Towards a Shared European Logistics Intelligent Information Space

VISIBILITY AND CORRECTIVE AND PREVENTIVE ACTIONS (CAPA)
European Green Logistics Strategy nº3

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Executive Summary

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Glossary of terms and abbreviations used

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1 Introduction

The EU relies heavily on the ease and reliability of international trade for its economic development. Nevertheless, in addition to logistics challenges which affect today’s transport processes, they are exposed to security and safety threats that come with this trade. Illicit international trade also undermines economic and social welfare in the EU. Consequently, risk management of the movement of goods through the international supply chain is critical for logistics operations, security and safety and essential to facilitating legitimate trade and protecting the financial and economic interest of the EU and its Member States [European Commission. 2013]. Visibility of transport processes, which is strongly correlated with a Digital Transformation of the Supply Chain, is an important pre-requisite for effective risk assessment and management and builds the basis for Corrective and Preventive Actions (CAPA) which aim at identifying problems and bottlenecks which affect goods transport and initiating related countermeasures in order to optimize the situation. “Systematic, real-time sharing or pooling of information, knowledge and expertise is essential to ensure that common equivalent minimum standards apply and that important information affecting supply chain risk is available to those who need it. Conversely, any significant weaknesses in information-sharing undermine the effectiveness of risk management at different entry points and for the EU as a whole.” [European Commission. 2013].

| Supply chain visibility and CAPA capabilities allow for agile operation planning and monitoring. |
| Visibility: right information at the right place at the right time. Enabling access to up-to-date, correct supply-chain related information when needed, to whom needs it. Supply chain visibility enable actors to plan, track and monitor activity and take informed-decisions. |
| Corrective actions and preventive actions: as a complement to visibility, proactive-event handling and deviation management provide the ability to maintain or surpass the targeted performance level. CAPA can both increase visibility and minimize the negative consequences of lack of visibility. |

The purpose of this White Paper is to present background and current status concerning the topics of visibility and CAPA, existing research gaps and resulting research questions.

1.1 Problem formulation and motivation

Visibility is a well recognized challenge in transport and logistics. Visibility – access to information, timeliness of information, correctness of information – is at the same time a factor of competitiveness and of risk, the main challenge being the lack of visibility as a hinder to supply chain agility and transport and logistics performance.

Visibility is a prerequisite for transport planning, execution and monitoring.

- During transport planning, capacity planning, allocation of cargo to transport capacity, route planning, transport optimization etc., is highly dependent on timely, up-to-date, accurate information.
- During transport execution, correct and timely information is crucial with regards to conditions of infrastructure, traffic, availability, in transit status and/or tracking and tracing of cargo (shipment and consignment levels), equipment or transport means.
- Monitoring (and re-planning) is highly dependent on visibility: detection and signalisation of anomalies and deviations from plan, ability to foreseen deviations (probability of occurrence, early detection, ..), and ability to evaluate and select corrective actions (re-schedule, switch to another resource / asset / service) , as well as tool for increasing predictability of events and tools for

The main challenge related to visibility gaps is the monitoring and detection of relevant changes during the process flow. Furthermore, lack of visibility and foresight is a bottleneck to transport planning and monitoring, and often the cause of expensive and time-consuming corrective processes.
The motivation for EGLS3 is to offer capabilities, strategies and tools for achieving agility and resilience in the supply chain, and more specifically in transport and logistics processes.

EGLS3 is defined in WP2 as a strategic capability using supply chain visibility to take appropriate responsive or pro-active action in transport systems.

The strategic relevance of higher visibility is its multiple impact on operation efficiency, supply chain performance, and that it enables other innovative strategies like risk and sharing collaboration (EGLS2), collaborative planning and synchromodality (EGLS1)

- Impact on operation efficiency: visibility enables efficient planning and monitoring operations, avoiding time-consuming search for information, providing more reliable information to the correct recipients
- Impact on performance: visibility and CAPA strategies enable improved resilience, based on dynamic replanning, event management, ability to foresee/anticipate unwelcome events

1.2 Research questions

- How to quantify the effect of lack of visibility? For individual actors; across the supply chain.
- How to achieve higher visibility?
  - Business collaboration,
  - Improved planning (strategic, tactical, operational),
  - ICT for supply-chain, transport and logistics
- Strategies to overcome the lack of visibility and / or to better exploit higher visibility
  - Corrective actions: post handling of deviations; real-time replanning of transport
  - Preventive actions: anticipation of undesired event, deviation from plan
- Strategies for switching from corrective actions (passive) to preventive actions (active)?
- How to ensure a correct match between technical solutions and existing/future business models
  - How to combine visibility across organization boundaries (owners /users of information) and across systems (integration)
  - Visibility vs. confidentiality
  - Incentives to information sharing

1.3 Foreseen innovations

- ICT for improved visibility (ALICE (2014) road map Information Systems for Interconnected Logistics)
  - overoming data-sharing barriers in collaborative networks
  - data correctness, timeliness
  - Internet of service, internet of things
- Data analytics to support for improved resilience and agility in transport and logistics (effective exploitation of visibility)
  - Risk management
  - Event detection, anticipation (effective/efficient monitoring)
- Dynamic capabilities, (re)dynamic planning
  - CAPA strategies to overcome the lack of visibility
- New business models
  - Based on information sharing; information as a service
- Improving environmental performance

While other strategies aim at achieving environmental efficiency (optimizing on cost, time, emissions per tkm), such as EGLS1&2, the EGLS "visibility and CAPA" can provide a tool for environmental
performance management. This by defining preventive and corrective actions to reduce the environmental impact of supply chain (at cargo, shipment, transport asset level?).

- Anticipation of environmental impact (CO2 emission): combining real-time information and historical data to estimate the real emission per tonnkm of own shipment under planning
- Corrective actions: Identify possible changes in transport plan
- Populate emission database for improving planning (and preventive actions)

### 1.4 Business relevance

Within transport and logistics (scope for EGLS3) visibility has multiple facets and goes hand-in-hand with corrective and preventive actions.

Taking a stakeholder perspective, visibility varies in terms of who needs visibility and about what. A transport service client needs visibility about transport capacity to plan shipment and about shipment under delivery, while a transport service provider needs visibility of demand for planning transport capacity and schedules, and about own transport resources for enabling best possible match asset-cargo.

The overall benefits of higher visibility and CAPA capabilities can be summarised as:

- improved transport & logistics service delivery
- Higher efficiency of transport & logistics operations
- Higher security in transport & logistics operations

The level of visibility required can vary from simple information (shipment tracking) to advanced analytics to anticipate an event (e.g. delay, incident..).

An important aspect of EGLS3 is to manage different expectations and needs in terms of visibility and CAPA without overcomplicating / overestimating the supporting solutions.

### 1.5 Overview of the paper

This document is structured in the following way: a brief review of literature on topics of visibility, risk management and ICT solutions for supply-chain, transport and logistics is given in chapter 2, followed by a summary of previous EU funded R&D projects, and a section of the state of practice, based on knowledge and experience from SELIS and previous research activity. In chapter 3, a summary of the research gap is provided based on the learnings from chap 2, as well as a list of suggested technical and managerial solutions required (chap 3.4). Chap 4 briefly positions EGLS3 with regards to other EGLS and provide a first list of required functionalities.
2 Existing body of knowledge

2.1 (Academic) literature

Visibility and CAPA is a very vast topic, which can be approached from distinct perspectives: visibility and information access/sharing, risk management (resilience), planning, monitoring etc.

Visibility – Definition & scope

In the context of this white paper on EGLS3, the following definition from literature can be retained: "Visibility means that important information is readily available to those who need it, inside and outside the organisation, for monitoring, controlling, and changing SC strategy and operations, from service acquisitions to delivery" (Schoenthaler, 2003, in Caridi et al., 2014)

Based on a review of several definitions of supply chain visibility, Caridi et al. (2014) pointed out that "the concept goes beyond simple access to certain information flows related to SC process, [but also encompasses] the properties of the shared information". Typical information flows include Transactions/events, Status information, Master data, Operational plans (Caridi et al., 2010).

Visibility = challenge

Supply chain executives still rank visibility as their greatest management challenge. 70% of Supply Chain Leaders report visibility impacts their supply chains to a significant or very significant extent (IBM, 2010). Nevertheless, the progress of digitizing the supply chain and implementing visibility solutions has been slow so far. 33% of respondents of a survey conducted by Capgemini Consulting (2016) said they are “dissatisfied” with the current progress. Key technology enablers such as Supply Chain Visibility Platforms/Tools (94%), Big Data Analytics (90%), Simulation Tools (81%) and Cloud (80%), which are seen as the biggest technology enablers of Digital Supply Chain Transformation, have been identified, but are not widely used yet. In fact, 48% of respondents admit that right now “traditional” methods such as phone, fax, email are still the dominant ways to interact with supply chain partners, who are lacking the necessary awareness, or the required skills. In more digitized cases, more information is available, but according to IBM (2010) proportionally less is being effectively captured, managed, analyzed and made available to people who need it. As a consequence, supply chain executives are flooded with more information than ever, but effective algorithms which are suitable to derive relevant information are lacking, and the majority of those who have tried to improve external visibility describe their efforts as largely ineffective, making external visibility projects the least effective of all initiatives executives are undertaking (IBM, 2010).

With increasing global trade and growing emphasis on security, enhanced information sharing between actors in global supply chains is required. Currently, the data about cargo transport available in the supply chain does not even provide a timely and accurate description of the goods (Klievink et al., 2012).

Managing visibility

Benefit of supply chain visibility has been studied by several authors. Caridi et al. (2014) established a model for assessment of the benefits of visibility in complex supply chains, based on five main performance parameters that affected by visibility: cost, quality, service level, flexibility, time. Although this paper focuses on visibility in the supply chain, the model described should be applicable for the transport and logistics domain as well.

Another quantitative model for Supply Chain Visibility is proposed by Lee & Rim (2016). The model uses Z score in Six Sigma methodology and serves to evaluate the visibility level of the overall supply chain. The proposed methodology can “facilitate assessing and comparing suppliers, customers, and competitors”.

Achieving higher visibility:
"Although SC visibility is garnering an increasing amount of attention in the relevant literature, it still remains an underexplored facet of SCM" (Lee et al. 2014, referring to Kim et al., 2011).

One of the main challenge is that of collaboration and sharing. While it is recognised that close cooperation among supply chain partners can enhance the performance of an entire supply chain (Lee et al. 2014), sharing information always implies a risk for the company and which is why "firms are cautious about releasing their internal information to others and therefore it is difficult to see a fully collaborative end-to-end SC in current practice (Bowersox, Closs, & Cooper, 2010)" (Lee et al. 2014: 292). Lee et al. 2014 studied interorganizational information sharing (IOS), concluding that IOS visibility leads to higher SC performance and that "firms should approach IOS visibility in a positive way to maximize the returns from IOS, while enforcing appropriate mechanisms to control a partner's potential opportunistic behavior. SC partners can use two different types of control mechanisms to protect against opportunism. They include informal safeguards such as interorganizational trust and formal safeguards such as joint governance structures" (Lee et al. 2014: 292).

**Risk Management**

Risk management, both related to logistics/operations as well as safety/security aspects, is a continuous process that requires identifying and assessing threats and risk and initiating appropriate counter-measures in case a risk is considered relevant. It is time-constrained and characterised by the need for knowledge of logistics and supply chains and the management and integration of multiple information and intelligence flows (European Commission, 2013). According to Simchi-Levi (2013), Companies with mature supply chain and risk management processes are more resilient to disruptions than those with immature processes, and companies with mature capabilities in supply chain management and risk management in general do better along operational and financial performance than immature companies. One reason for this is the fact that supply chain disruptions have a significant impact on company business and financial performance. To make full use of risk assessment methods, it is of course required to know ‘who is moving what, to whom, from where’. Data on the real parties behind the transaction and the movement of goods (buyer and seller or owner), and on the precise goods involved, is essential as is information on the routing of the goods throughout the supply chain (European Commission, 2013). The combination of supply chain visibility tools, big data analytics, and cloud provides a strong foundation for digital transformation of the supply chain, which 75% of respondents of a survey conducted in Capgemini Consulting (2016) consider “important or very important”.

**Corrective & Preventive**

As pointed out by Lee & Rim 2016, most studies of visibility have focused on information sharing and accuracy using information technology. They further raise the importance of approaches for not only improving visibility, but for capabilities to handle lack of visibility. "a reactive approach that focuses on information visibility is very important, but a proactive approach to improve process capability through process improvements and restructuring is also very important. [...]In order to acquire operational excellence, both reactive and proactive approaches are very effective" (Lee & Rim 2016: 10).

Cancellations, speculative bookings and no-shows are not only characteristics of passenger behaviour in airline industry (McGill et al., 1999), but also serious sources of uncertainty in short sea shipping and feeder shipping. To handle these and ensure higher capacity utilization, strategies like stand-by cargo, overbooking, booking rescheduling, price differentiation, and cargo prospect are suggested (Styhre, 2010, 2013). Based on root-causes and consequence analysis of the late cancellations problem (dummy booking, late information), business requirements towards a Future Internet based concept for handling of late cancellations have been identified in a previous project (Finest). These including functionalities such as open reservation of capacity, booking flexibility, alternative price models, early warning of cancellation, proactive event-handling and anticipation of cancellations, rapid replacement of cancellations (Riallant and Hagaseth, 2014).
**ICT for Transport & logistics**

According to IBM (2010), future supply chains will increasingly be equipped with sensor-based solutions to reduce inventory costs with increased visibility. Supply chain information that was previously created by people will increasingly be generated by sensors, RFID tags, meters, actuators, GPS and other devices and systems. In terms of visibility, supply chains not only will be able to “see” more events, but also react accordingly as they occur. In fact, Event Management is the backbone of a visibility solution, as it allows the monitoring of activities in the supply chain. However monitoring is just the start; reporting and handling are more advanced Event Management functions (Capgemini Consulting, 2012). In parallel to an increased digitization of the supply chain, objects — not people — must do more of the reporting and sharing of information. Critical data will come from trucks, docks, store shelves, and parts and products moving through the supply chain. This visibility won’t just be used for better planning — it will be fundamental to realtime execution. Smarter supply chains will track external factors such as soil conditions and rainfall to optimize irrigation, monitor traffic status to alter delivery routes or shipping methods, and follow financial markets and economic indicators to predict shifts in labor, energy and consumer buying. To make sense of available data, smarter supply chains will use sophisticated algorithms like intelligent modeling, analytic and simulation capabilities (IBM, 2010).

Talking about transported goods themselves, data should be captured upstream at the point where goods are packed for transport to the buyer in order to ensure the availability of high-quality information suitable for all necessary purposes like risk analysis and quality assurance. This will be guaranteed by innovative methodologies like the data pipeline concept, which is an IT innovation to enable capturing data at its origin by accessing existing information systems used by the parties in international supply chains. To achieve this goal, the implementation of a public-private governance model that has to accompany the technical innovation is of vital importance (Klievink et al., 2012).

This process can be supported by the implementation of Single Window systems which are suitable to harmonize logistics processes and thus to facilitate trade in general. Respective implementations need to take into account compatible standards regarding formal descriptions of logistics processes, interfaces and information content. It is important to further proceed in obtaining a distinct and unified framework and methodology for developing Single Window systems, which will crucially support a smooth and manageable integration of heterogeneous systems into a Single Window environment (Fjortoft et al., 2011).

When Capgemini asked to identify the different trends in the Supply Chain Visibility software market, collaboration beyond the silos of a single firm and with other supply chain members was often mentioned. Apparently, companies “seek to orchestrate their supply chain across functional and organizational boundaries”. Another important trend is the increase in demand for SaaS-solutions, allowing companies “to plug into (Cloud) visibility solutions at lower costs due to more effective and flexible pricing models”. Another important topic is increased collaboration and willingness to share data among supply chain partners, motivated by increased competitive pressure (Capgemini Consulting, 2012).

**Visibility services:**

From The Digital Transport and Logistics Forum (DTLF)\(^1\), the following is said about visibility services that Logistics Information systems must offer to support logistics processes:

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1 The European Commission launched on 1st July 2015 the Digital Transport and Logistics Forum (DTLF). The Forum will work for three years and aims at the further digitalisation of freight transport and logistics. It brings together Member States and stakeholders from transport and logistics communities in order to identify areas where common action in the EU is needed, to provide recommendations and solutions, and to work on their implementation, where appropriate. The DTLF envisages in particular addressing the following topics:

- Definition and acceptance of e-transport documents
- Optimisation of cargo flows through better use and exchange of data
- Languages / standards for seamless data exchange

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Visibility Services: The state of supply and logistics chains is shared via events containing milestones. By combining events from different sources or by applying rules by matching event data with already known information, new events might be generated (e.g. ‘too late’). ETA prediction might also be part of those events.

Logistics Platforms focusing on Booking and visibility: These platforms provide capabilities of booking transport for particular legs (e.g. sea transport), particular type of cargo (e.g. TEUB Booker for container booking to the hinterland), and provide visibility of individual bookings. Note that for instance Uber4Freight will probably also provide this type of functionality.

Logistics Platforms focusing on Visibility: These platforms only provide visibility services for particular shipments or objects like a container, barge, or a railway wagon. An example is Rail Net Europe (RNE) providing train visibility services based on input provided by national rail infrastructure managers. MarineTraffic provides a similar service for vessel tracking. Other examples are Transics and Astrata providing visibility for trucks to their owners based on On Board Units. Maersk develops the so-called Shipping Information Pipeline (SIP) providing Visibility Service, not only based on a transaction between two enterprises but also supporting visibility based on an authorization token to third parties.

2.2 Previous projects

Many previous projects addressed the topic of collaboration in supply chains in general, e.g. by increasing efficiency and sustainability in logistics by developing interconnected trusted collaborative networks along the entire supply chain and developing, professionalizing and disseminating information on the business strategy of logistics collaboration in Europe. By developing respective business models, models and capabilities for cooperation and communication between logistics stakeholders were provided. Efforts were taken to develop hardware and data management systems for data sharing, data analytics and asset tracking and to establish cloud-based collaborative logistics ecosystems for configuring and managing (logistics-related) information pipelines. In that way, through collaboration between industry partners, co-modality should be stimulated and co-modal networks should be made attractive to use. Special emphasis was put to raise the position of SMEs and get them with affordable, reliable and trusted IT solutions so to enable them to take part in international trade and commerce flows.

Projects related to visibility

A considerable number of projects was conducted to develop procedures and technologies allowing for supply chain visibility, security and predictability. Projects aimed at creating tools and methods that can be applied to increase container transportation security through integration of container security data in a common information distribution and sharing environment. By enhanced supply chain visibility, business operations as well as government’s cross-border security inspections should be improved, resulting in a higher hit rate and greater effectiveness of security related government inspections. One way to achieve this goal is to employ innovative IT technology solutions like RFID (Radio Frequency Identification) for container and seal identification.

Other projects aimed at developing common Future Internet software components, such as transport planning, open electronic market-places, shipment tracking, and proactive event handling, together with innovative cloud software solutions for effective and inexpensive deployment and management of Internet of Things (IoT) asset tracking systems exploiting live and actionable Big Data analytics.

Social aspects of digitalisation and education and training requirements
In the rail freight sector, efforts were taken to improve the freight rail services offered to shippers, focusing on five key topics: reliability, lead time, costs, flexibility and visibility. Furthermore, innovative and practical solutions for a sustainable wagonload transport were developed, e.g. by smart wagon telematics facilitating improved cargo tracking at reduced costs.

In addition, efforts were taken in awareness raising, capacity building and promotion activities for fostering business development of EGNSS based applications worldwide, convincing public stakeholders and other actors of the transportation industry about the benefits they could derive from implementing such innovative solutions. One project aimed to overcome shortcomings of GPS based systems for the freight and logistics sector in specific situations (limited spatial accuracy and availability in difficult environments, lacking integrity information).

Projects related to CAPA

With regard to corrective and preventive actions, projects supported the inter-company business interaction and collaboration alongside the transport logistics chain, e.g. by cloud-based services, and to foster secured and non-biased critical information exchange among logistics actors of the global logistic chains including Customs authorities. This is an important pre-requisite in order to generate situational awareness along global supply chains in support of enhanced logistics services. Furthermore, projects aimed to discover gaps and practical problems in this process and to develop capabilities and solutions that could deliver sizable and sustainable progress in this field. Special emphasis was put on mitigation of the impact of natural disasters and extreme weather phenomena on transport system performance, for example by implementing a systematic risk management framework that explicitly considers the impacts of extreme weather events on the EU transport system and developing a series of respective mitigation tools. In the field of road transport, efforts were taken to provide better and more detailed information about road and weather conditions in order to improve road safety and road transport efficiency.

When it comes to corrective and preventive actions related to shipment delivery and transport operations, several projects (Finest, FIspace) have worked on developing concepts for cloud-based services (platform, Apps) for supporting proactive event-handling, offering autonomous detection of deviation from plan (shipment status, cargo condition), search for alternative solutions (transport plan update; re-routing), and anticipation of deviations based on improved data analytics.

2.3 State of the practice

SELIS Living Labs (D7.1) (see Annex 2) to a large extent confirm that common challenges related to visibility are still very current. Visibility continues to be a weakness in transport and logistics operations. Lack of visibility is the biggest hinder to effective planning and monitoring of transport, including tracking to shipment and transport assets. From a business perspective, main requirements are still towards tools for higher visibility and business intelligence.

In practice, there are three main obstacles to achieve visibility⁡:

- Organisational: it is difficult to address the responsibility for visibility since it transcends different organisational functions and regional boundaries that all benefit from improved visibility.
- Technology: Visibility systems have to gather information from multiple internal and external systems; that requires many interfaces to other systems. However, web services, B2B hubs, and transportation carrier portals are now making interfaces more manageable.
- Managing visibility information: how to drive strategic business improvement from visibility information. Additional technology and organizational capabilities are needed to achieve this.

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⁡ Source: © SELIS, 2016
Companies need a system which can monitor the events in the entire supply chain and that provides reports to all stakeholders involved.

Another issue in achieving supply chain visibility is related to the strategic importance of information. A major dilemma for companies is to decide to share information or not to.

As expressed through Living Labs (LL6), it is of vital importance to develop and implement visibility solutions which provide a reasonable level of visibility to the end customer. Customers need to be provided with fast and reliable information especially in case of deviations of the transport process from the planned schedule in a pro-active way. Currently, it is often the case that common incidents like deviation of a vessel or re-scheduling of a container on another vessel causing the container to arrive late in the port of destination are not communicated or announced too late, such that the customer is not able to adopt his planning to the changed circumstances.

Also for planning of transport and logistics operations, visibility and capabilities for corrective and preventive actions are still missing. For better decisions, optimization of transport and higher resource utilization, services supporting match-making between transport capacity and cargo, benchmarking of services, combination of multimodal resources etc. are far from been widely implemented in practice.

Efficient match-making is about both increased transport capacity utilization and quick coupling between offer and demand of transport service. In today’s practice, this match-making is still time-consuming and costly, especially with regards to sea freight transport. In the transport sector, a number of examples of online matchmaking services like load-boards for matching trucks with cargo can be identified. In the sea-transport sector, several platform for publication of schedules and even transport needs are available (searates.com, bigschedules.com, shortseaschedules.com, velgsoveien.no, timocom.com, cargospace24.com og aferryfreight.com). Quite some research has been published about electronic logistics marketplaces (Nedelea, B. 2010; IMRC, 2008; Keifer, 2009; Noia et al., 2004), as well as models for match-making between offer and demand. These studies show a high potential for lower transaction costs, better capacity utilization and better planning (based on better benchmarking of services) thanks to such e-marketplaces (Nedelea, B. 2010; Wang et al., 2008). Still, no such model directly applicable for sea freight transport at cargo unit level can be identified, or which is commonly use in European shortsea shipping sector.
3 Research gap

3.1 What is the scope of the research?

Research activities focus business collaboration issues by investigating business strategies for logistics collaboration, e.g. by developing interconnected trusted collaborative networks along the entire supply chain. Furthermore, technical concepts for visibility, collaboration and data exchange are developed. Innovative logistics principles like co-modality and approaches towards the Internet of Things are developed and validated in real-life scenarios.

3.2 What academic research is required?

Academic research is necessary to clarify and structure the concept of visibility in the transport and logistics domain and to develop models and methodologies to support the establishment of corrective and preventive actions. The following research questions are suggested.

- How to quantify the effect of lack of visibility? For individual actors; across the supply chain.
- How to achieve higher visibility?
  - Business collaboration,
  - improved planning (strategic, tactical, operational),
  - ICT for supply-chain, transport and logistics
- Strategies to overcome the lack of visibility and / or to better exploit higher visibility
  - Corrective actions: post handling of deviations; real-time replanning of transport
  - Preventive actions: anticipation of undesired event, deviation from plan
- Strategies for switching from corrective actions (passive) to preventive actions (active)?
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  - Visibility vs. confidentiality
  - Incentives to information sharing

The core of research and most innovative aspect is the development of algorithms for achieving a higher level of proactivity (data analytics; event prevention; event anticipation, dynamic replanning etc.).

3.3 What applied research is required?

Applied research on visibility and CAPA as described in this white paper should take into consideration the diversity among actors of the transport and logistics sector. Needs and requirements with regards to visibility vary among actors, and so do their existing capabilities and resources in terms of tools and strategies for managing visibility and monitoring operations. This diversity makes it difficult to build one unique solution, IT or strategic approach, suiting all stakeholders. Applied research should focus on specific use case scenarios in order to uncover that diversity as well as to test the utility of solutions to be developed, in distinct contexts.

3.4 What solutions need to be developed?

The suggested solutions to be further explored are divided into (1) solutions for achieving higher visibility, and (2) CAPA strategies either exploiting higher visibility or overcoming the lack of visibility.
Achieving Visibility

- **Visibility as a service**: full shipment visibility from transport/logistics service provider to transport service client. SLA including visibility; incentives, contracts etc.
- **System integration** – information sharing (transport operators, terminals, cargo owners etc.), vertical collaboration (across supply chain)
- **Horizontal collaboration** – horizontal collaboration for access to information (more transparency about capacity availability, prices, transport demand) (e.g. Xeneta)

**CAPA strategies (exploiting higher visibility or overcoming lack of visibility)**

- **Shipment / cargo – monitoring, agile supply chain**
  - Corrective actions - deviation detection, handling, replanning
  - Adjustment - In-transit planning; re-routing...: follow new customer order, cargo status (condition, location), shipment status or transport capacity update, and re-plan / re-route.
  - Preventive action / risk management - From correction to prevention
  - (Transport planning: route optimization, multimodality etc. => link to EGLS 1)

**Perspective: transport service client**

![Figure 1: Bow-tie diagram illustrating corrective (reactive) and preventive (pro-active) actions wrt shipment monitoring](image)

- **Transport capacity utilization**
  - Match-making – optimization of allocation of cargo to transport capacity (linked to EGLS6??)
  - Optimal service configuration, resource management - adapt transport capacity to demand fluctuation (long-term; short-term; real-time – i.e. propose to reconfigure transport plan to optimize resource allocation and transport offering)
  - Incl. collaboration biz model for best resource utilization – active use of collaboration (achieve higher service level; higher resource utilization…) (linked to EGLS 2)
  - Reduce risk of reduction in capacity utilization:
    - Corrective action: replacement of cancellations,
- Preventive: anticipate cancellation, overbooking, pricing ..... 
  - Transport reliability service – (offering alternative services; plan B)
  - Transport monitoring: proactive event handling – based on data analytics (anticipation of deviation from plan)
  - Flexible transport service (dynamic services, resource allocation): improve service flexibility – wider ETA/ETD window, service for optimizing CO2 emissions...

Figure 2: Bow-tie diagram illustrating corrective (reactive) and preventive (pro-active) actions wrt transport capacity management
4 Framework

4.1 Helps position the research questions

4.2 Helps position the foreseen innovation

In brief, the foreseen innovation lies in the visibility and dynamic capabilities which can be offered by improved ICT and internet based technologies which can in turn contribute to improved business performance for both transport services providers and transport service clients, resulting in overall improvement at supply chain level.

The following diagram summarise the impact elements of visibility and CAPA on overall supply chain performance.

Innovation is necessary at two level:

1. Information visibility: Improved information quality, access, sharing (layer "system capabilities" in the figure above)
2. Strategic and operational visibility: dynamic capabilities based on adequate corrective and preventive strategies. (layer "process improvement" in the figure above)
4.3 Maps out EGLS + required platform functionality; what kind of functionalities are we going to require from the system

The strategic relevance of higher visibility is its multiple impact on operation efficiency, supply chain performance, and that it enables other innovative strategies like risk and sharing collaboration (EGLS2), collaborative planning and synchronomodality (EGLS1). Therefore it is important to consider EGLS 3 together with and as an enabler of EGLS 1 and 2.

Figure 3: interdependencies EGLS 1, 2, 3, 6 (figure adapted from EGLS1)

Required platform functionalities (in line with WP5)

- Track and trace
  Info cargo/shipment condition, current position, progress so far, and planned route.
  - Milestone Visibility
  - Visibility to customer
  track code + alerts in case od deviation.
- Resource filtering

For targeted search

- Interactive digital map
- Customized dashboard
- ETA calculation

Based on the initial Estimation Time of Arrival and different conditions that might occur along the route

- Monitoring Engine
on-predefined intervals checks for "anticipated" events, recalculates ETAs and if not complete (according to plan), creates an event trigger.

- **Rule Engine & Information Sources Integration**
  Dynamic combination of multiple events from different external sources or applications, and triggering multiple possible actions. Transportation optimization and planning based on up-to-the-minute information, and re-planning as information changes as part of a proactive event-handling functionality.

- **KPIs and Graphical Analytics**
  Integrated supply chain management KPIs Dashboard and analytics for cost and time optimisation.

- **Forecasting**
  Using of current and historical data to inform future transportation planning.

- **Delay Alerts**
  Of shipment, of schedule, of assept, of at transhipment point.

### 4.4 Connect the functionalities with the research needs
5 Bibliography


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Annex I: Previous projects with relevant topics

AEOLIX (Architecture for EurOpean Logistics Information eXchange)
Supply chain visibility supported by easy access to, and exchange and use of relevant and abundant logistics-related information is an important prerequisite for the deployment of pan-European logistics solutions that are needed to increase efficiency and productivity, and to reduce environmental impact. Although there is a proliferative development of logistics-related data stores, information channels, information management systems and data mining facilities, with both international and intermodal focus, this multitude of solutions exhibits a high degree of fragmentation, due to differences in user requirements, data models, system specification and business models. This legacy situation severely hampers the optimal use of logistics-related information. To overcome this fragmentation and lack of connectivity of ICT-based information systems for logistics decision making, AEOLIX will establish a cloud-based collaborative logistics ecosystem for configuring and managing (logistics-related) information pipelines.

http://cordis.europa.eu/project/rcn/204772_en.html

ASAP

CAPER

CASSANDRA (Common assessment and analysis of risk in global supply chains)
CASSANDRA addresses the supply chain visibility needs of both business and government in the international flow of containerized cargo. The main strategic goal is to enhance supply chain visibility to improve business operations as well as government’s cross-border security inspections. CASSANDRA helps customs to assess business processes and procedures and identify secure supply chains. By minimizing the attention given to these secure flows and businesses, government agencies can focus on high-risk flows resulting in a higher hit rate and greater effectiveness of security related government inspections. To provide supply chain actors and government authorities with these accurate data, the project develops a data-sharing concept: the Data Pipeline.

CELAR

CHINOS (Container Handling in Intermodal Nodes - Optimal and Secure!)
CHINOS supports container terminal and transport operators to exploit challenges like increasing cargo volumes and security demands, the related changes in business processes and the opportunities for process automation in the best possible way by employing innovative IT technology solutions like RFID (Radio Frequency Identification) for container and seal identification and automatic damage documentation. CHINOS will put a special focus on the integration of these new technologies into the terminals’ business processes and the demonstration of its success at several European locations.

COGNIMUSE

CONTAIN (Container Security Advanced Information Networking)
CONtainer securIty Advanced Information Networking (CONTAIN) is an EU funded project creating tools and methods that can be applied to increase container transportation security through integration of container security data in a common information distribution and sharing environment. The project has resulted in a comprehensive toolset, interlinked by the CONTAIN software platform, involving both physical devices and risk analysis software.

COMCIS (Collaborative Information Services for Container Management)

COMCIS is a collaborative project between multiple transport and logistics actors that generates situational awareness along global supply chains in support of enhanced logistics services. The vision of COMCIS is to deliver a proof of concept of how individual existing e-Freight solutions resulting from previous EU projects (and commercial developments) can be integrated as a set of collaborative information services that is feasible (technically and economically) for commercial deployment. Using data drawn from the entire supply chain, COMCIS provides accurate, comprehensive logistics information.

CORE (Consistently Optimised Resilient Secure Global Supply-Chains)

CORE will consolidate, amplify, extend and demonstrate EU knowledge and capabilities and international co-operation for securing supply chains whilst maintaining or improving business performance, with specific reference to key Supply Chain Corridors. CORE will consolidate solutions developed in Reference Projects in each supply chain sector (port, container, air, post). Implementation-driven R&D will be then undertaken designed to discover gaps and practical problems and to develop capabilities and solutions that could deliver sizable and sustainable progress in supply chain security across all EU Member States and on a global scale.

CO3 (Collaboration Concepts for Comodality)

The EU-funded project CO3 aims to develop, professionalise and disseminate information on the business strategy of logistics collaboration in Europe. The goal of the project is to deliver a concrete contribution to increasing load factors, reducing empty movements and stimulate comodality, through collaboration between industry partners, thereby reducing transport externalities such as greenhouse gas emissions and costs. Furthermore, the project consortium of knowledge institutes and industry partners are coming up with joint business models for logistics collaboration.

http://cordis.europa.eu/result/rcn/163400_en.html

CO-GISTICS (Deployment of cooperative intelligent transport systems (C-ITS) applied to logistics)

CROW (Condition of Road and Weather Monitoring System)

The project focuses on the improvement of road safety and road transport efficiency by providing better and more detailed information about road and weather conditions. A new prototype monitoring station is developed able to determine safety margins along the road using information about current and expected road and weather conditions. Account is taken of driver response to changing conditions and road configuration. The system can predict combined risks associated with hazards and an overview of changing weather conditions can be given from six hours in the past to two hours in advance. Prototype sensors are developed to determine visibility levels and road surface conditions, along with knowledge-based systems to predict fog and aquaplaning hazards.


DISCWISE (Digital Supply Chains for European SMEs based on the Freightwise Framework)

Easy-OBU (Enhanced (EGNOS/EDAS) Accuracy SYstem with GNSS Outage Bridging Unit)

GPS based systems have shortcomings for the freight and logistics sector in specific situations (limited spatial accuracy and availability in difficult environments, no information on integrity). What still has not been tackled is the position solution when visibility of GNSS satellites is limited (e.g. in urban canyons) or completely obstructed (e.g. in tunnels). However, not all GNSS applications need real-time availability of positional information. In many cases it is sufficient to have this information with a time lag of a couple of minutes. Easy-OBU steps in exactly here if the application can tolerate the position determination with a short delay for scenarios of GNSS outage, and applies an innovative filtering approach to cover blind spots and provides the necessary data for the accurate computation.
EasyWay/EiP (Harmonized deployment of ITS services on the Trans-European Road Network, including services for freight and logistics)

ECOHUBS (Environmentally COherent measures and interventions to debottleneck HUBS of the multimodal network favoured by seamless flow of goods)

ECOHUBS provides models and capabilities for cooperation and communication between green hubs’ stakeholders, plus establishing value added services making co-modal networks attractive to use and, at the same time, contributors to reduction in greenhouse gas emissions and other pollutants. Special attention will be given to building improved understanding of prevailing complexities and business interests and ensuring long term sustainability of project outputs and market take-up based on an inclusive Stakeholder Engagement Strategy emphasizing European wide co-operation both to promote best practices and to support further development and implementation of international standards.

http://cordis.europa.eu/project/rcn/105757_en.html

EFFICIENCY

EfficienSea

e-Freight (e-freight capabilities for co-modal transport)
e-Freight, a part EU funded project, has announced the implementation of an innovative co-modal transport optimisation (CTO) solution that can plan and schedule freight movements through Europe’s complex multi-modal transport networks.


EURIDICE (European inter-disciplinary research on intelligent cargo for efficient, safe and environment-friendly logistics)

EWENT (Extreme weather impacts on European networks of transport)
The goal of the EWENT project was to assess the impacts of extreme weather events on European Union (EU) transport system. These impacts were monetised. EWENT also evaluated the efficiency, applicability and finance needs for adaptation and mitigation measures which will dampen and reduce the costs of weather impacts. The methodological approach was based on generic risk management framework that follows a standardised process from identification of hazardous phenomena (extreme weather), followed by impact assessment and closed by mitigation and risk control measures.


Finest
The main results from the Finest project were proposed solutions for a wide range of transport and logistics businesses, centered around common Future Internet software components, such as transport planning, open electronic market-places, shipment tracking, proactive event handling. Concepts and technologies from Finest are further developed in the follow-up project FIspace, working on the creation of a Collaboration Platform and associated Applications. (MTEC Rialand, Tjora 2014)

FIspace
Cloud-based services like the Flspace platform and its applications provide a huge potential for improvement in business interaction and collaboration. First of all, operational costs can be strongly reduced, but also greater achievements can be realised by exploiting the capabilities offered by Flspace. Better visibility and transparency, more reliability and timeliness of information, automatic booking and more effective exchange of information, earlier warning of cancellations, better time to react, and efficient search for replacement cargo are among the expected contribution of the Flspace, leading to better operational planning and capacity utilization. (MTEC Rialland and Hagaseth 2014)

FREIGHTWISE (Management Framework for Intelligent Intermodal Transport)

iCargo (Intelligent Cargo in Efficient and Sustainable Global Logistics Operations)

INTEGRITY (Intermodal global door-to-door container supply chain visibility)

Main challenges facing today’s international intermodal door to door container transport system are logistics efficiency and security which may lead to contradictory business strategies. INTEGRITY will develop procedures and technologies allowing for supply chain visibility, security and predictability. INTEGRITY will validate targeted and verifiable benefits through real operational business and customs operations in door to door supply chains in the major trade corridor of China to the EU via the ports of Yantian, Rotterdam and Felixstowe, using all modes of transports within the EU to various destinations. INTEGRITY will raise the standard for door-to-door container chains by providing high quality and integrity information.

JUPITER (Joint EUropean Project for International ITS/EGNSS awareness Raising)

JUPITER aims at EGNSS awareness raising, capacity building and promotion activities for fostering business development of EGNSS based applications worldwide in response to the H2020 societal challenges at stake for mobility and transportation. In order to ensure that EGNSS comes to prominence in the ITS sector, the added value of EGNSS, compared to or in combination with GPS/Glonass/Beidou constellations should be clearly demonstrated and promoted. Once ITS service providers can demonstrate innovative EGNSS ITS applications, another key challenge is to convince public stakeholders and other actors of the transportation industry about the benefits they could derive from implementing such innovative solutions.

LOGICON (Lean Secure and Reliable Logistic Connectivity for SMEs)

The common objective of LogiCon project is to raise the position of SMEs and get them with affordable, reliable and trusted IT solutions so to enable them to take part in international trade and commerce flows. LogiCon aims at setting up, testing and facilitating the adoption of low-cost, low-barrier Data Connectivity Solutions. The LogiCon project is aimed at facilitating the development of efficient ICT solutions for logistics SMEs that will be capable of meeting current and future communication needs. Besides proposing a very basic ICT that can be affordable and easily adopted by SMEs, LogiCon proposes the new business models to make cooperation in co-modal supply chains commonplace in practice.

LowCostTracking (Low cost tracking and data management solution for biopharma cold chain logistics)

The Danish company Globe Tracker International (GT) is revolutionizing supply chain visibility and profitability as a leading provider of data sharing, data analytics and global asset tracking. GT has developed a fully functional hardware/data management system that is ready to be deployed globally and is currently being tested in commercial trials in the reefer market. For this project, GT has identified the the pharma product delivery market as a high value segment in which demand exists but where its solution needs adaptation to meet customer and regulatory requirements. The demand stems from the need for safe, secure and efficient distribution of pharma products in a strictly controlled and refrigerated environment in order to protect the integrity of the drugs.
MOBINET (The Internet of Transport and Mobility)

MOWE-IT (Management of weather events in transport system)
The goal of the MOWE-IT project was to identify existing best practices and to develop methodologies to assist transport operators, authorities and transport system users to mitigate the impact of natural disasters and extreme weather phenomena on transport system performance. The adaptation of logistics and freight transport to climate change, also referred to as “adaptive logistics”, considers how such systems can better respond to the impacts of climate change. To ensure information flow, ICT support (e.g. monitoring by satellites) and passenger services, ICT technologies and services for passenger and freight transport should be implemented.

http://cordis.europa.eu/project/rcn/208145_en.html

NEXTRUST (Building sustainable logistics through trusted collaborative networks across the entire supply chain)
NEXTRUST objective is to increase efficiency and sustainability in logistics by developing interconnected trusted collaborative networks along the entire supply chain. These trusted networks, built horizontally and vertically, will fully integrate shippers, LSPs and intermodal operators as equal partners. NEXTRUST will build these trusted networks ideally bottom up, with like-minded partners, adding multiple layers of transport flows that have been de-coupled and then re-connected more effectively along the supply chain. We will develop C-ITS cloud based smart visibility software to support the re-engineering of the networks, improving real-time utilization of transport assets.

PortDial

PROPS

PROXITRAK (Next generation IoT tracking solution for a connected logistics – collect, analyse and visualise big data in a true real time)
ProxiGroup delivers innovative cloud software solutions for effective and inexpensive deployment and management of Internet of Things (IoT) asset tracking systems exploiting live and actionable Big Data analytics. The problem we are addressing is limited visibility of assets throughout the enterprise and in the supply chain, which generates billions EUR lost every year in the EU. The emerging Internet of Things (IoT) concept is providing opportunity for efficient management of the company assets.

http://cordis.europa.eu/project/rcn/208145_en.html

RAIN (Risk Analysis of Infrastructure Networks in response to extreme weather)
The RAIN vision is to develop a systematic risk management framework that explicitly considers the impacts of extreme weather events on critical infrastructure and develops a series of mitigation tools to enhance the security of the pan-European infrastructure network. The outputs of RAIN will aid decision making in the long term, securing new robust infrastructure development and protection of existing infrastructure against changing climates and increasingly more unpredictable weather patterns. Transport, energy, and telecommunications infrastructure will all be considered, and risk mitigation strategies will be developed.

RISING (RIS services for improving the integration of inland waterway transports into intermodal chains)

SMART-CM (Smart container chain management)
SMART-CM aims to advance technology implementation and research in order for the global container door-to-door transport chains to become more efficient, secure and competitive. The work focuses on the development, demonstration and the after project robustness and operation of the 'SMART-CM platform' which will support secured and non-biased critical information exchange among actors of the global logistic chains (B2B) and between the logistics actors and the customs authorities (B2C) for achieving quick customs clearance of the containers and better chain visibility and control by the logistics actors.

http://cordis.europa.eu/project/rcn/90084_en.html

Smart-Rail (Smart Supply Chain Oriented Rail Freight Services)
Smart-Rail introduced a wide set of innovative measures aiming to improve the freight rail services offered to shippers, focusing on five key topics: reliability, lead time, costs, flexibility and visibility. The project contributed to a mental-shift of the rail sector toward a client oriented and supply chain focus and developed working business models for cooperation of different stakeholders. Furthermore, a methodology and architecture for exchange of data/information required for the optimisation process between stakeholders was developed, making use of existing initiatives where available (for instance the European Corridor Management and national logistical information centres).


ROLLING STOCK (Supply chain visibility by dynamic consolidation of ROLLING STOCK information)
The aim of the project is a web-based information platform (Rolling Stock Monitor), which supports the inter-company cooperation alongside the transport logistics chain. An existing web-based platform for stock control alongside a supply chain is used and will be customised and adapted to freight transport requirements. The platform will collect information from freight sending as well as receiving companies, from transport logistics service providers and from dedicated communication devices on vehicles. The Rolling Stock Monitor will enable in particular the receiving company to control the incoming flows across different logistics service providers.

http://cordis.europa.eu/project/rcn/61540_en.html

VIWAS (Viable wagonload production schemes)
A consortium of 10 European companies and research institutions, from the areas of rail transport and logistics, was formed, creating the project VIWAS. Researchers focused on presenting innovative and practical solutions for a sustainable wagonload transport. First, it improved last-mile operations integrating hybrid locomotives and bimodal shunting engines, ultimately resulting in reduced costs. Newly invented smart wagon telematics enable an improved cargo tracking at reduced costs.

http://cordis.europa.eu/result/rcn/188589_en.html
## Annex 2: summary table LL 1, 4, 6

<table>
<thead>
<tr>
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<th>LL1</th>
<th>LL4</th>
<th>LL6</th>
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<tbody>
<tr>
<td><strong>Business context</strong></td>
<td>DHL Iberia</td>
<td>Northern Germany Hinterland hub</td>
<td>DFDS logistics network – Vlaardingen/Gothenburg/Immingham routes</td>
</tr>
<tr>
<td><strong>Goal</strong></td>
<td>Consolidation of information and Business Intelligent Platform for visualisation, performance monitoring, decision-support through scenario simulation</td>
<td>Supply chain visibility and CAPA for hinterland hub</td>
<td>Integrated shipping and logistics network (collaboration)</td>
</tr>
</tbody>
</table>
| **Requirements, Problem description** | • Lack of data consolidation; integration of transport information  
  • Multi. non integrated systems  
  • Lack of visibility | • Lack of integration of information for planning collaboration between hinterland hub and sea terminal  
  • Perception of lack of reliability and monitoring capability in IWT | • Tracking customer shipment  
  • Tracking empty trailer movements  
  • Tracking trailer idle time |
| **Required tools** | • Business intelligent system (dashboard, support strategic decisions)  
  • Maps (routes)  
  • KPIs (analysis, benchmark)  
  • Simulation tool (choice criteria and algorithms; prediction models) | • Visibility platform (tracking, monitoring)  
  • CAPA dashboard (linked to capacity planning tool)  
  • Integration of sea terminal, ocean carrier data, vessel schedules and container availability  
  • Advanced capacity planning tool  
  • Environmental KPIs | • Planning and optimization tool  
  • Collaboration platform  
  • Customer portal (mylogistics)  
  • Business intelligence and analytics tool |