PLANET TEN-T Revision

2023

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PLANET WHITE PAPER FOR THE TEN-T REVISION

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

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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 Citizens 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

Executive Summary

The present document is a summary of the results of the work undertaken in the context of PLANET, a H2020 project. 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 taking into account: **a)** the Geo-economics aspect and the related dynamics of new trade routes affecting logistics infrastructure & operations, and **b)** a specific new operational model of TEN-T and EU-Global network enabled through disruptive concepts and technologies which can shape its future and address its shortcomings.

The purpose of this white paper is to share the findings and knowledge produced in PLANET in relation to the future TEN-T evolution principles in order to reach the characteristics of the EU Global Transport & Logistics network (EGTN) as defined by PLANET and contribute to the sustainable development of the EU economy and of the transport and logistics sector. Thus, this document aims at contributing to the planning and the development of the future TEN-T in the context of the ongoing process of the TEN-T regulation revision to which PLANET participated in the public consultation.

PLANET knowledge contributing to future TEN-T development

The vision for an Integrated Green EU-global Transport & Logistics network

PLANET defined the vision for the Integrated Green **E**U-**G**lobal **T**ransport & Logistics **N**etwork (**EGTN**): it consists of a globally connected network that is intelligent but not just in terms of technology and innovation implementation on operations. It will be also "intelligent" in terms of global geo-economic & geopolitics awareness and of the ability to anticipate future developments. Moreover, it will have the ability to self-assess and prioritise its development while being able to timely react to external or internal stimulations like a living organism, with the ability to constantly adapt to changing circumstances of all kinds (short- and long-term disruptive events). It will be a network that will achieve more with less as far as the consumption of resources and the impact to the environment is concerned and finally, it will be a network that will be for everyone, both in terms of participation to its governance and in terms of being able to properly serve/support the development of the entire EU community.

In this context, achieving/transitioning towards EGTN is not just a physical network infrastructure planning and development issue. It is also the formulation of a new Transport & Logistics community collaboration at local and regional level for better managing transport and logistics related resources and infrastructure through technology and innovation adoption.

Achieving EGTN requires different rationales for private and public investment decision making along corridors and at nodal points of the Pan-European network. This rationale should be based on common understanding of risks and mutually agreed strategy of Transport & Logistics ecosystems for achieving efficient and resilient operations along the TEN-T corridors and at TEN-T nodes, making them attractive to global flows and also technology driven for reducing negative impacts through the increase of the efficiency of operations. Planning for EGTN requires new tools able to estimate the impact of the technology to operations and to align business objectives with public decision making for investing to soft and hard infrastructures.

The global corridors considered to be converted and integrated to the TEN-T are:

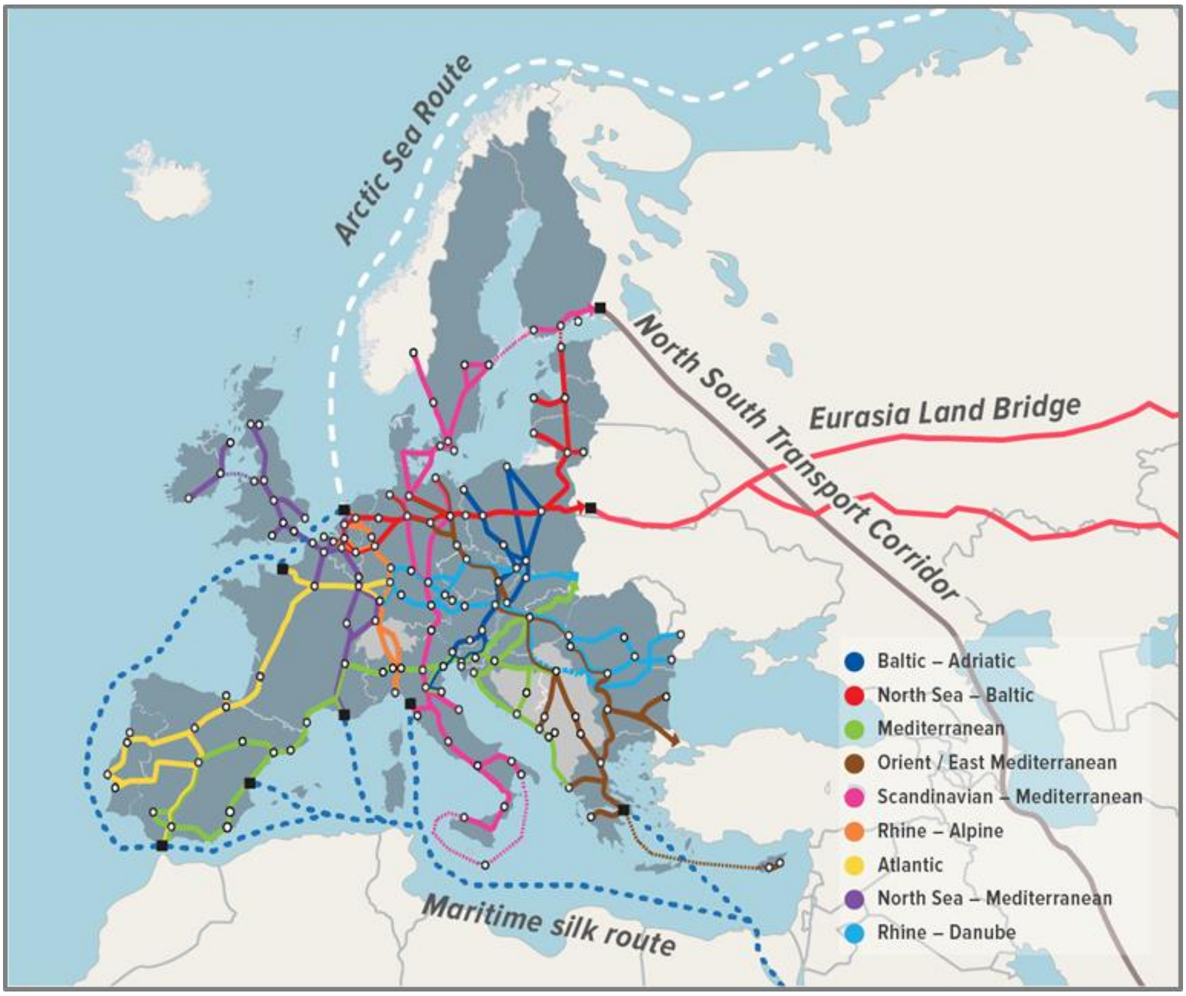


Figure 1: Emerging global corridors considered in the context of PLANET: the Eurasian Land bridge, the Arctic Sea Route and the North-South Transport Corridor

Main uncertainties and challenges for transitioning to the TEN-T of the future

Transition towards EGTN

The TEN-T of the future requires efficient planning under uncertainty. Within the context of the PLANET project, the main future uncertainties have been identified which are expected to affect future freight flows and the TEN-T network development. These critical uncertainties cover all aspects, i.e., social, economic, environmental, political, technological and were used to draw plausible alternative future scenarios for the time horizon of 2030 which were then simulated through the strategic modelling capability of the project.

More specifically, according to the analysis performed, Europe's Transport & Logistics Network needs to face risks/uncertainties in the following main areas:

- Climate change; impacts may reduce the availability of inland waterways
- Disruptive events in congested networks due to man made interventions, such cyber attacks or mistakes (like the Ever Given Suez Canal incidence); may cause the emerge of alternative networks dealing with disduptive events
- EU economic development; should adapt to the meta-globalization period
- Digital transformation/ innovative Transport & Logistics concepts & technologies
- Geo-political parameters; may affect the T&L network operation and the regional economy growth
- Global development
- Development of disadvantaged regions in EU

During 2022, Europe experienced multiple crisis which explains how all of the above uncertainty areas areas connect with each other and the invasion of Russia in Ukraine can serve as an example. Port and transport infrastructure have been severely affected, either by brutal missile attacks, as well as by sanctions by the European Commission against Russia. Both have had a paralysing effect on significant parts of the transport and logistics network, and have also demonstrated the necessity to have alternative routes available for continuation of trade, e.g. to create humanitarian corridors. A scenario analysis methodology which has been set forward in the first foundational position paper of the PLANET project helps in analysing the consequences and impacts of temporary or permanent changes on the transport and logistics system.

In order for the transport and logistics network to be resilient to sudden shocks or more gradual shifts in trade patterns, there is a need to define the EGTN profile.

Integrated Green EU-Global Transport & Logistics Network Profile

Outlining the profile of a network that will be able to achieve the attributes described above and face the uncertainties described in the PLANET future scenarios, the project has concluded that appropriate provisions should be included in the EU policy and regulation in order for the network to be:

- **Responsive to changes**, by considering in its physical infrastructure development (planning process and operations monitoring) the impact of new trade routes and of the innovative technology and concepts implementation to logistics operations through scenarios creation and integrated simulations testing at micro (company) - and strategic EU - level.

- **Optimisation ready**, with increased efficiency of operations (cost, environment, time etc.) under the Physical Internet (PI) paradigm, implementing new technologies (blockchain, IoT, AI, drones, Hyperloop, 3D printing etc.) and concepts (collaborative logistics, shared capacity models, synchromodality, multimodality, intelligent PI nodal points etc.).
- **Resilient**, dealing with: 1) regional/periodical infrastructure capacity shortages, 2) uncertainties with low predictability (accidents, natural disasters, political instability) and partially predictable uncertainties through scenarios simulation (climate change impact, international foreign relationships, geo-economic changes) and 3) dominance over freight flows of a single country/region/company.
- **Oriented towards facilitating exports**, besides facilitating import flows (mainly from China) which is the dominant orientation of the EU network today (especially to the port sector), helping to achieve trade balance with China and support regionalisation as counterpart of the globalisation of economy.
- **Bridge business/industry needs for planning to the EU policy and infrastructure planning**, taking advantage of the unique knowledge which businesses/industry have regarding real logistics operations in order to achieve consensus among stakeholders and to support decision making for (hard and soft) infrastructure investments. At the same time, it will feed this knowledge at a higher (strategic) level in order to create awareness of the industry needs and thus align EU policy and infrastructure planning to these needs to the extent possible.
- **Supporting social cohesion & inclusiveness**, being inclusive by design, ensuring accessibility to disadvantaged regions and their development in alignment to the European social cohesion policy.

Future TEN-T as part of EGTN

Future TEN-T is a structural part of the EGTN (network of global-EU connected corridors) with specific characteristics as defined in EGTN profile (globally connected, resilient to disruptions, export oriented, optimal in capacity use through technology implementation and technology enabled business collaboration, highly interconnected, etc.).

PLANET is proposing an **EGTN configuration** for fulfilling these network characteristics for the 2030-time horizon. For this configuration the following are provided:

1. **A Physical network description (links of all modes, nodes & global connections).** The core TEN-T network needs to be further extended to include more physical nodes and new gate points in alignment also to the relevant provision in the proposal for the TEN-T regulation revision. EGTN 2030 network includes proposals for such extensions based on the analysis of the results of future scenarios simulation. Moreover, PLANET considers that the selection of additional nodes should be made taking into account rational network connectivity and accessibility metrics and suggests such type of metrics to be used, like the Corridor Connectivity Index (CCI) briefly described below. The CCI will also be used to assess the accessibility of nodal points of lower importance (today) that will be proven necessary in the future for realistically defining the operationalization of a new type of multimodal Physical Internet nodal points proposed by PLANET.
2. **Priority corridors for (PI inspired) technology implementation**. These are the corridors that should have a priority in technological investments because they provide the best prospects for achieving high efficiency.
3. **New multimodal Physical Internet nodal points of TEN-T**. Extended TEN-T comprehensive network of nodal points at selected regions, implementing efficient green intermodal solutions in the context of a collaborating ecosystem that is involved in the infrastructure and technology development and operation.
4. **Clustering of nodes in the new entry points**. A vision for achieving cooperation between existing and new terminals/nodes that will be created in the new entry points for serving the increasing flows of the Eurasian land corridor in order to better utilise infrastructure and support regional development.

These network configurations of EGTN will be strongly supported in terms of decision making and planning as well as their operationalisation under the PI paradigm by a **cloud-based Open EGTN technological infrastructure (platform)** that was developed in the context of the PLANET project.

EGTN & TEN-T paradigm network for 2030

Within the PLANET project, several global routes have been analyzed that will have an impact on shifting transport flows within Europe in the future. Special attention is devoted to the Chinese Belt and Road Initiative (BRI), the potential Arctic sea route and the International North-South Transport Corridor.

The drive behind the BRI is described as fostering economic and trade growth by strengthening transport and logistics ties between China and the larger Eurasian hemisphere. Currently, the most important intercontinental railway corridor connects the EU and China through Poland, Belarus, Russia and Kazakhstan. Apart from more covert motivations, the fact that rail is cheaper than air and faster than ocean motivates additional BRI rail expansion and factors such as occasional capacity shortages in ocean and air freight are strengthening rail's appeal. Nevertheless, important challenges such as infrastructure shortfalls and delays and congestion at EU arrival terminals remain and EU shippers see additional obstacles such as import sanctions between the EU and Russia.

Results from the PLANET modelling exercise demonstrate, for the base year, to which PEP the import flows from China are currently heading (see *Figure 1*). The impact of this route will only increase in the future with the introduction of more Eurasian services between the existing PEPs; the development of new PEPs, especially in the Eastern European countries of Hungary, Slovakia and Romania; and the further expansion of the Middle Corridor, which will bring cargo via the Caspian Sea and either via the Black Sea or overland via Turkey to Europe.

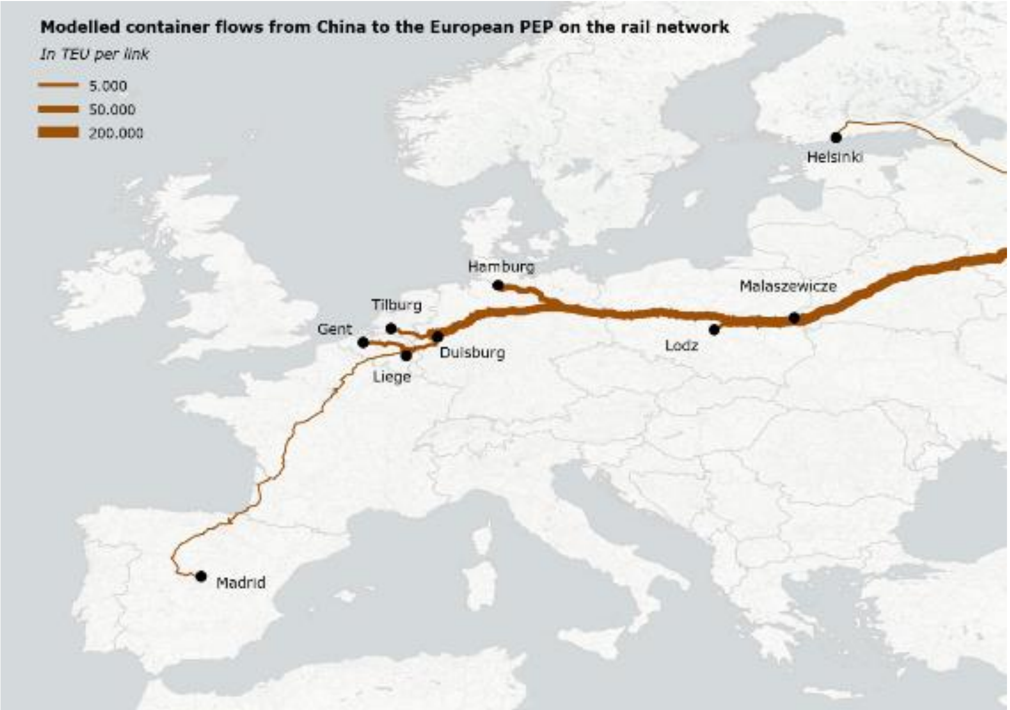


Figure 2: Modelled container flows from China to the European PEP on the rail network as it was before the war in Ukraine.

The analysis of the PLANET project showed that it is in particular the BRI that will define the EGTN vision in 2030 and beyond. The expected volumes on this route necessitate sustained efforts to accommodate these flows on the TEN-T network, part of which will be combining intra and intercontinental movements, which will also heavily rely on digital solutions as well as infrastructure development.

During the corona crisis, rail transport on the BRI was flourishing, mainly due to the incredibly high sea freight rates. But in early 2022, the route suffered a setback. As a result of the war in Ukraine, Eurasian rail freight transport came to a virtual standstill. Due to the fact that other Eurasian rail corridors are not sufficiently developed- the Middle Corridor can only handle up to 5% of the maximum capacity of the main route - no good land-based alternative can be offered at the moment, causing cargo that previously went by rail to travel by sea or even by air to Europe. This development highlights the importance of a resilient network, an integral part of the EGTN vision.

As mentioned before, the war in Ukraine has resulted in a virtual standstill of the Eurasian rail freight transport. Shippers have three alternatives for avoiding Russia in Eurasian (rail) transport operations: (1) Shift from Rail to Sea transport (2) use the Middle Corridor as an alternative or (3) shift from Rail to Air transport.

These alternatives have impact on the transport operation; all three alternatives bring additional costs. Since the closure of Russian and Ukrainian airspace, the rates in air transport are significantly raised making air transport an unattractive alternative for the Eurasian cargo transport. The higher demand for sea transport resulted in sea freight rates for westbound traffic around $ 12.000 per EU (as of April 2022). Normally, these are around $ 1.000 per FEU. Shippers collectively incur an additional cost of € 46 million per month due to the current higher sea freight rates. In practice, the costs will be even higher, since a proportion of shippers will opt for air freight the cost of which is four times higher. Sea transport from China to Europe takes twice as long as rail transport (~40 vs ~20 days). Therefore, shippers lose € 52 million a month in value of time. The Russian railways, as a result of a shift to sea transport, miss out € 720 million per year on transit fairs.

Based on the PLANET model it is expected that most cargo from China is to shift from rail to sea, especially in the routes to the hinterland of the Hamburg-Le Havre range. As mentioned before, the Middle Corridor can only handle up to 5% of the maximum capacity of the main route. The Caspian Sea is bottleneck and also Bakou-Tbilisi-Kars line between Azerbaijan, Georgia and Turkey, as well as the port in Constance are overloaded due to the pandemic and the war in Ukraine. In *Figure 2* below the container volumes on the Middle corridor in 2021 and the % growth compared to 2020 are shown. It is important to realise that EGTN can reduce the barriers on this corridor by reducing lead times. At the same time the Middle corridor is important as it provides access to the landlocked countries of Central Asia.

Figure 3: Container flows on the Middle corridor in 2021 (in thousand TEU) and % growth in relation to 2020 in 3 different sections

As for the Arctic route, optimism has been growing that it might form a supplement to the much more time-demanding Suez-canal route. However, the greatest impact for the Arctic on TEN-T lies not in transit traffic but in the raw materials that come from this region, especially energy-related raw materials. Russia has plans to more than triple the amount of raw materials extracted by 2030. However, Russia at the same time plans facilities to be able to process the raw materials on its own soil, so that transport to Europe will no longer be necessary. Also, taking into account that Europe wants to significantly reduce its dependence on Russian energy as a result of the Ukrainian war, the impact of this trade route on TEN-T in 2030 is considered negligible.

Last, the International North-South Transport Corridor (INSTC), a 7,200-km-long multi-modal network of ship, rail and road route for moving freight between India, Iran, Afghanistan, Armenia, Azerbaijan, Russia, Central Asia and the Baltic sea area in Europe, may be another site of international rail expansion. At present, this route is not yet in use. In the event that this route does come into use in 2030, its impact on TEN-T will be limited, because the volumes of high-value goods from India to the countries in the Baltic Sea are too small to run shuttle trains on a regular basis.

Definition of a priority network for guiding technological investments to the PI network development

With respect to the logistics operations, the EGTN will be a network with an increased development of collaborative logistics as a backbone of the PI concept implementation. The PI concept not only makes use of (smaller) standardized load units (pi-containers), but also builds on the availability of open and integrated networks that connect freight transport origins and destinations. In this context, the PI is based on the physical and digital collaboration between different actors in the supply chain along the corridors, through sharing information and resources such as transport capacities or storage areas.

However, EGTN has a realistic approach toward the PI concept implementation, acknowledging that it is not feasible to implement the PI concept to the entire network by 2030. For this reason, EGTN will be a network that has prioritised corridors and nodes for PI development. Based on current and forecasted flows, it defines a subnetwork of corridors and nodes that will benefit the most from the PI in order to establish policies and to provide incentives for the development of PI infrastructure and services.

As a first step toward PI, the deployment of Synchromodality is envisioned which allows for the dynamic deployment and routing of a variety of transport modes (using various infrastructures, renewable energy sources, and specific vehicle or vessel technologies, including automation). In this manner, the core network is more than the sum of the individual mode infrastructures. These innovations require investments both in physical and digital infrastructures, first to be targeted at selected corridors as stated above.

Recognition of design of digital infrastructures as counterpart to physical infrastructures requires even more explicitly the involvement of stakeholders of freight and person mobility. In addition, private and public investments in digital infrastructures are currently interwoven and require careful consideration of the public stake in developing and upholding digital connectivity.

New type of PI enabled collaborative nodal points

Integral part of the PLANET's EGTN vision is a new type of intelligent PI nodes/hubs which will replace the node concept as it is applied today in the TEN-T policy (as individual modal or intermodal terminal(s) in a specific location of the TEN-T corridors).The development of new typelogy of EGTN nodes beyond the definition of the urban nodes of the TEN-T is aiming at increasing network resilience (both in terms of capacity availability & handling unexpected operations disruptions) and also the enhanced economic, environmental & social efficiency of freight transport operations. These PI nodes/hubs include:

1. **A set of transport infrastructure assets** (e.g., ports, intermodal stations, warehouses, transportation links) supporting logistics operations in a specific geographical area or located along a corridor.
2. The **technological infrastructure** for supporting PI paradigm operations in logistics.
3. The **ecosystem of stakeholders** who are active and operating in this area, sharing interests and engaged collaborating towards the increase of the node efficiency and attractiveness through digitalization and PI enabled collaborative logistics.

More specifically, the vision of EGTN is to provide to the stakeholders of these ecosystems the knowledge and the tools to identify their common goals and to find common ground to establish trust-based relationships and reach consensus in investment policies, leading to in-depth collaboration and the implementation of resource sharing business models in alignment to the PI concept. These ecosystems will be open and digitally enabled, aiming to expand and ultimately include all other actors that are operating in the nodal point area, to jointly develop collaborative infrastructure and services for sustainable logistics.

Clustering of nodes and new entry points

EGTN involves the emergence new nodes/hubs in areas that currently have limited connection to global trade routes as well as better cooperation between the nodes/hubs. With the rise of Eurasian rail transport, container traffic now enters TEN-T not only through seaports, but through entry points for intercontinental rail. From there, cargo is transported to every corner of Europe.

At present, these Eurasian flows mainly go through the intermodal infrastructure that was already developed before the emergence of this intercontinental rail route, mainly in Western Europe. As the Eurasian route becomes more mainstream, areas that are currently less connected, but geographically well-situated to facilitate far east freight flows, will seize their opportunity to benefit from this global route. In this way, new nodes/hubs will emerge, mainly in Eastern Europe, to facilitate these global trade flows. The regionalisation of production and the commitment of European policymakers to the development of intermodal transport will only accelerate the development of nodes/hubs in this region. These new nodes/hubs and the connections to them are part of the EGTN.

A major bottleneck at the moment is congestion also due to poor infrastructure and operations level at the border points of intercontinental transport. Expanding the capacity of the border points themselves is a solution to this, but of course this is not an option in the short term. As more train connections to the Far East are established, also on routes that do not exist at the moment, more cooperation between the terminals is required. Shippers will operate from several terminals in Europe and thus divert trains when congestion at certain border points becomes too great. The organisation of cooperation between logistics parties, in which the digitalisation of logistics operations plays an important role, determines the extent to which the nodes will actually cooperate.

Of course, this is not only important for addressing congestion, but also for other hiccups in the logistics system, such as temporary stoppages or geopolitical developments that put parts of the route temporarily out of action. EGTN offers an integrated vision for terminal development where cooperation between terminals is key, so that the emergence of new terminals does not become a zero-sum game.

Implementing & monitoring balanced development of EU regions in the context of EGTN (EGTN / TEN-T operationalisation)

Competition among EU regions especially regarding the PEP areas

The attractiveness of nodes to the shippers depends on many factors, including the available intermodal connections to the hinterland, transport costs and personal preferences. All these factors determine the hinterland that belongs to a node. The generic pattern is that the closer a region is to a certain PEP, the more likely it is that trade flows to and from this region will pass through this PEP. But for more distant regions – regions that lie exactly between different nodes – this is less evident. These regions are located in the so-called 'battleground': i.e. regions that lie in the hinterland of different PEP nodes. PLANET shows which hinterland shifts will occur with the development of new trade routes and the emergence of PEP nodes.

Region development on the principles of inclusiveness

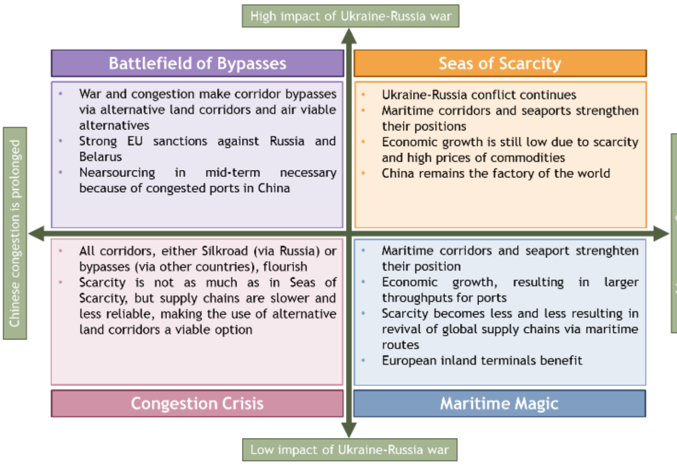
PLANET's EGTN is a network that is intended to be inclusive by design, ensuring accessibility to disadvantaged regions and facilitating their development, in alignment to the European social cohesion policy. This will be achieved by enhancing the regional dimension of logistics through the implementation of the new type of PI-enabled collaborative nodal points concept and the corresponding development of infrastructure and services. This will increase the connectivity and attractiveness of disadvantaged regions to freight flows, leading to economic development, job creation and development of workforce skills and knowledge.

Corridor Connectivity Index and attractiveness of regions, corridors, nodes

The current research gap identified by the PLANET project is that there is a need to get a grip on shifting trade patterns, not just by using macro-economic indicators, but using logistical performance indicators that actually can monitor a set of determining factors for connectivity of crucial nodes in the European TEN-T network vis-à- vis the trade routes that are connected with the TEN-T network via gateway ports.

The Corridor Connectivity Index (CCI) which is being developed in the PLANET project aims at capturing a transport node's level of integration in the TEN-T network as well as in the global maritime transport network, since accessibility and connectivity are indicators for the effectiveness of the transport network as an enabler for trade. A transport node's level of integration in the global transport network in CCI is manifested by its position in port capacity, efficiency and ease of processes, service frequency, distance to seaports and digital connectivity. Connectivity in CCI definition is based on input indicators, in the sense that we consider factor conditions. If it wasn't for these conditions to be in place an inland port would not have the opportunity to attract cargo. Therefore, we do not use costs and transit time, which are output indicators. Cost and transit time are the result of the conditions and facilities in an inland port. The index has been designed to help port authorities – both seaport as well as inland port authorities – to identify and improve their position in the network, and thereby improve the network. Moreover, monitoring and consolidating the CCI of the nodes in a corridor or a region, can be used as an indicator to assess the level of their overall connectivity and attractiveness.

To illustrate the use of the CCI, we have worked out 4 scenarios relating to the impact of the Ukraine-Russia war, presented in *Figure 4.*



Scenario impact on Duisburg (GER)

Component	Battlefield of Bypasses	% impact on volume*	Maritime Magic	% impact on volume*	CCI
Infrastructure		0%		0%	100,00
Port capacity		10%		20%	35,82
Efficiency		0%		0%	61,54
Service frequency		5%		10%	100,00
Centre of gravity		- 5%		10%	100,00
Green facilities		5%		10%	100,00
Digital connectivity		10%		10%	33,33
CCI		5%		13%	75,81

*) Percentage change is subject to experts' opinions

Figure 4: Scenarios Impact Ukraine-Russia war

Duisburg is the inland port which is best connected (through rail) over Russian territory, connecting EU to China. The left diagram shows the scenario logic. The right diagram combines the 7 subcomponents of the CCI with two of the scenario logics, namely the "Battlefield of Bypasses" and "Seas of Scarcity".

In "Battlefield of Bypasses", Duisburg needs to act upon the shift of main maritime/rail routes to bypasses. Rail connections to China become more important, especially via the Middle corridor. Near-sourcing might result in a shift of the centre of gravity. Moreover, there is a potential to improve/enhance green facilities and digital connectivity. There are early indicators for this scenario, such as the CEVA Logistics operations in the Middle Corridor with weekly departures. Also, Maersk has launched a rail service over the Middle Corridor. However, the capacity on the Middle Corridor could be a limiting factor. Inland ports with best connections to gateway ports have best opportunities to attract cargo. Duisburg, with a high score on centre of gravity towards gateway ports and good service frequency with seaports will manage to shift trade to maritime routes. However, improvement of railway and waterway capacity is needed in order for Duisburg to be able to handle even more volumes. Furthermore, there is a significant potential for green facilities on this corridor.

There is a need to get a grip on shifting trade patterns, not just by using macro-economic indicators, but using logistical performance indicators to monitor determining factors for connectivity of crucial nodes in the European TEN-T network

In conclusion, Duisburg would benefit more from “Maritime Magic” scenario as it is located in the optimal place for both seaports and inland terminals. “Battlefield of Bypasses” scenario would also result in more volume, but near-sourcing might impact this in a slightly negative way. Nevertheless, there are early indicators that Duisburg is currently setting up frequencies on the Middle Corridor.

The EGTN network of 2030

With respect to the significant nodes of the EGTN, the nodes identified through the strategic modelling simulations of the project combined with additional important inland nodes identified through the CCI that can support the orientation of the EGTN towards supporting EU exports are presented in *Figure 5.*

Another important conclusion from the disadvantaged regions analysis is that not specifically one terminal is best positioned to serve the disadvantaged regions and that there is sufficient market potential to pursue a broad development of multiple terminals in this region. Investing in multiple terminals in a region contributes to the resilience of the transport network by creating redundancy. If one terminal fails, the presence of additional terminals allows alternative routes to be used and maintains the flow of goods. Multiple terminals enable better distribution and localisation of goods, increasing the overall flexibility and resilience of the network.

Micro and macro simulation models of PLANET showed that the implementation of PI to enable syncromodal solutions along EGTN, efficient interferes between ports and hinterland and in collaborative last mile brings important benefits for T&L in Europe, i.e. increase efficiency of networks up to 20%, reduce CO2 of the operations at minimum 20% and working hours of operation activity by 26%. It also increases visibility by 20% and decrease supply chain suppliers by 20%.

Nevertheless, PLANET chose to have a more modest and realistic approach for the development of EGTN, in terms of the rate of development of the required PI enabling technologies implementations.

Therefore a prioritization approach was implemented for suggesting the TEN-T sections where PI technologies implementation should be promoted by priority. Based on link criticality, attached flow and importance to EGTN connectivity, a set of sections of the TEN-T which appear to be more significant for the development of the EGTN is created and presented in *Figure 5* (highlighted in grey colour).

Figure 5: Map of proposed nodes and links of revised significance for the realisation of the EGTN on EU corridors

Discussion on EGTN development for 2030-2050

EGTN aspires to be the realization of the vision of how a future TEN-T-based, EU-global transportation network should be and operate in order to support the EU strategic directions for the future. In this context, PLANET has identified at its early stages the need for achieving network attributes such as resilience, technology integration and global connectivity, even before the impacts of major disruptive events that changed the way we consider global logistics were identified. It has focused its work on developing network configurations and digital solutions towards addressing these requirements, which are reflected in all three constituting layers of the EGTN, namely the infrastructural, the technological and the governance layer. For this reason, the aforementioned outcomes and the knowledge that has been produced in the context of the PLANET can have a significant contribution to the TEN-T revision process that is aiming to define the EU transportation network of the future.

Future TEN-T should consider new critieria apart of the recorded level of freight volumes for introducing a nodal point to the TEN-T and therefore for having access to TEN-T and CEF funding. The comprehensive network of TEN-T needs to be expanded to include new areas of interest and the network nodes of increased significance for the development of EGTN as globally connected network. These areas include the Eastern and Southeast parts of Europe which are expected to attract the majority of the Eurasian rail route freight flows but also parts of Europe located in the Iberian Peninsula and parts of France and Italy on the Mediterranean that will also emerge as attractive for these flows once the PI concept will be extensively implemented. These areas together with the traditional trade areas in Northern Europe which will retain their role in the future should be the focus for the development of the EGTN.

It should be noted though, that in all initially simulated scenarios the projections of the rail future flows appear to remain low compared to maritime transport. Even in the future scenario when a significant development of the rail sector & rail infrastructure is foreseen, the volume of cargo coming from China through rail remains low in absolute terms, even though percentage-wise it shows a significant increase. This is mainly due to the fact that the development of intercontinental rail transport is not so much a matter of capacity availability (with some exceptions perhaps in specific points of the network) but more a matter of the lack of reliability and efficiency which increases the cost and time parameters of rail transport. And it is at this point where innovative technologies implementation and concepts like the PI can provide a solution by enhancing and supporting the logistics processes, optimizing the use of existing infrastructure and leading to greener and more efficient systems as has been proved through the extensive technology simulations and also the LLs testing of the project.

Having said the above, regarding the question of whether technology can reduce the need for public funding in hard infrastructure, the answer is that technology can improve processes that need to be improved (e.g., customs processes) regardless of the possible need for hard infrastructure investments (e.g., new rail lines or terminals). Through this process improvement, indeed some hard infrastructure bottlenecks will be alleviated by a better use of the existing infrastructure without the need of additional infrastructure funding but since the current capacity in most cases is capable of handling the foreseen future additional flows, the level of the possible investment reduction in hard infrastructure in the short/medium term cannot be determined with certainty.

In addition to the above, based on the simulation results of the final and enhanced future scenarios in which the technological implementation together with the policy and legislation initiatives impacts has been considered for calculating future flows, it appears that technology has the potential to significantly alter the mode selection for the cargo flows originating from China. The analysis shows that for the high value products the area of the EU where rail transport costs are lower compared to maritime transport becomes significantly larger, reaching areas which are served through the sea for many years now. This fact is expected to have a major impact in the long term to the mode selection for Eurasian flows and thus for the rail network within the EU, especially when the western regions of China which are far from the shore increase their production.

Therefore, the attractiveness of rail transport for the Eurasian cargo due to the efficiency increase emerging from the technology implementation may have an opposite effect in the long term; instead of reducing the need for hard infrastructure investments, the increase of rail flows may create the need for additional funding of the already congested EU rail network in order to support the increased flows. Given also that the EU network development over the past decades has been focused on maritime transport and the port-hinterland connections by allocating significant funds in their development, the policy decisions regarding the time horizon for the intercontinental rail development should be carefully considered by the EU.

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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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