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SETRIS PROJECT

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1	Newcastle University	UNEW	UK
2	European Conference of Transport Research Institutes	ECTRI	Belgium
3	AVL List GmbH	AVL	Austria
4	BMT Group Limited	BMT	United Kingdom
5	Centro National de Competencia en Logistica Integral	CNC-LOGISTICA	Spain
6	The European Earth Friendly Logistics Association AISBL	CO-TREE	Belgium
7	Stichting Dutch Institute for Advanced Logistics	DINALOG	Netherlands
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9	Forum des Laboratoires Nationaux Europeens de Recherche Routiere	FEHRL	Belgium
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12	Promotion of Operational Links with Integrated Services	POLIS	Belgium
13	Ships & Maritime Equipment Association of Europe	SEA EU	Belgium
14	Union Internationale des Chemins de fer	UIC	France
15	Union Internationale des Transports Publics	UITP	Belgium
16	The Association of the European Rail Industry	UNIFE	Belgium
17	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	Netherlands
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Final	05.08.2016	Quality Assurance Process	ALICE AISBL

* CO-TREE has changed the name to ALICE AISBL

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GLOSARY AND DEFINITIONS:

ACARE: Advisory Council for Aviation Research and Innovation in Europe**.** Air ETP (http://www.acare4europe.com/)

ALICE: Alliance for Logistics Innovation through Collaboration in Europe. Logistics ETP. (www.etp-alice.eu)

DTLF: Digital Transport and Logistics Forum (http://ec.europa.eu/transport/media/news/2015-04-15-setting-up-dtlf_en.htm)

ERRAC: European Rail Research Advisory Council. Rail ETP. (http://www.errac.org/)

ERTRAC: European Road Transport Research Advisory Council. Road ETP (http://www.ertrac.org/)

ETPs: European Technology Platforms.

SRIA: Strategic Research and Innovation Agenda.

WATERBORNE: WATERBORNE ETP (http://www.waterborne-tp.org)

DEFINITIONS:

European Technology Platforms. European Technology Platforms (ETPs) are industry-led stakeholder fora recognised by the European Commission as key actors in driving innovation, knowledge transfer and European competitiveness. ETPs develop research and innovation agendas and roadmaps for action at EU and national level to be supported by both private and public funding. They mobilise stakeholders to deliver on agreed priorities and share information across the EU. (http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=etp).

Internet of Things. The network of physical objects—devices, vehicles, buildings and other items—embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. (https://en.wikipedia.org/wiki/Internet_of_Things)

Physical Internet. Open global logistics system founded on physical, digital, and operational interconnectivity, enabled through modularization, standard interfaces and protocols, with the aim to move, store, produce, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient and sustainable. (http://physicalinternetinitiative.org/)

Shipper: Manufacturers, retailers and wholesalers, and in general cargo owners who sends goods for shipment, by packaging, labelling, and arranging for transit, or who coordinates the transport of goods.

Synchromodality. Synchromodality, or synchronized intermodality, is the optimally flexible and sustainable deployment of different modes of transport and hubs in a network in which the user or customer (shipper or forwarder) is offered or can directly access to an integrated solution for his (inland) transport. It involves informed and flexible planning, booking and management, that allows to make mode and routing decisions at the individual shipment level almost in real time. (http://www.synchromodaliteit.nl/en/definition/) and (http://www.etp-logistics.eu/?page_id=79).

EXECUTIVE SUMMARY

This document provides a holistic overview of a truly integrated transport system as the vision to reach significant advance in terms of efficiency, effectiveness and sustainability of freight transport and logistics, creating value and adding competitiveness to all manufacturing and retail sectors in Europe and supporting the achievement of societal challenges associated to freight transport.

Freight transport and logistics is the link between different processes in the value chain of goods from raw materials to finalized products and end of life management. Transport needs to be seen from a systemic perspective allowing end-to-end solutions addressing first mile, long distance transport and last mile in the context of cities, regions, countries European and global trade.

Freight transport and logistics is key for European industry competitiveness and sustainable growth. According to the World Bank, the best 4 logistics performers are from the EU and out of the global top-10, 7 of them are from the EU in 2014 and 2016[1]. Keeping current European world leadership in logistics is key for European citizens' future. The EU is the world's largest exporter and biggest trader of goods[2]. However, it is estimated that in the next 10-15 years, 90% of the world's growth will come from outside the EU, so the EU has every interest in making sure that its companies remain very competitive and are able to access new markets and benefit from these sources of growth. It is estimated that logistics account for 10 to 15% of the final cost of finished goods hence competitiveness of industry sectors (such as the automotive and the food industries) relies heavily on the performance of freight transport and logistics. In this sense, a 10% to 30% improvement in efficiency in the EU logistics sector would potentially equal a € 100 – 300 billion cost relief for the European industry and also reducing 15% to 30 % CO2 emissions.

The aims to achieve the truly integrated transport system for sustainable and efficient logistics are:

- To maximize the efficiency and effectiveness of freight transport system supported by current infrastructure, including corridors and hubs, and maximizing socio-economic impact of future infrastructure developments.
- To maximize the support to EU policies, in particular transport, energy and environment policies by increasing vehicles´ load factors, asset utilization and minimizing empty travels increasing overall system sustainability i.e. progressing towards low carbon low energy transport system, reducing congestion, improving safety and security as well as increase competitiveness of European industry, supporting growth.

A truly integrated transport system for sustainable and efficient logistics is defined as follows:

A truly integrated transport system for sustainable and efficient logistics is based on an open and global system of transport and logistics assets, hubs, resources and services operated (in an open environment and framework conditions) by individual companies. They are fully visible and accessible to market players hence creating a network of logistics networks. Coordination of logistics, transport, infrastructure and supply networks aim to move, store, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient, secure and sustainable. The system will be based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation interfaces and protocols[3].

[1] World Bank "Connecting to Compete 2014" and "Connecting to Compete 2016". https://wb-lpi-media.s3.amazonaws.com/LPI_Report_2016.pdf & http://lpi.worldbank.org/

[2] Strategic approach for Horizon 2020 - a contribution from foresight. Ref. Ares(2014)1202380

[3] See the Physical Internet concept: http://physicalinternetinitiative.org/ and www.etp-alice.eu

To address the definition, this document includes:

- Key characteristics, components and requirements of the truly integrated transport system for sustainable and efficient logistics in the urban and long distance contexts (i.e. which are the problems and challenges, what needs to change and into what needs to be changed)
- Key trends and policies impacting the process of its achievement.
- Key enablers and barriers identified.
- Key stakeholders addressing this concept, specific interests and their expected developments contributing to the fully integrated transport system for sustainable and efficient logistics.
- The contributions of the different transport European Technology Platforms, ETPs, to the achievement of the truly integrated transport system.

The document is targeting transport, logistics and industry stakeholders, the European Commission and Member States as main stakeholders concerned. The document has been prepared in the frame of SETRIS project and the contents have been reviewed and approved by the five transport ETPs:

1) ACARE (Advisory Council for Aviation Research and Innovation in Europe),
2) ALICE (Alliance for Logistics Innovation through Collaboration in Europe),
3) ERRAC (The European Rail Research Advisory Council),
4) ERTRAC (European Road Transport Research Advisory Council) and
5) WATERBORNE.

The purpose of the SETRIS project (SETRIS) is to deliver a cohesive and coordinated approach to research and innovation strategies of air, road, rail and waterborne transport modes in Europe. SETRIS seeks to identify synergies between the transport European Technology Platforms' (ETPs´) strategic research and innovation agendas (SRIAs) and between these and relevant national platforms.

As the next step to build on the agreement and consensus reached on this document, a Strategic Research Agenda and Implementation Plan will be prepared (SETRIS Deliverable D2.6) to pave the way towards the implementation and achievement of the truly integrated transport system for sustainable and efficient logistics defined in this document.

2. THE TRULY INTEGRATED TRANSPORT SYSTEM FOR SUSTAINABLE AND EFFICIENT LOGISTICS IN THE URBAN AND LONG DISTANCE CONTEXTS

In this chapter, we will address the key characteristics, components and requirements of the truly integrated transport system for sustainable and efficient logistics in the urban and long distance contexts. The elements included are addressing the system perspective. Consensus from the different stakeholders: users, service providers, terminals and transport mode operators has been reached on this. Specific improvements and contributions at modal level are not specifically addressed in this document as they are already addressed by the different agendas within the transport modes.

In Figure 1. main expectations on the truly integrated transport system for sustainable and efficient logistics are included from different perspectives (i.e. people, planet and profit perspectives).

People, as consumers, expect to get the products they want on time and intact therefore enhancing consumer experience and satisfaction. More and more, people expectations are also aligning with planet/profit related expectations in terms of decarbonization.

Planet and general society expectation is to increase both economic growth and sustainability. This requires to reduce not only environmental impacts: noise and emissions, but also energy consumption and increase renewable share in energy consumption.

From industry transport users' perspective (i.e. manufacturers, retailers, wholesalers and logistics service providers), the expectation is to increase profit while meeting both people and planet expectations. To address these expectations, they look forward to increase return on assets and working capital targeting full asset utilization, increase service levels while reducing costs, energy consumption and environmental impacts in their supply chains.

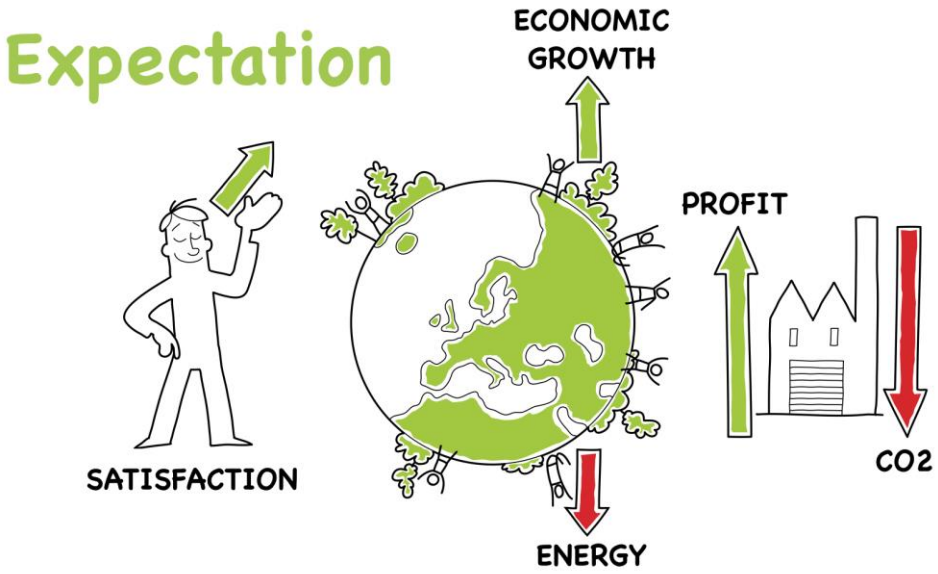

Figure 1. People, Planet and Profit perspectives and expectations on the truly integrated transport system for sustainable logistics expectations.

Transport modes are progressing fast to meet these expectations, especially through the improvement of engines and propulsion including the electrification of the system that have allowed important reductions in energy consumption and emissions in the last decades. However, transport modes are also approaching fast to their maximum potential engine and propulsion efficiency and it is more and more recognized that by increasing transport modes efficiency only, energy and decarbonization target will not be meet. Here, the challenge is to achieve a true integration of the transport system breaking the walls between silo approaches and ensuring full connectivity and utilization of the transport modes as a system using rail and waterborne, wherever possible in terms of efficiency (Figure 2).

The *Dream* (Figure 3) is therefore to achieve a truly integrated transport system for sustainable and efficient logistics. We may define this system as follows:

A truly integrated transport system for sustainable and efficient logistics is based on an open and global system of transport and logistics assets, hubs, resources and services operated in an open environment and framework conditions by individual companies. They are fully visible and accessible to market players hence creating a network of logistics networks. Coordination of logistics, transport, infrastructure and supply networks aim to move, store, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient, secure and sustainable. The system will be based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation interfaces and protocols[3].

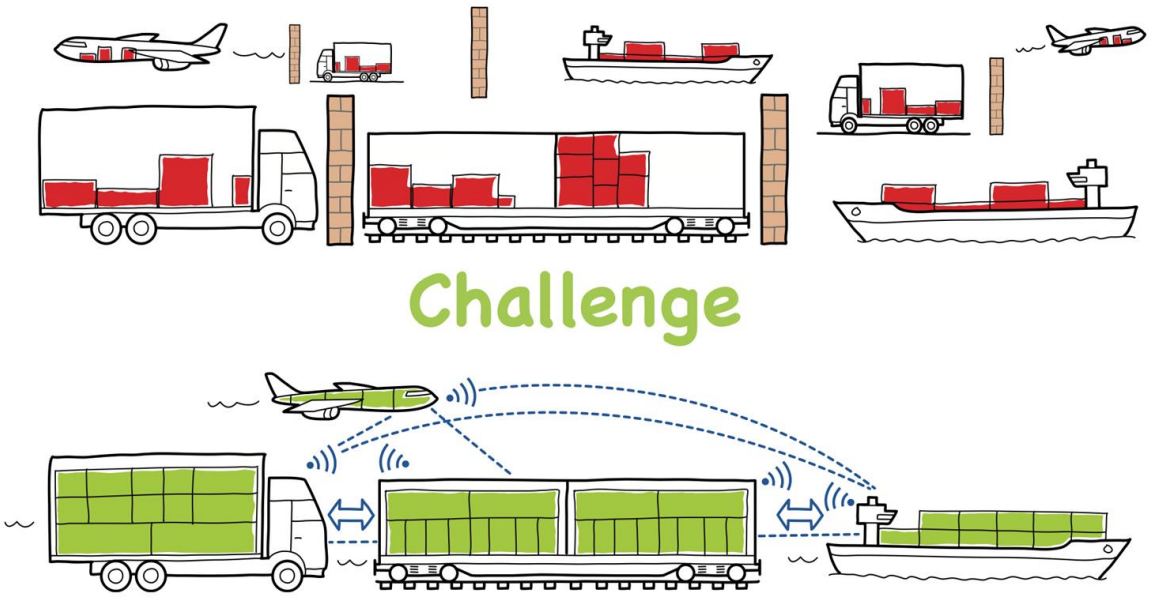

Figure 2. Challenge towards the truly integrated transport system.

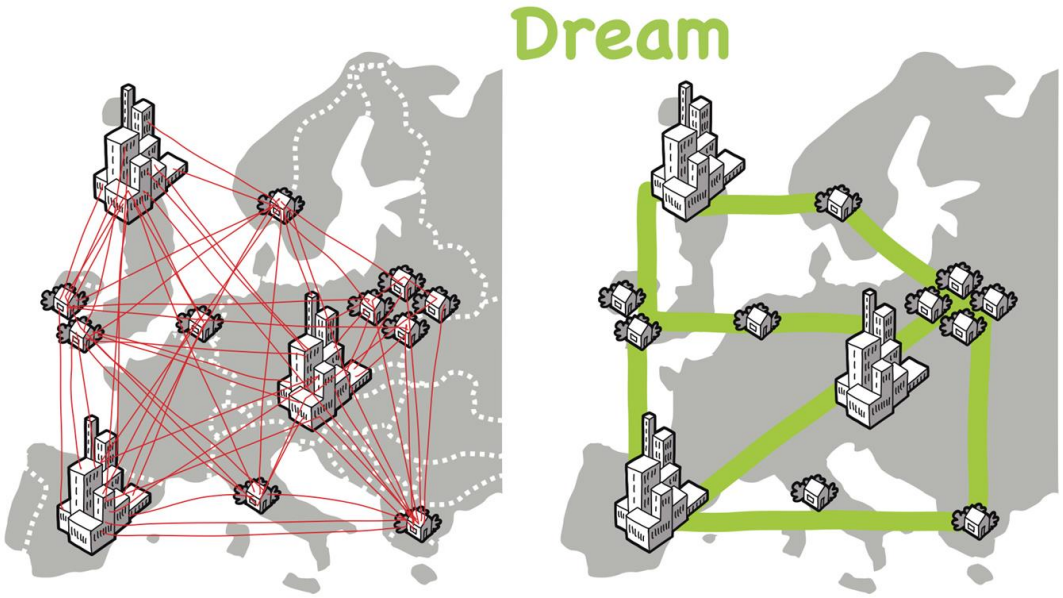

Figure 3. The truly integrated transport system

Once introduced the expectations, challenge and definition of the truly integrated transport system for sustainable and efficient logistics, the different connotations for the urban and long distance contexts are addressed.

In the **urban context**, the vision is to: *achieve a full integration of freight flows in cities' operations and activities that allow citizens to access the goods they require and the goods to reach the citizens, while at the same time supporting sustainable development*[4] aiming to:

- Increase energy efficiency of the urban logistics system as a whole adding to the expected gains in the energy efficiency of vehicles and electrification;
- Improve the urban environment by increasing air quality and reducing noise and progressing towards city logistics decarbonization[5];
- Increase customer satisfaction by delivering the goods on time and improving the reliability of the systems;
- Increase safety and security, reducing injuries and fatalities as well as cargo loss or damage.

In the **long distance context,** the ambition is the achievement of EU wide co-modal transport services within a well synchronized, smart and seamless network, supported by corridors and hubs, providing optimal support to global supply chains door-to-door aiming to:

- Increase energy efficiency, the use of renewable energy and electrification.
- Progressing in the reduction of CO2 and other pollutants.
- Achieve seamless network and transport integration including cross border co-modal transport operations ensuring both smooth transport and security for Europe.

Additionally, urban and long distance freight transport context require **seamless and fully operational long distance and last mile transport links**. This means (i) structure and definition of coherence system linking long distance (major hubs) and last mile (city hubs) rethinking urban distribution of goods up to end consumer (ii) the introduction of more efficient handling systems and cross-dock operations in consolidation/distribution hubs close to cities keeping the added value of the long haul, and (iii) efficient trans-shipment of goods from long distance to last mile vehicles.

While there are specific challenges for the different contexts (urban and long distance) and solutions that are mainly relevant only for one of them, others are common and need to be addressed from an end-to-end system perspective.

Addressing greenhouse gas emissions and energy challenges by increasing end to end efficiency

The European Union identified as one of its objectives the decoupling of economic growth and the use of resources, by a shift towards a low-carbon and energy-efficient economy, and by modernization of the transport sector[6]. According to analysis performed in 2007, the long-term annual growth rate of the logistics industry is between 4% and 8% and exceeds on average 2.5 times the GDP growth rate of the EU[7]. However, some countries are however already and currently showing a positive decoupling between economic growth and transport by means of increased efficiency.

Transportation is responsible for around a quarter of the EU greenhouse gas emissions[8] (data from 2012). The European Commission has established a 60% reduction of Green House Emissions as the

[4] *Urban Freight Research and Innovation Roadmap*. ERTRAC/ALICE. December 2014

[5] COM (2011) 144 final. "*Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*" European Commission, Brussels, 28.3.2011

[6] COM (2010) 546 final. "*Europe 2020 Flagship Initiative – Innovation Union*", European Commission, Brussels, 06.10.2010

[7] Prof. Dr. Dieter W. Rebitzer (University of Nürtingen-Gieslingen), "*The European Logistics Market*". 2007

[8] http://ec.europa.eu/clima/policies/transport/index_en.htm

target to be reached by 2050 compared to 1990 figures[9]. Concerning the freight transport and logistics sector, similar targets have been established for the reduction of CO2 emissions[5].

According to the conclusions of the COP21 in Paris[10], Transport Emissions are increasing in absolute. They represent 30% of all GHG emissions (24% if you exclude aviation and maritime), 32% of energy consumption and 94% of the oil import of the Union. Importantly at least 60% of freight related emissions are linked to movement below 300 KM being the "last mile" an important contributor to the problem.

Moreover, the intended shift of long distance transports to more environmental friendly modes will further support this tendency and will contribute to the overall reduction of GHG emissions. The SPIDER PLUS project of the European Commission has shown that the targets are possible to meet in the case of rail, even if the market growth rate has to be handled to a large extend on the existing infrastructure of these modes, if the right supporting measures are introduced in the short term.

In this context, there is a need to develop appropriate Key Performance Indicators to properly assess the situation and the progress at system level including transport modes and terminals based on current and future efforts[11].

Transport and logistics costs (€, CO2 and other emissions, Energy, land use and congestion) are fully accountable and comparable, using actual figures and allowing identification of measures to allocate and reduce the impact associated*.

From the long distance perspective, Eurostat surveys estimate that 24% of good vehicles in the EU are running empty and the average loading of the rest is 57% giving an overall efficiency: of 43%. Flow imbalances can explain only half of this loss. The opportunity is estimated as €160 billion and 1.3% of EU27 CO2 footprint[12]. Reported load factors in delivery vehicles in cities (e.g. 38% for vans in London[13]) show even a higher opportunity in that context.

Achieving increased vehicle utilization is therefore one of the major opportunities a truly integrated transport system for sustainable and efficient logistics should address in both urban and long distance contexts. Sector fragmentation and reduction of shipments sizes are important reasons contributing to low load factors. In order to overcome this issue cargo pooling and bundling is needed, so combination allows increased load factors.

Achieve that horizontal and vertical coordination and collaboration is common practice between shippers and Logistics Service Providers pursuing increase in load factors and assets utilization: vehicles, hubs, warehouse; and reducing costly empty runs in both long distance and urban freight contexts. It is also important to ensure an appropriate (not excess) capacity in terms of infrastructure, fleets, etc. associated to market needs. This could be driven by public incentives on efficiency and sustainability.

* Identified characteristics, components and requirements of the truly integrated transport system for sustainable and efficient logistics are included in the squares.

[9] COM (2011) 112 final. "*A Roadmap for moving to a competitive low carbon economy in 2050*" European Commission, Brussels, 8.3.2011

[10] Data from the Public hearing on COP 21 impact on European transport policy, Brussels, 04 April 2016

[11] See Global Logistics Emissions Council (*http://www.smartfreightcentre.org/main/what-we-do/glec*) and Ecotransit (*http://www.ecotransit.org/calculation.en.html*) and awarded project on H2020 call MG 5.3-2016. Promoting the deployment of green transport, towards Eco-labels for logistics.

[12] *Supply Chain Decarbonization. The Role of Logistics and Transport Reducing Supply Chain Carbon Emissions*. World Economic Forum-2009

[13] European Commission, 2012, Final Report Study on *Urban Freight Transport*, DG Move & MDS Transmodal Limited, Brussels, Belgium.

According to recent studies[14] results from a simulation experiment with top retailers Carrefour and Casino in France and their 100 top suppliers showed a potential economic benefit of combining flows of 32%, 60% reduction of greenhouse gas emissions and 50 % of volume shifted from road to rail. Proof of concepts are starting to be tested in the field with promising results showing load factors of 85 % on average in the network.

One of the most important enablers to achieve proper expansion of consolidation and bundling of goods and efficiency is modularization. Modularization need to be understood at different scales: from cases to pallets and to containers ranging from long distance to last mile distribution.

Further deployment and evolution of modular load units from transport to handling containers (following the example of maritime transport) compatible with the current existing ones and extended for end-to-end transport, up to last mile and urban distribution to facilitate consolidation of goods and handling up to the retail shelve or delivery to the end consumer.

The Truly Integrated Transport System in the Long distance context

TEN-T has defined the core transport network for Europe in terms of infrastructure. Transport and other services need to be deployed on top to achieve a truly integrated transport system and ensure a seamless, integrated sustainable and resilient cross border co-modal transport network in Europe supporting the processes described above to meet green house, energy and growth targets.

So far, network integration has been focused on the needed interconnectivity and interoperability of transport processes and equipment. Integration has been achieved only partially at the TEN-T core network level and efforts in this direction need to be continued.

TEN-T Corridors und hubs should enable to operate services in a network providing efficiency and resiliency to the transport system and seamless connection to global chains. Several projects (e.g. CORE project[15]) are expected to highly contribute in this area while ensuring security of European citizens.

Resilient transport and logistics networks minimizing negative impacts of unexpected events, caused by natural and man-made events (e.g. weather or terrorism) and ensuring **seamless and secure cross borders transport operations** (at least in Europe) which are enabled by cross border infrastructure links, also ensuring security for Europe.

European transport heavily relies on road transport. One of the key targets of the Transport White paper is that 30% of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50 % by 2050, facilitated by efficient and green freight corridors. A substantial growth in modal shift is not achieved yet, however a first step in this direction has been made by, for example, the FP7 project SPIDER PLUS, which has just recently prepared a road map to achieve this target. A number of challenges still remain compared to other regions such as US. Rail transport in the US between coasts implies no borders to cross, only one language, one rail gage and one regulation. Similar transport in Europe, Lisbon – Riga, implies seven borders to cross, five languages, three different rail gages and eight different regulations. On top, surveys show that cost, reliability and flexibility are among major barriers for modal shift to happen (probably as a consequence of the complexity explained earlier and also, with regard to the costs competitiveness, because of the missing internalization of external costs).

A truly integrated transport system should allow overcoming these barriers through harmonization of regulation and seamless cross border operations. One of the challenges is to smooth

[14] Ballot É., B. Montreuil, R. Meller (2015), The Physical Internet: The Network of Logistics Networks, Documentation Française.

[15] www.coreproject.eu

transhipment operations between transport modes, warehouses and infrastructure increasing end-to-end efficiency.

Develop seamless transhipment (automation) technologies and operations between transport modes and between modes and warehouses/hubs. i) enabling fast and low cost handling of freight in loading and unloading operations within a mode of transport or for any type of vehicle from any mode: vehicle to vehicle, vehicle to warehouse, warehouse to vehicle for long distance and ii) ensuring operation in cross-border networks will favour multimodal transport

Moreover, building decentralized Manufacturing networks, empowered by Industry 4.0 and technological enablers such as 3D printing, that could collaborate (vertically and horizontally) in order to increase efficiency of transport on top of TEN-T could support this process providing the hubs with a higher role in the whole network. Further alignment of hubs and corridors to be operated as a network matching door-to-door freight services requirements and transport demand from manufacturers, distributors and the wholesale sector within Europe and for global trade is needed. Freight services are, therefore, insufficiently customer-oriented to serve increasingly diverse client's needs.

Set-up a European core freight network of **"smart" hubs bearing the emerging needs of the transport industries to serve supply chains and manufacturing networks with a customer-oriented focus**. Collaboration, process reengineering and business models are important areas of intervention needed to pursue a seamless, European synchromodal system.

Transport resources and services need to be more visible to increase their utilization reducing empty trips. Market places and other initiatives are trying to provide a full overview on transport services, therefore matching offer and demand to reduce empty trips and synchronization of flows. First attempts for supply chain composition tools have been made.

Fully available & visible intermodal transport services to deploy end to end synchromodal logistics solutions need to be achieved.

A lot of potential is still in this area that is expected to be deployed fast in the upcoming years due to widespread proliferation of information exchange and automated processing as well as the push of new market players providing: (i) necessary visibility of operations to improve end to end management of logistics chains, (ii) fulfilment of legal and administrative requirements: e-documentation, e-customs, smart multimodal e-way bill, EU/national statistics, CO2 reporting, (iii) enhanced horizontal collaboration opportunities, (iv) improved multi modal freight traffic management and (v) Interoperability of electronic road toll systems for heavy goods vehicles.

Seamless information exchange in end-to-end logistics: including SMEs, public administrations, and different stakeholders in the supply chain on top of transportation modes. The Digital Transport and Logistics Forum[16] will boost this area.

The Truly Integrated Transport System in the Urban context

Urban freight is currently an important traffic and congestion contributor in cities (10 to 15% of vehicle equivalent miles). Moreover, it accounts for a significant part of ambient noise in cities and impacts air quality as it generates 30 to 50% of transport-related pollutants such as particulate matters (PM) or Nitrogen Oxide (NOx). In this context, improve urban environment by increasing air quality and reducing noise and congestion is a major challenge and a priority for cities.

[16] http://ec.europa.eu/transport/media/news/2015-04-15-setting-up-dtlf_en.htm

While CO_2 is not directly impacting quality of life of people living in cities, it is responsible for 25% of urban transport-related CO_2 emissions hence, being a relevant contributor to the issue. In that sense, the transport white paper stablished the target to achieve zero CO2 emissions in cities by 2030. Consumer trip (transport between home & store) account for around 20 % of the total CO_2 emitted in the value chain of a product[17] being an important contributor to the overall picture.

On top, a number of factors will impact cities development and therefore urban freight:

- Urban population accounted for 73% of European citizens in 2014 is expected to be over 80 per cent urban by 2050[18].
- e-commerce is growing at double-digit rate and accounts for up to 25 % of returns. This combined with smaller shipment sizes is increasing freight trips. According to research in UK, in 2013, products ordered online generated just over one billion deliveries. By 2018, this number is expected to grow by 28.8% to 1.35 billion[19].
- Teleworking, may reduce the demand for passenger transport but may increase the demand for shopping trips or home deliveries.

Although it is true that urban transport electrification will fundamentally contribute to meet some challenges (i.e. CO_2, ambient noise and pollutants) a number of measures from the perspective of a truly integrated transport system need to be considered to positively impact the process and reduce contribution to congestion in the long term. New delivery patterns (for example combining direct and reverse flows) coupled with innovations in automation and electro mobility may reduce the CO_2 emitted in shopping trips for example.

Adaptability to new freight transport technologies and concepts like automated land- or air vehicles, drones and AGVs.

The truly integrated transport system would be expected to consider both people and goods mobility in cities developing solutions for optimizing the use of the urban infrastructure in space and time for urban freight activities and mobility of people.

Increase the optimal integration of freight transport with people mobility. Freight and people are moving sharing infrastructure and resources in a smart combination leveraging infrastructure utilization.

Business models, harmonization of regulation and workforce

The evolution towards a truly integrated transport system will enable but at the same time require new business models and further harmonization of regulation so full potential is leveraged. On top, work force will need to get appropriate skills to operate in the new context.

1. **Improved and new business models.** The evolution to the truly integrated transport system will generate new business opportunities. In order to fully exploit them appropriate business models will be developed. The notion of 'time' (JIT, fast-moving, slow-steaming etc.) will be agreed upon by striking a healthy balance between cargo commodities, customer preferences and infrastructure capacities.
2. **Ensure appropriate education, skills and workforce to leverage efficiency and effectiveness in operations while ensuring good working conditions, safety and security for workers and**

[17] LCA study, P. van Loon, J. Dewaele, L. Deketele - Heriot-Watt University / P&G 30 items/shopping basket - UK B&M supermarket - typical (average) travel behavior (distance, transport mode

[18] World Urbanization Prospects. United Nations ISBN 978-92-1-151517-6. 2014.

[19] The last Mile, Exploring the online purchasing and delivery journey. Report produced by Columino for Barclays. September 2014

goods. This includes preserving the integrity of the goods minimizing theft and damage. Special attention is needed to ensure safety for the workers and people regarding transport operations.

3. **Harmonization of regulation** dealing with transport in terms of administrative burden, operations, reporting, etc. by transport industry, public administrations and (enforcement) authorities on the air/road/rail/waterborne.

3. TRENDS AND POLICIES IMPACTING THE PROCESS OF ACHIEVING A FULLY INTEGRATED TRANSPORT SYSTEM FOR SUSTAINABLE AND EFFICIENT LOGISTICS

1. **Policy and society push towards low carbon, low energy and circular economy.** This, in combination with energy provision and global warming will push stakeholders to look for more efficient solutions in terms of transport and logistics emissions and energy consumption as well as recycling and reuse that could potentially create new freight flows.
2. **Society moving to a shared and collaborative economy.** Emergence of social networks is changing citizens´ lives and behaviours. Making use of social networks, new transport business models are appearing such as Uber for freight. This societal trend may impact the whole transport system and the way operations are running, for example reducing existing mental shift barriers towards sharing assets, capacities and networks.
3. **Demographical change and ageing society.** This will drive the need of new services as well as the people mobility therefore impacting freight.
4. **E-Commerce is growing at a double digit rate in all European Countries**. On top of big e-commerce new companies traditional retail is facing this challenge which implies running two different distribution channels: traditional and on-line. This trend will impact transport systems in cities, while shopping trips will probably be reduced, personalised parcel deliveries will increase thus creating a must towards overall efficient management and use of the transport system. Packaging demand and management will grow accordingly, while the need for smart vehicle management will increase.
5. **E-commerce and product customization** is moving transport demand to **small size shipments** that are a challenge for efficient and sustainable management of logistics.
6. **Integration of transportation as a policy support**. The Transport White paper[20] (2011) specifically addresses the need of having a single transport space in Europe and further integration of transport including the TEN-T Network deployment.
7. **Societal push for a better utilization of existing infrastructure** rather than building much more new infrastructure unless clear return for society. Respecting that comprehensive and transparent impact on environmental and land utilization issues.
8. **Fast technology developments responding to a changing world:** Industry 4.0 and 3D printing, automation, robotics, IoT, Big Data, Future Internet, machine learning and connectivity.

4. KEY ENABLERS AND BARRIERS TO ACHIEVE THE TRULY INTEGRATED TRANSPORT SYSTEM FOR SUSTAINABLE AND EFFICIENT LOGISTICS

[20] White paper 2011. Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system

In order to reach the truly integrated transport system for sustainable and efficient logistics as described above, there are some elements that should enable or trigger the change. However, there are other elements that are identified as barriers or gaps and would need to be specifically addressed with concrete measures to overcome them.

The technological and non-technological elements that will enable and will impact transport in the process of reaching the "Truly integrated transport system for sustainable and efficient logistics" are:

1. **Reaching consensus and support** from all **transport and logistics** stakeholders, including **European Commission** and **Member States** on the **need to achieve the truly integrated transport system** for sustainable and efficient logistics **and on the overall vision on the system**, and subsystems integrated within it so a clear path for implementation can be developed including policy-making.
2. **Current development on robotics for logistics and autonomous operations**: warehouses, transport systems, transshipment points: vehicle to vehicle, vehicle to storage. This should enable the seamless transshipment requirement mentioned above
3. **Autonomous transport.** Autonomous transport, for large or small units' freight transport, will impact the sector in terms of costs reduction, GHGs, asset utilization, efficiency improvement and social impact. Development of Autonomous Transport will be accompanied of required infrastructure developments.
4. **Internet of Things.** The "*Internet of things"* will support asset monitoring and enhanced management enabling asset sharing as well as generating better information on the status of cargo. Associated to this, new technologies for easy interconnection and interoperability of current legacy systems need to be developed
5. **Big Data.** Big data analysis should increase logistics chains resiliency, reducing risks through better forecasting, anomaly detection when executing transport and logistics. High performance computing, optimization and matching algorithms might also contribute to identify synergies across supply chains and thereby contribute to increasing both asset utilization and load factors. To leverage big data analysis full potential open questions on data sensitiveness and security need to be solved.
6. **Crowdsourcing and sharing economy.** On top of the technological barriers, a mental shift towards more open and collaborative environments is required in order to achieve a fully integrated transport system for sustainable and efficient logistics. New trends in crowdsourcing and sharing economies will impact the behavior and position of people regarding sharing and collaboration.
7. **Fast evolution of interoperability towards easier connectivity of independent ICT systems.** Machine learning and other technologies are demonstrating their value in many different applications. Application to the transport and logistics sector will contribute to interoperability and connectivity.
8. **Leadership and entrepreneurship** that may allow new concepts and business models to emerge as a consequence of the new technology and societal developments, user needs, policy, regulations and business opportunities.

On top of the enablers and triggers, there are current barriers impeding the truly integrated transport system for sustainable and efficient logistics:

1. **Market dynamics.** Logistics has traditionally been a sector with low innovation investments, due to smaller margins and high fragmentation that

(i) make it difficult to implement new technologies and processes,
(ii) discourage collaboration because collaborations are currently negotiated at huge cost,
(iii) prevents data sharing because stakeholders are concerned about competition/disintermediation/commodification of services, and
(iv) discourage investments because:
   a. investors cannot be sure they will capture the benefit of investment (i.e. no one is prepared to invest in common infrastructure),
   b. the benefits from some investments are translated to gains for other parties (e.g. a track friendly bogie saves infrastructure costs),
   c. because some investments only improve one link in a chain which does nothing if the next link is still a bottleneck and
   d. Investments should be a national or even supranational business. Moreover, human beings are by nature conservative slowing down evolution.

2. **Lack of industry well recognized business and operational models implementing horizontal collaboration.** The development of appropriate revenue/cost sharing models is needed to make it easier for logistics stakeholders: shippers, logistics service providers and transport companies to engage broadly in this kind of collaborations while meeting competition law regulations. Revenue/cost sharing models are usually negotiated and then it is not necessarily rational for individual actors to cooperate even though it would be more efficient overall.
3. **Lack of modular load units facilitating inland and air transport.** Containerization of goods has been a game changer in commercial trade facilitating bundling cargo in maritime routes and allowing outstanding performance and efficiency. However, this is still not transferred into the inland transport, making use of smaller sub-containers and boxes more adequate to some flows and combination of flows. This is preventing both easy bundling of cargo and reduction of trans-shipment costs hence preventing the reaching of appropriate conditions to fully deploy synchromodal transport. Such modular units have to be compatible with already existing assets used in maritime transport.
4. **Too many regulations that hinder innovation.** Different standards, regulation and procedures in member states prevent the seamless cross border transport operations as well as the synchromodal transport when the logistics chains involve several countries.
5. **Lack of appropriate transshipment technology** i) enabling fast and low cost handling of freight in loading and unloading operations: vehicle to vehicle, vehicle to warehouse, warehouse to vehicle for long distance and urban transport and ii) respecting the need of efficient operation in networks.
6. **Lack of ICT to rapidly connect to, and disconnect from, supply networks at two levels, the business level and the technical ICT level.** ICT systems are usually complex and customized, therefore information interfaces are not suited to efficiently execute transport and logistics operations. Systems and device interconnections are still quite complex and costly. Moreover, open cloud based collaboration platforms to facilitate the dynamic and cost effective formation and management of complex supply networks are still not deployed mainly due to governance, control, trust and investment issues. Market players (i) do not want to become dependent and cede strategically important platforms to another party – e.g. cloud platform provider, (ii) have different agendas which complicate governance, (iii) have difficulty with agreements on who and how common ICT infrastructure is paid. iv) some 4PLs (organizing logistics services for an external company) may feel their business model threaten due to standardization of service composition.

7. **Lack of trust on sharing information services and systems.** Information sharing across the logistics chain is critical to ensure a truly integrated transport system. Currently, information systems and business models do not ensure the secure and reliable data management approaches that facilitate the collection and analysis of authorized data so that operational efficiency can be improved while assuring that privacy is maintained. In urban deliveries, the lack of knowledge on freight traffic and its load factors prevents the possibility to create synergies of combining flows (e.g. pooling solutions to reduce traffic and congestion). Additionally, parcel and other companies are reluctant to share vehicles due to fear of losing their image.
8. **Lack of appropriate standards for data collection, data collection systems for reporting commercially and socially important information as well as data quality monitoring** (e.g., emissions, load factors, congestion levels, etc.) so that proper comparisons between value chains, including all modes of transport, can be obtained and informed decisions made.

4. STAKEHOLDERS´ INCENTIVES TO REACH A TRULY INTEGRATED TRANSPORT SYSTEM FOR SUSTAINABLE AND EFFICIENT LOGISTICS

Reaching a fully integrated transport system for sustainable and efficient logistics should be driven by the benefits of reaching this system. In the Table 1, different stakeholders are listed including the positive and negative incentives they might experience:

Table 1. Freight transport and logistics stakeholder's incentives to advance towards a truly integrated transport system.

Stakeholder	Positive incentives	Negative Incentives
Shippers	Improved interoperability and quality of interfaces between transport chain elements therefore: 1. Reduced costs[21] 2. Increasing product accessibility to end consumers 3. Reducing overall lead times and increasing reliability, 4. Better control and reliability of stock in transit, 5. Improved management (ability to change destination to satisfy unexpected demand)	1. Solutions in cities linked to traffic restrictions could affect retailers' operations.
Freight Forwarders	1. Reduced transport coordination costs and 2. possibility for SME logistics providers to start cooperative formats due to global visibility	1. Freight forwarder/shipping agent role may be undermined as coordination and visibility becomes commoditised. ICT platforms for data sharing, organisation and booking may reduce value added of freight forwarders and competition with shipping lines/agents for the control of the inland leg of transport.

[21] Euro, emissions, energy

		2. Costs for ICT might be too high and too much for SME logistics providers, resulting in further strengthening of already medium/big players.
Logistics Service Providers	1. Reduced operation costs, 2. Increased asset utilization. 3. Provide new value added services and value creation in supply chains.	1. Not clear impact on benefits for the individual companies, the benefits could go to other stakeholders. 2. More flexible systems may further increase intensity of competition and variability of return. 3. Costs for ICT might be too high and too much for SME logistics providers, resulting in further strengthening of already medium/big players.
Road transport operators	1. Reduced costs. 2. Increased value added to customers. 3. Increased transparency of processes and interfaces; problems can be spotted and solved more easily	
Rail Transport operators	1. Increased attractiveness as flexibility and timeliness of rail freight increase its competitiveness, 2. Better integration in the chain as transhipment costs are reduced.	
Waterborne Transport operators.	1. Opportunity for short sea shipping and inland waterway transport as they become visible and better integrated into the rest of transport system (i.e. reduced transhipment cost). 2. Reduced costs. 3. Increased value added to customers. 4. Increased transparency of processes and interfaces; problems can be spotted and solved more easily.	
Air Freight transport	1. Reduced costs[3]. 2. Increased value added to customers	
People/consumers	1. Faster and more reliable delivery of their orders. 2. Increased availability and accessibility to products. 3. More sustainable transport system with less congestion, emissions and energy usage. 4. Increased market competition will lower prices. 5. Reduced number of accidents with fatalities and severe injuries	
Vehicles manufacturers	1. Modernization of fleets required, 2. Development of efficient and competitive products.	

Ports and Hubs	1. Easier (standardized) collaboration with shippers and LSPs will increase added value in the chain 2. Automated/autonomous operation will lower costs and raise throughput	
ICT and Technology Companies	1. Creation of new markets.	
European and Member States Governments	1. Meeting policy targets on emissions and Energy reduction, 2. Higher added value employment in the sector, 3. Reduced number of accidents with fatalities and severe injuries. 4. Less waste due to better management of perishable goods. 5.	1. Some labour force may be not so intensively required: truckers, warehouse and hubs handling although higher level labour, due to increased automation and at the same time the use of autonomous transport entities.
Customs and other administration dealing with illicit trade and security (food safety)	1. Increased visibility of freight flows end to end as better input for risk assessment tools.	
Local authorities	1. Optimized urban freight traffic, reducing congestion, emissions, noise and congestion: meaning better life for urban citizens. 2. Better information for planning activities.	
All stakeholders	1. More efficient and effective overall system, including less energy consumption, pollution and traffic. 2. Increased transparency of processes and interfaces; problems can be spotted and solved more easily; 3. Communication between individual players is easier once interfaces are standardised; 4. A true integrated system supports the use of real-time information on the whereabouts of goods; 5. It enables e-customs and e-freight throughout the transportation chain	1. Low profit margins hamper the required investment in new technology. 2. Change management required in organizations. 3. Such a system will be even more a critical infrastructure that will need to be protected, safe and secure without vulnerabilities.

5. STAKEHOLDERS CONTRIBUTIONS TO REACH A FULLY INTEGRATED TRANSPORT SYSTEM FOR SUSTAINABLE AND EFFICIENT LOGISTICS

Transport and Logistics stakeholders have prepared their own vision of the future and drafted research and innovation roadmaps to reach that vision. In this section, the potential contribution of these roadmaps to the achievement of the fully integrated transport system for sustainable and efficient logistics is listed. Additionally, projects advancing in that specific field are referenced. Suitable collaboration areas between the ETPs´ are also shown.

Table 2. ETPs contributions to reach the fully integrated transport system for sustainable and efficient logistics.

Stakeholder	Contribution
ACARE	In line with ACAREs Vision 'Flightpath 2050' and the SRIA: 1. Improved **on-time performance**, predictability and resilience of aircraft operations. 2. Coherent **ground infrastructure and airspace capacity**. 3. Aviation´s contribution to a **seamless, resilient, predictable and integrated transport system for freight** (transport system architecture, procedures, protocols, systems, infrastructure, etc.) 4. **Efficient security checks and procedures allowing seamless security**
ALICE	1. Establishing appropriate business models and procedures for further deployment of **vertical and horizontal collaboration** across supply chains. (NEXTRUST, CO3). Improve cost/revenue sharing models; develop markets and other tools to reduce the game theoretic barriers, legal, negotiation and implementation costs of entering into collaborations. This should increase load factors and asset utilization. 2. Advancing and progressing towards **smart steaming and synchromodal transport** extension: logistics integration between long distance and last mile transport adapting speed to the lead times. SYNCHRONET project will advance in this direction. Advancing in the creation of **modular load units** enabling consolidation, bundling and collaboration in the hinterland. From boxes to full containers. 3. Achieve **full visibility and reporting of CO2 emissions and energy consumption** in end to end logistics. 4. **Facilitating trade while keeping or improving security in EU borders.** This is being worked on through FP7 project CORE. 5. Available and affordable **ICT** for all types of companies, whether large or small, and enabling **Real time configurable supply chains** (business and technical ICT level) in (global) supply chain networks. 6. **Full integration of freight flows in cities** operations and activities that allow citizens to access the goods and the goods to access the citizens they require, while at the same time supporting sustainable development in cities *(Shared with ERTRAC).* 7. **Further development of the Physical Internet** concept getting consensus within shippers and logistics community. 8. Smart liaison with **key enabling technologies** such as IoT, Robotics, Automation, and Big Data Value **and Manufacturing** (EFFRA).
ERRAC	1. Improvements of Rail Freight in Europe through Shift2Rail – Innovation Programme 5; intelligent and predictive **train operation command systems** thus giving higher capacity of a given line, higher performance freight trains that are **easier to blend with regional passenger traffic**, **automation of handling and driving**, electrification of wagons-facilitating distributed braking, sensors, **customer information and status of wagons.** 2. Better **integration of rail freight terminals/intermodal hubs** into the **corridor management** process. New transhipment technologies and operational concepts for **low cost terminals and fast handling**. (In cooperation with the other ETPs) 3. Finding a good **equilibrium between freight and passenger traffic across the Rail Freight Corridors** in order to ensure appropriate capacity for freight in line with

	market needs and ensuring that common punctuality, reliability and **service level** targets for freight trains are met. 4. Development of transport services within single or multiple dry-ports (In cooperation with the other ETPs) 5. Horizontal collaboration between shippers of the same modality. 6. Spatial planning for mega hubs freight villages necessary for development of co-modality and long distance transportation, 7. Urban green logistics associated to the mega hubs and freight villages (In cooperation with ERTRAC and ALICE.)
ERTRAC	1. **Electrification and greening of commercial vehicles** transferring energy demand to sustainable energy sources such as wind, hydro, solar and biomass. Key is **solving the current limitations in energy storage** capacity and **energy transfer speed** which will require considerable investments in the whole energy supply infrastructure. 2. Advancing in the **automated road transport** starting by platooning in long distance freight transport and **(semi) autonomous vehicles in last mile delivery.** 3. **Supporting green corridors concept** (in Collaboration with ALICE) and de bottlenecking road, rail, sea, and air transportation *"infrastructure"* (where it is not possible to create new links) by, for example, increased utilization of the available capacity through different means requiring a systems approach involving vehicle, trailer and load carrier manufacturers, infrastructures, logistics operators, etc. 4. Novel and highly **advanced co- and intra-modal hubs** (in collaboration with ALICE) to enhance further optimisation of the available modal mix. By co-utilisation between different freight forwarders and by speeding up transfer times, land resources can be freed. In both cases vehicles, load carriers and the equipment for transferring loads must be optimised to work in these new physical environments.
WATERBORNE	1. **Increased visibility, efficiency, safety and predictability of maritime and waterway links**. (Development of data sharing, information and service platforms building upon cross-border River Information Services and Ship2Shore communication enhanced routing path planning and scheduling). 2. Autonomous and semi-autonomous ships for freight. 3. "*As a Service*" **business models** to promote investment in new technologies (e.g. maritime track and trace and visibility of cargo). 4. **Sea port, inland ports and waterway optimisation, automation and robotisation towards the physical internet**. 5. Sea and inland ports low-cost and fast handlers as well as **market makers for last mile** provider ensuring that container empty returns are matched with pickups and port gate congestion is minimised. 6. **Spatial planning for mega hubs freight villages** necessary for development of co-modality and long distance transportation. 7. Sea and Inland ports as providers of **consolidation, modification and value added services** such as Single Windows, Port Community Systems and ICT platforms port-hinterland operations interoperable with other modal systems. 8. Tradeable **smart multimodal e-weigh bills**. 9. **Greening of fleet, smart steaming** and **common emission architecture** for emission measuring for inland waterways development