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BOOSTLOG PROJECT

DELIVERABLE REPORT

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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)	BE
6	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (ICCS)	GR
7	Vlaams Instituut voor de Logistiek VZW (VIL)	BE
8	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. (Fraunhofer)	GE
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)	SW

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Contents

Definitions and concepts used in these 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

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

BOOSTLOG project vision lies in transforming European freight transport and logistics R&I ecosystem to perform optimally[1] boosting impact generation out of R&I investment contributing to EU policy objectives[2] and *Companies* sustainability and competitiveness generating value for society. Increasing visibility and support valorisation of EU funded R&I project Results, Outcomes and Implementation Cases in the freight transport and logistics is one of the strategies implemented to reach that vision. Indeed, this deliverable on Logistics coordination and collaboration is the first issue of a series of the comprehensive and industry actionable reports targeting *Companies*, that will be created in the framework of BOOSTLOG for different logistics domains, also known as *clouds*.

This document focuses on assessing completed European funded Research and Innovation Projects (see Figure 1) in the field (also referred as *cloud*) of **logistics coordination and collaboration that refers respectively to vertical and horizontal synergies along** (including within a company) **and across different supply chains maximising assets and resources utilization**.

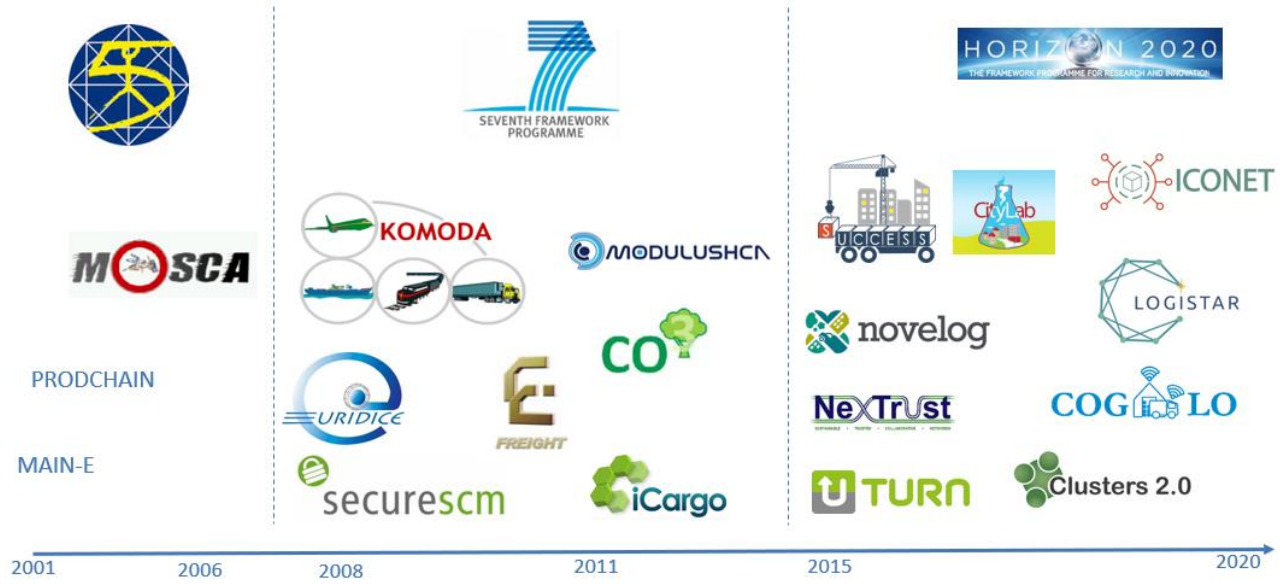

Figure 1. European funded R&I coordination and collaboration projects

[1] R&I systems are complex ecosystems which need various elements to perform optimally. These include a solid public science base producing high quality outputs; strong business participation in innovation activities; fluid and abundant knowledge flows across R&I actors; and good framework conditions that allow business innovation to flourish. *European semester thematic factseet. Research & Innovation.* https://ec.europa.eu/info/sites/info/files/file_import/european-semester_thematic-factsheet_research-innovation_en.pdf

[2] namely: decarbonization, emissions and congestion reduction, free and seamless movement of goods and sectorial digitalization capabilities upgrade. https://ec.europa.eu/info/priorities_en

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The main outcomes showcased in this document tackle the four **main barriers hindering cooperation and collaboration**: **scalability of governance, business and operational models, , complexity of transition management, legal issues and soft/behavioural aspects.** This can be seen in the table below:

BARRIERS	SOLUTIONS
Scalability of governance, business and operational models	• Smaller prizes, fragmented flows in terms of volumes or destinations, not stable with high variability may direct you to a "platform" solution trusting in the system: online trustee (e.g. TRANSPOREON, CRC-SERVICES, OGOSHIP, MIXMOVE). • Stable and big flows may direct you to customized trustee models (TRI-VIZOR) • Be concrete in defining your case (see section 1.1. and 1.2). • Start within your company, looking for complementary flows or how to combine volume and weight in your shipments. Define these as KPIs • The more companies participating the more resilient/sustainable is the model.
Complexity of the transition management: Transactional, set-up and operational costs hinder benefits from efficiency gains	• Clearly define the prize/benefit which will direct to a concrete governance or business model. • Identify clearly what needs to change in your supply chain to achieve the benefit: some flexibility will be needed! • Start with higher prizes opportunities. • Test small but think big in terms of potential impact.
Legal issues: Competition rules compliance	• Go beyond the myth: *"Logistics Coordination and Collaboration is not legal"* • Several governance models (see above) are demonstrated already with a solid legal framework: choose the one that fits better your needs. • Make sure you are supported properly in the process: there is plenty of knowhow market ready.
The collaboration framework requires soft/behavioural aspects to be addressed • **Not finding good partners** • **Collaboration culture** • **Unbalanced flows in terms of time and volumes** • **Losing SC control (including losing purchasing power)** • **Work with competitors**	• Create your company framework: investigate the different governance, business and operational models and legal framework clearly addressing all the guidelines mentioned in this table. • Complementarity is key. Define who are your potential collaborators. • Organisations should share goals and be committed to overcome barriers and ready for change. • Start with those ones already understanding the prize and the requirements. • Do not press companies that are not ready /have a clear interest. Let them return naturally. • If competitors are around the table, a trusted organization (trustee) needs to arrange the collaboration and arrange processes.

An in-depth analysis of initiatives stemming from European funded projects' outcomes around those solutions has identified the following implementation cases:

MIXMOVE offers intelligent, horizontal collaboration between shipper, carrier, hub, distributor and the end customer. The aim is to increase load factors to boost efficiency and reduce costs, while at the same time creating more sustainable supply chains by making smart use of transport modes.

TRI-VIZOR is the first impartial orchestrator for transport and logistics, that prepares, designs, and operates horizontal partnerships and collaborative communities among shippers. The company offers specialized knowledge and solutions to prepare, create, support, and orchestrate flow bundling and horizontal partnerships in transport and logistics.

SMARTBOX is an innovative and reusable transport box to increase efficiency and sustainability in logistic processes.

CRC Services has developed a model to help companies to mutualize their flows for the last 100 km of goods delivery. The model allows suppliers to deliver goods from their distribution centres in collaboration with other supplier and to make savings by optimising orders and vehicle loads.

Those implementation cases can be grouped in two different categories. On the one hand, initiatives well established as MIXMOVE, TRI-VIZOR and CRC-SERVICES have been developed in the last decade since the first projects were funded (including the project lifetime). These initiatives are mature and present in the market even at low scale. In the coming years, it is expected to see them grow in terms of market share. On the other hand, implementation cases such as SMARTBOX are more disruptive and therefore the path ahead will encounter a range of barriers, but its scalability potential could really mean a turning point for collaboration and coordination in logistics in the coming years.

Additionally, several companies and market initiatives have been identified that even if they do not have causal links with project outcomes are addressing similar problems bringing solutions to the market.

In Table 1, the targeted impacts of the projects and the assessment of the readiness (not only technical but also market, operational, etc) is included in 6 levels: 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)

Table 1. Expected impacts, number of projects addressing it and readiness of the solutions

Targeted Impact	Nr. of projects	Status
Decrease of environmental impact in terms of GHG emissions, pollutants, and noise	11	IMS
Increase transport efficiency (load factors, empty trips, shorter delivery routes, reduce failed deliveries)	10	ISS
Reduction of congestion	9	ISS
Decrease of overall transportation and logistics cost	4	ISS
Achieving and increase in modal shift to rail freight/waterways transport	4	PoC
Increased reliability of the Supply Chain	2	TD
Decreased Lead Times	2	TD

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1 Introduction and methodology

1.1 BOOSTLOG project

BOOSTLOG Vision is transforming European freight transport and logistics R&I ecosystem to perform optimally boosting impact generation out of R&I investment contributing to i) 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 ii) *Companies* sustainability and competitiveness generating value for society.

In order to do so, BOOSTLOG has identified 4 main areas of action: i) increase visibility and support valorisation of R&I project Results, Outcomes and Implementation Cases in the freight transport and logistics field ii) develop and implement valorization 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, iii) Define high potential & priority R&I gaps to make efficient uses of R&I investments and iv) 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 more than 160 EU-funded R&D since FP5 in different freight transport and logistics domains (i.e. the Logistics *Clouds*), so as to develop at 8 comprehensive and industry actionable reports. The first issue of those report is the present document, that will focus on logistics coordination and collaboration.

These company-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. The present deliverable shows the first report stemming from task 2.2, i.e. focussed analyses in selected Clouds: i) freight and logistics data sharing, ii) coordination & collaboration iii) urban logistics, iv) logistics nodes, v) multimodal freight, corridors & transport networks, vi) modularization and transhipment.

Indeed, this report focuses on logistics coordination and collaboration, 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 later showcased in future cloud reports (such as urban logistics or logistics data sharing).

This report is targeting companies: therefore, it focuses on the main barriers hindering coordination and collaboration, and how companies could tackle those, specifically building upon solutions that have been developed as project outcomes and implementation cases. Insights in terms of barriers faced by projects, as well as positive framework conditions, are not part of the scope of this deliverable and can be found in upcoming deliverable D2.3.

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1.3 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[3].

According to Alan McKinnon[4] 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[5]. 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.

The European Green Deal[6] sets out a detailed vision to make Europe the first climate-neutral continent by 2050. Recently, the Commission increased 2030 emissions reduction target of net 55 % compared to 1990 levels, from the previous 40 % emissions reduction target[7] and to implement the increased ambition, on 14 July 2021 the Commission presented the first series of adopted files under the 'Fit for 55' package.[8]

More than 934 companies have committed to science-based targets, with some pledging to reach zero emissions by 2050[9] and many of them including freight transport and logistics within their scope.

ALICE published end of 2019 its framework for a roadmap *"Towards Zero Emissions Logistics 2050"*[10] to clearly state the challenge and establish a direction to address it. One of the five key areas to address the challenge is: *Fleets and Assets are Used and Shared to the Max.* Indeed, increase the usage efficiency of the fleets and assets is one of the key enablers to achieve an affordable transition and this requires further coordination and collaboration in the supply chain.

This document focuses on assessing the R&I results, Outcomes and Implementation Cases in the field of logistics coordination and collaboration, defining next steps to reach impact and contribute to freight transport efficiency and to support addressing Climate Change.

The present report focuses on the Collaboration and Coordination Cloud identified under the framework of BOOSTLOG. The Coordination and Collaboration in this context refers respectively to vertical and horizontal synergies along and across different supply chains maximising resources utilization, with a focus on transport and warehousing.

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[3] European Environment Agency (2020). *Greenhouse gas emissions from transport in Europe*

[4] McKinnon, (2018)A. Decarbonizing Logistics: Distributing Goods in a Low Carbon World; Kogan Page, London, UK

[5] SWD (2018) 183 final - PART 1/2. *IMPACT ASSESSMENT Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on electronic freight transport information.*

[6] COM (2019) 640. *The European Green Deal.* Brussels

[7] COM (2020) 562. *Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people*

[8] Package fit for 55 (https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/package-fit-for-55)

[9] https://sciencebasedtargets.org/

[10] Roadmap Towards Zero Emissions Logistics 2050. http://www.etp-logistics.eu/?p=3152 ALICE (2019)

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1.4 Why improving coordination and collaborate? Expected positive impacts

Both Coordination and Collaboration can produce significant gains in terms of both efficiency and sustainability, eventually leading the transition from individually managed supply chains to open supply networks[11].

One of the initial studies on the impacts of the Physical Internet[12], based on simulations of logistics of top French retailers Carrefour and Casino, and their 100 top suppliers[13,14], showed that moving to a "*Physical Internet Model*" could:

- shift 50% of goods transport from road to rail,
- cut costs by 32%,
- reduce t.km by 15%
- increase fill-rate from 65% to 85%
- reduce greenhouse gas emissions by 60%.

In Table 2 there is a compilation of the expected impact from the R&I projects which have been analysed, because of improved coordination and collaboration:

Table 2. Expected Impacts KPIs and projects addressing them

Expected Impact	KPIs	Projects
Decrease of environmental impact	CO2 emissions	CITYLAB, COG-LO, CLUSTERS 2.0, CO3, iCARGO, ICONET, LOGISTAR, MODULUSHCA, NEXTRUST, NOVELOG, SUCCESS, U-TURN
	Local pollutants	CITYLAB, NEXTRUST, NOVELOG, SUCCESS, U-TURN
Increase transport and logistics efficiency	Increase load factors (urban, *non urban*, **both**)	CITYLAB, *COG-LO, CLUSTERS 2.0, CO3*, iCARGO, **ICONET**, *LOGISTAR*, **NEXTRUST**, NOVELOG, MODULUSHCA
	Reduce empty trips/kms	NEXTRUST, MODULUSHCA, iCARGO, CO3
	reduce empty storage/space	ICONET
	shorter delivery routes	CITYLAB, NOVELOG, SUCCESS, U-TURN
	Reduce failed deliveries	CITYLAB, U-TURN
Reduction of congestion	Reduced vehicles movements /Nr. of vehicles	CITYLAB, COG-LO, CLUSTERS 2.0, ICONET, LOGISTAR, NEXTRUST, NOVELOG, SUCCESS, U-TURN, iCARGO
Achieving and increase in modal shift to rail freight/waterways transport	Create new intermodal connections	CO3, CLUSTERS 2.0, ICONET, NEXTRUST, LOGISTAR
Decrease of overall transportation and logistics cost	Cost/unit of transport	CITYLAB, NOVELOG, SUCCESS, U-TURN, iCARGO
Increased reliability of the Supply Chain	On time delivery	COG-LO, LOGISTAR
Decreased Lead Times	Reduced Travel time	COG-LO, LOGISTAR

[11] ALICE (2020). Roadmap to the Physical Internet. https://www.etp-logistics.eu/alice-physical-internet-roadmap-released/

[12] Sarraj, R. et al. (2014) 'Interconnected logistic networks and protocols: simulation-based efficiency assessment', International Journal of Production Research. Taylor & Francis, 52(11), pp. 3185–3208. doi: 10.1080/00207543.2013.865853.

[13] Ballot, E. (2012) Simulation de l'Internet Physique : contribution à la mesure des enjeux et à sa définition. Edited by PREDIT. Paris: MEDDAT.

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

Additionally, based on the experts' sessions within ALICE Supply Network Coordination and Collaboration Thematic Group, there are other impacts may be achieved through better coordination and collaboration even if not addressed in R&I projects:

- Smooth transition and accelerate adoption of zero emission vehicles (more expensive zero emission assets with lower OPEX) or more efficient vehicle configurations (e.g. European Modular Systems as further developed in AEROFLEX project[15]).
- Increase productivity of transport and logistics assets.
- Increase parcel deliveries per stop.
- Increase frequency of shipments.
- Reducing cost in reaching new (geographical) markets.

1.5 Defining the scope and the potential strategies

In order to achieve the envisioned benefits, it is also important to define the scope, i.e. transportation, storage or both and in case of transportation the characteristics of the flows (urban, last mile/regional, medium distance or long distance) as well as the transport units (i.e. Full Truck Loads (FTLs), Less than Truck Load (LTLs) and the handling unit: pallets, big bags, boxes, parcels, etc.

Based on that, different strategies can be defined for the different scopes and targets. (see Figure 2)

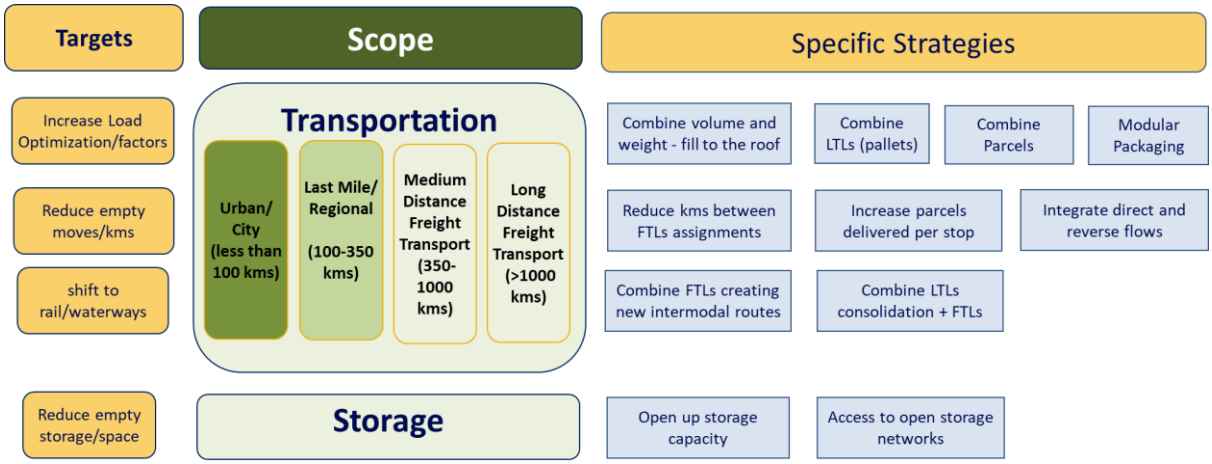

Figure 2. Example of Targets, Scope and potential strategies to be addressed.

1.6 Barriers and guidelines to achieve the benefits of logistics coordination and collaboration

Despite the well-known opportunities and benefits of further collaboration and coordination described above, the sector has not adopted it broadly yet. The following table shows the main (perceived) barriers that hinder collaboration. While some appear to be clear hurdles, other have been overcome or strategies developed to overcome them. Table 3 therefor also shows guidelines how to overcome the specific barrier.

[15] https://aeroflex-project.eu/

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Table 3. Barriers hindering collaboration in logistics and guidelines (Adaptation from Source: Alvarez and Felipe (2021)[16])

BARRIERS	GUIDELINE
Scalability of governance, business and operational models	• Smaller prizes, fragmented flows in terms of volumes or destinations, not stable with high variability may direct you to a "platform" solution trusting in the system: online trustee (e.g. TRANSPOREON, CRC-SERVICES, OGOSHIP, MIXMOVE). • Stable and big flows may direct you to customized trustee models (TRI-VIZOR) • Be concrete in defining your case (see section 1.1. and 1.2). • Start within your company, looking for complementary flows or how to combine volume and weight in your shipments. Define these as KPIs • The more companies participating the more resilient/sustainable is the model.
Complexity of the transition management: Transactional, set-up and operational costs hinder benefits from efficiency gains	• Clearly define the benefit which will direct to a concrete governance or business model. • Identify clearly what needs to change in your supply chain to achieve the benefit: some flexibility will be needed! • Start with promising opportunities; low effort – high rewards. • Test small but think big in terms of potential impact.
Legal issues: Competition rules compliance	• Go beyond the myth: *"Logistics Coordination and Collaboration is not legal"* • Several governance models (see above) are demonstrated already with a solid legal framework: choose the one that fits better your needs. • Make sure you are supported properly in the process: there is plenty of knowhow market ready.
The collaboration framework requires soft/behavioural aspects to be addressed • **Not finding good partners** • **Collaboration culture** • **Unbalanced flows in terms of time and volumes** • **Losing SC control (including losing purchasing power)** • **Work with competitors**	• Create your company framework: investigate the different governance, business and operational models and legal framework clearly addressing all the guidelines mentioned in this table. • Complementarity is key. Define who are your potential collaborators. • Organisations should share goals and be committed to overcome barriers and ready for change. • Start with those ones already understanding the prize and the requirements. • Do not press companies that are not ready /have a clear interest. Let them return naturally. • If competitors are around the table, a trusted organization (trustee) needs to arrange the collaboration and arrange processes.

[16] From Collaboration to system efficiency: maximizing the usage of resources in the logistics chain (2021). MDSC Master Thesis, Aristides Alvarez and Alba Felipe

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1.7 Methodology

These *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. The reports contain clear and companies' actionable items such as cases on how to implement the Outcomes or build on the Implementation Cases.

The methodology to develop such reports can be seen in Figure 3. First of all, BOOSTLOG analyses the R&I Results and Outcomes at Cloud level. The Outcomes are then analysed based on the TRL of the project results and further development TRL achieved.

The organizations with most prominent participation in projects for each Cloud are then identified, as well as individual people from those organizations participating in the projects contacted (i.e. the experts).

Semi-structured interviews (see Annex 2) have been performed to key experts, with the ultimate goal of validating the identified outcomes and gather additional ones, as well as to investigate which Outcomes have resulted into Implementation cases (i.e. they have been implemented and adopted by the freight transport and logistics stakeholders).

The interviews are the main input for the cloud report, complemented with the desk research on projects deliverables and communications, market/sector current practice analysis and the market solutions implemented and adopted including examples of Implementation Cases. The draft report is then shared with the experts for further input and discussion through an online workshop for validation of the report. The experts validated report will be then presented in a webinar with ALICE members and other stakeholders through BOOSTLOG partners networks.

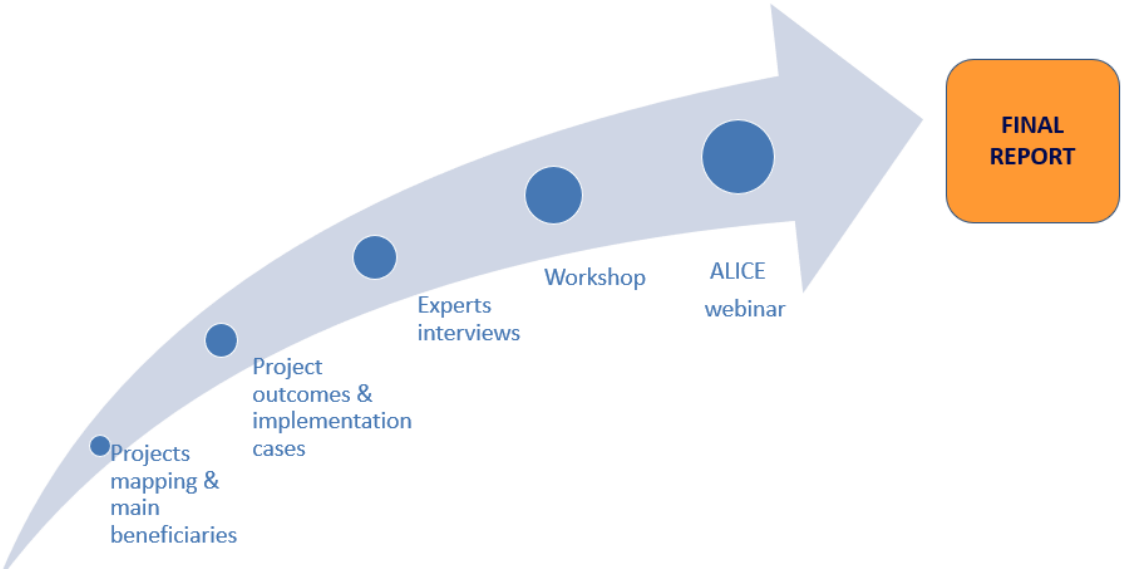

Figure 3. Methodology for a cloud report development

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2 Market current practice analysis

The need for coordination and collaboration in logistics is mainly driven by the underutilization of assets. In this context, logistics collaboration implies cooperation of two or more independent companies with the ultimate goal of optimizing supply chains in terms of cost, flexibility, agility, quality, service, and pollution.

The table below illustrates the existing collaboration models for logistics, considering the number of stakeholders involved as the business and governance models behind identified in the ICONET project:

Collaboration Model	Number of Stakeholders	Activity Types	Risk Taking Initiator	Gain Sharing Model	Data Sharing Model	Flexibility
Subletting Warehouse Space	At least two shippers, LSP and Trustee are optional.	Storage Handling	No specific risk Use of existing assets	Contractual Negotiation or Gain Sharing (Shapley)	Data shred between shippers	Specific Business Case Small Member Base Low flexibility Low Scalability
Collaborative Roundtrips	At least two shippers and one LSP. Trustee is optional	Transportation	No specific risk Use of existing assets	Contractual Negotiation or Gain Sharing (Shapley)	Data shared between with trustee for overall analysis. Data shared with LSP for specific lane.	Specific Business Case Small Member Base Low flexibility Low Scalability
Collaborative Vehicle Fill	At least two shippers and one LSP. Trustee is optional	Handling Transportation	No specific risk Use of existing assets	Contractual Negotiation or Gain Sharing (Shapley)	Data shared between with trustee for overall analysis. Data shared with LSP for specific lane.	Specific Business Case Small Member Base Low flexibility Low Scalability
Collaborative Logistics Platforms	At least two shippers and one LSP. LSP takes the role of trustee.	Storage Handling Transportation Order Management	Risk for LSP for platform implementation	Contractual Negotiation	Data shared with LSP	Specific Business Case Medium Member Base Medium flexibility Medium Scalability
Parcel Delivery Networks	At least two shippers and one LSP. LSP takes the role of trustee.	Handling Transportation Routing	Risk for LSP for hub and spoke implementation	Fixed price grid with option to negotiate for B2B	Data shared with LSP	Collaboration Network Large Member Base High flexibility Large Scalability
Collaborative Corridor Management	At least two shippers and one rail / barge operators. LSP takes the role of trustee.	Transportation Routing Scheduling	Risk for LSP (subcontracting) and rail/barge operator (implementing service).	Contractual Negotiation	Data shared with LSP	Specific Business Case Medium Member Base Medium flexibility Medium Scalability
Logistics Clusters	At least two shippers. Public body takes the role of trustee.	Community Building Data Sharing	Risk for public body for data platform and community building.	Fixed pricing structure for data platform	Data shared with public body for data sharing.	Specific Business Case Medium Member Base High flexibility Large Scalability

Figure 4. Overview of logistics collaborative models (ICONET project[17])

Already in 2014, ALICE European Platform in Logistics released its Global supply network coordination and collaboration roadmap[18] aiming at:

- Removing barriers to improve vertical and horizontal collaboration through new concepts and approaches.
- Promoting a smooth transition from independent supply chains to open supply networks.
- Making the use of available resources more efficient, making them more compatible, accessible, and easy to interconnect.

[17] ICONET Deliverable D1.2 PI business and governance models

[18] ALICE Global Supply Network Coordination and Collaboration research & innovation roadmap

To achieve those, the following paths were suggested:

- Collaborative supply network design and operation, creating new business models
- Supply network coordination: coordinating the synchronization of the supply chains, overcoming anti-trust issues and concerns for data sharing.
- Enablers for collaboration and coordination: fostering incentives to promote the transition to a more collaborative environment, i. e. governance models

In 2021, also in the framework of ALICE platform, a master thesis project[19] was developed to collect best practices and guidelines for implementing collaborative strategies and approaches to increase logistical efficiency, reduce costs and emissions through load consolidation and share assets, reduce empty movements.

Through a survey to network of companies, the thesis identified that the main enabler for collaboration was having a framework of successful use cases. The Implementation cases identified in this report provide this framework. Indeed, raising awareness on successful use cases, showing their experiences and learnings can incentivize other companies to enter the coordination and collaboration domain.

Currently one can see in the market new companies that have arisen around the topic of coordination and collaboration, as it can be seen below:

CHEP traditional business is the management, maintenance, transportation, and supply of pallets that are shared and reused by producers, manufacturers, distributors, and retailers. While doing this, they realized that their unique position in the supply chain, reach and data could enable their customers to get all the benefits of transport collaboration: fewer empty miles, less wasted fuel, less needless CO_2 emissions and reduced costs.

ES3 provided both manufacturers and retailers with an automated shared warehousing solution, which, thanks to the software used, allows them to have a more agile, efficient, and cost-effective supply chain. It offered collaborative storage in a wide network of warehouses that spans the US, making use of optimisation software that enhances the entire user experience. In 2019 it was absorbed by Ahold Delhaize, in the midst of its investments to transform supply chains of the future.

Flexe is a warehousing company that offers unified and centralised software for its whole network, with modules for inventory management, ordering, shipping, and invoicing. As a result, all operations are centralised in one place. It also drives unified warehouse sourcing and configuration and streamlines material handling operations. Flexe impacts on the asset productivity growth model by connecting companies that lack storage space with those that have too much.

Freightera is a Canadian company offering a cloud based B2B online freight marketplace of a large number of LTL carriers and trucks, where you can search and compare instant all-inclusive freight quotes and book shipments online. To promote freight consolidation and increase asset productivity, it offers the possibility of combining empty trucks to eliminate inefficiencies of traditional freight transport.

Mutual Logistics The company offers solutions related to supply chain, transport, and co-packing by applying multi-customers operations able to share asset and to create economy of scale.

[19] From Collaboration to system efficiency: maximizing the usage of resources in the logistics chain (2021). MDSC Master Thesis, Aristides Alvarez and Alba Felipe

OGOship is company that allows its users to outsource the entire warehousing and logistics of their physical inventory. It provides the entire warehousing and logistics package: storing and holding stock, shipping goods globally with the best possible freight forwarders and providing a variety of value-added services. By consolidating small volumes from growing e-commerce. Receives, stores, and distributes merchandise from entrepreneurs around the world and places it in its warehouses closer to its target customers.

Stockbooking is a marketplace designed for on demand logistics services. They connect storage place suppliers with any company in need of temporary or long-term storage services.

Stockpots is a company that facilitates collaboration between a user (company) and a logistics service provider, promoting more reliable, flexible, and faster transactions. It connects users seeking warehousing capacity and fulfilment services with logistics service providers that have it available, so 3PLs can optimise their assets and make them more productive. In addition, it offers a specialised network for on-demand warehousing.

TRANSPOREON is a cloud-based transportation sourcing and management platform for shippers, suppliers, retailers, goods recipients and carriers in the world. It aims at reducing the number of empty trucks, improve transparency, cut waiting times and enable efficient, digital end-to-end processes making collaboration as easy as possible.

As part of the market practices, there are **further initiatives stemming from EU funded Research & Innovation projects outcomes and implementation cases.** Several of these initiatives have successfully been implemented and are currently operating in the market:

CRC Services has developed a model to help companies to mutualize their flows for the last 100 km of goods delivery. The model allows suppliers to deliver goods from their distribution centres in collaboration with other supplier and to make savings by optimising orders and vehicle loads.

MIXMOVE offers intelligent, horizontal collaboration between shipper, carrier, hub, distributor, and the end customer. The aim is to increase load factors to boost efficiency and reduce costs, while at the same time creating more sustainable supply chains by making smart use of transport modes.

SMARTBOX is an innovative and reusable transport box to increase efficiency and sustainability in logistic processes.

TRI-VIZOR is the first impartial orchestrator for transport and logistics, that prepares, designs, and operates horizontal partnerships and collaborative communities among shippers. The company offers specialized knowledge and solutions to prepare, create, support, and orchestrate flow bundling and horizontal partnerships in transport and logistics.

Document elaborated with the support of the BOOSTLOG project has received funding from *the European Union's Horizon 2020 research and innovation programme* under grant agreement No 101006902

3 Project Results and Outcomes

This section presents the main Results and Outcomes stemming from European funding projects. Indeed, in the Coordination and Collaboration Cloud, the following 19 projects have been identified as being key contributors to the field. As it can be seen in Figure 5 below, the pool of projects has evolved for 20 years, starting with only 3 projects in FP5 and increasing significantly in the subsequent Framework Programmes.

The FP5 projects focused on network coordination, while FP7 projects set the building blocks for future research in coordination and collaboration (i.e. information sharing, business models, governance models). Horizon 2020 projects deployed those learnings in new environments and new sectors, but also started the path for the Physical Internet, a paradigm shift that is building upon coordination and collaboration.

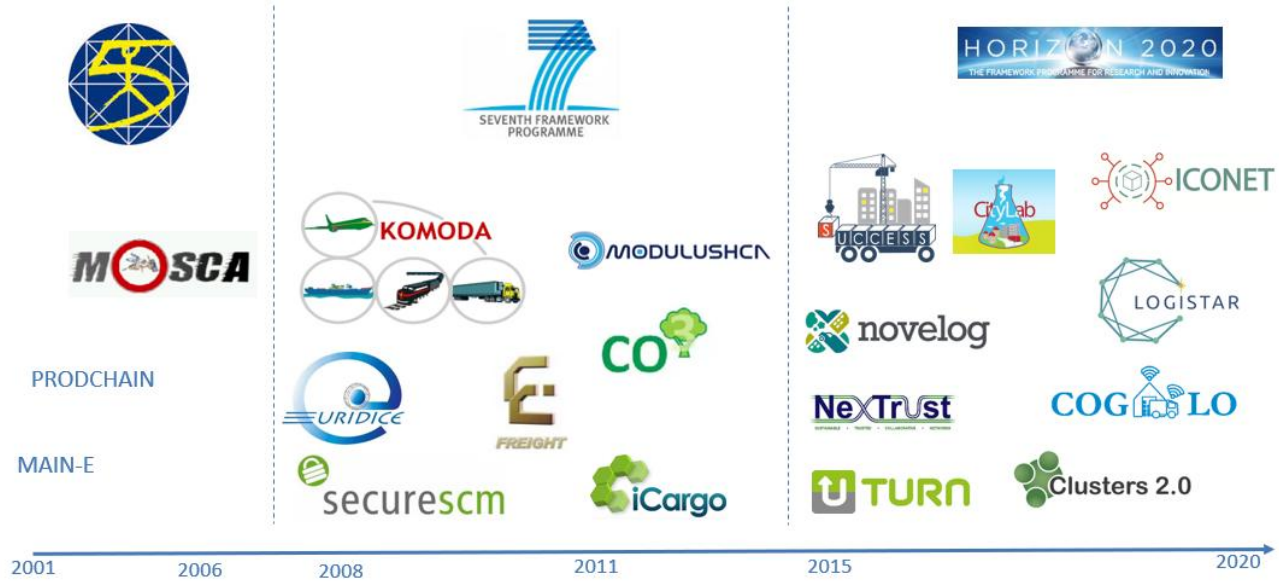

Figure 5. Coordination and collaboration projects

For collaboration to be successful the analysed projects in this cloud proposed governance and Business Models (section 3.1), dedicated or existing (IT) platforms to manage operations (see section 3.2) as well as specific legal frameworks involving a neutral party to solve anti-trust issues (see section 3.3 for more details). Indeed, coordination and collaboration may generate distrust and the feeling that the distribution of gains is not fair.

The outcomes in the projects vary from specific technology developments, new business models, policy related contributions (including guideline and roadmaps) and service/product related accomplishments. The outcomes for the Collaboration and Coordination Cloud are shown in Figure 6. Most of the outcomes from the projects belong to the service/product category, including tools, legal frameworks and platforms.

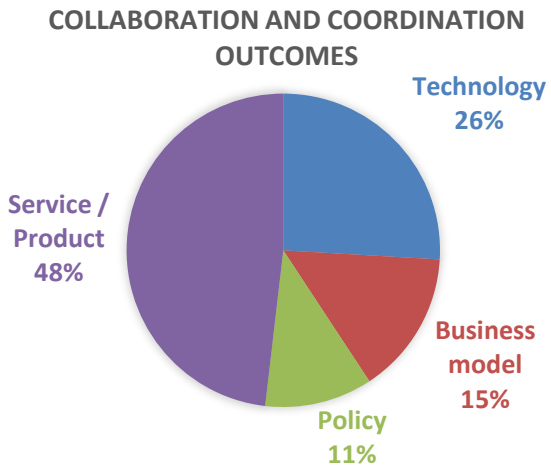

Figure 6. Coordination and collaboration projects outcomes

3.1 Governance, Business and operational models

Several projects have addressed collaboration and coordination opportunities and advanced on defining governance, business and operational models to enable them e.g. the European CO3 project[20] developed interesting case studies that illustrate how horizontal collaboration (in which companies share services for mutual advantage) leads to a reduction of GHG emissions and cost. Two Fast Moving Consumer Goods (FMCG) shippers (Nestlé & PepsiCo), a logistics service provider (STEF) and a neutral trustee (TRI-VIZOR) built a collaboration community in fresh and chilled retail distribution[21]. An interesting outcome of this project was the definition of the role of a neutral trustee, not involved in the operational area, which would maximize the total synergy gains of the network while keeping its impartiality.

Consolidating, balancing, and synchronising the loads of Nestlé and PepsiCo into Full Truck Loads (FTL), cost savings of 10-15% and similar CO_2 reductions were achieved. In another case, two shippers with two separate supply chains but similar lanes, P&G and Tupperware, collaborated to deliver products from Belgium to Greece optimising light and heavy goods mix in the trucks. The resulting collaborative supply chain saved 150,000 truck-km, improving from 55% to 85% cube and weight fill, and attaining 17% cost savings. More recent projects such as NEXTRUST[22], LOGISTAR and CLUSTERS 2.0[23] have shown similar benefits on additional horizontal collaboration examples following similar Governance and business models.

To enable collaboration, business and operational models should be in place to ensure the economic sustainability of the system. Indeed, an open and shared system requires a fair cost and value sharing. The allocation of costs along a network could also become an issue if not clearly defined. Two examples of how to overcome those challenges have been implemented in the projects:

[20] CO3 project, Collaboration Concepts for Co-modality. http://www.co3-project.eu

[21] Horizontal Collaboration in Fresh and Chilled Retail Distribution. D4.3, CO3 project.

[22] *"Building sustainable logistics through trusted collaborative networks across the entire supply chain"* NEXTRUST H2020 project. https://nextrust-project.eu/

[23] Open network of hyper connected logistics clusters towards Physical Internet, CLUSTERS 2.0 H2020 project http://www.clusters20.eu/

On the one hand, CO_3[24] project created gain-sharing rules and also business models in the form of a self-assessment workbook to remove managerial barriers to horizontal collaboration. CO3 identified the limits to collaboration for its practical application (the framework was useful for 2-3 partners; higher number of actors increased the complexity).

For the successful realization of collaboration, not only business but also governance models should be in place. According to Forbes, "Coopetition" is "a term used to describe unconventional collaboration and cooperation within an otherwise competitive field of players". Indeed, competitive shippers may distribute jointly to a common retailer orchestrating the operation and thus save transportation costs and reduce their carbon footprint. A system based on the sharing of assets, data, cost information, would benefit from a neutral body or trustee that has a clear mandate and governance rules but also protecting confidential data and creating a legal framework for the collaboration (see section 3.3).

NEXTRUST project worked in the collaboration on access corridors, the organization of sharing corridors for the shippers took long time and if they change anything the corridor doesn't work anymore. The project outcomes were later implemented in the city of London, through London child distribution project which was parting from one consolidation centre with 1 vehicle. Since then, they have been extended, having 4-5 consolidation centre with 10 vehicle feet serving them.

Clusters 2.0 developed later its Cluster Community System (CluCS), an IT platform managing the resources within a cluster and the synchronization of operations in the cluster network of hubs, terminals and warehouses. CluCS can be defined as a "physical internet platform", as it offers services strictly related to physical facilities and within the defined geographical boundaries of a Proximity Terminal Network (PTN) supporting better use of the assets and resources within the cluster.

Along with the shift in the governance approach to allow collaboration, PI related strategies were also explored by the projects. ICONET project provided roadmap recommendations as to how the PI will accelerate the strategic evolution of the T&L sector with new logistic models and technologies. ICONET analysed and evaluated the impact of the proposed PI approach and investigate financing and investment sharing strategies and therefore prove the value of PI, in improving operational efficiency.

ICONET explored and created a set of innovative PI network services and their interaction workflow that optimise cargo flows against throughput, cost and environmental performance, based on Governance policies and SLAs, constantly and fully aware of network operations and status.

ICONET investigated and developed (a) the architecture required to support PI network operations, (b) the PI networking, routing, shipping and encapsulation layer algorithms and services (as per the attached figure "PI Hub PI Services Workflow"), (c) designing and implementing IoT Architecture in the context of PI (d) a blockchain implementation of the actual smart contract, and (e) a PI Hub Optimization Algorithm related to loading containers onto wagons and building trains (f) the digital and physical simulation models necessary to assess different scenarios.

ICONET open sourced most of the innovation and technology advancements through 4 patents in the areas of (a) Authenticated Container Access, (b) Authenticated Document Container Access by Geography/Role/Time, (c) Self-Auditing of Route by Container and (d) Physical Internet Twin Generation. ICONET also developed the

[24] https://cordis.europa.eu/project/id/284926

structure for early invoice payments. Even though many developments were mainly theoretical, the e-commerce delivery application was implemented by SONAE, a company in Portugal and

Table 1. Key R&I results available from previous projects: Business and Operational Models

Projects Results	**Outcomes**
Horizontal Collaboration Business Model - Web Accessible Set of Methods and Tools Supporting Collaboration And Co-Modality (CO3): • Collaboration and Co-modality Example • Shapley Gain Sharing Calculator • Collaboration Trustee Game	Bundling of road transport flows between the manufacturing companies JSP and Hammerwerk, that formed a horizontal collaboration community for the regular co-loading of their products from the Czech Republic to Germany. A neutral trustee, TRI-VIZOR, facilitated the collaboration process. Costs savings of 10% were achieved.
	Acting as 'offline trustee', TRI-VIZOR first identified a number of compatible shippers and calculated their potential transport network synergy. It then created a horizontal collaboration community with 4 of those shippers to set up a balanced and synchronized transport loop with Full Truck Loads between Belgium and the northwest of Spain (Baxter, Colruyt, Eternit, Ontex). In terms of sustainability, the community achieved a substantial carbon emission reduction of more than 30% compared with individual road transport before the collaboration. In terms of profitability, the community experienced a slight cost increase of ca. 3% when compared with the total baseline cost of road transport before the collaboration. This was caused by an unforeseen drop in roundtrip volumes just before the go-live of the project, in combination with the suboptimal geographic spread of the shippers' pick-up and drop locations in Spain.
	Four FMGC shippers (Mars Petcare, United Biscuits, Saupiquet, Wrigley) shared Norbert Dentressangle as LSP. IPS Europe and GOLS acted as neutral trustees.
	Horizontal collaboration community in fresh & chilled retail distribution between 2 Fast Moving Consumer Goods shippers (Nestlé & PepsiCo), a logistics service provider (STEF) and a neutral trustee (TRI-VIZOR). 10-15% cost savings were achieved.
Horizontal collaboration in Less-than-truck-load (LTL) transport flows across shipper in a trusted network environment to create "collaborative FTLs" (NexTrust)	Flows from fresh and frozen food shippers across Europe pilot - collaboration between the shippers was enhanced to the point that 25% of the volume that they had previously shipped as LTL on the identified lanes was consolidated to FTL shipments. This saving can be expressed as a reduction in truckloads carbon. However, financial savings were not forthcoming as consolidation opportunities that had been previously available to one shipper were not taken up during the period of the pilot.

	Improving the efficiency of inbound transport to retailers in the Benelux pilot - Multi-Supplier/Multi-Retailer Platform setup to test the feasibility of the use of a consolidation platform for multiple suppliers and multiple retailers for the category of biscuits and cookies. The scale of the pilot was not big enough to demonstrate the profitability of the concept. A trustee model was put in place to guarantee complete impartiality and anti-trust compliance.
Business models considering the Physical Internet approach to use modular cargo units (MODULUSHCA)	Poste Italiane and Jan de Rijk Logistics opened up their transport networks especially for a MODULUSHCA pilot. Procter & Gamble offered freight streams for the pilots. This mix resulted in an interesting operational result of using less trucks, so a higher utilization per truck.
Physical Internet governance models (ICONET)	Ports as the future engines of the Physical Internet and IoT Supply Chains Living Lab (Port of Antwerp): To increase use of full trains, more visibility and integration is required to generate the synchronisation capability at the end of the train segment of the logistics process. Optimise the use of single wagons, where clients do not have the volume to build full train loads or block trains, and so the commercial operation is built around matching flows of wagons and moving these wagons from origin to destination.
	High volume transport corridors enabled by the Physical Internet Living Lab (Procter & Gamble): Smart Contracts for recording and allowing a single source of truth when activity is not going to plan; synchro-modality for responding to exception reporting (through the dynamic rerouting of transport and rescheduling of receiving operations at destination warehouses)
	Reducing costs and stock outs in fulfilment of online retail and home delivery Living Lab (SONAE): enabled networked solutions in home delivery and last mile logistics to address fulfilment processes and operational costs, and so enable a growth and expansion in the retail offering, reducing costs but critically also increasing revenues through reduction in lost sales.
	Physical Internet as enabler towards networked Warehousing as a Service (WaaS) (Stockbooking): several retailers collaboratively using the same network of warehouses to service their retail outlets across France; this network modelled a central warehouse located in the Paris region, supporting a network of regional distribution centres, serving a network of retail outlets across France, and fed by imports entering the country. All flows were routed initially via the central warehouse before redistribution to the regional hubs and retail outlets.

3.2 Managing the transition: Addressing set up and transactional cost

CO3 project proposed the trustee model that was broadly assessed and used in NEXTRUST. One of the main barriers for adoption and scalability was indeed, managing the transition and setting the collaboration was costly and time consuming and therefore difficult to scale up fast.

Moreover, in those cases that the gains were not high enough (i.e. smaller, variable flows) the set-up and transactional cost hampered the potential benefits.

I-CARGO developed an architecture to enable and/or improve the exchange of information between supply chain organizations in order to reduce the burden for collaboration and as a result lowering transactional costs. First, the team derived to a body of knowledge combining literature - on supply chain collaboration and challenges, but also corresponding areas such as web services - with empirical knowledge gained from applied research and industrial projects we were and are involved in. Secondly, I-CARGO proposed a semantic architecture able to support seamlessly integration and create an ecosystem where programmable logistics are the future. (Decentralized ICT infrastructure, Intelligent Cargo items). I-CARGO project deeply contributed to MIXMOVE MATCH.

MODULUSHCA project selected and described algorithms for digital interconnectivity between different IT systems, as well as a sensors and communication approach for modular logistics units. As project outcomes, ARMINES worked with CGF and PG and then GS1 Germany, first at pilot level, but later on incorporating those into their operations. The project outcomes resulted in SMARTBOX Implementation Case, that will be seen in detail in the coming section.

Clusters 2.0 developed horizontal collaborations among shippers to bundle their freight volumes on a same train towards one destination through massification project, thus creating intermodal collaboration aiming at reducing set up costs.

Over the years, an evolution of the trustee role has been developed. Additionally, to the original process defined by TRI-VIZOR in CO3 and NEXTRUST that is completely operational as described in chapter 4, there are other forms of digital trustees. Clusters 2.0 explored the concept of CargoStream, as a digital platform to scale up horizontal collaboration. Currently, digital platforms already operating in transport and logistics gathering and sharing data are becoming digital trustees (e.g. CHEP, OGOSHIP, TRANSPOREON, operating in different domains) that generate opportunities for collaboration within their network.

Projects Results	**Outcomes**
CargoStream, an independent Pan-European platform that creates scale among shippers to drive horizontal supply chain collaboration through bundling their transportation needs with other shippers (Clusters 2.0)	Living Lab with Bologna-Trieste hubs. The service planning and coordination foreseen were revised since CluCS would have not communicated with CargoStream platform anymore. It was then decided to connect CluCS to a X-intermodal platform, allowing to interact with a network of other clusters at European level, all aggregated in such a platform, and in doing so also improving the organization of cargo flows to and from destinations outside the cluster.
Massification project to develop horizontal collaborations among shippers to bundle their freight volumes on a same train towards one destination (Clusters 2.0)	Massification project was applied in the following clusters:Zaragoza (PLAZA), Duisburg (Duisport), Lille (Delta 3 - Euralogistic), Bologna (Interporto), and Piraeus (Port of Piraeus).The massification project relies on three tools: 1) Quick Check Tool; 2) X-Intermodal Tool; 3) Collaboration workshops

3.3 Legal aspects and compliance with antitrust/competition law

On top of business, operational and governance models, collaboration requires legal contracts that address rights and obligations of all the parties involved. Indeed, collaboration is articulated around different areas of compliance, including competition, data sharing, transport and international laws. Project such as CO3 and NEXTRUST have developed legal frameworks to tackle those needs.

The innovative concept of collaboration between the Shippers, resulting in various efficiency gains, other (public) benefits and improvements in logistics, with the Trustee as third-party advisor bound to strict confidentiality and as manager of the collaboration in an open cooperation with the LSP's also appreciating the legitimate interests of the transport sector, could, when implemented and carried out the right way, hardly lead to serious objections and a restriction of competition. The legal framework developed in CO3 has been applied by P&G (partner of the project) in collaboration with another shipper in a shared warehouse. CO3 outcomes were applied by French companies, resulting in the CRC Services implementation case that can be seen in the next section.

NEXTRUST project developed a legal framework and model contracts to cover logistics collaboration for e-commerce and developing a legal basis for CITS/ICT.

These outcomes can be seen below: CO3 determined theoretically why collaboration makes sense and established the legal framework. CO3 concluded that the (legal) possibilities to collaborate horizontally in the supply chain are there and should not be directly considered 'unsafe' from an antitrust perspective.

Table 2. Key R&I results available from previous projects: Legal aspects and compliance

Projects Results	**Outcomes**
Legal framework for horizontal collaboration (CO3): • Collaboration agreement between the shippers • Agreement between shippers and trustee • Framework carriage contract between shippers and LSPs	NDA between JSP and Hammerwerk for co-loading.
	LOI between Baxter, Colruyt, Eternit, Ontex. Carriage contracts between those individual shippers and the main carrier, Corneel Geerts Transport.
	Formal written contracts between four FMGC shippers (Mars Petcare, United Biscuits, Saupiquet, Wrigley) and their LSP (Norbert Dentressangle) and between the shippers and the trustee. LOI signed between the shippers.
	Individual contracts between LSP and shippers (competitors Nestlé & PepsiCo). Rights and obligations of horizontal collaboration were included in these contracts. No multilateral collaboration contract was signed (due to competition laws).
Legal framework (NexTrust): • Legal aspects in the pre-contractual phase • Competition law aspects	The following pilots were implemented: • Large shipper just in time (JIT) flows to retailers in the United Kingdom

• Legal definition of the trustee concept • The effect of the absence of an international convention on multimodal transport • General framework for e-commerce	• Combining SME-size shipper flows to retailers in the United Kingdom/France • Flows from fresh and frozen food shippers across Europe • Flows from high-tech/electronics shippers across Europe where participants signed an NDA. Information exchange was solely done through the trustee. Insurance coverage was also agreed upon. Possible anti-trust risks were identified due to corporate group structures.

4 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. Indeed, Implementation Cases are 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.

BOOSTLOG has identified 4 Implementation cases in the framework of coordination and collaboration by developing any logistics collaboration model or solution.

4.1 MIXMOVE

MIXMOVE[25] offers intelligent, horizontal collaboration between shipper, carrier, hub, distributor and the end customer. The aim is to increase load factors to boost efficiency and reduce costs, while at the same time creating more sustainable supply chains by making smart use of transport modes. The logistics process, taking place in terminals (nodes) is based on splitting logistics units down to parcel-level so that cross-docking can be used to produce logistics units with vastly improved load factors. Splitting up pallets down to parcel level ensures dynamically meeting customer needs. The consolidation/reconstruction process also makes decisions about how the logistics units are being moved from the terminal. Decisions about consolidation/reconstruction and use of transport services are based on a set of decision rules that can be changed at any time. Hence to solution offers resilience in case new barriers or disruptions should occur.

MIXMOVE is the result of iCargo project. iCargo aimed at improving logistics' sustainability by using information technologies – reducing load factors was a natural target for the project. Among others, MARLO and DHL were involved in the consortium. They worked with 3M. 3M has a large number of products. By preparing customer orders at the factory or distribution centre, they needed significant space to "pick by order", and the resulting pallets were not stackable, hence one level of pallets was possible in trucks, resulting in low load factors. Delaying preparation of orders to the terminal closest to the customer, meant shifting from pallets to parcels, filling transport units as much as possible, thus increasing the load factor from 45 to 90%. To enable this process to be implemented in all terminals handling 3M cargo, without changing physical infrastructure or the existing information systems, 3M needed an information system to manage this new logistics process. This solution was developed by MARLO in the framework of iCargo jointly with DHL and 3M.

Indeed, iCargo's main outcome was shifting from local operations systems to a fully collaborative network, with decisions taken in real time using smart automation. iCargo thus developed a capability to mix, move and match cargo. The mechanism created could turn any terminal into a logistics node, very close to a PI node (this received an award in IPIC 2017).

[25] https://www.mixmove.io/en/

Document elaborated with the support of the BOOSTLOG project has received funding from *the European Union's Horizon 2020 research and innovation programme* under grant agreement No 101006902

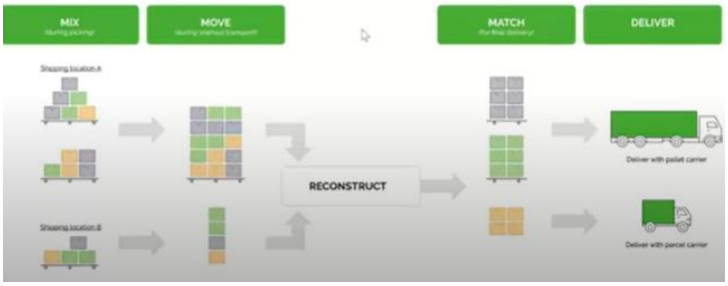

Figure 7. Figure 1 The reconstruction/consolidation process

The success factors from iCargo were not only having the R&D expertise, but also an interested customer (3M) and a provider willing to exploit the project's outcomes (MARLO). As part of this exploitation exercise, in 2017 MARLO decided to form a new company, MIXMOVE, and transferred all the related IPR to the new company. In 2019 they were awarded cool vendor in the supply chain by Gartner.

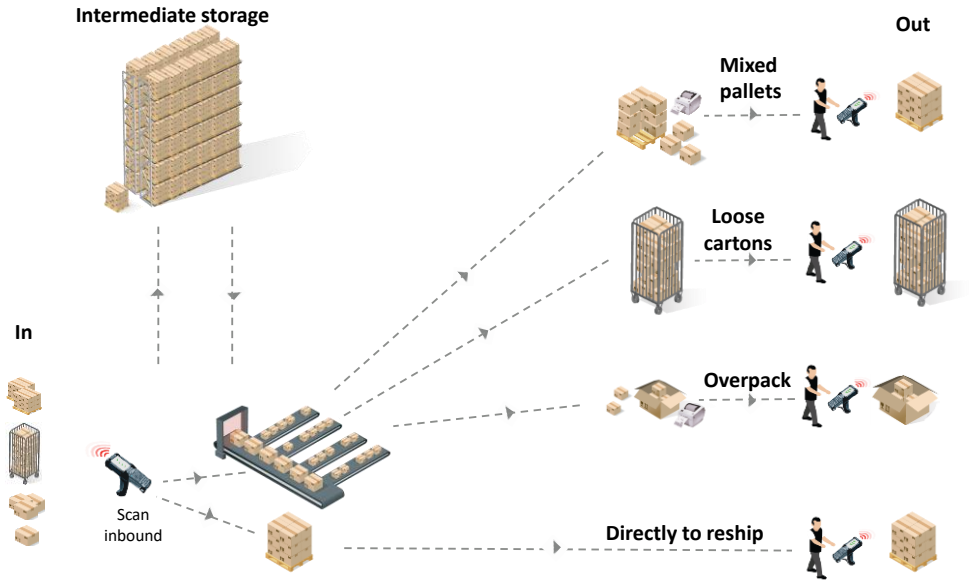

Figure 8. Figure 2 Inside the terminal

Currently MIXMOVE is transitioning its growth path, incorporating artificial intelligence for decision support and digital twins for interoperability. The aim is to ultimately become a facilitator of Physical Internet Services. It should be noted that even if the solution originally was developed in close collaboration with 3M, the solution is generic and can turn any terminal into a "network node", without changes to physical or information infrastructure.

The MIXMOVE solution is currently operating in more than 30 terminals in Europe and the US. Approximately 150 million parcels have been mover using the solution.

4.2 TRI-VIZOR

TRI-VIZOR[26] is the first impartial orchestrator for transport and logistics, that prepares, designs, and operates horizontal partnerships and collaborative communities among shippers. The company, originally raised as a spin-off of the University of Antwerp in 2008, offers specialized knowledge and solutions to prepare, create, support, and orchestrate flow bundling and horizontal partnerships in transport and logistics.

In the framework of CO3 project[27], a horizontal collaboration community in fresh & chilled retail distribution between 2 Fast Moving Consumer Goods shippers (Nestlé & PepsiCo), a logistics service provider (STEF) and a neutral trustee (TRIVIZOR) was created. In 2010, the Belgilux Association of Branded product Manufacturers (BABM) brought together a group of retail suppliers to identify potential consolidation opportunities. The project took 2 years to reach its implementation phase with two companies, PepsiCo and Nestlé. The distribution synergy between the Belgian fresh networks of Nestlé and PepsiCo was simulated and the potential consolidation gain was calculated by the neutral trustee TRI-VIZOR in an 'offline' mode.

Subsequently, a community was built around the two companies with TRI-VIZOR as the trustee providing the appropriate governance framework. A joint Request for Proposal was launched by TRI-VIZOR on behalf of the two companies to select the most adequate logistics service provider to organize the operational aspects (warehousing and transport). The logistics service provider that was selected in this case was STEF, a European logistics service provider that specializes in temperature-controlled logistics.

Since all logistical processes were managed by STEF, they were also fully responsible for the management of the administrative and financial flows. The neutral trustee performed periodic audits to make sure that the agreed gain sharing principles were respected in the invoicing by STEF and to ensure that the collaboration kept running smoothly.

A very important aspect of this horizontal collaboration was how to cope with anti-trust laws. As Nestlé and PepsiCo are competitors, antitrust compliance was crucial and e.g. detailed cost or order information could not be shared amongst both parties. Company-sensitive information was therefore only shared with the TRI-VIZOR. The process was closely monitored by a specialized external lawyer and by the legal departments of both PepsiCo and Nestlé.

The PepsiCo-Nestlé project was ground-breaking and attracted a lot of attention and exposure leading to prizes and awards. In 2014, the project won the European CO³ Award. The project was granted with the 2014 Prize of the Audience of the Supply Chain Award, organized by VIB – The Belgian Procurement and Logistics Association. In 2015, the project won the prestigious European Supply Chain Project of the Year Award of the European Logistics Association (ELA).

After CO3, TRI-VIZOR has further developed its strong vision on how logistics and supply chain management will evolve in the coming years. In essence, they claim that current business models in transport and logistics will fail due to low efficiencies caused by fragmentation and important capacity shortages. The new business models for smart and sustainable logistics will be based on sharing capacity, i.e. bundling of flows, clustering of activities, sharing services and pooling resources. TRI-VIZOR has demonstrated that horizontal partnerships and platforms are the most fair and appropriate way to realize this. Nowadays, in its role as neutral

[26] *http://www.trivizor.com/*

[27] *CO3 deliverable 4.5 CO³ Test Project Report: Horizontal Collaboration in Fresh & Chilled Retail Distribution*

orchestrator, TRI-VIZOR prepares, involves and supports companies in the processes of creation (as 'architect') and managing (as 'trustee') horizontal collaboration partnerships and platforms.

Some other innovative and ground-breaking projects of TRI-VIZOR include FJORDFRENDE (https://www.fjordfrende.no/) and CULT (https://www.cultcitylogistics.be/).

4.3 SMARTBOX

SMARTBOX[28] is an innovative and reusable transport box to increase efficiency and sustainability in logistic processes.

It was developed by GS1 under the framework of the "smartBOX" project[29] which developed the technical design of the smartBOX as reusable container, designed a standardized pooling system including tracking and tracing technology and a business model for intelligent order control and cost splitting, designed of vandalism-proof pick up and drop off terminals to be implemented at public hot spots as well as housing complexes, developed a comprehensive, intermodal transport concept to enable autonomous and bundled transports.

Indeed, Shared Load Carriers is one of the main elements towards Physical Internet[30]. The Modulushca[31] project developed initial principles. The goal of Modulushca's Implementation Pilots was to demonstrate the concept of Interconnected Logistics, to test the prototype iso Modular Logistic units, and to show how transportation of Fast-Moving Consumer Goods (FMCG) would be with modular boxes.

From those roots, the Consumers Goods Forum and GS1 have assessed the concept and made steps towards implementation. The project is becoming a reality and will be launch soon in real operations.

In the design of the SMARTBOX different sizes were used (based on 600x400 and 300x400 mm) considering the process requirements, fitting to the conveyor system, shutter for easier picking process and using nap field for easier removal of labels. GS1 identification standards and security requirements were fulfilled. The boxes count on serialized GRAI for asset type and version and left-/right-identification (shutter).

The GS1 Smart-Box has cleared an important hurdle with the test run between industry and retail and is now under series production. The first of the 100,000 blue series containers were delivered at the end of April 2021. With a size of 600x400x211 mm, they form the basis for the later container family. These dimensions have been chosen to exploit the EUL loading heights of 1.20 m and 2.40 m, thus enabling optimum transport and storage utilization for fewer transports and, not least, lower CO_2 emissions.

In the test run, the gray-colored prototype, the so-called 0-series, was tested for performance in automated processes as well as smooth identification via applied GS1 barcodes, among other things. Industry and retail sent a total of 500 containers through their production and packaging processes. For example, they scrutinized the process in the distribution center.

Product manufacturers and retailers both participated in the test. On the industry side, Beiersdorf, Cosnova, Henkel, Kao, L'Oréal, and Procter & Gamble took part. From the retail side, dm-drogerie markt, Edeka, Müller and Rossmann participated.

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[28] *https://www.gs1belu.org/sites/gs1belu/files/2021-04/GS1%20Innovation%20Caf%C3%A9%20GS1%20SMART-Box.pdf*

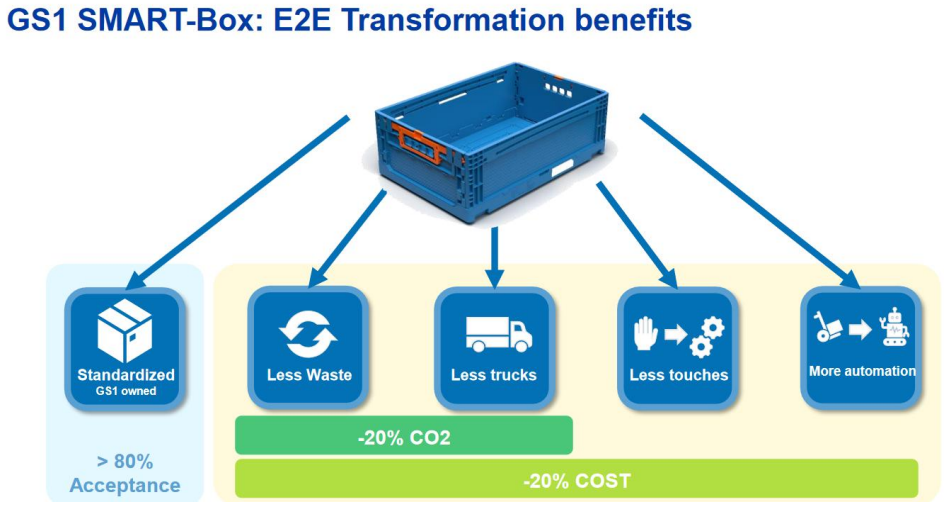
[29] *https://packagingrevolution.net/gs1-smart-box-is-going-live/*

[30] *https://www.pi.events/IPIC2021/content/s1-shared-load-carriers-manufacturer-retail-distribution-networks*

[31] *https://cordis.europa.eu/docs/results/314/314468/final1-modulushca-finalreport-sectiona.pdf*

The GS1 SMARTBOX shows important advantage covering the entire logistics cycle from the supplier's production plant to retail stores such as increased efficiency and more optimal environmental compatibility including reduced material usage which results in:

- Lower cost (avoid extra handling)
- Lower complexity (only one load carrier in the entire process)
- More flexibility in peaks periods for storage
- Less waste (cardboard)
- Open pool based on GS1 standards



The business case of SMARTBOX is based in three main pillars:

1. Optimizing loading capacity
   - change from stacked consignments with American boxes to EUL 1/2 consignments with the GS1 SMART-Box
   - Reducing pallet space (transport)
   - Reducing cost for pallet cycle
   - Reducing administration expenses
2. Optimizing of processes
   - change from opening the cardboard box, repacking the goods and dispose of packaging material to an optimized flow
   - optimized picking process both at the manufacturer (mixed pallets) and the retailer
   - saving in material costs
3. Optimal transport and storage utilization

The additional potential of SMARTBOX includes:

- savings on foils and labels
- using serialized GRAI for identification instead of a separate article label (GTIN) → SSCC only on pallet
- the serialized GRAI is fixed to the box across all processes
- the removal of the label is not necessary after each circulation and thus reduces the pooling costs

The path ahead looks as follows:

SMARTBOX needs to define and install an industry standard for boxes and load carriers that can be shared and interoperable across supply chains to reduce waste and enable further sustainability increasing assets utilization.

GS1 is playing a leading role to facilitate and enable this transformation with the GS1 SMART-Box project to be in operations soon in the German Market involving leading retailers and brands.

After Germany, other markets will adopt the standard creating additional scale and enabling other category products to be incorporated to the pool.

4.4 CRC SERVICES

CoLivRi
Artificial intelligence and algorithms

CRC Services[32] has developed a model to help companies to mutualize their flows for the last 100 km of goods delivery. The model allows suppliers to deliver goods from their distribution centers in collaboration with other supplier and to make savings by optimising orders and vehicle loads.

ADEME in France (Agency for ecological transition) enabled the development in a first place. ADEME selected industrial and logistics partners proposing sustainable solutions to be developed in the framework of collaborative projects, with other industries and operators. CRC Services has been working on the collaborative model, in "project mode", for 5 years with the support of ADEME. This model has proven to be more efficient for small orders in the industry, improving the performance in economic and environmental terms. The project´s full trucks optimise the service by 10 to 15 points and reduce GHG emissions by 20 to 30 %.

After this project CRC Services expanded to the north of France.

To improve the model, CRC Services thought about the need of having not only a physical approach but a digital one, introducing algorithms to optimize the delivery and all complex activities as well as show the performance to all the actors. With his in mind, CRC Open Network Project was born, partially funded by the French Government (2016-2018). The partners, 4S Network, CRC Services, GS1 France, ARMINES and TAB (https://librairie.ademe.fr/mobilite-et-transport/559-crc-open-network.html), aimed to set a digital platform to put all the algorithms and KPIs to help people to collaborate.

CRC Open Network project started with a physical approach to turn into a digital approach. The project implemented several use cases being CRC Services one of them. After 6 months the use case started to go into the market with the interest of 2 companies. The first one a supplier of sandwiches and salads (with a few

[32] http://www.crc-services.com/

hours of goods duration). In this case, an algorithm to analyze historical data and optimise the economic performance of deliveries was implemented. The company could organize the deliveries by themselves (optimizing the in-bound full trucks) and save money. The second use case was the "Mut@Log" project, initiated by Leroy Merlin, a French multinational company specialising in DIY, construction, decoration and gardening. The company wanted to improve the delivery of their suppliers to a delivery service of 97-98%. The painting material was delivered directly to the shops from the producer (around half pallet daily to all the shops). The company wanted the suppliers to deliver full trucks as much as possible and use the free space for other shops if possible. From this success, two new implementation cases for CRC Services came along.

CRS Services was born as a subsidiary of 4S Network to operate sustainable supply chains working in loop, setting up plans to reduce the carbon footprint. Many people were contacted in the field to better understand their activity and to integrate them into the use cases. An important asset to the success of CRC Services was the large number of interested contacts and the right time for this kind of developments in the companies. CRC Services knew that it was important to reach the market and to have implementation cases with potential customers.

Key for the success of CRC Services. Combination of research and development with applied use cases in companies. These implementation cases allowed CRC Services keep working with the companies after the success of the cases overcoming the general barriers and hurdles found in collaborative models. It is also worth to mention the importance of customers in the developments. Retailers are the ones initiating the projects to meet a specific need, then the shippers are involved and contracts are stablished between them and the carriers and/or logistics providers, the retailer not being directly contractually. The Retailer is "just" the prescriber of the project and drives the overall performance.

The partners involved in the project that enabled the developments used by CRC Services were a mix of small and medium-sized enterprises as well as larger groups and research organizations. These partners covered all the roles and profiles needed to the success of the development and worked together in the research part (Academia) but also implementing and creating business models. The communication between the research and the market implementation was crucial for the success of this case, speaking the same language and pursuit the same goal. This collaboration is the solution to go from research to implementation, as for funding for this step is not easy to obtain and is not affordable for all the companies (usually a mix of grants and repayable advances), CRC Services has found a way to accelerate this uptake by effective implementation cases, continuation of the services and sustainable relationships with the companies.

5 Potential implementation paths

The projects analysed showed that the most critical issue to make horizontal collaboration successful was the mental shift, and that trust amongst the partners could be achieved through gain sharing tools or trusted governance models. Through the projects, trust has been built by showing working governance, business and operational models, advancing in the reduction of transition management costs and times and providing a legal framework for the collaboration.

The implementation paths will depend on the scalability potential of the coordination and collaboration solutions.

When looking at the implementation cases showcased in this report, one can identify the following success factors:

- Finding the right partners: not only providing R&D expertise, but industry commitment to exploit the project's outcomes
- Having implementation cases with individual customers that showcase the potential behind the solution.
- Setting a clear vision for the new business, clearly identifying the value proposition and market target.
- Developing a growth path, incorporating advances beyond the state-of-the-art.

This cloud report has identified two types of implementation cases. On the one hand, initiatives well established as MIXMOVE, TRI-VIZOR and CRC-SERVICES have been running for over a decade (including the project lifetime) and therefore are more mature and present in the market. In the coming years, it is expected to see them grow in terms of market share.

On the other hand, implementation cases such as SMARTBOX are more disruptive and therefore the path ahead will encounter a range of barriers, but its scalability potential could really mean a turning point for collaboration and coordination in logistics in the coming years.

Currently there are initiatives in the market to reduce emissions that are cost-neutral or even saving costs, but this does not apply to all cases. Indeed, when a shipper is shifting freight from road to rail, costs might increase, as road transport costs are currently very low. This is the case even the most optimistic situation, that is, with full trucks and with full loads on the train. Therefore, the path ahead is focusing on decarbonization bearing in mind that it not always is coupled with cost reduction.

Also, comparing the AS IS situation with the TO BE situation in terms of logistics coordination and collaboration, one may argue that there is a cost reduction. Nevertheless, there are associated transition costs that have to be considered. As long as the inefficiency costs are lower than the transition costs, collaboration will not be a reality.

Therefore, in the coming years the focus should be on reducing that transition cost, to make sure it does not make efficiency gains meaningless. Transition costs can be lower thanks to digitalization and connectivity, thus the implementation path to be followed should gravitate around those areas. Examples on data sharing are mainly found in road transport, therefore in the coming years focus should be on the rail sector advancing in this domain. For this to be realized, not only digitalization but also governance is required, as rail should also

consider themselves as providers of end to end supply chain services, therefore including service level as one of their KPIs.

Additionally, the inclusion of carbon emission costs into the total costs will also shape this trade-off in favour of collaboration. This will be possible with the introduction of CO2 taxes as well as with the necessary willingness from the customers.

Document elaborated with the support of the BOOSTLOG project has received funding from *the European Union's Horizon 2020 research and innovation programme* under grant agreement No 101006902

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 – Semi-structured interview guide

1. Project introduction

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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

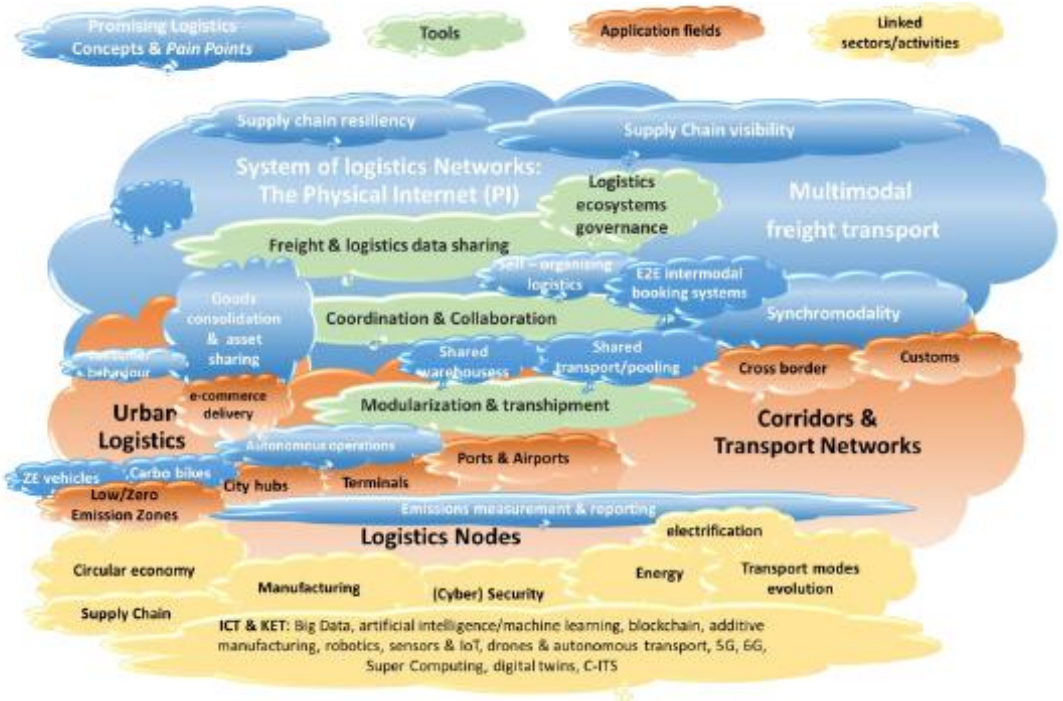
This Project is supported by the European Commission and framed as part of the activities in ALICE building on its network and past projects such as SENSE, SETRIS and WINN and is an integral part of ALICE outreach to R&I funding organizations

Coordination and collaboration* refer respectively to vertical and horizontal synergies along and across different supply chains. In this context, Supply Network Coordination deals with the synchronization and dynamic update of logistics and transport plans, across modes and actors. Supply Network Collaboration deals with maximising resources utilization by matching demand from multiple shippers with available transport and logistics services from different modes and service providers.

Both Coordination and Collaboration can produce significant gains in terms of both efficiency and sustainability, leading the transition from individually managed supply chains to open supply networks

*Based on the discussions, the definition was sharpened to: *Coordination and collaboration refer respectively to respectively to vertical and horizontal synergies along and across different supply chains maximising assets and resources utilization*

2. Cloud and subclouds diagram



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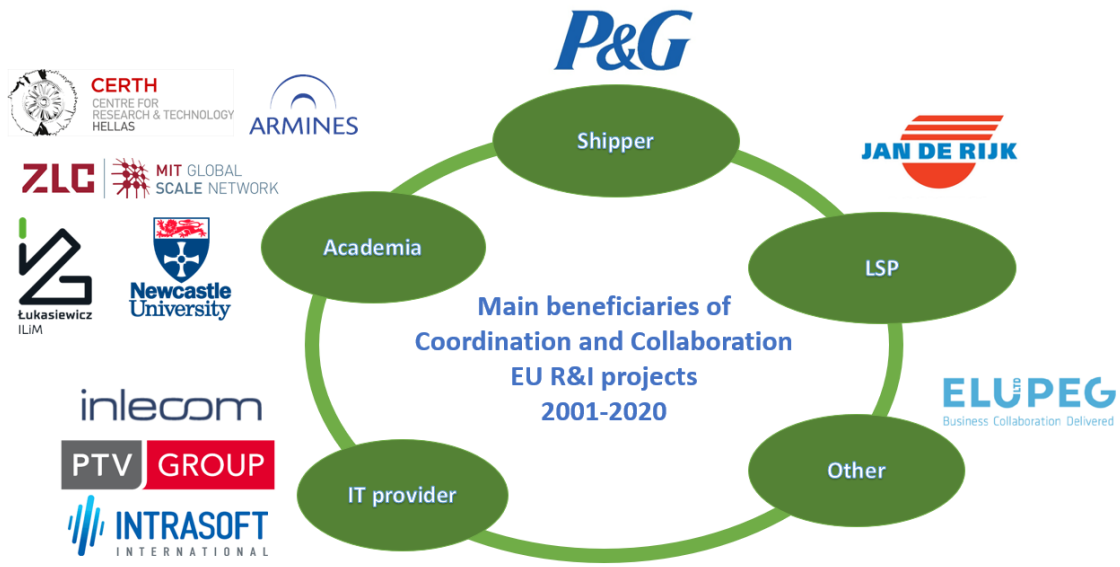
- Do you miss any important cloud/subcloud?

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**
- **Economy that Works for People**
- **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.
    - 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.