Decentralised management of logistics documentation

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DOCKLAB & UIRR
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DECENTRALISED MANAGEMENT OF LOGISTICS DOCUMENTATION

2023

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

This project is funded from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 860274

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The PLANET Project

ABOUT PLANET PROJECT

PLANET project aims at boosting the EU's leadership in global logistics flows **by effectively interconnecting infrastructure with cost considerations, geopolitical developments**, as well as **current and emerging transport modes and technological solutions**, enabling an EU-Global network that ensures equitable inclusivity of all participants, increase the prosperity of nations, preserve the environment and enhance citizen's quality of life.

The realization of this vision in PLANET is branded as the EGTN (Integrated Green EU-Global T&L Network).

Physical Internet concepts in combination with disruptive technologies such as **Internet of Things (IoT)** and **Blockchain** will be used by PLANET to move towards more optimal and efficient transport and logistics (T&L).

Accelerating the collaborative transition towards the Physical Internet in the context of the new emerging trade routes

OBJECTIVES

1. Generate a Simulation Capability for the assessment of the expected impact of new trade routes, national strategies and innovations on the TEN-T corridors and European logistics operations.
2. Built an Open cloud-based ICT Infrastructure facilitating the implementation of EGTNs.
3. Employ 3 Living Labs to facilitate experimentation and testbeds for project's solutions.
4. Formalize an EU Roadmap along with a Capacity Building effort purposed to accelerate EGTN realisation, closely aligned with prominent T&L blockchain initiatives and the ALICE Physical Internet working groups.
5. Ensure wide Dissemination supported by a clear Commercialisation Strategy and Policy recommendations.

Project Start	01/06/2021
EU Budget	€ 7 097 670
Instrument	MG-2-9-2019
Duration	36 months
Consortium	33 partners from 14 countries

Preface

This whitepaper is part of the result of three years of intense international collaboration between research institutes, transport interest groups, logistic service providers and software developers within the PLANET project. The mission was to discover pathways to enable dynamic synchromodal management focused on promoting rail transport, and assess its impact on Trans-European Transport network (TEN-T) and intercontinental flows, utilising Port of Rotterdam as main transhipment hub.

The main purpose of synchromodality is reducing costs, emissions, and delivery times while maintaining the quality of supply chain service through smart utilization of available resources and synchronization of transport flows. A fundamental element to achieve synchromodality is visibility; visibility on shipment destinations and arrival dates, visibility on modality capacities, routes and schedules, and visibility on transport or customs documentation and the involved stakeholders that should be able to access them.

To get visibility, a lot of information needs to be collected, processed, aggregated, and analysed. Current state logistics still heavily relies on physical paper and paper-based processes, which undermines the ability to achieve visibility, thus real-time synchromodal management.

This paper explains the negative impact of paper-based logistics in general, the developed solution for enabling the first steps towards synchromodal management, and the expected added value businesses could be derived from it.

We would like to thank the PLANET project organisation, all the members, and in particular the Living Lab 2 partners for this opportunity and their contributions.

Executive Summary

Not only for synchromodal management, but also in the light of Brexit and the need to boost efficiency in the Eurasian rail link, digitization of supply chains has become increasingly important. Brexit has resulted in increased trade costs and non-tariff barriers, making cross-border trade a challenge. The Port of Rotterdam Authority has developed Quayconnect, a blockchain solution that enables fully digital customs declaration for imports into the UK, reducing the cost of customs clearance by up to 35%.

The Eurasian rail cargo transport has seen significant growth, but still has a low intermodal market share of ~1%, with sea transport being the preferred mode of transportation (>90%).

The Living Lab focused on developing innovative document exchange platform for the EU-RU-CN trade lane to overcome barriers of growth, including focusing on interoperability scenarios.

Blockchain technology was selected as part of the solution because of two unique capabilities. First, it provides a trustworthy, accessible, common-frame-of-reference over many geographically distributed, and silo-ed systems active on these trade lanes. Those systems range from customs, transport and port authority systems, to TMS and ERP systems. The second unique capability valuable to this application is the digital notary capability; it can immutably log data entries and token transfers, including submitter, receiver, and timestamp. This allows each stakeholder to notarize logistic or logistic documentation updates and distribute it over the common-frame-of-reference to each connected system in the trade lane.

The developed solution was a multimodal shipment documentation collection and exchange platform. The platform allows to create shipment objects, where container-level cargo details and documents can be submitted to and be digitalised. Essential, yet unsensitive, shipment information and document completeness updates are shared in the blockchain network, so that the stakeholders are aware of, and can anticipate on the logistic and document state of the shipment. The platform is via the blockchain also integrated with other logistic platforms and the EU covering EGTN platform. This allows for the collection and sharing of shipments and regional logistic events, that are validated by IoT devices, and aggregated by EGTN for an EU-level real-time state of logistics. This is a first step towards dynamic synchromodal management. The next step would be to develop and implement synchromodal planning algorithms for the allocation of cargo on assets and to optimise the scheduling for each time window.

The research, development and testing of the multimodal document platform leads to interesting findings on the business value, that differ per use-case. The business value for digitization in the import and export of goods between UK and EU centres around the financial benefits of reduced border waiting times, sharing document electronically for efficient shipping, and reducing labour costs.

The business case for improving Eurasian rail traffic includes time compression over the whole shipment, additional trade lane capacity, faster and greener transport, and counter-acting political and pandemic-related resource constraints. That could all be improved with digitization of information, documents and processes. However, experts identified the standardization and technology gap in the rail industry as a key hurdle to overcome and emphasised the importance of complete information flow for plannable, robust operations.

Setting the scene

The digitization of supply chains has revolutionized the way companies operate and interact with their suppliers, customers, and partners. It has enabled companies to automate processes, improve transparency, and gain greater control over their supply chains, leading to increased efficiency and cost savings. In the context of Brexit and the need to boost the efficiency and effectiveness of the Eurasian rail link, the digitization of supply chains has become even more important, as it can help companies mitigate the challenges posed by these two issues.

The two issues have been at the centre stage of Living Lab 2 within the PLANET Project. In this chapter we provide the background against which the solutions as described in *The business model* chapter were developed.

Brexit

Brexit has had a significant impact on cargo flows to and from the United Kingdom. Before Brexit, the UK was part of the EU's single market and customs union, which allowed for the free movement of goods, services, capital, and people within the EU. As a result, the UK enjoyed tariff-free trade with the EU and benefited from a wide range of trade agreements negotiated by the EU with other countries. However, with Brexit, the UK is no longer part of the EU single market and customs union, and trade between the UK and the EU is now subject to tariffs, customs checks, and other trade barriers.

Research conducted by ESRI[1] shows reductions in UK to EU goods trade by 16% and trade from the EU to UK by 20% relative to the scenario in which Brexit had not occurred. The comparison scenario is that trade with the UK should have been expected to grow at a similar pace to that of the same products being traded with other EU partner countries around the world. Although goods trade between the EU and UK recovered most of its previous level in value terms following the sharp fall in the early months of 2021, this recovery leaves it well below the levels that would have been expected if it had performed on a comparable level with other trade partners.

One of the most significant impacts of Brexit on trade between the UK and the EU has been the increase in trade costs. Tariffs have been introduced on a range of goods, including agricultural products, cars, and textiles, making them more expensive for consumers in both the UK and the EU. In addition, non-tariff barriers, such as customs checks and rules of origin requirements, have increased administrative and logistical costs for businesses engaged in cross-border trade.

[1] **https://www.esri.ie/news/brexit-reduced-overall-eu-uk-goods-trade-flows-by-almost-one-fifth**

The position of the Netherlands as an important logistics pivot point for cargo to the UK has therefore also been compromised as traders are now faced with customs procedures at both the EU and UK border and opting for direct shipment to the UK instead. This trend also affects the ports of Rotterdam and Hoek van Holland. As an indication, in 2019 there were about 890,000 TEU and 450,000 RoRo movements (source HBR). The high cost per customs clearance in the UK contributes significantly to this negative trend; these are around a factor of 2 above those in the Netherlands. This negative trend is expected to continue in 2023, given the stricter import requirements that have come into force after 1 January 2022 and the high inflation in the UK (14% in February 2023).

Furthermore, 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. For this reason, the Port of Rotterdam Authority, together with partners in the UK, has developed Quayconnect; a blockchain solution that enables fully digital customs declaration for import into the UK based on the principle of (validated) data available for export. This development was done as part of Living Lab 2 within the PLANET Project. The development of the solution also involves UK customs and authorities such as Border Force and the Department for Environment Food and Rural Affairs (DEFRA). This solution is now live and reduces the costs of customs clearance by up to 35%. In addition, the exporter has a definite answer within a few minutes whether or not the goods can be shipped.

[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).

Eurasian rail transport

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 (see *Figure 1*). 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 million TEU in 2027 for sea, air and rail transport combined, compared to 11.1 million 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)[3]. 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 1: 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[4].

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. After several consultations with UIRR members, the decision was to focus on B2B and B2G document interoperability scenarios. 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.

[3] More information: **https://uic.org/IMG/pdf/corridors_exe_sum2017_web.pdf**
[4] The volatility of the sea freight rates and capacities influence the importance of this argument considerably over time.

What blockchain brings to the table

Blockchain fundamentals

Blockchain is a distributed ledger technology, where transactions between participants are recorded on various nodes in the network. Special purpose nodes collect these transactions into a block and propose to append that block to the existing chain of blocks. Once the whole network agrees on the block proposal, meaning that all transactions inside the block are valid and according the rules of the protocol, the block gets accepted and immutably appended to the blockchain. Blocks contains a cryptographic hash of the previous block, timestamp, and transaction data, forming an immutable chain. To arrive at the current state of the ledger, one would need to process all of the transactions since genesis state of the ledger. Participants in the network own a pair of public and private keys. The public key is their representation in the network, comparable to a bank account number. The private key acts as a secret password that is used to sign off the transactions executed by the public key holder. Transactions include the public key of the sending party, public key of the receiving party, timestamp, block number, transaction metadata, and the value that is being transferred. The value can either be an amount of cryptocurrency or any other fungible or non-fungible token.

Every node in the network keeps a local copy of the entire blockchain, which allows for transparency and security. Instead of being stored in one central location, blockchain data is distributed across a network of computers. Because nodes interact peer-to-peer, the blockchain also offers censorship resistance and will always be accessible to any participant.

The technology is often associated with cryptocurrencies like Bitcoin, however the application range is much wider than electronic money. Other interesting applications are supply chain management, voting systems or identity verification. Applications outside of electronic money are usually enabled through the use of smart contracts. Smart contracts are programmed business logic, that are deployed on the blockchain and operate automatically once the rules of the program are met. Smart contracts allow for tokenisation of any type of asset, being financial, physical or digital, and for automation. Smart contracts become operational by transacting with them, either by sending value (cryptocurrencies) or data in the form of tokens or transaction metadata.

A commonly used argument against the use of blockchain technology is the high energy consumption of the network. That is true for most so-called proof-of-work blockchains, where the nodes execute lot of energy consuming calculations to reach consensus over the state of the ledger. However, next generation blockchains — such as Ethereum — apply different consensus protocols that do not rely on energy consuming operations, such as proof-of-authority or proof-of-stake.

Digital notary

The technology does not prevent faulty data being entered into the blockchain, the common expression “shit in, is shit out” applies here. However, ownership and double-spending of value or tokens are well protected. Since every transaction includes the sender, receiver, a timestamp, a block number, and the item being transferred, it can fulfil the function of a digital notary. The ledger, the result after processing all transactions, provides proof-of-ownership, proof-of-existence, and data integrity. The immutable blockchain, the chain of all timestamped transactions, provides traceability and provenance. So, the blockchain provides a secure, integer and traceable recording of interactions between participants and smart contracts.

Common frame of reference

Due to the immutable and peer-to-peer nature of the network, offering a reliable, traceable, and accessible recording or data entries into the ledger, it can serve as a common frame of reference in a multi-party business case. Not only from a data security perspective, but also from the perspective of system integrations, it is more efficient to integrate one-to-many than many-to-many. Especially in supply chain business cases, where multiple actors need to collaborate and do not necessarily trust each other, an immutable and accessible common frame of reference connecting various silo-ed systems can be a key enabler for the business case.

Smart contracts

Smart contracts are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. They run on a blockchain network and automatically execute when certain predetermined conditions are met. Smart contracts can be used for a variety of purposes such as transferring money, property or shares, and even for voting systems.

The idea of smart contracts was first proposed by Nick Szabo, a computer scientist, in 1994. He defined smart contracts as computerized transaction protocols that execute the terms of a contract. However, it wasn't until the emergence of blockchain technology that smart contracts became a practical reality.

Smart contracts are built on blockchain networks such as Ethereum, which was specifically designed for creating and running smart contracts. The Ethereum network allows developers to create and deploy decentralized applications (Dapps) that can be used for a variety of purposes. One of the most common uses of Ethereum is for creating and deploying smart contracts.

Tokenisation

Tokenisation is the process of converting a real-world asset, such as property or shares, into a digital token that can be traded on a blockchain network. This process is made possible by the use of blockchain technology, which allows for secure and transparent transactions without the need for intermediaries. Tokenisation has the potential to revolutionise the way we invest in and trade assets, making it more accessible, transparent and efficient.

The process of tokenisation begins with the creation of a digital token that represents ownership of a particular asset. This can be done by converting the asset into a digital form, such as a smart contract, which can be executed automatically on the blockchain. The smart contract contains the terms of the asset ownership, such as the transfer of ownership and any other relevant conditions.

Once the digital token has been created, it can be traded on a blockchain network, just like any other cryptocurrency. The token can be bought and sold by investors, who can then benefit from any increase in the value of the underlying asset. This makes it easier for investors to gain exposure to assets that were previously difficult to trade, such as property or fine art.

Multimodal document management platform

Brexit, Covid and increasing volumes of Eurasian rail transport all laid bare how paper-based operations in international trade and logistics can lead to huge operational inefficiencies and should quickly become a thing of the past. Over the years, blockchain technology has proven itself as a reliable medium to record data, transfer value, secure ownership, and provide an accessible common frame of reference. Various industrial sectors have acknowledged these unique capabilities and are increasingly incorporating the technology into their operations. In this chapter is described the functionals and technical aspects of a newly developed multimodal document management platform, that exploits the unique proposition of blockchain technology to replace paper-based operations with fully digitalised and automated operations for international trade and logistics.

Purpose and Scope

The main purpose of the developed platform is to contribute to the achievement of the objectives of the PLANET project, and more specifically to the objectives of the Living Lab. The objective is to research and advance dynamic and synchromodal management of Trans-European Transport Network (TEN-T) and intercontinental flows promoting rail transport, with the Port of Rotterdam as principal entry node linking and coordinating the Eurasian rail transport chain to the UK and the Rhine-Alpine Corridor destinations. Dynamic synchromodal management of logistics at hub, regional, or (inter)national level can be achieved in the following high-level steps:

1. Sharing shipments. Knowing which shipment needs to go where and when
2. Sharing of logistic events in real-time. Knowing the latest state of regional logistics
3. Determine the state of logistics. On hub, regional, or (inter)national level collect events, routes, schedules, location and capacity of logistic assets to create overview of logistics state
4. Implement synchromodal management. Per time epoch, optimise planning and allocate cargo to logistic assets and service providers
5. Distribute documentation. Distribute the shipment associated trade and logistics documentation according the planning to the right LSPs and authorities to be able to execute the shipments

One thing is clear, the reliance on paper-based documents and operations is an absolute dealbreaker in achieving the aforementioned objectives, as it is simply impossible to send numerous of human couriers around to distribute trade and logistics documentation to the right service providers and authorities within, and according, each synchromodal planning window.

The applied scope on the work done to achieve the objectives is illustrated in *Figure 2* below. With the Port of Rotterdam as transhipment hub of focus, the addressed logistic connections are the

inbound Eurasian rail transport starting in China and entering the EU via Poland; outbound maritime transport towards the UK; and the road connection between the Port of Rotterdam and Port of Valencia.

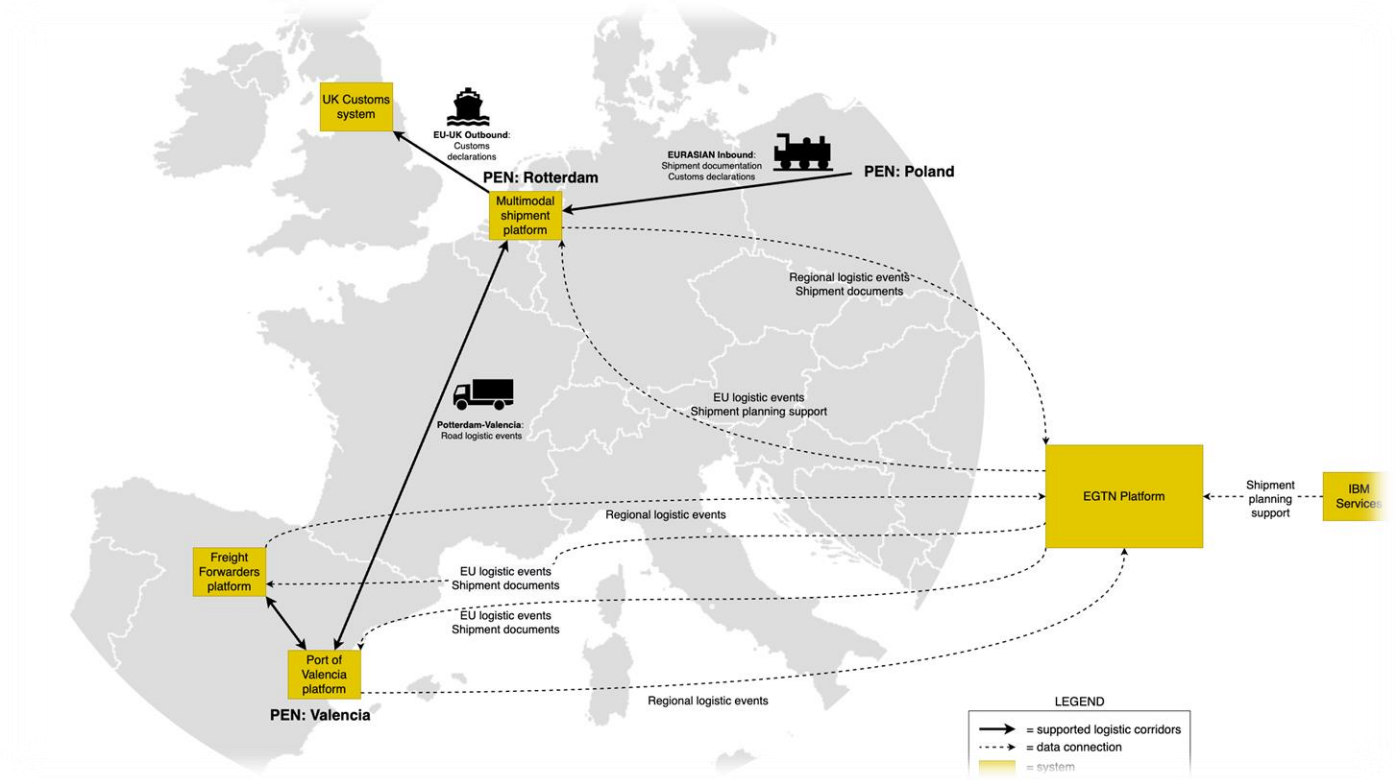

Figure 2: Scoped logistics and data connections, projected on a map of the EU

On these logistic connections the following stakeholders are considered and supported:

- Logistic service providers.
- Freight forwarders.
- Customs, transport and port authorities.
- Logistic operators.
- Consignors.
- Consignees.

The aim is to allow consignors, logistic service providers and freight forwarders to create shipment objects on the platform. For each shipment object, the user can digitalise and attach logistics and trade documentation necessary for the execution of the shipment. The user can authorize other users – LSPs, authorities, logistic operators and consignees – to access their uploaded documents, later this right could be given to a synchromodal planning algorithm.

Furthermore, as indicated by the dotted lines, the platform is integrated into a network of regional logistics platform, and the overarching EGTN platform. This allows for the sharing of regional logistic events in order to create an EU-level logistics overview. The events that are shared are the shipment creation, including high-level shipment details, and the attachment of each document. These events reveal which shipment needs to go where and when, and the logistic state of the shipment as indicated by the type of attached document, e.g., a Transport Order indicates a transport is about to happen on a particular day, a single signed CMR indicates a pick-up by a transporter, and a double signed CMR indicates a successful delivery confirmed by the consignee. This covers step 1, 2 and 3 of the steps towards synchromodal management.

Besides the integration with logistic platforms, the platform is also integrated with the UK custom authority system to allow for fully digitalised customs declarations, and real-time feedback on the declaration progress.

The following, to be extended, list of documents is supported by the platform:

- Customs and trade documents:
  - Purchase Order.
  - Sales Order.
  - Commercial Invoice.
  - Transport Order.
  - Export declarations (EXS).
  - Import declarations (SAD, ENS, EIDR).
  - Phytosanitary certificates.
- Logistics documents:
  - Packing lists.
  - (e)-CMR.
  - (e)-CIM.
  - (e)-Bill-of-lading.
  - Delivery note.
  - Dangerous Goods declarations.

Platform Description

Now that the purpose and scope of the developed platform are covered, this section will explain the architecture and its workings. The developed platform consists of the subsystems as described in *Table 1* below. These four subsystems enable the platform to fulfil the functional requirements as mentioned in the scope.

Subsystem	Description
User web interface	Entry point for users where they can view, and manage shipments and the documents associated to them.
System backend	Backend that supports and links the web interface functionalities with the blockchain components and the off-chain components, such as a document vault. The vault stores original documents and simultaneously generates cryptographic document hashes to provide proof of integrity. The backend also contains the identity framework that manages the authentication and authorization of each user based on their role and organization.
External integrations	Integrations with external systems such as UK customs system to perform fully digitalized customs declarations. The platform is also integrated in a digital infrastructure for sharing logistic events in the EU.
Public blockchain	On the accessible, censorship-resistant, public blockchain the shipment creation and document attachment events are immutably and transparently recorded. Two smart contracts are also deployed on the blockchain. The Notary contract notarizes the document hash, document type, submitter, shipment reference and relevant logistics data. It provides proof of existence, proof of origin and proof of ownership over the document and data. The Shipment Registry contract aggregates the notarized data linked to a specific shipment and allows for real-time tracking of shipment progress.

Table 1. List of platform subsystems and their descriptions

A screenshot of the user web interface is included below (see *Figure 3*). For a selected shipment, the user sees an overview of attached shipment documents. Here the user can choose to attach or download documents and authorize other users to access specific documents. Below the documents list, the cargo details on container level are displayed.

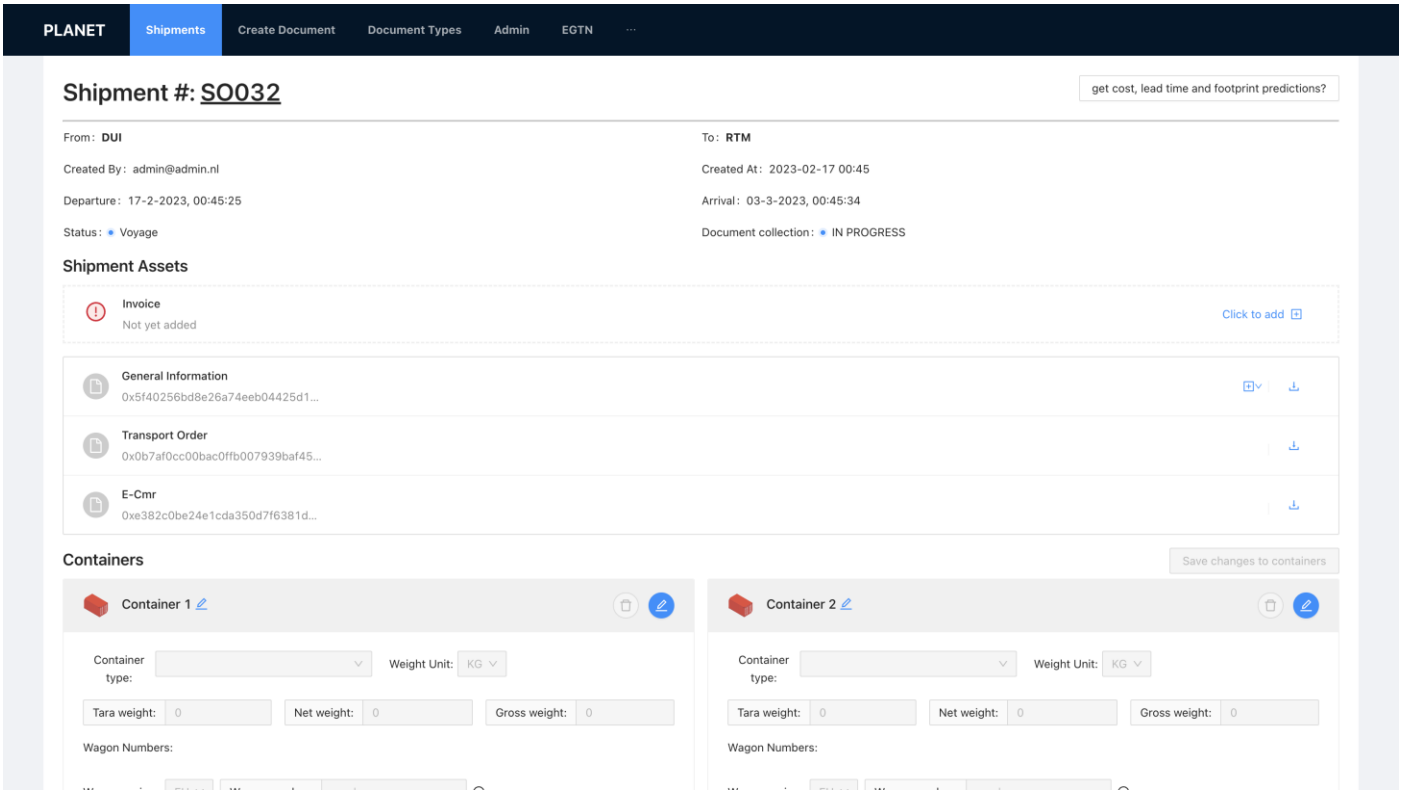

Figure 3: Screenshot of the user web interface of the platform, displaying an opened shipment object

How the data is managed inside the platform, starting from the web interface, is explained by the following workflow: a user creates a shipment and attaches the first documents via the user web interface. Each entity in the logistic chain also uses the web interface to view attached documents or to upload them. The system backend digitalises, stores and hashes the document, and links it to the shipment and the submitter. The backend forwards the right data to the deployed Notary and Shipment Registry smart contracts on the blockchain for notarization. The smart contracts process the request and immutable records the data on the public blockchain. This process of document collection and digitalisation is illustrated in the swimlane diagram below (see *Figure 4*). The top two swimlanes depict the physical information flow of an arbitrary shipment. The lanes below show how the information is digitalised, stored and notarized, whereafter it is linked to a specific shipment reference.

At this point, the documents are digitalised and stored on the platform, and notarizations have been made on the public blockchain. Because of the accessible, censorship-resistant and immutable nature of the blockchain, it is used as a common frame of reference for the systems taking part in the digital infrastructure for logistics. Meaning that, the logistic events that are notarized on the blockchain, are intercepted by an inter-ledger service and are forwards to the other connected blockchain platforms and overarching EGTN platform. This allows for the sharing of regional logistic events, and collecting them on an EU-level to generate the real-time state of EU logistics.

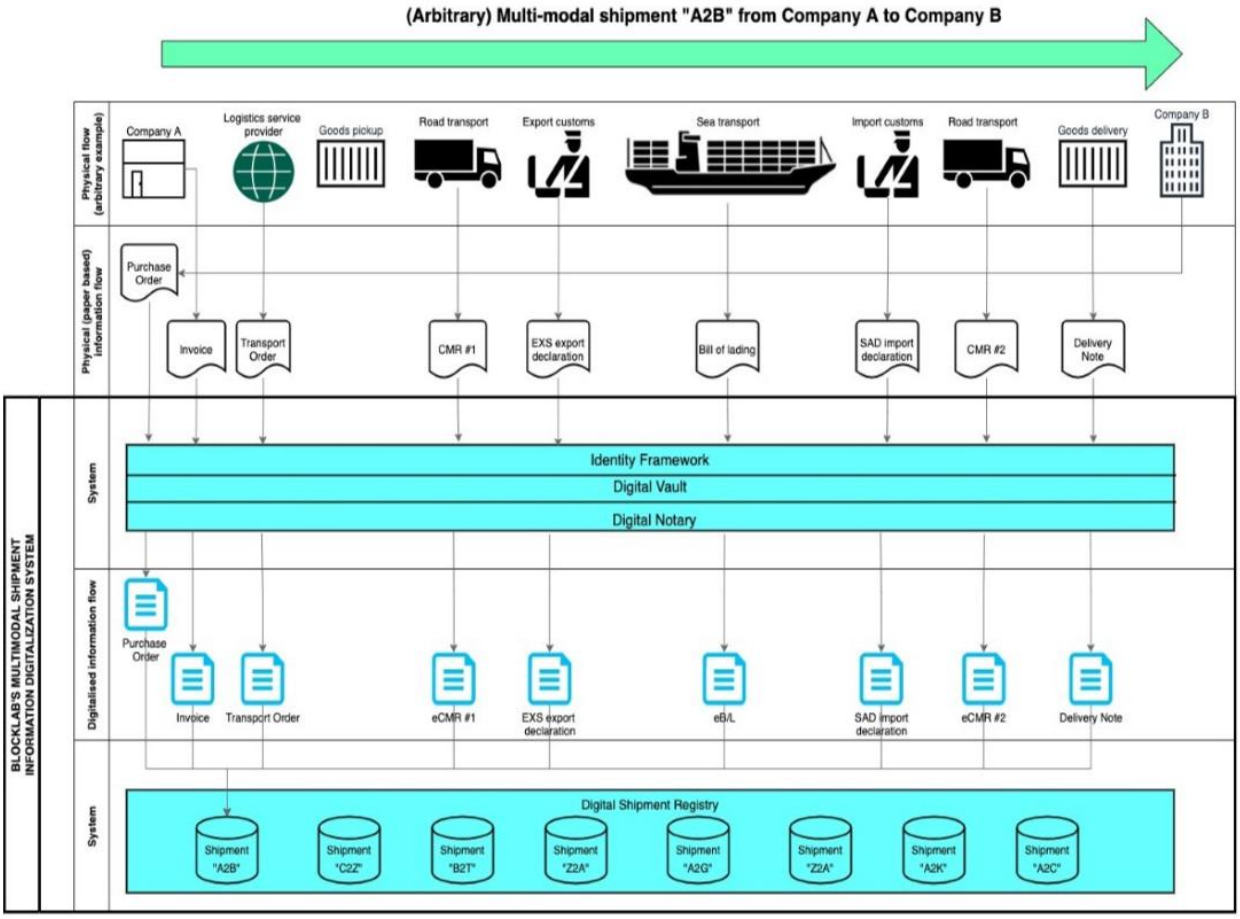

Figure 4: Shipment document collection and digitalisation

The following illustration visualises the core of the digital infrastructure of logistics, connecting various public and permissioned blockchain based platforms via the overarching EGTN platform (see *Figure 5*). Each of these platforms supports their own regional logistic community. Logistic events are first notarized in one of the blockchains, before being forwarded to the connected platforms. Finally, these events are validated by data injected from IoT devices attached to the cargo and logistic assets.

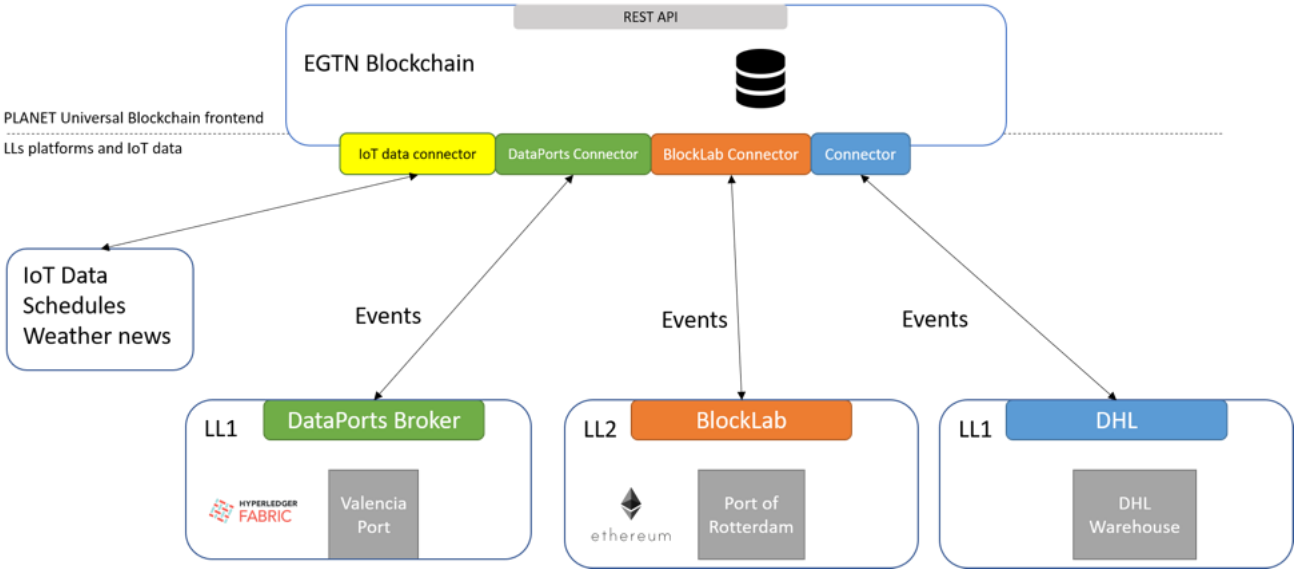

Figure 5: Architecture of digital infrastructure for logistics, sharing logistic events between platforms validated by IoT devices

Concluding Remarks

Utilizing the unique capabilities of blockchain technology, the developed platform as described in this chapter allows for the complete digitalisation of trade and logistics documentation, and for an integrated, interoperable EU-wide digital infrastructure for logistics. Operational errors, delays, and waste of paper-heavy processes, such as customs declarations or rail transport document collection, can become a thing of the past.

With the platform and the external system integrations, steps 1, 2, 3 and 5 towards synchromodal dynamic management can be achieved. Those steps respectively being: sharing shipments, sharing logistic events, real-time determination of state of logistics, and automated document distribution that can take place after a synchromodal management algorithm schedules and allocates the logistic movements for the next time epoch.

The business value

In this chapter we describe the business value for both of the solutions developed within Living Lab 2 (LL2).

Brexit

First and foremost, the business case, centers around the health & safety of the people involved in the import and export of goods between the continent and GB. We will not put a monetary value on the lives of the tens of thousands involved in the day-to-day operations that ensure, even under the difficult conditions in a pandemic, we have food to eat, clothes to wear and medicine to take; instead we argue that digitization has proven itself as a way to deal with these exceptional conditions, allowing companies and authorities to continue their operations while their employees are at home.

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 Deliver5 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.

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

- 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.

Eurasian rail transport

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%[6] since 2014 (see *Figure 6)*.

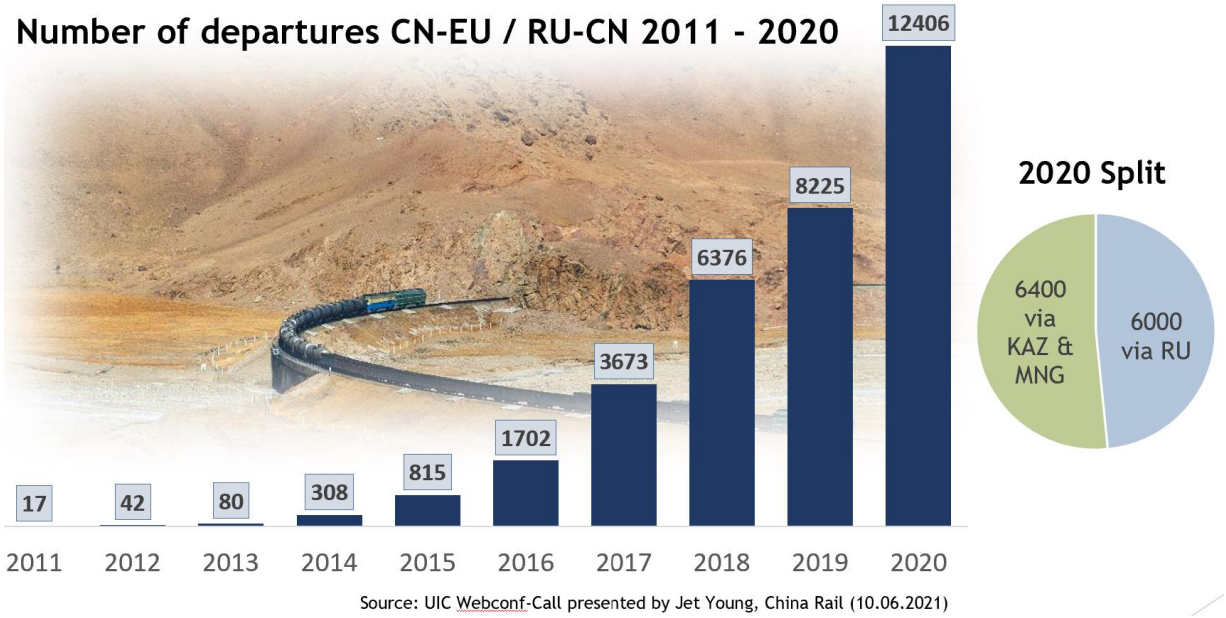

Figure 6: Growth of train traffic EU / RU to CN

[6] 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.

The growth of intermodal transport between EU and Asia is significantly growing (see ***¡Error! No se encuentra el origen de la referencia.***).

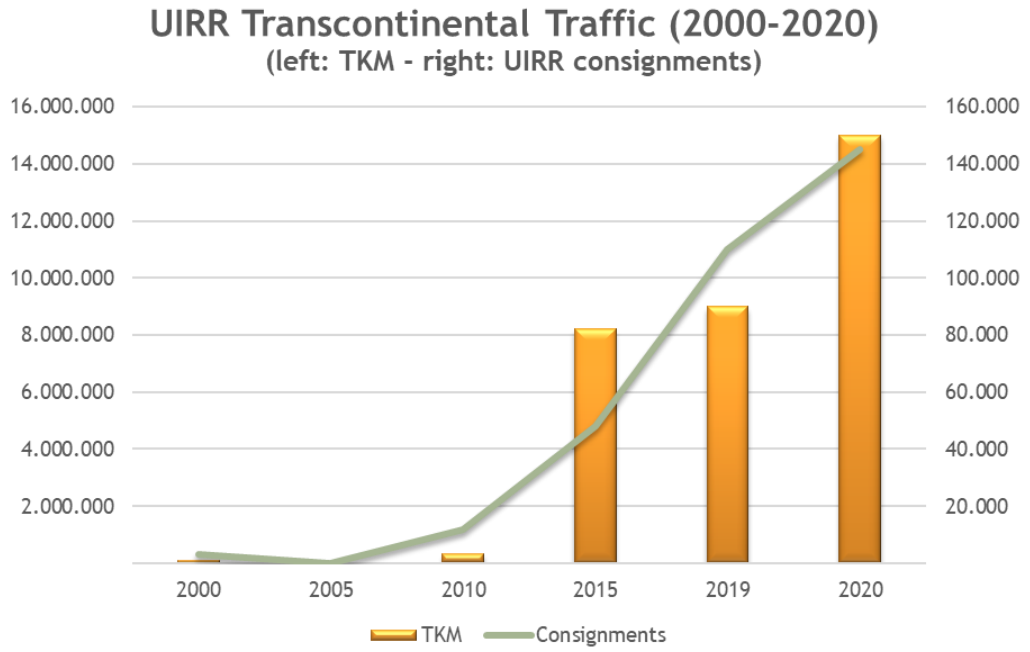

Figure 7: Growth in shipping volume[7]

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)[8].

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.

[7] 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).
[8] UNCTAD (2021) "Review of Maritime Transport 2021", p. 15, United Nations, Geneva.

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 *8*)[9].

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 8: Comparison of pollution impact[10]

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 longer or the same as sea freight, then we’ll lose the advantage” 11 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

[9] **https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_190325_STREAM_Freight_Transport_2020_FINAL.pdf**
[10] **https://cedelft.eu/wp-content/uploads/sites/2/2021/03/CE_Delft_190325_STREAM_Freight_Transport_2020_FINAL.pdf**
[11] **https://qz.com/2102636/supply-chain-chaos-spurs-china-europe-rail-freight-revival/**

to $15,000 USD in July 2021, according to data presented at the European Silk Road Summit held on Dec. 7-8 2021[12].

As shows *Figure 9*, current political constraints are likely worsened by process and data interoperability issues demand for activities to counteract and mitigate the potentially downward spiral.

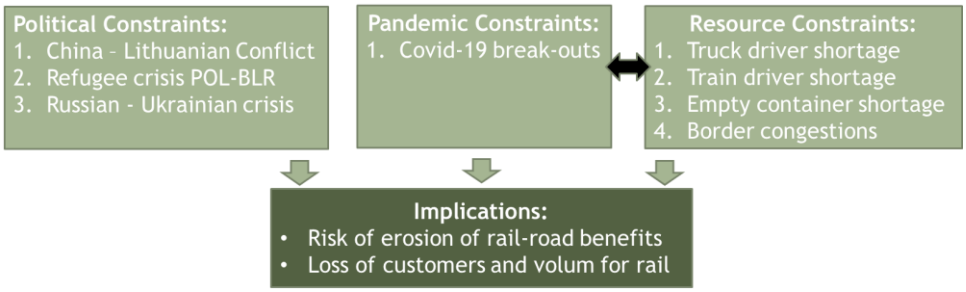

Figure 9: Recently political and pandemic constraints

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.

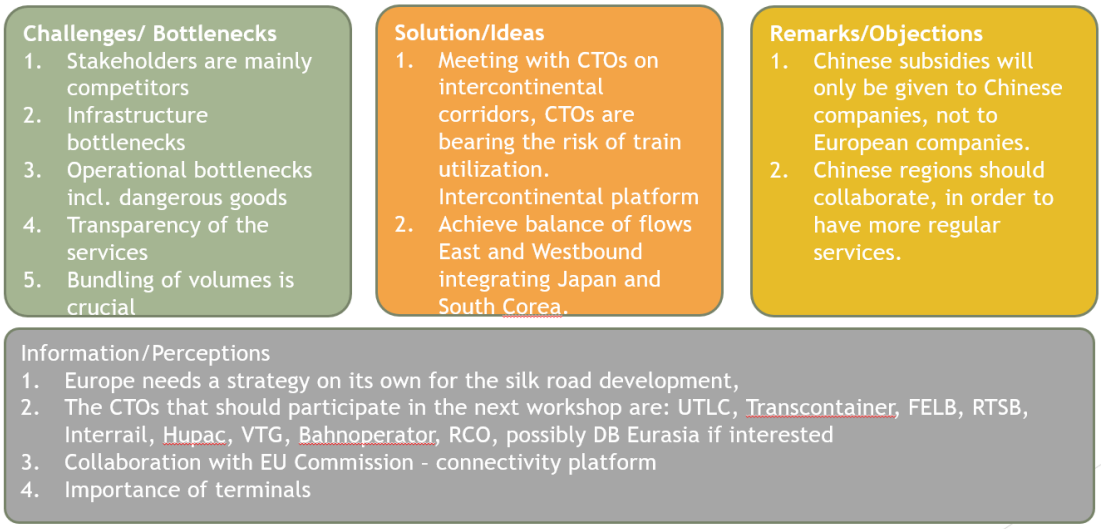

Figure 10: Workshop Result (1/2)

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

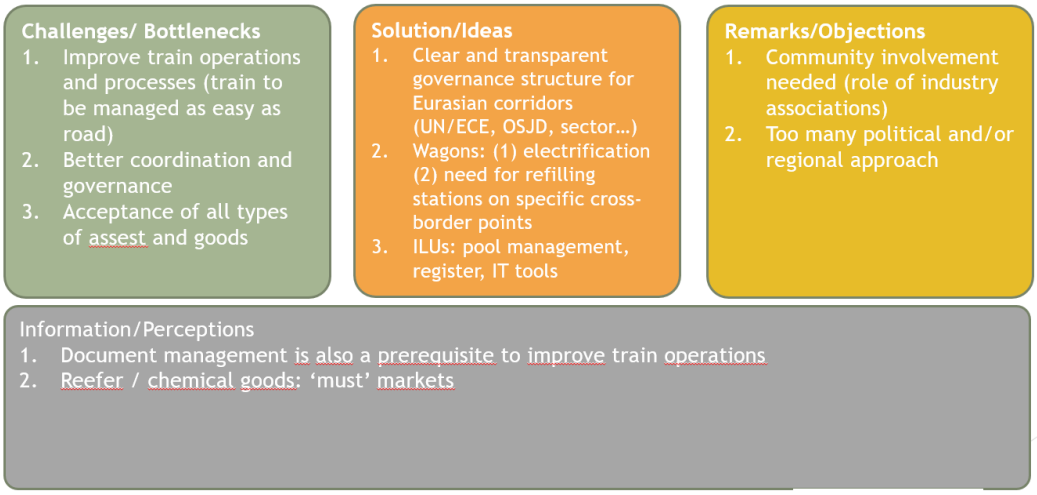

Figure 11: Workshop result (2/2)

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[13] 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.

[13] 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**).

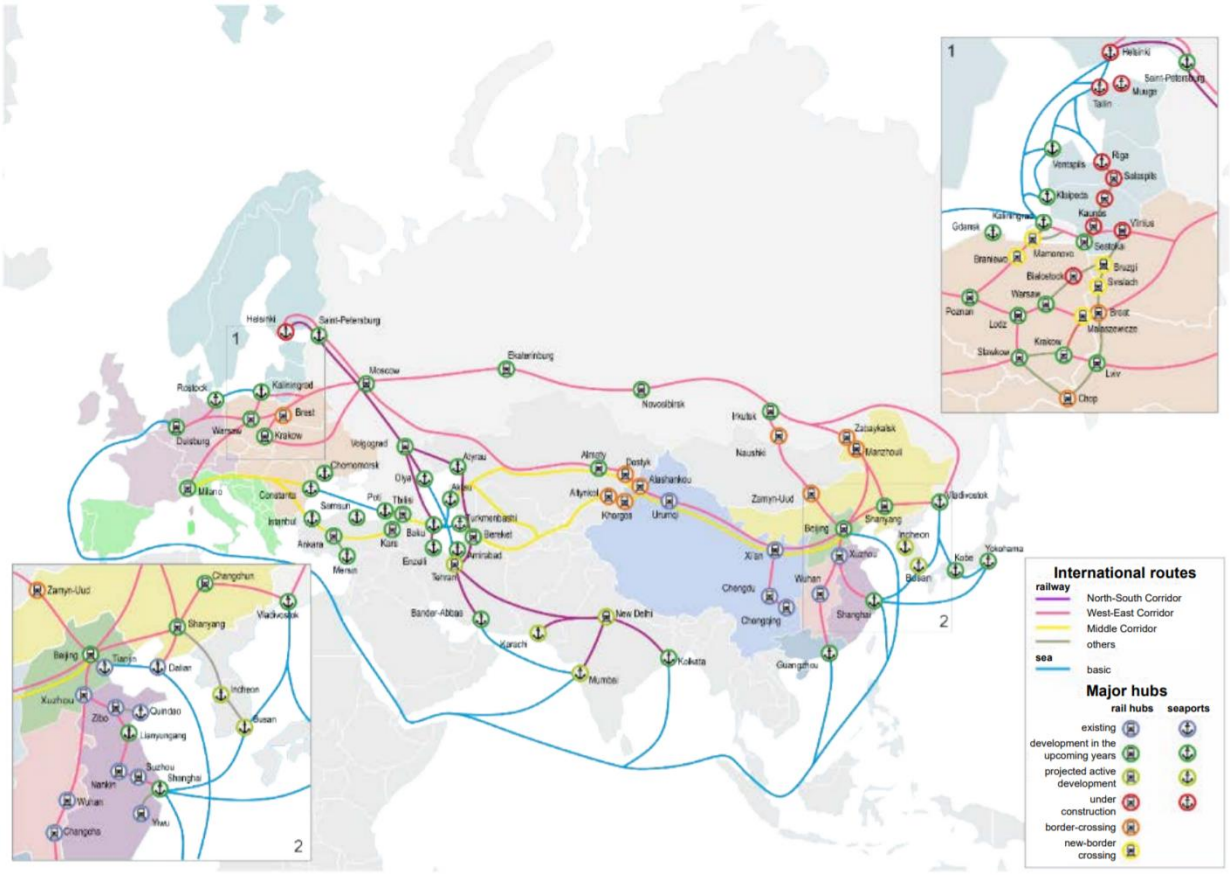

Figure 12: Major new transit routes: Use Case 3 implications for European corridor planning

Conclusions and next steps

In conclusion, paper-based processes lead to inefficient logistics as emphasised by Brexit, Covid and Eurasian rail transport, that eventually lead to devaluation of cargo and the preference for the more polluting sea alternative. It also prevents the implementation of synchromodal management, as a huge amount of logistic data is needed for real-time multimodal optimisation on any scale.

The Living Lab partners see blockchain technology as a key part of the solution to combat paper-based inefficiencies, as it provides a way to reliably notarize logistic and document events, and share them over the common-frame-of-reference with all connected stakeholder systems. This leads to regional awareness of the logistic and document state of any planned shipment, and allows for the collection of regional events to generate an overview of the state of logistics on EU scale. The latter being the first step towards synchromodal management – knowing what cargo, needs to go where, and when, and which documents are involved. The second, yet to be developed, step is to design and implement synchromodal plannings algorithms that allocate cargo over assets and their routes for a certain time window. The last step is to exchange the right shipment documents with the right LSPs and authorities for the execution of the shipment according the synchromodal planning, a feature that is already incorporated into the developed multimodal document exchange platform.

By digitizing paperwork and sharing data electronically, congestion and waiting times can be reduced, and goods can be shipped more efficiently, reducing costs, waste, and improving visibility for stakeholders and for the enabling of synchromodal management. Once implemented, synchromodal management by itself can lead to great improvements in terms of efficiency and cost reductions. This will also iron-out the information and time inefficiencies on the EU-RU-CH trade lane, making rail transport not only a greener, but a faster alternative for sea transport. However, there are challenges to overcome, including standardization and technology gaps in the rail industry, as well as political and pandemic-related resource constraints. Through strategic planning and use of tools like PLANET, stakeholders can work towards improving and optimizing rail traffic in the future.

Authors and main contributions

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About PLANET

PLANET addresses the challenges of assessing the impact of emerging global trade corridors on the TEN-T network and ensuring effective integration of the European to the Global Network by focusing in two key R&D pillars:

- A Geo-economics approach, modelling and specifying the dynamics of new trade routes and their impacts on logistics infrastructure & operations, with specific reference to TEN-T;
- An EU-Global network enablement through disruptive concepts and technologies (IoT, Blockchain and PI, 5G, 3D printing, autonomous vehicles /automation, hyperloop) which can shape its future and address its shortcomings, aligned to the DTLF concept of a federated network of T&L platforms.

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