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BOOSTLOG PROJECT

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The BOOSTLOG project consortium consists of:

Part. No	Participant organisation name (short name)	Country
1 (Coordinator)	Alliance for Logistics Innovation through Collaboration in Europe, ALICE AISBL (ALICE)	BE
2	STICHTING SMART FREIGHT CENTRE (SFC)	NL
3	FUNDACION ZARAGOZA LOGISTICS CENTER (ZLC)	ES
4	STICHTING TKI LOGISTIEK (TKI Dinalog)	NL
5	HACON INGENIEURGESELLSCHAFT MBH (HACON)	DE
6	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (ICCS)	EL
7	Vlaams Instituut voor de Logistiek VZW (VIL)	BE
8	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. (Fraunhofer)	DE
9	FIT Consulting SRL (FIT)	IT
10	FUNDACION DE LA COMUNIDAD VALENCIANA PARA LA INVESTIGACION, PROMOCION Y ESTUDIOS COMERCIALES DE VALENCIAPORT (VPF)	ES
11	TECHNISCHE UNIVERSITEIT DELFT (TU Delft)	NL
12	EUROPEAN ROAD TRANSPORT TELEMATICSIMPLEMENTATION COORDINATION ORGANISATION - INTELLIGENT TRANSPORT SYSTEMS & SERVICES EUROPE (ERTICO ITS EUR)	BE
13	LINDHOLMEN SCIENCE PARK AKTIEBOLAG (LSP)	SE

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Definitions and concepts used in this report

Experts are persons with extensive knowledge or ability in an area of study or work.

Results are the main deliverables, publications etc. out of the projects. For EU Horizon 2020 projects, they are available through CORDIS projects pages.

Outcomes are products, services or solutions for business applications aiming at addressing Pain Points and other value-added results potentially impacting the market (by creating it or transform it), the Companies operations as well as polices and regulation. Results that could set direction in Companies and Governments are considered Outcomes too.

Implementation Cases are concrete examples in which causal links between public R&I funding and technology, organizational or process innovation in a specific logistics area can be established.

Logistics Clouds are used in BOOSTLOG to refer in a generic way to a freight transport and logistics domain providing flexibility in the way complex problems are defined and addressed

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EXECUTIVE SUMMARY

In order to optimise European investments in R&I projects in the field of transport and logistics, BOOSTLOG carries out a thorough evaluation process of concluded Research and Innovation (R&I) projects financed with EU-funds.

This evaluation is conducted from the perspective of different key domains of transport and logistics (T&L), (defined by BOOSTLOG as "Logistics clouds") to identify R&I gaps in T&L and prioritise the needs to be addressed in future research programmes, thus contributing to develop an innovation ecosystem for the logistics sector that also contributes to the EU policy objectives.

The present deliverable focuses on Logistics Networks, showing the main results and impacts derived from European-funded projects on this area. More specifically, the evaluation of nearly 300 concluded EU-funded R&D projects - from the 5th Framework Programme up to H2020 - has resulted in the selection of 17 projects (see Figure 1), as these are considered key projects with important contributions to the progress and evolution of the Logistics Networks.

Figure 1: *European funded R&I Logistics Networks projects*

For the elaboration of the present report, a major part of the analysis was dedicated to identifying valuable project outcomes in the sense of products, services or solutions with relevance to real-life business operations. As a result, 29 outcomes have been generated by the 17 projects included in the deeper analysis for the Logistics Networks cloud report, most of them have proven their technical feasibility by test operations and demonstrations during the project lifetime. However, only 5 implementation cases have been identified which means outcomes that are operable still today and potentially have been further developed since then:

- Train monitoring (Train Monitor) – CREAM (FP6)
- Multimodal short sea – rail transport service Turkey – Germany (via Trieste) (EKOL) – CREAM (FP6)
- New through-going corridor-wide rail transport- and logistics concept (RETRACK network) – RETRACK (FP6)
- Cross-border dispatcher – Smart-Rail (H2020)
- Hub- and spoke concept to integrate smaller terminals via mega hubs (Intermodal Network 2015+) – TIGER DEMO (FP7)

Reasons for this low rate of sustainable implementations can be found at three levels:

- Conditions or circumstances hindering the implementation of a specific solution or continuation of a specific service (e.g., legal issues, commercial success);
- Structural issues, which more or less apply to all outcomes of the Logistics Network cloud, and
- General framework conditions for all kind of R&I projects, which prevent bridging the "valley of death";

To overcome this unsatisfactory situation, potential implementation paths have been evaluated to be considered for future R&I programmes, projects and outcomes. This considers

- supporting factors for successful projects and implementations (gathered from expert interviews),
- the real-life environment and barriers for achieving the full benefits of Logistics Networks,
- current market practices and trends related to the Logistics Networks layers (network infrastructure, transport services, logistics) and action or intervention areas.

With view of improving the chances for successful implementations it is important to develop tailor-made measure bundles adressing the three levels of non-implementation reasons as stated above.

1. Introduction and methodology

1.1. The BOOSTLOG project

Freight transport and logistics is facing critical challenges to address climate change, to ensure that supply chains are well functioning, and people are served with required type of goods and services. In particular, coping with the expected growth of freight transportation and transition to zero emission logistics up to 2030 requires collaboration and speeding up innovation.

The BOOSTLOG Vision is to transform the European freight transport and logistics R&I ecosystem to perform optimally boosting impact generation out of R&I investment contributing to (1) EU policy objectives towards climate neutrality, pollution, congestion and noise reduction, free movement of goods, internal security, digital transformation of logistics chains and data sharing logistics ecosystems and (2) *Companies* sustainability and competitiveness generating value for society.

In order to do so, BOOSTLOG has identified four main areas of action: (1) Increase visibility and support valorisation of R&I project Results, Outcomes and Implementation Cases in the freight transport and logistics field (2) Develop and implement valorisation strategies and guidelines to speed up the technological and organisational innovation uptake, including the creation of the Innovation Marketplace and issue recommendations to increase impact of R&I public funding, (3) Define high potential & priority R&I gaps to make efficient uses of R&I investments and (4) Strengthen R&I impacts communication and Stakeholders engagement in the innovation process.

In the framework of the first of those actions, BOOSTLOG has mapped and assessed about 300 EU-funded R&D projects since FP5 in different freight transport and logistics domains (i.e., the Logistics *Clouds*), so as to develop eight comprehensive and industry actionable reports. The fifth issue of those reports is the present document focussing on Logistics Networks.

These industry-oriented reports will be later complemented by deliverables on valorisation strategies and guidelines for public R&I uptake (WP3), an innovation marketplace for R&I uptake (D3.3) and the identification of high priority and potential R&I gaps that need to be prioritized in future R&I actions targeting policymakers (WP4).

1.2. Scope of this deliverable

In the framework of BOOSTLOG WP2, "From R&I projects results to impact generation", Task 2.1 focused on the analysis of the EU funded projects: gathering Outcomes, Implementation Cases in specific Clouds: (1) Freight and Logistics Data Sharing, (2) Coordination & Collaboration, (3) Urban Logistics, (4) Logistics Nodes, (5) Logistics Networks, (6) Modularization and Transhipment plus two more topics (or Logistics Clouds) to be defined in the course of the project.

This document represents the fifth report stemming from Task 2.1 that focuses on Logistics Networks, showcasing both outcomes and implementation cases directly contributing to the field. To avoid overlaps, some cases with a minor impact on this Cloud have been left out of this report as they will be showcased in other cloud reports (such as urban logistics or logistics data sharing).

Logistics Networks in the context of this report deal with multimodal freight transport on corridors or networks. They are basically composed of three layers (see also Figure 2):

1. Network infrastructures and their interfaces;
2. Transport services;
3. Supply chain / Logistics services.

These layers are determined by the types of services as well as by the companies, which provide such services on the Logistics Networks: while infrastructure and interfaces are in the hand of Infrastructure Managers (IMs), the physical transport chain is operated by transport operators, railway undertakings, trucking companies, vessel operators etc. The logistics services along the supply and transport chain finally are provided by forwarders and Logistics Service Providers (LSPs).

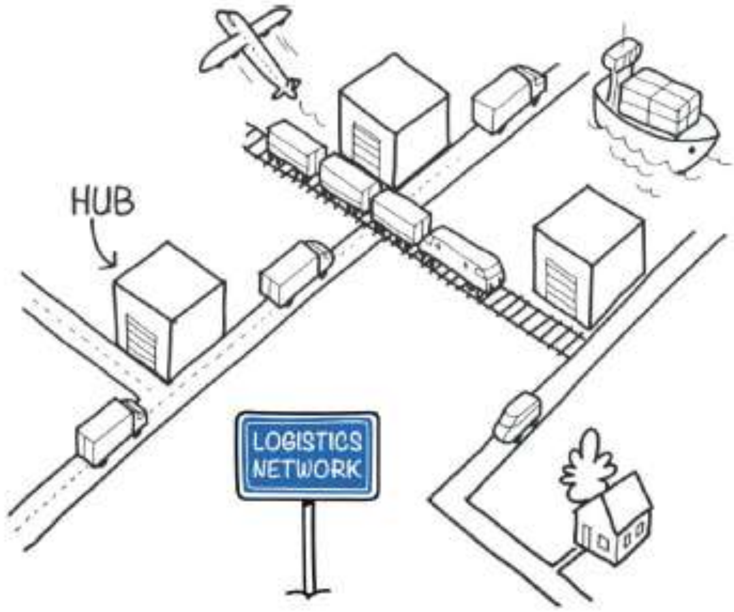

Figure 2: *Levels of Logistic Networks (source: ALICE, Physical Internet Roadmap)*

With respect to the R&I projects to be evaluated within this report, the following topics are in the focus of interest, whereas the "Transport services" layer" is of particular importance (see also Figure 3):

- Transport corridors or networks (focus on rail, waterways, road, air);
- Interfaces between networks (country-country borders) and between networks/lines and terminals (access to other modes);
- Nodes as origin / destination / connection points;
- Traffic management (dispatching);
- Transport services planning and operations/production (synchromodality);
- Contingency management.

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In addition, network infrastructure management/optimisation/maintenance processes and network capacity management might be relevant, if the transport services or transport/logistics operators are affected. This is for instance the case for topics like train path allocation or temporary capacity restrictions (TCRs).

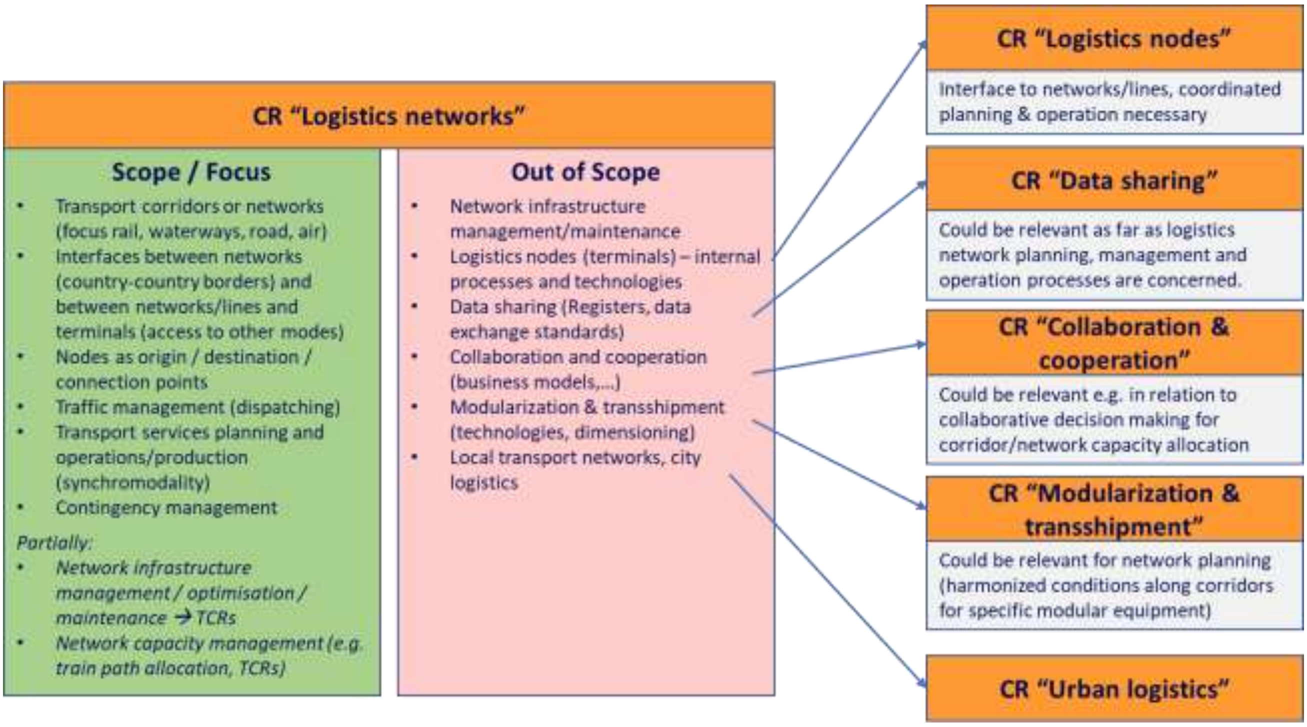

Figure 3: *Scope of cloud "Logistics Networks" and connections/overlapping with other clouds*

There are several issues that have been considered out of scope of Logistics Networks, however, there are connections or overlapping identified with almost all other Cloud Reports; this particularly refers to the following topics:

- Logistics nodes' (terminals') internal processes and technologies are out of scope and tackled within CR "Logistic nodes"; could be relevant in relation to interfaces between nodes on the one side and networks or lines on the other;
- Data sharing (Registers, data exchange standards) are out of scope and tackled within CR "Data sharing"; could be relevant as far as logistics network planning, management and operation processes are concerned;
- Collaboration and cooperation (business models…) are out of scope and tackled within CR "Collaboration & cooperation"; could be relevant e.g., in relation to collaborative decision making for corridor or network capacity allocation;
- Modularization & transhipment (technologies, dimensioning) are out of scope and tackled within CR "Modularization & transhipment"; could be relevant for network planning (e.g., ensuring harmonized conditions for specific modular equipment along corridors).
- Local transport networks and city logistics are out of scope and tackled within CR "Urban logistics".

A clear separation is often difficult, and requests detailed single case analyses.

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1.3. Methodology of Cloud Report elaboration

The Cloud Reports include a brief highlight of the main challenges, past and current specific pain points in a given cloud, key R&I results that have resulted in outcomes and key milestones achieved such as implementation cases establishing causal links between the R&I funding and innovation supporting the seamless integration and harmonization of transport modes, the more efficient management of physical, information and financial flows as well as reducing negative impacts such as decarbonization, emissions and congestion reduction, ensuring the free and seamless movement of goods and digitalization. This basic framework is provided in chapters 2 and 3. The reports contain clear and companies' actionable items such as cases on how to implement the outcomes or build on the implementation cases.

The main purpose of the Cloud Reports is to evaluate the results and Outcomes from R&I projects performed since FP 5. The methodology for this core topic is shown in Figure 4. Firstly, BOOSTLOG identifies and analyses the R&I results and outcomes at cloud level (chapter 4). The outcomes are then checked for eventual implementation after the project lifetime (chapter 5) i.e., whether they have been implemented and adopted by the freight transport and logistics stakeholders). This investigation step is mainly performed by interviews with key experts, complemented with the desk research on projects deliverables and communications. These key experts are stemming from organisations with most prominent participation in projects for each Cloud; in addition, individual people from those organizations participating in the projects are contacted.

The draft report is then shared with the experts for further input and discussion through an online workshop for validation of the report. The validated report will be then presented in a webinar with ALICE members and other stakeholders through BOOSTLOG partners' networks.

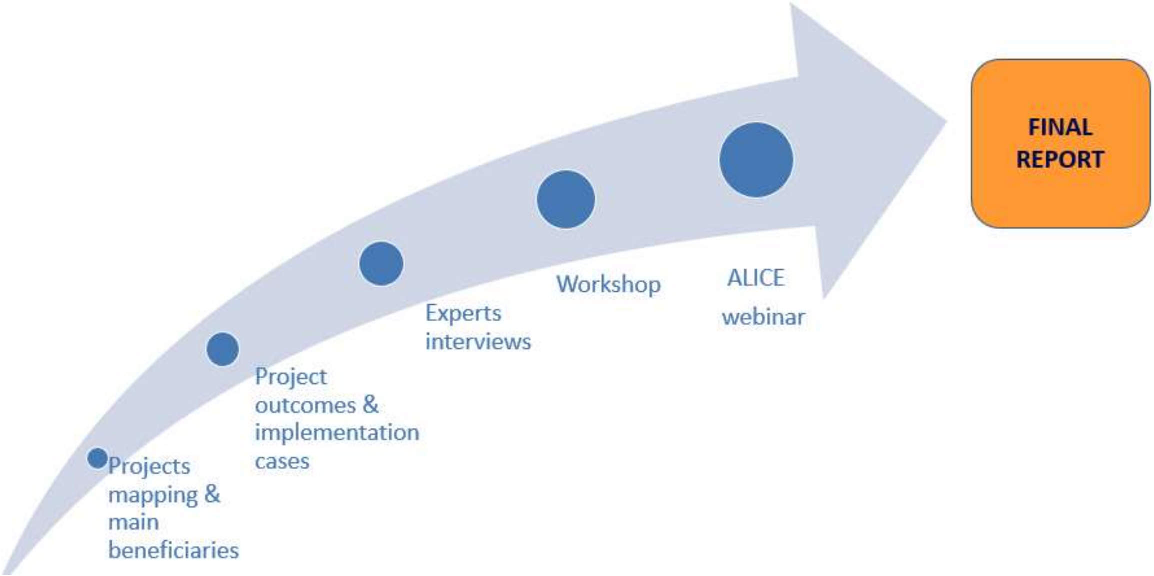

Figure 4: *Methodology for a cloud report development*

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2. Why improving Logistics Networks?

2.1. Introduction

Despite the efforts of Governments and Companies, greenhouse gas emissions from the EU's transport increased in 2018 and 2019 and have not followed the EU's general decreasing emissions trend. National projections compiled by the European Environment Agency suggest that transport emissions in 2030 will remain above 1990 levels, even with measures currently planned in Member States.[1]

According to Alan McKinnon[2], freight transport will be the hardest economic sector to decarbonize because it relies very heavily on fossil fuels and the demand for freight transport is expected to rise sharply over the next few decades. Total freight transport in the EU is projected to further increase by 51% during 2015-2050 under current trends[3]. The objective for transport, that accounts for a quarter of the Union´s GHG emissions, is to achieve a 90% reduction in emissions by 2050.

Logistics Networks are indispensable in international freight trade as they act as physical infrastructure, operational transport chains and logistics service concepts, linking transport modes and trade flows and connecting long haul transport with regional/urban distribution.

Past and current events such as the line blockade at Rastatt, suspension of inland waterway transport due to low water levels, rising energy prices, truck and locomotive driver shortages, susceptibility of the rail system to disruptions, bottlenecks in the procurement of raw materials and supplier parts, as well as increasing politically motivated (and tolerated) blockades of infrastructure and industrial operations by radical climate activists highlight the need to establish flexible, competitive and resilient multimodal transport chains on high-performance corridors and infrastructure networks.

Moreover, Logistics Networks are of strategic relevance in the transition towards zero carbon supply chains and, consequently, to accelerate the green transition and the achievement of the objectives declared by the European Commission through the European Green Deal[4] (EU climate neutrality by 2050 and reduction of greenhouse gases by at least 55% by 2030).

The topic is also reflected in the EU Strategy for Sustainable and Smart Mobility (EUSSSM) 2020 and the related action plan[5]. Here, Logistics Networks are addressed in Flagship 4 ("Greening freight transport") by

- Closing missing links in multimodal infrastructure;
- Revising of the regulations governing Rail Freight Corridors (RFCs) and the TEN-T Core Network Corridors (CNCs), aiming at integrating them into "European transport corridors";

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1 *European Environment Agency* (2020) <https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases-7/assessment>

2 McKinnon, (2018). D*ecarbonizing Logistics: Distributing Goods in a Low Carbon World*; Kogan Page, London, UK

3 SWD (2018) 183 final - PART 1/2 <https://www.eumonitor.eu/9353000/1/j4nvgs5kjg27kof_j9vvik7m1c3gyxp/vkol7hhee5y5/f=/9060_18_add_2.pdf>

4 COM (2019) 640. The European Green Deal. Brussels <https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf>

5 European Commission (n.d.). *Mobility Strategy* <https://transport.ec.europa.eu/transport-themes/mobility-strategy_en>

- Improve rules on rail capacity allocation in line with the ongoing project on the timetable redesign (TTR)

and in Flagship 8 ("Reinforcing the single market") by

- Prioritisation of international infrastructure projects along European networks and corridors, such as the Oresund bridge, Rail Baltica, Fehmarn-Belt fixed link, Brenner base tunnel or Dresden-Prague;
- Acceleration of efforts to ensure multimodality and interoperability between different modes as well as to complete the Single European Transport Area.

Another focus of the European Union's attention is the promotion of railway as a decisive transport mode in the future. Initiatives like Shift2Rail and its successor Europe's Rail or institutions like the European Union Agency for Railways (ERA) reflect that effort[6] [7]. They acknowledge that a key element for the enhancement of the railway are intermodal services along pan-European corridors.

ALICE published end of 2019 its framework for a roadmap "Towards Zero Emissions Logistics 2050[8]" to clearly state the challenge and establish a direction to address it. One of the five key areas to address the challenge is: "Transport modes are smartly used and combined". Two of the proposed solutions within this key area, namely multi-modal optimization and synchromodality, correspond with core elements of Logistics Networks.

For all these reasons, this report is focussing on the Logistics Networks, a critical domain that deserves and needs to be studied separately. In particular, it aims to study the effects of European projects to date, the current market and the implementation cases that have been carried out.

2.2. Expected positive impacts

Logistics Networks are key economic drivers for keeping the leadership and competitiveness of the European Union in the present circumstances, determined by world-wide crises such as the COVID pandemic, the Ukraine war, energy shortage or inflation. Moreover, pan-European Logistics Networks enable global supply chains as wells as international and intra-European trade. In consequence, they are undoubtedly decisive for boosting the EU economic and trade activity while maintaining environmental sustainability of the passenger and freight transport sector.

More specifically, the outstanding importance of Logistics Networks relates to all three layers as outlined above (see chapter 1.2):

1. Corridor and network infrastructure sets the basis for Europe-wide freight transport:

This is reflected in the establishment of eleven Rail Freight Corridors (RFCs) and nine Core Network Corridors (CNCs) of the TEN-T network (for all transport modes, passenger and freight transport). The corridors shall enable Member States to achieve a coordinated and synchronized approach regarding investments in infrastructure in order to manage capacities in the most efficient way.

6 Shift2Rail (n.d.), <https://shift2rail.org/>

7 European Agency for Railways (ERA): Fostering the railway sector through the European Green Deal; Report part 2 – Freight <https://www.era.europa.eu/sites/default/files/events-news/docs/fostering_the_railway_sector_through_the_european_green_deal_-_freight_p.pdf>

8 ALICE-ETP, 2019. Roadmap towards Zero Emissions Logistics 2050 <https://www.etp-logistics.eu/wp-content/uploads/2019/12/Alice-Zero-Emissions-Logistics-2050-Roadmap-WEB.pdf>

For the development of the corridors, specific implementation plans (RFCs) and work plans (CNCs) have been elaborated and are being updated regularly. These plans set the framework for the development of the transport infrastructure, allowing the seamless functioning of multimodal transport chains. The improvement of the framework infrastructure conditions of international rail freight service are a clearly defined focus of project activities.

Thus, the infrastructure corridor network shall enable infrastructure capacity increase by combining modes and by technical upgrades of the existing infrastructure in a better way rather than building additional infrastructure.

2. Modal-shift depends on the capability of transport services, their characteristics and changes:

Modal-shift is a matter of market-oriented transport systems, capable to attract and to take over additional volumes in a significant range.

In this context, the competitiveness of rail services depends on the attributes of the production system(s) and on the availability of respective capacities (trains, access points, lines). Looking at the main market segments of rail (single wagon, block trains, intermodal transport), some important main characteristics must be noted to correctly assess the expectable impact of Logistics Networks:

The single wagon transport system used to be the (national) standard transport system in the past. It was designed for area-wide coverage of each country. Due to this, it stands for a network of train composing stations for bundling and distributing single wagons and wagon groups – in former days even part loads. To run such a network, (1) both consignor and the consignee must be connected to the rail network via (private) siding and (2) a critical volume is requested not only for single destinations, but also for the entire network. Due to a high demand for infrastructure (and thus fixed costs), to costly modes of operation and to only limited correspondence to requirements of the market, many countries in Europe have already completely abandoned single wagon traffic or are considering doing so. Remaining single wagon flows are mainly reduced to (large) private sidings with dedicated commodities. A revitalisation of single wagon traffic on European level is more than unlikely and due to ripped and redesigned infrastructure mostly impossible.

Block trains always run between private sidings. In contrast to single wagon trains, they are operated as fixed wagon compositions and do not request wagon collection/distribution processes. Thus, block trains are restricted to relations with large point-to-point volumes. In their pure configuration, they compose no network, but a compilation of single destinations with each critical volume to be achieved. Visible future trends such as reduction of fossil fuel consumption or de-industrialisation will reduce the typical markets of block trains. Current production systems show a tendency towards mixtures of block and wagon group trains; however, the contribution of block trains to modal shift will be very limited, if any.

Intermodal transport (mostly rail/road) is considered as the most promising rail production system in terms of modal shift. In most cases, trains start and terminate in dedicated terminals which are designed for loading unit transhipment as well as for train splitting/composing processes (as far as necessary). Collection/distribution of the loading units is dedicated to road pre-/end haulage. In case of direct/shuttle trains they operate similar to block trains; however, there are also intermodal production systems designed for transfer of loading units and/or wagon (groups) between trains. Intermodal rail/road transport is the only rail market segment that showed (1) significant volume increase in recent years and (2) sufficient market acceptance. For this reason, most innovations and R&D projects in the rail sector are assigned to intermodal transport.

Inland waterway transport also plays an important role in modal shift. However, it must be taken into account that the inland waterway network in Europe is not as densely developed as the rail network. Nevertheless, inland waterways offer important perspectives for efficient transport and logistics concepts. Outstanding examples are the intermodal transport chains connecting of the European seaports (e.g., Rotterdam and Antwerp) with locations in the hinterland, the deep integration into logistics chains of the chemical industry (e.g., along the Rhine) or new perspectives in last-mile logistics concepts in large agglomerations. Increased use of this transport mode requires efficient IT systems (RIS), environmentally friendly propulsion concepts, a more automated navigation, and also a new design of hulls to enable competitive transport even in dry summers with long low water periods.

3. Logistics framework conditions are changing

In the past years, decreasing shipment sizes, the need for a deeper integration of transport services into complex logistics chains and growing customer's requirements for any time availability of transport information (tracking and tracing, estimated time of arrival etc.) had provided increasing market shares for road against the transport modes. In view of recent pan-European or even worldwide crises, trade flows will look for new ways in higher frequency and define new logistics framework conditions. If industrial societies geared to the international division of labour are to continue to function in the future, they will be dependent on high-performing international Logistics Networks. Multimodality is a key to offer alternative, flexible transport chains, to combine strengths of transport modes and to bypass infrastructure bottlenecks. Applied to infrastructure networks and connected with operation services (see above), such multimodality becomes synchromodality.

Concluding, Logistics Networks are the bracket that connects infrastructure, technologies, operations, and logistics. Logistics Networks ARE freight transport. Only with efficient Logistics Networks, freight transport will actually work and fulfil the requirements of politics, society and the market. In turn, without such efficient Logistics Networks, the projects of the other Cloud Reports, however innovative they may be in technical terms, will remain piecemeal.

Following this approach, when looking for projects focused on Logistics Networks, these should address areas focused on improving the three layers described above. Specifically, seven main action areas have been identified to which improvements can be applied: "Intermodality (Multimodality, Synchromodality)", "Operations and processes, Digitalisation, Transport management (transport service planning and controlling)", "Network capacity management (TCR, train path allocation,…)", "Contingency management" and "Last mile (operation processes, propulsion concepts and technologies)".

Measures or projects of these areas are supposed to have positive impact on Logistics Networks. These impacts are: "Decreased environmental impact (incl. "Improved energy consumption)", "Reduction of congestion on the road network", "Modal shift", "Improved capacity utilisation (barge, train and truck)", "Decreased cost of transport & overall logistics (incl. "Increase transport efficiency")", "Increased transport reliability and responsiveness", "Decreased travel times", "Improved performance of the European transport" as well as "Improved long distance-city distribution connectivity".

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The following Table 1 shows the (main) allocations of these impacts to the previously defined action areas with special view on the characteristics of Logistics Networks.

Table 1: *Action areas of Logistics Networks and expected impacts*

	Expected impacts								
Action areas	**Decreased environmental impact; Improved energy consumption**	**Reduction of congestion on the road network**	**Modal shift**	**Improved capacity utilisation of barge, train and truck**	**Decreased cost of transport & overall logistics; Increased transport efficiency**	**Increased transport reliability and responsive-ness**	**Decreased travel times**	**Improved performance of the European Transport**	**Improved long distance-city distribution connectivity**
Intermodality (Multimodality, Synchro-modality)	x		x					x	
Operations and processes	x								
Digitalisation						x			
Transport management; Transport service planning and controlling		x		x	x		x		
Network capacity management (TCR, train path allocation…)		x					x		
Contingency management						x			
Last mile (operation processes, propulsion concepts and technologies)			x						x

2.3. Barriers and guidelines to achieve the benefits of Logistics Networks

Logistics Networks are linked to a great diversity of actors and factors that make their operation and performance very complex. More recently, distortions on the demand and supply side have challenged the highly interconnected global supply chains. This, together with other causes linked to the way of producing and managing production - ability to establish new strategies in real time, commercial route and transport used, extension of the supply chain, etc. -, have shown the vulnerability of Logistics Networks. This vulnerability has manifested itself in the form of several barriers that prevent more efficient and sustainable Logistics Networks, which are addressed in Table 2.

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Table 2: Barriers *hindering more efficient and sustainable Logistics Networks and possible solutions*

DESCRIPTION	SOLUTIONS & GUIDANCE
Climate change risks	
Climate change will have a negative impact on Logistics Networks, either by worsening existing risks or by introducing new ones. According to the BSR "Guide for the Transportation Industry"[9], the risks affecting Logistics Networks can be allocated to three main areas: • Disruptions to service operations: extreme weather events, rising sea levels, and changes in temperature might lead to supply chain disruptions. In consequence, supplier's assets may be harmed, causing service delays or temporary shutdowns. • Threats to assets and infrastructure: the infrastructure of Logistics Networks in Europe was not built to withstand increased sea levels, storms, or other extreme weather events. Thus, infrastructure, transhipment facilities and rolling stock prone to weather impacts have an increased risk of malfunctioning and/or being damaged. • Changes to underlaying markets: the rise in fuel and energy prices might lead to service disruptions, further compounded by increasing emissions regulations and the need for alternate fuel types.	• Further develop Logistics Networks to enable alternative supply chains in case of disruptions. • Adapt technical guidelines for construction and operation of infrastructure, facilities and rolling stock to the anticipated climate conditions. • Substitute conventional fuels by near zero or zero emission solutions such as 100% renewable electrification, green Hydrogen, biofuels, etc. • Low- and zero emission vehicles and machineries. • Provide sufficient human resources to restore the functionality of critical infrastructure and transhipment facilities as quickly as possible in the event of climate-related damage.
Diversity and/or insufficient level of infrastructural and technical standards	

Despite regulatory initiatives to harmonize technical and infrastructural standards on European Corridors (particularly by the TEN-T Regulation), especially the European rail network is partially still related to it national origins. Harmonisation of infrastructure is generally costly and time consuming, whereas infrastructure investment plans are still merely national issues. Some of the symptoms that result from these obstacles are:
• ERTMS completion on all European TEN-T corridors and RFCs that will be achieved only after 2030;
• Partially non-compliant and not harmonised technical/ infrastructural parameters like permitted axle load, traction power supply voltages, train length, track gauge or (intermodal) lauding gauge;
• Missing harmonisation of technical standards of the lines with the last-mile (particularly terminals). Examples are
  ○ Requested train length of 740m on the line is not possible in almost all European intermodal terminals;
  ○ No through-going train runs from the line to the last-mile and vice versa due to e.g., missing electrification on the last-mile.
In some cases, mandatory technical standards are fulfilled pro forma only, without real relevance for freight operation. One example is the
	• Strictly apply existing regulations relevant for Logistics Networks (particularly related to corridor implementation). Non-compliance with the directives should not be masked by feel-good political papers.
	• Top-down approach for efficient European funding of Logistics Networks (particularly CEF)
	  ○ Define exact needs for Logistics Networks, e.g., dedicated infrastructure or nodes with missing technical standards or capacity to be achieved.
	  ○ Allocate funding (only) to exactly these requirements.
	  ○ Question funding for project applications, which might be in line with general goals but whose benefits can be achieved only by additional (funded) projects.
	• Simplify and accelerate permits for

9 Tiffany Finley, Ryan Schuchard (BSR): "Adapting to Climate Change: A Guide for the Transportation Industry" <https://www.bsr.org/reports/BSR_Climate_Adaptation_Issue_Brief_Transportation.pdf>

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<table>
<tr><th>DESCRIPTION</th><th>SOLUTIONS & GUIDANCE</th></tr>
<tr><td>permitted train length, which many Member States declared to meet the 740m TEN-T criterion. In practice however, respective train paths are only available to customers to a very limited extent (if any). Further examples are the (theoretical) fulfilment of the 22.5 t axle load and the P/C 70/400 criteria, which are only achieved with reduced line speed in some countries.

For inland waterways, TEN-T standards are less comprehensive. Regarding infrastructure, they focus on the requirements that rivers, canals (and lakes) have to comply with the minimum requirements for class IV waterway draught of 2.50 m and minimum bridge clearance of 5.25 m. Additionally, Member States have to ensure that waterways are equipped with RIS (River Information System) and that alternative clean fuels must be available to the core network.

Bridge clearance and waterway draught are very challenging to inland waterway transport because at on hand enormous investments are needed to reach the standards. At the other hand, increasing low water periods hinder full capacity utilisation of existing types of vessels.</td><td>infrastructure expansion/ upgrade.
• Better include last-mile into European corridors and networks, including respective regulations.</td></tr>
<tr><td colspan="2">Socio-economic developments</td></tr>
<tr><td>Some socio-economic developments are hindering the development of sustainable and market-compatible Logistics Networks. Examples are
• Energy scarcity, partially evoked by shutting down energy sources that are considered as not environmentally sound and sustainable, without replacing them equally by renewable energy.
• The progressing de-industrialisation and de-economisation of countries. This has further far-reaching effects on Logistics Networks, such as
  o Decreasing capacity of industry as suppliers of infrastructural and technical equipment as well as performer of construction works. This capacity situation is already tight due to political deadlines such as completion of CNC corridors by 2030[10];
  o Progressing lack of work force and technical know-how in construction and transport & logistics sector (e.g., due to lack of attractiveness of this sector).
• Resistance of citizens' initiatives to any kind of infrastructure expansion and freight activity. This also refers to the expansion of renewable energies (power lines, wind turbines, etc.).</td><td>• Foster a holistic approach for economic developments, energy production/distribution and ecological requirements
• Question global supply chains and redevelop European economies and production
• Improve education and measures to reduce unemployment and activate potential workforces
• Streamline infrastructure planning and improve related communication activities</td></tr>
</table>

[10] See also M. Grosch: „The 5th Workplan of Orient/East-Med Core Network Corridor"; presentation on 17th OEM Corridor Forum, Brussels, 29th September 2022

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DESCRIPTION	SOLUTIONS & GUIDANCE
Increased operational problems	

From the operational perspective, Logistics Networks are hampered by the following main barriers:
• Operational bottlenecks in European rail freight transport due to country specific or even unnecessary regulations. These have been documented in the Technical Operational Issues Log Book (ILB)[11], a European Commission initiative to accelerate progress on interoperability on the European railway network in order to stimulate international rail transport. Consequences of the issues listed therein are
  o Waiting times at borders,
  o Additional operational processes at borders,
  o Additional administrative effort,
  o Problems with train path allocation,
  o Additional staff required.
• Missing capacity on many sections of the European corridors. This generally affects all transport modes as well as the transhipment and access points, but most severly rail. In this context, temporary capacity restrictions (TCRs), mostly due to construction works, are of particular relevance, as they often lead to long blockage of lines or tracks and are not always coordinated between the Infrastructure Managers of the affected countries.
Sufficient capacity is crucial for Logistics Networks to (1) comply with market requirements regarding transport time and reliability, (2) to enable synchromodal, flexible network connections and (3) to cope with the envisaged modal-shift.
• Complex organisation of multimodal transport chains due to multiple actors involved. One reason is the liberalized transport market, which led to horizontal and vertical split-up of formerly united companies. This requires new and advanced forms of collaboration and data exchange. Nevertheless, such transport chains tend to be more fragile due to their increased number of organisational, operational and infrastructural interfaces.
• The shortage of truck drivers is one of the major problems of the European road transport market for many years. Recent publications estimate a total shortfall of drivers in Europe of more than 400,000[12]. The main factors behind this problem are an ageing workforce and an insufficient number of new recruits due to working conditions and image problems of the profession.
• The increasing shortage of qualified nautical personnel is a growing problem for inland waterway transport which tends to raise personnel costs, a significant cost factor in this area.
	• Further clean-up of national rules (in progress by ERA).
	• Europe-wide coordination of infrastructure construction works.
	• Effective punishment of Member States that do not fulfil their commitments to create infrastructure capacities and to reduce unnecessary regulations.
	• Real-time communication between equipment/ machineries of each logistics node to detect operational bottlenecks in advance and improve operational processes.
	• Promote and participate in cooperation from all types, from simple cooperation agreements to full joint ventures or mergers.
	• Long-term planning and Europe-wide coordination of infrastructure construction works.
	• Marketing campaign to increase / promote attractiveness of logistics sector.
	• Advance automation of transport to replace truck drivers and nautical staff (IWW).

11 <https://transport.ec.europa.eu/document/download/caae0bd3-e3e5-481d-a053-28f8c0957b71_en?filename=ILB-Issues_20220214-V12.xlsx>

12 <https://www.ti-insight.com/briefs/europes-road-freight-market-short-of-more-400000-drivers/>

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3. Analysis of current market practice

3.1. Overview

This chapter provides a compilation of market practices which can be considered as "innovative" in the sense that they contribute to further development of Logistics Networks. Such practices encompass

- Innovations already in place,
- Innovations under development in dedicated projects or research programs,
- Rules, guidelines and technical documentations that pave the way for subsequent application of innovative market practices.

In line with the previously introduced structure of this cloud topic, the identified practices have been allocated to the layers and the action areas of Logistics Networks (see Table 3). The claim is not to give a complete overview on all existing innovations – this would be beyond the scope of this deliverable -, but to give prominent examples that are on the one hand representative and that on the other hand show in which fields of the matrix the focal points of innovative practices and trends can be found. Moreover, it must be noted that most market practices are connected to several fields of the matrix, which is just logical in view of the characteristics of Logistics Networks. The allocation shown in the table shall therefore indicates the main focus regarding addressed layers and action areas. According to expectations and to the scope of this report (see chapter 1.2), the majority of innovative market practices refers to (transport and logistics) services.

Table 3: *Current market practices related to layers and action areas of Logistics Networks*

	Layers of Logistics Networks		
Action areas	**Network infrastructure, Interfaces**	**Transport services**	**Supply chain, Logistics services**
Intermodality (Multimodality, Synchromodality)	TEN-T, RFC networks: Updated and united regulations for improved multimodality	• Multimodal transport planners • Multimodal booking systems • Alternative transport systems	• LSP control towers • Supply chain visibility • Track&Trace capabilities
Operations and processes		• Digital Automatic Coupling (DAC) • Alternative fuels • New concepts for single wagon load • Automated operation (platooning)	• Modularisation and flexibilisation of rail wagons and loading units
Digitalisation		• Estimated time of arrival (ETA) • Tracking and tracing	• Blockchain • Telematics and sensor technologies
Transport management; Transport service planning and controlling	Feed control systems for terminals and ports		

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	Layers of Logistics Networks		
Action areas	**Network infrastructure, Interfaces**	**Transport services**	**Supply chain, Logistics services**
Network capacity management (TCR, train path allocation…)	• R-CDM	• C-ITS • TTR	
Contingency management	• EU's new Contingency Plan for Transport (May 2022) • European Rail Infrastructure Managers Handbook for International Contingency Management	• Innovative barge for low water	
Last mile (operation processes, propulsion concepts and technologies)		• Alternative locomotive power supply	• Autonomous and automated delivery systems (Drones and robots)

The topics and keywords included in Table 3 are explained and described in the following paragraphs, broken down to the three layers and furthermore to the action areas within each layer.

3.2. Market practices at the "infrastructure" layer

Innovative market practices at the infrastructure layer predominantly address targets such as technical standards, capacity and reliability. Consequently, the European Commission is currently in the process of revising the Regulation of the TEN-T network. For the action area "**Intermodality**" of Logistics Networks, the following aspects, which also cover other action areas like Digitalisation, Contingency management or Last-mile, have particular relevance[13]:

- High infrastructure standards for all modes applied throughout the entire network;
- Nine 'European Transport Corridors', representing the main arteries of EU transport, that integrate the former Core Network Corridors with the Rail Freight Corridors;
- Stronger synergies between infrastructure planning and the operation of transport services. Examples include higher speeds for train services across the TEN-T network (160 kilometres per hour for passenger services and 100 kilometres per hour for freight), maximum waiting times at borders of 15 minutes for rail freight. Another example is guaranteed good navigation status per river basin on the inland waterways on the TEN-T network;
- Requirements for the deployment of the charging and refuelling infrastructure needed for alternative transport fuels in line with the Alternative Fuels Infrastructure Regulation;

[13] Questions and Answers: The revision of the TEN-T Regulation <https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_6725>

- Use of innovative technologies like 5G to further advance the digitalisation of transport infrastructure, further increasing efficiency, and improving the safety, security and resilience of the network;
- Increased resilience of the TEN-T network to natural and human-made disasters via climate-proofing requirements and environmental impact assessments for new projects, and to the implications of an accident or breakdown (e.g., by enabling alternative route alignments to the main network);
- More transhipment hubs and multimodal passenger terminals in cities to facilitate multimodality, in particular for the last-mile of a passenger or freight journey;
- Connect large airports to rail, where possible high-speed rail;
- Making it possible network-wide for lorries to be transported by trains.

Within the action area "**Transport management, planning and controlling**", feed control systems for trucks and trains are important tools to reduce bottlenecks and congestion and to create additional capacities in terminals and port areas. Such systems include routing optimisation, monitoring of scheduled, real-time and expected arrival times as well as information on potential disruptions. Such information is made available for truck drivers and to dispatchers in the terminals, who are then able to optimize truck and train inbound/departure. Examples are installations in Duisburg port area[14] or the North Sea ports[15]. With reference to the BOOSTLOG clouds, such feed control systems represent the interface between Logistics Networks and Logistics Nodes.

An important methodology for the action area "**Network capacity management**" is the so-called "Rail-Collaborative Decision Making (R-CDM)". Intermodal rail/road transport suffers from a general lack of transparency and predictability of operation along the logistics chain. A promising approach to overcome these shortcomings is performance monitoring. The aviation sector has long-time experience with such procedures, implementing the "Air-Collaborative Decision Making (A-CDM)" approach during the last 15 years in Europe and worldwide. The RFC Rhine-Alpine showed in a feasibility study that these experiences might be transferred to a "Rail-Collaborative Decision Making (R-CDM)"[16], provided that there is a common willingness among all stakeholders in the intermodal transport chain to share their data. The main advantages of R-CDM consist in improving quality of service by

- Reducing delays,
- Improving reliability by increasing predictability,
- Optimising resource utilisation,
- Optimising infrastructure capacity,
- Creating situational awareness.

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[14] Siemens und duisport installieren intelligente Lkw-Zulaufsteuerung <https://oevz.com/siemens-und-duisport-installieren-intelligente-lkw-zulaufsteuerung/>

[15] Seehäfen Bremerhaven: Dispositive Zulaufsteuerung eingeführt <https://www.eurailpress.de/nachrichten/unternehmen-maerkte/detail/news/seehaefen-bremerhaven-dispositive-zulaufsteuerung-eingefuehrt.html<

[16] <https://www.corridor-rhine-alpine.eu/news-detail/results-rail-cdm-feasibility-study.html>

In times of increasing unforeseen events with a major impact on freight transport it is essential to ensure the availability of European infrastructure by **Contingency management**. This topic has been taken up by the European Commission as well as by the Infrastructure Managers:

- In May 2022, the European Commission published its Contingency Plan for Transport, with a ten-point toolbox of measures to guide EU institutions and Member States in safeguarding the free movement of people and goods during major crises.[17] [18] The toolbox contains the following 10 areas of action: (1) Making EU transport laws fit for crisis situations, (2) Ensuring adequate support for the transport sector, (3) Ensuring free movement of goods, services and people, (4) Managing refugee flows and repatriating stranded passengers and transport workers, (5) Ensuring minimum connectivity and passenger protection, (6) Sharing transport information, (7) Strengthening transport policy coordination, (8) Strengthening cybersecurity, (9) Testing transport contingency, (10) Cooperation with international partners.
- According to Directive 34/2012/EU, article 54.1, Rail Infrastructure Managers (IMs) have to draw up a contingency plan for the event of serious incidents or serious disturbance to train movements. To support the IMs in fulfilling this obligation for serious incidents with international impact, the "European Rail Infrastructure Managers Handbook for International Contingency Management"[19] describes the international processes how to handle such cases. It specifically tackles the following processes and conditions: (1) How to recognise and when to declare an internationally relevant disruption, (2) The preparatory processes for international business continuity management, (3) The roles needed for the international cooperation, (4) Pre-defined procedures and best practices, (5) Data gathering for reliable re-routing statistics, KPIs and (6) Legal framework.

  The ICM Handbook is coordinated by RNE and is generally effective from January 2022. The capacity allocation related procedures will be effective from timetable period 2024, as these procedures must be first published in the Network Statements. Rail Freight Corridors (RFCs) act as facilitators with respect to the disruption management and the communication process.

3.3. Market practice at the "transport service" layer

The action area "**Intermodality and synchromodality**" of the transport layer is featured by

- Multimodal transport planners, which combine several transport modes to door-to-door transport chains. One example is Match2Rail, which aligns exiting intermodal connections with transport demands[20]. However, one has to acknowledge that many of those planning tools had only a very short lifetime and were given up again. This is also because it is not possible for IT platforms to make the existing connections of different combined transport providers transparent smoothly, as not all intermodal operators publish their network and, if they do, the information is provided in an inconsistent manner. Further problems are due to inconsistent labelling of the terminals. Therefore, the Studiengesellschaft für den Kombinierten Verkehr e.V. (SGKV) and PTV Group have launched an

[17] <https://transport.ec.europa.eu/news/protecting-eu-transport-times-crisis-commission-adopts-contingency-plan-transport-2022-05-23_en>

[18] <https://www.iru.org/news-resources/newsroom/learning-past-crises-eus-new-contingency-plan-transport>

[19] <https://rne.eu/wp-content/uploads/RNE-International-Contingency-Management-handbook-v-2.0.pdf>

[20] <https://www.shift2030.eu/match2rail/>

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initiative to make connections in multimodal freight transport visible. The aim is to develop a uniform timetable for combined transport in close exchange with the sector. The feasibility study is being funded by the German Ministry of Transport (BMDV)[21]. Within the project Clusters 2.0, PTV has developed an intermodal route planner (X-Intermodal) to plan transport orders using different means of transport[22].

- Online platforms for identification and booking of capacities based on real-time availability, like Click2Rail[23]. This same approach is also pursuit within the Modility project, funded by the Federal Railway Authority of Germany[24]. The aim of the project is to develop a broking and booking portal for intermodal transport. More specifically, the tool shall make booking simple and quick by using B2C best practices to enable a binding booking in under a minute. Modility was awarded the German Excellence Award 2022 in the category „Strategy, Transformation & New Work".
- Additional, new transport systems that might supplement the existing (freight) transport modes and thus contribute to enhanced synchromodality. One prominent example is the "Hyperloop" technology, designed for high-speed, energy-saving and autonomous transport of goods and passengers in coaches, which run substantially free of air resistance or friction inside special tubes (tunnels) using magnetic propulsion[25]. There is a huge variety of proposed routes in Europe, North America and Asia. The technology is currently being further researched in programs of TUM Hyperloop[26] and EuroTube[27]. Next to technological issues, particularly questions regarding security and economic application are to be solved.

Not surprising, the action area "**Operation and processes**" is largely represented in the transport service layer of Logistics Networks:

- Digital Automatic Coupling: Coupling and de-coupling currently is belonging to the main manual work processes in train operation in Europe. Digital Automatic Coupling (DAC) is considered as the unique chance to revolutionise European rail freight transport, as it is the essential element to transform railway operation management. With the implementation of DAC, more capacity for shifting freight transport shall be provided: DAC is seen as a key enabler for further digitalisation and automation of the European rail system and therefore a prerequisite to significantly increase the modal share of rail freight to 30% by 2030 compliant with the Green Deal[28]. There are several activities and projects running on national and European level to support and push the implementation of automatic couplers[29].

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[21] PTV Group: Verbindungen im Kombinierten Verkehr sichtbar machen <https://transport-online.de/news/ptv-group-verbindungen-im-kombinierten-verkehr-sichtbar-machen-72714.html>

[22] <https://company.ptvgroup.com/en/resources/newsroom/latest-news/ptv-coordinates-eu-research-project-clusters-20>

[23] <https://www.click2rail.com/>

[24] <https://www.eba.bund.de/Z-SGV/Projekte/Projektsteckbriefe/modility/modility_node.html>

[25] <https://en.wikipedia.org/wiki/Hyperloop#Hyperloop_research_programs>

[26] <https://tumhyperloop.com/>

[27] <https://eurotube.org/>

[28] <https://www.railfreightforward.eu/node/68<

[29] <https://blog.railcargo.com/en/artikel/dak-faq1>

- Alternative fuels – RH2INE: The RH2INE project[30] focusses on the application of hydrogen in the transport sector. The general objective is to stimulate a targeted structural demand for hydrogen in the mobility sector, aligned with a sustainable hydrogen supply network. The project takes a first step towards a zero-emission transport corridor by developing the right conditions and infrastructure for the use of hydrogen in the inland transport and logistics chains, e.g., inland waterways, road and rail transport in the last-mile. The RH2INE project consists of several sub-studies that provide a detailed insight into the sustainable integration of hydrogen as a transport fuel in the whole logistics chain. A roll-out plan shall provide an outlook on the necessary steps for actual implementation and expansion of use.
- Alternative fuels - Hydrogen-powered trucks on the road (HyTrucks): HyTrucks is a European initiative supporting the deployment of a zero-emission heavy-duty Hydrogen truck fleets in most intense traffic areas in Europe[31]. Members of this initiative are leading European shippers, carriers, truck manufacturers, refuelling station operators and hydrogen suppliers. Goal is to significantly reduce CO_2 emissions in 2025 by an estimated amount of about 120,000 tonnes per year thanks to 1,000 trucks in operation, and a first network of 25 high-capacity hydrogen stations connecting Europe's important logistics hubs: the seaports of Antwerp and Rotterdam and Duisburg as the largest inland port in Europe.
- New concepts for single wagonload transport: Although abandoned by many incumbent railway undertakings in Europe, single wagonload transport (SWL) is still an important service for many shippers in particular from the chemical and automotive industry. Furthermore, competitive SWL logistics chains are needed to support the European and national political goals for modal shift. Therefore, a lot of projects have been initiated to improve operation and processes ins SWL. The importance of improvement needs becomes obvious by the fact that three of the selected 17 projects are focussing on the area: the R&I projects LessThanWagonLoad, RETRACK and ViWaS. Additional important projects and measures are:
  - Swiss Split[32] is a rail service which distributes containers via conventional shunting yards directly from intermodal terminals to the final recipients' sidings by rail in Switzerland;
  - The railway undertaking DB Cargo operates single wagonload services throughout Germany. The company has planned several measures that, when combined, are intended to increase the competitiveness of rail freight transport. An important element of the strategy is the complete automation of locomotive shunting activities in DB Cargo's train formation facilities[33].
- Automated operation: Automated operation in transport and logistics means in most cases the replacement of driving personnel by sophisticated technical solutions. A well-known solution mainly for long-distance transport is so-called "platooning". Following the example of rail transport (operating with locomotives and wagons), in platooning concepts one or more driverless vehicles

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30 <https://www.rh2ine.eu/>

31 <www.waterstofnet.eu/en/projects/vehicles/hytrucks>

32 <https://www.sbbcargo.com/fr/offre/prestations/trafic-combine/swiss-split.html>

33 <https://www.railfreight.com/railfreight/2021/10/27/db-cargo-automates-shunting-to-boost-single-wagon-load-traffic/>

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is/are assigned to a manned driving unit and following it remote-controlled. Reasons to implement platooning solutions are the improvement of capacity utilisation of transport infrastructure and the reduction of fuel consumption and emissions. Additionally, platooning can support to overcome the lack of driving personal and reduce transport costs. In Europe, numerous activities are ongoing. Two of them are briefly described below:

- The project "Enabling safe multi-brand platooning for Europe (Ensemble)[34]: this project shall take important steps of technological research before full deployment of multi-brand truck platooning. The project shall also communicate the economic, societal, and environmental impact of decisions surrounding platoon forming and dissolving. Goal of the project is to modernise the transport system by finding an optimal balance between fuel consumption, emission level, travel times and impact on highway traffic flows, resulting in reduced impacts on climate change, air pollution, noise, health and accidents.
- The project "Novel IWT and maritime transport concepts"[35] developed a new waterborne transport concept called the "vessel train". This formation consists of a "lead" vessel, followed by a series of lowly manned, digitally connected "follower" vessels. The concept shall reduce operational costs and increase economies of scale due to a better usage of existing infrastructure. Envisaged reduction of personnel costs shall significantly enlarge the economic potential for smaller vessels. This in turn will lead to improved access to urban environments for smaller vessels, thereby reducing congestion in populated areas. The legal challenges for automated (autonomous) vessel operation are very high, among other things due to the high traffic density on inland waterways. Until now, inland navigation has been considered one of the safest transport modes. One reason for the good safety record is the advanced control technology onboard of the vessels with autopilot, echo sounder, bow thruster, radar equipment and river information services. Technical equipment allowing automated navigation today does not replace the steersman but can support him because a legal framework for autonomous shipping has been lacking up to now. Although there is a large number of regulations, there is yet no specific one for autonomous navigation on inland waterways.

"Estimated Time of Arrival (ETA)" is one of the key topics in the action area "**Digitalisation**". Following the 'Rotterdam Declaration' endorsed by European transport ministers during the 2016 TEN-T Days in Rotterdam, the railway sector developed its own Sector Statement to boost international rail freight by defining ten priority actions, one of those aims at providing information on Estimated Time of Arrival (ETA) to all actors in the logistics chain.

- In this context, the ELETA project - co-financed under the Connecting Europe Facility (CEF) - has been launched in 2017 to demonstrate the advantages of exchanging the Estimated Time of Arrival (ETA) data within the entire rail supply chain management[36]. ELETA, acronym for "Electronic Exchange of ETA information", included 12 selected intermodal transport relations, operated by the Combined Transport Operators (CTOs) CEMAT, Hupac, Inter Ferry Boat, Kombiverkehr and Rail Cargo Operator.

[34] <https://platooningensemble.eu/project>

[35] <https://novimar.eu/>

[36] <https://www.railfreight.com/policy/2018/12/11/estimated-time-of-arrival-to-become-more-accurate/?gdpr=deny>

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ELETA made a step forward to overcoming legal, operational and technical obstacles in the electronic exchange of ETA information. The ELETA project ended in 2019, it was coordinated by Rail Net Europe (RNE) in close cooperation with International Union for Road-Rail Combined Transport (UIRR).

- As a follow-up of ELETA, RNE´s ETA programme[37] aims to improving the ETA accuracy by helping stakeholders to take different sources of providers into account and introduce ETA calculation based on an algorithm using artificial intelligence. In addition to rail freight operators, further stakeholders - predominantly terminals and CTOs - can benefit from the ETA information and provide their own train data (e.g., train loading status) in TIS. In order to have the possibility to compare the ETAs provided from different sources, new ETA qualifiers (ETAQ) have been introduced and tested during a pilot in 2021. Subsequent activities of the ETA Programme are focused on the introduction of a new approach, allowing to cover the entire European network with ETA and improvement of ETA accuracy using information exchange on operational obstructions.

The action area "**Network capacity management**" focusses on better usage and customised allocation of infrastructure capacity. For road transport, such technologies are subsumed under the topic "Cooperative Intelligent Transport Systems (C-ITS)", while rail is addressed by "Timetable and Capacity Redesign (TTR)":

- <u>Cooperative Intelligent Transport Systems (C-ITS):</u> while Intelligent Transport Systems (ITS) focus on digital technologies providing intelligence placed at the roadside or in vehicles, Cooperative Intelligent Transport Systems (C-ITS) deals with the communication between those systems. C-ITS use wireless technology to enable real-time vehicle-to-vehicle and vehicle-to infrastructure communication, which enables a better coordination between road users and consequently more efficient traffic flows.[38]

  The implementation of C-ITS is likely to be done in three phases: Phase 1 contains systems that deliver warnings. For example, if a vehicle experiences a slow-moving vehicle ahead, road works or a traffic jam, it can communicate this message to all other vehicles heading in its direction. Or a vehicle could receive warnings on changing road rules or speed limits. Phase 2 includes sensor data, where vehicles will collect data from different signals and read the traffic situation. It will then alert the driver and provides corresponding instructions. Phase 3 is about collaboration between vehicles. It involves continuous vehicle-to-vehicle and vehicle-to-pedestrian connectivity which enables effective warning and improved response times to potential accidents.

  In 2016, the European Commission adopted a European Strategy on Cooperative Intelligent Transport Systems (C-ITS).[39] The objective of the C-ITS Strategy is to facilitate the convergence of investments and regulatory frameworks across the EU, in order to support the deployment of mature C-ITS services. This includes the adoption of the appropriate legal framework at EU level to ensure legal certainty for public and private investors, the availability of EU funding for projects, the continuation of the C-ITS Platform process as well as international cooperation with other main regions of the world on all aspects related to cooperative, connected and automated vehicles. It also involves continuous coordination, in a learning-by-doing approach, with the C-ROADS platform, which gathers real-life

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[37] <https://rne.eu/tm-tpm/estimated-time-of-arrival/>

[38] <https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/cooperative-connected-and-automated-mobility-ccam_en>

[39] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility; COM(2016) 766 final

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deployment activities in Member States. In the private sector, several truck suppliers have been developing and testing C-ITS technologies in applications like platooning. In 2019, the Commission adopted a delegated regulation on specifications for the provision of C-ITS, which did not enter into force following an objection by the Council of the European Union. In June 2019, initiated by DG MOVE, the Cooperative, Connected, Automated and Autonomous Mobility (CCAM) platform[40] has been set up, that contains some 400 public and private experts to coordinate open road testing of connected and automated mobility and to link with pre-deployment activities.

- Timetable and Capacity Redesign (TTR): incomplete harmonisation of timetabling procedures between European countries makes it difficult to cooperate at international level. To remedy this unsatisfactory situation, both RailNetEurope (RNE) and Forum Train Europe (FTE) – supported by European Rail Freight Association (ERFA) – launched the Redesign of the international Timetabling Process project (TTR)[41] to improve the international timetable planning process.

  TTR introduces a new approach to capacity management. Existing process components have been streamlined and improved, and some innovative process components and products were newly created to fully cover all market requirements. In order to test this new approach, especially the innovative process components, the TTR programme has launched several pilots (e.g., Brenner: München-Verona, Rotterdam – Antwerp). The results shall be used to define the process to the last detail, improve process components and demonstrate first benefits for the market. In addition, experiences and best practice from these TTR pilots should be used for the TTR Migration.

An example for transport services related to the action area "**Contingency management**" is the "Innovative barge for low water periods on the river Rhine" project. In the recent past, low water levels on the Rhine have caused logistics chain problems for the industry located there. The main objective of the development of a new type of inland barge was a high load-bearing capacity with a shallow draught. This concept shall ensure safe operation and full-manoeuvrability in extreme low-water situations. The dimensions of the new barge ship are 135 metres by 17.5 metres, which is considerably larger than the dimensions of the common tankers on the Rhine, which are usually 110 metres by 11.5 metres. In order to achieve a high load-bearing capacity with these ship dimensions, a hydrodynamically optimised casco with propulsion adapted to it was designed. An additional innovative feature is the lightweight construction, which ensures high structural stability by transferring methods from maritime to inland waterway vessels. The new vessel is powered by three electric motors, which are fed by the latest generation of efficient Stage V diesel generators with exhaust gas after-treatment.

Within the action area "**Last-mile operation**", rail suffers from many problems. One of the key issues is missing electrification on private sidings or on connecting lines. This shortcoming shall be overcome by hybrid or dual mode locomotives. These engines have an electric as well as a Diesel power unit on board. With this technology, electrification gaps in the rail network can be bridged, as can non-electrified sidings on the last-mile without stopping and without changing locomotives. This enables the rail company to respond even more

40 <https://www.ccam.eu/>

41 <https://rne.eu/sales-timetabling/ttr/>

flexibly to customer requirements. Examples for such locomotives are the Siemens Vectron Dual Mode[42] or the Euro9000 locomotive by Stadler[43].

This technology is also further developed in the eLM-Lok project, funded by the Federal Railway Authority of Germany[44]. The aim of the project is to integrate a lithium-ion-based battery power module on board a Vectron series electric mainline locomotive to enable its use on non-electrified lines. The project includes both the certification-relevant tests for the approval procedure and the testing and optimization of operational suitability on a test site and in pilot traffic on the test track.

3.4. Market practices at the "logistics" layer

The action area "**Operation and processes**" of the logistics layer is represented by modularisation and flexibility of rail wagons and loading units. A core element for competitive rail-bound logistics chains are economical and modern freight wagons that meet the requirements of state-of-the-art logistics chains. These requirements include high loading capacity and low tare vehicle weight, flexibility with regard to different commodities, reliability and high annual mileage. A challenge is that the technical life span of wagons is 30 to 40 years, which entails very long innovation cycles, and therefore only few numbers of new rail wagons are annually procured in Europe. In order to increase flexibility of rail wagons, several projects / developments have been executed focussing on the flexible interchange of loading units and wagons for different commodities, in addition to "conventional" combined transport. In general, for combined transport, there is a trend for a deeper integration into the logistics chains between production and connected logistics chains.

- Innofreight[45], an Austrian rail operator, developed a modular concept of loading units and wagons offering transport solutions for timber products, steel, liquid goods (energy), building material, agriculture and chemicals and energy. Currently, Innofreight is active in 20 European countries, operating 23,000 intermodal loading units, 2,700 wagons and 10 terminals in various countries.
- The BASF "heavy" chemical containers: BASF, based in Ludwigshafen, has integrated a new storage and logistics concept in 2018[46] consisting of:
  - new optimized-rail tank containers with a payload of 66 tonnes operated instead of conventional rail tank wagons;
  - an automated tank container depot ate the BASF plant in Ludwigshafen and
  - the operation of automated guided vehicles in the storage area.
- Wascosa's "flex freight system" is another prominent example for the flexibility of rail wagons and loading units[47]. The Swiss freight wagon provider developed its flex freight system based on standard intermodal wagons for different commodities, amongst others for the above-mentioned BASF containers.

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42 <https://www.mobility.siemens.com/global/en/portfolio/rail/rolling-stock/locomotives/vectron/dual-mode.html>

43 <https://www.europeanlocpool.com/lokomotiven/euro9000-lokomotive/>

44 <https://www.eba.bund.de/Z-SGV/Projekte/Projektsteckbriefe/eLM-Lok/elm-lok_node.html>

45 <www.innofreight.com/en/>

46 <www.basf.com/global/en/who-we-are/organization/locations/europe/german-sites/ludwigshafen/the-site/news-and-media/news-releases/2017/05/p-17-183.html>

47 <www.wascosa.ch/de/media/medienmitteilungen/in-the-pursuit-of-productivity_m545>

In the action area "**Digitalisation**", important contributions are expected from Blockchain and Telematics/ sensor technologies:

- Blockchain: today, data from transactions between parties is usually stored individually with no overview on all the activities. Blockchain is a mechanism that gives access to numerous parties, involved in the logistics process, to a shared database where they can exchange information, send documentation (such as SMART contracts, consignment notes, ECMRs), share delivery status updates, perform payments and transactions etc. Overall, Blockchain creates a trusted environment between the key players and thus has the potential to reduce inefficiencies and disruptions in the supply chain.[48]

  However, real breakthrough of the blockchain technology in logistics has not yet happen. There is a lack of trust and understanding regarding the technology and its applications. Blockchain's capacity to offer a new form of infrastructure and a new way to digitise assets through tokens is not easy to grasp because it is an underlying technology which works in the background. Currently, there is no industry standard for blockchain available and existing solutions are very fragmented. It would require the promotion of leading industries to develop industry-wide standardisation enabling the development of solutions at a larger scale.[49]

- Telematics and sensor technologies: transport telematics involves the technology of sending, receiving and storing information via telecommunication devices in conjunction with secure remote control. Typically, data - gathered from various sensors - is transmitted over wireless radio interfaces to an operation centre as the assets travel from one location to another.[50]

  Telematics and sensor technology is applied within different transport modes (e.g., rail, road, shipping) at different types of assets (e.g., rail wagons, barges, trucks, trailers or containers) for different purposes (e.g., for localisation of assets as well as the automated capturing of conditions related to the assets, or the cargo transported).

  Telematics solutions and sensors are required for a digitalised supply chain enabling the networking of processes, service providers and customers to optimize data exchange and access to services via interfaces in order to have all required data available everywhere at any time ("Logistics 4.0"). By networking all participants in the supply chain and automating production and logistics processes, existing operations can be made more efficient and customized.

Concerning the action area "**Last-mile**", a foreseeable trend is automating delivery, particularly with the help of robots and drones. This aims at decongesting roads in urban areas, reducing subsequent emissions and energy consumptions as well as at contributing to contactless delivery in a post COVID-19 world. As by example, Swiss Post started a drone-based delivery service for the healthcare sector in 2017[51]; delivery robots

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48 <https://vrioeurope.com/en/blockchain-future-logistics-supply-chain-management/>

49 <https://www.pwc.de/de/strategie-organisation-prozesse-systeme/blockchain-in-logistics.pdf>

50 <https://en.wikipedia.org/wiki/Telematics>

51 The first autonomous drone delivery network will fly above Switzerland starting next month <https://www.theverge.com/2017/9/20/16325084/matternet-autonomous-drone-network-switzerland>

are about to be permitted on public roads in Japan[52]. However, such concepts currently still struggle with technical constraints: the Swiss project had to be suspended in 2019, after one of the drones crashed near a group of small children[53]; delivery robots and drones are more or less restricted to fair-weather locations. Nevertheless, some forecasts predict a high share of autonomous vehicles in last-mile deliveries in the mid-term[54].

52 New Japanese rules to operate delivery robots on public roads progressing smoothly <https://mlexmarketinsight.com/news/insight/new-japanese-rules-to-operate-delivery-robots-on-public-roads-progressing-smoothly-official-says>

53 Swiss drone crashes near children, forcing suspension of delivery program <https://www.theverge.com/2019/8/2/20751383/swiss-drone-crash-delivery-program-suspended-matternet-post-hospital-samples>

54 The future of last-mile infrastructure <https://www.corrs.com.au/insights/the-future-of-last-mile-infrastructure>

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4. Projects to improve Logistics Networks

4.1. Identification and selection of R&I projects relevant for Logistics Networks

The selection of projects war performed within a three-step project mapping (see Figure 5). The aim of this exercise was to identify those R&I projects that shall be incorporated into the subsequent work steps of this Cloud Report. In practical terms, the almost 300 projects of the overall R&I project list were filtered according to following criteria:

- Step 1 (initial mapping): the titles and other entries of the project list were screened for relevant keywords and classifications, such as "multimodal", "corridor", "network", "Hubs & Synchromodality" or "Network services". Additionally, the summaries of the projects were checked for these keywords. In total, 115 projects have been identified to be tackled within the next step. Sources used were CORDIS, TRIMIS and the project's website, if still existing.
- Step 2 (relevance mapping): all projects of the R&I project list had received a relevance assessment ("high", "medium", "low"), referring to the general significance for the Cloud Reports. Basically, only projects with "high" relevance were further considered. In selected cases, however, also "medium" ranked projects were included, if they showed particular compliance with the characteristics of Logistics Networks. After this work step, 46 projects remained.
- Step 3 (content mapping): in the final step, the content of the 46 projects was analysed in detail. More specifically, the project documentations were checked regarding
    - Compliance with the identified action areas and expected impacts (see Table 1);
    - Consideration in one of the other Cloud Reports. Generally, this was no exclusion criterion; however, it should be ensured that the projects were properly allocated to the Cloud Reports according to their content focus.

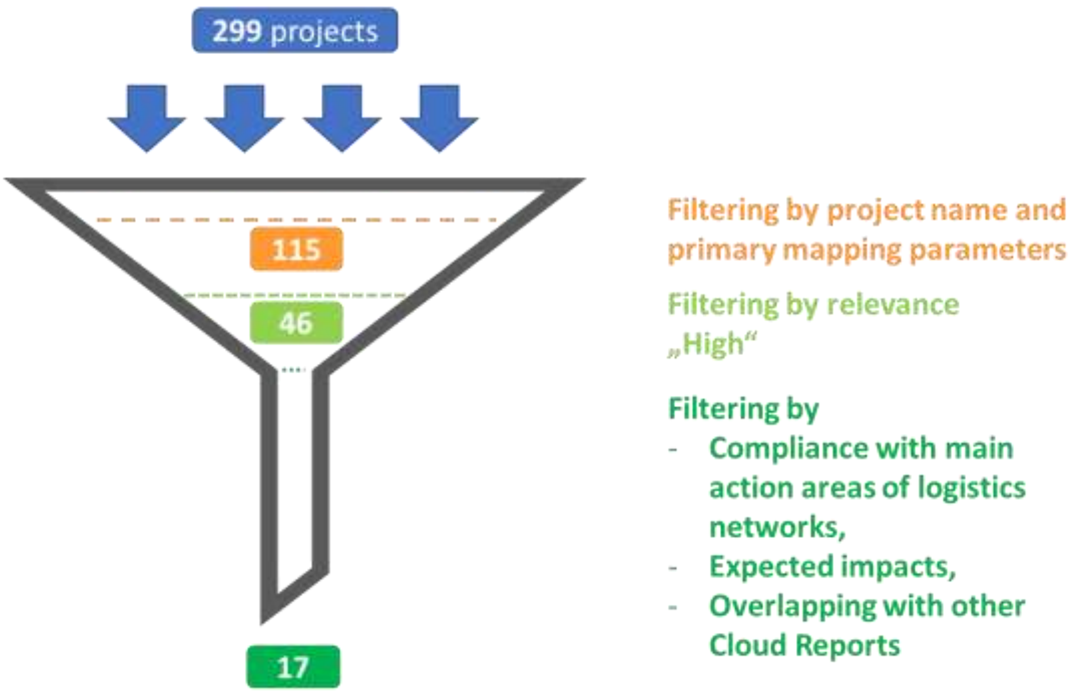

Figure 5: *Mapping of projects for the Logistics Network Cloud Report*

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As a result, the mapping exercise led to the identification of 17 projects relevant for this Cloud Report (see Table 4). At first glance, this relatively small number might be surprising, considering the outstanding importance of Logistics Networks (see above). In fact, it is precisely the all-encompassing approach of Logistics Networks that only few R&I projects meet. Most projects in the R&I project list are focused on specific technologies that can contribute to Logistics Networks, but which primarily miss the operational, network-related aspect. These holistic, operations-oriented attributes are difficult to implement in R&I projects. Moreover, the characteristics of Logistics Networks also imply a high likeliness of overlapping with projects and specific outcomes tackled by other Cloud Reports. Therefore, the low number of identified projects is understandable and plausible.

Table 4: *Selected R&I projects for the Logistics Networks Cloud Report*

Acronym	Name (CORDIS web Page)	Program	Coordinator	Period
ARCC	Automated Rail Cargo Consortium: Rail freight automation research activities to boost levels of quality, efficiency and cost effectiveness in all areas of rail freight operations	H2020	DEUTSCHE BAHN AG	2016 - 2019
CREAM	Customer-driven rail-freight services on a European mega-corridor based on advanced business and operating models	FP6	HACON INGENIEURGESELLSCHAFT MBH	2007 - 2010
FR8RAIL III	Smart data-based assets and efficient rail freight operation	H2020	DEUTSCHE BAHN AG	2019 - 2022
GET SERVICE	Service Platform for Green European transportation	FP7	TECHNISCHE UNIVERSITEIT EINDHOVEN	2012 - 2015
GIFTS	Global Intermodal Freight Transport System	FP5	TELESPAZIO S.P.A.	2001 - 2004
INTERFACE	Improvement of intermodal terminal freight operations at border crossing terminal	FP5	TECNIC CONSULTING ENGINEERS S.P.A. Italy	2002 - 2005
LessThan WagonLoad	Development of 'Less than Wagon Load' transport solutions in the Antwerp Chemical cluster	H2020	LINEAS GROUP	2017 - 2020
LOGISTAR	Enhanced data management techniques for real time logistics planning and scheduling	H2020	UNIVERSIDAD DE LA IGLESIA DE DEUSTO ENTIDAD RELIGIOSA	2018 - 2021
MOSES	Motorway of the sea European style	FP6	NORWEGIAN MARINE TECHNOLOGY RESEARCH INSTITUTE	2007 - 2010
NEWS	Development of a Next generation European Inland Waterway Ship and logistics system	FP7	TECHNISCHE UNIVERSITAET WIEN	2013 - 2015
NOVIMAR	NOVel Iwt and MARitime transport concepts	H2020	STICHTING NETHERLANDS MARIT. TECHNOLOGY FOUNDATION	2017 - 2021
RETRACK	Reorganisation of transport networks by advanced rail freight concepts	FP6	NETHERLANDS ORGANISATION FOR APPLIED SCIENTIFIC RESEARCH TNO	2007 - 2011

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Acronym	Name (CORDIS web Page)	Program	Coordinator	Period
Smart-Rail	Smart Supply Chain Oriented Rail Freight Services	H2020	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETEN-SCHAPPELIJK ONDERZOEK TNO	2015 - 2018
SYNCHRO-NET	Synchro-modal Supply Chain Eco-Net	H2020	DHL EXEL SUPPLY CHAIN SPAIN SL	2015 - 2018
TELLISYS	Intelligent Transport System for Innovative Intermodal freight Transport	FP7	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN	2012 - 2015
TIGER DEMO	Trans-Rail Integrated Goods European-Express Routes Demonstrators	FP7	CONSORZIO PER LA RICERCA E LO SVILUPPO DI TECNOLOGIE PER IL TRASPORTO INNOVATIVO/ITALY	2011 - 2013
ViWaS	Viable Wagonload production Schemes	FP7	HACON INGENIEURGESELLSCHAFT MBH	2012 - 2015

4.2. Overview on the selected projects

Figure 6 provides an overview on the selected projects and their assignment to the considered research programs. It is apparent that most projects stem from the more recent programs: Horizon 2020 is represented by seven and FP7 by five projects.

Figure 6: *Selected "Logistics Networks" R&I projects and their allocation to the funding programs*

Nevertheless, as it has been said in description of the projects' selection process, setting the boundaries between the clouds is an arduous task. Clouds are interdependent with each other, and many projects affect more than one cloud, to a greater or lesser extent. This particularly applies for Logistics Networks, a cloud, where innovations from multiple research areas are united in order to frame an overall vision of future freight transport. As Figure 7 visualises, the application fields connect the Logistics Networks especially with Urban Logistics and Modularisation & Transhipment Cloud Reports. In addition, it is obvious that topics such as synchro- and multimodality are also reflected in the other clouds. For these reasons it is not surprising that four of the projects are also included in other Cloud Reports: ARCC (Logistics Nodes), GET SERVICE (Data sharing), INTERFACE (Logistics Nodes) and LOGISTAR (Coordination & Collaboration, Data sharing).

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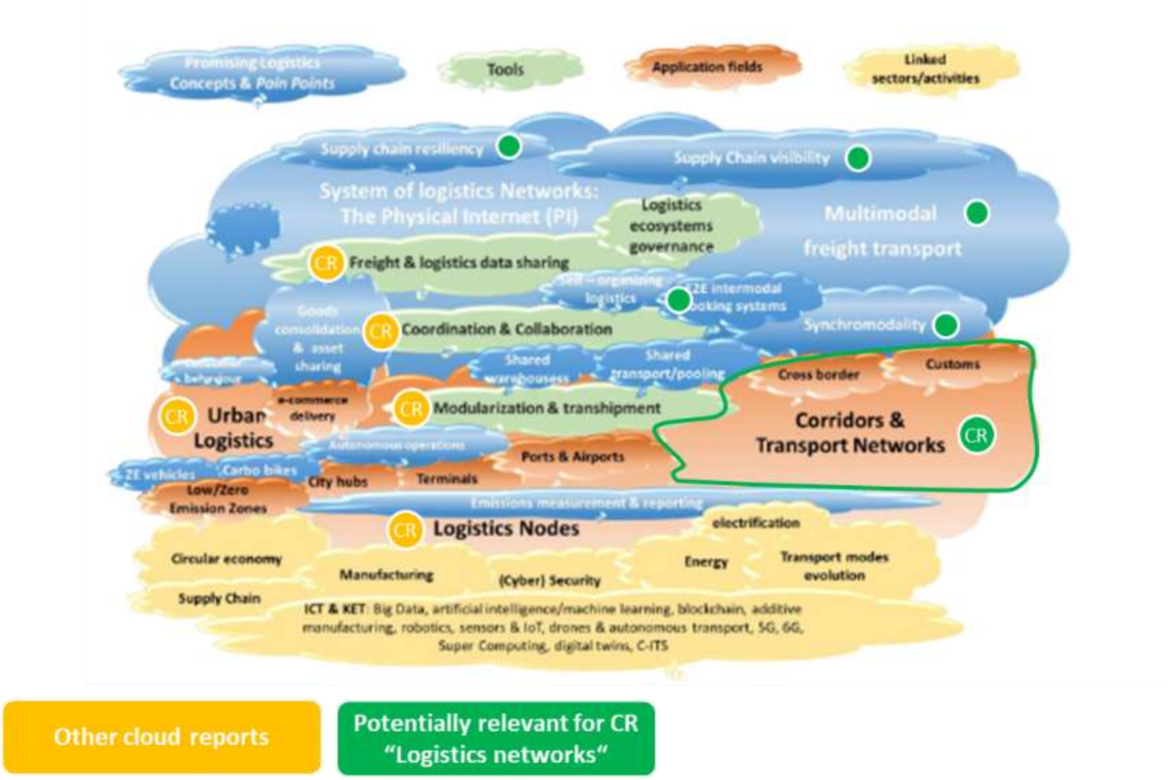

Figure 7: "*Logistics Networks" cloud and position to other clouds (source: BOOSTLOG proposal)*

Keeping this in mind it is only logic that the results of the selected projects radiate to other clouds, as well. These results are described in the following sub-chapters. Moreover, they are compiled in a schematic way, differentiating outcomes to different areas: Technology, Policy, Business Model or Service/Product (see Annex III - The projects' outcomes). **Error! Reference source not found.** shows the incidence of projects generating each type of outcome, showing that almost all (16 out of 17) projects elaborated technological output, which in most cases resulted in a concrete product and/or business service. However, these technologies and products referred to the lifetime of the respective projects, not necessarily leading to an implementation case thereafter. This restriction is also visible by the significantly lower number of business models. Outcomes that addressed policy actions were only found in a minority of projects.

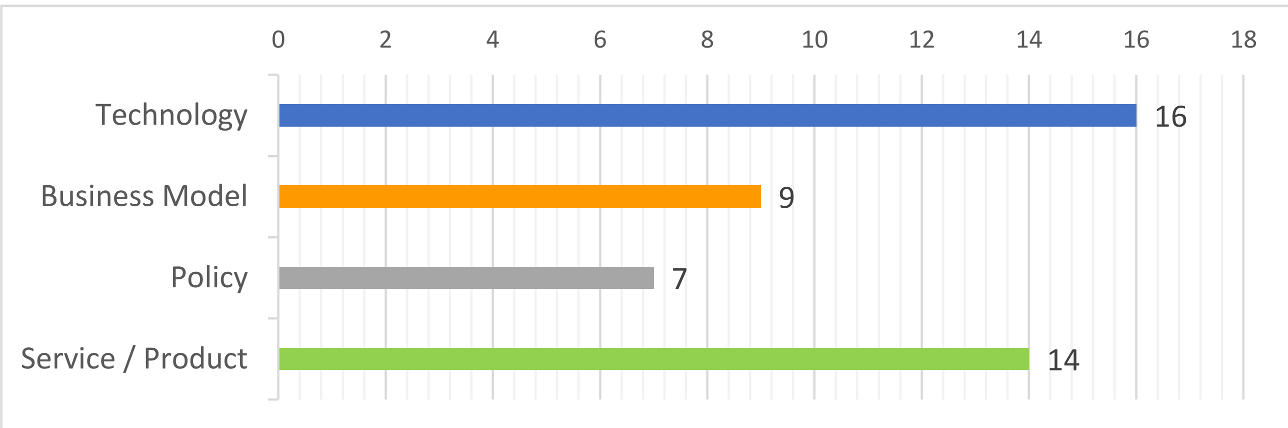

Figure 8: Areas of outcomes addressed by "*Logistics Networks" projects (total: 17 projects)*

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In addition, project results and outcomes must of course also be mirrored against the received funding, since this consists of public money. In this respect, (R&I) projects are obliged to return adequate benefits to the society that feeds them. The 17 selected Logistics Networks projects consumed more than 87 million EUR of funding altogether.

In a next step, the organisations with the highest level of involvement in the selected 17 projects were identified. The main criteria were frequency of participation in the projects as well as their role as provider of substantial results or as a project coordinator. These organisations are important for understanding and monitoring projects' outcomes as well as the implementation cases derived from them. Specifically, they form the basis for the selection of the interview partners. As Figure 9 visualises, 17 organisations were revealed as particularly involved in European research projects in the area of Logistics Networks. Not surprisingly, most of them were stemming from the "operators" cluster.

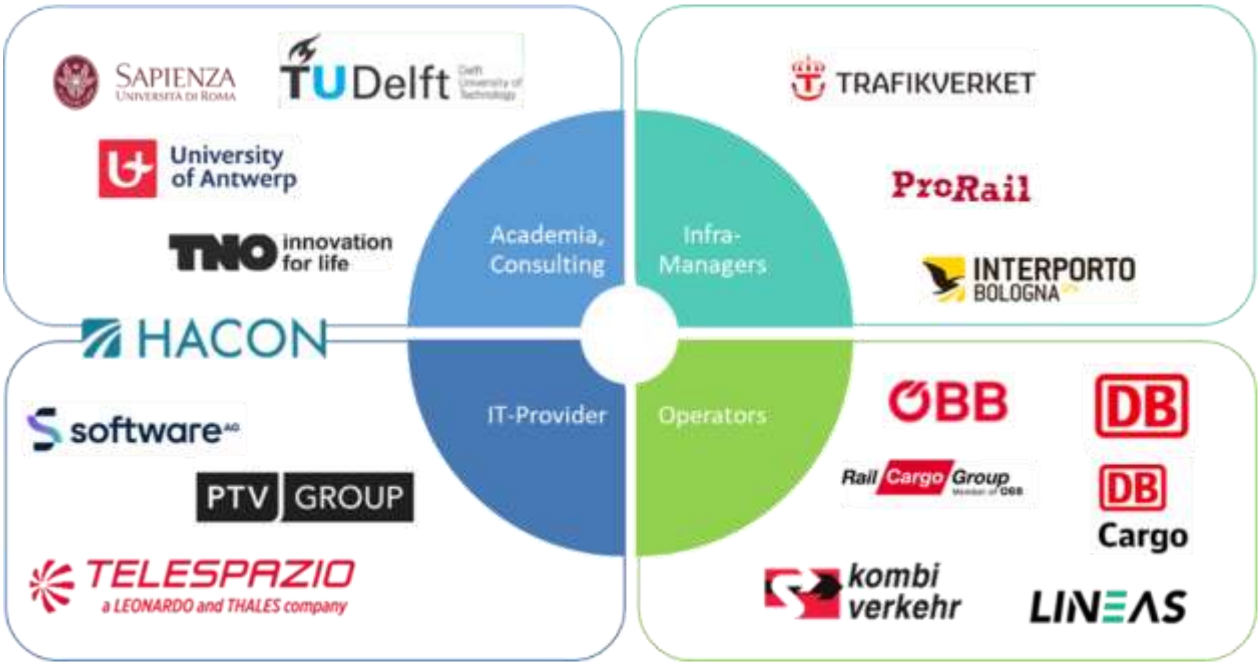

Figure 9: *Organisations with high level of involvement in "Logistics Networks" projects*

4.3. Expected impacts of the selected projects

The expected impacts of Logistics Networks as outlined in Table 1 (see chapter 2.2) have been broken down into their corresponding KPIs. The objectives and programs of the selected projects were scanned against these KPIs; the result of this exercise is shown in Table 5.

According to expectations and to the layers of Logistics Networks, the main focus of the projects is on providing robust and cost-efficient transport chains via synchromodal networks. Consequently, the ranking is headed by "Decreased cost of transport & overall logistics, incl. increased transport efficiency", "Increased transport reliability and responsiveness", "Improve the performance of the European transport" and "Modal shift". "Decrease of environmental impact" follows with some distance, although it should be noted that CO_2 reduction or lower energy consumption is also impact of modal shift or increased transport efficiency.

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Table 5: *Expected impacts, KPIs and projects addressing them*

Expected impacts	KPIs	Projects
Decrease of environmental impact	GHG emissions/Unit of transport	GET SERVICE, LessThanWagonLoad, NEWS, SYNCHRO-NET, TelliSys
	Energy consumption/Unit of transport	ARCC, CREAM
Reduction of congestion on the road network	Number of eliminated truck movements/a	LessThanWagonLoad, SYNCHRO-NET, TIGER DEMO
Modal shift	Absolute productivity [tkm]	CREAM, LessThanWagonLoad, MOSES, RETRACK, Smart-Rail, TIGER DEMO, ViWaS
	Market share in [%] per mode, related to [tkm]	CREAM, MOSES, NEWS, NOVIMAR, RETRACK, Smart-Rail, SYNCHRO-NET, TelliSys, TIGER DEMO
Improved capacity utilisation of barge, train and truck	Capacity utilisation [%], related to loading capacity [t]: barge, train, truck and/or to loading length [m] (train)	GET SERVICE, LOGISTAR, RETRACK, TelliSys, ViWaS
	Lead time [h]	ARCC, Smart-Rail, SYNCHRO-NET, TIGER DEMO
Decreased cost of transport & overall logistics **Increased transport efficiency**	Operational cost/unit of transport	ARCC, CREAM, FR8RAIL III, GIFTS, LessThanWagonLoad, NEWS, NOVIMAR, Smart-Rail, TelliSys, TIGER DEMO, ViWaS
	Share of empty runs per mode [%], related to [vehicle-km]	GET SERVICE, SYNCHRO-NET
	Transport performance per mode [tkm/vehicle-km]	SYNCHRO-NET
Increased transport reliability and responsiveness	Share of on-time deliveries [%]	ARCC, GET SERVICE, GIFTS, LOGISTAR, LessThanWagonLoad, NEWS, Smart-Rail, SYNCHRO-NET
	Reduction of (rail) process times	ARCC, CREAM, INTERFACE, TIGER DEMO, ViWaS
	Availability of rolling stock and ships	FR8RAIL III, INTERFACE, NEWS, NOVIMAR
Improve the performance of the European Transport	Hyper connected network of logistics hubs and clusters to optimize transport in the network, Number of intermodal connections	ARCC, CREAM, GET SERVICE, GIFTS, LOGISTAR, LessThanWagonLoad, MOSES, Smart-Rail, SYNCHRO-NET, TelliSys, TIGER DEMO
	Capacity utilisation [%] of the (rail) network	FR8RAIL III, SYNCHRO-NET
	Share of intermodal transport on total transport [%], related to [tkm]	CREAM
Improve long distance-city distribution connectivity	Direct accessibility of urban areas by long-haul transport	NOVIMAR, TIGER DEMO, ViWaS

4.4. Description of the selected projects

The following chapter provides brief descriptions of the selected projects regarding their main goals, their scope and the results achieved, as far as relevant for Logistics Networks. These descriptions mainly base on the official sources (CORDIS, TRIMIS and the project's website, if still existing), enriched by information gathered from interviews with the former project partners. Again, the projects are allocated to the three layers of Logistics Networks.

(1) Projects at the "infrastructure" layer

Projects that developed outcomes with particular relevance to the "infrastructure" layer (= 3 projects) are: ARCC, FR8RAIL III, MOSES.

ARCC (Automated Rail Cargo Consortium: Rail freight automation research activities to boost levels of quality, efficiency and cost effectiveness in all areas of rail freight operations)[55]

The overall aim of the Automated Rail Cargo Consortium (ARCC) project is to carry out an initial phase of rail freight automation research activities in order to boost levels of quality, efficiency and cost effectiveness in rail freight operations of the European railway sector. The three areas of research activities are: (1) Transporting and delivering freight via automated trains, (2) Developing automated support processes at the nodes (e.g. terminals, yards and transhipment points) and (3) Advanced timetable planning. The Consortium is made up of Joint-Undertaking (JU) members of Shift2Rail who are considered as the main drivers in developing and transferring automation technologies and processes for the railway freight sector.

The project result, that has been considered as most relevant for Logistics Networks, is advanced timetable planning: an optimal timetable planning is one of the key elements for successful and efficient railway operations. It is connected to operations planning in yards and terminals, which adds further levels of complexity to the planning activities. It is also related to traffic management, to the availability of rolling stock and to other typical factors related to the rail sector but also to the accessory services which are typical of the freight sector, such as goods loading and unloading, set up times at marshalling yards, shunting, etc. ARCC in this area focused on improved simulations and optimisation methods for timetable planning in long term planning, tactical planning and operational traffic.

FR8RAIL III (Smart data-based assets and efficient rail freight operation)[56]

The Shift2Rail (S2R) Strategic Master Plan is the key document adopted by the European Commission that defines EU strategy aiming to support the development, improvement and competitiveness of the European rail sector. Within the challenges highlighted in the IP5 part of the S2R Master Plan, FR8RAIL III further focuses on improving the freight eco system by addressing various challenges in 6 different fields: (1) Condition based maintenance, (2) Real-time Network Management, (3) Intelligent Video Gate Terminals, (4) Extended Market Wagon, (5) Telematics & Electrification, (6) Freight Loco of the future

The project will approach various aspects of the freight ecosystem aiming to increase EU freight rail transport competitiveness. The work is partly based on results achieved in the previous projects of the S2R Annual Work

55 <https://projects.shift2rail.org/s2r_ip5_n.aspx?p=ARCC>

56 <https://projects.shift2rail.org/s2r_ip5_n.aspx?p=FR8RAIL%20iii>

Plans 2015-2016 (FFL4E, ARCC, FR8RAIL), 2017 (FR8HUB) and 2018 (FR8RAIL II) – as well as the open calls within IP5.

The project result, that has been considered as most relevant for Logistics Networks is a Real-time Network Management, Yard Coordination System (YCS): Real-time network management is intended to improve the operational process by improved methods and information support and human interaction. The research here aims at reducing the gaps between timetable planning and operational traffic, and between yard management and network management. During the project research work, it has been investigated that there is a great need for information sharing between organizations at a marshalling yard. The demonstrator for information sharing between Infrastructure Managers (IMs), Marshalling Yard Managers (YMs), Terminal operators (TOs) and Freight Railway Undertakings (FRUs) regarding the arrival yard (Yard Coordination System) is expected to contribute in reducing shortcomings in several different ways. This support tool for co-operative planning of the common arrival/departure yard has been tested and finalized on an iterative process between the partners.

MOSES (Motorways of the Sea European Style) [57]

The main objective of the project was to define the criteria and minimum conditions to be implemented in order to ensure the successful development of a Motorways of the Sea (MoS) network as part of the Trans-European Transport Network (TEN-T). The project consisted of the following activities:

- Analysis of potential scenarios for the provision of the TEN-T, which could yield an increase in efficiency, service quality and competitiveness of intermodal transport chains, as well as of the options for developing the infrastructure and the transport network;
- Assessment and evaluation of the global impacts and potentialities of the scenarios identified for the optimal development of transport logistics linkages (including the feasibility of implementation), related services and organizational operations in the areas involved.
- Identify optimal feasible scenarios that could, amongst others:
    - Increase the efficiency of different modes of transport and the combination of modes in order to facilitate the future development of the freight transport market;
    - Ensure more efficient and effective future investments in the TEN-T Motorways of the Sea (in terms of costs, environmental impact, return on investment, for the provision of infrastructure, etc.), in order to achieve the maximum cohesion between the ports and inland economic regions (central and peripheral) through the connection with the existing TEN-T corridors and the priority projects and actions supported;
    - Guarantee seamless integration between the important sea and land routes as well as between different modes of transport;
    - Ensure the bundling of freight flows, the frequency, and the reliability of the MoS.

Due to political reasons, the project was aborted before the envisaged finalisation.

[57] <www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Meeresautobahnen_dt.pdf>

(2) Projects at the "transport services" layer

Projects that developed outcomes with particular relevance to the "transport services" layer (= 10 projects) are: CREAM, GET SERVICE, INTERFACE, LessThanWagonLoad, NEWS, NOVIMAR, RETRACK, Smart-Rail, ViWaS, TIGER DEMO.

CREAM (Customer-driven Rail-freight services on a European mega-corridor based on Advanced business and operating Models)[58]

The CREAM project was set up to respond to the increasing demand for rail-based logistic systems and to support the implementation of change in the European railway area, initiated by the European legislation. Against the benchmarking business models of logistic service providers, CREAM has defined advanced customer-driven business models for railway undertakings and intermodal operators. CREAM has analysed the operational and logistic prerequisites for developing, setting up and demonstrating seamless rail freight and intermodal rail /road and rail/short sea/road services on a Trans-European mega-corridor between the Benelux countries and Turkey/Greece. On this basis the CREAM partners developed different business cases which were integrated into an innovative corridor-related freight service concept; topics include (1) Innovative rail-based supply chains including intelligent rail and multimodal operation models, (2) a quality management system, (3) Interoperability and border crossing, (4) Integrated telematic solutions for train control, tracking & tracing of shipments and customer information, (5) Rail logistics for temperature-controlled cargoes and (5) New technologies for the transport of unaccompanied semi-trailers in intermodal transport.

As stated in the final project report, rail freight transport has benefited from these improvements by shorter transit times, improved transport quality and an increase in the annual transport performance of more than 1 billion tonne-kilometres. The CREAM project was performed in the period between 2007-2011; the consortium comprised 30 partners from 13 countries - including railway companies, the International Union of Railways UIC, transport operators, technology providers, research institutes and consulting firms.

The project results, that have been considered as most relevant for Logistics Networks, are

- Chain management: The management of the entire process chain, including loading/unloading of trains, the short-haul train runs between different sidings and the marshalling yard and the main train runs to connected European corridors, is called "chain management". Its primary objective is to increase the punctuality particularly of intermodal rail freight services on the local (harbour) line and to conduct related installations to effectively use resources (locomotives, train drivers), terminal capacity and rail infrastructure capacity (corridor rail lines, shunting yard) and thus increase the quality of the entire rail product. In the context of CREAM, the chain management has been developed and implemented in the Port of Rotterdam and a completely new railway line, dedicated for freight trains, the "Betuweroute" between Rotterdam and Venlo.
- Interoperable traction schemes: Interoperability is a key issue of the European transport policy which aims at promoting a single European rail area. CREAM has searched for opportunities to set up interoperable services. The investigations have shown that interoperable operations are often hampered e. g. by long border station stopping times, long and inefficient turn-around times of locomotives due to low frequency of transports, insufficient availability of interoperable locomotives,

58 <https://cordis.europa.eu/project/id/38634>

long-lasting homologation procedures for locomotives and inappropriate market conditions in some countries. The conditions are in general not appropriate to operate long-distance train services over multiple countries with just one locomotive. However, with the help of real uses cases, it could be demonstrated that it is favourable to reduce the number of operational interfaces and to introduce interoperability section wise, especially feasible on bi-national routes.

- Improved border crossing procedures: One of the major issues to reduce the overall transport time of rail freight services in South-East Europe is the optimisation of border processes and related border stopping times. Within the research works for this topic, 20 railway border crossings have been analysed on the CREAM corridor, taking into account the legal and technical framework. To boost the level of cooperation and to optimise the interfaces between the interacting parties at the border, the CREAM project initiated bilateral initiatives at seven concrete border crossings; thereby integrating railway undertakings, infrastructure managers, authorities and relevant customers to develop improved procedures, which were applied in a demonstration phase of the project. The improvement activities have been basically focussing on implementing electronic data exchange methods, procedures for advance notifications of train arrivals (pre-information) and on optimising the process organisation within the relevant border stations.
- Telematics and train monitoring: In line with increasing information needs in the logistics sector, rail transport customers call for efficient tracking and tracing solutions. In correspondence to these needs CREAM analysed different technical solutions based on GPS or simple tracking technologies and evaluated their applicability on the CREAM corridor. The results have been integrated in a comprehensive information management concept. In this context, a new IT system "Train Monitor" has been developed and implemented. This system can be regarded as a virtual rail transport management centre, connecting all relevant partners. The IT system "Train Monitor" closes existing information gaps by integrating train operation data from numerous sources (including GPS), showing automatically calculated values for the estimated time of arrival (ETA) and providing a train data base for quality statistics and operation analyses.
- Multimodal short sea – rail transport concept: Turkish trucks travel up to 7.000 km in each round-trip on their journey to and from West European countries. Ekol Logistics has developed an effective and environmentally friendly solution to this problem. A new intermodal transport system which reduced the share of land transport to only 2.000 km. Originating from the use of ferry services between the Turkish ports in Istanbul, Izmir and Mersin and the Italian Port of Trieste, the multimodal concept exhibits an innovative combination of these ferry boat connections on one side and a shuttle-train connection between Trieste and Worms (Germany), on the other side.

GET SERVICE (Service Platform for Green European Transportation)[59]

The main objective of the project was to develop a Service Platform for Green European Transportation (GET). The GET SERVICE platform shall provide transportation planners with a tool to plan transport routes more efficiently and to respond quickly to unexpected events during transportation.

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59 <https://cordis.europa.eu/project/id/318275>

To this end, it connects to existing transport management systems and improves on their performance by enabling sharing of selected information between transport companies, logistics service providers and authorities. In particular, the GET SERVICE platform consists of components that:

- enable aggregation of information from the raw data that is shared between partners and transportation information providers;
- facilitate planning and re-planning of transport based on that real-time information; and
- facilitate real-time monitoring and control of transportation, as it is being carried out by own resources and partner resources.

The service platform for Green European Transportation provides transportation planners and drivers of transportation vehicles with the means to plan, re-plan and control transportation routes efficiently and in a manner that reduces CO_2 emission. The GET SERVICE platform shall

1. enable improved transportation and route planning, by incorporating transportation- and logistics-related tasks, such as transfer of goods and administrative tasks, into the planning;
2. facilitate more accurate transportation and route planning, by using real-time information from multiple information sources;
3. facilitate quick effectuation of changes to transportation plans, including the execution of necessary transportation-related tasks, such as (de-)reservation of necessary resources and unloading of already loaded freight;
4. enable holistic planning, where transportation routes and placement of transportation resources is planned jointly to optimize resource usage.

To achieve these objectives, the GET SERVICE platform was developed, with subsystems for information aggregation, real-time planning, transportation control and transportation service development. The GET SERVICE platform contributes to the state-of-the-art by providing real-time transportation planning algorithms, a transportation-specific service development subsystem, transportation control and reconfiguration mechanisms; and automated real-time information aggregation mechanisms.

INTERFACE (Improvement of intermodal terminal freight operations at border crossing terminal) [60]

Main goal of the INTERFACE project was to identify and test innovative solutions to improve border-crossing terminal operations between the EU and CEEC countries as well as inside the EU. This should contribute to reducing customs waiting times, increase of safety, harmonising regulations and to develop additional functions to accommodate border-crossing terminals. Within the project, three demonstration sites were foreseen to test and validate solutions in a "real environment", also allowing for adoption to other sites. INTERFACE focused not only on isolated solutions but also on combined measures stressing their potential at different levels (technical, economical, organisational, etc.).

The specific measurable objectives of INTERFACE were the following[61]:

[60] <https://trimis.ec.europa.eu/project/improvement-intermodal-terminal-freight-operations-border-crossing-terminal>

[61] <https://cordis.europa.eu/project/id/11038>

1. To provide an inventory and an assessment of relevant cases on the borders inside the EU (France-Spain, alpine crossing), between the EU and (former) Accession Countries (Czech Republic-Austria, Finland-Lithuania) as well as between EU and Russia;
2. To identify dedicated concepts and combination of concepts limiting or eliminate the lack of border-crossing terminals' interoperability and interconnectivity;
3. To analyse, test and validate the developed concepts (a) in a theoretical view by modelling and assessing the intermodal potential in order to measure the dimensions of the identified concepts and (b) through running of demonstrations validating the concepts in a real environment;
4. To produce recommendations and an implementation plan for all levels of the decision-making and for the different intervention areas in the logistic chain.

Innovative solutions implemented in INTERFACE were operational optimisations, improvement of data exchange, providing real-time information and improvement of transhipment processes. An important KPI was the reduction of border-crossing times.

LessThanWagonLoad[62]

LessThanWagonLoad had the objective to develop a specialised logistics cluster for the chemical industry in the Port of Antwerp in order to shift transport volumes from road to rail to reduce CO_2 emissions. In order to reach the goal, the following project activities were carried out:

- Development of a less than wagon load concept: setting up a competitive door-to-door transport concept for LTL (less than truck load) freight volumes by using rail instead of road for the long-haul transport;
- Design and build a prototype of an automated system[63] for loading and unloading rail wagons: inspired by already existing automated truck loading systems, the new solution was intended to decrease costs for transhipment to rail to make the 'less than wagon load' offer more competitive;
- Identification of new added value rail services for the chemical industry focussing on (a) a multimodal freight village with a cross-docking warehouse for pallets, (b) specialised parking, repair and picking services, (c) advanced cleaning services for chemical rail wagons, trucks and tank containers, and (d) improved rail connections by combining conventional and intermodal freight volumes.
- Development of governance and business models: for the proposed new services potential markets were assessed, and detailed business cases were built to demonstrate the potential benefit for the stakeholders involved. In addition, governance models and financing schemes were worked out for the most promising new services;
- Assessment of the environmental performance improvement for the logistics cluster: given that the proposed optimisations contribute to a modal shift from road to rail, a decrease of the carbon footprint of the Antwerp chemical logistics cluster should be achieved.

62 <http://lessthanwagonload.eu>

63 <https://www.youtube.com/watch?v=itYkenghgfE>

NEWS (Development of a next generation European inland waterway ship and logistics system)[64]

The NEWS project conceived a new vessel type to minimise carbon dioxide emissions from container transport and make transport links across continental Europe more accessible, addressing bottlenecks along the major freight route Rhine/Meuse-Main-Danube. The project had two main research focus areas:

- Developing and validating a novel container ship (hull) with the capability to carry three layers of containers stacked and four side-by-side on at least 80% of the European Inland Waterways, with the deckhouse and a liftable wheelhouse in the front, with a completely new aft ship design for optimised propulsion efficiency and resistance efficiency and with Diesel- or gas-electric propulsion for clean and economical operation
- Developing a logistics system based on the novel container ship. This part of the project is particularly relevant for the Logistics Networks cloud. It contained the following main components:
    - Handbook for port infrastructure enhancement in the Danube area;
    - NEWS terminal planning tool.
    - Concepts for container liner service routes based on the macro- and micro regional analysis;
    - NEWS route and cost-planning tool;
    - NEWS Finance- & Business plan;

Although the technical and logistic feasibility of the new vessel concept could be validated, the cost calculation showed that return on investment would currently be too high to make the concept commercially viable. Therefore, no large-scale demonstration or regular implementation took place.

NOVIMAR (NOVel Inland waterway and MARitime transport concepts)[65]

The NOVIMAR project aimed to adjust waterborne transport in such a way that it can make optimal use of existing short-sea, sea-river and inland waterways. The basic idea is the so-called "vessel train concept". The vessel train consists of a manned lead vessel, followed by several vessels of various types and/or sizes with reduced crew level. With regard to Logistics Network, the following topics of the project are of interest:

- Composition & design of the vessel train: normally, vessels vary in type, size, and technical specifications. NOVIMAR assessed economic and logistic viability of the various compositions and researched new ship designs including optimised cargo handling systems;
- Navigating and manoeuvring the vessel train: the vessel train is navigated and manoeuvred by the crew on board of the leader vessel. For this, NOVIMAR developed a user-interface for the control of the course and speed of vessels participating in the vessel train, supported by a communication system between these vessels. In addition, an overlay on the navigation chart with detailed information about water depth was developed.
- Transport system: the waterborne transport system included both the sea and inland waterways, including locks and bridges, and deep-sea and inland ports and terminals. The vehicles were sea, sea-river and inland vessels. Operations dealt with the way the vessels were operated and the procedures

64 <https://cordis.europa.eu/project/id/314005>

65 <https://novimar.eu/>

set for this purpose including financing, legalities, and policies. NOVIMAR assessed the viability of the vessel train in the total transport system by use of simulation.

- Business concept of the vessel train: The business concept of the vessel train organizer was a plan for how revenues would be generated, and a profitable company would be developed. For this purpose, all parameters of the transport system were included in a chain cost model. Therefore, this model allowed calculating the generalised transport chain costs for different transport chains, including modal competition from road and intermodal rail transport.

In February 2020, model scale tests for the vessel train concept were performed at the laboratory of DST Entwicklungszentrum für Schiffstechnik und Transportsysteme in Duisburg. The full-scale demonstration of the Vessel Train concept took place in March 2021 on the Haringvliet near the village of Willemstad (the Netherlands). These tests proved the feasibility of the vessel train concept in real life.

RETRACK (Reorganisation of transport networks by advanced rail freight concepts)[66]

The RETRACK partners have taken the initiative to design, develop and implement a new and innovative trans-European rail freight service concept, starting with the rail corridor Rotterdam to Constanza (Romania) and investing potential extensions to the Black Sea area and Turkey.

The RETRACK project aimed at generating a significant modal shift of cargo from road to rail and to create an effective and scalable rail freight corridor between high demand regions in Western Europe and new high growth regions in Central and Eastern Europe. Important issues, tackled in this context were the integration of strategic port hubs (to provide access to the large goods repositories and generating the necessary volumes to make rail freight transport along the corridor economically feasible) and comparable short and guaranteed door-to-door delivery times of shipments. With this new rail freight service concept, the RETRACK partners aimed at demonstrating that rail freight services on trans-European corridors can be a competitive alternative to road haulage.

The project result, that has been considered as most relevant for Logistics Networks, is a new and innovative trans-European rail freight service concept: To identify and test the possibilities and limits for this new and innovative transport concept in practice, a "demonstration train" has been operated between the hubs Köln-Eifeltor and Györ with a secondary hub established in the Rotterdam region. The RETRACK demonstration train is conceived as a "group of wagons train", i.e. transport volumes of various customers - usually being smaller than the amount suitable for a block train - are combined into a train set. The volumes have been composed of all kinds of goods – from agricultural products and powdery bulk cargo to semi-finished products from the coal and steel industry, chemical products incl. dangerous goods as well as machine parts and containers. In 2022, the RETRACK train system is still in operation.

Smart-Rail (smart supply chain oriented rail freight services)[67]

The SMART-RAIL project aimed to improve the freight rail services offered to the shippers by focusing on making improvements of reliability, lead time, costs, flexibility, and visibility. Solutions developed in the course of the project three were implemented and tested in three Continuous Improvement Tracks (CITs):

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66 <https://cordis.europa.eu/project/id/38552>

67 <https://smartrail-project.eu/>

- CIT 1: Wagonload train services. This CIT aims to create and validate a concept for wagon-load trains on two corridors that has proven to be most effective with the support of the stakeholders involved. This is based on the existing, promising example of a successful SWL operation (of which partners are included in the consortium) to create a European network solution to follow up and expand on these practices. Furthermore, this CIT aims to develop new cooperation models between the different stakeholders in the SWL business and introduce improved IT tools that lead to a more efficient transport offer. The corridor Lyon-Munich is targeted with a continuation to Austria, Czech Republic, Slovakia, and Hungary.
- CIT 2: Managing connectivity of rail with other modes; Control tower for long distance rail freight transport. This CIT aims to increase the reliability for both planned and unplanned disruptions and to increase the visibility of the supply chain. Two long distance intermodal rail connections are covered, namely UK to Poland and UK to France, Spain and Italy. As of August 2017, Control Tower Rail went into operation. For door-to-door operational corridor management, LSP Seacon has developed a monitoring dashboard and an integrated module for its transport management system (TMS).
- CIT 3: Reliability in case of (unexpected) obstructions on the track. This CIT aims to increase the flexibility and reliability of rail freight transport within a multimodal transport system. Selected test bed for solution was the Rotterdam-Genoa corridor.

ViWaS (Viable Wagonload Production Schemes)[68]

Single wagonload (SWL) transport is still a major component in numerous European states' transport systems and in the logistics of different economic sectors such as steel, chemical industry and automotive. However, changing framework conditions and increasingly demanding market requirements have led to dramatic market losses and even to complete shutdown of SWL business in some countries. As this business segment has been evaluated as important for specific transports in a European co-modal transport system also in the future, significant improvements are needed. The ViWaS partners believe that for the success of SWL the following two issues might be crucial: (1) A viable SWL system is highly dependent on the critical mass. Thereby all options have to be considered to secure a high utilisation of the trains operated on the trunk lines, including a combined production with intermodal loads. (2) Only comprehensive and complementary measures are able to sustainably improve and preserve the European SWL systems in accordance with increasingly demanding market requirements. The ViWaS project has followed such a comprehensive approach; therefore, aiming at the development of (1) Market driven business models and production systems to secure the critical mass needed for SWL operations, (2) New ways for "Last mile" infrastructure design and organisation to raise cost efficiency, (3) Adapted SWL technologies to improve flexibility and equipment utilisation and (4) Advanced SWL management procedures & ICT to raise quality, reliability and cost efficiency. The applicability of these solutions and their effects have been tested on the basis of pilot business cases (by demonstrations).

The project results, that have been considered as most relevant for Logistics Networks, are

- <u>Simulation tool for SWL network planning:</u> Wagon SIM is an agent-based simulation tool for SWL transport, based on the Open-Source software MatSIM. The tool models the routing of freight wagons according to the routes within the real SWL network and thus enables the development of improved SWL networks and production schemes. The model reproduces in a two-layer structure, the

68 <http://www.viwas.eu/>

infrastructure and the operation of the SWL network. Therefore, it allows to model improvements in infrastructure, schedule and shunting operations.

- Regional network of rail logistics centres: Whereas the number of small rail sidings is continuously decreasing it becomes more and more important to develop capable rail freight bundling points that also serve rail freight customers without own rail siding. ViWaS has taken up this challenge with the further development of the "Railport" concept: The core of the concept is a network of multifunctional rail logistics centres (RLC) in close neighbourhood to each other to facilitate the transhipment of a wide range of products (e.g., palletized, oversized and heavy goods, liquid and bulk goods, containerized goods). The concept is combined with a set of complementary improvement areas: (1) Efficient rail production schemes for long haul and "last mile" transport, involving the use of hybrid "last-mile" locomotives, (2) Extended logistics service profiles of rail logistics centres (e.g., enabling buffer storage / just-in-time deliver) to widen the range of potential customers (3) Improved transhipment processes and technologies within the rail logistics centre.

TIGER DEMO (Trans-Rail Integrated Goods European-Express Routes Demonstrators)[69]

The TIGER DEMO project dealt with the demonstration of innovative hinterland transport concepts for reasons of economy, competitiveness, infrastructure capacity and ecology. It is the successor of the TIGER project[70], in which these new transport services had been developed and tested within the scope of pilot services. TIGER DEMO extended these pilot services to three full-scale demonstrators, located in Italy (A) and Germany (C, D):

- Demonstrator A: Genoa Fast Corridor (GFC) had the objective of transferring containers arriving at Genoa port terminals to the inland dry port of Rivalta. Shuttle trains were operated adopting random train loading in order to speed up operations in a total industrial way. New technologies and management systems (e-seal, e-custom, e-freight, ICT etc.) as well as investments in equipment, ports and dry port infrastructures and railway signalling were introduced to make the whole operations and their control viable. Inter alia, security and customs operations are carried in Rivalta instead of Genoa port while in transit via rail. By doing so, congestion in the port of Genoa was relieved and transit time and costs were reduced.
- Demonstrator C: Innovative Port and Hinterland Operations (iPort) dealt with hinterland transport services for the German North Sea ports. The nucleus of these concepts was (a) the consolidation volumes and (b) the composition of terminal dedicated trains in rail hubs outside the seaports. In so doing, cost- and time- consuming shunting operations within the seaports were reduced and rail infra-structure was decongested. In total, these effects improved efficiency and competitiveness of intermodal traffic against pure road transport. At the same time, the seaports became capable to increase their throughput of maritime containers.
- Demonstrator D: Intermodal network 2015+ aimed at making a further quality step change in the inland distribution by intermodal trains. This was achieved by connecting intermodal seaport-hinterland services and inland destinations in high-capacity hubs and gateway facilities. This concept was designed to integrate also small and middle-sized terminals into the high-quality hinterland network and to combine maritime and continental volumes at the same time. By doing so, the concept

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69 <https://cordis.europa.eu/project/id/265478>

70 <https://cordis.europa.eu/project/id/234065>

increased terminal productivity and efficiency both to and from the seaports and the national/international inland terminals.

The common denominator characterizing the three TIGER DEMO full scale demonstrators was the enlargement of their traffic attraction zones. This increased competitiveness of the hinterland maritime services was achieved through the dry port strategies.

(3) Projects at the "logistics" layer

Projects that developed outcomes with particular relevance to the "logistics" layer (= 4 projects) are: GIFTS, LOGISTAR, SYNCHRO-NET, TELLISYS.

GIFTS (Global Intermodal Freight Transport System) [71]

The main goal of the GIFTS project was to develop a fully Integrated Operational Platform GIP for managing door-to-door freight and logistics chains in an intermodal environment. The idea was to setup a system providing a full service to transport operations accessible to the small- and medium-sized companies. GIFTS was aimed to provide applications for the operational (e.g., track, trace and monitor the door-to-door transport, aid in transport and fleet management), as well as e-commerce functions and insurance of a door-to-door transport chain (including order matching, e-document transfer, e-payment).

To achieve this goal, a core platform has been developed that supports information sharing, based on service orientation and complex event processing. To the core platform, all objects and services that provide information, such as traffic information, GPS locations of transportation resources, water levels, and queues at the harbour gate, are event sources. Subsequently, information aggregators are developed that use low level events to aggregate information like the estimated arrival time of a truck at the harbour and the expected loading time of the container from the resource onto a ship. Planning services were built on top of these information services, to improve transportation plans by exploiting real-time information about resource positions and infrastructure status and by improving the robustness of transportation plans in handling unexpected events. Also, monitoring services were built, which planners and drivers of transportation companies can use to monitor the status of their own and other resources.[72]

GIFTS has been tested by means of a demonstrator platform, used in three different pilot scenarios.[73]

LOGISTAR (Enhanced data management techniques for real time logistics planning and scheduling) [74]

The main goal of the LOGISTAR project was to support effective planning and optimising of transport operations in the supply chain. This should be realised by taking advantage of vertical and horizontal collaboration among different sectors and companies and by increasingly using real time data gathered from the interconnected environment such as Internet of things (IoT) devices, smartphones, on-board units and open data.

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[71] <https://cordis.europa.eu/project/id/IST-2000-29364/it>

[72] <https://trimis.ec.europa.eu/sites/default/files/project/documents/20060821_170416_11126_GIFTS%20Final%20Report.pdf>

[73] <https://trimis.ec.europa.eu/project/global-intermodal-freight-transport-system>

[74] <https://logistar-project.eu/>

The key element of this approach was the development of a real-time decision and visualization tool of freight transport using advanced algorithms, big data analytics and artificial intelligence to deliver key information and services to the various agents involved in the supply chain. For this purpose, primarily real-time data, both from the systems of the actors involved in the transport and logistics chain and from the "Internet of Things" (IoT), were received, merged and interpreted within the framework of horizontal and vertical cooperation. Different aspects with impact on the transport performance were considered, such as weather conditions, strike situations, capacity utilisation or road conditions and delays.

The LOGISTAR developments have been tested in three uses cases with different stakeholders of the transport and logistics chain, such as 4/5PL (Logistic Service Providers), Infrastructure managers and FMCG (Fast Moving Consumer Goods) manufacturers.

SYNCHRO-NET (Synchro-modal Supply Chain Eco-Net)[75]

The SYNCHRO-NET was designed to demonstrate the integration of the slow steaming concept into synchromodality, guaranteeing cost-effective robust solutions that de-stress the supply chain to reduce emissions and costs for logistics operations while simultaneously increasing reliability and service levels for logistics users. The project was based on the building of demonstrators in order to show the power and the effectiveness of the synchromodal approach proposed by the several tools included in this Eco-Net.

With respect to Logistics Networks, the following outcomes shall be highlighted:

- Maritime modules that allow assessing ship slow and smart steaming, either at a strategic level, either for real time operations, taking into account interactions with the other transportation modes in the supply chain.
- SYNCHRO-NET tool for the optimization of the transport chain: the simulator is an applicative software module able to create reliable plans for freight transportation from an origin to one or many destinations, considering different constraints and enabling the final users to monitor different KPIs (Key Performance Indicators), such as distance, time, and emissions, and KRIs (Key Risk Indicators), such as flexibility and reliability.
- Weather Routing Module: the tool computes the Key Performance Indicators (KPI) for the maritime transport from a harbour of arrival to a destination harbour depending on weather data and operational conditions.
- Cooperative Speed Pilot: to assess the costs and speed of a maritime route, and then choose the correct way to operate this route, the "real-time speed pilot" computes the optimal speed based on ship speed, ETA, time-window at each waypoint along the route and rates.
- Synchromodal Logistics Optimisation Toolset: addresses the operational and real-time aspects of logistics planning in synchromodal smart-steaming supply chains. The toolset includes:
    - Real-time multimodal logistics optimisation of container movements from door-to- door, dynamically re-optimising in response to deviations and operational issues;

75 <https://www.synchronet.eu/>

- Hinterland logistics planning, addressing multiple modes through major ports and terminals, taking into account reverse logistics, container repositioning, driver hours balancing and resource utilisation;
- Real-time smart-steaming- aware dock and berth scheduling algorithms for large ports and terminals;
- Dynamic de-stressing algorithms which balance and smooth activity through main terminals to reduce queues and congestion and increase capacity.

- SYNCHRO-NET Driver Interaction Layer: a real-time scheduling system designed to cope with the complexities associated with synchromodal logistics planning.

TELLISYS (Intelligent transport system for innovative intermodal freight transport)[76]

TelliSys was the follow-up of the TelliBox project. The main goal was to actively promote the EU's objective of optimizing the performance of intermodal logistic chains and will provide smooth and cooperative interactions between different modes of transport. More specifically, the scientific aim was to develop an intelligent transport system applicable for road, rail, short sea and inland shipping. The system consists of a modular set of volume-optimised and traceable MegaSwapBoxes (MSB), an adapted trailer and a tractor for the road transport.

The results, that are most relevant for Logistics Networks, are

- <u>MegaSwapBoxes (MSB):</u> Nine different conceptual designs for the MSB (Intercontinental and Continental) were developed. Some of them varied in the design of the bottom frame, the internal height and possible expansions. Based on the defined requirements three solutions were taken into consideration for further evaluation: The continental MSB, the Automotive MSB and the Intercontinental MSB. The MegaSwapBox designs fix known disadvantages of 45 ft containers or swap bodies like reduced inside measurements, improper outside height and difficult handling. The solutions are incorporated into three main designs, from which two of them were also produced as prototypes: Automotive MSB and Continental MSB.
- <u>Super low-deck truck:</u> The final design was a 6x2 tractor that fulfils the Euro 6 standard with an extremely low fifth wheel height of 850 mm. It is compatible with the required GCW (gross combination weight) of 44 t for intermodal transport in Europe.
- <u>Trailer chassis:</u> The TelliSys trailer chassis was designed to carry up to 36 t of payload while having a tare weight of less than 3,900 kg. The chassis has a coupling height of 850 mm with a gooseneck tunnel, which makes it compatible with standard ISO containers. The screwable axle bearings is a pioneer for drawbar chassis designs for the manufacturer. The design allows for more flexibility by using one chassis design for several axle and tyre configurations. A total of three different concepts for the chassis were discussed and evaluated.

Extended test runs of the prototypes proved the technical concept and showed advantages regarding utilisation of loading unit volume, energy consumption, GHG emissions and operative costs.

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76 <https://cordis.europa.eu/project/id/314310>

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5. Implementation cases

5.1. Overview on Outcomes and Implementation cases

As stated before, BOOSTLOG aims at establishing causal links between the public R&I funding and deployment of results in the market; such links can be created through projects' *Outcomes* and *Implementation cases*. Within the BOOSTLOG project, ***Outcomes*** are primarily understood as products, services or solutions for business applications aiming at addressing Pain Points and other value-added results potentially impacting the market (by creating it or transform it), the Companies operations as well as polices and regulation. ***Implementation Cases*** are considered as outcomes where research results have been further developed and have been deployed as commercial solutions, have generated a new market or have contributed to new policies.

In the scope of the present report, all outcomes from the 17 identified projects in the area of "Logistics Networks" have been identified and analysed with respect to their grade of implementation. It is distinguished between (1) outcomes which have been implemented in a real-life environment and which are still in operation today or further used/developed in other commercial framework – the so-called "Implementation cases", (2) outcomes which have been demonstrated during the project and/or implemented afterwards in a real-life environment, but disrupted or stopped meanwhile, and (3) outcomes, which have not yet been demonstrated or deployed in real-life operation. In total, 29 Outcomes have been identified, thereof 5 implementation cases (= category 1), 17 demonstrations and/or temporary implementations (= category 2) and 7 outcomes without any implementation.

Figure 10: "*Logistics Networks" projects' outcomes by implementation category – overview*

Table 6 lists all identified outcomes per project and implementation category.

Table 6: "*Logistics Networks" projects' outcomes by implementation category (total: 17 projects)*

Acronym	Implementation case	Demonstration and/or temporary implementation	Outcome without implementation
ARCC	-	-	Advanced timetable planning
CREAM	Train monitoring (Train Monitor) Multimodal short sea – rail transport service Turkey – Germany (via Trieste) (EKOL)	Chain management "Ketenregie" Interoperable traction schemes Telematics (NAVMASTER)	Improved border crossing procedures

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Acronym	Implementation case	Demonstration and/or temporary implementation	Outcome without implementation
FR8RAIL III	-	Real-time Network Management / Yard Coordination System (YCS)	-
GET SERVICE	-	IT Services Platform connecting different systems	-
GIFTS	-	Operational Platform GIP supporting information sharing for operational and e-commerce functions	-
INTERFACE	-	-	Improvement of train border operations (supported by optimised processes and IT)
LessThan WagonLoad	-	Automatic loader	Mixed trains with LTWL cargo, New value-added services for chemical industry/LSPs
LOGISTAR	-	Transport managing system (for real-time transport and logistics chain visualisation and decision support)	-
MOSES	-	-	-
NEWS	-	-	Novel container ship and related logistics system
NOVIMAR		Composition and operating concept of vessel trains (platooning)	-
RETRACK	New through-going corridor-wide rail transport- and logistics concept (RETRACK network)	-	-
Smart-Rail	Cross-border dispatcher	Control tower for long-distance rail freight transport Expansion of SWL-operation based on new cooperation models and IT tools	-
SYNCHRO-NET	-	Concept for slow/ smart steaming of maritime vessels coupled with synchro-modal logistics optimisation	-
TELLISYS	-	Intelligent, intermodal transport system, involving new technologies: MegaSwapBoxes, Super low-deck truck and trailer chassis	-
TIGER DEMO	Hub- and spoke concept to integrate smaller terminals via mega hubs (Intermodal Network 2015+)	Shuttle train concept between Genoa port and Rivalta dry port (Genoa Fast Corridor); Operating system involving shift of port functions to hinterland hubs (iPort)	-
ViWaS	-	Simulation tool for SWL network planning, Regional network of rail logistics centres	-

5.2. Implementation cases

As shown in the previous section, BOOSTLOG has identified 5 Implementation cases in the framework of Logistics Networks:

(1) Train monitoring (Train Monitor) – CREAM (FP6)
(2) Multimodal short sea – rail transport service Turkey – Germany (via Trieste) (EKOL) – CREAM (FP6)
(3) New through-going corridor-wide rail transport- and logistics concept (RETRACK network) – RETRACK (FP6)
(4) Cross-border dispatcher – Smart-Rail (H2020)
(5) Hub- and spoke concept to integrate smaller terminals via mega hubs (Intermodal Network 2015+) – TIGER DEMO (FP7)

All the Implementation cases involve rail transport, one case is also related to multimodal transport. With respect to the intervention areas, three cases relate to transport and logistics services (cases 2, 3 and 5), one case to digitalisation of transport (case 1) and another to operations and processes or traffic management (case 4).

(1) Train monitoring (Train Monitor) – CREAM (FP6)

As an outcome of the CREAM project, the train monitoring solution "Train Monitor" has been developed and implemented within and after the project lifetime.

In 2007, when the CREAM project started, a long-standing deficit in rail transport was the availability of status information to smoothly integrate rail transport into logistics processes. Developments in the previous years had improved the situation e.g., on transalpine corridors. However, all in all the conditions continued to be poor for international rail freight, as on the routes between Western Europe and Southeast Europe. The IT system "Train Monitor" closed existing information gaps by integrating train operation data from numerous sources, showing automatically calculated values for the estimated time of arrival (ETA) and providing a train data base for quality statistics and operation analyses.

Train Monitor is a web-based software system for the monitoring of train movements, developed by Hacon. It is well suited for being used on the entire transport corridor considered by CREAM. Train Monitor has been adapted to the specific needs of Kombiverkehr – one of the biggest combined transport operators in Europe – and integrates information on process steps connected with train handlings inside the transshipment terminals. Thanks to the modular system architecture it can easily be adapted for other operators and railway companies. Train Monitor consists of three functional modules: (1) RealTime for tracking and tracing of currently running trains, (2) HIM Information Manager for exchanging additional operation information and (3) File&View to store data appropriately and to exploit this data for ex-post analysis purposes. Besides this the system enables a multi-client access, backs on a sophisticated user ac-cess management for keeping secured data confidential and supports a number of languages (e.g., German, English, Italian, Slovenian).

Tracking & tracing module (RealTime):

This module compiles and displays all data, received from different data sources, needed to track international train runs in real time. Different viewing options (screens) – all of them automatically refreshed every minute – are provided to support the staff in the transport monitoring and dispatching centres according to their individual needs:

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- With the train overview table clearly arranged information on the status of the current train operations is provided. This table basically contains information, which identifies the train (train number, departure / arrival station, date of planned departure), indicates the current status (last message point, time, delay) and gives an estimation on the arrival time at the final destination (ETA). The train overview can be configured individually by a train filter or a column sorting function. (2)
- Another viewing option is the map view, which shows the current position of all trains listed in the tabular train overview on a map. This is done by linking train run messages for stations with corresponding station reference codes. It is further possible to zoom in and out to follow specific train movements or to get a better overview on the overall operational situation. Trains are displayed by train numbers; a tooltip shows further in-formation on the served relation and the current deviation from the timetable.
- Arrival boards of selected terminals show status information of the trains (on the way, arrived, train ready for unloading) and relevant terminal times e.g., on the planned, estimated and actual availability of the loading units for unloading. With this information it is possible to optimally dispatch the trucks for the last-mile operations.

Information management module (Hafas Information Manager HIM):

In addition to the simple tracking of train movements, the system offers a platform for exchanging further train information with the HAFAS Information Manager HIM. For the first time, rail transport providers can access all relevant operating data using just one software system. The new system helps to keep an overview also in difficult operating situations. This allows operators to achieve competitive transport times with optimal use of resources. Should there, however, be a deviation, their customers will be informed reliably and even earlier with support from Train Monitor. Information to be exchanged with the support of the HIM module can be events relevant for operating a train such as irregularities or wagon detachments. New entries (events) are generated by filling a graphical entry form. This entry will be stored in the database and afterwards published through different distribution channels, which are Train Monitor itself (display in RealTime train overview), notifications to recipients e.g., via email and interfaces to other IT systems.

Statistics module (File&View):

All data on already operated trains is stored in a data base. On this basis it is possible to analyse in detail already operated train runs can be analysed train operations and generate individual quality statistics. Quality statistics can be generated for different trains operating on one route

The EDI concept is based on the idea of integrating train operation data from different sources in one system (see Figure 11). It is thereby making use of train operation data, received from other IT systems of infrastructure operators and train operators – e.g., LeiDis (DB Netz, Germany), Aramis (ÖBB, Austria) and USE-IT (UIC GTC railway operators) –, GPS tracking data of locomotives or wagons and data manually entered into the system. Data from all described sources are stored in a central train run database. This database provides all information needed for the real time transport monitoring, for ex-post transport monitoring and for statistical calculations to determine the estimated time of arrival.

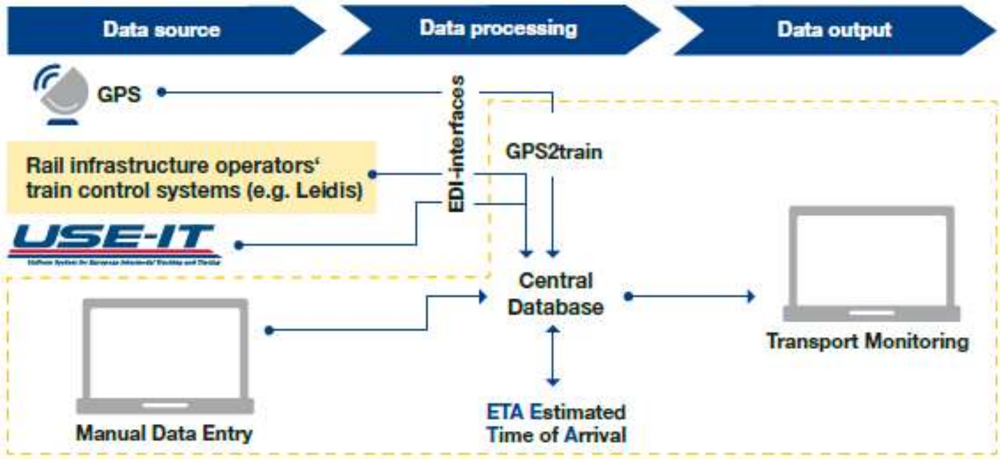

Figure 11: "Train Monitor" EDI concept[77]

During the CREAM project period the system had been piloted and introduced at Kombiverkehr, granting access to specific information/trains to their partners such as new-entrant railway operator Lokomotion (e.g., for the route Munich-Ljubljana) and the cooperating intermodal operator Adria Kombi (for the route Ljubljana – Halkali). For demonstration and testing purposes the system was also opened for all interested parties in- and outside CREAM to view the system for a limited period.

Today, Train Monitor is exploited by Kombiverkehr's transport monitoring service team to control the operation of Kombiverkehr's European train transport network. Monitoring involves train and shipment tracking and thus status queries as to where the loading units are at what point in the transport chain. Customers are informed in case of irregularities (e.g., delays, loading deadline extensions, technical problems, etc.). To provide optimal support, Train Monitor has been further improved in the subsequent years. Train Monitor was one of the first monitoring IT solutions receiving data from Europtirails, the predecessor of RNE TIS. Meanwhile, it is connected to RNE TIS with a TAF/TAP TSI compliant interface.

The knowledge and developments for Train Monitor have been also used for other systems such as Hacon's HAFAS Smart VMS system. Smart VMS is a smart, scalable solution for fleet management, primarily used by rail and public transport operators. Using a platform-independent driver app for smartphones, tablets or on-board computers, the system collects the current vehicle locations in real time, communicates with the control center and transmits the data to various passenger information systems. The Smart VMS system together with the experience in train monitoring and ETA calculations forms the basis for the ETA Management Platform, which has been set up for the ELETA project and which is currently further developed.

In relation to Logistics Networks, Train Monitor and related systems have achieved major steps towards full visibility of rail transport operations, which is a prerequirsite for the automation of rail operations and the building of PI based logistics networks.

Expected impacts mainly concern:

- Increased transport reliability and responsiveness;
- Decreased cost of transport & overall logistics; Increased transport efficiency.

[77] "The CREAM Project: Technical and operational innovations implemented on a European rail freight corridor", 07/2012

(2) Multimodal short sea – rail transport service Turkey – Germany (via Trieste) (EKOL) – CREAM (FP6)

Another outcome of the CREAM project, is a new multimodal short sea – rail transport service between Turkey – Germany vie the Port of Trieste in Italy.[78]

Turkish trucks travel up to 7.000 km in each round-trip on their journey to and from West European countries. Ekol Logistics has developed an effective and environmentally friendly solution to this problem. A new intermodal transport system which reduced the share of land transport to only 2.000 km.

Started in 2008, Ekol Logistics, in cooperation with further CREAM project partners Kombiverkehr, Lokomotion and Rail Traction Company (RTC), has conducted transports between Turkey and Western Europe according to a completely new organisation form. This new intermodal transport service, developed as part of the CREAM project activities, is mainly based on short sea and rail transport service and is using the route Turkey – Italy – Germany. Originating from the use of ferry services between the Turkish ports in Istanbul, Izmir and Mersin and the Italian Port of Trieste, the multimodal concept exhibits an innovative combination of these ferry boat connections on one side and a shuttle-train connection between Trieste and Worms (Germany), on the other side.

In detail the new transport concept works like this: Turkish commodities are loaded to semi trailers, capable for being used in intermodal transport, and are hauled to Istanbul, Izmir and Mersin ports. There the semi trailers are loaded on board of Ro-Ro vessels and are transported to Italy in a 3-days ship passage. After arrival in the Port of Trieste, the semi-trailers are transhipped on the intermodal block train towards Germany. The train trip to its destination, the intermodal transshipment terminal in Worms, required a transit time of less than one day. From Worms or via Ekol's distribution centre in Heppenheim the semi trailers were transported with German registered trucks to destinations in Germany or other West European countries such as Benelux countries, France, United Kingdom, Switzerland, Denmark, Ireland and Spain.

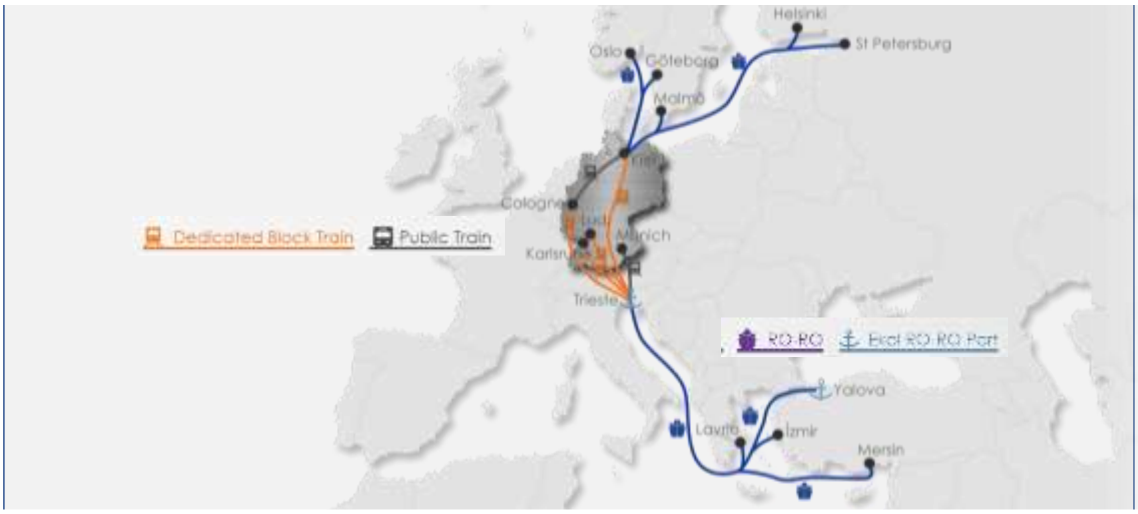

Figure 12: Ekol's multimodal transport network TR/EL – IT - DE[79]

Having started in 2008 with initially one weekly train round trip, the frequency could be extended stepwise from year to year up to seven weekly round trips at the beginning of 2012. Also in the following periods, Ekol's

[78] "The CREAM Project: Technical and operational innovations implemented on a European rail freight corridor", 07/2012

[79] <https://www.ekol.com/en/countries/germany/intermodal/>

multimodal network has been further strengthened and extended with own shares in port terminals, extended consolidation points and further transport relations, additional extensions are in the pipeline.

Recently, Ekol acquired a 65-percent share in Europa Multipurpose Terminals (EMT) in Trieste. Following further investments in the terminal, it will be possible to handle two separate Ro-Ro operations simultaneously and train loading capacity will grow to 10 daily trips. Since 2018, Ekol's Ro-Ro services also connects the Port of Lavrio in Greece in addition to the Turkish port destinations developed during CREAM. Further Ro-Ro services are planned between Trieste and other countries including Israel and Egypt. In Germany, meanwhile three consolidation centers have been developed, which are in Köln, Ludwigshafen, and Kiel. Within Ekol's multimodal network, Germany acts as a transportation bridge to other European countries, offering services across Europe and Scandinavia.[80]

In parallel, the multimodal short sea – rail transport concept has been adapted and further developed by MARS Logistics, another turkish forwarding company. As Ekol, MARS transports cargoes from various regions in Turkey via Istanbul, İzmir and Mersin seaports and Ro-Ro services to Trieste. From there, the cargo is transported by rail to Luxembourg. Currently, there are six weekly round trips opertated between Trieste and the intermodal terminal in Bettembourg (Luxembourg). The last leg by road connects various destinations in Luxemburg, Belgium, the Netherlands, UK, France and Germany.[81]

In relation to Logistics Networks, the multimodal transport concept can be considered as a lighthouse initiative for multimodality. The concept combines different modes smartly, utilising each mode according to their best capabilities.

Expected impacts mainly concern:

- Decreased travel times;
- Modal shift;
- Improved capacity utilisation of assets (specifically Ro-Ro ships and trains);
- Reduction of congestion on the road network;
- Decreased environmental impact; Improved energy consumption.

(3) New through-going corridor-wide rail transport- and logistics concept (RETRACK network) – RETRACK (FP6)

The main outcome of the RETRACK project has been a new and innovative trans-European rail freight service concept as an alternative to the national railway's single wagon system.

In 2007, multiple partners joined forces in the European RTD project RETRACK with the aim of simplifying single wagon transport and offering customers a new cross-border European portfolio with a reliable running schedule. RETRACK intended to develop a sustainable alternative concept to the national railway's single wagon system. This concept was expected to contribute to a significant modal shift of cargo from road to rail and to create an effective and scalable rail freight corridor between high demand regions in Western Europe and new high growth regions in Central and Eastern Europe. Important issues, tackled in this context were the integration of strategic port hubs (to provide access to the large goods repositories and generating the

[80] <https://www.ekol.com/en/countries/germany/intermodal/>

[81] <https://www.marslogistics.com/en/intermodal-transportation>

necessary volumes to make rail freight transport along the corridor economically feasible) and comparable short and guaranteed door-to-door delivery times of shipments. With this new rail freight service concept, the RETRACK partners aimed at demonstrating that rail freight services on trans-European corridors can be a competitive alternative to road haulage.

During the project, a “demonstration train” has been operated enabling the identification and testing of the possibilities and limits for new and innovative transport concepts on selected routes in practice between the hubs Köln-Eifeltor and Györ with a secondary hub established in the Rotterdam region. The RETRACK demonstration train is conceived as a “group of wagons train”, i.e. transport volumes of various customers - usually being smaller than the amount suitable for a block train - are combined into a train set. The volumes have been composed of all kinds of goods – from agricultural products and powdery bulk cargo to semi-finished products from the coal and steel industry, chemical products incl. dangerous goods as well as machine parts and containers. The train was operated by the RETRACK consortium members Central European Railways Rt. (Hungary), LTE Logistik (Austria) and Transpetrol GmbH (Germany), with Transpetrol assuming the role of a neutral train operator and railway undertaking for the German part of the service. In 2011, one year after the start of the first train with two customers and one departure per week, the service attracted more than 10 customers from various economic sectors and the frequency could be increased to three weekly departures between the hubs Köln-Eifeltor and Györ with train lengths of up to 740m and 2,300 tonnes in each direction.

In 2014, after several partners had withdrawn from RETRACK, VTG decided to take control of the project. Since then, the VTG railway undertaking (Bräunert) operates under the name RETRACK. The new company, Retrack GmbH & Co. KG headquartered in Hamburg, is a subsidiary of VTG Rail Logistics. Today, VTG's RETRACK network provides a logistical link between the most important economic centers in Europe, covering Germany, Austria, the Czech Republic, Hungary and Slovakia. The focus is on three main corridors with nodes, feeders and distribution antennas (see Figure 13).[82]

Figure 13: VTG's RETRACK network corridors[83]

[82] <https://www.vtg.com/news-and-insights/press-releases/detail/vtg-rail-logistics-railway-undertaking-now-called-retrack>

[83] <https://www.vtg.com/products-and-services/logistical-services/traction>

Individual wagons as well as wagon groups and complete freight trains can be mapped. The aim is to optimize freight transport by rail, taking into account all cost factors - from critical quantities to large-scale solutions. Retrack achieves this by intelligently linking all options available in the rail network of a given freight corridor. Thanks to its own locomotive pool, consisting of both diesel and electric trains, VTG Rail Logistics can carry out freight transportation just as flexibly on the network as single wagonload traffic as it can with groups of wagons or block trains.

In relation to Logistics Networks, the RETRACK transport concept demonstrates the possibility for developing a competitive rail transport offer for volumes below the block train and intermodal train segment.

Expected impacts mainly concern:

- Decreased travel times;
- Decreased cost of transport & overall logistics; Increased transport efficiency
- Increased transport reliability and responsiveness;
- Improved performance of the European Transport;
- Modal shift ;
- Improved capacity utilisation of assets (freight trains);
- Reduction of congestion on the road network;
- Decreased environmental impact; Improved energy consumption.

(4) Cross-border dispatcher – Smart-Rail (H2020)

The Smart Rail project outcomes have been implemented and tested in three so-called "Continuous Improvement Tracks" (CIT) during the project, focussing on different aspects of the SMART-RAIL concepts and furthermore aim to generate improvements on different corridors. CIT 3 targets the Rotterdam-Genoa corridor and deals with rail freight reliability in case of (unexpected) obstructions on the track. It specifically aims to increase the flexibility and reliability of rail freight transport within a multimodal transport system.

One solution, analysed and developed in this context is the implementation of a border dispatcher, to ensure and optimise smooth rail operations on the cross-border rail sections between the Netherlands (Betuweroute) and Germany (Oberhausen – Emmerich). These sections belong to the Rail Freight Corridors Rhine-Alpine (RFC1) and North Sea – Baltic (RFC8). The Betuweroute is a double track, electrified railway line between Rotterdam and Venlo dedicated for freight trains and equipped with ETCS level 2. It is fed by the Oberhausen – Emmerich line, which is also double track and electrified. The border station is located in Emmerich.

The border dispatcher is a joint function of the respective infrastructure managers Prorail (NL) and DB Netz (DE) and is located in the Central Office for border traffic in Duisburg. The idea of the border dispatcher is to connect the respective IM operation centres in the best way, optimise the coordination of dispatching decisions with respect to the concerned cross-border sections and bundle the information flows between railway operators (RUs) and infrastructure managers (IMs) (see Figure 14).[84]

[84] Handbuch Dispositionskonzepte SGV, DB Netz AG, 11.12.2022

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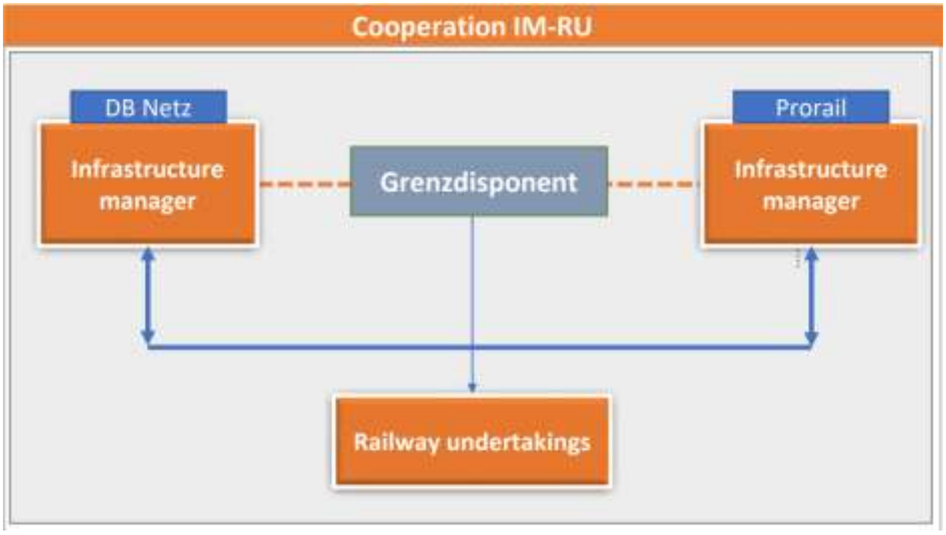

Figure 14: IM-RU cooperation via cross-border dispatcher ("Grenzdisponent")[85]

Meanwhile, there is also a border dispatcher on the Rail Freight Corridor North Sea - Baltic (RFC 8) for the Polish-German border route Frankfurt (Oder) - Rzepin.[86] Even though the issue of developing and implementing a cross-border dispatching function cannot be considered as a groundbreaking technical innovation, developing solutions fostering cooperation seem to gain importance in view of multimodal and increasingly work-sharing transportation and logistics systems with multiple roles. A well-functioning of multimodal Logistics Networks can only be ensured if the operations of all unimodal networks and interfaces work themselves and especially across borders.

Expected impacts mainly concern:

- Increased transport reliability and responsiveness;
- Decreased travel times;
- Decreased cost of transport & overall logistics; Increased transport efficiency.

(5) Hub- and spoke concept to integrate smaller terminals via mega hubs (Intermodal Network 2015+) – TIGER DEMO (FP7)

The TIGER DEMO project was the logical follow-up and continuation of the TIGER project in which innovative concepts for rail-based intermodal hinterland connections of seaports have been developed. TIGER DEMO focussed on the implementation, execution and assessment of three demonstrators in which "real" intermodal trains have been operated.

One of these demonstrators was the "Intermodal network 2015+", designed to integrate and connect small and medium-sized intermodal terminals to hinterland networks with transport volumes not sufficient to operate direct trains. The general idea was to interconnect intermodal trains with loading units for different destinations and to build new direct trains for destinations / terminals in the hinterland by (a) direct transhipment of loading units between trains or (b) by using intermediate storage of loading units in the

[85] <https://rail-research.europa.eu/wp-content/uploads/2018/05/20180418_Final-Event-Vienna_WP3.pdf>, Matic Prosen

[86] Handbuch Dispositionskonzepte SGV, DB Netz AG, 11.12.2022

terminal when incoming and outgoing trains are operated in different time windows. Trains that are dedicated to specific O/D intermodal services must arrive at the hub as a "bundle" within a defined time-window to enable direct transhipment of loading units between trains and avoiding intermediate storage due to train delays. All time-consuming and costly shunting and train formation processes are avoided because the trains enter and leave the terminal directly.

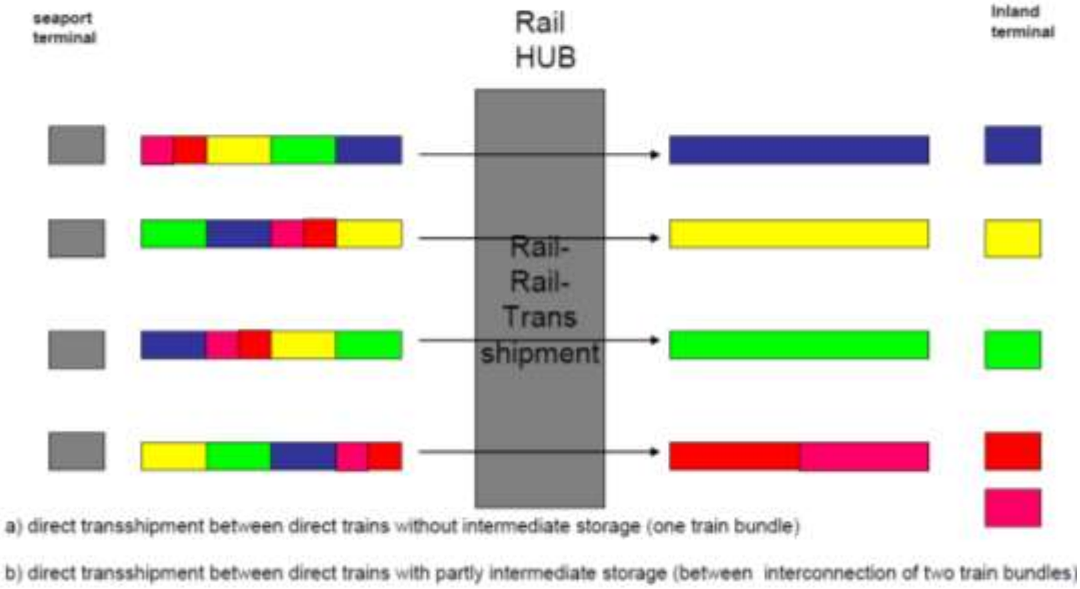

Figure 15: Intermodal train bundling concept via a rail hub (Intermodal Network 2015+)

Initially, it was planned to use the Megahub Hannover-Lehrte for the demonstration, but as the construction and opening of the terminal had been considerably postponed, it was decided to shift the Intermodal Network 2015+ activities to the intermodal terminal München-Riem, which could offer comparable conditions for hub and train operation.

The Intermodal Network 2015+ demonstration integrated the following operational and technical components which are necessary for an efficient and effective intermodal hub-and-spoke-concept:

- Direct long-haul train entrance with momentum and direct train departure;
- Automated longitudinal transport of loading units to reduce gantry crane-movements (this technique was not available in München-Riem);
- Customized train path and resource planning;
- Optimised terminal processes (supported by a Terminal operating System);
- Information and communication technology: tools for technical management, capacity management and train monitoring.

All "Intermodal Network 2015+" activities have been concluded successfully in 2015 within the project lifetime but could not be used / implemented in the Meguhub Hannover-Lehrte directly, because, as already mentioned, the opening had been delayed.

This facility was set into operation in 2020 having the Megahub-specific technical design elements: transhipment tracks with a sufficient length (700m) to accommodate a complete train and with electrified ends allowing for operation of long-haul locomotives, three gantry cranes covering all six transhipment tracks,

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gantry crane operation supported by battery-powered driverless Automated Guided Vehicles (AGVs). These vehicles take over the longitudinal transport of loading units between the rail wagons.

Trial operation in Hannover-Lehrte started in June 2021 with five train pairs per week connecting two terminal locations/regions in Germany (Osnabrück and Regensburg/Landshut). In April 2021, the German intermodal operator Kombiverkehr started additional train connections to the terminals in Ludwigshafen, Duisburg, Lübeck, Kiel, Hamburg, Nürnberg, München, Mannheim in Germany and Malmoe (SE), Verona (IT), Rotterdam (NL), Lovosice (CZ), Malaszewicze (PL). [87]

Figure 16: Megahub Hannover-Lehrte[88]

Kombiverkehr highlights that in their marketing activities that *"Terminals in northwestern and northeastern Germany can also benefit from the diverse routings to a large number of national and international economic centers via short feeder services. In the future, mixed trains will start from locations that are not able to handle whole trains for only one destination terminal, and their loading units will be loaded onto trains with a single destination in the MegaHub. From each terminal, all other connected terminal locations are possible via Hanover, as well as further antenna transports via gateway"*[89].

In relation to Logistics Networks, the "Intermodal Network 2015+" activities successfully demonstrated the concept to integrate smaller terminals into intermodal hinterland networks via Megahubs.

Expected impacts mainly concern:

- Decreased environmental impact; Improved energy consumption;
- Reduction of congestion on the road network;
- Modal shift;

[87] <https://megahub-lehrte.deutschebahn.com/megahub-lehrte/MegaHub-Kundeninfos/MegaHub-Verkehrsverbindungen-5141814>

[88] <https://www.dbcargo.com/rail-de-en/logistics-news/megahub-lehrte-now-officially-in-business-6354672#>

[89] <https://www.kombiverkehr.de/en/transport/megaflexible/>

- Decreased travel times;
- Improved performance of the European transport.

5.3. Further demonstrations and temporary implementations

As shown in Table 6 (in section 5.1 above), most outcomes of the selected 17 projects have proven their technical feasibility by implementation during the project lifetime. For Logistics Networks, real "live" demonstrators of operation concepts are particularly relevant. Such demonstrators were performed successfully in e.g., CREAM ("Ketenregie", interoperable traction schemes), LessThanWagonLoad (automatic loader), Smart-Rail (expanded Single Wagon Load services), TelliSys (prototypes of boxes and truck/trailer) or TIGER DEMO (dedicated train services between the seaports and hinterland hubs). All these and other operation concepts worked well during the project and fulfilled their technical requirements.

Looking at the implementation in the post-project period however, the results appear sobering at first glance. None of these 17 demonstrations continued beyond the project lifetime or for a longer period after the project. In order or correctly assess this result, it must firstly be considered, that projects assigned to Logistics Networks are always of intermodal or multimodal nature. Inter- and multimodality have positive connotations in political discussions and programs, but from logistics perspective, this form of transport is complicated. Inter- and multimodal transport chains are always broken transport chains, consisting of several transport modes, infrastructures, operators, and data management systems – or all three layers of Logistics Networks. They also struggle with problems of equal and fair cost/risk/revenue allocation to the partners. Summarising, they demand optimised and robust operational, organisational, legal, and financial interfaces, also to compete successfully with uni-modal transport services. However, experience shows that the entire construct is highly endangered, if one of these pieces breaks away. It may sound like irony, but in fact inter- (or multi-) modal transport systems, that are expected to contribute to the resilience of Logistics Networks, are often not resilient themselves. From logistics point of view, simple transport chains are always better that complicated ones.

Secondly, most of the analysed demonstration cases included rail operation. This sounds good in terms of modal shift, but rail transport is always costly, due to complex operation and high fixed costs. In a cost comparison with pure road transport, rail bound services are at best marginally more economical in most cases. Therefore, even small changes in the market or microeconomic conditions are usually enough to call their economic viability into question. Even if studies repeatedly cite other criteria for the choice of transport mode, the price issue cannot be neglected.

Transferring these acknowledgements to the 17 outcomes that did not survive the project phase, the reasons for these failures can be distinguished between specific conditions or circumstances and structural issues as follows:

Specific conditions or circumstances affecting (only) one dedicated outcome, but might be also regarded as typical for similar projects, for instance:

- The chain management system "Ketenregie" (CREAM) along the Betuweroute (CREAM), which turned out to be an "isolated" outcome. For cross-border implementation, a European solution about capacity allocation would have been needed.
- The expanded Single Wagon Traffic services established in France within the Smart-Rail project that were abandoned, because the RU commissioned with the rail operation went bankrupt.

- The Vessel Trains of the NOVIMAR project that were not allowed to operate due to legal issues (there must always be a captain and a helmsman on board along the river Rhine).

Structural issues, which more or less apply to all the outcomes of this cloud, and which prevent bridging the "valley of death". This valley of death is mostly not evoked by lack of technical readiness, but by missing commercial maturity:

- Responsibility/leadership: during the project, these aspects are normally well defined by contracts between EU and consortium as well as between the consortium partners. By end of the project however, also these contracts terminate, which leads firstly to a lack of leadership and afterwards to missing allocation of tasks and responsibilities. No leadership - no initiative. The situation is even more complicated, if the consortium leader was a consultant or a research institute, for which it is not possible to take over leadership of operational services on commercial basis.
- The same goes for the project partners, particularly those who are directly involved in the performance of the operation. As explained above, inter- or multimodal transport chains are complex and fragile. Their composition might have worked with partners committed to the same project goal and respective contracts. After the project however, the consortium (partners of the transport chains) often breaks up. It is then difficult to find suitable replacement partners - especially operative ones - in the short term. And the longer the "valley of death", the less likely successful implementation.
- The end of the R&I projects also means end of funding. It should be remembered that especially rail operation is expensive. A re-start-up phase after the project is necessary that needs additional financing. This financing must be provided or organised by a company leader, which probably does not even exist (see "leadership" above). Moreover, pre-financing of rail or barge services using innovative technologies (for the first time) is affected with extremely high risk. No bank would approve a loan on this.
- Business model: this is included in many R&I projects, however often only for formal reasons. In addition, business models must cope with changes of business partners (see above) and commercial priorities of the partners (see below). In general, business models as part of R&I project do cover these cases sufficiently. It is also questionable if this should be an obligation to (basic) research projects.
- Finally, it lies in the nature of economy that business cases and commercial priorities of operating partners change. This might be due to internal (e.g., change of management and portfolio) or to external (e.g., competition situation, change of rules and regulations, energy crisis) reasons. In any case, the rather long-term set-up of R&I projects (including application phase) is not compliant with short-term reaction times of market participants. As long as funding is granted, contracts with the Commission might be fulfilled, but afterwards operation that is no longer regarded as profitable will stop immediately.

The identified implementation cases (see section 5.2) show very clearly that outcomes can only implemented successfully, if these structural obstacles are overcome.

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6. Potential implementation paths

As a matter of fact, the success of research projects cannot exclusively be determined by the implementation of project outcomes. However, the desired impacts highlighted by BOOSTLOG can only be generated through implementations of outcomes beyond the project. The present cloud report on Logistics networks addresses potential outcomes in 7 intervention areas generating impacts in three different categories (see Figure 17: environmental (green), capacity/costs (blue), transport performance / connectivity (orange).

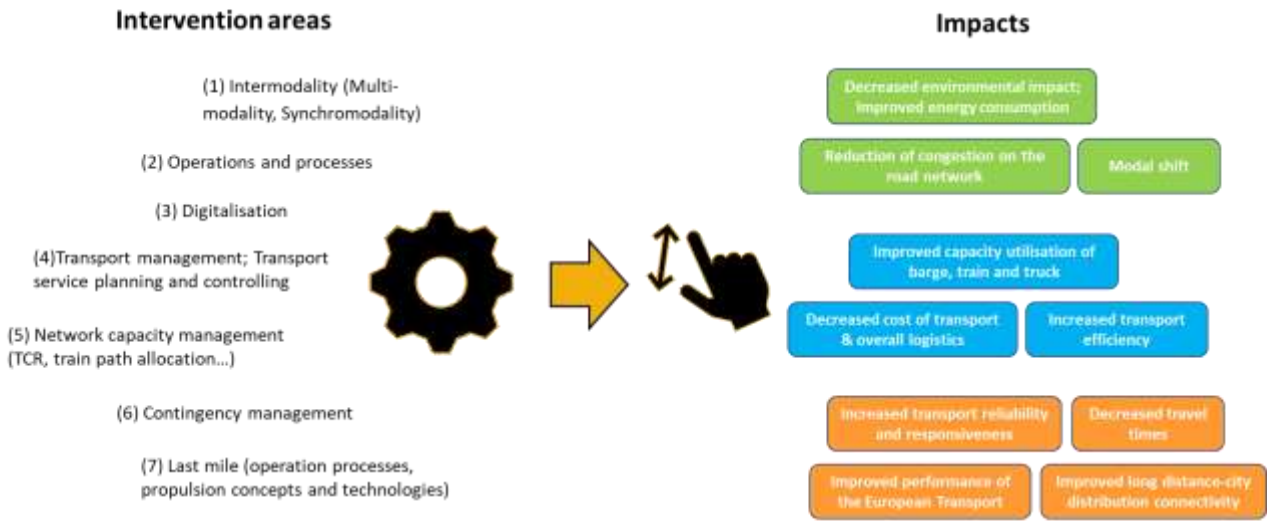

Figure 17: Intervention areas and expected impacts in the area of "Logistics Networks"

For the elaboration of the present report, a major part of the analysis was dedicated to identifying valuable project outcomes in the sense of products, services or solutions with relevance to real-life business operations. As a result, 29 outcomes have been generated by the 17 projects included in the deeper analysis for the Logistics Networks cloud report, most of them have proven their technical feasibility by test operations and demonstrations during the project lifetime. However, only 5 implementation cases have been identified which means outcomes that are operable still today and potentially have been further developed since then. The reasons for this low rate of sustainable implementations can be categories in two groups: (1) conditions or circumstances hindering the implementation of a specific solution or continuation of a specific service (e.g., legal issues, commercial success); (2) structural issues, which more or less apply to all the outcomes of this cloud, and which prevent bridging the "valley of death.

When evaluating potential implementation paths, it is also worth highlighting supporting factors for successful projects and implementations. The compilation presented hereunder result from numerous expert interviews performed during the elaboration of this report. They are neither considered to be comprehensive nor seen as recommendations from the authors of this report. Supporting factors gathered during this process can be allocated to four areas, (1) Composition of the consortium, (2) Topic/subject of the project, (3) Process of tendering/application/funding, (4) Project execution and implementation of outcomes.

(1) Composition of the consortium

- **Right mix of partners** - involvement of real operating partners needed;
- **Trust within consortium** (complementary interests, advantages visible for all partners, partners knowing each other);

- **Same level of knowledge and "access" to the topic** (skilled experts from the project partners involved in the project work);
- **Partner commitment** - Sufficient efforts of partners investing in the project.

(2) Topic/subject of the project

- Project/**Solution must be economically viable**;
- Projects must be **linked to real practice**;
- **Project must consider European decision-making environment (entity and rules / priorities)**;
- **Focus on a fewer, but dedicated topics** better than including everything.

(3) Process of tendering/application/funding

- **National projects often allow more efficient consortia** (limited number of partners, complementary interests);
- **Flexibility for project design in application phase, focus on project result** (e.g. demonstrator, product), NOT on tasks/work content (best practice: ITEA 4stage).

(4) Project execution and implementation of outcomes

- **Rules in the grant agreement**, if deployment does not happen to hand over IPRs e.g. to a "Implementation agency" (like CESAR for the aviation industry);
- **Idea: dedicated consultant paid by EU for project documentation and administration** (selected by the consortium);
- **Non-feasibility of a solution might be also an outcome** (e.g. vessel train / NOVIMAR).

Furthermore, RTD programmes, projects and outcomes should take into account or address (1) the real-life environment and barriers for achieving the full benefits of Logistics Networks as well as (2) current market practices and trends related to the Logistics Networks layers (network infrastructure, transport services, logistics) and action or intervention areas.

Identified barriers relate to **(1) Climate change risks** e.g. disruptions to service operations, Threats to assets and infrastructure (due to extreme weather events, rising sea water levels,…), **(2) Diversity and/or insufficient level of infrastructural and technical standards**, e.g. in relation to TEN-T standards (ERTMS, 740m train length, IWW navigability,…), **(3) Socio-economic developments**, e.g. energy scarcity, deindustrialisation / disrupted supply chains, citizens resistance against infrastructure projects **(4) Increasing operational problems**, e.g. decreasing capacity of networks and corridors due to increasing traffic and construction works, lack of qualified operational staff, disrupted transport chains (e.g. in IWW due to low water levels).

Identified market practices and trends in relation to the "Network infrastructure" layer concern: TEN-T, RFC networks: Updated and united regulations for improved multimodality, Feed control systems for terminals and ports, Colaborative decision making for rail (R-CDM), EU's new Contingency Plan for Transport (May 2022) and European Rail Infrastructure Managers Handbook for International Contingency Management.

Identified market practices and trends in relation to the "Transport services" layer concern: Multimodal transport planners, Multimodal booking systems, Alternative transport systems, Digital Automatic Coupling (DAC), Alternative fuels, New concepts for single wagon load, Automated operation (platooning), Estimated time of arrival (ETA), Tracking and tracing, Collaborative Intelligent Transport Systems (C-ITS), (Rail) Timetable Redesign (TTR), Innovative barge for low water, Alternative locomotive power supply.

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Identified market practices and trends in relation to the "Logistics" layer concern: LSP control towers, Supply chain visibility, Track&Trace capabilities, Modularisation and flexibilisation of rail wagons and loading units, Blockchain, Telematics and sensor technologies, Autonomous and automated delivery systems (Drones and robots).

Annex I – Implementation case template

1. Main R&I projects which have developed results/outcomes based on which you developed this implementation case
2. Main Implementation Case/product or Solution: Overview and key pain point addressed/Market addressed/Users/How the implementation case impacts on EU Policies
3. How Public funded supported the Implementation Case development and in which stages?
4. How you Covered the Gap between the project Results & reaching the market?
5. Which have been the main hurdles to overcome:
    - Financing for further development,
    - Finding right partners,
    - Value proposition towards customers,
    - Business models,
    - Other.
6. Which have been the key success factors to move from R&I results to an actual implementation?

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Annex II – Evaluation of the projects' status

The following table has been completed considering the last known status of the projects, beyond their official completion date.

TARGETED IMPACTS	NR. OF PROJECTS	PROJECT/STATUS	
Decrease of environmental and climate impact	**8**	ARCC	ND
		CREAM	IMS
		GET SERVICE	TD
		LessThanWagonLoad	PoC
		NEWS	TD
		SYNCHRO-NET	TD
		TIGER DEMO	PoC
		TelliSys	PoC
Reduction of congestion on the road network	**3**	LessThanWagonLoad	PoC
		SYNCHRO-NET	ND
		TIGER DEMO	PoC
Modal shift	**11**	CREAM	IMS
		LessThanWagonLoad	PoC
		MOSES	ND
		NEWS	TD
		NOVIMAR	TD
		RETRACK	IMS
		Smart-Rail	PoC
		SYNCHRO-NET	ND
		TelliSys	ND
		TIGER DEMO	PoC
		ViWaS	PoC
Improved capacity utilisation of barge, train and truck	**9**	ARCC	ND
		GET SERVICE	TD
		LOGISTAR	TD
		RETRACK	IMS
		Smart-Rail	PoC
		SYNCHRO-NET	TD
		TelliSys	PoC
		TIGER DEMO	PoC
		ViWaS	PoC
Decreased cost of transport & overall logistics **Increased transport efficiency**	**13**	ARCC	ND
		CREAM	IMS
		FR8RAIL III	PoC
		GET SERVICE	TD
		GIFTS	TD
		LessThanWagonLoad	PoC
		NEWS	TD

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TARGETED IMPACTS	NR. OF PROJECTS	PROJECT/STATUS	
		NOVIMAR	PoC
		Smart-Rail	PoC
		SYNCHRO-NET	TD
		TelliSys	TD
		TIGER DEMO	PoC
		ViWaS	PoC
Increased transport reliability and responsiveness	**12**	ARCC	ND
		CREAM	IMS
		FR8RAIL III	PoC
		GIFTS	TD
		INTERFACE	TD
		LessThanWagonLoad	PoC
		NEWS	ND
		NOVIMAR	ND
		Smart-Rail	PoC
		SYNCHRO-NET	ND
		TIGER DEMO	PoC
		ViWaS	PoC
Improve the performance of the European Transport	**12**	ARCC	ND
		CREAM	IMS
		FR8RAIL III	PoC
		GET SERVICE	TD
		GIFTS	TD
		LessThanWagonLoad	PoC
		LOGISTAR	TD
		MOSES	ND
		Smart-Rail	PoC
		SYNCHRO-NET	TD
		TelliSys	PoC
		TIGER DEMO	PoC
Improve long distance-city distribution connectivity	**3**	NOVIMAR	ND
		TIGER DEMO	PoC
		ViWaS	PoC

Assessment of readiness level (not just technical but also market, operational, etc):

- Not demonstrated (ND),
- Theoretical Demonstration (TD),
- Proof of Concept (PoC),
- Implemented Small Scale (including Niche Markets) (ISS),
- Implemented Medium Scale/Several Companies (IMS),
- Implemented Large Scale/Mainstream in Industry (ILS).

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Annex III - The projects' outcomes (long list)

The list includes all identified outcomes in the sense of products, services or solutions with relevance to real-life business operations as well as components or other results that could set direction in Companies and Governments.

PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
ARCC	• Advanced timetable planning (initial research)	---	---	---
CREAM	• Chain management process and tool (implemented on the Betuweroute) • Interoperable traction schemes (analysis and demonstrations for specific cases on dedicated sections) • Improved border crossing procedures (analysis and improvement concept, initiation of border initiatives) • Advanced wagon telematics (prototype) and train monitoring system (implemented)	---	• Modal shift • Management for a CREAM corridor-related Quality Management System • Declaration for an intermodal terminal in the Sofia areas	• Multimodal short sea – rail transport concept (demonstrated on the TR-IT-DE transport lane)
FR8RAIL III	• Real-time Network Management, Yard Coordination System (YCS) (demonstrator)	---	---	---
GET SERVICE	• Prototype of "GET Service IT-platform" planning tool and monitoring tool	• Creation of exploitation model; • Business models for all potential actors involved (service platform).	• Reduction of CO_2 emissions; • Support co-modality and synchro-modality.	• European-wide multifunctional service platform for all transport modes and stakeholders.

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PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
GIFTS	• Prototype of "IT-Platform for managing intermodal transport and logistics chains" (operational, commercial, and administrative functionalities); • Integration of Galileo & UMTS.	• Focus on small and medium-sized companies.	• Support SMEs.	• Demonstration of main platform functions and applications by three pilot transport chains.
INTERFACE	• Reduction of waiting times at borders.	---	• Support intermodal transport	Three demonstrators/case studies: • border crossing AT-CZ, • border crossing ES – FR, • border crossing IT – CH.
LessThanWagonLoad	• Prototype of an "Automatic rail wagon loading/ unloading system".	• Business cases for the identified new services market potential have been developed.	• Modal shift from road to rail; • Reduction of CO_2 emissions; • Reduction of rail freight cost; • Support inter-modality.	• Concept for mixed trains for conventional and maritime container volumes; • Automated wagon loading and unloading; • New added value rail freight services for the industry within the Antwerp chemical cluster. (e.g., parking, repair, picking and cleaning for chemical wagons) .
LOGISTAR	• Prototype of "Real-time decision-making tool" and "Real-time visualization tool"; • Reduction distribution cost (5-10%); • Increase load factor (up to 10%).	---	• Support of synchromodality	• Planning and optimizing of transport operations by horizontal cooperation (visibility, planning of resources and dynamic planning).
MOSES	• Concept for MoSs; • Quality standards for MoS;	• Supporting marketing concepts for MoS.	---	---

PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
	• Modal shift; • Reduction of CO_2 emissions			
NEWS	• NEWS container vessel: Technical construction concept and models of different versions (scale = 1:12.5).	• Finance- & Business plan; • Danube infrastructure and service concepts.	Recommendations for • Implementation of action plans for rehabilitation and maintenance of the Danube as a waterway; • EU regulations to provide more encouragement and support to the IWT as an environmentally favourable mode of transport; • Harmonization of legislation and encouragement of uniform application of EU legislation in the area in order to avoid retention of cargo flows at the state borders.	• Route- and cost-planning tool; • Terminal planning tool.
NOVIMAR	• Composition & design of the vessel train; • Navigating and manoeuvring concept of the vessel train.	• Business concept vessel train; • Waterborne transport system.	---	• Cargo handling vehicle; • User-interface for the control of the course and speed of vessels participating in the vessel train; • Communication system between the vessels; • Overlay on the navigation chart with detailed information about water depth.
RETRACK	---	---	---	• New and innovative trans-European rail freight service

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PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
				concept (demonstrated on the route NL-DE-HU-RO)
Smart-Rail	• Improves and extended single wagon load services; • Control tower for long distance rail freight transport	• New cooperation model + business model + transport cost model.	---	• Logistic control tower for freight transport on multi -modal corridors including monitoring dashboard and an integrated module for its transport management system (TMS). • Extended single wagon traffic on several destinations.
SYNCHRO-NET	• Maritime modules that allow assessing ship slow and smart steaming, either at a strategic level or for real time operation; • Synchromodal Logistics Optimisation Toolset: real-time logistics planning in synchromodal smart-steaming supply chains.	• Synchro-collaborative business model.	---	• SYNCHRO-NET simulation tool for the optimization of the transport chain; • Weather Routing Module Key Performance Indicators (KPI) depending on weather data and operational conditions; • Cooperative Speed Pilot: "real-time speed pilot" to assess the costs and speed of a maritime route; • SYNCHRO-NET Driver Interaction Layer: a real-time scheduling system designed to cope with the complexities associated with synchromodal logistics planning.
TELLISYS	• Modular set of volume-optimised and traceable MegaSwapBoxes (MSB);	---	---	• Nine different conceptual designs for the MegaSwapBox (MSB), from which two of them were also produced as prototypes:

PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
	• Adapted trailer and tractor for the road transport.			Automotive MSB and Continental MSB; • Super low-deck truck: tractor with an extremely low fifth wheel height; • Trailer chassis (three different concepts).
TIGER DEMO	Genoa Fast Corridor demonstrator: • Introduction of the "ship-to yard-to-train" and use of shuttle trains; • Open up of effective competition inside the port by introducing new rail freight operators managing the shuttle transfer trains. • Implementation of e-seals, e-custom and e- freight technologies and of operative systems at port and dry port for computerised traffic management; • Integration of the terminal operation system with the AIDA, the Italian Custom Authority system. Innovative port and hinterland operation (iPort) demonstrator: • Concept for wagon group exchange and train composition	• Maritime distribution business model based on the dry-ports mega hub utilization and development.	---	• Genoa Fast Corridor demonstrator: shuttle trains between three Genoa port terminals and the dry port in Rivalta with re-engineering processes along the Genoa maritime CT transport chain; • Innovative port and hinterland operation (iPort) demonstrator iPort: "Close to the Market" and "Close to Port" concepts for hinterland rail transport, implemented in the rail hubs on Nienburg, Bremen and Munich-Riem; • Intermodal network 2015+ demonstrator: shuttle trains of the existing intermodal network, high performance gantry cranes, double sided, electrified rail access and advanced terminal management and train planning systems.

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PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
	in Nienburg rail hub (terminal dedicated trains); • Concept for CT group exchange and train composition in Bremen rail hub; • Optimised logistic & operational processes (definition of regular processes, regulations & guidelines for adjustment of rail service to daily changes of the situation in seaports) in Nienburg and Bremen rail hubs; • IT tool to support wagon dispatching, slot management; • Lean and ecologic shunting concept (by electric line locos, no dedicated shunting (diesel) loco required) in Nienburg rail hub; • Electronic data exchange between the BLU system and the system boxXbase of boxXpress; • Train monitoring with customer interface. • External depot for maritime containers with associated shuttle service from/to the rail terminal. Intermodal network 2015+ demonstrator: • "Second-level-production" into the intermodal transport chain			

PROJECTS (acronym)	OUTPUTS			
	Technology	Business Model	Policy	Service / Product
	with quality efficiency and competitive services based on the designated München-Riem rail hub; • Organisation and operation concept directly connecting the trains via a rail-rail-cargo handling in the rail hub München-Riem; • Concept for coordinating and controlling the production processes for the inbound and outbound trains, as well as the rail hub processes; • Integration of the rail hub München-Riem into the seaport/inland transport network. • Information and Communication technology: tools for technical management, capacity management and train monitoring.			
ViWaS	• Simulation tool for SWL network planning	---	---	• Regional network of rail logistics centres

Annex IV– Semi-structured interview guide

1. Project introduction

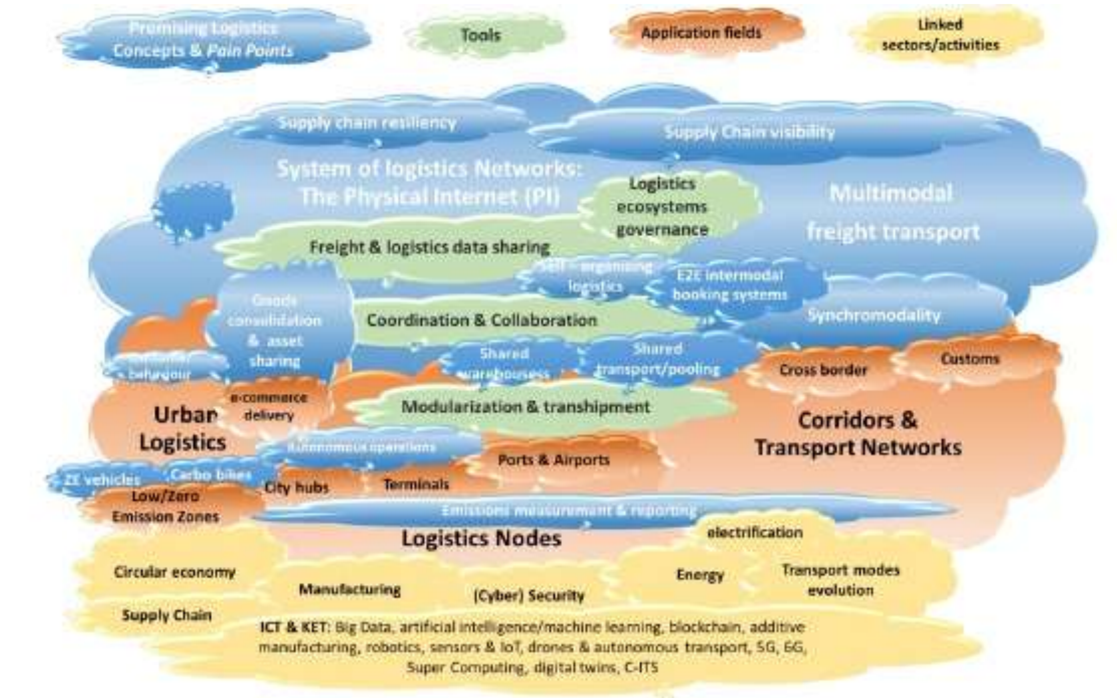
For more than two decades EU has invested in research and innovation (R&I) through various Framework Programmes, e.g. FP5 (1998-2002), FP6 (2002-2006), FP7 (2007-2013), and the ongoing HORIZON 2020 (2014 – 2020). This has contributed to the development of the logistics sector through the creation of new companies, implementation of concepts in practice and through science-based regulation. The BOOSTLOG project aims to boost impact generated from future EU funded R&I projects to contribute to EU policy objectives, address societal challenges and increase EU's competitiveness. The project will map more than 160 projects funded by FP5, FP6, FP7 and Horizon 2020, and identify successful implementation cases into the market and regulations and will develop actionable reports on various subjects prioritized by stakeholders. The project will assess the impacts generated, identify gaps and priorities for future funding programmes.

Logistics Nodes are centres of freight transport where a large activity of cargo logistics and related services are concentrated with different degree of added value. Located at strategic points of interconnection along the main supply chain routes, its objective is to facilitate and improve the control and performance of all activities necessary for the transport of goods, including services, processes and procedures from planning to performance. In the current Cloud Report, five infraestructures are taken into account: Maritime & River Ports, Inland Ports, Intermodal Terminals, Container Depots and Airports; excluding Warehouseses since they are reasonable related to the last mile distribution, considered in a specific BOOSTLOG Cloud of the project.

Following the previous approach, when looking for projects focused on logistics nodes, these should address areas focused on improving the focal infrastructures. Specifically, three main areas have been identified to which improvements can be applied: Operational Efficiency, Operational Safety & (Cyber-)Security Sustainability & Environmental Impacts.

This Project is supported by the European Commission and framed as part of the activities in ALICE building on its network and past projects such as SENSE, SETRIS and WINN and is an integral part of ALICE outreach to R&I funding organizations

2. Cloud and subclouds diagram



- Do you miss any important cloud/subcloud?

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3. Most relevant projects in the cloud

- Do you miss a relevant R&I project not included here?

4. Organizations with highest participation in relevant projects in the cloud

- Do you miss an important/relevant organization with good R&I results in this area?
- If yes? Which organizations and for which results? Who is the contact person?

5. Trends and societal drivers relevant/addressed for the Cloud

LIST of trends and societal drivers:

Climate change, urbanization, individualization, digitalization, demographic change, resource scarcity, circular economy, driver shortage, online shopping, COVID-19

- Do you agree with this list of External Factors?
- Which are for you the 2/3 most critical/relevant?
- Which are the specific consequences to the logistics sector (e.g. online shopping means fragmentation of flows, instant deliveries/speed, last meter delivery)?

6. Relevant EU policies addressed

LIST of policies addressed by the cloud:

- **The European Green Deal**
- **Promoting our European way of life**
- **A Europe fit for the digital age**

- Which other policies you know are also relevant?
- Which is the EU policy this area has a greater impact?

7. Project participation of your organization per Cloud

- Have your organization participated in other relevant projects? Which ones? Could you share some information references?
- Which are the most Relevant/Key R&I results project deliverables for each project? Could you share them with us?
- Which have been the key partners on those projects à Generating results/outcomes and after project implementation?
- Overall, which is your conclusion on the projects in terms of:
    - Progress made
    - Level of adoption of results
    - Which have been for you the 2/3 key barriers for adoption?
    - Which would you think is the best (or best 2 projects) and why?

8. Project Outcomes

- Do you have any outcome out of these projects in this field?
- If a research center, is it your ambition to transfer/implement the Knowledge?
    - How your organization address that?
        - Through Market agreements on Knowledge Transfer to Companies.
        - Spin offs
        - Other
- What is the main barrier to reach the market you faced:
    - Financing for further development.
    - Finding right (industry) partners
    - Value proposition towards customers.
    - Business models.

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- Other?

- Do you have outcomes out of R&I projects in other BOOSTLOG CLOUDS?

9. Implementation Cases

Implementation Cases are concrete examples in which causal links between public R&I funding and technology, organizational or process innovation in a specific logistics area can be established.

Implement Cases are that research results have been further developed and have been deployed as commercial solutions, have generated a new market or have contributed to new policies and will stablish causal links between research funding and impact.

- Do you know any Implementation Cases out of these projects?
- If yes, which entity was the R&I/Outcome owner and which entity was the Innovation Seeker.
- Would you like ALICE/BOOSTLOG to promote the Implementation Case?

10. Final comments

- How could we improve the interviews?
- Would you like to join a workshop in which we will share the aggregated results and discuss conclusions with your peers?
- Any further comment.