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

D3.3 LL2 Specifications and baseline measurements

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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
BCPs	Border Control Posts
BRI	Belt and Road Initiative
EGTC	Interregional Alliance for the Rhine-Alpine Corridor
EGTN	EU-Global Transport &Logistics Networks
GVMS	Goods Vehicle Movement Service
IoT	Internet of Things
NUTS	Nomenclature of Territorial Units for Statistics
PEP	Principal Entry Point
PoR	Port of Rotterdam
PoV	Port of Valencia
PI	Physical Internet
RALP	Rhine-Alpine corridor
RFCs	Rail Freight Corridors
SCOR model	Supply Chain Operations Reference model
TEN-T	Trans European Transport Network
TEU	Twenty-foot equivalent unit

1 Executive Summary

This report introduces the work carried out during the first steps of this Living Lab: Synchro modal dynamic management of TEN-T & intercontinental flows promoting rail transport: China – Rotterdam, USA/UK focusing on the role of rail transport.

This Living Lab consists of three Use Cases:

1. The first use case focuses 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 LL2's corridors;
2. The second use case focuses on investigating Eurasian rail freight expansion in the LL2 corridor by building on results from T1.2. Key issues for infrastructure development are explored, as well as the potential for expanding services in the corridor and implement (in a test environment) the use of Blockchain on rail freight transport between China and Europe. This will also utilize use case 1 tools to investigate freight flow synergies and Blockchain innovation to support integration with European RFCs;
3. The third use case analyses LL2 corridor flows and assess the implications for TEN-T infrastructure, extending T1.2 results with data from EGTC and use cases 1 and 2. This is directed at strategic corridor planning and its use for EGTC members (focusing on the EGTC Rhine-Alpine area);

Within Use Case 1, Blocklab has developed a blockchain demonstrator to deal with post-Brexit customs processes between the Netherlands (PoR) and the UK. The functional specifications of this demonstrator will also be used as an initial step for Use Case 2. With the information gathering of functional requirements now on the way, Use Case 2 stakeholders, including HUPAC and VTG, are now able to reflect on initial requirements.

This use case will analyse LL2 corridor flows and assess 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 will be 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 will be carried out.

In this report we provide an overview of the Use Case 1 demonstrator in terms of its functional capabilities, explain why this demonstrator is of interest for Use Case 2 and propose a phased approach that will allow LL2 and PLANET to benefit from the lessons learned and the digital infrastructure created for the post-Brexit use case. For Use Cases 1 and 2, the business case is shown to be significant, with potential for market uptake of the solutions elsewhere. Also, the implications for synchromodal management are addressed. For Use Case 3, the baseline measurements of the dynamic scenario simulation for future TEN-T planning is established.

Finally, alignment of LL2 with the wider purposed of EGTN development is also examined. To support EGTN services, the Blockchain platform shall include a service that summarizes non-sensitive logistic data related to a certain shipment. Information included in those data will allow for synchromodal dynamic management and logistic optimisation.

2 Introduction

This report introduces the work to be carried out during the first steps of this Living Lab: Synchro modal dynamic management of TEN-T & intercontinental flows promoting rail transport: China – Rotterdam, USA/UK/Scandinavia focusing on the role of rail transport. This LL2 is part of Work Package 3 (WP3) of the Progress towards Federated Logistics through the Integration of TEN-T into A Global Trade Network – PLANET project.

LL2 will focus on dynamic and synchro modal management (achieving synergies between) of TEN-T & intercontinental rail freight flows, utilising the Port of Rotterdam (PoR) as the principal smart EGTN node centering rail focused transport chains. This will focus on intercontinental rail freight between China and the EU, but also on linking China and Russia through Rotterdam to/from USA and the UK (shortsea and ocean freight). The following objectives are involved in order to support PLANET's vision:

- Assess the implications of new trade routes and how best to maximise the EU's economic prospects through strategic planning at PoR and EGTC Rhine-Alpine;
- Examine the role of new technologies (e.g. block chain) on intercontinental rail services promoting EU's strategic cooperation with China, USA and the UK;
- Leverage Blockchain interoperability and federation for Supply Chain platforms extending the Blocklab repository knowledge hub with synchro modality models as a service with predictive and prescriptive analytics enabling corridor actors to establish the best multimodal solutions that can optimise the interconnection of supply chains along the TEN-T Corridors a "green" Global T&L context.

Since 2014, the European Union has taken on a leading role in further expanding and improving the quality of the transport networks of the European Union. The EU's long-term TEN-T policy belongs to the world's vanguard in terms of ambition, geographical scope and network density. Further advancing the EU's leadership in global transport flows and logistics starts with establishing a sound and fundamental understanding of the impact on the TEN-T network of global transport and geo-economic trends. A vital component of this is exploration of synergy potential between intra-TEN-T and intercontinental rail freight.

The EU-China rail connection has been experiencing strong growth, yet the long-term economic viability and competitive neutrality of this rail connection needs to be addressed. Also, the route's competitive position vis-à-vis other modes is subject for analysis, which should involve the rapid expansion of intra Eurasian rail connections and rail freight services, especially between China, Russia and Central Asian countries.

This Living Lab consists of three Use Cases:

1. Improving information flows through Blockchain enabled platform
2. Potential for Eurasian rail freight expansion through streamlining information flows
3. Implications for European corridor planning of the expansion of new trade routes

In this deliverable, the first phase of the Living Lab is reported on, including detailed problem and goal definition, approach design, operationalization of impact assessment, and initial implementation.

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.

PLANET GA Component Title	PLANET GA Component Outline	Respective Document Chapter(s)	Justification
DELIVERABLE			
D3.3 LL2 Specification and Baseline measurements	Specification and Baseline measurements	Chapters 3, 4	Chapters 3 and 4 outline detail problem setting, specification of the solutions desired, and the approach taken (with added value for synchromodal management detailed in par. 4.1.5).
TASKS			
LL2: Synchromodal dynamic management of TEN-T & intercontinental flows promoting rail transport corridors	Synchromodal dynamic management is enhanced through the solutions developed as well as dynamic simulation	Chapters 5, 6, 3.2	Chapter 5 outlines the current state of LL2 implementation; Chapter 6 specifies impact assessment of the solutions; Chapter 7 explores LL2 alignment with PLANET's EGTN objectives.

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

2.2 Deliverable Overview and Report Structure

This Living Lab comprises three Use Cases, all with their specific problem settings and methodology. In Use Case 1, we set forth the rationale for Blockchain development in synchromodal management on the China-PoR-UK corridor, including the business case. In Use Case 2 we define challenges and opportunities pertaining to expansion of intercontinenal rail freight, as well as requirements and business case for further use of Blockchain technology. In Use Case 3, we will analyze the effects of increased intercontinental rail freight on (local and regional) corridor planning, using dynamic simulation based on the results of T1.2. For this third Use Case, this deliverable presents the baseline modelling.

In chapter 3, we detail this Living Lab's goals, problem definitions, and structure. Chapter 4 refines the approach design. Chapter 5 sets forth the first results from the Use Cases. For Use Case 1 this includes the initial implementation results; for Use Case 2 the progress report of the first project phase is presented; for Use Case 3 the baseline measurements are established. Chapter 6 explores the impact assessment of the actions and solutions developed. Finally, chapter 7 elaborates on LL2 alignment with EGTN objectives, as well as its impact on synchromodal management capabilities.

3 Living Lab goals and problem definition

3.1 Overall purpose of Living Lab 2

LL2 focuses on dynamic and synchromodal management of TEN-T & intercontinental flows promoting rail transport and utilising the Port of Rotterdam (PoR) as the principal smart EGTN Node in the rail focused transport chains linking China and Europe, and through Rotterdam to/from USA and the UK, and the Rhine-Alpine Corridor destinations. LL2 therefore includes 3 main use cases:

4. The first use case focuses 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.
5. The second use case focuses on investigating Eurasian rail freight expansion in the LL2 corridor by building on results from T1.2. Key issues for infrastructure development are explored, as well as the potential for expanding services in the corridor and implement (in a test environment) the use of Blockchain on rail freight transport between China and Europe. This will also utilize use case 1 tools to investigate freight flow synergies and Blockchain innovation to support integration with European RFCs.
6. The third use case will analyse LL2 corridor flows and assess the implications for TEN-T infrastructure, extending T1.2 results with data from EGTC and use cases 1 and 2. This is directed at strategic corridor planning and its use for EGTC members (focussing on the EGTC Rhine-Alpine area).

The 3 use cases therefore support PLANET’s vision, in particular to:

- Assess implications of new trade routes and how best to maximise the EU’s economic prospects through strategic planning;
- Examine the role of new technologies (i.e. blockchain) on intercontinental rail services promoting EU’s strategic cooperation with China and through to the UK and potentially USA;
- Leverage Blockchain interoperability and federation for Supply Chain platforms extending the Blocklab repository knowledge hub with synchromodality models as a service with predictive and prescriptive analytics enabling corridor actors to establish the best multimodal solutions that can optimise the interconnection of supply chains along the TEN-T Corridors a “green” Global T&L context.

LL2 focuses on the corridor linking China – Rotterdam, UK/USA, as well as implications for the Rhine-Alpine Corridor (EGTC area).

3.2 Organization and planning

Living Lab 2 is organized and planned as detailed in the Gantt chart below. The present deliverable sets out the use case specifications, baseline measurements and first results of the new technologies developed and tested.

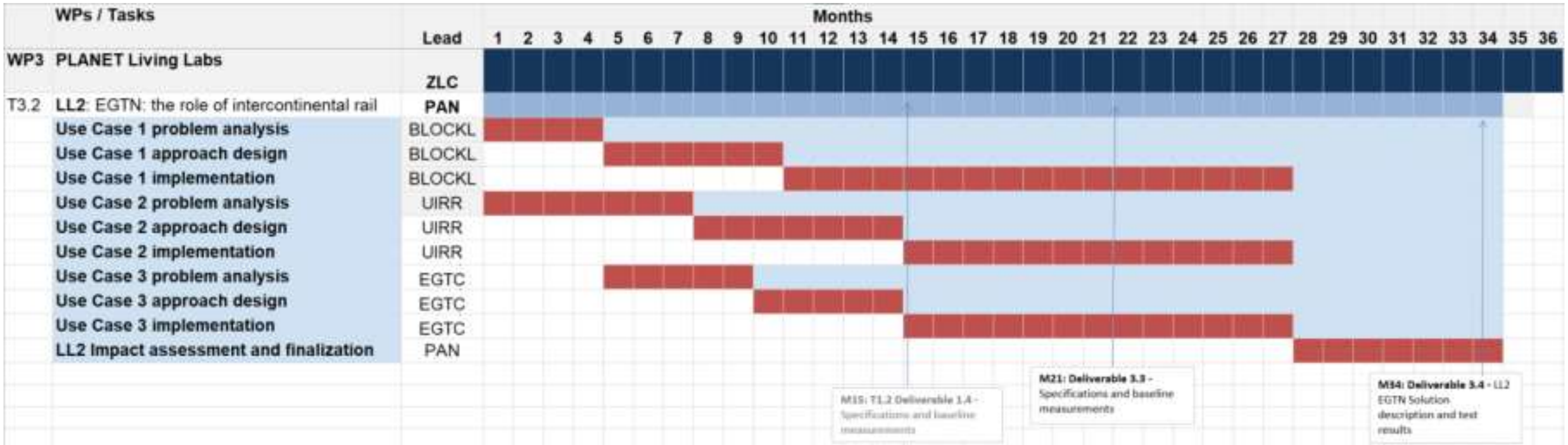

Table 2. LL2 planning

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 860274.

3.3 Use Case 1: improving information flows through Blockchain enabled platform

3.3.1 Introduction

Within the PLANET project, Living Lab 2 specifically addresses improvements in the handling of rail freight between China-USA and the UK with the port of Rotterdam as transshipment and modality shift point. Use case 1 focuses on *Synchromodality in a Blockchain-enabled Platform* involving the PoR community and customers. Use case 2 will focus on investigating Eurasian rail freight expansion through, among other things, the use in a test environment of Bockchain for rail freight transport between China and Europe.

Within use case 1, Blocklab has developed a blockchain demonstrator to deal with post-Brexit customs processes between the Netherlands (PoR) and the UK. The functional specifications of this demonstrator will also be used as an initial step for use case 2. With the information gathering of functional requirements now on the way, use case 2 stakeholders, including HUPAC and VTG are now in a position to reflect on initial requirements.

In this report we provide an overview of the use case 1 demonstrator in terms of its functional capabilities, explain why this demonstrator is of interest for use case 2 and propose a phased approach that will allow LL2 to benefit from the lessons learned and the digital infrastructure created for the post-Brexit use case.

In this paragraph we will describe this use-case in terms of its problem definition, business case and the functional and technical aspects of the solution.

3.3.2 Problem definition

Great Britain has left the European Union per the 1st of January 2021. As per the 1st of July 2021 traders moving any goods will have to make full customs declarations at the point of importation and pay relevant tariffs. Full Safety and Security declarations will be required. While commodities subject to sanitary and phytosanitary (SPS) controls, will have to be presented to Border Control Posts (BCPs) and there will be an increase in physical checks and the taking of samples. SPS checks for animals, plants and their products will take place at GB BCPs and not at destination. Per the 1st of January 2022, the Goods Vehicle Movement Service (GVMS) is in place for all imports, exports and transit movements at border locations which have chosen to introduce it.

With the first full year of Brexit behind us we can already observe that the increase in physical checks and additional paperwork is affecting the flow of goods in a negative way. While various mitigating actions have been put in place on both sides, these actions still rely to a greater or lesser extent on paper and human interaction.

As paper-based trade processes have proven themselves to be extremely brittle during the recent Covid-19 outbreak[2] and given their inherent inefficiencies and vulnerabilities to frauds, the need for further digitization of the trade processes between the continent and GB is still very much a priority.

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[2] See for example https://www.shippingandfreightresource.com/coronavirus-covid-19-and-bill-of-lading/ and https://amp-ft-com.cdn.ampproject.org/c/s/amp.ft.com/content/c8a13e05-f47f-410a-898b-af3d758d7a6e (the latter is behind paywall).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 860274.

3.3.3 Import & Export Statistics UK-EU

Below an overview of the import & export statistics post Brexit as published by the Office of National Statistics in the UK[3].

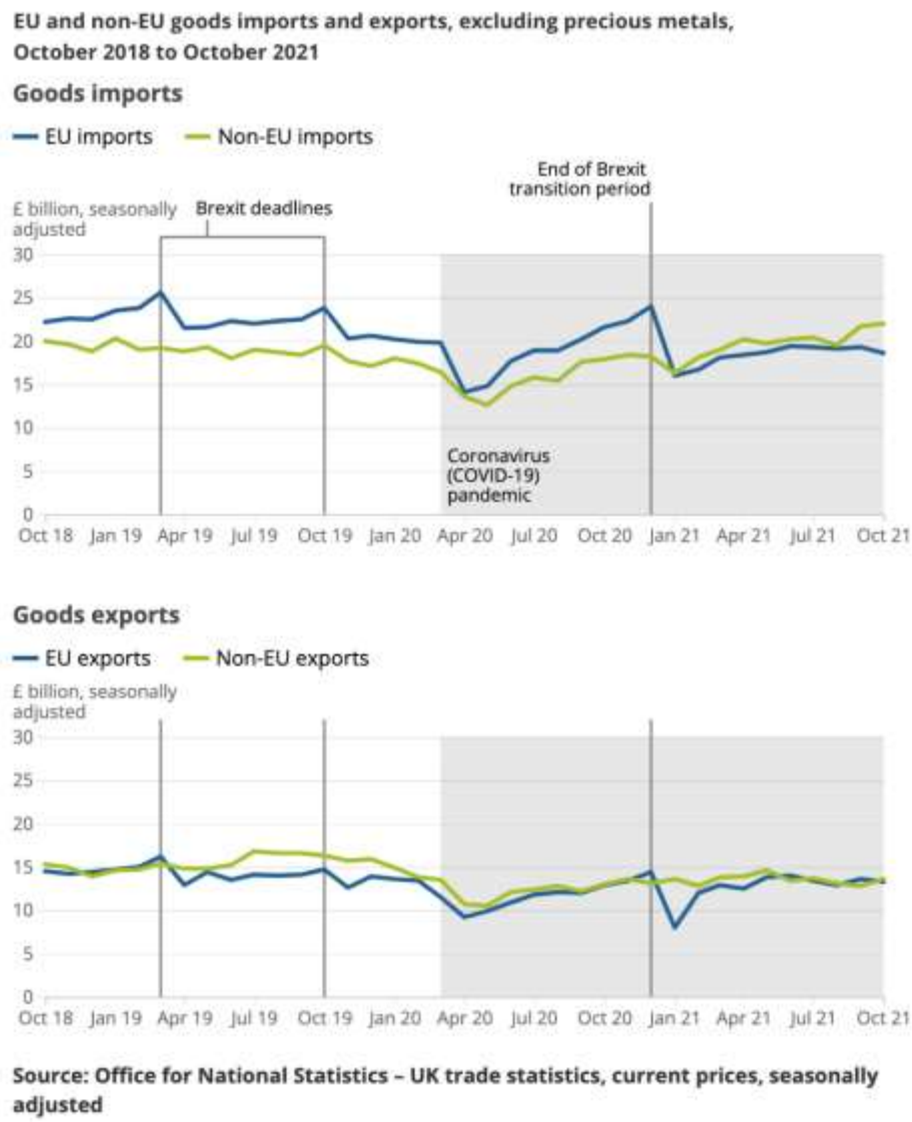

Figure 1. Import & Export Statistics

While still very early days to do any meaningful predictions on volumes and value, a number of fundamental shifts can already be observed:

- British importers are shifting the paperwork burden of importing goods into the UK to the exporter (from EXW & FCA incoterms to DAP & DDP).
- British SMEs are opening offices & warehouses in the EU to be able to serve their EU clients from there[4].

[3] https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/uktrade/february2021. The table will be updated with release of each monthly figures.
[4] https://nltimes.nl/2021/01/27/uk-companies-looking-nl-brexit

- Prior to Brexit, the Netherlands acted as a hub for EU and non-EU exporters of fresh produce, consolidating cargo in the Netherlands before shipping it to the UK. More and more non-EU countries now opt for direct shipment into the UK, because of the high costs and risks of custom clearing the goods in both The Netherlands and the UK.

3.4 Use Case 2: potential for Eurasian rail freight expansion through streamlining information flows

3.4.1 Introduction

Within the PLANET project, Living Lab 2 specifically addresses improvements and growth in the transportation of rail freight between China-USA with the port of Rotterdam or other close central transshipment nodes (e.g. Germany/Poland) located on a TEN-T or RFC corridor (in particular on the RFC8 – North Sea-Baltic corridor).

Use case 2 will focus on investigating Eurasian rail freight expansion. Depending on the identified key requirements and on the growth hurdles, the most appropriate organizational measures and (IT-) technologies will be chosen. The insights, experiences, and early demonstrators of innovative solutions such as Physical Internet, blockchain, smart contracts will be given sound analysis if a use for rail freight transport between China and Europe is likely to be successfully adopted.

This document provides an overview of the use case 2 project plan and a first draft of the reasoning of the initial phases to identify a beneficial use case and demonstrator in terms of its functional capabilities, stakeholder benefits and adoption within the chosen focus areas above.

3.4.2 Eurasian rail improvement through platforms

This use case is described in terms of its problem definition, business case requirements and the functional/technical aspects of the possible solution (e.g. set-up of community platforms in an intercontinental ecosystem). Platforms are a general term that needs to be further specified to be meaningful and be considered useful and relevant by the stakeholders. Since the number of stakeholders of international rail freight are numerous the adoption is of the highest importance. Initially we started with a route analysis and a collection of the needs of the stakeholders to be able to propose a demonstrator with a high likelihood to add benefits and foster international rail transport from EU to China on the selected emergent routes thanks to the implementation of new digital data sharing solutions.

The use case 2 is split into 5 phases. Its project plan is updated to reflect the current status. The project set-up and the problem analysis and requirements specification phase are completed whereas the development of the future measures is ongoing. Based on the completed requirements document the design specification is currently elaborated (Phase 2).

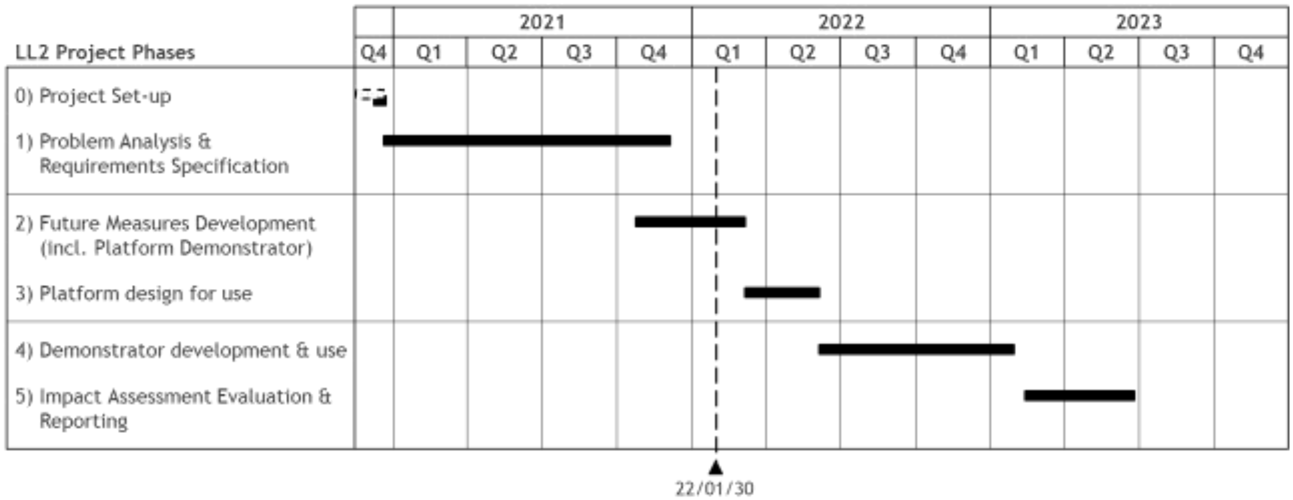

Figure 2. Status quo of LL2 UC2 project plan

3.4.3 Problem definition and analysis

Given the continuing global and regional economic development, cargo traffic flows between Asia and Europe have steadily increased in the last two decades and are expected to rise still further. Eurasian rail cargo transport has grown significantly in recent years but its share remains limited. The number of operated trains rocketed from ~300 in 2014 to nearly 1,800 in 2016, while the transport volume grew from 25,000 TEU to 145,000 TEU. Despite this strong development, rail transport still has a low intermodal market share of ~1% in the trade between Asia and Europe. The majority of freight is transported by ship (more than 90%). The total traffic potential between the 28 European and five Asian countries is forecasted to reach 25.6 m TEU in 2027 for sea, air and rail transport combined, compared to 11.1m TEU in 2016. For 2027, total rail potential of around 636,000 TEU is forecasted, with a significant amount coming from a shift from sea transport, which equates to 21 trains per day in 2027 (assumption: 82 TEU per train)[5]. The UIRR CT operators have recorded in 2019 a total of 8.8 million TEUs in cross-border traffic, 4% (180,000 TEU) of which have been conveyed to Russia/China. Compared to the UIRR 2017 figures, the traffic to China/Russia records a small decline in 2019. In 2020, the market share reaches 5% of the total UIRR traffic with a total traffic of more than 280,000 TEU.

Figure 3. Growth of transcontinental transport Asia-Europe

A first analysis considered the following elements as main barriers for further growth: (1) disadvantages in border crossings, (2) reliability, (3) infrastructure and (4) other factors (subsidies reduction, legal restrictions for dangerous goods) while (5) falling sea freight rates aggravate the competition[6].

LL2 use case members therefore are focusing on a strategy to identify a combination of underdeveloped areas and innovative services to achieve the highest possible leverage of the demonstrator(s) of the LL2.

[5] More information: https://uic.org/IMG/pdf/corridors_exe_sum2017_web.pdf

[6] The volatility of the sea freight rates and capacities influence the importance of this argument considerably over time.

The selection of the routes is not only based on the current known traffic volume but also on the growth potential and the leverage a platform innovation can bring.

The Euro-Asian Conference on Transport held in Saint Petersburg defined the following Trans-Eurasian Land Transport Corridors:

1) The **Northern** Corridor (Trans-Siberian): Europe – Russia – South Korea – Japan, with two branches:
   a) Russia – Kazakhstan – China
   b) Russia – Mongolia – China (Central Corridor)
2) Transport Corridor **Europe – Caucasus – Asia** (**TRACECA**), Eastern Europe – Black Sea – Caucasus – Caspian Sea – Central Asia.
3) The **Southern** Corridor: Southern-Eastern Europe – Turkey – Iran, with two branches:
   a) Central Asia – China
   b) Southern Asia – Southern-Eastern Asia/Southern China
4) The **North-South** Transport Corridor (NOSTRAC): Southern Europe – Russia, with two branches:
   a) Caucasus – Persian Gulf
   b) Central Asia – Persian Gulf

The LL2 members have pre-selected the following corridors to be analyzed in detail for the choice of the best possible business case for the design and test of a viable demonstrator:

1a) Kazakhstan, Russia and Belorussia (New Silk Road)
2) Caspian East-West Corridor (emerging routes)
4b1) North-South corridor connecting the Persian Gulf to the Baltic (NSTC) - Baltics-Kaliningrad (emerging routes)

4b2) Northern corridor via Vladivostok to connect via short sea to China, Japan and South Korea (emerging routes)

The chosen preferred option was 4b2). The innovation elements were the key drivers in favor of this option:

1) Expand capacity for dangerous goods to China via short sea "last mile"
2) Attract additional non-dangerous goods volumes
3) Explore the potential of intermodal traffic towards China further
4) Connecting other regions via short sea (e.g. Japan and South Korea) increases success potential
5) Increased use of IT or information-based innovations through platform-based solutions accessible to all relevant stakeholders (see chapter 3.4.4)

3.4.4 Requirements specification

Use case 2 has pre-selected four possible routes that were narrowed down to one as practical demonstrator for the planned innovation. This scoping was in parallel complemented by the analysis and prioritization of the key hurdles that prevent the Eurasian Railway growth in order to support the integrated Green EU-Global Transport & Logistics Network (EGTN).

Based on an initial list identified potential hurdles are:

- Inter-organizational alignment gaps (common language, multi-national contractual and governance standards and rules)
- Standardization gaps (processes, documents, IT systems interoperability and missing interfaces)
- Digital transformation needs (common operating processes, data exchange and no accepted digital documents)

In this context, the following relevant associations to be contacted are (in order to extend the initial list and to collect also more statistical evidence):

- Association of Metro (CAMET)
- Organisation for co-operation between railways (OSJD)
- The National Railway Administration (NRA) and
- China's Academy of Railway Sciences (CARS)
- Eurasian Rail Alliance Index (ERAI)

As far as the Key supportive IT tools for improvements to be analyzed at minimum:

- Physical Internet
- IoT applied to logistics
- Blockchain and other platforms
- Smart contracts
- Predictive Analytics

The following areas are identified initially as critical:

Degree of interoperability and enablers

A previously elaborated comprehensive business and public ecosystem interoperability framework will be used to structure the project work to identify the potential barriers to growth.

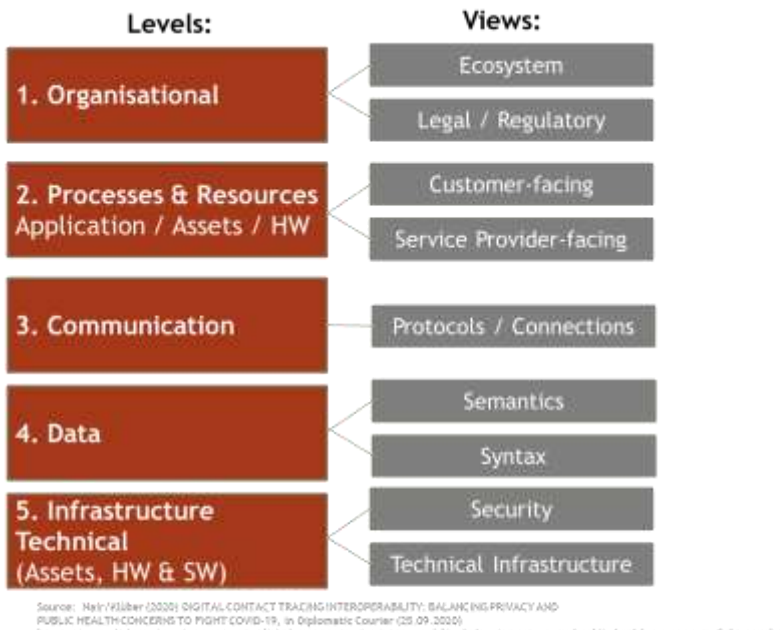

Figure 4. Interoperability framework as guiding structure for areas of improvement (updated)

The framework helps to identify not only the hurdles but also the enablers for higher interoperability between the relevant stakeholders such as

- Governance & legal incompatibilities
- Processes
- Hardware standards
- Railway asset standards

- Documents (customs, booking, safety etc.)
- IT-Standards
- IT-Platforms

Availability of infrastructure or services

Analysis of the current physical infrastructure on the chosen corridors and the available services to facilitate traffic growth. The focus will be to analyze the relevant stakeholders and their capabilities and service quality in the chosen corridors. Based on this stock taking, a prioritization of the most needed improvement measures is performed.

Utilization and adoption

The ultimate proof of the LL2 use case next to its future economic viability is its utilization and adoption rate. Early measures on stakeholder involvement and participation need to be devised and implemented to achieve stakeholder buy-in and adoption.

3.5 Use Case 3: Implications for European corridor planning of new trade routes

3.5.1 Introduction

This use case will analyse LL2 corridor flows and assess 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 will be 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 will be carried out. The simulation will take into account both Eurasian rail freight transport entering the R-ALP region and the potential shift of freight flows from Northwest European seaports to Mediterranean seaports stemming from BRI and TEN-T investments.

Eurasian rail freight is typically processed through Duisburg, Tilburg and a small number of alternative centres. In addition, although not part of the R-ALP corridor, the port of Hamburg handles considerable volumes as well. The main routes for Eurasian rail freight transport are seen in figure 5.

Figure 5. The main Europe-China railway corridor.

3.5.2 Problem definition

For the purpose of this Living Lab, the main results (2030 and 2050 scenario calculations) from T1.2 will be used. Importantly, these scenario calculations will incorporate the possible implications of several new technologies, including 3D printing, hyperloop, and advanced IoT. Increased growth in trade and investments in Eurasian rail infrastructure, including the popularity of new lines, such as the Kaliningrad route to Hamburg, are expected to impact the Eurasian rail freight flows in the future.

4 Living Lab 2 approach design

4.1 Use Case 1: improving information flows through Blockchain enabled platform

This paragraph describes the functionals and technical aspects of the solution.

4.1.1 Functional

As previously stated, this project will focus on the transport of foodstuff between GB and the continent. This transport is either by means of Roll-On Roll-Off (RoRo) vessel or by containers on board of short-sea shipping vessels. Port of Rotterdam has direct connections with a variety of GB ports, such as Hull, Felixstowe, Harwich.

In case of RoRo the trailers can either be accompanied by a truck or are decoupled from the truck before boarding the vessel and a truck at the port of arrival takes care of the further transport into the hinterland. Containers are off-loaded from the trailer at the terminal at the port of departure, loaded on board of the vessel, offloaded and then loaded on a trailer at the port of destination.

The project serves to provide valuable information for the design of a fully digital trade ecosystem between GB and the continent that links the various stakeholders (e.g. ports, authorities, shippers, carriers) on both sides of the Northsea for both import and export flows. This trade ecosystem puts the supply chain central; local optimization is avoided, instead the aim is system wide optimization.

4.1.2 Technical

To start quickly, we make use of a number of existing solutions. More specifically in GB, this is Amphora, a tool that allows for secure peer-to-peer data-sharing between legacy systems and blockchain solutions, while in the Netherlands we make use of a specially created environment of the DELIVER network.

In the first phase DELIVER will provide a “digital vault” for secure storage and sharing of “assets” (i.e. documents), a digital notary that provides timestamping and “fingerprinting” (i.e. hashing) services and a User Interface (UI) for tracking & tracing services.

Phase 1 focuses on the fully automated creation of an Entry In Declarant’s Records (EIDR) document, that is needed for to import goods in the UK and the creation of an audit-trail on the blockchain based on the underlying assets allowing for digital proof-of-existence, proof-of-integrity and proof-of-origin of those assets.

Below is a high-level overview of the data included in the EIDR:

- Metadata of the SAD, such as owner, type, creation date and signature
- Consigner;
- Consignee;
- Marks & Numbers, including quantity, description of goods and container number;
- A list of documents that are linked to this SAD, including pro-forma invoice, certificate of origin, consignment note and phytosanitary certificate.

The EIDR data will be created straight from the DELIVER’s digital vault in this phase by Amphora. The vault will act as an Oracle for a smart contract that will create the EIDR. The user in DELIVER will be able to check the EIDR’s correctness and if correct confirm. This will result in the EIDR being finalized, including hashing of the document on the DELIVER notary.

Phase one will have the following steps:

1. **Start a shipment from a Booking Confirmation**
   In the DELIVER management dashboard create new shipment by filling out the "Booking Confirmation" form.
2. **Add e-CMR (press [+] dropdown on booking confirmation asset)**
   Populate the e-CMR form with the realistic data, and at least ensure that all the Asterix marked fields are populated.
3. **Sign e-CRM document in the TransFollow app**
   For the moment in this pilot- and test configuration it is only possible to sign the Transfollow e-CRM checkpoints with an Android TF-partner app that was designed for the evaluation suite.
4. **Attach e-CRM document to Shipment dossier**
   For now there is a manual step required from the DELIVER Track & Trace dashboard to export the e-CRM document after signing for collection of the goods. Click on the "Active Shipments" table view (upper left-hand corner of the screen). The click on the Purchase Order Reference label and download the e-CRM document. Then open the vault interface and choose "Upload" from the menu, the set an expiration date, and drop the e-CRM document on the page.
5. **Upload Certificate of Origin (CoO)**
   Similar to the e-CRM Vault upload procedure you here upload the obtained electronic Certificate of Origin from the local chamber of commerce.
6. **Upload the SAD**
   Similar to step 4 and 5 you here the SAD is created and uploaded. The SAD will contain the hashes of the documents (Booking Confirmation, e-CMR, Certificate-of-Origin).
7. **Share Document link to SAD with MTI-UK**
8. **MTI-UK to create the EIDR**
9. **EIDR confirmation is shown as task in the DELIVER UI**
10. **DELIVER user confirms EIDR**
    EIDR is stored in the vault and the hash stored on the DELIVER notary.

4.1.3 Phased Approach

In this paragraph we describe the various project phases. Note that phases 1 and 2 have already been finalized. In phase 3 we will further investigate the use of the Deliver platform for the implementation of the other LL2 use cases.

Phase 1

In phase 1 we will work with anonymized but realistic shipping data from previous pilots within the fresh produce supply chain. The deliverable of phase 1 will be used for demo purposes, to gather further user input and as a starting point for real-life pilots. This phase ran from October 2021 to May 2021.

Phase 2

In this phase we focused on the full customs clearance process for goods imported under DAP incoterms from the Netherlands to the UK as well as integrating Transfollow's eCMR solution. The solution was piloted in parallel with the existing process and provided valuable input for the business case. This phase ran from May 2021 to September 2021.

Phase 3

The exact scope of phase 3 is still to be decided as it is very much dependent on the actual requirements of the Living Lab (LL). However, taking into consideration that the overall aim of the LL is to improve rail freight between China-USA with the port of Rotterdam as transshipment and modality shift point, there's considerable potential to further built on the lessons learned and the digital infrastructure created in phases 1 and 2 for them to be relevant for the LL. In particular, we can think of the following:

- Assist in "demystifying" blockchain, by using the solution developed in phase 1 as a demonstrator of the capabilities offered by blockchain technology as compared to more traditional solutions such as Electronic Data Interchange (EDI);
- The reference implementation in phase 1 shares some important characteristics with the particular challenges faced in the LL, such as reliance on paper, scanned documents, mails and MsExcel to coordinate activities between the various supply chain actors. Furthermore, the lessons learned in phase 1 with regard to digitization of custom related processes can be of benefit for digitization of the borderpoints along the Silk Road in use case.
- Last, but not least, coordination of changes in modality is a common theme and while the modalities may vary, the particular challenges, such as availability and validity of data, timeliness and sharing of sensitive data.

In this phase, work started on a patent that is inspired by the solution; "6200-037BE Multimodal Real-Time Decentralized Supply Chain Coordination". Patent submission is planned for mid-March 2022 and will be filed in Belgium.

Parties involved

- Her Majesty's Revenue & Customs (HMRC)
- Azarc (Azarc.io)
- Blocklab
- Port-of-Rotterdam
- Erasmus University Rotterdam
- Panteia
- Dutch Chamber of Commerce
- Dutch Blockchain Coalition
- Dutch customs

4.1.4 System description: digitalization and decentralization of multimodal logistics documentation

The purpose of this document is to describe the innovative multimodal blockchain-based supply chain execution system, developed by BlockLab. The system shall be described on high level to only capture the essential workings and functionalities.

The goal of the system is to provide a single platform for the digitalization and automation of the information flow related to multimodal, multi-stakeholder, cross-border shipments in order to streamline shipment processes to reduce process lead time and costs of compliance, labour costs, waiting times and disputes. The documentation required for these multimodal shipments can be categorized as commercial trade documents, logistic documents, and customs documents for export and import. After authentication and authorization, a user shall be able to create shipments, and digitalize and attach required documents for that shipment. For each of these digitalized documents, the system provides cryptographically secured proof of existence, proof of origin, proof of integrity, and proof of ownership (see Figure 8). For each digitalized shipment, the system provides multi-stakeholder end-to-end real time shipment tracking, real-time validated information for authorities, and stakeholder document issuing, viewing, singing, and ownership transfer.

The novelty lies in the unprecedented manner of secure digitalization of the information flow on shipment level, enabling multi-stakeholder real-time tracking and viewing of end-to-end shipment related information.

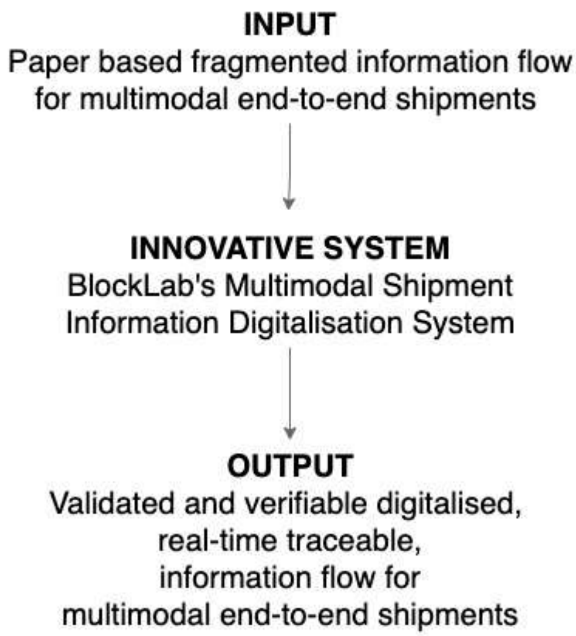

Figure 6. Input, innovative system, output (schematic)

General Features

Stakeholders to the system:

- Logistic service providers (Road, rail, sea)
- Freight forwarders
- Customs, transport, inspection, port authorities
- Logistic operators (Drivers, captains..)
- Consignors
- Consignees

The list of documents supported by the system:

- Commercial trade documents:
  - Purchase Order
  - Sales Order
  - Commercial Invoice
  - Transport Order

- Logistic documents:
    - (e)-CMR
    - (e)-CIM
    - (e)-Bill of lading
    - Delivery Note
- Customs documents:
    - Export declarations (EXS, ..)
    - Import declarations (SAD, ENS, EIDR)
    - Phytosanitary certificates

The system can be subdivided in the following main subsystems:

Subsystem	**Function**
User web interface	Entry point for users where they can view and manage documents and shipments associated to them
System backend	"Off-chain" backend that supports and links the web interface functionalities with the blockchain components. Amongst others, it includes the Vault where original documents and document hashes are securely stored in order to provide proof of integrity. It also contains the identity framework that manages the authentication and authorization of each user based on their role and organization
External integrations	External system integrations for non-human validation of certain documents, and for customs information distribution
Public blockchain	One part is the public ledger, the transparent administration layer where user interaction with the "on-chain" components is securely registered, in order to provide proof of origin. The other part is the smart contract layer hosting the Notary and Shipment Registry contracts, of which the Notary provides proof of existence and proof of ownership for shipment documents. The Shipment Registry enables the transparent registration and real-time tracking of the information flow per shipment

Table 3. Subsystems

General Diagrams

The diagram below illustrates an arbitrary multimodal shipment, the documents related to each part of the shipment process, and the digitalization of the information flow on top level.

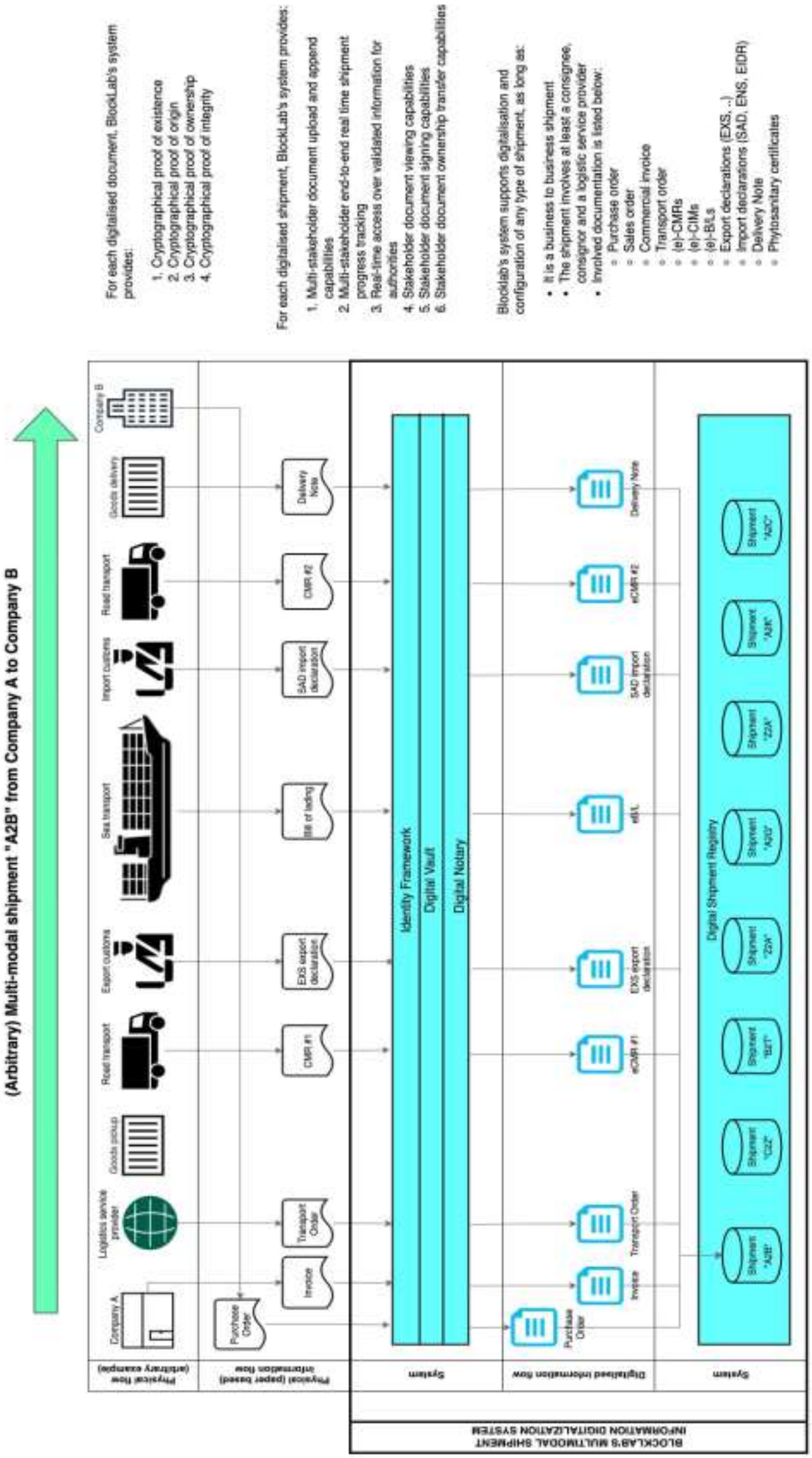

Figure 7. Multi-modal shipment diagram

The diagram below shows a general simplified process of issuing and digitalizing a shipment document by a user in the system. The document is eventually attached to a shipment in the Shipment Registry. A separate (dotted) flow can be distinguished for documents that are being validated non-humanly and created through external services. The diagram is subdivided in the earlier mentioned subsystems and their essential components.

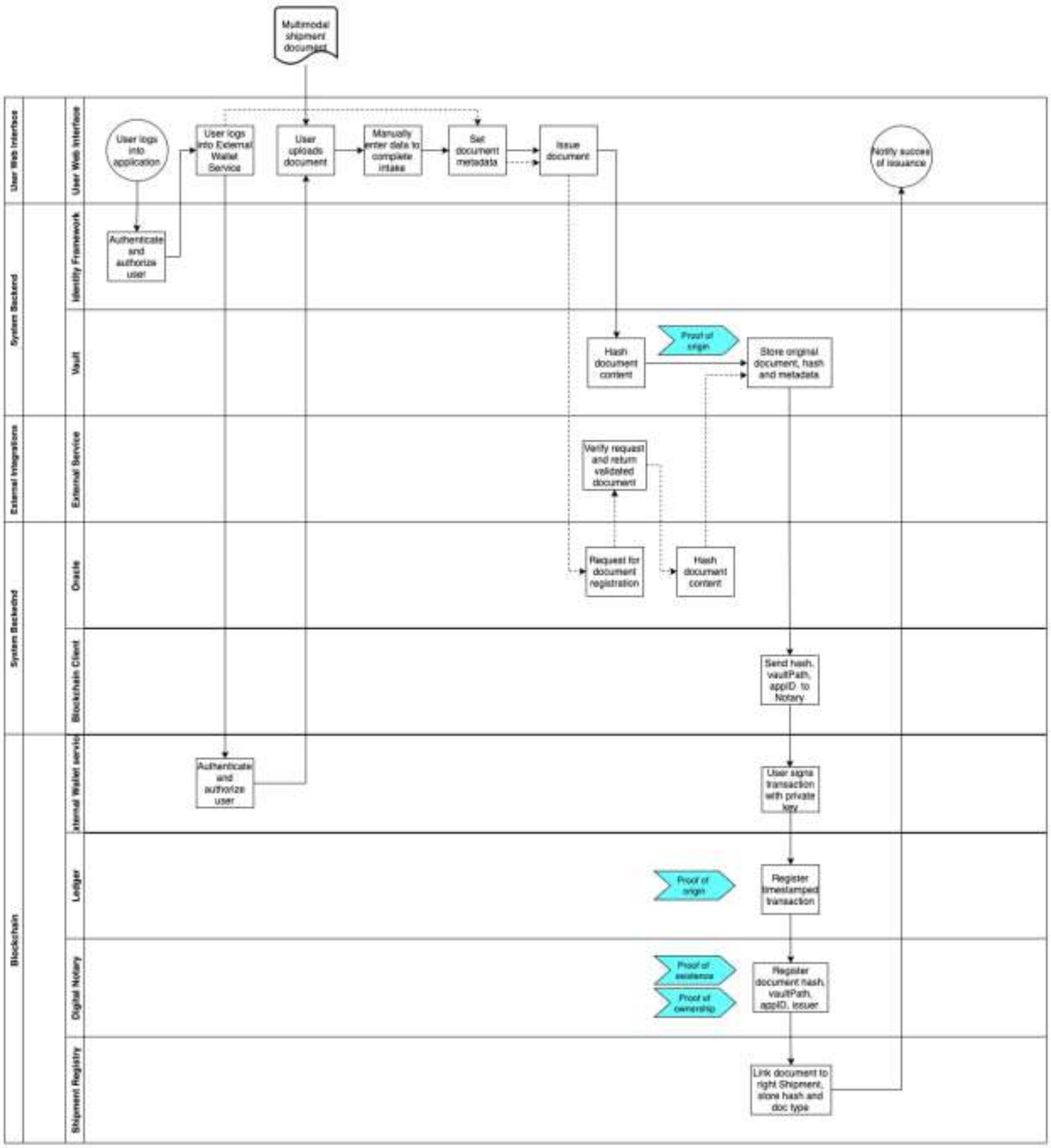

Figure 8. Proof generation

4.1.5 Synchromodality and the Physical Internet

Synchromodality and Physical Interet will receive attention in the first use case of LL2; Synchromodal dynamic management of TEN-T & intercontinental flows promoting rail transport. In particular, the first use case will focus on Synchromodality on a Blockchain enabled Platform, utilizing advanced IoT, supporting individual firms including SMEs (PoR customers/ communities) to create the best multi-modal alternatives for logistics solutions within the LL2 corridors. Based on the premise that Synchromodal transport is the closest concept to PI, we formulate a number of planned actions (*in italics*) and how we will approach these in the living lab.

Test Synchromodal dynamic routing of containers through a network where multiple modes of transport are used in sequence (vertical integration) and as alternatives (horizontal integration). The dynamic allocation of containers to (scheduled) services can be supported by smart contracts as well, including the preparation of required documentation.

Using Blocklab's blockchain infrastructure, Deliver, a pilot was conducted in July 2021 with ABC Logistics, Groente- en Fruithuis (Dutch Association of Fresh Produce Producers) and Azarc (www.azarc.io) that demonstrated the use of smart contracts to prepare the required import documentation for the United Kingdom, post-Brexit, based on validated data available at export. The pilot combined ro-ro (ferry) and road transport and the Transfollow eCMR app was used on a smart phone to sign-on glass to confirm pick-up and delivery of the cargo, including accurate locations. The blockchain infrastructure can be extended to include other modes of transport (rail and sea) and smart contracts. Deliver will be made interoperable with EGTN as part of work package 2, task 2.5. Based on the positive results of the pilot, work started on a production version of the service, called QuayConnect, built on the enterprise grade Naviporta blockchain platform of the Port of Rotterdam.

https://www.linkedin.com/feed/update/urn:li:activity:6851783978492424192

Test value proposition based on delivery of service, not prior commitment of resources that are planned a priori. As services are deployed dynamically, the corresponding agreements are also made in a dynamic fashion, which can be supported by smart contracts.

Synchromodal dynamic routing logic has been established in D1.8, which includes a capacity booking logic that allows flexibility in dynamically adapting routing to changing circumstances. The associated algorithm will be converted into open source code and released in the Open Source Library (WP4).

Test Dynamic demand management and pricing where the delivery of logistics services is synchronized with actual customer demand. Smart contracts come into play here by tuning customer demand and the optimal use of logistics services in a dynamic way.

The Synchromodal dynamic routing logic includes the necessary reservation of capacity to accommodate customer service level, which comes at a cost. The algorithm determines for a required service level the reservation costs. This comes down to determining the cost of reliability.

What remains to be done is (1) designing a Blockchain enabled process flow accommodating dynamic routing through a Synchromodal network using smart contracts, and (2) testing this process flow in either a simulated environment or a real environment in LL2. We plan to establish Blockchain enabled process flow accommodating dynamic routing through a Synchromodal network using smart contracts, and test this process flow in either a simulated environment or a real environment in LL2.

Explore the capabilities needed to transform PoR into an PI Hub.

This would be a concluding reflection on how PoR would engage in such developments and could be accommodated by means of stakeholder consultation. We plan to perform a stakeholder consultation to sketch how PoR could be transformed into a PI hub.

4.2 Use Case 2: potential for Eurasian rail freight expansion through streamlining information flows

4.2.1 Future Measures Specification

The stakeholders of LL2 mainly UIRR and its subcontractors HUPAC and VTG will define which of the identified problem areas can be addressed most sufficiently and adopted so the benefits are shared for the whole CT business ecosystem from Europe to China on the selected routes. The measures are targeted to achieve (intermodal) rail traffic growth, TEN-T utilization and support of EGTN.

The measures can comprise the following elements or combinations thereof:

1. Organizational and regulatory harmonization
2. Establish and utilize standards
3. Selection of IT platforms

The likelihood of adoption is the core element of the assessment and prioritization of the measures based on the collected insights from past transport volumes, hurdles and insights from the interviewed and surveyed experts. The current political situation is of high relevance regarding the adoption of a cross-regional approach between EU, Russia and China. The likelihood of the adoption of full scale demonstrator has greatly diminished during the cause of 2021. Therefore, the goal remains the same but the scoping and phasing was revised.

The interviews with the project partners are finished (1.) and the UIRR member questionnaire based on these results is finalized (2.) (see Figure 9). The platform workshop was held in June and results are integrated (3).

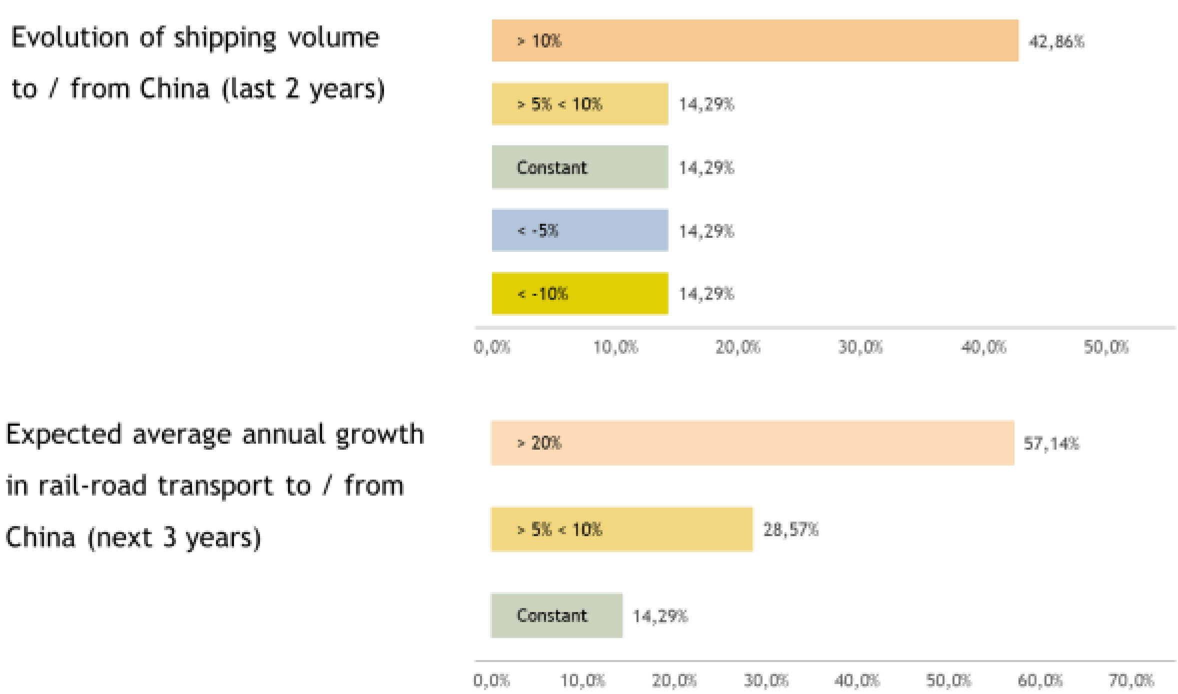

Figure 9. UIRR member survey results (June 2021)

The break-out session during the UIRR platform workshop (23.06.21) on documents exchange confirmed the findings from (1) and (2) (see Figure 10):

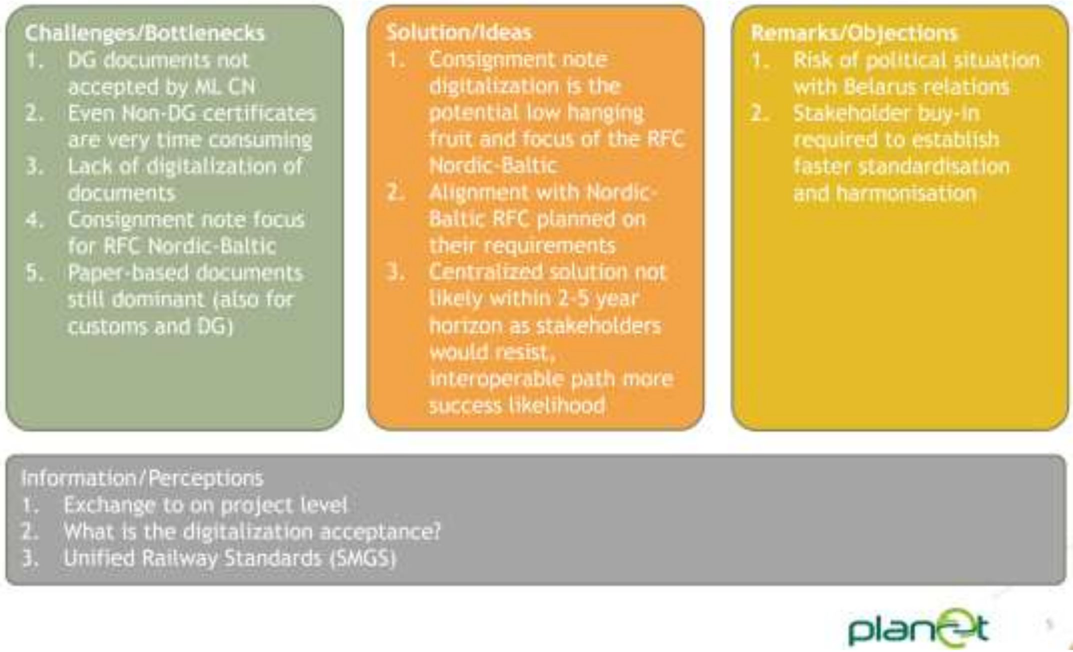

Figure 10. Break-out session results from UIRR-Planet workshop 23.06.2021

The identified demonstrator case options that were ranked by UIRR members and during the International Platform workshop are the following:

Name	Description
CO2 calculator	Calculation of CO2 benefits of rail for international routes vs air vs sea
Customs document interoperability facilitation	Speed-up customs processing at the transshipment points through a higher degree of digitalization and standardization. Include insurance.
Commercial document interoperability facilitation	Improve processing speed through agreeing on the same or convertible document structure (international consignment note & DG & non-DG documents)
Semi-trailer	Use of semi-trailers for EU-CN or partial only? Intermodal solutions (e.g. battery powered & power generation reefers) for 1520-gauge
Tracking & Tracing	Improved T&T (incl. ETA) for trimodal transit from EU to CN (incl. timetables); temperature monitoring.

Booking platforms	Missing end-to-end booking system compared to air or sea freight
Digital maintenance	Asset management, maintenance etc. for 1520-gauge, temperature monitoring

Table 4. Overview of digital innovation potentials for use case 2

The total transit time reduction goal is 3-5 days at economically viable costs and service frequency. This can only be achieved by a combination of measures (see list above).

Key assumptions for the selection of the LL2 Use Case 2:

1. The change can be implemented within the control of the key partners and the directly involved stakeholders
2. The results are practical and measurable
3. High potential to survive the pilot phase and high ability to roll-out to a wider scope than the demonstrator alone

Name	Description	Synchro-modality	Integr. Green EU-Global T&L Network	Interoperability innovation	New techno-logy	Growth (mid / long)	Economic viability & svc quality	Political change
1) CO2 calculator	Calculation of CO2 of intern. rail vs air vs sea	0	++	0	++	+	0	+
2) Customs document interoperability facilitation	Speed-up customs processing at the transshipment points	+	+	++	++	+	+	+
3) Commercial document interoperability facilitation	Improve processing speed structure (intern. consignment note)	+	+	++	++	+	+	+
4) Semi-trailer (partial)	Use of semi-trailers for EU-CN or partial only?	+	+	+	+	+	+	0
5) Tracking & Tracing	Improved T&T (incl. ETA) trimodal transit from EU to CN	++	+	++	++	+	+	0
6) Booking platforms	Missing end-to-end booking system vs air or seafreight	++	+	++	++	+	+	+

Legend: ++ very strong + positive, 0 neutral, - negative impact, -- very negative impact

Table 5. Preliminary assessment of identified IT innovation levers to foster shift-to-rail (by project partners)

Selection criteria for pilot case:

- High growth potential (e.g. leverage shift-to combined transport)
- Interoperability innovation potential (attractive offering to be expanded)
- Nucleus to build major changes for chosen route and others
- Economic viability & service quality
- Implications for political change (e.g. harmonization of document languages)

The contribution to the goals of the LL2 are shown in an intermediate draft that is not yet fully aligned with all partners and will be adapted based on the insights from the questionnaire and the international platform workshop (see figure below).

The resulting choice of the collective input was to focus on the document interoperability scenarios (2) and (3). The LL2 UC2 members focused on the design of a document exchange platform (DXC) and its requirements engineering for the chosen trade lane EU – RU – CN.

4.2.2 Requirements Definition and IT System Design for Document Exchange Service

The chosen demonstrator will focus on the digital facilitation of the document exchange service (DXS) between the different stakeholders. The approach was chosen to allow a low entry barrier in a year 2022 that is politically difficult for closer collaboration between EU – Russia and China. This external factor leads to a re-assessment and consequentially a lowering of the adoption rate on the Russian and China stakeholder side.

Despite the chosen blockchain-based solution should have advantages for future data sharing between EU, Russia and China due to the distributed storage of the data the demonstrator will be limited to the EU stakeholders as initial user group with EU due to the political hurdles (see Figure 11):

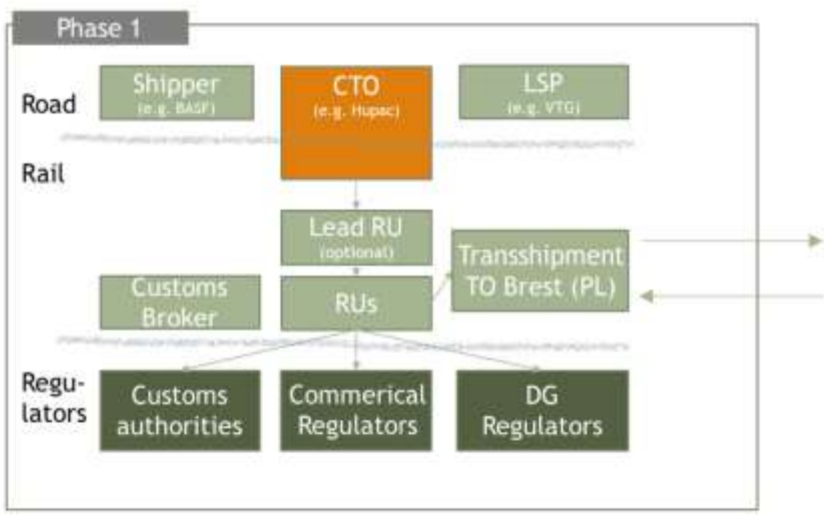

Figure 11. Planned initial stakeholder groups of Phase 1

Future target stakeholder development will be the extension of stakeholders to RU and China[7]. The functional scoping of the solution is depicted below (see Figure 12):

[7] Phase 2 to include Russia and Phase 3 to include China are not in the scope of the Planet demonstrator due to the low likelihood of sufficient adoption within the project lifetime resulting from little stakeholder willingness to advance inter-regional digitalisation.

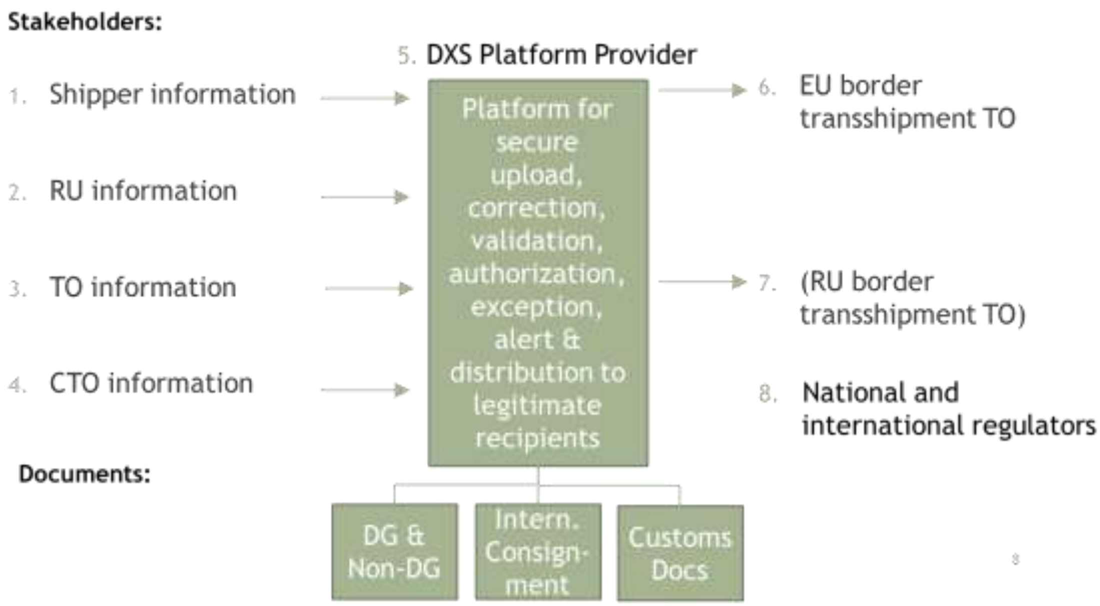

Figure 12. Functional overview of the DXS platform

The functional scope of phase 1 covers the following document types that are shared between the different stakeholders:

#	Document Class	Document Type
1	Commercial documents	Commercial invoice
		Signed consignment note (CIM & SMGS)
2	Logistics documents	Packing list
3	Customs documents	Export declaration (MRN)
		Certificate of Origin
		T1 (westbound)
		Pro-forma invoice
4	Dangerous Goods	Non-DG and DG declarations
5	HS category specific documents	
	Plants and plant protection	Phytosantitary certificate
	Animals	Veterinary certificate

Table 6. Overview of the DXS document types

The flow of the to be DXS allows the originator of the respective document to upload it to the relevant route and defines the rights for the other users of the DXS. As the figure below illustrate the envisioned interplay that is facilitated (only the documents of the possible originator depicted and the received documents are not depcited):

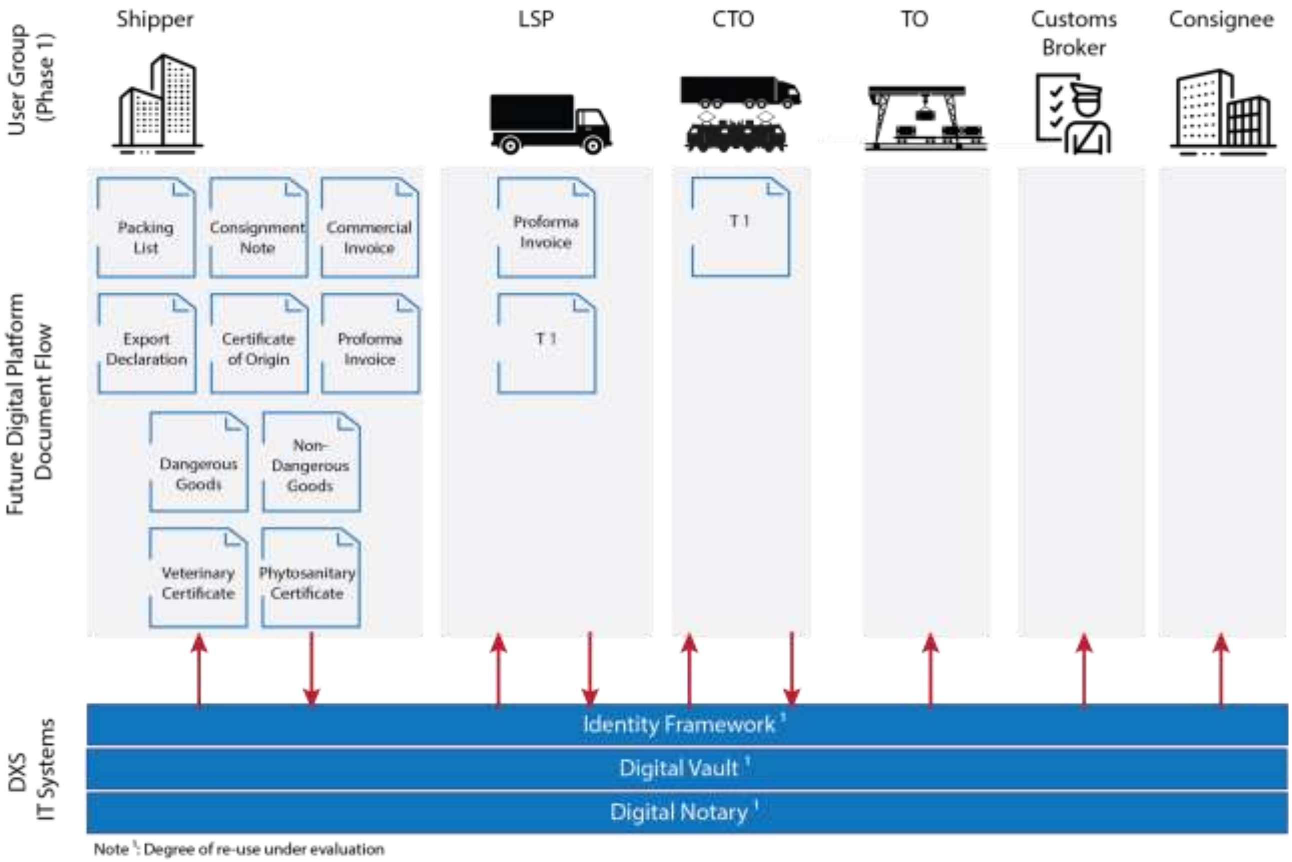

Figure 13. First draft of envisioned functional and document coverage of LL2 UC2 in Phase 1

Compared to today's exchange of e-mails the logically centralized but physically decentralised secure storage has several advantages:

1) Completeness check is possible to allow for preventive actions
2) Higher level of security possible
3) Ease of checking the validity and consistency of documents by human experts

4.2.3 Implementation and Adoption Management

The implementation, adoption facilitation and sign-off of the demonstrators by the project partner and potentially additional stakeholders are the key result of this phase. Possible demonstrator scenarios that have been deselected were facilitated customs processes, harmonized wagon types, infrastructures, common booking processes or digitalized documents and processes.

The implementation will include the solution design, testing and adoption management. Specific plans will be developed once the chosen measures and scoping are finalized.

4.3 Use Case 3: implications for European corridor planning of the expansion of new trade routes

4.3.1 Increasing Eurasian rail freight transport

For the R-ALP area, the estimated Eurasian rail freight flows that apply to the R-ALP area will be listed, showing the destinations of these flows and the terminals that are used to facilitate these flows (indicating their potential to grow given the outcome of the different scenarios). The implications for (first and last mile) through connections in Europe will be assessed, for all modes of transport. An analysis will be performed on the way the cargo is transported from the principal entry point in Europe (i.e. rail terminals and seaports) to its final destination and vice versa. With an increased focus of policy makers and transport operators on the modal shift from road to rail and inland waterway transport, these 'first and last mile' connections within Europe are increasingly becoming intermodal. Intermodal transport in Europe is already highly competitive to road transport over the medium to long distances. This potential model shift of European freight flows is included in the analysis.

The results show the additional transhipment per terminal, for the principal entry points in Europe as well as the terminals facilitating the first and list mile flows in Europe. The results also include the additional potential shift to rail per terminal.

Finally, the implications of these primary terminal-to-terminal flows for railway infrastructure capacity use will be estimated by assigning flows to specific stretches and comparing related capacity use to the infrastructure's overall capacity.

4.3.2 Investments in South European seaports

Intercontinental rail freight is expected to constitute an increasing share of freight flows to and from the R-ALP region. However, Chinese infrastructure investments that affect Europe are seen to be aimed not only at railway connections, but also at seaports and some of their hinterland connections. Examples are the Greek port of Piraeus, a controlling stake of which is now owned by Chinese state-owned COSCO, and plans for upgrading the Belgrade-Budapest railway[8] as well as investments of COSCO in the port of Genoa (Vado Ligure terminal). This raises the question as to whether improved capacity and hinterland connections of *Southern European ports* might significantly shift freight flows away from Northwest European ports, and affect intra-European rail freight flows between Northwest ports and Southern Europe (e.g. between Rotterdam and Italy and vice versa).

Figure 14 shows the competitive hinterlands, or 'catchment areas', of the European seaport regions. The Dutch, Belgian and German ports first and foremost serve the markets of those three countries and parts of France, Switzerland, Italy, Austria and the Czech Republic. Competition with the Mediterranean ports is seen in a relatively limited area. This division is augmented by intra-European rail freight flows (as opposed to import/export flows) from rail terminals located in Northwest European ports to Southern Europe. However, increasing freight flows from South to Northwest Europe would be beneficial by reducing empty wagons running back North from southern destinations as well as reducing total freight kilometres by serving Northern Italian, Swiss and South Germany destinations via Genoa. The PLANET scenarios of this LL and task 1.2 will make clear the extent to which these mechanics can be expected to alter over the decades ahead.

8 www.bbc.com/news/world-europe-41654346

4.3.3 Scenarios

For our purposes, four different scenarios (see figure 15) will be detailed, after which the 2030 and 2050 implications for intra-European seaport competition and related rail freight flows are calculated. The investment scenarios need to consider both investments in the seaports and related terminals as well as those in railway infrastructure specifically in the Italian section. EGTC members Regione Liguria, Lombardia and Piemonte may be available to provide info.

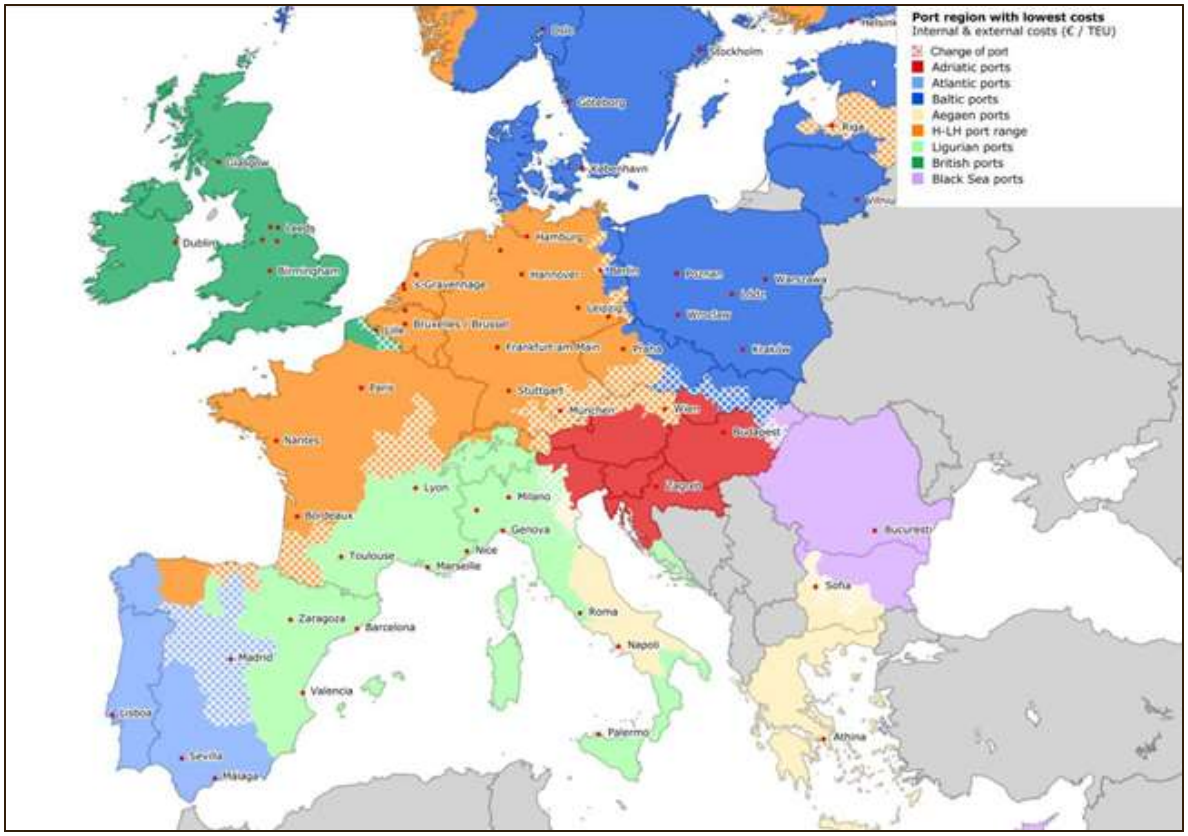

Figure 14. Catchment areas in the European hinterland arranged by port region

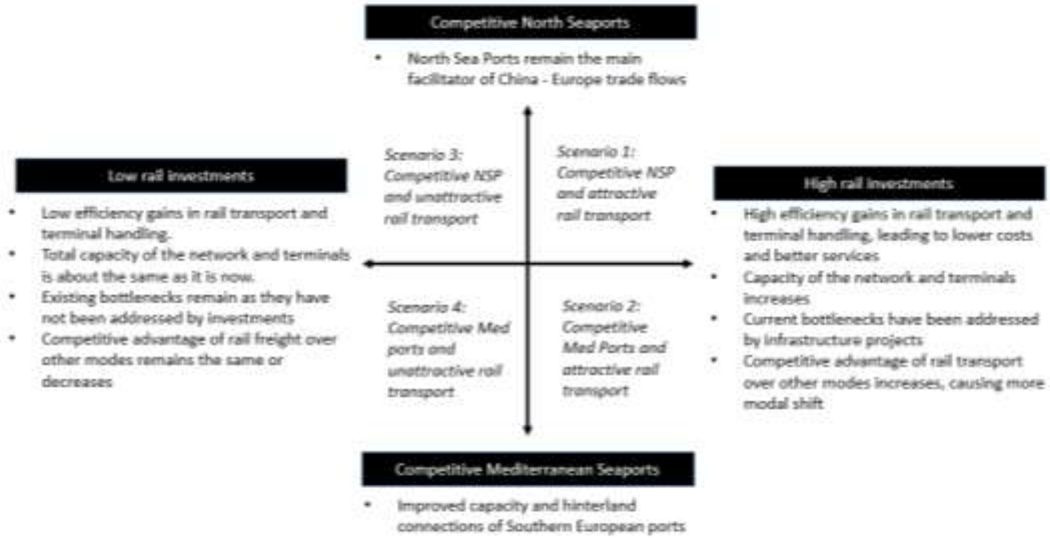

Figure 15. Four suggested Living Lab 2 scenarios.

4.3.4 Modelling work steps

The model that will be used in this living labs is Panteia's Terminal Model[9]. This also the model that is used for T1.2. The steps necessary to carry out the modelling are shown in figure 16.

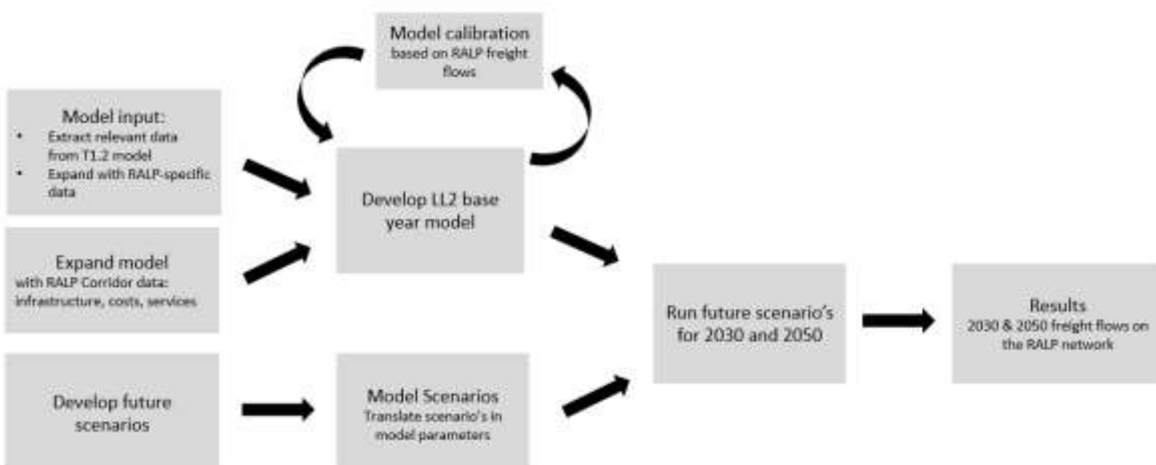

Figure 16. Modelling tasks for LL2

[9] Previously, Panteia's Terminal Model has also been used in 2020 in a study commissioned by the EGTC to investigation of the freight modal shift potential on the Rhine Alpine Corridor.

5 Living Lab 2 implementation

5.1 Use Case 1 implementation

5.1.1 Results Phase 2

Based on the feedback obtained from the first demonstrator, we further extended the demo to include the full customs declaration in order to be able to cover the DAP scenario. This can be further extended to include also the DDP scenario as well as other incoterms. We have piloted the demonstrator with the use of shadow transactions for the DAP scenario between mid-May 2021 and July 2021 in order to assess the business-case. The pilot showed proof for the business cases as identified for stakeholders.

The positive business-case has resulted in the development of an enterprise grade solution inspired by the demonstrator. This solution is called Quayconnect which runs on Port of Rotterdam's Naviporta blockchain platform. On the 7th of December, 2021 the first live transaction was done.

Furthermore, a patent submission inspired on the work done in Phase 2, will be submitted on the 15th of January, 2022.

5.1.2 Attachments

This video of the demonstrator can be found here:

https://drive.google.com/file/d/1EC2xdOVoUrpN06VjdwBBM6Sy7m_7y7DJ/view?usp=sharing

5.2 Use Case 2 implementation

5.2.1 Progress report of phase 1

The interviews with the project partners are almost finished (1.) and the UIRR member questionnaire based on these results is in finalization (2.). The platform workshop content is aligned, participants are in finalization but timing is not yet confirmed (3). The pre-selection of the pilot case and chosen technology approach will only be possible after the activities 1-3 are completed.

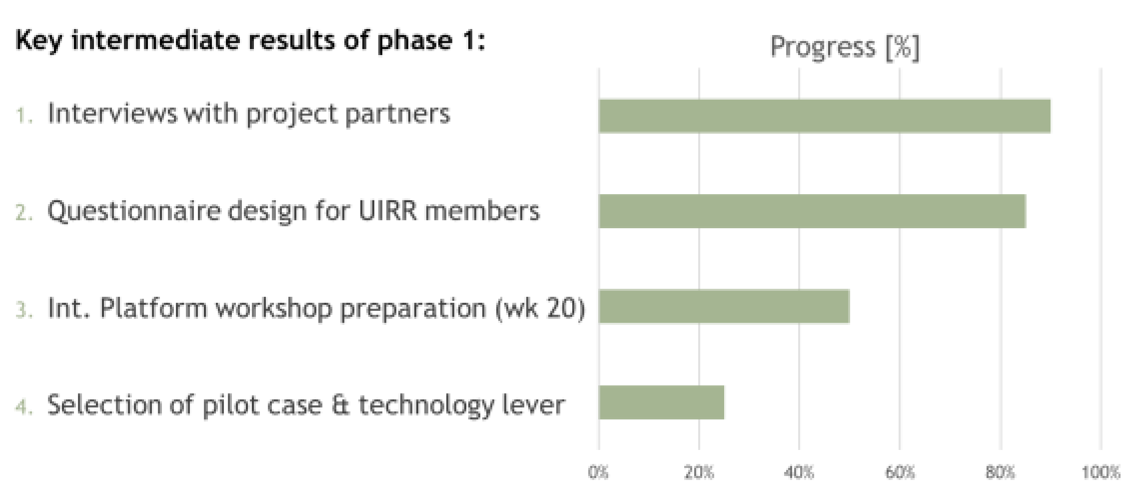

Figure 17. Progress overview for Phase 1

The identified demonstrator case options that will be ranked by UIRR members and during the International Platform workshop are as mentioned in table 7.

The total transit time reduction goal is 3-5 days, economically viable costs and service frequency. This can only be achieved by a combination of measures (see list above).

Key assumptions for the selection of the LL2 Use Case 2:

4. The change can be implemented within the control of the key partners and the directly involved stakeholders
5. The results are practical and measurable
6. High potential to survive the pilot phase and high ability to roll-out to a wider scope than the demonstrator alone

Selection criteria for pilot case:

- High growth potential (e.g. leverage shift-to combined transport)
- Interoperability innovation potential (attractive offering to be expanded)
- Nucleus to build major changes for chosen route and others
- Economic viability & service quality
- Implications for political change (e.g. harmonization of document languages)

The contribution to the goals of the LL2 are shown in an intermediate draft that is not yet fully aligned with all partners and will be adapted based on the insights from the questionnaire and the international platform workshop (see Table 7).

Name	Description	Synchro-modality	Integr. Green EU-Global T&L Network	Interoperability innovation	New techno-logy	Growth (mid / long)	Economic viability & svc quality	Political change
1) CO2 calculator	Calculation of CO2 of intern. rail vs air vs sea	0	++	0	++	+	0	+
2) Customs document interoperability facilitation	Speed-up customs processing at the transshipment points	+	+	++	++	+	+	+
3) Commercial document interoperability facilitation	Improve processing speed structure (intern. consignment note)	+	+	++	++	+	+	+
4) Semi-trailer (partial)	Use of semi-trailers for EU-CN or partial only?	+	+	+	+	+	+	0
5) Tracking & Tracing	Improved T&T (incl. ETA) trimodal transit from EU to CN	++	+	++	++	+	+	0
6) Booking platforms	Missing end-to-end booking system vs air or seafreight	++	+	++	++	+	+	+

Legend: ++ very strong + positive, 0 neutral, - negative impact, -- very negative impact

Table 7. Preliminary assessment of identified IT innovation levers to foster shift-to-rail (by project partners)

5.3 Use Case 3 implementation

In order to analyse the impact of Eurasian rail on freight flows in the RALP region, the PLANET model is used. This model, based on one of Panteia's in-house models, is specifically developed to simulate the impact of Eurasian rail on the European transport network. The model can simulate containerized cargo flows between China and Europe for different types of commodities. It uses complex intermodal networks (rail, road, inland waterway, maritime, first- and last mile connections and transhipment points) to estimate intercontinental and inter-European trade flows. The properties of the PLANET model have already been described in D1.2.

Figure 18 shows a snapshot of the network and transhipment points on the RALP region included in the model. The grey area constitute the NUTS3 regions covered by the RALP TEN-T corridor. On top of the network is a layer of transport services between the transshipment points using the transport network.

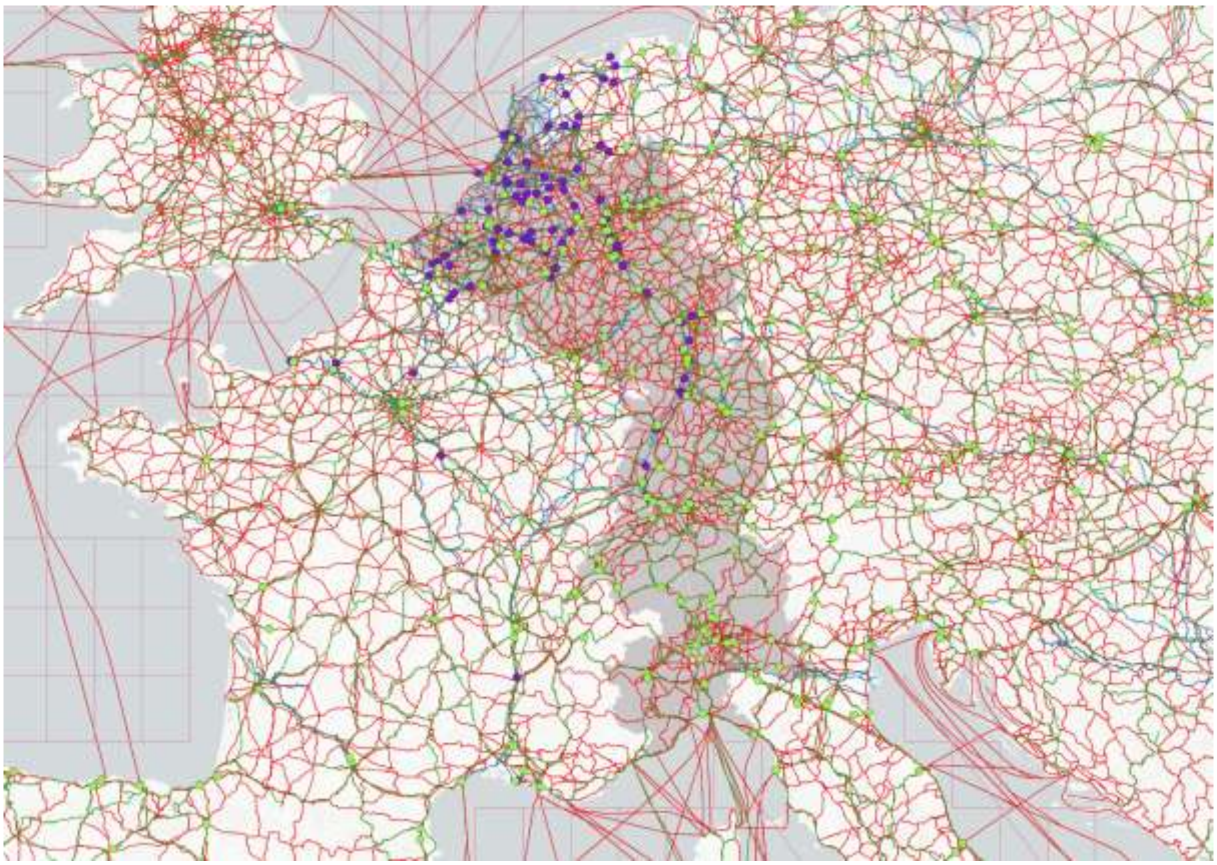

Figure 18. Snapshot of the network and transhipment points used in the use case 3 modelling exercise

Eurasian trade enters Europe through Principal Entry Points (PEPs). In the baseline model a total of 9 rail PEP and 31 sea PEP are defined, which together handle almost all trade with China. The PEPs located on the RALP are shown in Figure 19. Trade entering the RALP corridor through these seaports and rail terminals form the basis of the analysis. While trade may also enter the RALP area via other PEPs that are close by the RALP corridor such Marseille, Dunkerque, Le Havre and Hamburg, impact on of freight flows through these nodes on the infrastructure in the RALP region is limited and therefore not considered in the analysis. The main focus of the analysis is the infrastructure belong to the RALP Core Network Corridor as defined in the TEN-T Regulation. The road, rail and IWW network of the RALP Corridor is also shown Figure 19. Similar to D1.2, the baseline year of the model is 2019. This is the last year in which the transport flows have not been disrupted by the corona crisis, and therefore provide a realistic picture of the normal situation. As we do not yet know which changes in the transport system are permanent as a result of the corona crisis, these have been left out of consideration.

Figure 19. RALP PEPs and Core Network Corridor Infrastructure

5.3.1 Baseline results

The baseline results of the PLANET model is shown in table 8. In total, 98% of total container imports from China come via seaports, while 2% come by rail to the RALP region.

	PEP	TEU (x 1.000)
Rail terminals	Tilburg RT	17
	Liege RT	6
	Duisburg RT	45
	Gent RT	9
Seaports	Antwerpen	1.250
	Rotterdam	1.550
	Genova	750

Table 8. Total imported containers (x 1.000) from China to Europe through the RALP PEP, baseline scenario (year 2019)

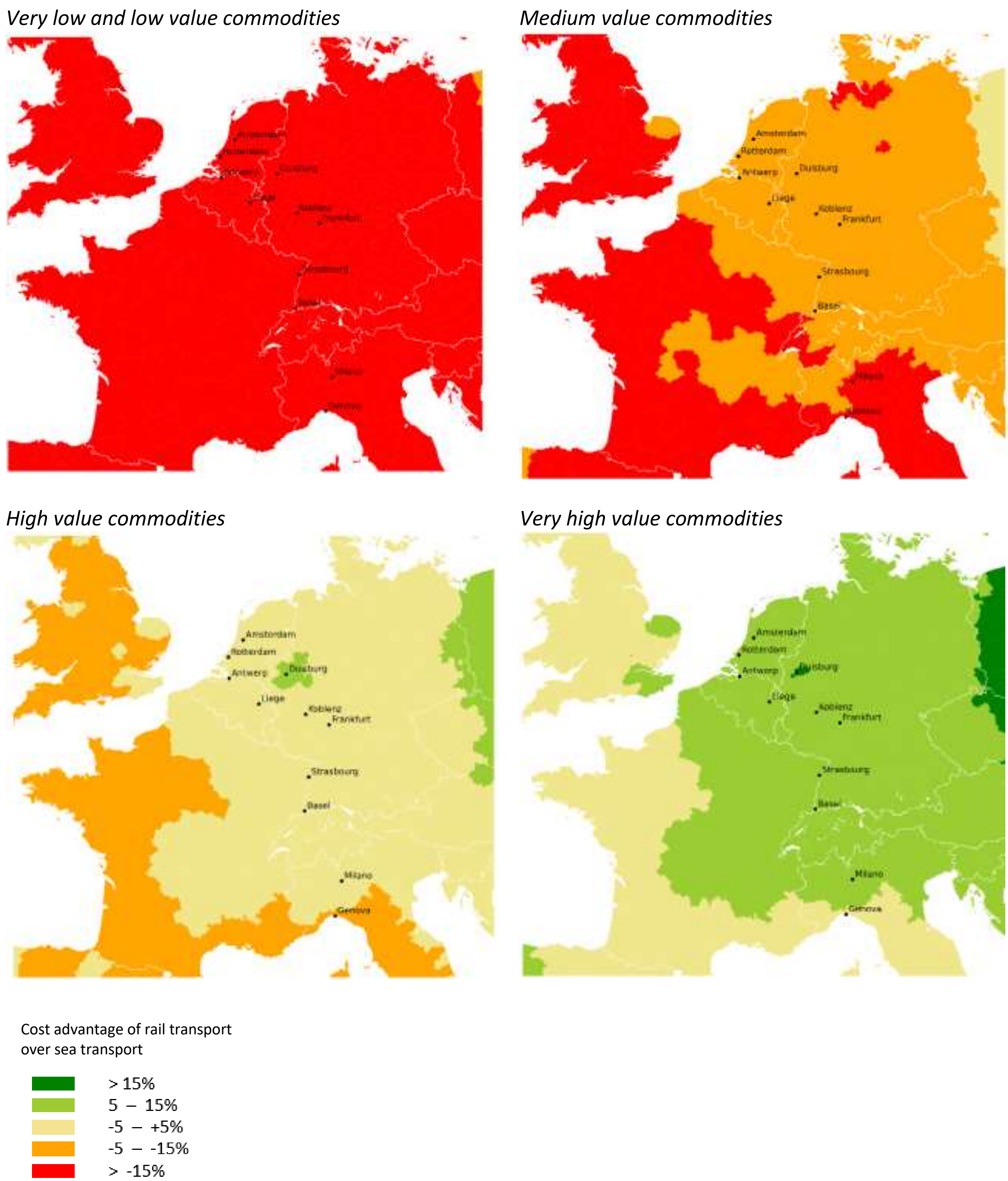

Figure 20. Costs advantage of Eurasian rail transport over sea transport between Chengdu and the RALP region for different type of commodities

The model shows in which situations rail transport from China is interesting from a cost/time perspective. The areas that are likely served by Eurasian rail transport differ per commodity type and region of origin. The more expensive the commodity, the more the shipper is willing to pay for a faster modality. Goods from the interior of China are also more likely to qualify for rail transport because there is no long transport leg to one of the seaports. Goods from Chengdu, for example, can be put on the train to Europe and thus save about 1.800 kilometers in transport costs through China to a Chinese seaport.

The costs difference between land and sea transport between Chengdu and the RALP region for different commodity types is shown in Figure 20. Between these two regions, Eurasian rail transport is competitive for high and very high value goods. This applies especially to the northern part of the corridor, which is well connected to China, especially via Duisburg. The southern part of the RALP region, in particular around the Genova seaport, is not always attractive, even for high-value goods, as there is no fast land connection with China.

If the origin of goods in China is closer to seaports, Eurasian rail transport becomes less attractive. Figure 21 shows the costs difference between land and sea transport between Shanghai and the RALP region. Even for very high value goods, Eurasian rail transport is hardly attractive due to the change in first mile costs in china in favor of sea transport.

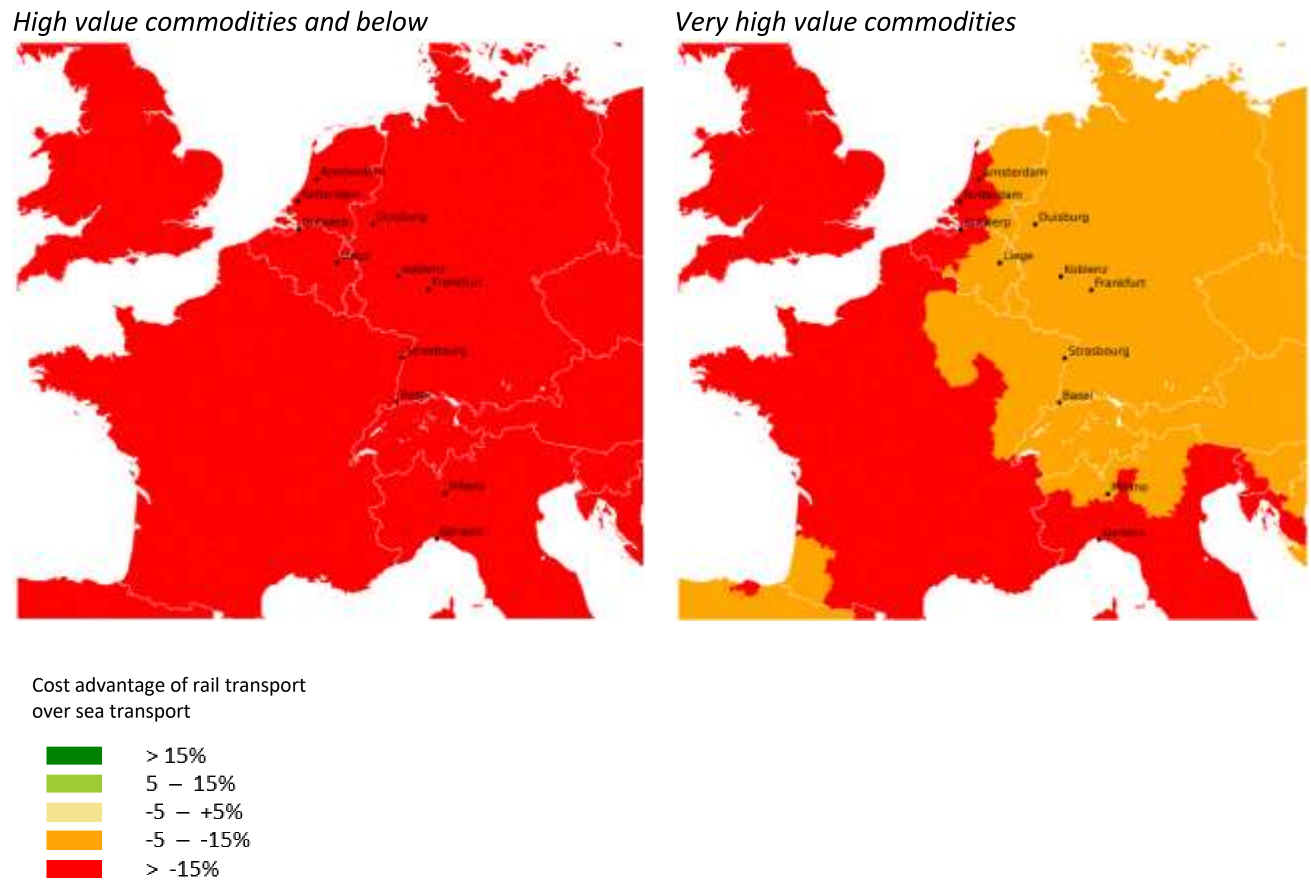

Figure 21. Costs advantage of Eurasian rail transport over sea transport between Shanghai and the RALP region for different type of commodities

The model also provides insight into the hinterland served by a PEP. The hinterland, defined at a NUTS3 level, is assigned to a PEP if transportation to this region is most attractive through this particular PEP. The hinterland of a PEP depends on the specific connections between china and the RALP region.

Figure 22 shows the hinterland belonging to PEPs for trade of very high-value goods between Chengdu and the RALP region. In the base year 2019, Chengdu mainly served Duisburg, Tilburg, and Lodz, hence the hinterland of this PEP on this connection is the largest. The hinterland of Hamburg, Malasewice, and Madrid is also shown on the map. From Xian, a rail connection to these terminals exists. First mile transport in China through the Xian terminal to these three terminals is more economical than going through Chengdu and Duisburg, Tilburg or Lodz,

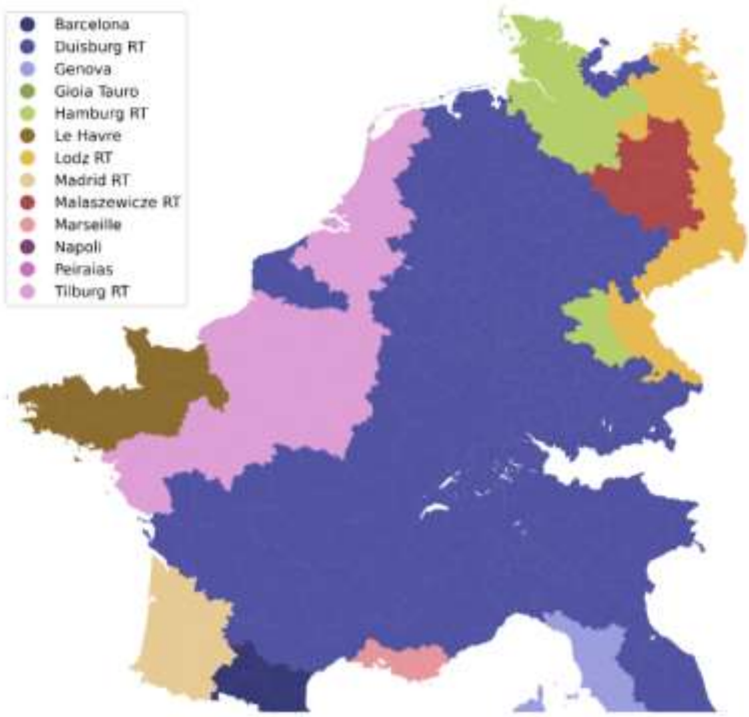

Figure 22. Hinterland area per PEP or trade of very high-value goods between Chengdu and the RALP region

The hinterland served by PEPs changes per region of origin in China. Figure 23 shows the hinterland of PEPs for very high value goods coming from Shaanxi Province, in which the Xian rail terminal is located. From this terminal there is a frequently used rail connection to Duisburg, Hamburg, Gent, Madrid and Malaszewice.

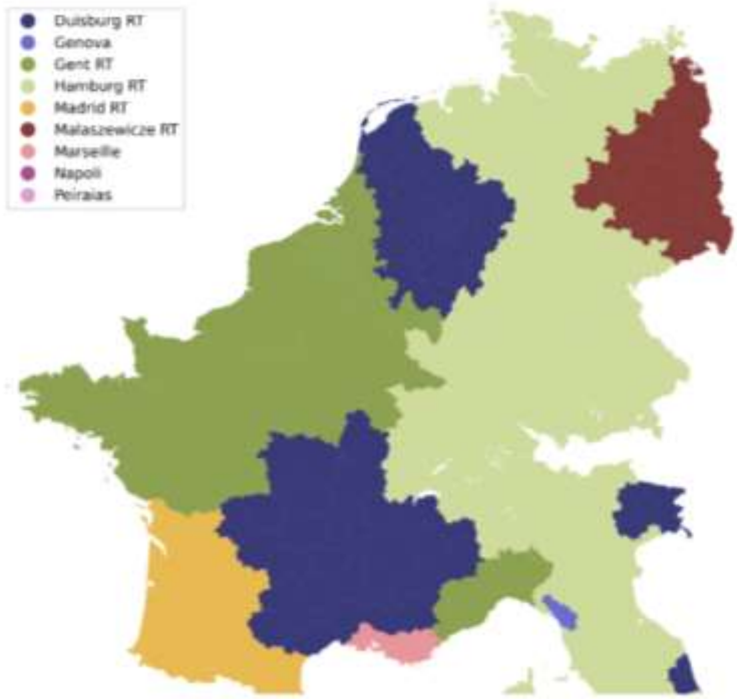

Figure 23. Hinterland area per PEP or trade of very high-value goods between Shaanxi and the RALP region

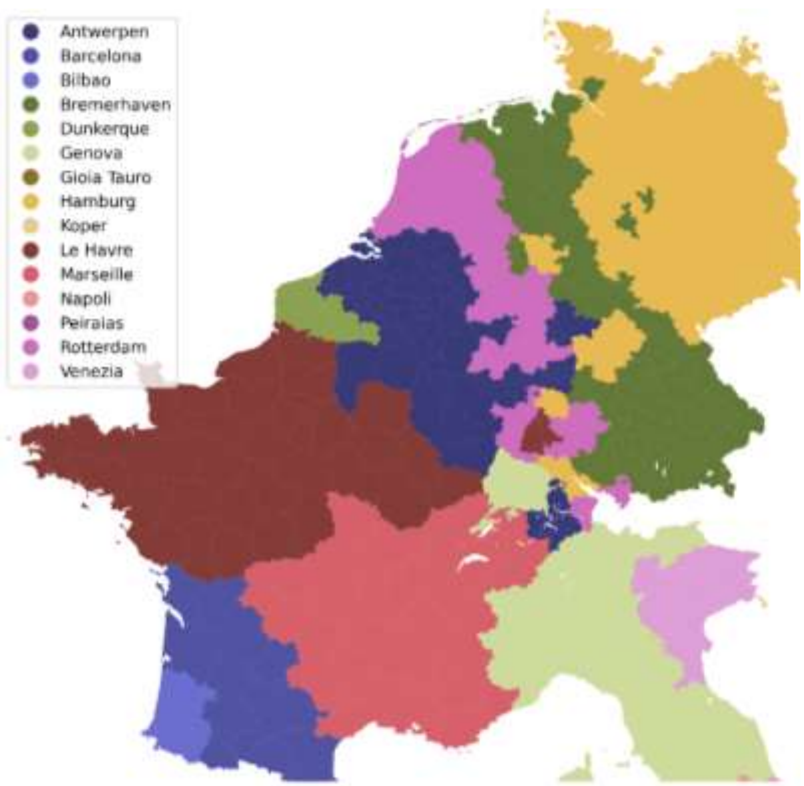

Figure 24. Hinterland area per PEP or trade of low-value goods between Shanghai and the RALP region

The previous two figures showed the hinterland of high value goods. It is also noticeable that the areas around the seaports are still attractive for maritime transport. The short distance to the terminals located in the interior of Europe means that maritime transport is still competitive for these types of goods.

Once the location of origin in China is closer to the Chinese coast, the hinterland of European rail terminals loses attractiveness. The following figure shows the hinterland of high value goods for trade between Europe and Shanghai Province. Maritime transport remains the most attractive options for trade with China's coastal provinces.

5.3.2 Network impact

The transport flows depend on the region of origin, the value of the goods and the presence of train connections. Based on the flows of goods, the impact or the network can be analyzed.

In contrast to intercontinental transport, the model does an all-or-nothing allocation for hinterland transport. For the transport from the PEP to the NUTS3 region, one modality is chosen: inland navigation, rail or road. This data is subsequently calibrated on the basis of the actual modal split of the hinterland transport in the PEP. For example, if the model estimates too much rail transport from a PEP to its hinterland, excess rail transport is allocated to road transport or to inland navigation, until the modal split of the PEP corresponds to observed modal split. In this way, we get a realistic picture of the hinterland flows.

The observed modal split per PEP are derived from Mueller et al (2020) and European Parliament (2015). No such data was available for the rail PEP, therefore a minimum share of hinterland transport by road of 50% is assumed, based on the observed minimum of the modal split in seaports. Fortunately, no such correction needed to be applied to the rail PEP, demonstrating the robustness of the model estimates. The following table shows the modal share for the PEP rail terminals and seaports on the RALP corridor.

PEP	Rail	Road	IWW
Rail terminals	29%	71%	-
Seaports	12%	62%	26%

Table 9. Model estimated modal split of hinterland flows for the RALP PEP

From the modal split, the traffic in amount of trucks, barges and trains[10] generated by Chinese imports entering the RALP region can be estimated. This is shown in Table 10.

	Per year	Per week
Trains	7.800	150
Trucks	1.500.000	29.000
Barges	4.600	90

Table 10. Estimated amount of trucks, barges and trains generated by Chinese imports entering the RALP region

[10] Assuming an average of 60 TEU per train, 1.5 TEU per truck and 200 TEU per barge

Subsequently, the estimated traffic can be projected on the infrastructure. The following figures show the rail, road and iww flows on the RALP corridor.

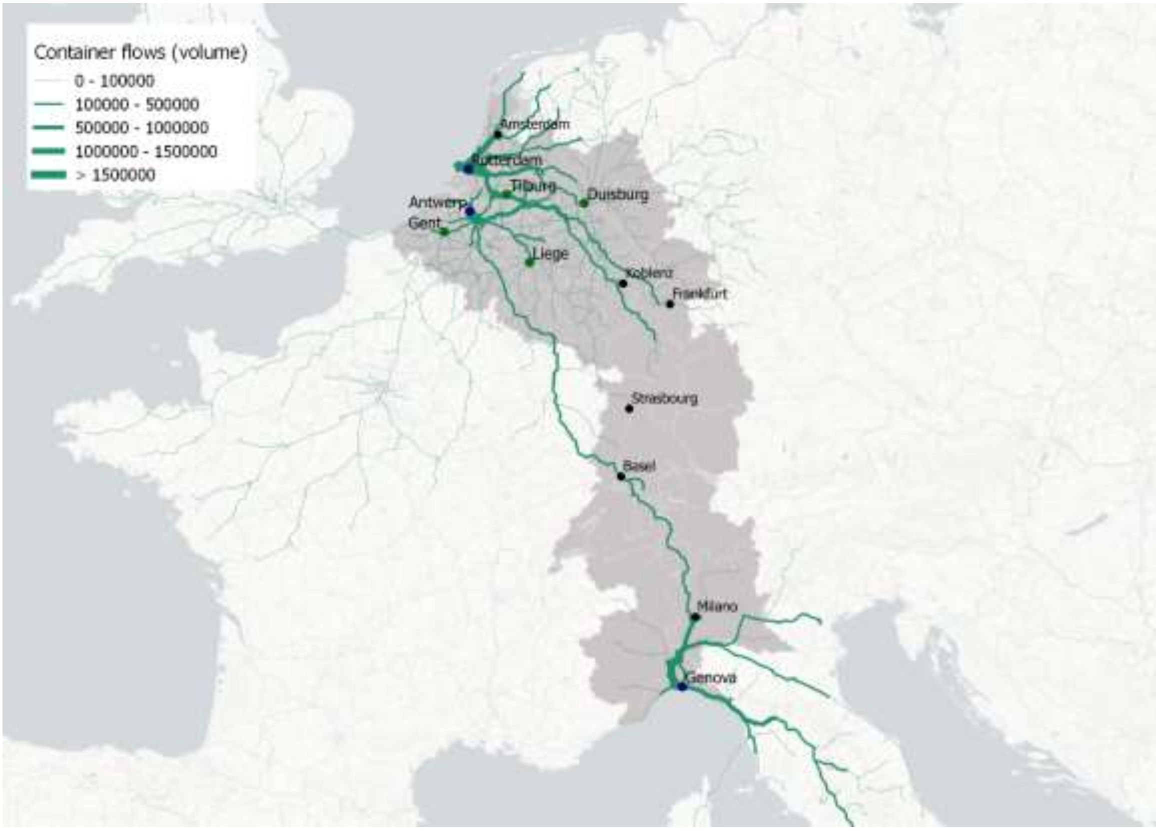

Figure 25. Modelled container flows from the RALP PEP to the hinterland via road (excluding last-mile transport)

Figure 26. Modelled container flows from the RALP PEP to the hinterland via rail

The estimated flows on the network can then be compared with existing traffic flows. This data is available through research conducted on behalf of the European Commission on the status of the European TEN-T Corridor network. The latest data is available for the year 2016 and is shown in the following figures.

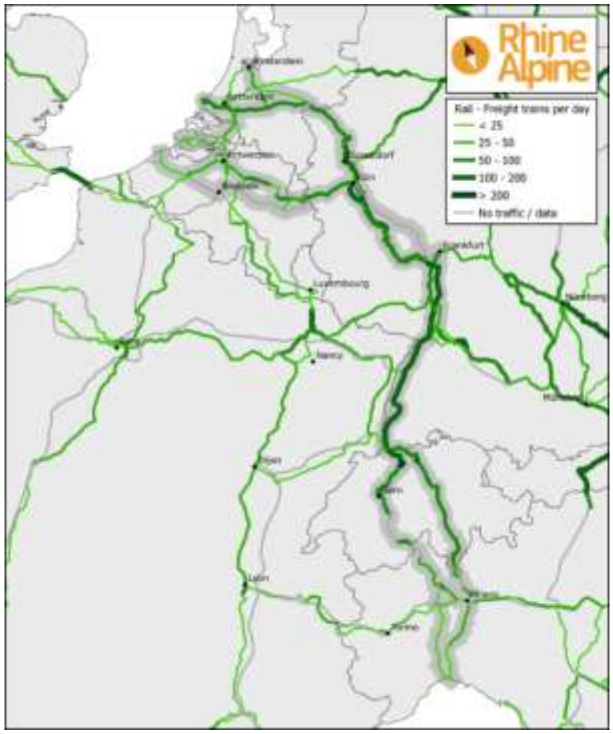

Figure 27. Freight trains per day on the RALP corridor, year 2016

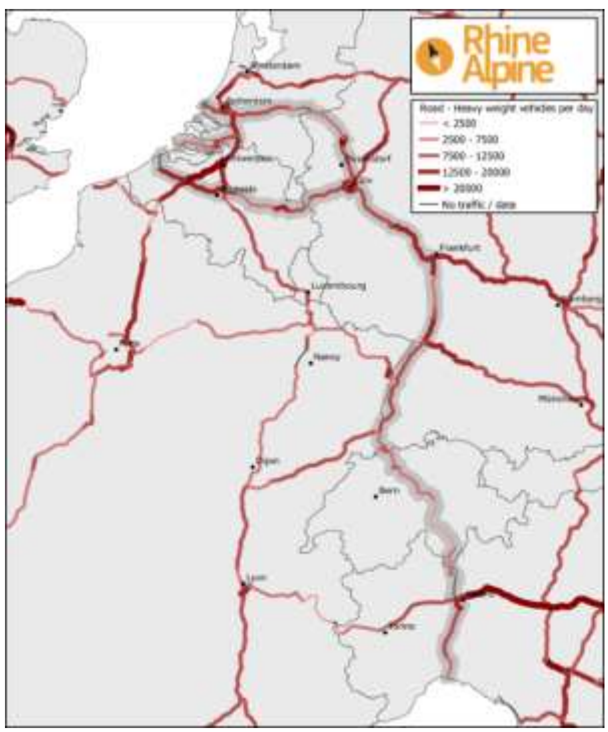

Figure 28. Heavy duty vehicles per day on the RALP corridor, year 2016

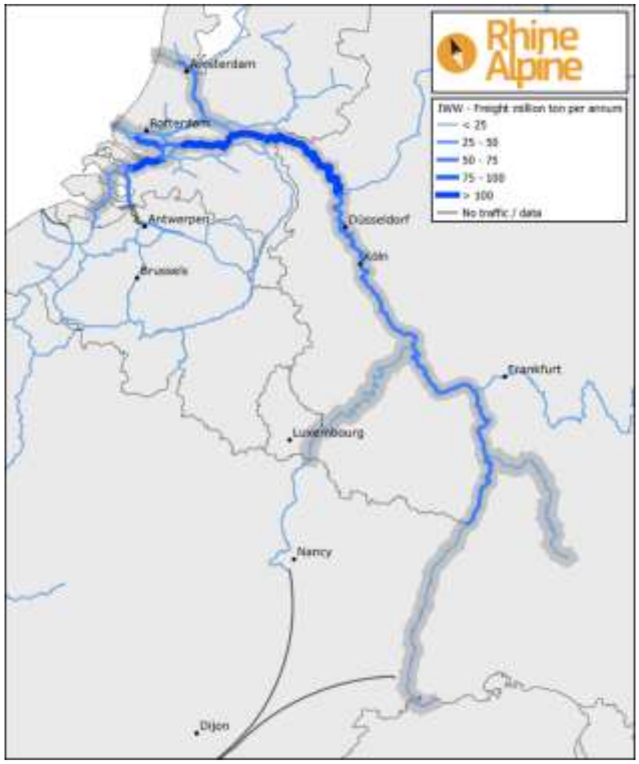

Figure 29. Freight flows on the RALP IWW network in million tons per annum, year 2016

5.3.3 Next steps

This section has shown the model results of the baseline scenario. The analysis is carried out based on these results. The analysis will look at the impact of the increasing Eurasian rail traffic on the RALP network for the years 2030 and 2050 using different scenarios. These results are then compared with the other traffic on the RALP corridor to identify potential bottlenecks. This follow-up exercise will be carried out during the next phase of the project.

6 Impact assessment of actions and adopted innovations

6.1 Use Case 1

Detailed impact assessment is foreseen for the next deliverable, in which the final results of the innovation action will be presented. For the final impact assessment, the 'SCOR' model will be used, which provides KPIs for specific (sub)processes and which was previously used by Blocklab to identify the potential impact of blockchain on transport processes.

Financially, there's a number of cases to be made for digitization:

- Fresh produce cargo depreciates rapidly in value; 10%-15% reductions per day are quite common. Digitization of paperwork reduces waiting time and congestion, for example when digitizing phytosanitary and veterinary certificates;
- According to Tan Chong Meng, the chief executive officer of PSA International, the Singapore based terminal operator, 30% of food production is wasted before reaching consumers due to "logistics failures" which are avoidable by digitalization;
- By sharing data electronically cargo can be shipped more efficiently. Research from TNO and TU Eindhoven has shown that by combining transports the number of empty kilometers is reduced by 15% and 13% fewer trucks are needed;
- By linking the (customs) information flow with the information from the physical flow by means of the eCMR authorities have better visibility over the flow of goods.
- Recent research conducted as part of the Deliver[11] project, shows a reduction of approximately €25 in labor costs per shipment per entity involved in the supply chain. According to data from the Port of Rotterdam, it takes on average 29 parties to ship a container from the hinterland of China to the Western European hinterland.
- Pilot with ABC Logistics showed that the cost of customs clearance to the UK could be reduced by between 40% to 50%. See also: https://www.linkedin.com/feed/update/urn:li:activity:6863772426753335298

Supply chain management objectives and the scor reference

Model

As blockchain technology research has up to now predominantly focused on technological questions of design and features, while neglecting applications, value creation and governance (Risuas & Sphohrer, 2017), there's for supply chain management practitioners little to go by in terms of practical guidance for blockchain technology adaptation in the supply chain. To bridge that gap, we have developed a framework, based on the SCOR model that links blockchain roles and mechanisms to supply chain management objectives.

The framework for analysis has focused on the process elements as the unit of analysis for as far as the Plan, Source, Make, Deliver, and Return processes are concerned. For the Enable process, our unit of analysis was the process category, primarily because for most of the Enable process elements[i] no metrics were defined on the process elements level.

Example

[11] DELIVER is a blockchain platform developed jointly by Port of Rotterdam, ABN-AMRO and Samsung SDS for global trade and logistics.

The model is best illustrated using an example. See Table 11 for (a subset of) the SCOR Distribution Process.

PROCESS		DESCRIPTION	BLOCKCHAIN'S ROLES	MECHANISMS INVOLVED	METRICS AFFECTED	
sD1. 1	Process Inquiry and Quote	Receive and respond to general customer inquiries and requests for quotes	Provide order tracking data.	Detection, measurement and tracking of inventory with IoT	RS.3. 100	Process Inquiry & Quote Cycle Time
					CO.3. 14	Order Management Costs
			Blockchain's serves as a single consensus based source of truth.	Transaction data can be validated by Oracles before being permanently added to the blockchain.		

PROCESS		DESCRIPTION	BLOCKCHAIN'S ROLES	MECHANISMS INVOLVED	METRICS AFFECTED	
sD1. 2	Receive, Enter and Validate Order	Receive orders from the customer and enter them into a company's order processing system. "Technically" examine orders to ensure an orderable configuration and provide accurate price. Check the customer	Elimination of paper records.	Cost-effective transmission of transactions in peer-to-peer networks (Korpela, Hallikas, & Dahlberg, 2017).	RL.3. 33	Deliver Item Accuracy
					RL.3. 34	Delivery Location Accuracy
					RL.3. 35	Delivery Quantity Accuracy
					RS.3. 94	Order Fulfillment Dwell Time
					RS.3. 112	Receive, Enter & Validate Order Cycle Time
			Simplify business-to-business integration	Data security and cost-effective transmission of transactions in peer-to-peer networks (Korpela, Hallikas, & Dahlberg, 2017).		
			Enable fully automated order processing ("straight through processing").	Enable fully automated processing ("straight through processing") without human communication of interaction.		

Table 11 Blockchain Roles and Mechanisms

6.2 Use Case 2

The impact is assessed based on the results of the demonstrator, its wider adoption strategy, and transferability to other routes. The degree of digital transformation achievable and the capability improvement towards synchromodality will be addressed based on the findings of the demonstrator. This will be the basis for a fact-grounded proposal of future measures.

The business case focuses on the improvement of rail traffic between EU and Asia including the global flows from the US. Generally, the train traffic EU-CN is rising significantly with a CAGR of on average 85,1%12 since 2014 (see Figure 30).

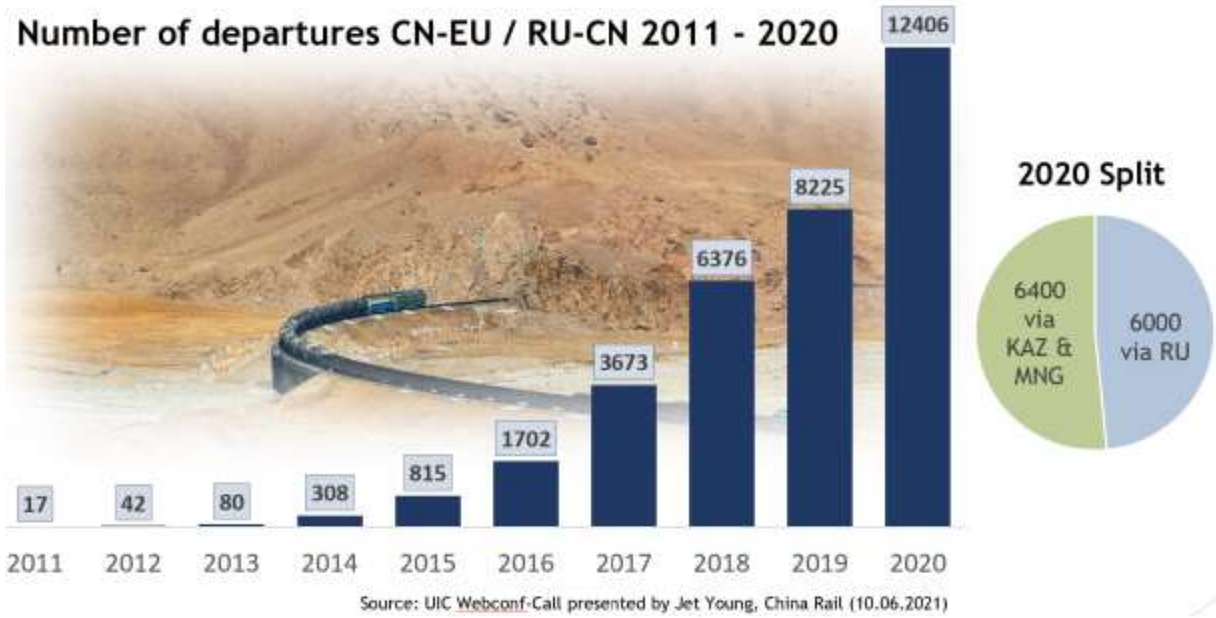

Figure 30. Growth of train traffic EU / RU to CN

The growth of intermodal transport between EU and Asia is significantly growing (see Figure 31):

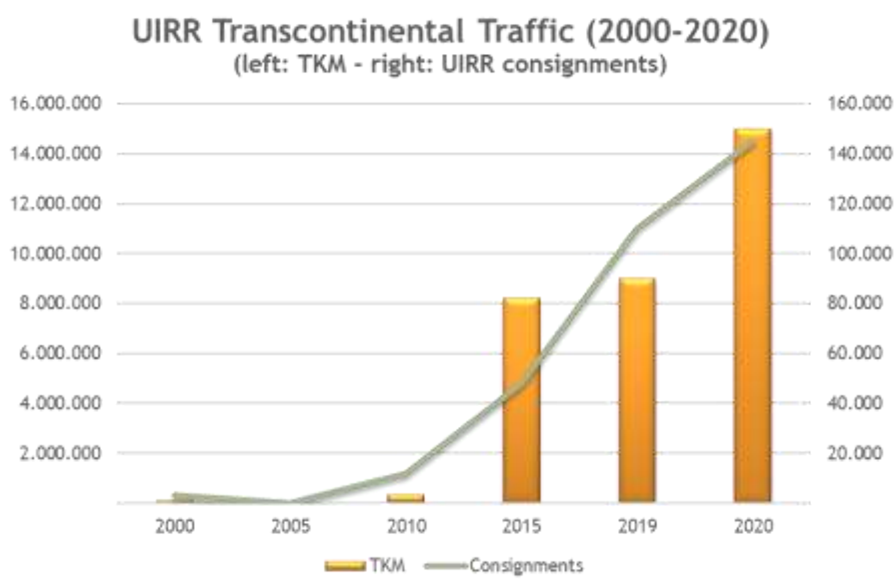

Figure 31. Growth in shipping volume[13]

[12] Similar growth rates of 140,4% have been reported by UIC in a study from 2016 (from 2014-2016) but for a shorter time span and applying the same figures for the years 2014-2016.

[13] Source: UIRR Transcontinental Growth (2021) of traffic from/to TR/RU/CN; UIRR consignment corresponds to the transport capacity of one full size truck on road (equivalent to 2 TEU).

The main mode of transport between EU and China is ocean (more than 90%) but with lower growth rates -2.6% (2019-2020) and 9% recovery (2020-2021)[14].

First and foremost, the business case centers around the enablement of further growth in the railway traffic towards a higher share and modal shift where possible. Economic, technical and organizational feasibility as well as green impact are central business case categories to be evaluated.

The business case details will be elaborated after the choice of the demonstrator measures is finally agreed between the partners and potentially required additional stakeholders.

The business case drivers are multi-fold:

1. Time compression through additional monitoring and exception management activities via digitalization and sharing of information thereby promoting reliability and resilience
2. Additional trade lane capacity via rail through enabling dangerous goods transports via rail
3. Potentially 8-10 days faster and greener transport mode compared to sea. From a distance relation viewpoint rail produces about a third less CO2 emissions as the land link alternative is roughly half the distance; NOx output is 17% of the sea emissions, PMc for particles rail emits is about 18% if the average figures of the University of Delft are applied (see Figure 32)[15]
4. Recent volume increase is at risk due to recently added political and pandemic related resource constraints

Mode	Vehicle/Vessel	Type of freight	CO_2 (g/tkm) (WTW)	PM_c (g/tkm) (TTW)*	NO_x (g/tkm) (TTW)*
Road	Tractor-semitrailer, heavy (2 TEU)	Med.-weight	121	0.003	0.30
Rail	Long train (electric 73%: diesel 27%)	Med.-weight	18	0.0018	0.08
Inland shipping	Rhine-Herne canal (RHC) vessel (96 TEU)	Med.-weight	52	0.019	0.55
	Large Rhine vessel (208 TEU)	Med.-weight	32	0.013	0.34
Maritime shipping	Short-sea: 1,000-1,999 TEU container ship	Med.-weight	32	0.013	0.57
	Deep-sea: 8,000-11,999 TEU container ship	Med.-weight	12	0.005	0.23

* The emission factors for air pollutants provide no indication of the potential health damage associated with the various modes, which depends on where the emissions occur.

Figure 32. Comparison of pollution impact[16]

The business value of the importance of seamless administrative operations especially at the transshipment points to avoid a shift back to sea due to delays and uncertainties can be highlighted by a statement from Jacky Yan, CEO of New Silk Road Intermodal: “If we cannot resolve the congestion issue or the transit time is even

[14] UNCTAD (2021) “Review of Maritime Transport 2021”, p. 15, United Nations, Geneva

[15] Source: https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_190325_STREAM_Freight_Transport_2020_FINAL.pdf

[16] Source: https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_190325_STREAM_Freight_Transport_2020_FINAL.pdf

longer or the same as sea freight, then we'll lose the advantage" [17] in the light of transshipment point congestions end of 2021.

The volume of goods carried on rail from China to Europe increased from 14 million metric tons in 2019, to 24 million metric tons in 2020. Prices increased from $2,000 USD per container in June 2020 to $15,000 USD in July 2021, according to data presented at the European Silk Road Summit held on Dec. 7-8 2021[18]

Current political constraints are likely worsened by process and data interoperability issues demand for activities to counteract and mitigate the potentially downward spiral.

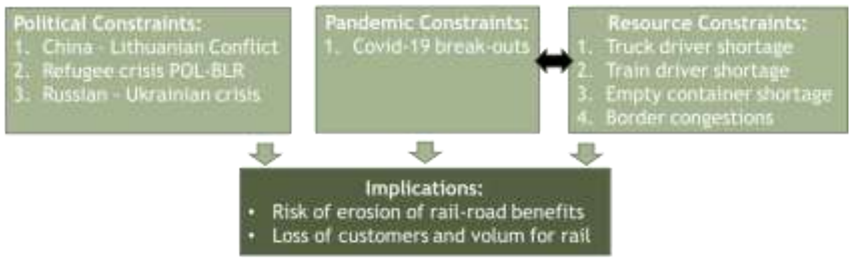

Figure 33. Recently political and pandemic constraints

During a workshop organized in June 2021, experts have been invited to express their views on three aspects: (1) Political & Stakeholder Motivation, (2) Interoperable Documents & Information, (3) Processes & Assets. The following figures summarize the findings of the breakout sessions 1 and 3. The results of the breakout 2 is detailed in chapter 5.2.

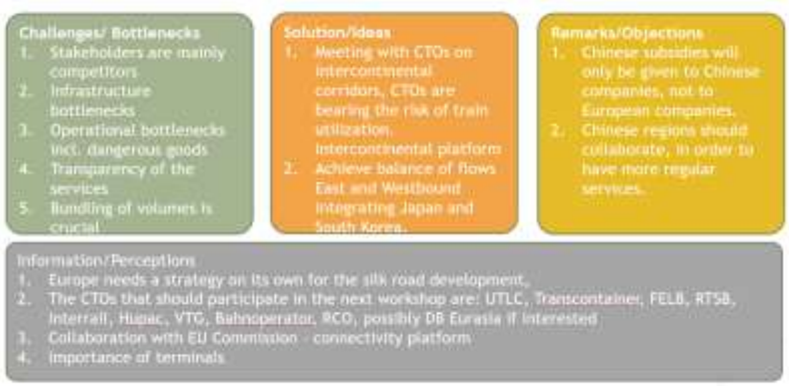

Figure 34. Workshop Result (1/2)

[17] https://qz.com/2102636/supply-chain-chaos-spurs-china-europe-rail-freight-revival/
[18] https://qz.com/2102636/supply-chain-chaos-spurs-china-europe-rail-freight-revival/

Figure 35. Workshop result (2/2)

One key hurdle identified during this workshop as well is the standardisation and technology gap of the rail industry vs other industries such as road, air and ocean. In order to stay competitive, the intermodal industry must gradually establish standards that already exist in other competing transportation modes. One example of a global effort to increase the efficiency of the data exchange that started in 2005 in the airfreight industry[19] and similar initiatives exist for sea and road.

One key argument is the faster and greener way of transport possible through rail if transport operations are plannable, robust and the information flow is complete. Use case 2 aims to explore a way into this direction.

This use case analyses LL2 corridor flows and assess 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" and use cases 1 and 2. Accordingly the starting point is defined by availability of T1.2 and LL2 preliminary results. The use of the PLANET tools by the EGTC will be 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 will be carried out. The simulation will take into account both Eurasian rail freight transport entering the R-ALP region and the potential shift of freight flows from Northwest European seaports to Mediterranean seaports stemming from BRI and TEN-T investments.

[19] Source: IATA Guidance on Compliance with Electronic Advance Cargo Information requirements (https://www.iata.org/contentassets/2c4495c8abb64352acaef69b73d0b783/guidance-on-compliance-with-electronic-aci-requirement.pdf)

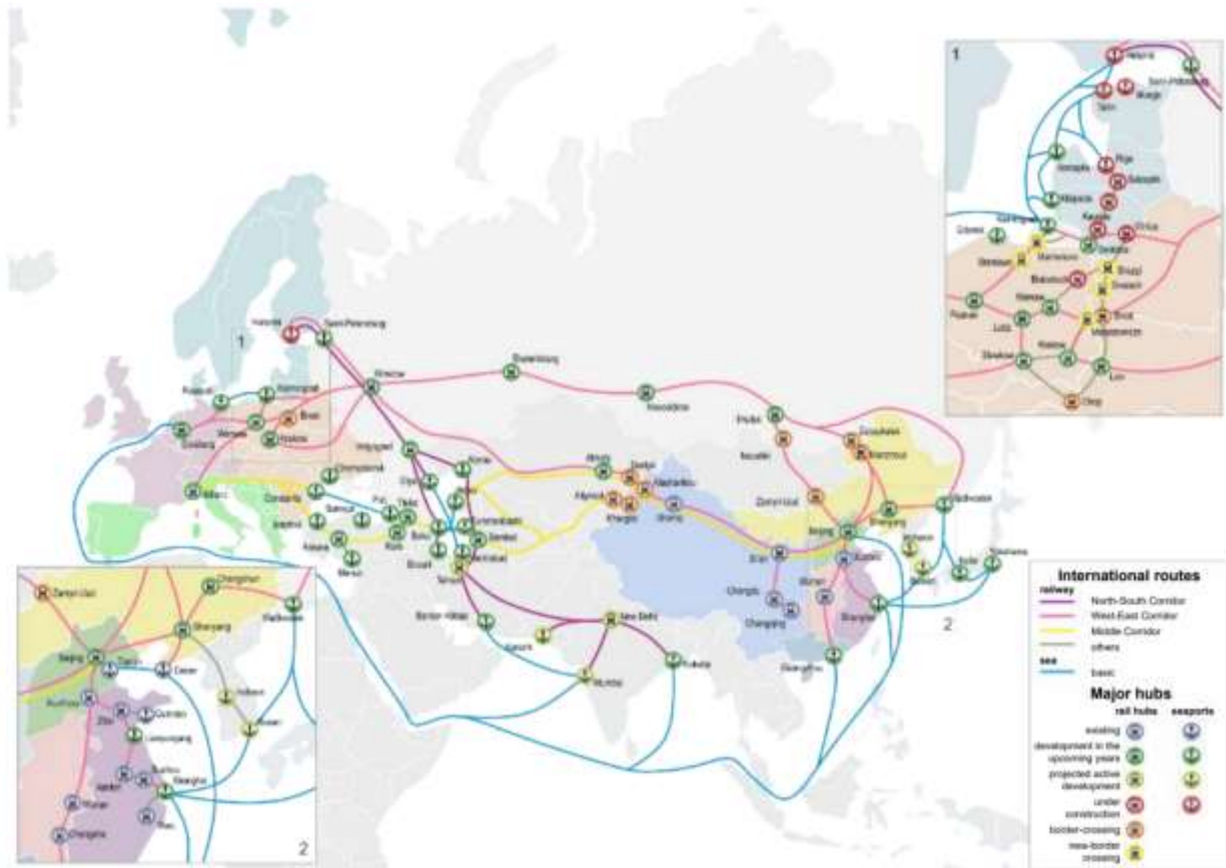

Figure 36. Major new transit routes: Use Case 3 implications for European corridor planning

6.3 Use Case 3

As Use Case 3 does not entail technological innovation or improvement action, detailed impact assessment is not foreseen. However, the next deliverable, foreseen to present the end results of the dynamic simulation, will assess the impact of policy measures following from the analysis as compared to a ‘do-nothing’ scenario.

7 Living Lab 2 alignment with EGTN objectives

7.1 LL considerations for the EGTN Platform integration

The vision of PLANET is to advance the European Commission's strategy for Smart, Green and Integrated Transport and Logistics by efficiently interconnecting infrastructure (TEN-T, Rail-Freight Corridors) with geopolitical developments (e.g. future New Silk Road and emerging trade routes), as well as to optimise the use of current & emerging transport modes and technological solutions, while ensuring equitable inclusivity of all participants, increasing the prosperity of nations, preserving the environment, and enhancing Citizens quality of life. The realization of this vision is what PLANET calls the Integrated Green EU-Global T&L Network (EGTN).

PLANET's vision is supported by two key R&D pillars:

- Understanding and assimilating global, geopolitical, trade and economic imperatives
- Leveraging technological advancements and new logistics concepts

The objectives to achieve this vision are, which is illustrated below:

1. Provide a Simulation Capability for analysing the impact of new trade routes and emerging innovations for the TEN-T and f European logistics operations, and for designing a geo-economics aware and PI inspired Integrated EU Global Trade Logistics Network [EGTN]
2. Deliver the PLANET Cloud-based Open EGTN ICT Infrastructure, leveraging inter-organisational workflows and smart contracts linked with IoT and federated Blockchains, to support the development of EGTN solutions in the Living Labs
3. Set up and operate 3 global corridor-Living Labs, interconnected into a Digital Clone, to provide an experimentation/innovation environment and testbed for EGTN solutions involving major actors from the T&L industry
4. Provide an EU Roadmap and Capacity Building program to steer innovation towards EGTNs aligning with global T&L blockchain initiatives and the ALICE PI working groups.

Figure 37. PLANET objectives overview

7.1.1 Software context

The task for BlockLab is to develop a transport and logistics management platform for Port of Rotterdam logistic hub and its community, particularly focused on streamlining the rail transport chains coming linking China through Rotterdam to/from USA, UK and Port of Valencia. On this platform LSPs and FFs can digitalise and manage their shipment related information and the national and international required logistics and customs documentation. Also, they are enabled to track their shipments, receive dynamic multimodal routing decision support via the EGTN platform, and monitor the emissions of their shipments, also provided via EGTN.

The other logistic hub is the Port of Valencia, linking sea transport from/to China and Africa with the Spanish hinterland and European rail and road transport networks. Key difference between the PoV platform and the PoR platform is that the latter is based on a public blockchain, while the PoV platform uses a permissioned Hyperledger blockchain.

As an overarching layer over these platforms, the EGTN platform is developed. Logistic data of all connected hubs will be collected on the platform, which utilizes the SOFIE Interledger[20] as a component to communicate with and between different blockchain environments. Service providers are enabled to offer all kinds of logistics services, such as emission tracking, routing optimisation, cargo forecasting etc.

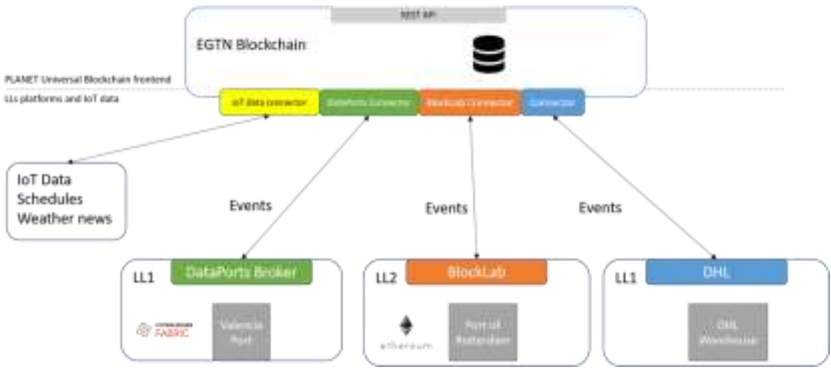

Figure 38. Provided by Konnecta Systems Limited

7.1.2 Design and Implementation Considerations

As of this moment, only a few considerations have to be taken into account during the design and development phase of this project.

1. PoR platform operates on a public Ethereum test network, which has much different privacy, throughput and hosting dynamics than the permissioned networks EGTN and PoV are operating on.
2. Discussions with the Port of Valencia and PLANET consortium revealed that the logistic business cases between PoV and PoR are rather limited. However, to demonstrate interoperability, two functioning platforms and a business case are required. Therefore, the determined business case is sharing road transport information on the basis of road transport documents (eCMRs and packing list) between the two logistic hubs.
3. The absence of an internationally accepted standard for rail transport documents in electronic format might be an obstacle for live testing, but not for to demonstrate the proof of concept.

7.1.3 Scientific and industrial contribution

The scoped work for BlockLab within the PLANET project has an indirect contribution to science. By implementing the latest scientific advances in logistic management and information technologies, the digital infrastructure that is created allows for valuable inputs and insights towards modelling and researching of European transport flows, and it enables to verify theoretical research via practical experiments.

The industrial contributions of the scoped work for BlockLab are abundant:

- Management and digitalisation of commercial, transport and customs documents and information
  - Enormous decrease in paper work
  - Decrease of human errors with paper work (manuals errors, completeness checks, validity checks, secure storage)

[20] https://github.com/SOFIE-project/Interledger

    - Decrease in process lead times (auto-completion, information availability and accessibility, real-time distribution etc)
- Real-time decentralised multimodal logistics coordination system
    - Full control over data by the data owner (data sovereignity)
    - Technology agnostic, while adhering to the SDK standard to ensure interoperability
    - Configurable services offered by various technology providers (best of breed 2.0)
    - Neutral to all users
    - Digital proofs of real world events
- Access to EGTN services
    - Shipment CO2 emission tracking and reporting
    - Subsequent transport leg routing proposals, to enable synchromodal dynamic management

All these contributions shall lead to:

- Less errors caused by manual paperwork
- Efficient information collection and distribution for custom clearances
- Environmentally focused transport optimisation
- Transport capacity optimisation
- Streamlined import processes
- Real-time information distribution

7.1.4 EGTN platform integration– shipment data

Event on each blockchain platform will be transported to the other blockchain via the SOFIE interledger. Functionalities of SOFIE shall be incorporated in our smart contracts.

See for more information: https://github.com/SOFIE-project/Interledger

Specifically, to support potential EGTN services, BlockLab's platform shall include a service that summarizes unsensitive logistic data related to a certain shipment. Information included in this data should be sufficient to perform synchromodal dynamic management and logistic optimisations. Most important information: pickup and delivery destinations, packaging type, number of packages, package weight, package volume.

The workflow we have in mind to support EGTN services and enable synchromodal dynamic management and logistic optimisation:

1. User creates shipment on platform, enters main shipment information, and attaches first document
2. A root hash of the shipment is notarized as reference to the shipment, and emitted by the Customer Journey Contract
3. Blockchain client of EGTN platform listens to the contract and pickups the root hash
4. Root hash is forwarded to the EGTN API
5. Together with the access token, the root hash is presented to the BlockLan API
6. Internally, the root hash is forwarded to the Shipment Summary Service
7. For the root hash, the Shipment Summary Service fetches data from underlying documents in the Document Vault and prepares a shipment summary
8. Shipment summary is sent back to the BlockLab API and forwarded to the EGTN platform

Data format of the shipment summary is JSON data.

Data format of the messages emitted by the Customer Journey Contract is Javascript Object.

7.1.5 EGTN platform integration – documents

The following workflow describes how an external platform, such as EGTN, is enabled to extract logistic document data from the BlockLab platform. The numbered steps in the workflow align with the numbered steps in the diagram in figure 39.

1. LSP/External platform/stakeholder uploads logistics document and attaches it to their shipment on the platform
2. Document Vault generates hash of the document “doc hash”, and forwards doc hash + document owner’s blockchain address to the Notary Contract
3. External blockchain clients are able to listen to timestamped transactions (events) of the Notary Contract and pickup a doc hash for a certain document type (identified by a number), for example an eCMR.
4. The doc hash has to be stored and forwarded for retrieving the document from BlockLab’s Vault.
5. Together with (earlier received) access token and doc hash, an external platform has to request the retrieval of an original document from the BlockLab API.
6. If the requested party is authorised by the document owner, the API will release the document content in JSON format
7. External platform may store the document content for various applications
8. To reach the blockchain environment of an external platform, the platform has to upload the data themselves, with respect to commercial sensitivity and GDPR.

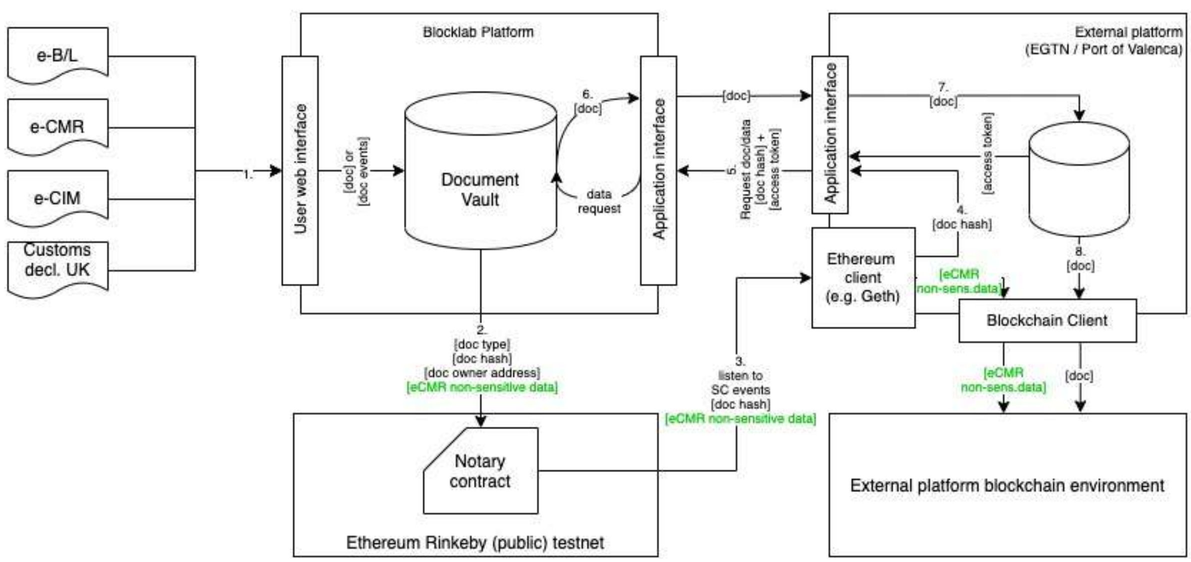

Figure 39. General document data exchange and eCMR interoperability

7.1.6 Port of Valencia platform intergration – e-CMR

- Focus on (road) Transport Orders and eCMRs heading for Port of Valencia ecosystem, Transport Orders shall be used for midterm planning, eCMRs are used for planning feasibility, updates and shortterm planning
- The red labelled non-sensitive eCMR data in figure 39. illustrates the data flow from BlockLab platform to PoV platform
- For Transport Orders with destination PoV ecosystem, additional to the doc type, doc hash and doc owner's address, we will publish following data on the Transport Order:

  - Transport Order reference number
  - City of loading
  - Date of loading
  - Time of loading (if applicable)
  - City of discharge
  - Date of discharge
  - Time of discharge (if applicable)
  - Type of packages
  - Number of packages
  - Weight
  - Volume
  - Issue date
- For eCMR with destination PoV ecosystem, additional to the doc type, doc hash and doc owner's address, we will publish following data on the eCMR:
  - Transport Order reference number
  - City of loading
  - Date of loading
  - Time of loading (if applicable)
  - City of discharge
  - Date of discharge
  - Time of discharge (if applicable)
  - Type of packages
  - Number of packages
  - Weight
  - Volume
  - Issue date
  - State (i.e. issued, pickup, delivery, cancelled)
- The format of the data emitted by the Notary Contract is Javascript Object, see examples:
  - https://web3js.readthedocs.io/en/v1.2.9/web3-eth-contract.html#id50
  - https://medium.com/linum-labs/everything-you-ever-wanted-to-know-about-events-and-logs-on-ethereum-fec84ea7d0a5
- The format of the data retrieved from the Document Vault is JSON

7.1.7 User interface design

Overview:

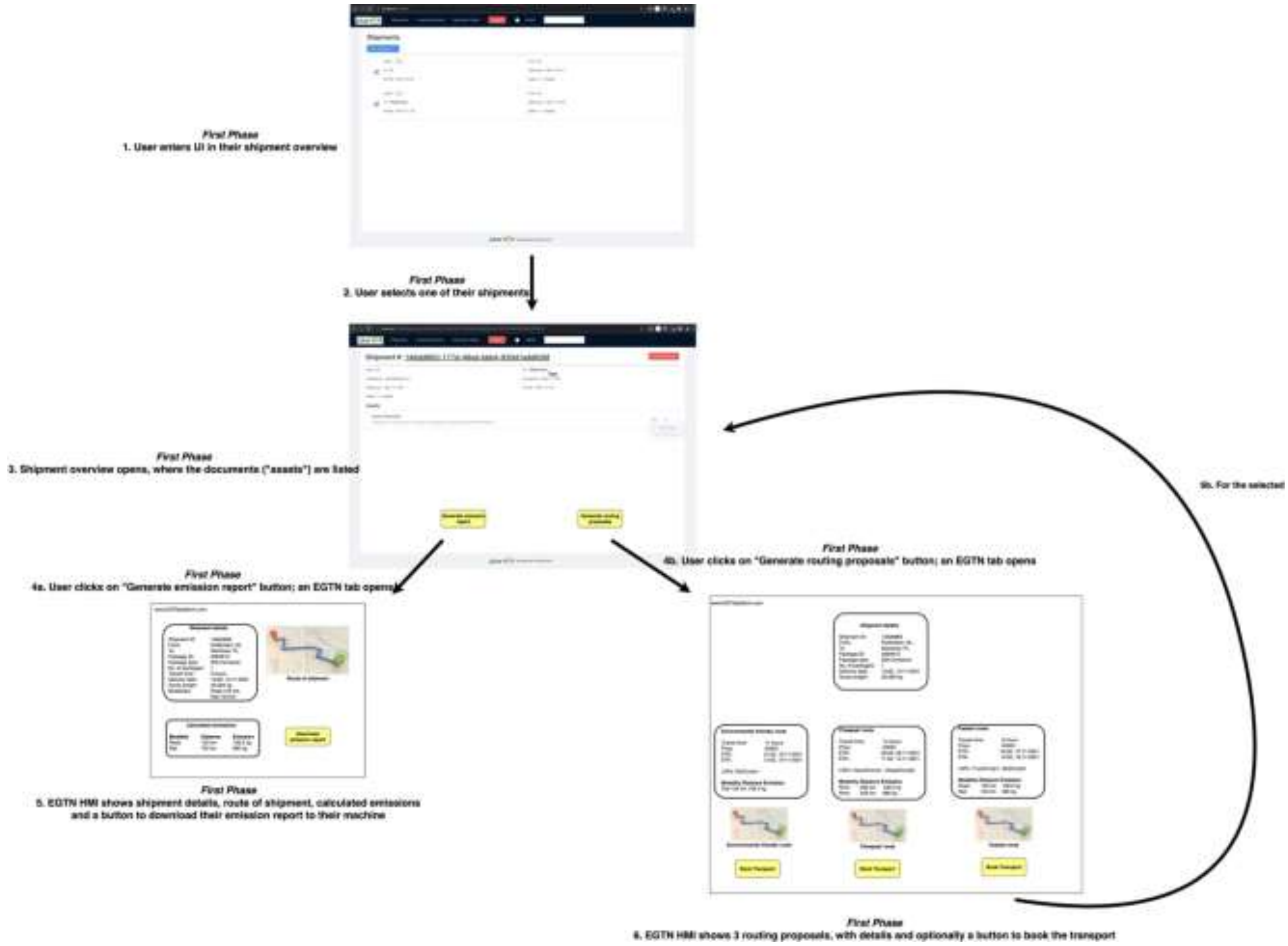

Figure 40. Overview of user interface design

Shipment Overview of logged in user

After logging in, a user can view shipments that specific user is a stakeholder in. The user is also enabled to create a new shipment object, for which he has to enter most essential information in a root document. Most essential information includes; *from and to location, amount of cargo, type of cargo, type of packaging, arrival date.* To each shipment object, documents can be attached required for the fulfilment of the shipment. These documents are commercial, transport and custom documents. For each document, authorizations (e.g. viewing rights, editing rights) for other stakeholders can be set by the document owner.

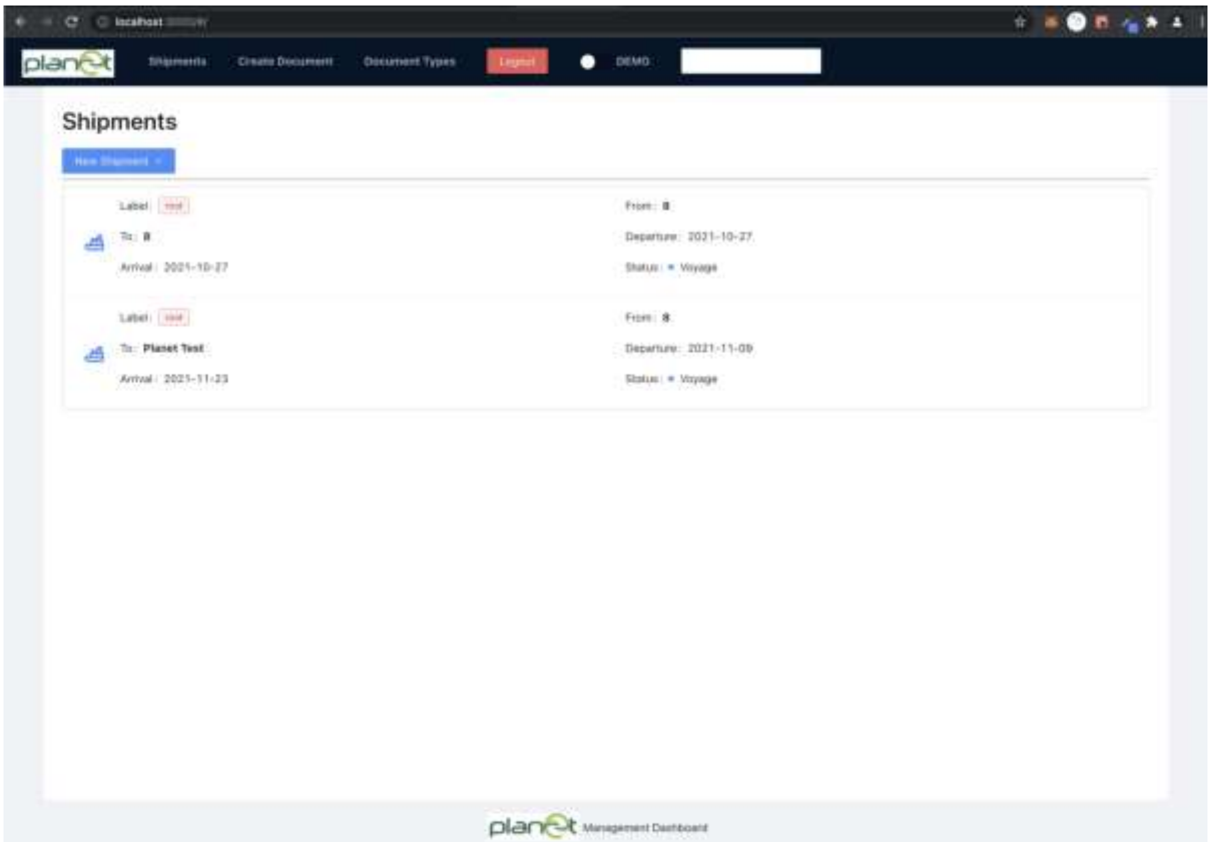

Figure 41. Shipment overview, logged-in user

Inside a Shipment Object

A list of attached documents is presented. Also, the user or authorized stakeholders can attach additional documents to the shipment. Since the most essential information of the shipment is already submitted, via a button routing alternatives are calculated by the EGTN platform and presented to the user. The user then can select one of these routes and add them for the remaining part of the shipment. The other button is to generate emission reports from a selected shipment (or perhaps part of a shipment).

Figure 42. Shipment object

Shipment Routing Proposals

After a user requested routing proposals, a new tab is opened showing the EGTN website where various routing proposals are offered for (the remaining part of) his shipment. Once one of the proposals is selected, a user can book that transport (via EGTN?) and associated documents (e.g. transport order, required certificates) will be added to his Shipment object in partly completed form.

These proposals are generated via the routing and transport capacity optimisation tools as offered on the EGTN platform.

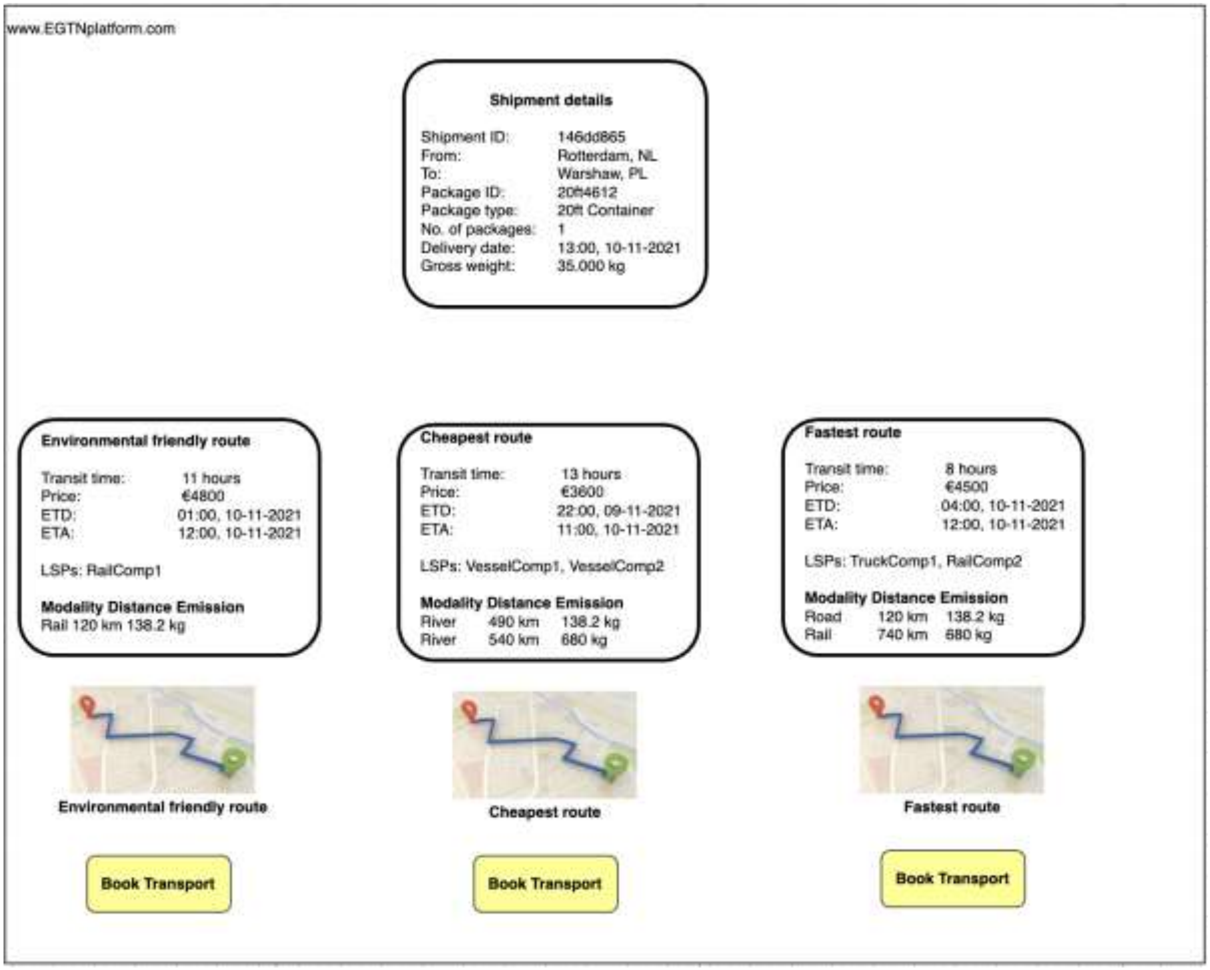

Figure 43. Shipment routing proposals

Shipment emission reporting

After a shipment is completed, a user or authorized stakeholder can request emission reporting done by the EGTN platform. A new EGTN tab will be opened, where an overview of the shipment is shown and calculated emissions for each segment of modality of the transport. The user or stakeholder is enabled to download the report for their administration.

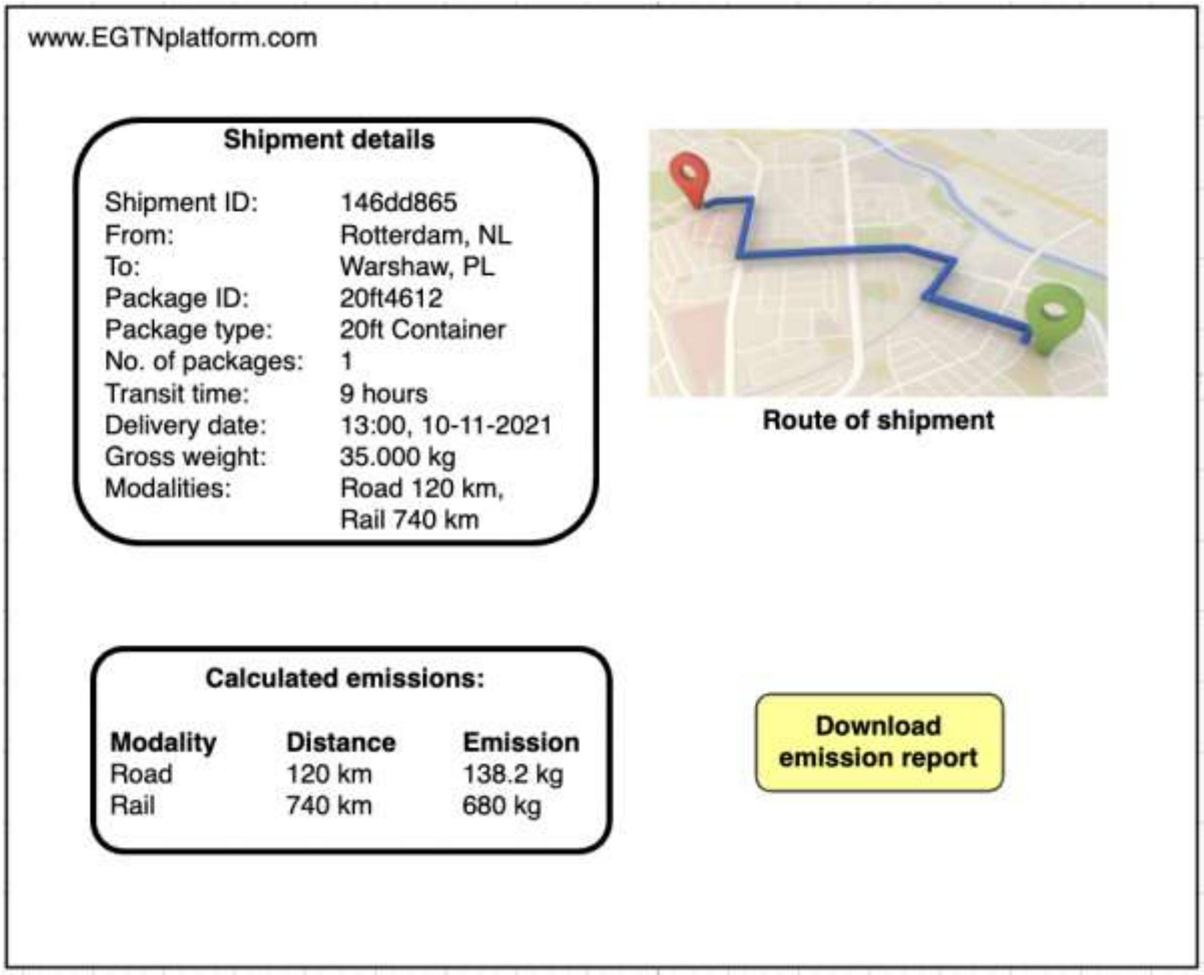

Figure 44. Shipment emissions reporting

Explanation EGTN services

In support of the objectives of synchromodal dynamic management and logistic optimization, certain services are envisioned that will be provided by the EGTN platform. Those services are enabled though the shipment level data workflow, as described in the previous section.

After the creation of a shipment on the platform, or when transport for a shipment is nearing the next logistic hub, we would like to receive routing proposals on:

- The fastest route to end destination
- The route with the lowest environmental footprint
- The cheapest route to end destination
- The route that optimizes on logistic capacity

For both the entire route (after creation of a shipment), and for the remaining route of the shipment. Based on these proposals, a cargo owner or freight forwarder can dynamically switch modalities and routes.

The first step is to provide the routing proposals as decision support, the cargo owner or freight forwarder will still have to book the transport manually and provide the documents for it. The second step, in addition to the proposal, is to automate the booking process (and the required information flow) after a cargo owner or freight forwarder manually selected one of the routing proposals. The third and final step would be to let an optimization algorithm coordinate the shipment and automatically book transports or segments of transport.

In addition to this, a nice to have service would be environmental footprint tracking per shipment. Once a shipment has completed, an environmental report might be generated that customers could use for various purposes.

7.2 State of Affairs

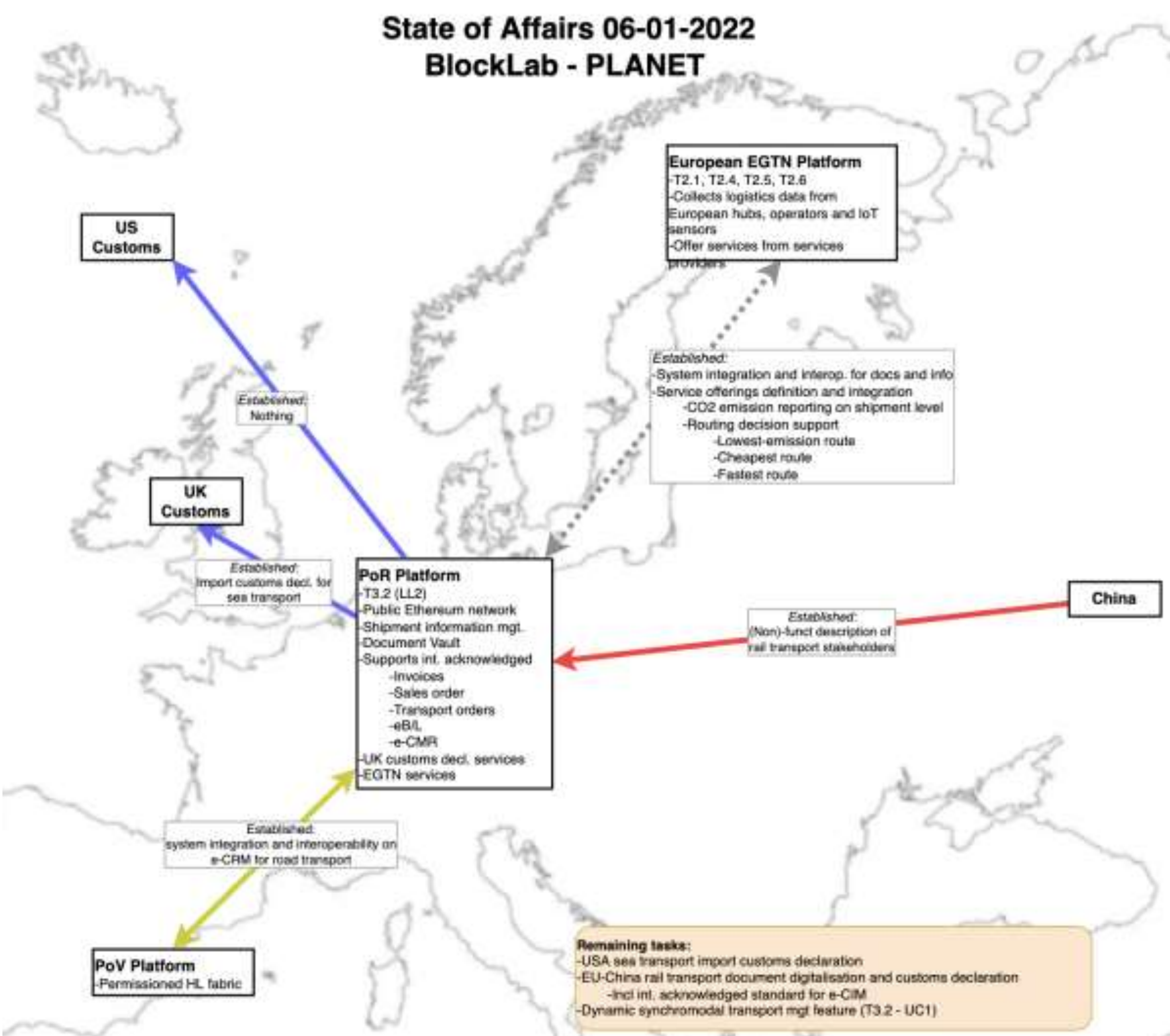

Figure 45. LL2 considerations for EGTN platform

8 Conclusions

This report has set forth the work carried out and the results achieved during the first phase of this Living Lab: Synchro modal dynamic management of TEN-T & intercontinental flows promoting rail transport: China – Rotterdam, USA/UK focusing on the role of rail transport. This was done for this Living Lab's three Use Cases:

1. Improving information flows through Blockchain enabled platform
2. Potential for Eurasian rail freight expansion through streamlining information flows
3. Implications for European corridor planning of the expansion of new trade routes

Within Use Case 1, a blockchain demonstrator has been developed to deal with post-Brexit customs processes between the Netherlands (PoR) and the UK. Based on the feedback obtained from the first demonstrator, we further extended the demo to include the full customs declaration. We have piloted the demonstrator with the use of shadow transactions between mid-May 2021 and July 2021 in order to assess the business case. The pilot showed proof for the business cases as identified for stakeholders. The positive business-case has resulted in the development of an enterprise grade solution inspired by the demonstrator which runs on Port of Rotterdam's blockchain platform. On the 7th of December, 2021 the first live transaction was done.

For Use Case 2, The demonstrator case options were defined, anticipating a total transit time reduction goal of 3-5 days, economically viable costs and service frequency. This can only be achieved by a combination of measures, based on three key assumptions:

1. The change can be implemented within the control of the key partners and the directly involved stakeholders
2. The results are practical and measurable
3. High potential to survive the pilot phase and high ability to roll-out to a wider scope than the demonstrator alone

For Use Case 3, the baseline measurement was established, allowing for dynamic scenario simulation in the second phase of the project. In order to analyse the impact of Eurasian rail on freight flows in the RALP region, the PLANET model was used. This model, based on one of Panteia's in-house models, is specifically developed to simulate the impact of Eurasian rail on the European transport network. Similar to D1.2, the baseline year of the model is 2019. This is the last year in which the transport flows have not been disrupted by the COVID crisis, and therefore provide a realistic picture of the normal situation. As we do not yet know which changes in the transport system are permanent as a result of the pandemic, these have been left out of consideration.

Finally, alignment of LL2 with the wider purposed of EGTN development was discussed. To support potential EGTN services, the Blockchain platform will include a service that summarizes non-sensitive logistic data related to a certain shipment. Information included in those data will allow for synchromodal dynamic management and logistic optimisation.