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SETRIS PROJECT

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3	AVL List GmbH	AVL	Austria
4	BMT Group Limited	BMT	United Kingdom
5	Centro National de Competencia en Logistica Integral	CNC-LOGISTICA	Spain
6	Alliance for Logistics Innovation through Collaboration in Europe	ALICE AISBL	Belgium
7	Stichting Dutch Institute for Advanced Logistics	DINALOG	Netherlands
8	German Aerospace Center	DLR	Germany
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GLOSARY AND DEFINITIONS:

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

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

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

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

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

ETPs: European Technology Platforms.

SRIA: Strategic Research and Innovation Agenda.

WATERBORNE: WATERBORNE ETP (http://www.waterborne.eu/)

DEFINITIONS:

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

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

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

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

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

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EXECUTIVE SUMMARY

The European Technology Platform, Alliance for Logistics Innovation through Collaboration in Europe (ALICE), was launched on 11 June 2013, and received official recognition from the European Commission in July 2013. ALICE was established to develop a comprehensive strategy for research, innovation and market deployment of logistics and supply chain management innovations in Europe with the mission: "to contribute to a 30% improvement of end to end logistics performance by 2030". The Physical Internet (PI) Concept is one of the key elements identified by ALICE as the Vision to achieve its mission.

This roadmap, complementary to current ALICE roadmaps will have as background the major innovation areas already identified and will outline how advancing in them will contribute to a real Physical Internet in 2050. Remaining research and innovation gaps will be identified with specific focus on business models, regulations and governance. On top, barriers and enablers for the Physical Internet will be outlined. Examples of sub-systems with similarities to physical internet will be analysed. Specifically, SETRIS have run workshops within IPIC (International Physical Internet Conference) in 2015 (Paris) and IPIC 2016[1] (Atlanta, US). The outcome of this process has been checked and benchmarked with the discussions within IPIC 2017[2]. Moreover, a task force on modularization, a key development area for physical internet has been launched in the frame of ALICE and supported by SETRIS project initially. Currently, this activity is in further development and implementation through the Consumers Goods Forum[3].

This Physical Internet Roadmap is also complementary and aligned with SETRIS Deliverable D2.3 "*Defining the concept of a truly integrated transport system for sustainable and efficient logistics"* which is indeed defined similarly to the Physical Internet:

A truly integrated transport system for sustainable and efficient logistics is based on an open and global system of transport and logistics assets, hubs, resources and services operated (in an open environment and framework conditions) by individual companies. They are fully visible and accessible to market players hence creating a network of logistics networks. Coordination of logistics, transport, infrastructure and supply networks with the aim to move, store, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient, secure and sustainable. The system will be based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation interfaces and protocols[4].

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

[1] http://www.pi.events/IPIC2016/program

[2] http://www.pi.events/IPIC2017/program

[3] http://www.theconsumergoodsforum.com/e2e-value-chain-projects/modularisation

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

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1. Introduction

Digitalization is transforming industry and particularly logistics through a variety of new technologies and developments that are expected to have a huge impact on transport and logistics, such as: robotization, human machine interfaces, automation of transport and drones, automated delivery vehicles, Internet of Things (IoT), augmented reality, big data and data analytics, block chain, Industry 4.0 and Additive Manufacturing (3D printing), machine visualization and learning, fifth generation mobile networks (5G), enhanced system interconnectivity and interoperability, etc. These technologies enabling and/or combined with innovative concepts and trends such as: synchromodal transport, horizontal collaboration, sharing economy, growing of e-commerce may deeply transform current logistics practices. ALICE vision is that this transformation of the current paradigm will track us to a "Physical Internet" paradigm as the integrative concept considering technologies, innovative concepts and enormously improving efficiency and sustainability (i.e. reducing congestion, emissions and energy consumption) of freight transport and logistics.

The Physical Internet Concept was outlined in 2011 through Physical Internet Manifesto[1] and lately developed by Prof. Ballot (ARMINES) in 2015[2]. The Physical Internet (PI) concept is based on an open and global system of transport and logistics assets, hubs, resources and services operated, in an open environment and framework conditions, by individual companies. They are fully visible and accessible to market players hence creating a network of logistics networks. The Physical Internet is based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation of interfaces and protocols[5].

In this interim period, the interest on the Physical Internet has been constantly growing within the research community. In parallel, and starting in 2014, ALICE developed its research and innovation roadmaps aiming to achieve a 30% improvement in efficiency and sustainability of logistics (with a bottom up approach and identifying research and innovation challenges and expected progress and impacts so that the desired improvements could be realized with a time frame until 2050. During this process, there was a growing convergence within the ALICE network on the following statement: "*the realization and implementation of ALICE roadmaps would lead to a paradigm aligned with the Physical Internet concept*".

Physical Internet should be inclusive, open and for the benefit of all stakeholders including SMEs. However, this transformation may not end up in this desirable future if the transformation is not fully supported in the right direction. We mean that Physical Internet might be developed in a different way, for example, as a monopolistic, very-profitable business but not necessarily open and more sustainable. Digitalization and innovative concepts may enable profitable business models, e-commerce for example, that are not directly more efficient and sustainable, due to way in which delivery is organized nowadays in the mentioned case of e-commerce.

[5] Montreuil B. (2011). "Towards a Physical Internet: Meeting the Global Logistics Sustainability Grand Challenge", Logistics Research, Vol. 3, No. 2-3, p. 71-87.

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1.1. ALICE Vision and Mission

The European Technology Platform, Alliance for Logistics Innovation through Collaboration in Europe (ALICE), was launched on 11 June 2013, and received official recognition from the European Commission in July 2013. ALICE was established to develop a comprehensive strategy for research, innovation and market deployment of logistics and supply chain management innovations in Europe with the mission: "*to contribute to a 30% improvement of end to end logistics performance by 2030".*

ALICE is based on the recognition of the need for an overarching view on logistics and supply chain planning and control, in which shippers and logistics service providers are indispensable and should closely collaborate to reach sustainable and efficient logistics and supply chain operations.

The key idea behind the logistics and supply chain planning and control concept is the recognition that decisions on a supply chain level may have effects on transportation that far outweigh decisions made in the transport area solely. At the same time, these effects can only be reached if shippers and logistics service providers join hands. An example is the decision to transport components instead of full products and postpone final product configuration until close to the customer which serves sustainability (people, planet, profit) in a broad sense because of both less inventory investments due to uncertainty reduction and increased loads of the transport means used due to a far higher packing density. Many shippers start to realize that efficient and sustainable logistics (referring to energy usage and environmental footprint) are two sides of the same coin. However, the decision to redesign the supply chain accordingly is typically a manufacturer/shipper decision, not a decision taken by the transport sector itself.

Enlarging the scope to fully include decisions made in the shipper's boardrooms means considering not only *"how to transport"* but also *"what to transport".* That is, we do not only view (multimodal) transport as such but also strategic decisions on a supply chain level that strongly influence economic, ecological and social effects of transportation.

One of the key elements identified by ALICE as the Vision to achieve *a 30% improvement of end to end logistics performance by 2030* is The Physical Internet (PI) Concept[6]. The PI Concept is based on an open global logistic system founded on physical, digital, and operational interconnectivity, enabled through encapsulation of goods, standard interfaces and protocols, with the aim to move, store, produce, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient and sustainable.

The mission of ALICE is to contribute to the development of new logistics and supply chain concepts and innovation for a more competitive and sustainable industry. ALICE aims to accelerate the deployment of more efficient, competitive and sustainable supply chains. To accomplish this mission, ALICE brings together as primary stakeholders: shippers and logistics service providers, as well as other relevant stakeholders including but not limited to: transport companies, terminal operators, support industry (Finance, ICT, Equipment/vehicle/vessel manufacturers, infrastructure providers, inspections) and research and education institutions to:

[6] Ballot, E., B. Montreuil, and R.D. Meller, *The Physical Internet: the network of logistics network*. PREDIT. 2014: La Documentation Française. 271p.

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- Define research and innovation strategies, roadmaps and priorities agreed by all stakeholders to achieve ALICE on Logistics vision.
- Foster innovation in logistics and supply chains, stimulating and accelerating innovation adoption to make possible the growth of the European economy through competitive and sustainable logistics.
- Raise the profile and understanding of new logistics technologies and business processes, monitoring progress and adjusting research and innovation roadmaps accordingly.
- Contribute to a better alignment and coordination of European, national, regional innovation programs in logistics.
- Provide a network for interdisciplinary collaborative research involving industry, academia and public institutions.

1.2. ALICE Research and Innovation Roadmaps, Milestones and Expected Impacts

ALICE Working Groups, composed of industry, academia and public bodies analyse and define research and innovation strategies, roadmaps and priorities to achieve ALICE Vision and Mission. These Working Groups are:

1. Sustainable safe and Secure Supply Chains
2. Corridors, Hubs and Synchromodality
3. Information Systems for Interconnected Logistics
4. Global Supply Networks Coordination and Collaboration
5. Urban Logistics

In December 2014, each of these working groups delivered a research and innovation roadmap[7] including research and innovation gaps and challenges that need to be addressed to drive the process from current situation to achieve ALICE Vision and Mission.

Different milestones were identified as core elements to achieve the vision in each of the areas as shown in Figure 1. This implementation plan is specially targeting to achieve milestones set for 2020 and paving the way to achieve 2030 milestones.

[7] ALICE Research and Innovation Roadmaps (www.etp-alice.eu)

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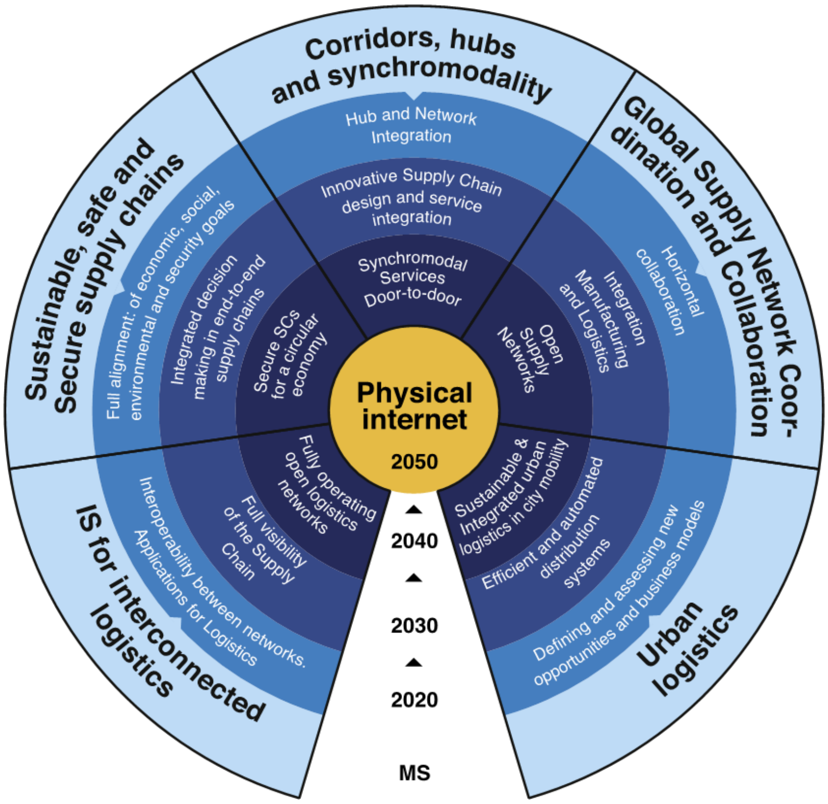

Figure 1. *Milestones towards the Physical Internet*

ALICE roadmaps identified expected impacts that should be addressed to "*contribute to a 30% improvement of end to end logistics performance by 2030".* These impacts should have a societal, environmental and economic approach based on the concept of the "triple bottom line." Therefore, expected impacts were identified in three dimensions: People, Planet and Profit.

The impacts discussed below are separated into one of these three categories for a more intuitive understanding by stakeholders.

Table 1. *Expected impacts from the implementation of ALICE roadmaps proposed actions.*

	Primary Impacts	**Secondary impacts**
People	+ Increase customer satisfaction + Products availability + Secure societies	+ Load factors: weight and cube fill of vehicles - Empty Running Kilometres + Volume flexibility (Time to +/- capacity) + % Synchromodal + Asset utilization + Supply Chain Visibility

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<table>
<tr><td>Planet</td><td>- Energy consumption (kWh Logistics/GDP)
+ Renewable energy sources share
- CO2 Emissions</td><td rowspan="2">+ Reliability of transport schedules
+ Perfect order fulfilment
+ Transport routes optimization (reducing Kms)
+ Transport actors using automatic data exchange
+ Cargo and logistics units integrated in the automatic data exchange
+ Upstream/Downstream Supply Chain Adaptability and Flexibility
+ Decoupling logistics intensity from GDP
- Waiting time in terminals
- Risk factor reduction
- End-to-end transportation time
- Travel distance to reach the market
- Lead times</td></tr>
<tr><td>Profit</td><td>+ Return on assets and working capital
- Cargo lost to theft or damage
- Total supply chain costs</td></tr>
</table>

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1.3. The Physical Internet Concept

The Physical Internet (PI) concept is based on an open and global system of transport and logistics assets, hubs, resources and services operated, in an open environment and framework conditions, by individual companies. They are fully visible and accessible to market players hence creating a network of logistics networks. The Physical Internet is based on physical, digital, and operational interconnectivity, enabled through modularization as well as standardisation of interfaces and protocols[8].

The PI aims to achieve an order of magnitude increase of efficiency and sustainability by interconnecting logistic networks universally, as the Internet did with computer networks. PI envisions a new way to achieve further consolidation of goods where the complexity of the required coordination in terms of physical and information flows is addressed by further modularization and standardisation. The concept involves generalising the use of modular containers or boxes (PI-containers) in inland logistics with modular dimensions and standardised interfaces for handling and communication aiming to get similar benefits to the ones achieved by the maritime containers in maritime transport. Moreover, PI-containers aim to give shippers a "private space" in open networks so that the routing of these PI-containers is done like the routing of 'packets' in the Digital Internet, yet in a manner adapted to the needs of logistics.

Instead of the current owned or exclusively used assets in a supply chain, Physical Internet will allow interconnecting and using different existing transport and logistics networks in a seamless and more efficient way in terms of cost, emissions, energy and congestion. For example, 24% of good vehicles km´s in the EU are running empty. When carrying a load, vehicles are typically only 57% loaded as a percentage of maximum gross weight[9]. The total cost burden this inefficiency generates is estimated as €160 billion and 1.3% of EU27 CO_2 footprint. Transport infrastructure, especially rail, is poorly utilized. While the intensity of use of road infrastructure was 25.3 Million-Ton Kilometre per Network Kilometre, rail was 1.7 in 2009[10]. Per recent studies[11], results from a simulation experiment with top retailers Carrefour and Casino in France and their 100 top suppliers moving from actual practice to a "*Physical Internet Model*" showed a potential economic benefit of 32%, a 60% reduction of greenhouse gas emissions and 50% of volume shifted from road to rail. Proofs of concepts are starting to be tested in the field in France through Start-ups such as CRC[12]. Similar concepts form the core value messages of the recently (November 2016) launched company MonarchFx[13] and (January 2017) Carrycut[4].

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8 Montreuil B. (2011). "Towards a Physical Internet: Meeting the Global Logistics Sustainability Grand Challenge", Logistics Research, Vol. 3, No. 2-3, p. 71-87.

9 Supply Chain Decarbonization. The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions. World Economic Forum. Geneva. 2009.

10 Data elaboration of EU Commission - Transportation Statistical Pocketbox

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

12 http://www.crc-services.com/en and short explanation of the concept in this video: https://youtu.be/WkQycFH3Kms

13 http://www.monarchfxalliance.com/ & http://www.carrycut.com

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For the industry stakeholders (including SMEs), the most important strategic drivers towards the PI are:

- Increasing the service level to the consumer of products and services, in the most efficient and sustainable way.
- Lowering the barriers to enter new markets and for consumers to have access to new products.
- Reducing the environmental burden of transportation in logistics chains.

Efficiency and sustainability are the core implicit messages of the Physical Internet vision: by opening the logistic networks and sharing resources, higher levels of efficiency can be achieved, unattainable by any individual company. Anyway, a company would never share assets/services in the supply chain if they were unique for its strategic position, therefore, a transition is also required in terms of business models for true Physical Internet realization.

The easy access to market is a critical factor in the eyes of the industry, especially for SMEs. The Physical Internet opens access to new markets by multiplying the sources of transport and logistics services. Participants benefit from the economies of scale of sharing assets and resources with other participants. New products that were previously unavailable or too expensive to get to a certain market can be matched with new sources of demand at a reduced cost (e.g. new retail models and the raising demand from on-line sales and e-commerce).

In our vision, the Physical Internet will be realised in a gradual process where global supply networks evolve through three main stages:

1. Fully owned supply chains, where the assets and services are key constituents of the company products/services, as differentiators for the customer. This is the current situation.
2. Horizontal collaboration and vertical coordination in a defined limited network of companies, sharing what are considered “commodity” assets and services. Several initiatives and programs are currently in a consolidation phase[14].
3. Physical Internet for most goods, in a full collaborative network involving multiple parties (unaware of the implicit collaboration), with the lowest costs and maximum availability and service level, almost full asset utilization and sustainability enabled by the efficient use of resources.

1.4. Scope and purpose of the roadmap

The roadmap is addressing different aspects that need to be considered in the evolution to Physical Internet Paradigm and that are addressed in subsequent areas:

Components & technical developments (including standards) needed to achieve PI implementation

Transition management: business models, regulations and governance

Expected impacts of Physical Internet realization

[14] Collaboration Concepts for Comodality (http://www.co3-project.eu/) Building sustainable logistics through trusted collaborative networks across the entire supply chain, NEXTRUSt (http://nextrust-project.eu/)

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2. Methodology

An extensive literary review has been made including main documents and papers on the Physical Internet (see introductory section) as well as previous discussions in the frame of ALICE, in particular within the Executive Group.

Based on this and through the attendance by the SETRIS partners to the different Sessions of the International Physical Internet Conference (IPIC) held in Paris, July 2015 a broader analysis of the key topics and challenges have been identified.

This preliminary outcome was shared and discussed with ALICE Steering Group (Annex 1) an in a general workshop (Annex 2). Through these workshops, main contents of the different chapters in this deliverable were identified.

In order to get better understanding of the relevance of the different topics a survey was prepared (Annex 3). During IPIC 2016 in Atlanta this survey was shared and a Plenary Forum was organized[15] to discuss and share results. The survey was afterwards updated and shared with ALICE members and the analysis of the results included in this document.

Additionally, the contents of the document have been reviewed based on the discussions and presentations of IPIC 2017 in Graz[2].

3. Components & technical developments (including standards) needed to achieve PI implementation

To transition from the current paradigm to the Physical Internet, several components, technical developments and standards will need to be realised. Technical developments, such as smart handling and transhipment technology for handling and transport of Physical Internet containers, the actual π-containers, Physical Internet nodes and network management systems, IT, standardization requirements, etc., are required to realize the Physical Internet vision.

The different components and technical developments can be grouped in the following topics. The topics are sorted regarding their importance:

1. Boxes, containers and physical handling
2. PI nodes and network operation
3. Data sharing
4. Decision support
5. Work on standards
6. Business, governance and benefit models
7. Others

3.1. Boxes, containers and physical handling

[15] http://www.pi.events/IPIC2016/program Plenary Forum FB: Roadmapping Our Way Toward Achieving The Physical Internet Vision http://www.pi.events/sites/default/files/downloads/IPIC2016-Plenary_Forum_FB.pdf

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Considerable parts of the visions and value-adding innovation of the physical internet rely on the use of modularized PI-containers and boxes. The smooth handling of these boxes and containers is critical to enable the collaborative operations between companies, suppliers and logistics service providers and efficient handling in the PI nodes.

The most important open tasks regarding PI boxes, containers and physical handling are:

- Design of new PI boxes and containers that can be stacked/organized into each other
    - Common interface to existing containers, boxes and standards
    - Modular boxes and containers for different tiers (handling, transport, storage)
    - IoT-enabled PI boxes and container allowing real-time identification, tracking and monitoring of both box-internal (like content) and environmental parameters (like temperature, humidity, vibration)
    - Packaging technologies
- New devices and concepts for multimodal transhipment and handling
    - Automated handling to decrease handling time and costs
    - New or adapted vehicle and trailer concepts
- Link to standardisation: open design and blueprints for all boxes and containers

3.2. PI nodes and network operation

The network operation needs to take care of transport orders, bookings on top of PI nodes which are mainly physical assets like warehouses, distribution centres or cross-docks. They will ensure that the full potential of the PI can be used.

The most important open tasks regarding PI nodes and network operation are:

- Safety technology for the Physical Internet to secure the moving goods in an open network among different partners
- Different transport protocols for the movement of boxes and containers through the PI network
- Layout, design, management and operations of PI nodes with different functionalities including processes and handover of shipments between different service providers

3.3. Data sharing

The seamless access to information, about services and offers, the collection of data, like movement of goods, and knowledge exchange between companies is a critical component for PI.

- Therefore, solutions for the public access to information, like data pools, database or shared information services in which all companies, customers and service providers are connected to
- Automated and secure process for the collection, exchange, usage and analyse of the stored data

3.4. Decision support

The current planning paradigms should be adapted to fit to PI principles:

- Planning and scheduling systems should include decision support

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- The usage of artificial intelligence and complex adaptive systems can help to manage complex PI networks and support user's acceptance
- Dynamic decision making in real-time is necessary to optimize the flow of goods without human intervention

3.5. Work on standards

Standardisation is a very relevant topic for logistics, especially for the realisation of PI.

- Consistent standardization across borders on physical assets like PI boxes, containers and handling
- Consistent standardization across borders on virtual information, like data, interfaces etc.

3.6. Business, governance and benefit models

Beside pure technology business and governance aspects are also relevant. The will be highlighted in section 3 (Transition Management: business models, regulations and governance). The following aspects are related to components and technology and therefore listed in this section:

- Real-world case studies showing financial benefits for both companies and clients
- Key performance indicators for system metrics and the benchmarking of PI
- Open PI business architecture together with technical infrastructure
- Proof of financial incentive for large companies with significant infrastructure
- Means of governance, beside technical implementation, so that transactions and goods can flow without human intervention
- Development of registries allowing the discovery of partners and their capabilities

3.7. Others

Beside the above listed topics some general IT-related issues are also relevant for a realisation of the PI.

- Intuitive use of technology
- Investigate possible benefits of combination of smart manufacturing (Industry 4.0) and PII
- Usage of common IT-standards for the realisation of PI technology, like IPv6, IoT etc.

Some general remarks are:

- Keep in mind the low internet speed and bandwidth in some European regions

Political alliance with current PI initiatives in different nations, also outside of Europe

4. Transition Management: business models, regulations and governance

In addition to the components/technologies/standards other specific needs will arise to manage the transition to the PI. Areas such as worker skills and education, business models, governance and regulations, should be addressed.

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The survey's participants were asked to propose transition elements and classify them according to the following criteria:

1. Transition area: as specified before, four different transition areas were identified: Area 1 'Skills and Education'; Area 2 'Business Models'; Area 3 'Governance'; and Area 4 'Regulation'. Such areas represent knowledge fields where innovation is required so that the PI concept can become a reality.
2. Time frame: considering 2050 as the year to enable PI, the transition period should be developed from 2017 to 2035. In order to set a time line for the transition elements proposed by the respondents, the total period was divided into three shorter ones: Period 1 from 2017-2020; Period 2 from 2020-2025; and Period 3 from 2025-2035.

Table 2. *Criteria for the analysis of the transition elements.*

Transition areas	***Time frame***
Area 1: Skills and Education Area 2: Business Models Area 3: Governance Area 4: Regulation	Period 1: 2017-2020 Period 2: 2020-2025 Period 3: 2025-2035

According to the classification that the survey's participants did in terms of transition area and time frame, the general view shows that:

- The transition areas 1 and 2 ('Skills and Education' and 'Business Models' respectively) are the areas where more actions should be implemented to move forward the PI ambition, as most of the proposed transition elements fall under these both categories (39% and 35% respectively).
- The transition areas 1 and 2 consolidate 74% of the total number of transition elements proposed, while areas 3 and 4 ('Governance' and 'Regulation') only represent the remaining 26%.
- The category 'Regulation' (area 4) is considered by the interviewees the least important one when progressing towards the PI implementation, as only 9% of the proposed transition elements are classified under this category.
- The respondents consider that efforts for a successful transition to the PI should be developed in the first two periods (from 2017 to 2025). Both consolidate 91% of the transition elements opposite 9% that remains to be developed in the last period (from 2025 to 2035).
- During the first period those who responded reported that the most relevant transition areas for focussing efforts are areas 1 and 2. The percentages between both areas are very similar (44% and 38% respectively). In this period, the relevance of the transition areas 3 and 4 is much lower and only 12% and 6% of the transition elements were classified under these categories.
- The second period is more balanced. In this case, the area 2 slightly stands out (36%) but areas 3 and 4 take relevance (24% and 12% for each). The area 1 keeps its importance but at a lower level (28%).

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The **transition area 1, 'Skills and Education'**, claimed as the most important one by most of respondents, assembles initiatives that are focused on knowledge development. Connecting transition elements and time frame, a descending line of implementation is observed in this category: more than half of the elements (60%) are proposed under the 2017-2020 period; this percentage drops till 39% for 2020-2025 and finally reaches its lower level for the last period (12%). The approach of the proposed transition elements also evolves along the time frame. For the first period, the proposed elements aimed at creating a learning environment across community, with initiatives such as a PI for dummies book, a mapping with historical and old practices and PI visions, structures and results, engagement of the press media, and feedback from the industry. For the next periods, the initiatives capture the attention on the field of building capacity and claim for the interaction of knowledge in areas such as supply chain management, finance, law, business process management, computer sciences, digital internet, transportation management, analytics, and automation.

The transition area 2, **'Business Models'**, shows a similar behaviour to area 1. With a slightly lower relevance towards the PI ambition (39% for area 1 versus 35% for area 2), the greatest efforts are claimed by the respondents during the first period. Thus, 57% of the transition elements are proposed under the 2017-2020 timeframe, 39% falling under period 2020-2025 and only 4% remaining for the last years. Concerning the transition elements, the following aspects are common to the majority of respondents:

- When progressing towards the PI shift, the implementation of a system that claims a fairly distribution of costs and value sharing is required. It is due to the fact that the cost allocation in the hyper-connected operating environment is not as clear as in the current supply chains.
- Many respondents make reference to the term 'coopetition'. It is used to describe a scenario where companies compete in one area, but collaborate in others. 'Coopetition' models must set clear gain sharing policies.
- During the transition towards the PI reality, it is essential to promote experimental activities such as small-scale networks, start-ups, success stories with increasing level of PI development, and share-ware templates to capture all the impact on different supply chain designs. Industry should be involved in this type of initiatives as a way to show them the benefits and efficiency resulting from the use of the PI.
- PI makes a lot of sense conceptually, but it will be difficult to implement without proof of benefit to the large companies with significant infrastructure. Hence, the PI achievement will directly depend on the amount of savings and benefits that companies obtain during the journey. It is therefore essential that all the investments required for the PI implementation are based on the expected return.
- Aware of the difficulties in establishing high speed internet in developing countries, it is required that Governments launch initiatives that promote and motivate internet expansion in these areas. Regarding developing countries, the impact of PI on the world economy organization must be also considered as it probably results in an advantageous situation in favour of large cities and smart infrastructure such as ports and hubs.
- The business models FLEXE and Uber are of reference when discussing about the transition towards the PI.

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The transition areas 3 ('Governance') and 4 ('Regulation') are not clearly identified by the respondents as key areas when progressing towards the PI implementation. Although both are always lower than the areas 1 and 2, they gain relevance in the second period.

The respondent's answers indicate that progress in the field of **'Governance'** is required in order to support transparency when organizations and companies make the change of behaviour towards operating under an interconnecting environment. As stated before, even though the figures resulting from the analysis of the answers could suggest that Governance is considered by the respondents as a minor area of transition, the elements' description shows that the adaptation of Governance is a key factor for success in the PI. In general terms, the migration towards the PI must be accompanied by a Governance framework that represents a systemic approach and globally organizes the 'system of systems'. **Governance is considered to act as a body which would define the rules on PI, help to identify and solve the connectivity, infrastructure and regulation issues, and develop standards when needed.** In this sense, some of the respondents suggest the involvement of neutral third party organizations to oversee and monitor the processes (data flow, security, pricing…) that will take place once IP vision is a reality.

Concerning 'Regulation', those who were surveyed indicate that governmental organizations must be aware of how industry is changing and consequently adapt regulations. Laws and rules must be able to address any problem related to new technology developments and should not hinder the efficient utilization of any new infrastructure or collaboration.

5. Expected impacts of Physical Internet realization

The Physical Internet concept is developing greater importance as a possible way to progressively move from the current paradigm for mobility, including logistics, into a new one. The new paradigm could lead us to an order of magnitude of improvement in efficiency and sustainability.

Based on the experience and background participants in different surveys have been asked to select among three options the main impact criteria and its time frame from the perspective of PI implementation. In addition, the survey allowed participants to include other positive/negative impacts as a consequence of the realization of the Physical Internet that are important in their view but were not among the list of three predefined items.

The results of the ranking exercise are presented below:

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CRITERIA	TIME FRAME		
	2020-time frame:	2030-time frame:	2040-time frame:
ENERGY			
No energy (or minimal) savings	10	0	0
Energy savings between 5-10 %	20	13	4
Energy savings between 10-20%	10	17	10
Energy savings between 20-30 %	1	10	11
Energy savings above 30 %	0	1	16
COST			
No cost savings	9	0	0
Cost savings between 3 - 5 %	17	7	2
Cost savings between 5 - 15%	13	22	13
Cost savings between 15 - 30 %	2	8	12
Cost savings above 30 %	0	4	14
EMISSION			
No emissions (or minimal) savings	12	1	1
Emissions reduction between 5-10 %	19	13	6
Emissions reduction between 10-25%	10	18	11
Emissions reduction between 25-40 %	0	9	12
Emissions reduction above 40 %	0	0	11

Most of the participants believe that in the 2020-time frame PI will be able to generate the energy, and emission savings at the level of 5-10%, and cost savings from 3 to 5%. Furthermore, their prognoses are optimistic, because most of respondents claim that from 2030 to 2040-time frame savings will be evenly increasing (2030: energy 10-20%, cost 5-15%, emission 10-25% / 2040: energy 20-30%, cost savings above 30%, emission 25-40%).

ALICE mission is "to contribute to a 30% improvement of end to end logistics performance by 2030". This improvement needs to be translated into the People, Profit and Planet.

Respondents mentioned the following additional impacts to be considered, when talking about Physical Internet deployment, that are divided into these three categories:

PEOPLE:

- Social impact is hard to assess, but may be significant
- Effects on labour market –mainly less jobs for lower skilled people
- Flexibility of labour (time, place, type)
- There may be employment displacement as transportation resources are reallocated and skill sets become out of date
- A more interconnected society where a small company can serve customers worldwide
- Shift in the mind-set of people/companies towards collaboration, also needed in Physical Internet

PLANET:

- Savings in terms of energy by 20-30%, and greenhouse gases emission by 25-40% in the 2040-timeframe

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- Better utilisation of the scarce resource of drivers, reduced congestion--everywhere, a safer environment

PROFIT:

- Seamless movement of goods across borders, the global distribution becomes "internationalized", nationalities are irrelevant
- Potential for entirely new business models is high – new competition model
- Quality improvement of supply-chain and a fairer globalization of distribution
- Enhanced productivity and profitability via new business models and offerings, like digital internet in 1990s
- A positive impact is the new level of service and network access it will provide. It will also bring positive image
- It envisions a lot of positive impacts but there is a need for governance and administration. The Internet never put anyone out of business. The Physical Internet will.
- Service Level, Reliability and Resilience
- "We know how difficult it is to establish high speed Internet in all remote countries and in less developed countries. The same will happen with the PI and it will have an impact on the organization of the economy, favouring large cities and smart ports or hubs etc."

GENERAL OPINION ABOUT UPCOMING CHANGES:

- Realization of the PI vision will be a direct function of how much savings & benefits companies realize along the journey. Investments will follow based on the expected return. Companies operate in very short term because the world changes. 2020 is a distant target. 2040 is inconceivable.
- Negative: standards do sometimes reduce innovation and competition
- Positive: satisfaction of collaborating globally for a more sustainable future
- "When the physical internet is established the game only begins..."
- When we started to surf on the digital internet in the end of the 90's we only had the basics. In the last decade 2000-2010 we got E-bay, Amazon, Facebook, Twitter, Linked In... So with the Physical Internet we should think way ahead and think what will happen after the Physical Internet establishment...a true visionary discussion"
- Different levels (or sophistication) of PI might need to be defined.

Each company operating in a free market economy wants to reduce the cost of its activities. But often managers attempt to reduce costs pushing them into other actors operating in the supply chain or even to its surrounding environment. Consequently, such actions are very short-sighted, because all the costs generated by the logistics network are finally being felt in the external environment and price of the final product. Indeed, focus should be on fighting disturbance in the supply chain, that include the sustainability issues. Following social, business and technology trends by improving cooperation and better access to information among cells operating in the Physical Internet supply networks and their surrounding lead to significant positive results especially in fast growing FMCG industry.

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6. Barriers, opportunities/triggers and Infrastructural Investments for PI

6.1. Barriers

The following Barriers for realization of the Physical Internet were identified as a result of SETRIS/ALICE workshop in Vienna, February 2016:

1. New paradigm will have winners and losers
2. Data Sharing and Cyber Security
3. Uncertainty on governance models
4. Role of Governments and their control over the PI
5. Financing of required Infrastructure

Survey participants have been asked to select among these options the main and the second most important barrier for the Physical Internet realization. In addition, the survey allowed participants to include specific barriers in each category that are important in their view but were not among the list of five predefined items.

The results of the ranking exercise are presented below:

Predefined barrier	The main	The second	TOTAL score
Data Sharing and Cyber Security	11	14	25
Uncertainty on governance models	11	9	20
New paradigm will leave winners and losers	12	6	18
Financing of required Infrastructure	4	6	10
Role of Government's and their control over PI	3	6	9

Respondents mentioned the following additional barriers to be considered when building up the Physical Internet Roadmap:

- Changing the mindset and get all players to accept shared assets economy
- Missing fair revenue and cost sharing models and legal aspects

The biggest concern seems to be how to protect the data when it is shared and who decides on the data governance and processing. Another big barrier that is coming out from the survey is how to make a shift from privately held assets to commonly shared assets, what will be the effect to companies' business models?

6.2. Triggers and enablers

ALICE had identified the following triggers and enablers for survey to execute the Physical Internet Realization roadmap:

1. Societal push on environmental, congestion, energy challenge
2. Digitalization
3. Demonstration of Strong Business Cases

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4. Easy Life: Robust processes, increase resiliency flexibility, schedule and execution
5. Reconciliation of people needs vs Sustainability
6. Increased collaboration and social economy: crowdsourcing
7. New sources of market competition may promote faster implementation
8. Proper communication of the benefits of PI concept
9. Endorsement by authorities
10. Supporting tangible benefits of current public investments in infrastructure

Participants have been asked to select among these options the main, the second and the third most trigger and/or enabler for the Physical Internet realization. In addition, the survey allowed participants to include triggers and enablers that were important in their view but were not among the list of ten predefined items.

The results of the ranking exercise are presented below:

Predefined triggers and enablers	**The main trigger**	**2nd most important**	**3rd most important**	**TOTAL**
Demonstration of Strong Business Cases	19	8	2	29
Societal push on environmental, congestion, energy challenge	6	7	4	17
New sources of market competition may promote faster implementation	5	6	6	17
Digitalization	4	4	4	12
Easy Life: Robust processes, increase resiliency flexibility, schedule and execution	3	4	5	12
Increased collaboration and social economy: crowdsourcing	3	4	4	11
Endorsement by authorities	1	4	6	11
Proper communication of the benefits of PI concept	0	2	7	9
Reconciliation of people needs vs Sustainability	0	1	2	3
Supporting tangible benefits of current public investments in infrastructure	0	1	1	2

Respondents mentioned the following additional triggers and enablers to be considered when building up the Physical Internet Roadmap:

- New data securing technologies, e.g. block chain technology (trust and reliability) and the principle (no central governance, peer to peer model)

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- Increased collaboration and social economy, the sharing economy, crowdsourcing are more common amongst the “younger generation”

The results above show that the most important triggers and enablers are in the field of “change of mind-set”. PI is a very different business model from the todays business models.

New generations may create the disruptions in the existing system and have a different view on possession of assets, data-sharing in view of competition, efficiency and sustainability.

6.3.Infrastructural Investments

An important factor for the realisation of the Physical Internet concept is infrastructural investments. For that reason, two questions related to the investments were asked:

- **What infrastructural investments are needed to achieve the PI?**
- **Who should fund/implement these infrastructural changes?** (Public**,** Private**,** Combination)

The results can be summarised as the following:

Private investments:

- PI containers, smart boxes
- Redesign of distribution centres / shared warehouses
- Automation technology for sorting boxes
- Shared transport assets that enable PI containers
- Crowdsourcing platforms, smart last mile delivery solution (e.g. smart lockers)

Public investments:

- Traffic Information Management Systems
- European multimodal infrastructure network (TEN-M)
- Connecting Europe Facility (CEF) and Urban Consolidation Centres (Cities) can stimulate investments
- Current public investments supporting PI leveraging tangible benefits: CEF, Galileo, IoT, ITS

Combined investments:

- Open shared facilities, e.g. PI-hubs (synchromodal)
- Efficient and freight enabled public transportation systems in cities
- Lanes for autonomous transport, i.e. redesigned infrastructure
  Digital infrastructure to get the maximum visibility to operations and data of Physical Internet

7. Stakeholders position towards the Physical Internet

The main stakeholders relevant for Physical Internet are included in Figure 3. In this chapter, we briefly include their role and position towards it based on the different consultation processes.

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Industry
- Shippers and manufacturers, Retailers, Wholesalers
- Freight forwarding, Courier and Postal Operators, Logistics Service Provider (3PL-4PL)
- Transport: Intermodal and combined transport, Road, Maritime and Inland waterways, Rail freight
- Freight transport and logistics equipment (i.e. vehicles, load units, handling and transhipment)
- Information and Communication Technology & Consultancy

Standardization Bodies

Infrastructure and Infrastructure Managers
- Intermodal Terminals and Logistics hinterland hubs
- Ports and airports
- Road, Rail, Waterways infrastructure operators
- Real Estate

Clusters and National Technology Platforms
- National Industry associations and Technology Platform
- Regional Clusters

Research and Education, Training

TEN-T Corridors Managers

Governmental public bodies and administration
- European Commission
- Customs
- Transport authorities/ministry
- Research and Innovation Policy/ministry
- Agency (funding/Innovation)
- City representatives

Figure 2. *Stakeholders groups relevant for Physical Internet*

Shippers, including manufacturing industries, wholesalers and retail. This stakeholder group has already shown a strong support on Physical Internet benefits as potential cost, energy consumption and emission savings are clear for them. This target group, as end users of the Physical Internet, has a strong power to influence the market and the fast development of the Physical Internet. However, if the value for early adopters of the Physical Internet concepts is not clear, they will fear to move in the wrong direction. They may also have the (wrong) impression that with Physical Internet they will lose control of their transport and logistics chain. Indeed, enhanced operations visibility under the Physical Internet should provide higher control, flexibility and resilience to their supply chain.

Freight forwarders, courier, postal operators and logistics service providers. This stakeholder group is complex as both, strong supporters and opponents of the Physical Internet have been already identified. The reason is that the Physical Internet may heavily impact and even disrupt their current business models so while some perceive Physical Internet as an opportunity, others will perceive it as a threat. Some of these companies have heavily invested in their transport and logistics networks and they are unlikely to open them to other stakeholders as they are used only for their own business. However, opening and connecting seamless to other networks is seen by some companies as a strong opportunity to leverage additional value to its customer. Anyway, the stakeholders under this category may play even a more important role within Physical Internet compared to their role in the value chain today.

Intermodal and combined transport, Road, Rail, Maritime and Inland Waterways Transport. While this group of stakeholders may maintain similar added value in the value chain as they have today, the capability to adapt and benefit from the Physical Internet concept will impact their market share in future logistics from a modal and a singular company point of view. Digitalization of transport documents and processes, interoperability and flexibility will determine their role in future transport and logistics. These groups of stakeholders have been already addressed through SETRIS WP2 in which all Transport ETPs participate: ACARE, ERTRAC, ERRAC and WATERBORNE. They are already integrating the concept of the Physical Internet as part of their future developments following the joint document on the definition of the "*Truly Integrated Transport System for Sustainable and Efficient Logistics*" produced with the support of SETRIS project.

Freight Transport and Logistics Equipment (i.e. vehicles, load units, handling and transhipment equipment). Like the previous group, Physical Internet may increase the demand for higher

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technology equipment and this group of stakeholders will be interested on these new markets and on accommodating the needs of end users of the Physical Internet. In that sense, IPIC 2017 have incorporated major handling companies and closer relationship has been built. In their view, technology readiness is there and what is indeed missing is additional standardization of load units as well as take up of the concepts by users. Regarding, trailer manufacturers and innovative transhipment technology, these topics have been addressed in previous projects: Modulushca[16] and TRANSFORMERS[17] and are going to be further addressed by recently awarded projects: CLUSTER 2.0[18], LessThanWagonLoad[19] and AEROFLEX (under negotiation). These developments are fully framed under the vision of Physical Internet.

Information and Communication Technology providers & Consultancy. They have keen interest on Physical Internet development as they may benefit from an increased demand of new technology applications such as i.e. Internet of Things, risk management, track and trace, visibility platforms, collaborative platforms development, information sharing, etc. Currently, logistics is not a technology-intensive sector due to low margins, average size of the companies, etc. However, the potential of the increase in efficiency and cost reduction together with increased affordability and easy-to-use technology may change this situation.

Infrastructure and infrastructure managers & TEN-T Corridors Coordinators. This stakeholder group includes intermodal terminals and logistics platforms and hubs, ports, airports, real estate and modal transport infrastructure managers. They may need to invest in new and upgraded infrastructure which could be a barrier for them to support the Physical Internet concept, however, upgrading the infrastructure may save investments in new infrastructure as higher capacity might be enabled by embracing the Physical Internet concept. This target group is a key player in Physical Internet as a major role is already envisioned for freight hubs. The main challenges regarding this stakeholder group will be: a) how they will operate and will establish the right strategies to ensure the accommodation of freight flows managed through them and b) how fast they will be able to benefit from the consolidation of goods and flows they may achieve in the Physical Internet paradigm, through robust investments.

Physical Internet is a major game changer to leverage the value of TEN-T network on one hand but also demanding and accelerating the upgrade of the core network transport and logistics services, including inland terminals. I.

Clusters and National Technology Platforms. This stakeholder group my play loudspeaker role at member state level and regional level so the concept of Physical Internet is further endorsed.

Governmental and public bodies and administration. This stakeholder group needs to be addressed in different ways. First, clearer understanding on the benefits of the Physical Internet to meet policy objectives is needed. European Commission is supporting further research on the Physical Internet. At Member State level, different supporting programs have been already stablished in France, the Netherlands (DINALOG), Belgium (VIL) and Austria (BMVIT).

16 http://www.modulushca.eu/
17 www.transformers-project.eu
18 http://cordis.europa.eu/project/rcn/209715_es.html
19 http://cordis.europa.eu/project/rcn/209714_es.html

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Standardization organizations. Standardization of physical and information flows, processes and protocols will play an important role in the Physical Internet development

Research, education and training. Research and education is fast moving in the field of Physical Internet. ARMINES, KLU, Gratz University, Groningen University, Logistikum Steyr, TNO, TU Eindhoven and TU Delft already have dedicated resources and PhDs addressing directly the topic of the Physical Internet.

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ANNEX I: ALICE STEERING GROUP MEETING, BRUSSELS, 13TH NOVEMBER 2015

The Meeting is organised by ALICE within SETRIS (Strengthening European Transport Research and Innovation Strategies) project financed by H2020. Project Number 653739.

4th ALICE Steering Group Meeting

13th November 2015, Procter & Gamble (BIC),

Temselaan 100,1853 Strombeek-Bever Belgium

10:00-10:30 **Welcome coffee**

10:30-10:45 **Tour de Table, Approval of Agenda.** *Ralph Keck, ALICE chair.*

- New members of the Steering Group appointed by the Mirror Group.

10:45–11:00 **Report on ALICE activities.** *Fernando Liesa, ALICE Secretary General.*

Note: The report will be shared in advance to the meeting but not presented. The session will be for Q&A of the members.

11:00-11:30 **Approval if proceeds of next actions to be implemented:**

- Modification of Terms of Reference → Compliance with statutes.
- Renewal of Steering Group. Process Approval.
- Creation of task force/open group on Modular Load Units.
- Creation of the Academic Board.

11:30–12:00 **SETRIS project and the truly integrated transport system for logistics**

12:00-13:15 **Workshop on ALICE implementation plans of the Roadmaps**

13:15–14:00 **Lunch**

14:00-15:00 **European Commission/INEA/ALICE briefing**

15:00-15:30 **Results of the Workshop on the Implementation Plans**

15:30-16:30 **Workshop on the Physical Internet Roadmap**

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List of participants

SURNAME	NAME	ORGANIZATION
´t Hooft	Dirk	ALICE / DINALOG
Andres	Irene	CNC-LOGISTICA
Aulicino	Angelo	Interporto Bologna
Baeyens	Alain	ELUPEG / SOLVAY
Barbarino	Sergio	Procter & Gamble
Biggi	Dario	Poste Italiane S.p.A.
Coda	Alessandro	EUCAR
Cossu	Paola	FIT CONSULTING
De Carne	Philippe	GEODIS
Díez Orejas	Juan Manuel	Valencia Port
Franklin	Rod	Kuehne Logistics University
Fusco	Jean-François	EALTH
González	Emilio	ITENE
Huelsmann	Thorsten	Fraunhofer IML / Efficienzcluster
Ilves	Indrek	ALICE / INTERLOGISTICS
Journée	Herman	EIA/Eco SLC
Keck	Ralph	Procter & Gamble
Kirchner	Malgorzata	ILIM
Konstantinopoulou	Lina	ERTICO
Liesa	Fernando	ENIDE / ALICE
Marinus	Jos	European Logistics Association (ELA)
Nettsträter	Andreas	Fraunhofer IML
Nik	Delmiere	European Shippers Council
Olsson	Bo	Trafikverket
Persi	Stefano	ENIDE
Peto	Norbert	Mondelez International
Rydzkowski	Wlodzimierz	Uniwersytet Gdanski
Rodriguez	Mar	Kaleido
Saenz	Maria Jesus	Zaragoza Logistics Center
Schultze	Ralf-Charley	UIRR -International Union of combined road-Rail transport companies
Staberhofer	Franz	VNL - Association for Network Logistics
Van der Jagt	Nicolette	CLECAT
Yves	David	Casino Group
Zunder	Thomas	ERTICO / NewRail, Newcastle University
Zjim	Henk	DINALOG/UTWEENTE

European Commission

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ANNEX II: ALICE WORKSHOP, VIENNA 2-3 FEBRUARY 2016

The Meeting will be organised by ALICE with the support of SETRIS (Strengthening European Transport Research and Innovation Strategies) project financed by H2020. Project Number 653739.

ALICE members and experts workshop

Date: February 2-3, 2016

Venue: Wirtschaftsuniversität Wien, Welthandelsplatz 1, 1020 Vienna, Austria

AGENDA for Day 1: 2nd of February

10:00-10:30	Welcome coffee
10:30-10:45	Workshop overview: welcome, agenda, targets and expected results.
10:45-11:30	Definition of Truly Integrated Transport System for Efficient and Sustainable Logistics. An updated document with comments received will be shared second half of January.
11:30-11:45	Research and Innovation progress monitoring. Fernando Liesa. ALICE Secretary General, Logistics Innovation Leader, ENIDE.
11:45-12:45	*Implementation Plan. Topics discussed with all attendees (1)* *All participants working in parallel on selected topics.*
12:45-13:45	Lunch
13:45-14:45	*Implementation Plan. Topics discussed with all attendees (2 Continuation)*
14:45-15:15	Coffee Break
15:15-16:00	Plenary session to share outcomes
16:00-18:30	Public event organized with LRA
18:30	End of the day

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AGENDA for Day 1: 3rd of February

9:00-9:15	Warm up and introduction to the day
9:15-10:30	*Implementation Plan. Topics discussed in parallel session (1)*
10:30-11:00	Coffee Break
11:00-12:00	*Implementation Plan. Topics discussed in parallel session (2)*
12:00-13:00	Lunch
13:00-14:00	Plenary session to share outcomes
14:00-16:00	**ALICE Research and Innovation Roadmap on the Physical Internet**
16:00	End of the workshop

List of participants

First name	Last name	Company / Organisation
Waqas	Ahsen	PostEurop
Juan	Alcaraz	ITENE
Angelos	Amditis	ICCS
Corrado	Andrean	AJA REGISTRARS EUROPE
Angelo	Aulicino	Interporto Bologna SpA
Jannicke	Baalsrud Hauge	biba
Peter	Bachl	Industrie-Logistik-Linz
Eric	Ballot	Mines ParisTech
Sergio	Barbarino	P&G
Immacolata	Battaglia	Meware
Pierre	Beran	Jones Lang Lasalle
Jan	Bergstrand	Trafikverket
John	Berry	ELUPEG
Dario	Biggi	fondazione proPosta \ Poste Italiane SpA
Christian	Blobner	Fraunhofer IFF
Frédéric	Buyse	IFB
Franco	Castagnetti	NEWOPERA
Paola	Cossu	FIT CONSULTING

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Frans	Cruijssen	ArgusI
Alfons	Dachs-Wiesinger	MAGNA STEYR AG & Co KG
Yves	David	COMACAS - CASINO
Lieven	Deketele	P&G Sevrices Company SA
JUAN MANUEL	DÍEZ OREJAS	AUTORIDAD PORTUARIA DE VALENCIA
Verena Charlotte	Ehrler	DLR Institute of Transport Research
Olav	Eidhammer	Institute of Transport Economics
Rikard	Engström	Swedish Transport Admin
Eric	Feyen	UIRR scrl
Fabiana	Fournier	IBM Research - Haifa
Jean Francois	Fusco	EALTH
Pierre	Gabaud	EUCAR
Lukas	Gerhold	Siemens
Emilio	Gonzales	ITENE
Marcin	Hajdul	ILiM
Arni	Halldorsson	Chalmers University of TEchnology
Maria Dolores	Herrero Tomás	ITENE
Wout	Hofman	TNO
Indrek	Ilves	ALICE/Interlogistics
John	Ingram	Transport Systems Catapult
Werner	Jammernegg	WU Vienna
Mats	Johansson	Chalmers University of Technology
Anders	Johnson	SP Technical Research institute of Sweden
Mats	Johnsson	Lund University
Herman	Journee	ECO Sustainable Logistic Chain Foundation
Christian	Kassyda	Volkswagen Commercial Vehicles
Panayotis	Katsoulakos	INLECOM
Ralph	Keck	Procter & Gamble Purchases

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Christoph	Kern	Austrian Logistics Network
Gosia	Kirchner	Institute of Logistics and Warehousing
Ben	Kraaijenhagen	MAN Truck & Bus AG
Tobias	Kutzler	Fraunhofer IFF
Alessandra	Laghi	University of Bologna
Heikki	Lahtinen	LIMOWA
Jorge	Leon	ITENE
Chiara	Lepori	Consorzio IB Innovation
Alan	Lewis	Smart Freight Centre
Fernando	Liesa	ALICE/ENIDE
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Andreas	Nettsträter	Fraunhofer IML
Carina	Neveling	Fraunhofer IML
Pernilla	Ngo	Closer
Nico	Nuerbchen	HARTMANN Group
Murat	Ozemre	Bimar ARKAS
Paolo	Paganelli	Bluegreen Strategy
Alfonso	Pagliuca	AJA REGISTRARS EUROPE
Gianmarco	Pagliuca	AJA REGISTRARS EUROPE
Stefano	Persi	ENIDE
Norbert	Peto	Mondelez
Andreas	Pichler	Gebrüder Weiss GmbH
Matthias	Prandtstetter	AIT Austrian Institute of Technology GmbH
Sylvain	Prevot	TRAXENS
Katrin	Reschwamm	Verein Netzwerk Logistik Schweiz
Michael	Reske	duisport agency GmbH
Mar	Rodriguez	KALEIDO IDEAS & LOGISTICS
Emeline	Rousselet	CHEP Europe
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ANNEX 3: DETAILED RESULTS OF SURVEY TO ROAD MAP THE WAY TOWARDS THE PHYSICAL INTERNET VISION

Contents

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BACKGROUND AND GENERAL OVERVIEW OF THE SURVEY

The aim of the survey was to obtain input, ideas and thoughts from IPIC 2016 participants and ALICE members for the r*oad mapping process towards achieving the Physical Internet Vision*. The survey took place within the plenary session of the IPIC 2016 conference on July 1, 2016 and after ALICE plenary on October 13th, 2016.

PHYSICAL INTERNET SURVEY

The Physical Internet (PI, π) concept is becoming more and more important as a possible way to progressively move from the current paradigm of mobility, including logistics, to a new paradigm. This new paradigm is expected to generate an order of magnitude of improvement in efficiency and sustainability.

ALICE, the European Technology Platform for transport and logistics, is currently building consensus around the Physical Internet concept, and identifying the way forward towards implementation of the Physical Internet. As part of the activities within the EU funded project SETRIS, ALICE, with the support of industry and research stakeholders in the field of logistics and transport, is creating a roadmap leading to the realization of the Physical Internet. The Physical Internet Roadmap is intended to be a guide for the efforts of ALICE in future activities and, in particular, in the recommendations for research and innovation in Europe to be implemented through European funded research and innovation programs such as the current Horizon 2020 program. ALICE also expects this roadmap to be the starting point for a global roadmap for the Physical Internet agreed to on a worldwide basis.

The Physical Internet Roadmap will outline how implementation of the roadmap will contribute to a real fully implemented Physical Internet by 2050. Remaining research and innovation gaps will be identified with a specific focus on business models, regulations and governance. In addition, barriers and enablers for the Physical Internet will be outlined. Examples of sub-systems with similarities to the Physical Internet will also be analysed for clues on how the Physical Internet will operate.

The aim of this survey is to obtain input, ideas and thoughts that contribute to the topics summarized above.

The Survey is structured in four chapters:

Chapter 1: **Components & technical developments needed to achieve PI implementation**

Chapter 2: **Transition management: business models, regulations and governance**

Chapter 3: **Expected impacts of Physical Internet realization**

Chapter 4: **Barriers, opportunities/triggers and Infrastructural Investments for PI.**

First Name:

Last Name:

e-mail:

Company:

Type of company

Industry

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Automotive and Road Freight Transport	
Consultancy	
Equipment for Transport and logistics	
Freight Forwarders	
Information and Communication Technology	
Intermodal and Combined Transport	
Logistics Service Provider (3PL-4PL)	
Maritime and Inland Waterways Transport	
Postal and courier companies	
Rail freight transport	
Retailers	
Shippers and manufacturers	
Wholesalers	
Other	
Infrastructure and Infrastructure Managers	
Airports	
Intermodal Terminals	
Logistics hubs	
Ports	
Other	
Associations and Clusters	
Industry association	
Research Association	
NGO	
Other	
Academia, Research and Technology Centers	
Research institute	
Technology Center	
University	
Other	
Governmental public bodies and administration	
City representatives	
Customs	
Transport authorities (road, rail, waterborne)	

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Other

Chapter 1: **Components & technical developments needed to achieve PI implementation**

To transition from the current paradigm to the Physical Internet, several components, technical developments and standards will need to be realised. Technical developments, such as smart handling and transhipment technology for handling and transport of Physical Internet containers, the actual π-containers, Physical Internet nodes and network management systems, IT, standardization requirements, etc., are required to realize the Physical Internet vision. In this regard,

1. **What specific components/technologies/standards need to be developed/realized to reach the PI vision? Include a short explanation of the component/technology/standard (2-3 sentences) and the relevance of it for the PI.**
2. **What is the time frame needed to develop this component/technology/standard?**

   Select among these options: 1. 2017-2020; 2. 2020-2025; 3. 2025-2035; 4. Beyond 2035
3. **This component/technology/standard falls within the following category:**

   1. Physical Internet network and nodes design.

   2. Infrastructure and equipment development.

   3. Standardization

   4. Physical Internet network and nodes management system.

   5. Integration with people mobility

   6: Other (please specify)

Components/technologies/standards explanation and relevance of it for the PI (1)	**Time Frame (2)**	**Category (3)**

Chapter 2: **Transition Management: business models, regulations and governance.**

In addition to the components/technologies/standards other specific needs will arise to manage the transition to the PI. Areas such as worker skills and education, business models, governance and regulations, should be addressed.

1. **Specify what kind of skills and education, business models, specific governance issues regulations or other aspects that will need to be addressed to achieve the Physical Internet.**

   Include as much as you want but at least the 1-2 specific issues that you consider more critical or important.

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2. **What is the time frame in which this transition aspect should be realized?**

   Select among these options: 1. 2018-2020; 2. 2020-2025; 3. 2025-2035; 4. Beyond 2035.

3. **This transition element falls within the following category:**

   Select among these options:

   1. Skills and Education

   2. Business Models.

   3. Governance.

   4. Regulation.

   5. Other (please specify)

Skills and education, business models, specific governance issues regulations or other aspects needed to achieve Physical Internet (1)	**Time Frame (2)**	**Category (3)**

Chapter 3: **Expected Impacts of Physical Internet realization**

The Physical Internet concept is developing greater importance as a possible way to progressively move from the current paradigm for mobility, including logistics, into a new one. The new paradigm could lead us to an order of magnitude of improvement in efficiency and sustainability. Based on your experience and background, what is your opinion on the following:

Evolution towards the Physical Internet will lead us *to: (1 selection per impact criteria and time frame)*:

Energy

2020-time frame:

☐ No energy (or minimal) savings

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☐ Energy savings between 5-10 %

☐ Energy savings between 10-20%

☐ Energy savings between 20-30 %

☐ Energy savings above 30 %

2030-time frame:

☐ No energy (or minimal) savings

☐ Energy savings between 5-10 %

☐ Energy savings between 10-20%

☐ Energy savings between 20-30 %

☐ Energy savings above 30 %

2040-time frame:

☐ No energy (or minimal) savings

☐ Energy savings between 5-10 %

☐ Energy savings between 10-20%

☐ Energy savings between 20-30 %

☐ Energy savings above 30 %

Costs

2020-time frame:

☐ No cost savings

☐ Cost savings between 3 - 5 %

☐ Cost savings between 5 - 15%

☐ Cost savings between 15 - 30 %

☐ Cost savings above 30 %

2030-time frame:

☐ No cost savings

☐ Cost savings between 3 - 5 %

☐ Cost savings between 5 - 15%

☐ Cost savings between 15 - 30 %

☐ Cost savings above 30 %

2040-time frame:

☐ No cost savings

☐ Cost savings between 3 - 5 %

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- ☐ Cost savings between 5 - 15%
- ☐ Cost savings between 15 - 30 %
- ☐ Cost savings above 30 %

<u>Emissions</u>

2020-time frame:

- ☐ No emissions (or minimal) savings
- ☐ Emissions reduction between 5-10 %
- ☐ Emissions reduction between 10-25%
- ☐ Emissions reduction between 25-40 %
- ☐ Emissions reduction above 40 %

2030-time frame:

- ☐ No emissions (or minimal) savings
- ☐ Emissions reduction between 5-10 %
- ☐ Emissions reduction between 10-25%
- ☐ Emissions reduction between 25-40 %
- ☐ Emissions reduction above 40 %

2040-time frame:

- ☐ No emissions (or minimal) savings
- ☐ Emissions reduction between 5-10 %
- ☐ Emissions reduction between 10-25%
- ☐ Emissions reduction between 25-40 %
- ☐ Emissions reduction above 40 %

- **Are you expecting any other positive/negative impact as a consequence of the realization of the Physical Internet?**
  (Free text)

Chapter 4: **Barriers, Opportunities/Triggers and Infrastructural Investments for PI.**

Barriers

Based on previous activities, ALICE has identified the following barriers for Physical Internet Realization:

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1 *New paradigm will have winners and losers. Conservative position in the sector may prevent realization*.

2. *Data Sharing and Cyber Security.*

3. *Uncertainty on governance models.*

4. *Role of Governments and their control over the PI.* 5. *Financing of required Infrastructure.*

4. Select the main barrier for Physical Internet realization from the list above.

5. Select the second most important barrier for Physical Internet realization from the list above.

6. Do you foresee other important barriers for Physical Internet Realization?

Yes, No (Free text in case Yes)

Triggers and enablers:

Based on previous activities, ALICE has identified the following triggers and enablers for the Physical Internet:

1. Societal push on environmental, congestion, and energy challenges.

2. Digitalization

3. Demonstration of Strong Business Cases.

4. Easing of business operations: Robust processes, increased resiliency, flexibility, schedule and execution.

5 Reconciliation of people needs vs Sustainability: Instant consumption vs efficiency and emissions; no longer a trade off with the PI.

6. Increased collaboration and social economy: crowdsourcing.

7. New sources of market competition may promote faster implementation.

8. Proper communication of the benefits of the Physical Internet concept.

9. Endorsement by authorities.

10. Supporting tangible benefits of current public investments in infrastructure

7. Select the main trigger/enabler for Physical Internet realization from the list above.

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8. **Select the second most important trigger/enabler for Physical Internet realization from the list above.**

9. **Select the third most important trigger/enabler for Physical Internet realization from the list above.**

10. **Do you foresee other important trigger/enablers for Physical Internet Realization?**

    Yes, No (Free text in case Yes)

Infrastructural investments.

- **What infrastructural investments are needed to achieve the PI?**
- *Include as many as you want. IMPORTANT! Use one box per specific investment considered.*
- **Who should fund/implement these infrastructural change?**
    - Public
    - Private
    - Combination

What infrastructural investments are needed to achieve the PI	**Who should fund?**

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Profile of participants

41 respondents from the survey:

- ✓ 14 respondents from industry
- ✓ 3 respondents from logistics cluster
- ✓ 23 respondents from academia
- ✓ 1 Respondent from Public Government or Public Body

Self-assessment results on the knowledge of Physical Internet

- ✓ Very high – 10 respondents
- ✓ High – 6 respondents
- ✓ Medium – 17 respondents
- ✓ Low – 8 respondents

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CHAPTER 1: COMPONENT/TECHNOLOGY/STANDARD

Summary of results

Categories of components/technologies/standards: Row Labels	Column Labels 2017-2020	2020-2025	2025-2035	Grand Total
1. Physical Internet Network and Nodes Design	5	1	1	7
2. Infrastructure and equipment development	12	12	1	25
3. Standardization	20	4	2	26
4. Physical Internet network and nodes management system	11	5	1	17
6. Other	4	2	1	7
Grand Total	**52**	**24**	**6**	**82**

2017-2020

1. **Physical Internet Network and Nodes Design**

   a. physical internet nodes with high levels of flexiblity in operations
   b. The method of barcoding the PI container will need to be standardized so that containers can be efficiently tracked through the PI.
   c. Connected Platform
   d. PI-Hubs
   e. Means of governance

2. **Infrastructure and equipment development**

   a. IoT enabled pi container ... is literally and figuratively a building block
   b. Concrete active PI-containers able to track goods indoor and outdoor whatever the conditions (fresh for instance).
   c. Access to information/data is a critical component for PI to be realized in order to enable a more efficient movement of goods and services. One component that needs to be developed is a public access database to transportation/freight flows that all service providers (sea, air, rail, trucking, intermodal) are linked to in a seamless and publicly accessible interface
   d. Anti-viruses of the Physical Internet - I believe some safety control technology needs to be developed in order to be able to start implementing PI concepts in a safe way. As PI can be compared in some ways to the Digital Internet, there is a need for what are anti-viruses in the digital world. Moving goods in an open network brings security concerns that we need to address at a large scale in efficient way to control high risks related to

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physical trade (such as already identified risks: illegal trade of drugs, weapons, bombing terrorism).

e. IT: Intuitive tech, Cloud technologies, advanced tracking technologies and Artificial intelligence algorithms/heuristics and systems.
f. Next to business models I see a need to develop interconnected IT platforms on which stakeholders of the Physical Internet can exchange, manage and analyse data. It will be key to develop an open architecture which can absorb all current existing IT infrastructure into one Physical Internet Big Bang which will level the digital playground for all Physical Internet actors.
g. Of course the containers themselves. Handling equipment based on the containers, so both should be designed at the same time
h. Handling technology is a key success factor to reduce the cost to pass through a hub and increase the efficiency of the network.

3. Standardization

a. Practical implemented case studies that demonstrate financial benefits to companies & clients. Does implementation of PI concepts correlate with marketplace wins?? Metrics & benchmarking comparisons must ultimately show that savings & efficiencies can be gained.
b. Agreements on various standards of: modules, data
c. Physical Internet containers
d. Consistent standardization across borders; Sensing technology needs to be developed for better automation.
e. Focus on building standards for π containers, functions and specification; Make blueprints of container open source available (e.g. github.com), so everybody can contribute to the design and also produce π containers."
f. The standardization of handling of goods, possibly achieved through standardization of containers and thereby enabling automated handling. When handling time and cost decrease significantly, the full potential of the PI gets in reach.
g. Standard modular stackable boxes to encapsulate most of the goods....and then all the automation technology to handle them and the planning routing software to flow them
h. Standards that identify each object. GS1 has already most of the needed standards in place but above all an organization to develop needed standards on a global level.
i. communication standards
j. Legal clauses or guidelines that put the concerns of liability into rest for the sake of collaboration
k. A standard will need to be developed for assigning responsibility and liability for lost and damaged goods traveling through the PI. There are several paradigms that exist now (Uniform Commercial Code, maritime law, Carmack Amendment) but as goods travel seamlessly through various modes and borders there will need to be consensus on how these matters are handled.
l. We also need communication standards and protocols (GS1) and neutral 3rd party organizations to oversee data flow, security, pricing, etc.

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m. Political alliance with current PI research to pave the way for the applications of several technologies
n. Modularized boxes

4. Physical Internet network and nodes management system

a. Protocols for the movement of containers through the network.
b. Means of governance so that transactions and goods can flow without human intervention.
c. Tracking - Ability to track shipments similar to emails being tracked through server logs
d. #1 component is about network management system: booking systems, market places, universal and reliable tracking systems are must to make it append on top of physical assets like warehouse, distribution centres or cross-docks. They will offer the potential (event if it is not the full potential) to the market and start a new market!
e. management systems to facility decision making for operations as well as to decide when and how to participate
f. Use IPv6 for communication between active tags equipped containers, hubs, trucks, people with smart phones etc.

6. Other

a. I am not so sure that the key focus for the Physical Internet implementation should be uniquely focused on technology. Although technology is an important factor to let the Physical Internet succeed, I think the biggest challenge is in business models. Key item here is how we will get to an open network in which logistics assets are shared. Many companies have a backpack full with heavyweight logistics assets. As long as the perceived value of these logistics assets is bigger than the perceived benefits of the Physical Internet it will be very difficult to make the leap forward towards a fluid and open Physical Internet business architecture. **(Business Models)**
b. Smart Manufacturing and packaging: linking the end-user to industry 4.0 paradigm **(User-centric technologies)**
c. Analytics to support stocking of same-day delivery storage points - similar to Amazon Prime Now, so this will likely be proprietary with some publicly available research via universities **(Analytics)**

2020-2025

1. Physical Internet Network and Nodes Design

a. AI for decision making

2. Infrastructure and equipment development

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a. PI-containers, boxes: Considerable parts of the visions and value-adding innovation of physical internet reply on the use of PI-containers/boxes; they are critical to enable the collaborative operations between companies and realize a smooth and efficient handling at hubs. So I believe having PI-containers/boxes being one of the most important steps for PI innovation either by designing a new standard boxes or by having a common interface embedded in existing containers/boxes.
b. Are pi-containers are critical to the success of PI, or just nice to have? If critical, then this area must be developed early. I do think someone needs to study how essential this area is to the overall goals of the PI.
c. Internet is about data/service/workflow. I feel like research and work in PI domain mainly focus on analogy with data. I also guess that all the servitization research and works may be a good contribution to PI maturity by making the analogy with services. However, I think there is a lack in the components and technical developments regarding the question of workflows. Probably collaborative business processes should be studied from the analogy with agile workflows on the internet.
d. Developing a standard conveyance - box -is a critical part of the PI evolution. So much infrastructure and process investment and improvements will be driven by this. Much like palletization and automation. You need to address the one before focusing on the other. Otherwise you are sub optimizing the process.
e. Interoperable modular PI-Containers on the different tiers (Handling container, Transport container)
f. Handling technology
g. Smart manufacturing and packaging, incl. Additive manufacturing
h. New methods for handling rapidly these containers. Personally, I believe fast handling is the linchpin for the success of the PI. Otherwise, the network doesn't work efficiently.
i. Modular smart containers - Containers that can verify contents and environmental compliance of contents to required handling conditions (temperature, non-static environment, etc.), and that can be stacked/organized into larger standardized meta-containers
j. Handling and storage equipment standards - standards for equipment to move and store modular smart PI containers

3. Standardization

a. standardization is highly required as soon as networks are open. It comes with 3 components:
- physical (handling boxes and transport containers);
- information (tracking of flows and means) - linked to Industry 4.0 and industrial data space.
- processes and specially how to handover a shipment to another LSP.

4. Physical Internet network and nodes management system

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a. Standardized resource categories and descriptions for making resources available for bidding; Micro contracting and selling of contracts to subcontractors; Performance measurement systems
b. Handling technology + Smart Manufacturing and packaging: Handling technology is closely related to the PI-containers and it needs to accompany the development of PI-containers to truly having efficient logistics system.
c. PI-oriented planning and scheduling decision support systems. As far as I know, most of the current research are focusing on physical dimension of the PI. But planning paradigms have to be shaked and changed to fit with the PI principles and philosophy. We cannot continue to use MRPII, DRP... in such a context!
d. Artificial intelligence systems that can do the dynamic decision making necessary to optimize the flow of goods without human intervention.

6. Other

a. The most important component needed to realize the PI vision is proof of financial incentive. PI makes a lot of sense conceptually, but it will be difficult to implement without proof of benefit to the large companies with significant infrastructure. **(Financial)**

2025-2035

1. Physical Internet Network and Nodes Design

a. Network infrastructure - standardized handling/movement infrastructure between existing and new nodes, should be multi-model whereby a mode can be selected in real-time at current node

3. Standardization

a. IT common protocols
b. Coopetition needs to be defined in detail. One major argument against the PI is the removal of competitive advantage. Companies need to understand the importance and benefits (financial, operational, etc.) of coopetition.

6. Other

a. Regulations / Laws issues have to be developed as they constitute probably the most important barriers of the PI. Elementary bricks have to be developed **(Acceptance)**

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CHAPTER 2: TRANSITION ELEMENTS

Summary of results

Transition elements	2017-2020	2020-2025	2025-2035	Grand Total
1. Skills and Education	15	7	3	25
2. Business Models	13	9	1	23
3. Governance	4	6	1	11
4. Regulation	2	3	1	6
Grand Total	**34**	**25**	**6**	**65**

2017-2020

1. Skills and Education

a. Writing a book able to cover the whole PI domain and to promote it everywhere: "PI for dummies"
b. Again, I am not an expert on logistics, supply-chain nor PI. However, I have the feeling that there are a lot of historical results on the domain of logistics and supply-chain, inherited from optimization, planning and other historical research domains. I miss a cartography mapping between historical and somehow "old" practices and PI visions, structure and results. That could be a great support for convincing ("this is new but it covers the old stuffs") and for teaching.
c. 1. A learning environment across community. 2. I also believe that some special journals of magazines need to be developed to share information across communities.
d. Its critical to develop and build π container in an agile manner; test-driven! Customer-driven development of π container and π active tags to get feedback from industry.
e. Supply Chain Experts
f. Digital internet
g. Mapping the PI concepts with existing and recognized disciplines like "Supply Chain Management", "Business Process Management", "Computer Sciences"... In other words, we have to clearly indicate what it is new and what is maintain from previous standards...
h. Automation skills
i. Transportation management
j. Encourage cross learning with academics and practitioners from other fields, particularly from "Computer Sciences". If we want to make the parallel with Digital Internet, we should know more about it!

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2. Business Models

a. Promote share-ware templates to capture the total supply chain impacts to different SC designs. Games, exercises, training to explore how concepts can be applied to reduce waste & improve service.
b. Experimentation and start ups
c. business models that demonstrate potential and benefits for participants
d. Enabling new business models like FLEXE and Uber seems like the most likely path toward transformative change. In other words, we cannot expect UPS and FedEx to initiate or even to respond gladly to the ideas behind the PI. It is simply a threat to them. So, building small-scale success stories with increasing "amounts of PI" seems like the best approach to demonstrate the value. UPS and FedEx will come to the party only when it becomes clear they will otherwise be left behind. (Example: Tesla and the Big 3 U.S. automakers.)
e. Innovative business models to set pricing and cooperation on the use of physical assets (warehouses, transportation systems, hubs, ...) will be essential to go from cooperation to coopetition. Being involved and use the Physical Internet Network should be attractive and clearly show benefits and projected efficiency increases.
f. I answered on that one in the previous section...
g. There will need to be a business model for allocating costs and benefits among collaborating parties in the PI. If there are costs savings realized across the system but not attributable to solely one party we have to know how these are distributed.
h. open Hubs
i. Ability and desire to collaborate and share
j. The quest of a business model for the whole thing is not really relevant from my point of view. But we definitely need experimentations and start-ups like Flexe, and others that will prove feasibility, thus real business models, as well as pull technologies and regulations.
k. Risk Management, legal and insurance

3. Governance

o. Means of governance
p. Definition around data sharing and governance is complex but key to success. Companies are hesitant to share data and will require detailed governance around data availability, access, and sharing.

4. Regulation

g. Regulations that support cooperation instead of being accused of cartel agreements
h. awareness at governmental organisations to adapt regulations (e.g., in allowing freight to be shipped in public transportation, cooperation between logistics providers and so on)

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2020-2025

1. Skills and Education

a. Agent modelling; Big data and analytics; Congestion analysis; Pricing and contracting strategies
b. We will need people with more technical skills: automation design and maintenance, IT, analytics, etc.
c. A new generation of SC managers (younger) with a higher level of education in IT and with all kind of networks experiences. Who grow up with GAFA.
d. knowledge transfer and participation in the initiative of people outside of the logistics sector (e.g., law, social science and so on)
e. Analytics - decision support for real-time mode selection, stocking for same-day delivery, design of new nodes, etc.

2. Business Models

a. Distributing cost and value sharing: In the hyper-connected operating environment, cost allocation is not as clear as that of current supply chain and without reasonable standards, complaints may arise as all companies think they are charged more unfairly.
b. There should be trust and confidence in an open network for transportation. This can be achieved by small scale experimental networks in which industry participates.
c. Neutral aggregator business models as well as neutral data sharing models
d. Transformation of business models from pure competition to "coopetition" - companies compete with another company on one project, but collaborate on others. IP, trade secrets and competitive advantages must be managed accordingly. This is already going on to some extent in aerospace and defence with firms like Lockheed and Boeing.
e. Fair gain sharing
f. Distributed payment and value sharing
g. Developing more the manufacturing component of the PI. For the moment, the PI is extremely distribution oriented. e.g. Manufacturing as a Service (MaaS).

3. Governance

a. Intergovernmental support for transparency/visibility and access to transportation flows by enforcing regulatory policy for service providers to share information
b. PI requires a culture change within organizations, then industry. Behaviours need to change.
c. Governance: openness for distributed models as opposed to proprietary ones
d. Methods to detect and blacklist bad actors (counterfeiters, etc.) - similar to spam filters

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4. Regulation

a. regulation in the city logistics towards consolidation of goods from different logistic service provider
b. Regulation: The regulation must be able to address any problems with new technology and should not hinder the efficient utilization of any new infrastructure or collaboration

2025-2035

1. Skills and Education

a. Mental shift. Willingness for cooperation. Cultural change.

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CHAPTER 3: EXPECTED IMPACTS OF PHYSICAL INTERNET REALIZATION

	2020-time frame:	2030-time frame:	2040-time frame:
No energy (or minimal) savings	10	0	0
Energy savings between 5-10 %	20	13	4
Energy savings between 10-20%	10	17	10
Energy savings between 20-30 %	1	10	11
Energy savings above 30 %	0	1	16
No cost savings	9	0	0
Cost savings between 3 - 5 %	17	7	2
Cost savings between 5 - 15%	13	22	13
Cost savings between 15 - 30 %	2	8	12
Cost savings above 30 %	0	4	14
No emissions (or minimal) savings	12	1	1
Emissions reduction between 5-10 %	19	13	6
Emissions reduction between 10-25%	10	18	11
Emissions reduction between 25-40 %	0	9	12
Emissions reduction above 40 %	0	0	11

Other impacts

- Realization of the PI vision will be a direct function of how much savings & benefits companies realize along the journey. Investments will follow based on the expected return. Companies operate in very short term because the world changes. 2020 is a distant target. 2040 is inconceivable.
- Social impact: positive or negative? I don't know yet...
- Negative: standards do sometimes reduce innovation and competition from variety
- Positive: satisfaction of collaborating globally for a more sustainable future
- effects on labour market jobs for lower skilled people
- seamless movement of people across borders, the global population becomes "internationalized", passports and nationalities are irrelevant
- Potential for entirely new business models is high.
- It will have a clear impact on social aspects as labour conditions, purchase behavior, ...
- Quality improvement of supply-chain and a more fair globalization of distribution.
- - flexibilization of labor (time, place, type)
- rise and fall of companies
- New business models around π or using π concepts.
- When we started to surf on the digital internet in the end of the 90's we only had the basics. In the last decade 2000-2010 we got E-bay, Amazon, Facebook, Twitter, Linked In... So in the Physical Internet we should think way ahead and think what will happen after the Physical Internet establishment... a true visionary discussion

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- There may be employment displacement as transportation resources are reallocated and skill sets become out of date.
- A more interconnected society where a small company can serve customers worldwide
- Enhanced productivity and profitability via new business models and offerings, similar to digital internet in 1990s.
- A positive impact is the new level of service and network access it will provide!
- It will also bring positive image.
- Shift in the mindset of people/companies towards collaboration, also needed in Physical Internet
- A lot of companies market by their fleet -- Would the effect sales?
- It envision a lot of positive impacts but there is a need for governance and administration. The Internet never put anyone out of business. The Physical Internet Will.
- Service Level, Reliability and Resilience
- A potential negative impact is the reduction in jobs for truck drivers, warehouses employees, etc.
- sharing facility will involve sharing data, so impact to be anticipated is data security to protect certain strategic data (clients´s business size) and how to separate it with public data (Eg. LSP available capacity)
- We know how difficult it is to establish high speed Internet in all remote countries and in less developed countries. The same will happen with the PI and it will have an impact on the organization of the economy, favoring large cities and smart ports or hubs etc.
- Here the impact will be positive. Somewhere else it might be negative.
- Different levels (or sophistication) of PI might need to be defined."
- The way we consume will drastically change in the coming years. I believe that metrics stated above will not be relevant as the context will substantially change.
- Better utilisation the scarce resource of drivers reduced congestion--everywhere, a safer environment

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CHAPTER 4: BARRIERS, OPPORTUNITIES/TRIGGERS AND INFRASTRUCTURAL INVESTMENTS

Results on prioritisation of barriers

Predefined barrier	The main barrier	Second most important barrier	TOTAL
1. New paradigm will leave winners and losers	12	6	18
2. Data Sharing and Cyber Security	11	14	25
3. Uncertainty on governance models	11	9	20
4. Role of Government's and their control over PI	3	6	9
5. Financing of required Infrastructure	4	6	10

Other identified barriers

- ✓ Willingness of people to accept an open logistic system
- ✓ Loosing competitive advantage
- ✓ General resistance to change among business and government leaders
- ✓ Major players have to "give up" their existing proprietary infrastructure in which they have invested
- ✓ To build trust, the new paradigm must repeatedly demonstrate lower cost, better service, perfect data integrity, security & traceability of goods, and continued ongoing investments.
- ✓ Internal culture change. Walls need to come down before organizations can cooperate and compete.

Results on prioritisation of opportunities/triggers

Predefined triggers and enablers	main trigger/enable	Second main trigger/enable	Third maintrigger/enable	TOTAL
3. Demonstration of Strong Business Cases	19	8	2	29
1. Societal push on environmental, congestion, energy challenge	6	7	4	17
7. New sources of market competition may promote faster implementati	5	6	6	17
2. Digitalization	4	4	4	12
4. Easy Life: Robust processes, increase resiliency flexibility, schedule an	3	4	5	12
6. Increased collaboration and social economy: crowdsourcing	3	4	4	11
9. Endorsement by authorities	1	4	6	11
5 Reconciliation of people needs vs Sustainability	0	1	2	3
8. Proper communication of the benefits of PI concept	0	2	7	9
10. Supporting tangible benefits of current public investments in infrastru	0	1	1	2

Other identified opportunities/triggers

- ✓ New generations get at higher positions in companies with different viewpoints
- ✓ Digitization
- ✓ Implementation of Artificial Intelligence and autonomous systems

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- ✓ Increased collaboration and social economy: crowdsourcing
- ✓ data securisation with block chain technology (trust and reliability) and principle (no central governance, peer to peer model)

Proposed Infrastructural investments

Private investments

- ✓ Digital Infrastructure to come to an open and interconnected Physical Internet architecture with maximum visibility
- ✓ Smart DC's at scale to handle shared supply chain.
- ✓ Governance systems
- ✓ Fast and reliable internet connections to exchange the big amount of data related to PI concepts
- ✓ Smaller but more frequent DCs
- ✓ PI-containers
- ✓ Redesigned distribution centres.
- ✓ Automation technology for boxes sorting
- ✓ Boxes and containers
- ✓ shared transport assets
- ✓ Security protocols

Public investments

- ✓ communicaton highways
- ✓ pipelines for containers flows
- ✓ Standard containers
- ✓ Technology and Infrastructure facilitating transhipments across several modes of transport

Combined investments

- ✓ Openly shared facilities, e.g. PI-hubs
- ✓ Overall improved logistics infrastructure ... PI or no PI, we need improved ports, roads, etc.
- ✓ Configurable hubs (plug&play) and associated PI-containers.
- ✓ Establishing standards between countries
- ✓ IT infrastructure that shows capacity available in resources and congestion in infrastructure (road, rail and inland waterways)
- ✓ IT infrastructure (servers)
- ✓ Wireless connectivity will require massive investment in private and public spaces so that smart containers, devices, and vehicles can communicate.
- ✓ Efficient and freight enabled public transportation systems in cities
- ✓ PI needs support from an IT perspective. In terms of Physical infrastructure we should benefit for the current infrastructure that we have.
- ✓ From my point of view, it seems that the standardized containers may be the first pre-requisite for a new PI infrastructure.

European Commission

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- ✓ More sensing technologies to use the IoT concepts
- ✓ Ports
- ✓ Modular π container
- ✓ Autonomous lanes
- ✓ An initial central governance base that is sustainable in annual support by contributions from industry and government
- ✓ Redesigned road systems.
- ✓ Urban consolidation hubs....this may be relatively small investments actually
- ✓ Technology
- ✓ Standard handling/movement/storage infrastructure for PI containers
- ✓ Data structure
- ✓ Energy
- ✓ "Transportation modes as well. Consider how LTL carriers might evolve equipment design to manage a new type of conveyance. In the United States, dual side trailer loading/unloading for example. Needs public private partnership to drive investment and awareness. Regulatory policy will be a hurdle."
- ✓ shared hubs
- ✓ Pick a test route with initial subsidized investment of hubs and supporting information system, used by a collection of major partners
- ✓ Transportation infrastructure

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