategic analysis of the most relevant emerging trade routes which are expected to gradually change global transport patterns, and a simulation of their potential impacts on the TEN-T. The Generic Use Case incorporates the integration of new trade routes to the TEN-T through the results of the abovementioned task.

Initially, the new trade routes under consideration within the framework of PLANET were the Belt and Road Initiative (BRI), the Arctic Route, and the International North South Corridor. However, during the preparatory study, it was found that the impact of the BRI on TEN-T is the most significant. This route is therefore in the focus of the comprehensive simulation model developed for identifying the potential impact of this route on TEN-T (D1.15).

PLANET uses Panteia's NEAC freight model to assess the impact of the new trade routes. NEAC is a European freight flow database and a multimodal transport model designed for analysing medium to long-distance traffic flows under scenarios of operational & cost parameters of transport per mode and at nodal points operations. It has been modified and extended to meet to meet the PLANET requirements.

The following scenarios were simulated in T1.2:

- 2030 Scenario: Describes what is to happen in 2030 if current trends and policies continue without any significant changes
- 2050 Scenario: Describes what is to happen in 2050 if current trends and policies continue without any significant changes
- Disadvantaged regions scenario: Describes the impact on disadvantaged regions for the year 2030 if these regions are better connected and have increased trade with China.
- Rail freight corridors scenario: Describes the impact on the railway sector and identifies necessary investments for the year 2030 if rail will experience increased efficiency.

The NEAC freight model provides the following two key results for PLANET:

- Generalized costs information of multimodal transport chains between the origin and destination for different values of commodities (Figure 9).
- The multimodal route that the container takes, including the transhipment points (Figure 10).

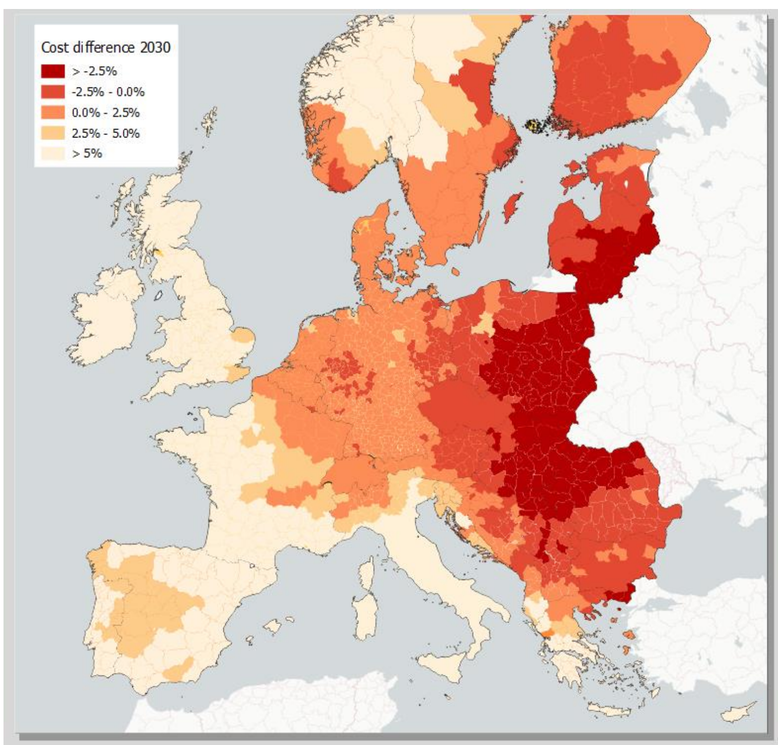


Figure 9 Percentage difference in generalized costs in 2030 between rail transport and maritime transport from China to Europe for high value goods (> 15 €/KG), per nuts 3 region.

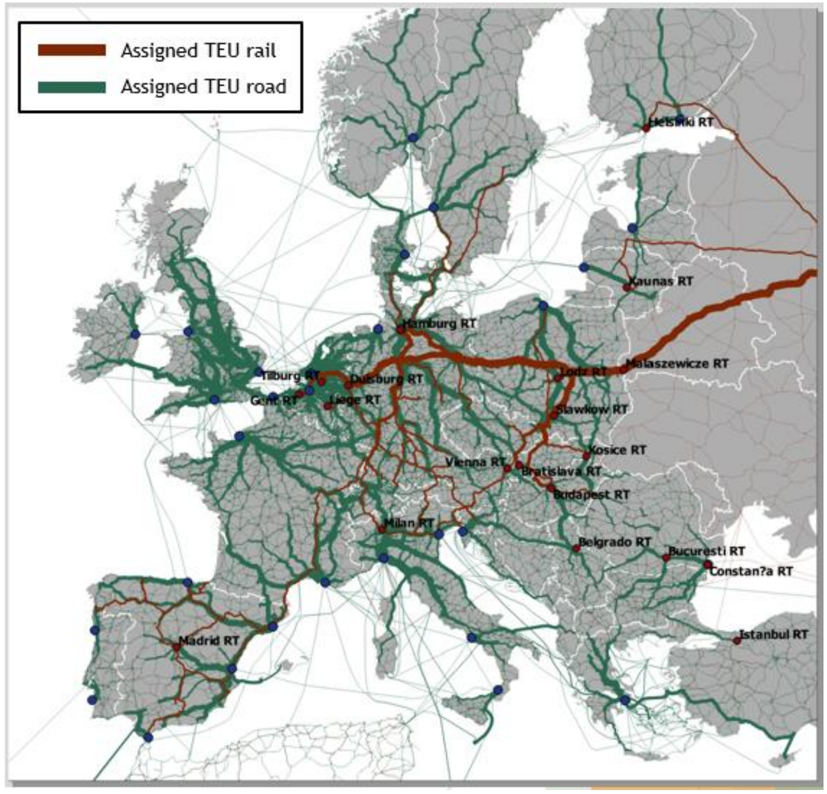


Figure 10 Example of NEAC model results: modelled network flows of containers by Road and Rail, 2030.

Besides the current/planned network of roads, railways, airports and water infrastructure in the European Union, the Generic Use Case will also take into account the **hyperloop network**. The future hyperloop network together with details of the system operation (operation times and travel speeds), cost data, capacity and vehicle characteristics will be incorporated into the simulation of the Generic Use Case to assess the impact of introducing this transportation system.

Hyperloop has an unmatched potential to be the key factor in tackling European (and global) sustainability challenge. This can be achieved on a continental scale by creating the European hyperloop network. In its envisaged shape (Figure 11), such continental network supports all strategic corridors within the Trans-European Transport Network policy (TEN-T policy), providing fast and sustainable connections to all major economic and population centers.

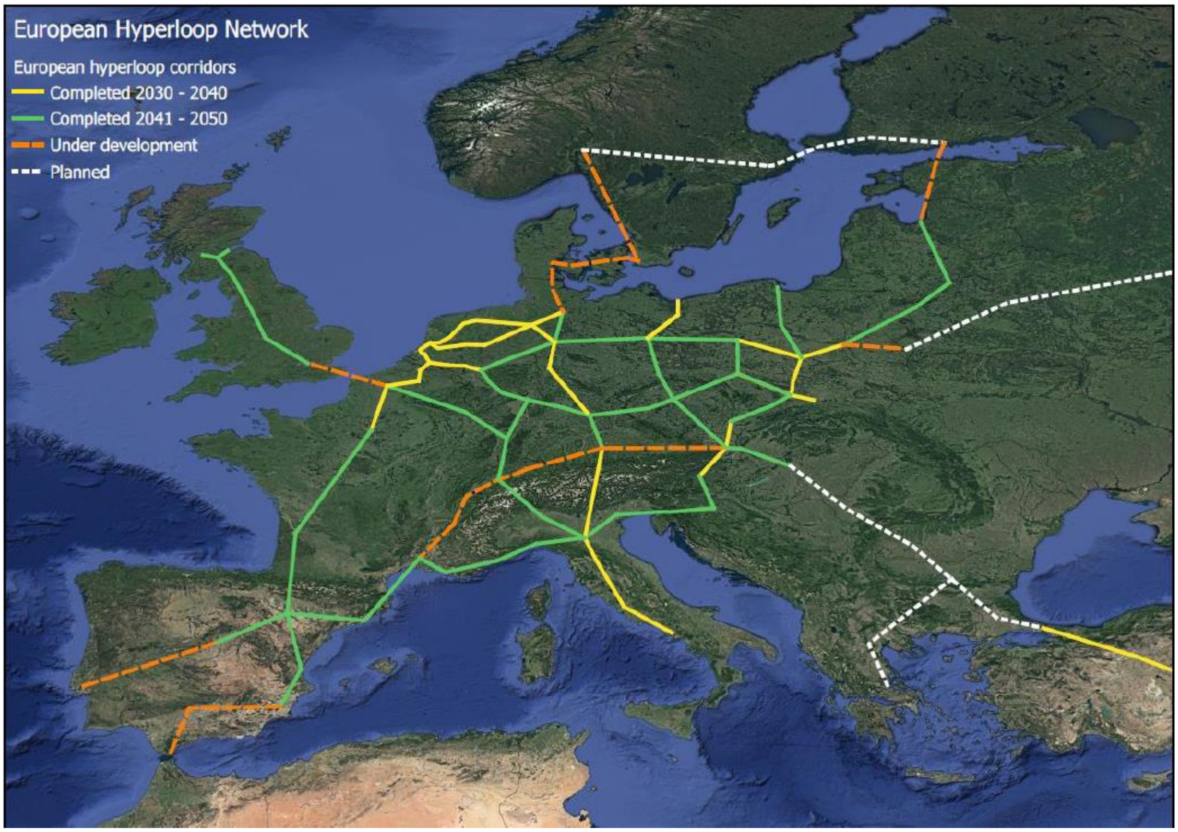


Figure 11 European hyperloop network (HARDT)

The hyperloop network comprises of links and nodes. The same links can be used by both passengers and cargo, while nodes are passenger stations or cargo hubs. Hyperloop for cargo is also known as Cargoloop. The network links will be those currently experiencing heavy cargo flows and requiring breakthrough transportation and infrastructure solutions to solve transport, logistics and socioeconomic problems, such as congestion, inefficiency, lack of reliability and pollution.

# 6 EGTN Generic Use Case Simulation Design

### 6.1.1 Simulation purpose

The Generic Use Case is used in PLANET to produce a **Digital Clone** aiming at investigating the impacts of introducing the EGTN infrastructure and the new logistics concepts and technologies, along complete TEN-T corridors. Such assessment includes financial, business, economic and social impacts (see Chapter 7).

As per the project DoA, PLANET Digital Clone is conceived as an open collaborative planning tool for TEN-T Corridor participants, infrastructure planners, and industry/technology strategists. The aim of this clone is to facilitate a future PI-oriented EGTN. It will be accessed through the EGTN platform, and will provide a dynamic model of EU-Global T&L Network or sub-Network utilizing the EGTN models (see PLANET D1.3 and D1.9 for more information) providing data driven simulation and AI based decision support to stakeholder groups.

The user of the Digital Clone is foreseen to be an operational user. However, it can be also used by policy makers to explore the impacts of EGTN-related concepts. Thus, the Digital Clone may help governments to create policy in advance and companies to create strategies for business and technology implementation.

Underpinning the simulation, an EGTN Dataspace is constructed supporting an ecosystem of actors that interact through the sharing of data in assessing the status of EGTN and contributing to its developments.

The simulation technology will facilitate in this generic use case the evaluation of possible future scenarios based on the generic components of the EGTN.

As it has been mentioned along the document and described in D1.3, within the PLANET project different types of models are considered to simulate transport networks depending on the specific objective. PLANET digital clone is developed using **Physical Internet Network Simulator**, based on **multi-agent simulation** techniques.

The PI Network simulator allows to evaluate how the impact of PI concepts in combination with new technologies (IoT, AI, BC) can improve the processes, operations, and efficiency of transport chains along corridors. The main questions answered by this model are: What’s the impact of applying PI concepts in a multimodal transport network? How different technologies affect cost-effectiveness, quality of service or environmental impact?

The purpose of using the PI simulator in the generic use case is to evaluate and compare different virtual scenarios in order to assess the impact of the different innovations in the project in certain network settings.

The simulation is a powerful tool to visualize the movement of products over a PI network, including flows from different companies. The models are used to quantify the impact of the different services and economic (transport and handling costs), business/operational (reducing lead time) and social ($CO_2$ emissions) indicators are obtained.

The main view of the PI Network simulator is shown in Figure 12. On the left-hand part of the image is the map where the different PI nodes are located and where the different transport flows (road, railway and maritime) can be visualised. There is also a panel to dynamically activate or deactivate the effect of the different technologies and concepts through checkboxes. On the right side, the main statistics calculated by the simulation model are shown. These include the number of containers delivered on time, the lead time histogram of the containers, or the distances, emissions, and modal split of the main modes of inland transport.

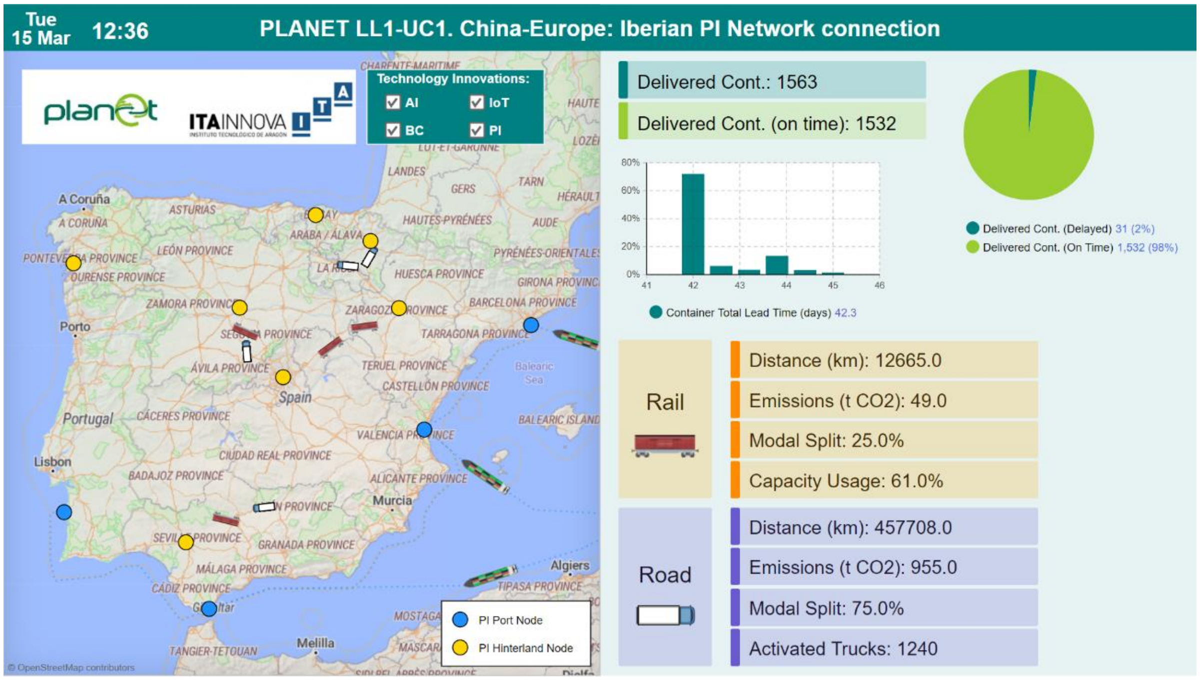

Figure 12: Main view of the PI Network Simulator (Iberian Peninsula in the example).

As mentioned above, the model has been built using multi-agent simulation techniques. The main agents of the model are:

- PI Nodes: the nodes in the PI network represent the places (port terminals, warehouses etc.) where goods are stored, transferred or handled between movements in the network. In the model, the main nodes are maritime terminals (PI Port Node) and inland warehouses (PI Hinterland Node). The properties that define a PI Node are unique identifier, position (latitude and longitude), name and type of node (sea terminal or warehouse).
- PI Containers: the container is fundamental for the Physical Internet; it is the metaphor of the Digital Internet. By analogy with data packets, the goods are encapsulated in intelligent containers of easy-to-interconnect modular dimensions, called PI Containers, designed to flow efficiently in hyperconnected networks of logistics services. The properties that define a PI Container are unique identifier, origin node, destination node (both destination port and hinterland port), day on which the container is available at the origin node and contractual due time.
- PI Transports: transports move or handle containers within and between nodes in the PI network. In the model, the main types of transport are trucks, trains, and ships, which are defined by the following properties: unique identifier, name, speed, capacity and emissions.
- PI Services: this agent defines the transport services operating in the PI network. Each service has its own characteristics, such as the origin and destination nodes, the frequency and schedules, the type of transport that performs it or the route it follows.

Thus, the simulation has two main objectives: on the one hand, to consolidate the expected impact of each of the living labs in terms of technology. This will demonstrate the potential that technologies such as IoT, Blockchain, Artificial Intelligence or Cargoloop have for improving the efficiency of the logistics network in economic, operational and environmental terms through greater visibility of the cargo, standardized information or streamlining administrative and operational processes.

On the other hand, to check the impact that the evolution of certain corridors has on the network. For this purpose, the T1.2 simulation results of selected TENT-T corridors are taken into consideration.

### 6.1.2 Scenarios definition/configuration

The simulation is used to represent and compare different scenarios so the results are studied and compared. The list of scenarios considered in the Generic Use Case is the following:

- **S1. AS IS simulation:** The simulation first represents the transport processes in the corridors as they are currently carried out. This is the base scenario (AS IS) to produce indicators for comparison. For this purpose, following the agent-based approach at an operational level, each agent is modelled according to its actual process diagram. As an example, a possible AS IS process diagram for the "truck" agent is proposed in Figure 13.

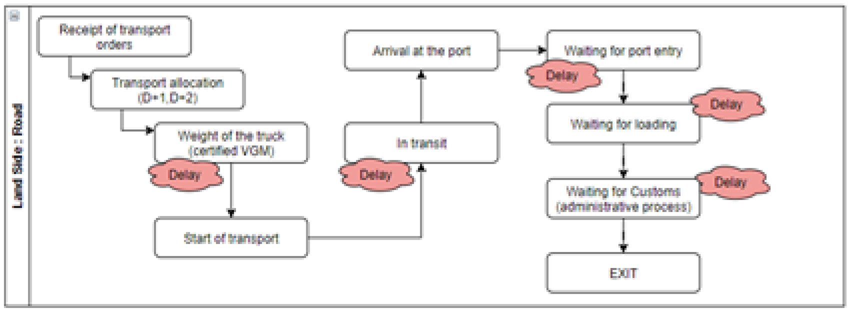


Figure 13: AS IS "truck" agent process diagram

- **S2. AS IS + 2030 projected flows:** from here, the transport flows in the year 2030 are evaluated. The results of the projections in T1.2 are simulated according to the expected transport increases based on the current network, without considering any of the improvements provided by PLANET's technological developments. This scenario helps to test whether the current network can withstand these transport increases by maintaining current operations and not incorporating new technologies. Therefore, in order to compare with the base scenario, some key KPIs could be the network congestion, transit times or order lead time.
- **S3. 2030 projected flows + EGTN innovations:** after that, the 2030 scenario is analyzed by applying the technological concepts to be developed in the PLANET project on the current transport network. The impact of EGTN innovations can be transferred to models through simulation parameters, by adding new transport agents (e.g., Cargoloop) or modifying current process diagrams. For example, it is expected that the adoption of blockchain smart contracts will reduce the time trucks spend in customs or that the use of IoT sensors in the containers will eliminate the weighing stage (see Figure 14). In addition, certain algorithms could be tested during the simulation runtime, such as routing or the port choice model for container ships. All these innovations are expected to have a positive impact on transport cost, end-to-end visibility, cargo safety and many others.

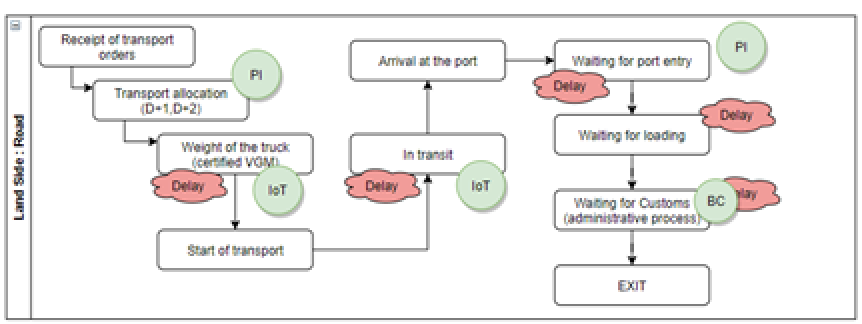


Figure 14: Technology-enabled "truck" agent process diagram

- **S4. 2030 projected flows + TEN-T evolution:** then, the 2030 scenario is be analyzed considering the evolution of the corridors for that year, with the expanded TEN-T network (after the integration of the emerging trade routes as per the results of T1.2). In this scenario, it is possible to check how the proposed investments or modifications to the current infrastructure (new terminals, warehouses, routes, etc.) affects the whole TEN-T network.
- **S5. 2030 EGTN innovations + TEN-T evolution:** finally, the 2030 scenario is analyzed considering both, the evolution of the corridors of the TEN-T network and the technological improvements developed in the PLANET project. This is expected to be the most favorable scenario, leading to a more collaborative, reliable, efficient and technology-enabled transport network that will have a positive impact on day-to-day operations, economy and society.

### 6.1.3 Simulation Plan followed

The following figure shows a high-level timeline on how the development of the digital clone was put in place from the time when the first version of this deliverable was submitted (D3.7, M17) until this final release in M36 (D3.8). A key milestone was the application of the Generic Use Case in the port of Sines that led to the submission of D3.9.

Figure 15 also shows the dependences on other project outputs (deliverables represented by diamond shapes, other milestones by triangles).

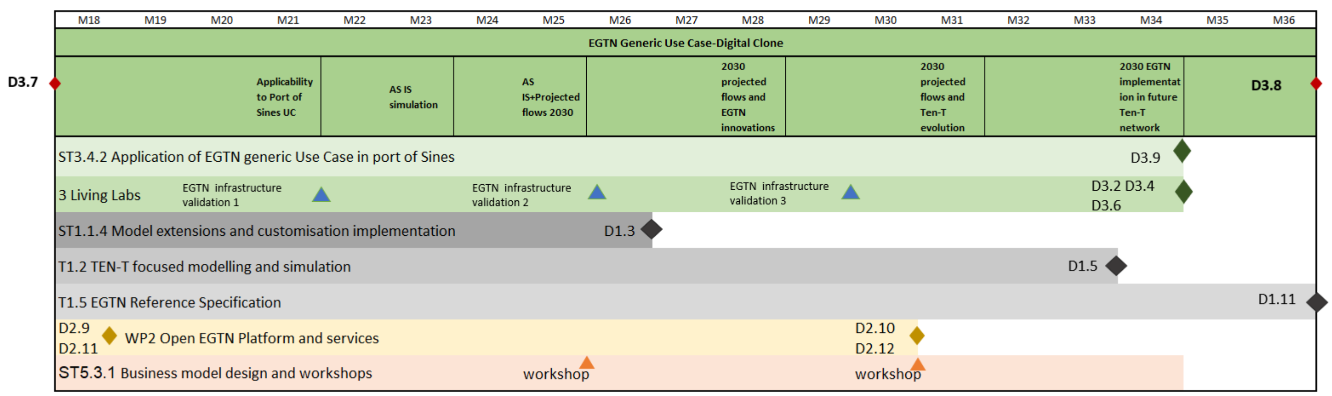


Figure 15: High level timeline of the simulation plan followed

### 6.1.4 Application to the Port of Sines

The Generic Use Case has been applied to the Port of Sines logistics environment to demonstrate how EGTN generic models and services can be applied by Sines T&L communities. This section presents just a summary of the scope and activities carried out in ST3.4.2. The specific use case and its results, together with a transferability guide for disadvantaged regions are presented in a dedicated document, PLANET D3.9.

The port of Sines is an important multimodal transfer node interfacing TEN-T (Atlantic corridor). It is the third in total cargo handled in the Iberian Peninsula (the first in Portugal). More than 90% of the total cargo (containerized and dry bulk) that is directed to the hinterland goes by train. Thus, Sines is an important rail freight platform, with trains carrying containers, refined & petrochemical products, and coal.

Portugal belongs to the EU Disadvantaged (less developed) Regions[7]. The regional policy of the EU, also referred as Cohesion Policy, is a policy with the stated aim of improving the economic well-being of regions in the European Union and also to avoid regional disparities. More than one third of the EU's budget is devoted to this policy. On the other hand, the TEN-T planning was segmented in the period 2014-20 in 30 Priority Projects (or

[7] https://ec.europa.eu/regional_policy/en/atlas/portugal

axes), most of which are still in progress. Two of those priority projects involve Sines terminal and are aligned with part of the activities foreseen in PLANET (Figure 16).

- Priority Project 8. Multimodal axis Portugal/Spain-rest of Europe.
- Priority Project 16. Freight railway axis Sines/Algeciras-Madrid-Paris

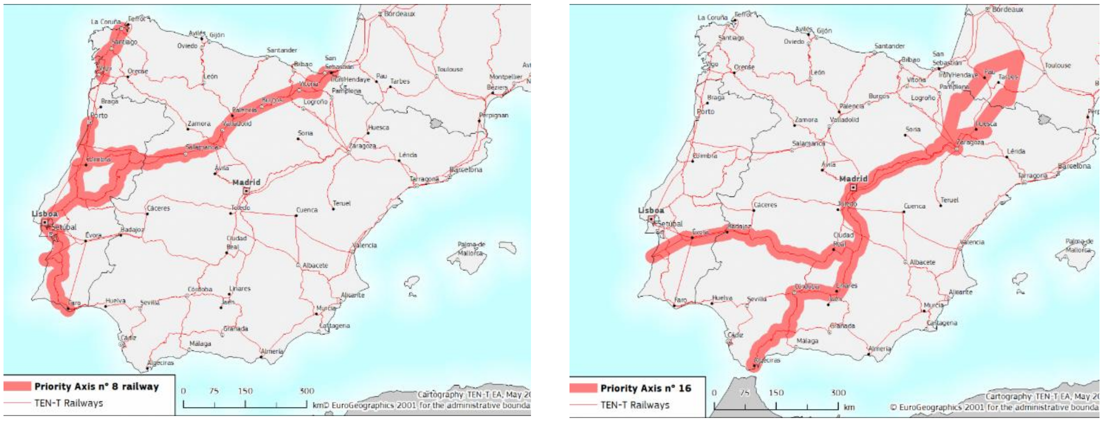


Figure 16: TEN-T programme priority projects involving Sines terminal

The Use Case took advantage of the insights gained and developments of the project to demonstrate how a disadvantaged region in the EU may be successfully integrated into the international trading system by offering innovative, integrated logistics solutions that take advantage of T&L and ICT innovations. The global trend towards integrated logistics, relying heavily on long-distance rail transport, is driving the transition to the Physical Internet, of which Sines is a leading example. Main objective is to transform the Port in a Principal Entry Node (PEN) interfacing TEN-T to global trade routes.

The use case focused on the EGTN implementation by the Port Community focusing on the creation of a Global trade zone as EGTN PEN. The use case combined Extension of the Single Logistics Window (SLW or JUL) concept (Figure 17 and Figure 18) not only at the port, but also internationally involving other Iberian dry ports, supporting multimodality. JUL's integration into the overall EGTN architecture, as an add-on service, will contribute to accelerate the transition towards the Physical Internet.

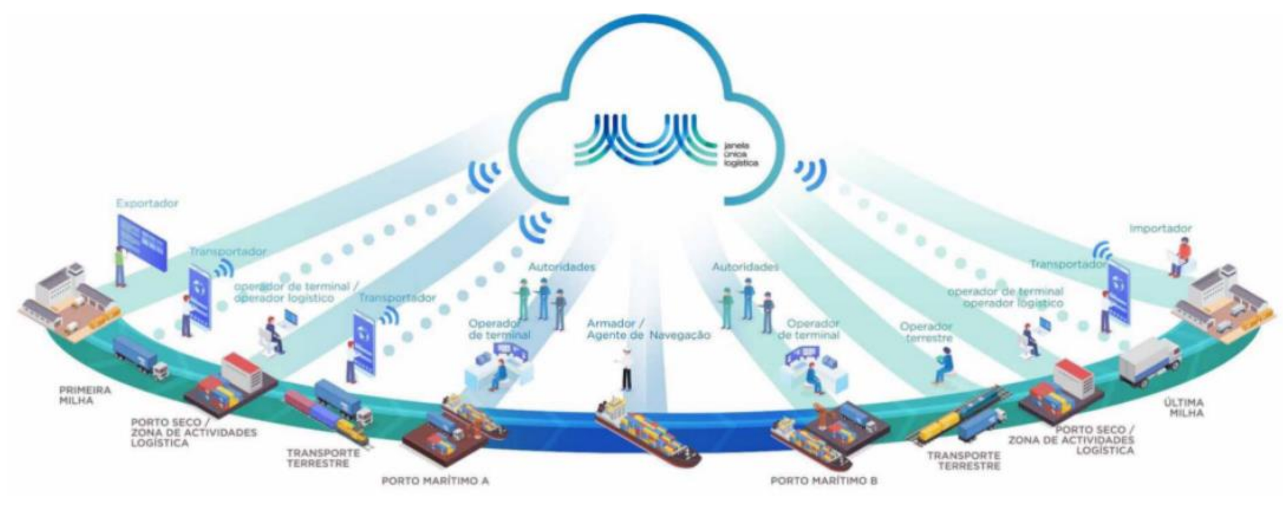


Figure 17: JUL (Logistics Single Window) (Source: APS-Port of Sines and Algarve Authority 2019)

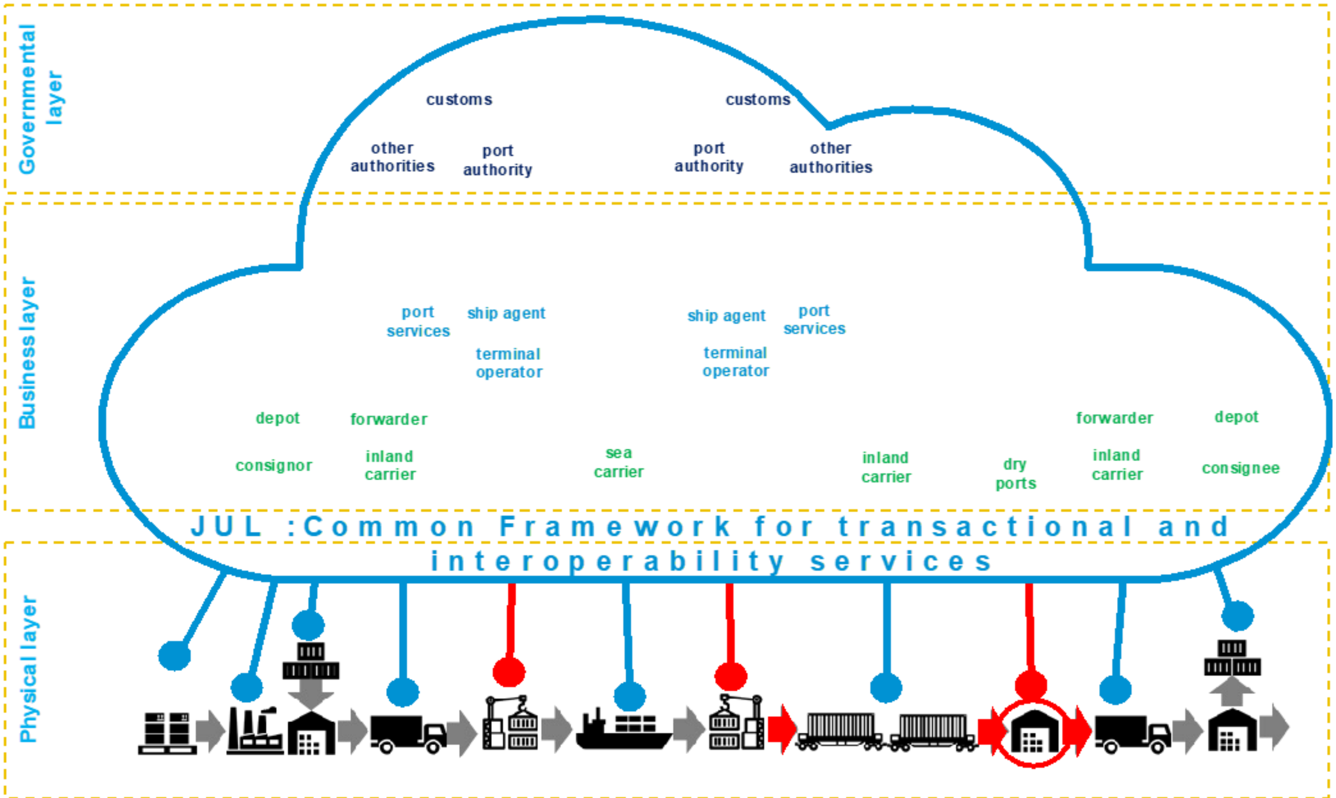


Figure 18 JUL architecture (from PLANET D3.9)

Simulation results shown that a more collaborative, reliable, efficient, and technology-enabled transport network would have a significant, positive impact on day-to-day operations, economy, and society (Table 11).

Table 11 Port of Sines EGTN technologies and benefits

**Port of Sines Use Case**

| Technology | Benefits |
| --- | --- |
| **Track & Trace monitoring** | • Reduce delays and the number of incidents in transportation. |
| **Routing optimization** | • Costs and emissions reduction |
| **Demand forecast and Predictive transport models** | • Make informed decisions and optimize their operations for maximum efficiency |
| **AI-enabled smart contracts:** | • Processes automation saving time and costs |
| **Logistics Single Window** | • Processes automation saving time and costs |

| | |
|---|---|
| **Collaborative logistics (PI)** | • Decrease transportation costs and GHG emissions |
| **Hyperloop** | • Fast, efficient, and sustainable transportation of goods over long distances |

# 7 EGTN Generic Use Case Assessment Methodology

Traditional supply chains have been reshaped by customers' requirements and new technologies. Increasing digitalization, and closer cooperation between partners have increased performance management demands on supply chains [1].

Supply chain performance is defined as the ability of the supply chain to deliver the right product to the correct location at the appropriate time at the lowest cost of logistics [2].

Typically, there are three basic criteria of performance evaluation [3]:

- efficacy: the relationship between the achieved results and the pursued objectives. It is related to the level of customer satisfaction with respect to the resources committed for this purpose;
- efficiency: the relationship between efforts and resources involved in the operation and the actual utility value as a result of the action. It is linked to the achievement of objectives at a lower cost;
- effectiveness: is related to the satisfaction with the results.

In practice, the functioning of the supply chains should be constantly improved, so measures to support the improvement of the performance of the global supply chain should be used, not only those that relate to the individual companies and their functions [4].

The performance measurement system should be adapted to the specific needs of each supply chain. Proper selection of a set of indicators, and their dimensions helps to identify problem areas, and is crucial in managing the organizations and whole supply chains in a turbulent environment and competitive global markets. An adequate system of performance measurement, considering the strategies of the company and the supply chain, provides the necessary information for decision-makers [5].

This section defines generic Key Performance Indicators (KPIs) which will allow a standard and common assessment of EGTN performance among different scenarios.

Those KPIs have the mission of giving a comprehensive vision of the impact of EGTN with regard to current situation and being an instrument able to shed light of strengths and weaknesses about different scenarios.

The EGTN Generic Use Case performance measurement system will analyze the EGTN on two different levels:

- individual performance indicators: each actor in the supply chain
- a set of performance indicators: supply chain as a whole

This approach is similar to the one followed in D1.8 where micro and macro EGTN KPI in the PLANET integrated modelling capability were introduced. Alignment between both sources of KPIs will be done in the final release of this deliverable.

The assessment of the EGTN Generic Use Case has been organized around two key performance indicators' broad categories, as per the project Grant Agreement: Financial and Business, and Economic and Social. Each of these perspectives focus on a key aspect of supply chain and its logistics and transport related processes and activities.

- Financial and Business perspective refers to the quality improvements and cost efficiencies achieved in day-to-day operations
- Economic and social perspective. It refers, on the one hand to the cost measurements/savings across the whole supply chain and within an individual actor. On the other hand, it addresses safety and environmental improvements (intra-logistics activities, long-haul transport and LMD).

The KPIs included in these categories have been defined and agreed in close collaboration with PLANET's Consortium partners, particularly with those leading and participating in the project's living labs. The table below details each of the KPI categories. The overall EGTN impact assessment will be reported in D3.10-EGTN Impact assessment- due in M36.

Table 12: KPIs used in the Generic Use Case assessment, classified per category

| | Considerations | KPIs |
|---|---|---|
| **Financial and Business** | Quality improvements and cost efficiencies achieved in day-to-day operations | • Use of infrastructure<br>• Total transit time<br>• Total waiting time<br>• On Time Delivery<br>• Real route distance vs Ideal route<br>• Distance<br>• Total distance travelled empty and full<br>• Disruptions of the Supply Chain<br>• End-to-end visibility<br>• Cargo safety |
| **Economic** | Covers not only costs measurement within an individual or isolated organisation but also total supply chain management cost (across the supply chain) | • Transport cost<br>o Cost of transportation ABC<br>principles (Activity Base Cost)<br>o Cost/km<br>• Handling costs<br>o Storage<br>o Handling<br>• Inventory holding cost |
| **Social** | Safety and environmental improvements (intra-logistics activities, long-haul transport and LMD) | • Accidents rate<br>• Network Congestion<br>• % CO2 emissions saved<br>• % Energy/fuel saved |

A selection of the above indicators was assessed in the application of the Generic Use Case in the Port of Sines (D3.9). The overall EGTN impact assessment following a methodological approach is described in D3.10.

# 8 Identification and engagement of interested agents, complementary networks and use cases

## 8.1 Value Network Analysis

The concept of a value chain has assumed a dominant position in the strategic analysis of industries. The value chain concept was originally introduced by Porter in 1985 [6] to include logistics, operations, marketing, sales and services as primary activities. Under this model, secondary activities are procurement, human resource management, technological development and infrastructure. A value chain has traditionally meant activities needed in order to deliver a specific valuable product or service for the market. Activities are seen as independent sequential tasks, which form a value chain.

However, as products and services become dematerialized and the system increases its complexity, the value chain itself no longer having a physical dimension, adopting a network perspective provides an alternative perspective that is more suited to many industries today and uncover sources of value (Figure 19 shows both perspectives). Value chain is focused on the end product and the chain is designed around the activities required to produce it. Every company occupies a position in the chain; upstream suppliers provide inputs before passing them downstream to the next link in the chain, the customer. In the value network concept, value is co-created by a combination of players [7]. A value network generates economic value through complex dynamic exchanges between companies, customers/suppliers, strategic partners and the community [8].

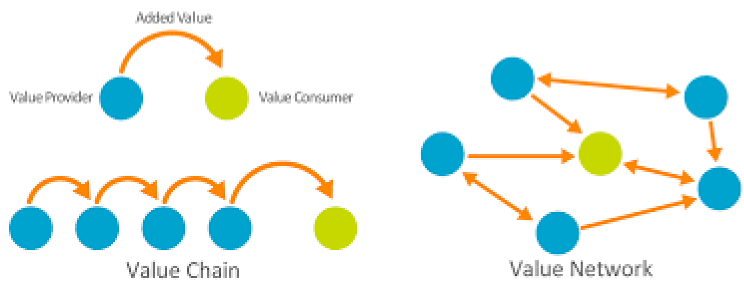


Figure 19: Value chain vs Value network perspective [9]

**Value network analysis** (VNA) is a methodology for understanding, using, visualizing, optimizing internal and external value networks and complex-and competitive- economic ecosystems [10]. The methods include visualizing sets of relationships from a dynamic whole systems perspective. All players of the network are considered: customers, suppliers, competitors, allies, regulators and policy makers, and any other network actors whose presence in the network can influence value creation. To understand the value generation of the network not only transactions around goods, services and revenues are considered, but also knowledge and other intangibles [11].

Identification of value networks can be a way of concretizing the actions and actors required for adopting the EGTN by T&L actors in the future. PLANET adapts to the project context the methodology developed by Tuominen (2015) [8], originally applied to the transition towards biofuels in Finnish road transport (further information can be found in PLANET D3.7).

## 8.2 Value Network Analysis of the Port of Sines Use Case

The Port of Sines use case takes advantage of the insights gained and the developments of the PLANET project to enhance Sine's role as a Principal Entry Node (PEN) interfacing TEN-T to global trade routes. It is focused on the implementation by the international rail operator Medway (belonging to the MSC Group) of an integrated logistics chain connecting Sines to Central Europe, via a rail hub located in Irun, Spain. This hub, dubbed "Irun Gateway" will transfer cargo hauled by Iberian-gauge trains to longer (750 m) trains operating on Europeangauge tracks. This use case applies different technologies integrated in the EGTN platform produced in PLANET, in a collaborative logistics setting (PI framework). The use case also considers the expected TEN-T evolution, namely the rail infrastructure improvements, that will contribute to more efficient and reliable services, thus attracting more cargo and boosting the desired modal shift.

Table 13, below presents main stakeholders involved in this use case, and their roles.

Table 13 Main stakeholders in the Port of Sines use case and their roles (adapted from SmartRail[8] project)

| Stakeholder | Role |
|---|---|
| Shipper | The EGTN concept enables to shippers, as end customers, the optimisation of modal choice to potentially gain the best service and capacity at the best price to fulfil shipper's supply chain performance |
| Logistics Service Provider/Forwarder | The logistics service provider is the "data consumer", and from this point of view controls the transport as a whole. Real time information on planning, capacity and status of the network from transport operators through the platform would enable the logistics service provider to make real time decisions on which modality is the best suitable for transport. |
| Railway Operator (RO) | Operates trains on the public railway infrastructure, based on the defined general, licensing, contractual, technical and other rules; it is the subject responsible for the train, it is the service provider for the LSP (providing the transport in the railway leg), and a "customer" or user of the public railway infrastructure managed by the IM. The RO/RU is responsible for the railway leg or its part thereof. |
| Railway Undertaking (RU) | Provides services for the transport of goods by rail. In order to develop cooperative services on a corridor operating between Portugal, Spain, France and Germany, cooperation between different RUs is required. |
| Railway Infrastructure Manager (IM) | Represents rail infrastructure providers which have effective control and management of the rail infrastructure of a railway. The IM should provide all necessary information about the state of rail infrastructure and possible bottlenecks due to unplanned disruptions. |
| Port Authority | Authority that operates sea ports and other transportation infrastructure |
| Terminal Operator | Logistic operator, serving a specific intermodal or logistic terminal and providing services as transloading, warehousing, etc. Terminal operators must ensure the safe and efficient delivery and packing up of goods on ships, trains and trucks, for instance. |
| Shipping lines | Provide maritime container transport. Besides the vessels, shipping line is also owner or lessee of containers in which the good is transported. Besides port-to-port service, shipping lines sometimes offer door-to-door and port-to-inland terminal service. They offer a more active role in developing hinterland intermodal network (rail shuttles to inland terminals), lower prices to customer |

[8] https://smartrail-project.eu/

| | |
|---|---|
| Ministry of Transport | Coordinating and realizing of national transport policies. They promote the intermodal (and implicitly rail freight transport) transport via various policies and regulations. |

The EGTN platform plays a central role in this use case. The roles of the involved stakeholders are their normal roles, augmented with information exchange through the platform in order to improve the quality of rail services.

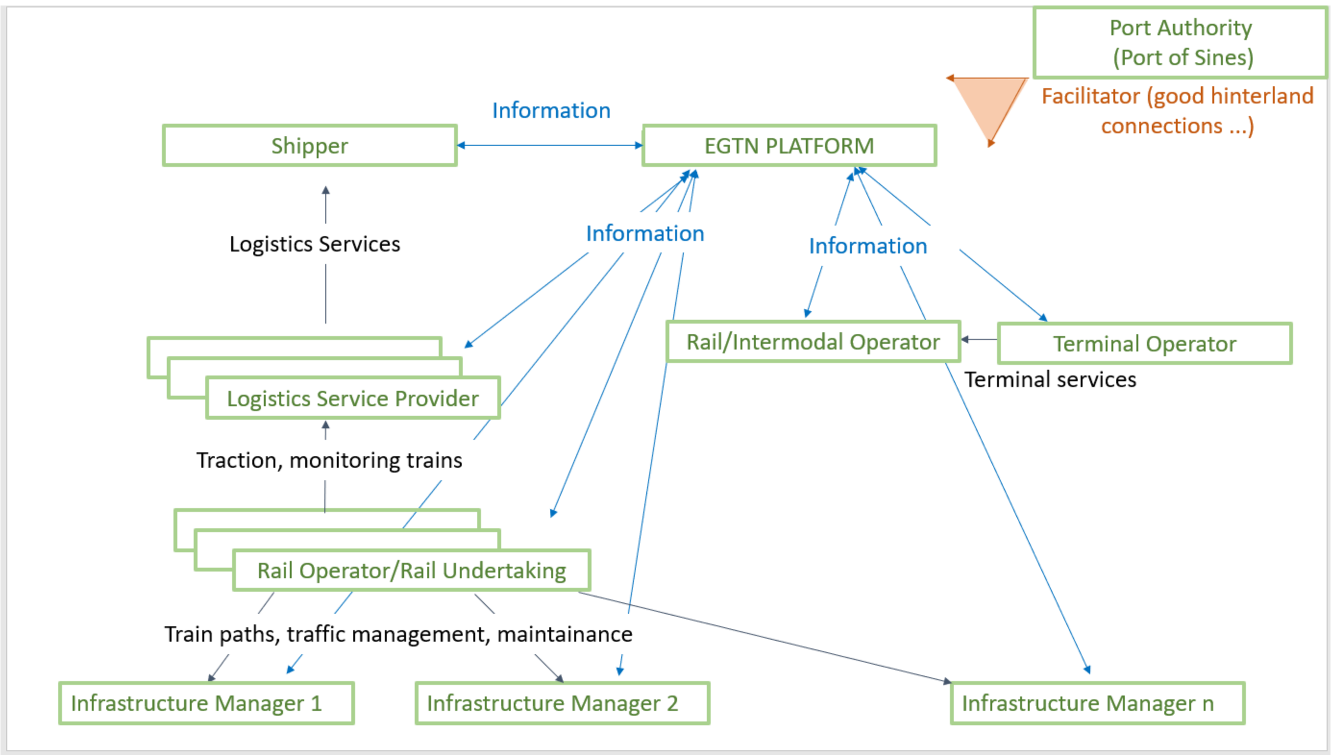


Figure 20 Value network for the Port of Sines use case (based on [12])

In general, we foresee that the changes to realise the improvement will have an impact on the main stakeholders as shown in Table 14, below.

Table 14 Barriers and drivers of the different stakeholders for the implementation of the use case (overall impact green:positive; yellow: neutral; red: negative). Based on [12]

| Stakeholder | Changes in business | Barriers | Drivers |
|---|---|---|---|
| Shipper | Better predictability, enhanced transport service | | Less emissions (environmental)<br>Cost savings due to more transportation via rail.<br>Decreased running capital costs |
| Logistics Service Provider/Forwarder | Increased visibility | Costs associated to information collection and IT investments | Extended portfolio<br>Better dynamical process<br>Less disruptions |
| Rail Operator | Business process redesign due to more demanding communication and more visible planning of operations.<br>Improve reliability because can respond more quickly to changes. | Unwillingness for information sharing.<br>Costly improvements of information sharing infrastructure.<br>Need for shifting in modality – from single modality to multimodality. | Improved reliability<br>Increase revenues of operation by process efficiency and improved use of available capacity. |
| Railway Undertaking | More reliable and flexible traction provider. | Actual improvement of the current performance requires more time, capacity and effort than anticipated. | Improved reliability between marshalling yard and terminal processes, increased flexibility and opportunities for asset allocation |
| Terminal Operator | | | Efficient and effective use of facilities. |
| Railway Infrastructure Manager | More services on existing capacity. | Unwillingness for more intensive information sharing.<br>No data sharing culture.<br>Legal barriers: with whom they are allowed to share the data. | Higher / more efficient utilisation of infrastructure. |
| Port Authority | Reliable hinterland transport, meeting the sustainability criteria. | | Contractual sustainability obligations and competitiveness/attractiveness of the port. |

 

In addition to individual drivers and barriers, the power relations of the parties are also important. Socio-grams are a useful stakeholder mapping technique. In the center of the socio-gram parties are placed that have full power to initiate the required changes for the innovation. One circle further, the parties are shown that may decide together about the changes. One further, parties can collaborate, and one further, parties can think along with others that can initiate the changes. In the last circle parties are limited to just inform others [13]. Figure 21 represents the mentioned relation between stakeholders for the Port of Sines use case.

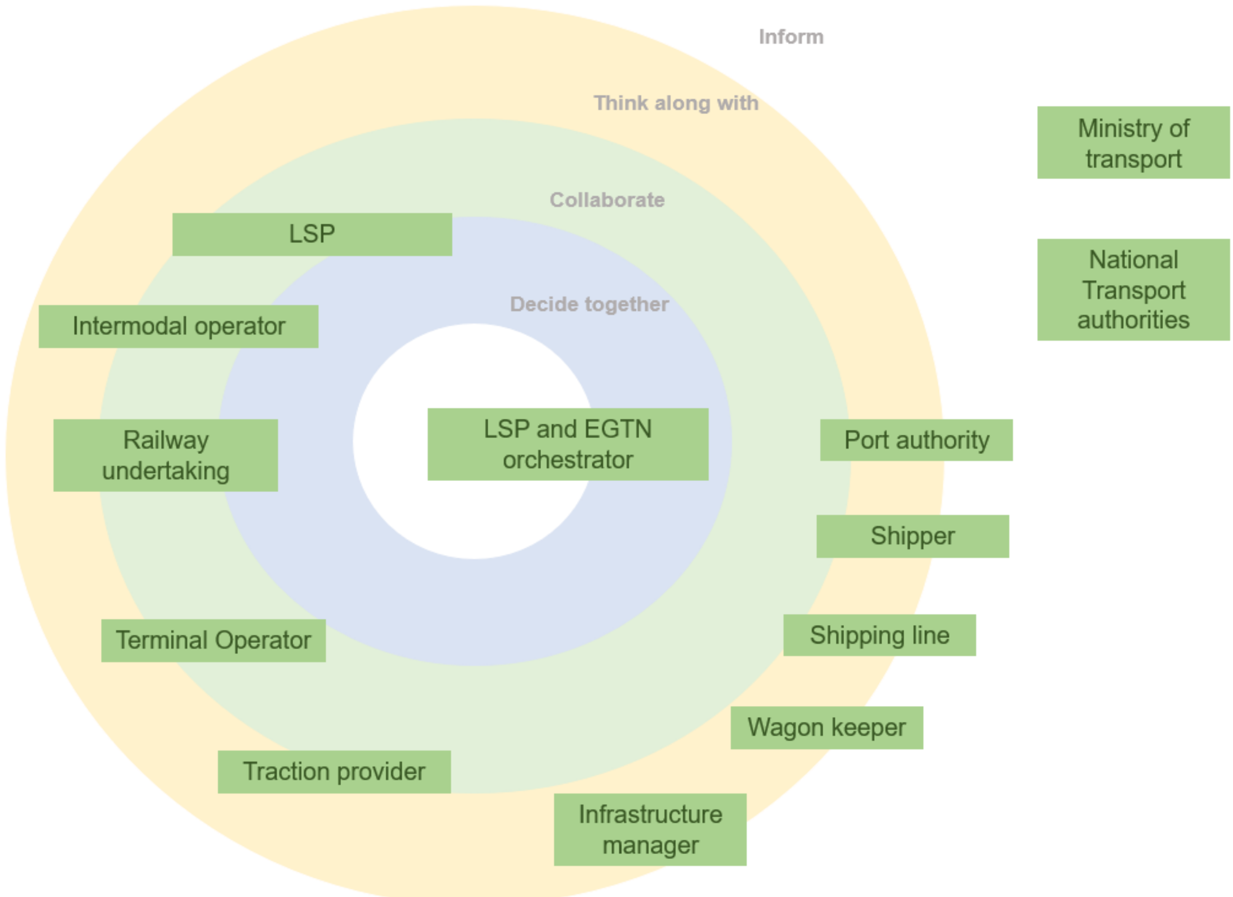


Figure 21 Por of Sines use case sociogram

To be cooperation initiated and sustained, a coordinating role is necessary. The party that fulfils this role should be seen as trusted and independent party by the different stakeholders.

# 9 Conclusions

This document is the final version of this deliverable (D3.8-M36) and an update of D3.7 (M17).The purpose of this deliverable is to define the elements and components of the EGTN Generic Use Case and the Digital Clone based on it. It goes one step further the use case developed in the European Project ICONET, incorporating disruptive technologies, emerging transportation modes and the impact of the new trade routes in the TEN-T following a bottom-up approach.

PLANET Generic Use Case combines generic elements from the three Living Labs and makes use of the tools and services that the Open EGTN platform offers to the different T&L actors. This document presents those generic elements and offers an analysis of the services hosted by the Platform, with a special focus on how collaboration is articulated.

The EGTN Generic Use Case has been used to produce a Digital Clone to explore the effect of introducing the EGTN concept along complete corridors. The Digital Clone is defined as data-driven simulations accessible to the different T&L actors that can be accessed through the EGTN platform and provide a dynamic model of EU-Global T&L Network or sub-Network utilizing the EGTN (PLANET) models.

Simulation is utilized to represent and compare different scenarios based on the generic components of the EGTN. Results of the simulation can be studied and compared through a set of generic Key Performance Indicators which will allow the Generic Use Case impact assessment on a standard and common basis.

The list of scenarios considered is: S1- the transport processes in the corridors as they are currently carried out (base scenario or AS IS), S2-AS IS and 2030 projected flows, S3- 2030 projected flows + EGTN innovations; S4-2030 projected flows + TEN-T evolution, and S5-2030 EGTN innovations + TEN-T evolution.

The Generic Use Case was applied in the Port of Sines Use Case developed under ST3.4.2. It considered the future logistics flows for 2030 of the selected TEN-T corridor and different innovations, including the hyperloop for freight. This activity led to the development of D3.9. Furthermore, the simulation plan that has been followed is presented in section 6.1.3. It also shows the interdependencies with other project outputs that guided the developments of ST3.4.1.

The work presented in this document generalizes the 3 project LLs, providing a simulation framework to be tailored to specific use cases where T&L actors (including policy makers) can evaluate EGTN solutions.

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